# MAURICE ILE DURABLE

**CONSULTATIVE WORKSHOPS**

**20 JUNE – 28 JULY 2011**

# Working Group 1

# Energy

**Final Report**

**15 August 2011**

# 1 PREAMBLE

In 2008, the Prime Minister, Dr. The Honourable Navinchandra Ramgoolam announced his vision of making Mauritius a Sustainable Island – "Maurice Ile Durable" (MID). The main objective of the Maurice Ile Durable concept is to make Mauritius a world model of sustainable development, particularly in the context of SIDS (Small Island Developing States). While the initial thrust was to minimize our dependency on fossil fuels through increased utilization of renewable energy and a more efficient use of energy in general, the concept soon widened to include all aspects of the economic model, society and the environment that are considered to be pivotal in the quest for a sustainable Mauritius.

The MID concept includes a participatory approach towards elaborating a strategy for sustainable development aiming to take on board the whole society in the implementation of this ambitious project. "The Maurice Ile Durable project belongs not to its conceptors or to Government but to the whole Mauritian nation. It is a social project and is essentially a vision that seeks to transform the environmental, economic and social landscape of the country" (Dr the Honourable Navinchandra Ramgoolam).

A wide National Consultation Process (NCP) was launched in February 2010 with the aim to come up with a Green Paper, elaborating embodying the needs and aspirations of Mauritian and to develop a Shared Vision on MID. The Green paper was submitted by Prof Odendaal in April 2011 and Cabinet has been apprised of the contents of the document.

The Government now intends to have a concrete MID Policy, a clear ten year MID Strategy and a detailed MID Action Plan to pave the way for the sustainable development of Mauritius. In order to achieve this objective, the Government has constituted six working groups to work out on the following themes, covering the 5Es of MID, namely Energy, Environment (two working groups), Education, Employment and Equity. Each Working Group held four one day workshops from mid June to the end of July 2011, with all concerned stakeholders from Ministries, parastatal bodies, public sector, local communities, civil society as well as other associations.

The objective of the Working Groups is to identify the means and ways of achieving the "National MID Vision" and come up with **concrete recommendations in each theme** which will feed in the process of formulation of the MID Policy, Strategy and Action Plan. The

working groups will use the Green Paper and other sectoral policies and strategies as base documents for discussion.

*"The VISION describes an end point to which we all aspire, and provides a beacon along the way. It is an expression of where we want to see our country heading, how we want to live in that country and to a large extent, the kind of people we want to be as a nation. The VISION hence was created through a dialogue between Government and civil society" (extracted from the Green Paper)*

*ACKNOWLEDGEMENTS*

The Animation Team of the Working Group on Energy wishes to thank all the members of the MID Consultative Working Group on Energy for their help and support during the workshops.

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The report of WG 1 is divided in two sections:

- Section 1 : Demand side
- Section 2 : supply side

Demand side includes 4 themes: Transport, Land use, Buildings and Industrial/Manufacturing processes. For each theme in Section 1, the recommendations are presented at the end of the respective chapter.

For section 2 - supply side, the recommendations are presented in Chapter 11.

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## *LIST OF ACRONYMS*

EGS – Export of goods and services

DSM – Demand Side Management

GDP - Gross Domestic Product

GHG – Green House Gases

IMFL – Imports of mineral fuel and lubricants

ISO – International Standard Organisation

ISWM – Integrated Solid Waste Management

LT – Long Term

MID –Maurice Ile Durable

MT – Medium Term

PV – Photovoltaic

RE – Renewable Energies

RET – Renewable Energy Technologies

SIDS – Small Island Development States

ST - Short Term

WG – Working Group Energy

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# 2 EXECUTIVE SUMMARY

One of the main objectives of the Maurice Ile Durable project is to make Mauritius, Rodrigues and the outer Islands be less dependent on fossil fuels. This can be achieved by increasing energy efficiency in order to reduce the consumption of energy in sectors which are high energy consumers; for example: transport, land use, buildings, and industrial processes.

Consideration of prosperity in terms of profitability only, based on the current economic paradigm, is often at the expense of social and environmental aspects. In order to address such a distortion and internalise the latter aspects, sustainability criteria are needed. Among the criteria used for sustainability assessment are GHG considered over an entire chain, competition with other applications like food supply, biodiversity, quality of soil, water and air, contribution to local communities as well as parameters of well-being. In this report, a **recommendation** is a proposal from the WG as a whole, on the basis of consensus. Wherever, dissenting views are expressed, this is explained. It is not a policy directive as the WG is not mandated to outline policies, strategies and action-plans. It is proposing measures based on feasibility studies.

The conduct of **feasibility study** currently focuses on the financial aspect, with reference to market forces. However, MID requires a new economic framework, integrating environmental and social costs. Long term holistic feasibility rather than short-term profitability will be possible only if externalities are fully integrated in the MID context.

This WG focuses on the INTEGRATED management of Energy issues and is closely linked to Climate Change Mitigation. The topics addressed were as follows: Energy Sources, Buildings, Transport, Housing, and Land Use.

After discussions of the WG, the categories were redefined and were the following: Energy sources, Transport, Buildings – including housing, Industrial/Manufacturing processes and Land use.

Apart from climate change, democratisation of the energy sector, green economy, institutional and regulatory aspects, technological dimensions, sensitization, training, capacity-building and research as well as reference to international/regional cooperation, Rodrigues, Agalega / outer-islands will be cross-cutting issues.

## 1. Recommendations

The WG 1 is of the opinion that the following are non-MID: 24/7, 2 million tourists in 2020, triple GDP to 1 trillion rupees in 2020.

After the discussions, the WG Energy came up with the following recommendations: **Sustainability Indicators**: Instead of using only GDP, a set of sustainable indicators should be introduced to gauge the progress of the Republic towards the MID vision.

**Recommended studies**

- A study should be carried out to assess the feasibility conditions of capping the number of vehicles in Mauritius and to assess the carrying capacity of the Mauritian road network by 2020
- A land use survey should be undertaken for the whole country prior to devising strategy related to integrated land use by 2015
- A study to assess the allocation of land for priority to attain 60% food security in the country as well as the demands from the other sectors including energy self-sufficiency by 2040. Consideration of potential of marine resources and regional cooperation should be included.
- Solar and wind maps should be produced in order to make efficient use of these renewable resources, including in Rodrigues.

## Demand Side

***The government should promote alternate modes of travel*:**

- The mass transport system should be introduced without delay and be operational by 2020, a priority for the WG as it would reduce the number of cars on the roads. It should be powered with clean energy sources in line with MID.
- Government should provide quality and efficient public transport to the population and should (along with private companies with more than 200 employees) promote alternate travel vehicles by providing company buses to 50% of its staff (target 2015).
- Alternate travel vehicles should be promoted by consolidating taxes based on car emissions and car occupancy (Car pooling should be promoted by introducing toll based on car occupancy by 2015).
- Cycle and pedestrian paths should be introduced and selected roads be converted for pedestrian use only.

***Strategies, policies and regulations should be reviewed and made stricter in terms of enforcement in order to promote MID concepts*:**

- More efficient land use whenever applicable.
- Minimum energy performance standards for equipment should be enforced without delay and existing policies and regulations should be made stricter for new development projects.
- New guidelines to promote sustainable development and there should be incentives provided to people in order to encourage them to adhere to these new guidelines

- Energy audits in industries and assistance should be given in implementing recommendations. Voluntary initiatives should be promoted strongly in the context of Energy Management programmes.
- Administrative processes for industries using sustainable sources of energy should be facilitated to encourage industries to use lesser carbon fuels. This will encourage industries to adopt industrial ecology principles and design.
- Industries should be encouraged to promote a circular economy where materials should be reused as new raw materials. There is less consumption of resources and energy in a circular economy.

***Holistic and Integrated approach to Transport and Land use should be promoted in line with MID concepts*:**

- There should be an integrated approach to development in order to have regulations and policies more appropriate to the local context and better enforcement.
- Good governance should be promoted – for example there should be more transparency in decision making on tariffs for energy
- Delocalisation and decentralisation should be promoted in the event that the mass transit system is not implemented in order to reduce time and need of travel to work in the long term. While road construction has to be considered as favouring the car transport system and as a generator of more traffic problems and therefore shall not be encouraged; any ring road/by-pass road development should be thought in a holistic manner and should promote the use of mass transport. But, decentralisation should be encouraged to empower local authorities/organisations.
- Consultations with stakeholders should be led in a pro-active and preventive manner – for example, developers should have an opportunity to discuss their projects with decision makers in a pro-active manner and input of local consultants should be promoted in local projects by encouraging their participation.
- Review of land use for water shed management taking into account climatic changes in the Short Term.
- Clustering of shared facilities and mixed-use development in order to make an efficient use of the existing facilities/infrastructure, preventing the need for building new facilities and infrastructure and reducing need for travel.

***Capacity building in the main institutions is a high priority:***

- Allocation of more resources (especially for capacity building) to the main institutions specially Local Authorities (with the creation of new posts like architects, legal counselors) for better implementation of policies & regulations should be carried out in the short term.
- Empowerment of citizens/community to encourage community participation in decision making process - the bottom-up approach should be privileged by empowering citizens and communities to participate in the decision-making process.

***Creation of awareness / mindset of people – awareness campaigns***

- On MID concepts using the funds available in the short term and be on-going (for example, on eco-driving, bio-climatic architecture) in order to promote sustainable quality of life and to reduce amount of energy consumption
- About energy efficiency and incentives to industries to establish energy efficiency processes
- For reforestation & awareness about the negative carbon impacts in the short term

***Fiscal incentives or taxation***

- Fiscal policy to promote the use of renewable energy in the transport sector by 2015 and promote cleaner vehicles through incentives, green procurement and CSR in Mauritius and Rodrigues
- Energy+ buildings should be encouraged by giving financial incentives
- In order to promote local distribution and consumption, financial incentives and measures should be given to small planters to adapt to climate change in the long term. The distribution policy should also be reviewed to help these planters. Incentives should be given to planters to produce goods needed for local consumption and should ensure markets for the products in the Short Term

***Use of new technologies should be promoted in order to reduce waste of energy and to increase efficiency in buildings***

- New technologies could be used to reduce the amount of energy waste in our daily lives in the very short term as these technologies are already available

- To undertake Energy Management projects particularly in airport, port and cold storage which are the high consumers of electricity on the island and in Rodrigues

## Supply Side

***Fuel imports***

- All petroleum and coal imports for local consumption be displaced by local sustainable substitutes by 2040.

  Given the threats that high fossil fuel prices and supply interruptions pose to our economy and way of life, it is vital to decouple our economy from them as quickly as possible. Peak oil occurrence, as well as climate change, is additional compelling reasons. Contingency plans have to be drawn up to cope with significant interruptions or reductions in petroleum-based fuel imports.

***Production of Electricity***

Recommendation, in order of priority of the following options is favoured for base-load power generation in the short/medium term.

1. Biomass
2. Bagasse/Coal
3. LNG
4. Coal (high efficiency generation in terms of emissions /kWh). {The last option, i.e. coal-only, was not unanimously accepted. It was considered that it would be contrary to the MID vision and should, therefore, not be reckoned as a possible option in any event.}

Cogeneration should be favoured wherever possible and sustainability criteria applied. Energy Management programmes should be implemented to minimise the need for additional capacity. The idea of a moratorium on new coal-fired power plants was also debated.

***Bagasse / Coal***

- An ambitious but realistic target set was to maintain power production from bagasse at 17 %. It is then anticipated to increase electricity production from bagasse/biomass to 40% by 2025.
- Electricity production from energy crops to be optimised through the use of new technologies when they become available.
- More research needs to be undertaken on ways for ensuring the year round availability of electricity from energy crops.

***Hydro***

- The set target for electricity production from hydro is to maintain electricity production at 2 % from this source until 2025. There is also an urgent need to improve efficiency of actual production plants, taking into account change in rainfall patterns.

***Wind / Solar/ PV***

- Installed wind turbine and Solar PV capacity has to be continually increased in line with the maximum that can be supported by the network. The potential land-based installed capacity is far in excess of what we will ever need but is limited by land use conflict, among other considerations.
- By 2025 to increase our target for power production from Wind Energy and Solar Energy to 20 % through the promotion, particularly, of smart or intelligent systems. Immediate steps should be taken towards the feasible introduction of the latter.

***Energy from waste***

- The full potential of generating energy from societal “green” waste needs to be exploited within the next 10 years. Anaerobic Digestion (AD) is an appropriate, mature technology that generates biogas for electricity production while also

producing a high value fertiliser (if necessary, after further composting) for food and energy crops.

- The implementation of high flow AD for secondary waste water treatment within the next five years. Upflow Anaerobic Sludge Blanket digestion is an appropriate, mature technology that generates biogas to supplement the output from the sludge digester.
- The replication of the sludge digester at St Martin across all waste water treatment facilities as from next year. Ideally, industrial effluent would be cleaned on-site to remove contaminants such as heavy metals before disposal into the waste water network. Solid waste and liquid waste must be subject to the 3Rs.
- There is a need for an Integrated Solid Waste Management system, where solid waste is expected to be sorted at source. The energy potential of remaining Solid Waste need then be considered in line with sustainability criteria.
- The WG considers biomethane as a clean form of energy that should be promoted through off-grid applications particularly.
- Recommendation made was to consider production of energy of order of at least 5 % from biomethane by 2025.

***Transport Energy***

- Immediate decision to be taken concerning 30 million litres of hydrated ethanol available locally. To promote the use of ethanol or synthetic biofuels for public transport rather than private owned vehicles.
- Bioenergy, including advanced biofuels as well as green electricity, should be available by 2025 to cover most of our transport energy requirements. Walking and cycling should be promoted.
- To assess and exploit sustainably the potential of bio-energy (green waste, biomass and coconut oil) including in Rodrigues and Agalega.

***LNG***

- If a transition fuel be necessary, LNG will be considered subject to analysis in terms of investment, infrastructure, safety and sustainability criteria. In any event, by 2040 it should be phased out and replaced by alternatives like biomethane or biofuel using the same installed facilities with appropriate modifications, if any.

***Agriculture***

- The nutrients from harvested energy crops must be recycled to fertilise food crops.
- To maintain (increase if possible) the current land area of 60,000 hectares under agriculture. There is a need to maximize yield from land (by using crops yielding more biomass). Marine resources as well as regional cooperation opportunities should be considered.

# 3 INTRODUCTION

Due to an increasing awareness of the greenhouse effect and the depletion of fossil fuels, there is currently an increasing interest in possible alternatives for conventional energy sources. Given that renewable energy sources can be replenished in a relatively rapid pace, in a natural, ecological responsible manner, it is an attractive option for small island states like the Republic of Mauritius, which is undergoing a transition from a low income mono-crop economy to a middle income diverse economy. The Government is also envisaging ways to decrease the consumption of energy in order to decrease imports of fossil fuels.

## 3.1 MAIN CONCERNS OF STAKEHOLDERS

If world consumption of hydrocarbon fuel is to continue growing, massive development of unconventional resources will be required. While there are grounds for pessimism and optimism, it is certainly not too soon for extensive, detailed analysis of transitions to alternative energy sources (Greene, 2005). According to some studies peak oil crisis will occur in 2020 and some minority group of researchers report the date to 2030. The expected peak demand in 2020 and 2025 would be about 666 MW and 810 MW respectively compared to 403 MW in 2010. This will result in important impacts on economy, transport and food security of the country.

The WG is much concerned that 100% of our transportation energy is derived from fossil fuels.

There was general consensus that there is a need to reduce energy consumption patterns and the number of cars on our roads. It is believed that comfortable, reliable and cost competitive forms of common transport can provide an incentive to make a paradigm shift.

While there was general consensus that we need a transit away from fossil oil, one promoter of biofuel expressed his views on this matter that domestic production of biodiesel can be a future solution for the islands.

## 3.2 MAURITIUS AND THE OUTER ISLANDS: POPULATION AND DEMOGRAPHICS

The Republic of Mauritius comprises a main island of an area of 1870 $km^2$ which lies 800 km off the east coast of Madagascar at latitude 20º south and longitude 58º east and several outer islands, all of volcanic origin. As at 1st July 2009, the population of the Republic of Mauritius stood at 1,275,323 (1,237,286 in the mainland, 37,748 in Rodrigues and 289 in the other island) with a growth rate of 0.5% over the population at 1st July 2008 (CSO, 2009).

The climate is sub-tropical with winter prevailing from May to September and summer from October to April. The overall population density was around 625 persons per square kilometre as at 1st July 2009.


***Figure 1: Map showing positioning of Mauritius in Indian Ocean***

**Source: Government of Mauritius, Web Portal**

## 3.3 RATIONALE FOR STAKEHOLDER CONSULTATIONS

A key issue in the discussions raised was that the word 'sustainability criteria' had to be clearly understood by each stakeholder. Furthermore formulation of recommendations and their future implementation were questioned. The paragraphs below attempt to shadow the reflections made on these issues.

**In terms of Social and Environmental Dimensions: what are sustainability criteria?**

Consideration of prosperity in terms of profitability only, based on the current economic paradigm, is often at the expense of social and environmental aspects. In order to address such a distortion and internalise the latter aspects, sustainability criteria are needed. Internationally, marker players, government and civil society have determined the sustainability requirements in the form of voluntary agreements or certification schemes. National and regional standards are being more and more applied, together with systems being developed regarding audit and implementation. The International Standards Organisation will harmonize the existing practice soon. Among the criteria used for sustainability assessment are GHG considered over an entire chain, competition with other applications like food supply, biodiversity, quality of soil, water and air, contribution to local communities as well as parameters of well-being. In the context of MID, as a result of the next phase involving consultants and relevant authorities, a strategy will be needed to elaborate sets of sustainability criteria. A participative democratic approach will be appropriate.

- **The Political Dimension: what is a recommendation?**

This is a proposal from the WG as a whole, on the basis of consensus. Wherever, dissenting views are expressed, this is explained. It is not a policy directive. The WG is not mandated to outline policies, strategies and action-plans. On the contrary, it defines the stakeholders' agreed and common proposal on the specific orientation to be adopted in line with the MID vision. It is proposing measures based on feasibility studies. Pre-feasibility and feasibility studies are expected to follow in that concrete direction, coherent with the MID vision. The

first next step will be the work of consultants, along with relevant authorities, to define the draft MID policy, strategies and action-plan.

- **The Economic Dimension: what is feasibility?**

The conduct of feasibility study currently focuses on the financial aspect, with reference to market forces. However, MID requires a new economic framework, integrating environmental and social costs. Hence, it is expected that the conditions will have to be defined in order to ensure that feasibility is not considered only in terms of internal costs. The trends and uncertainties in terms of prices, e.g oil , as well as related to issues like climate change and technology will have to be fully addressed. Long term holistic feasibility rather than short-term profitability will be possible only if externalities are fully integrated in the MID context.

## 1.4 THE METHODOLOGY

A common methodology, as described in this section, was adopted for the five Working Groups, however the WG on Energy had its own specific approach to come up with the concrete, coherent and common recommendations. Four workshops were held and they were presided by the Chairperson and the vice-chairperson. They were assisted by two rapporteurs for the reporting and dissemination of the relevant information prior to each meeting.
Climate change adaptation and mitigation were considered highly important aspects although as SIDS, GHG emission reduction was not the prime focus.

This WG focuses on the INTEGRATED management of Energy issues (including Generation, Renewables, Distribution, Demand-Side, Efficiency and Conservation) and is closely linked to Climate Change Mitigation. The topics addressed were as follows:

- Energy Sources ( including Power Generation and Renewable Energy)
- Buildings ( ie Commercial, Industrial and End Uses of Energy)
- Transport
- Housing ( including End-Uses of Energy)
- Land Use ( including Agriculture-Energy linkages)

After discussions of the WG, the categories were redefined and were the following:

- Energy sources ( including Power Generation and Renewable Energy)
- Transport
- Buildings – including housing
- Industrial/Manufacturing processes
- Land use

Members wanted the focus on discussions to be on the different renewable forms of energies. Apart from climate change, democratization of the energy sector, green economy, institutional and regulatory aspects, technological dimensions, sensitization, training, capacity-building and research as well as reference to international/regional cooperation, Rodrigues, Agalega / outer-islands were cross-cutting issues.

### 3.5 Schedule of meetings

| | **WG 1 Energy** |
|---|---|
| **First Round of Meetings** | 20 June (Monday) |
| **Second Round of Meetings** | 30 June (Thursday) |
| **Third Round of Meetings** | 14 July (Thursday) |
| **Fourth Round of meetings** | 28 July (Thursday) |

Meetings with rapporteurs, organizing members, lead ministry and chairpersons were held prior to each round of meetings to plan for future working sessions and to review the outcomes of the recent working sessions where relevant. The Chairperson also relooked at the constitution of the WG and ensured that there was proper representation of all the listed stakeholders.

# Energy – The Demand Side

# 4 Transport

## 4.1 INTRODUCTION

*'Transport has a key role to play in the development of any country as it facilitates access to jobs, education, markets, leisure and other services. With rapid industrialisation, Mauritius too has experienced a drastic increase in the number of motor vehicles, thus aggravating the traffic congestion problem. This continuing increase in volume of transport is leading to consequential impacts on the environment, especially in terms of vehicular emissions, noise pollution and generation of waste oil as well as energy needs.'*

- In Mauritius, the transport sector is the heaviest energy consumer, accounting for 48% of total energy imports. In 2008, some 407 ktoe of energy were used for transport; diesel oil accounted for 154 ktoe or 37.8%, aviation fuel 137 ktoe or 33.7%, gasoline 110 ktoe or 27.0% and Liquefied Petroleum Gas (LPG), 6 ktoe or 1.5%. From 2007 to 2008 the consumption of diesel oil rose by 0.6% and gasoline by 2.8% while that of aviation fuel fell by 4.9%.
- Since the past 10 years, the fleet of vehicles has increased from some 190,000 to around 291,600 vehicles in 2004.
- Pollution problems, in terms of vehicular emission, are more acute in towns where there is heavy vehicular traffic.
- Traffic congestion is a major cost and inconvenience for many businesses and companies, particularly those whose activities demand high levels of transport per unit of production. Regular exposures to traffic congestion affect health and therefore work performance. Therefore, traffic congestion has a negative impact on the economy of the country. The cost of congestion can be approximated to about Rs 1.5 to 2 billion yearly in the Republic of Mauritius.
- At end of December 2010, 384,115 vehicles were registered at the National Transport Authority compared to 366,520 at the end of December 2009, i.e. an increase of 17,595

or 4.8%. Some 21,643 vehicles joined the fleet whilst 4,048 were put out of circulation during the year.

## 4.2 STOCK-TAKING

### 4.2.1 The existing policies/strategies

- Integrated National Transport Strategy Study (INTSS)
    - The INTSS which was initiated by the Ministry of Public Infrastructure, Land Transport and Shipping shows that the land transport in Mauritius is in difficulty and is not working within a clear strategy. During the past 7 years there has been an increase of 4.8% in the number of vehicles registered. This is mainly because there has been a rise in income whereby more people have had access to private cars and started using them to get to their work. This has lead to severe traffic congestion within the cities particularly entering Port-Louis from both directions, especially from the south during the morning and evening peak hours. This congestion occurs over very longs distances in two main roads namely A1 and M1 and affects the fluid movement of vehicles between Port-Louis and Curepipe and all the traffic entering the city from the northern, southern and western regions.

### 4.2.2 Existing institutional set-up

The different institutions involved in the transport sector:

- Traffic Management and Road Safety Unit
- National Road Safety Council
- Road development authority
- National Transport Authority
- Road Transport Advisory Board
- Transport Policy Unit

### 4.2.3 Existing legislative set-up

The different legislations in the transport sector:

- Environment Protection Act (standards)
- Road Traffic Act

## 4.3 GAP ANALYSIS

The weaknesses of the actual transport system identified by the WG were:

- The transport sector uses about 50% of energy (all imported fossil fuels) and emits 25% of $CO_2$ in the country. The number of cars has been increasing during the last years. This is causing an increase in the amount of fossil fuel used in the transport sector.
- Traffic congestion costing about Rs 1.5 to 2 billion yearly is getting worse even if there is an increase in the length of the road network.
- Linear and limited access to main town and villages and there are usually one through road in these areas.
- Lack of appropriate regulations and enforcement of the existing ones.
- The government is increasing mobility of cars (with construction of new roads) and not of the mass population.
- Old cars which are not energy efficient are still on roads and there is a lack of control in this sector.

The WG identified actions taken in the actual context which were considered to be NON-MID:

- Provision of parking in town centres and villages
- No consideration was given to bicycle paths network and pedestrians
- The number of cars is ever increasing
- The Mauritian towns have an ecological footprint of more than 2.5 gha per person

## 4.4 CHALLENGES/EMERGING ISSUES

The main challenges of the WG were to decrease the length of trips of Mauritians in order to reduce the amount of energy consumed and also to encourage people to use public transport. As such, an efficient and proper mass transport system was to be provided to people. The WG discussed the use of Biofuels as sources of energy for both private cars and public transportation in the Republic of Mauritius. The use of electric motor vehicles was also a challenge for the WG.

One major issue identified was that there should be a holistic and integrated approach to transport and land use planning. Land use planning was an effective tool to reduce the amount of trips and distance travelled by people.

## 4.5 RECOMMENDATIONS

**The target to be reached in 2020 is to reduce consumption of energy by the transport sector by 35%. This has been reached as a result of consideration of bench-mark targets set in the sector in other countries and consideration of the Mauritian context.**

After analysing the actual situation in the local context, the WG makes the following recommendations:

**Recommendation 1: Transport planning should be closely linked / integrated to land use planning in order to reduce energy consumption. This is a high priority for the WG and should be implemented in the next 2 years.**

1. Integrate transport and land use planning: it was observed by the WG that if a land use planning and transport would be integrated holistically, this would have a great impact on the necessity of trips and thus reduce the distance travelled by the Mauritian people. For example, if activities were delocalised towards the 'people', there would be less travel. Land use planning could be used as a tool to promote MID if it is coherent and holistic. This would reduce the amount of energy consumed by the transport sector.

**Recommendation 2: Delocalisation and decentralisation should be promoted in the event that the mass transit system is not implemented in order to reduce time and need of travel to work in the long term.**

Reduce time of travel to work: in Mauritius, traffic congestion is caused mainly by the traffic entering and leaving Port Louis during the morning and evening peak periods. This problem has become acute in the last years as more people own cars and to use them to travel to and from work. Delocalisation and decentralisation would help reduce the need and time of travel from home to work. However centralisation can be considered if a mass transit system is available.

**Recommendation 3: Any new large scale development should be mixed use in nature to reduce need for travel**

2. Mixed use development: in the past, 'zoning' was promoted in land use activities; for example there were residential zones, commercial zones. As such, people had to travel in order to access the different zones. The WG proposes that mixed-use development should be promoted: there are activities which are compatible and which can be clustered in close proximity. This would reduce the need to travel.

**Recommendation 4: Government and private companies with more than 200 employees should promote alternate travel vehicles by providing company buses to 50% of its staff in 2015**

3. Promote alternate travel vehicles
    a. Promotion of shuttle service in offices and outside town centres : this would encourage staff to make use of these facilities instead of using their private cars to travel to work. As the public sector was a large 'employer', the use of company buses should be encouraged.
    b. The public transport system need to be improved considerably in order to provide good quality buses and providing a reliable service.

**Recommendation 5: Car pooling should be promoted by introducing toll based on car occupancy by 2015**

a. Promotion of car pooling by introduction of toll fee based on car occupancy: today there are more and more people using their cars to travel to work, and usually they travel alone. In order to reverse this trend, the WG proposes to promote car pooling by introducing toll fee based on the car occupancy. This would encourage people to share car occupancy and this reduces the number of trips.

**Recommendation 6: Alternate travel vehicles should be promoted by consolidating taxes based on car emissions by 2015**

a. Lower prices of appropriate hybrid, low emission and electric cars (supported by renewable energies): in order to decrease the energy consumption of the transport sector, the government should encourage the use of hybrid and electric cars which are supported by renewable energies to make them core competitive on the market. Taxation of vehicles based on car emissions should also be consolidated.

4. Reduce the number of cars on roads and promote eco-friendly public transport

**Recommendation 7: The WG recommends that a study should be carried out to assess the feasibility of capping the number of vehicles in Mauritius and to assess the carrying capacity of the Mauritian road network by 2020**

a. Capping the number of motor vehicles in Mauritius: the members of the WG were of the opinion that the road network had reached its maximum carrying capacity. As such, it was important to limit the number of vehicles on the roads and the example of Singapore were this is the current policy was given.

**Recommendation 8: The WG recommends that mass transport system should be introduced in the very short term and be operational by 2020 and this is a priority of the WG as it would reduce the number of cars on the roads**

**Recommendation 9: The WG recommends that government should provide quality and efficient public transport to the population**

b. Mass transport system: the WG strongly recommends the use of mass transport system which use renewable energy and which would be eco-friendly. They are of the opinion that mass mobility of people rather than mobility of vehicles should be increased by increasing the quality and accessibility of public transport.

**Recommendation 10: the WG recommends that cycle and pedestrian paths should be introduced. It also recommends that some roads can be converted for pedestrian use only in the Medium Term**

c. Create dedicated cycle paths/pedestrian areas/towns and prioritise pedestrians/cycle pathways: people should be encouraged to use their bicycles or to travel by foot. In order to increase the security of these cyclists and pedestrians, paths should be dedicated to these activities.

5. Create awareness and educate main stakeholders/drivers

**Recommendation 11: the WG recommends that awareness campaigns should be carried out on eco-driving using the funds available in the short term (priority)**

a. Awareness campaigns on ecodriving – Mauritians are not really aware of the concepts of eco-driving, about how to drive in order to decrease the decrease the amount of energy consumed. The WG is of the opinion that awareness campaigns should be carried out by using the CSR/MID or any other fund available and courses on 'MID concepts' should be offered to drivers where there is a need for renewal of licence.

b.

6. Review the transport management system in a holistic, systemic, ecological manners

**Recommendation 12: the WG recommends that while road construction has to be considered as favouring the car transport system and as a generator of more traffic problems and therefore shall not be encouraged; and if nonetheless any ring road/by-pass road has to be built, it shall therefore be thought in a holistic manner**

a. While road construction has to be considered as favouring the car transport system and as a generator of more traffic problems and therefore shall not be encouraged; and if nonetheless any ring road/by-pass road has to be built, it shall therefore be thought in a holistic manner.

**Recommendation 13: The WG recommends that there should be a fiscal policy to promote the use of renewable energy in the transport sector in the short term**

**b.** Better fiscal policy: the WG recommends that there should be a fiscal policy to promote the use of renewable energy in the transport sector. For example, removal of VAT on selected products (bicycles…), subsidise selected products (vehicles using renewable energy).

**Recommendation 14: the allocation of more resources (especially for capacity building) to the main institutions in the transport sector for better implementation of policies and regulations should be carried out in the very short term**

**Recommendation 15: the WG recommends that there should be stricter regulations in the transport sector in the short term**

7. Better regulations and policies/ enforcement in the transport sector should be implemented by:
    a. capacity building
    b. stricter regulations

**Recommendation 16: incentives should be given to planters to produce goods needed for local consumption and should ensure markets for the products in the Short Term**

8. Reduce maritime/air transport by encouraging production and consumption of local products (at micro level). The government should give incentives to local planters to produce goods so that there is less need for the import of these goods.

**Recommendation 17: All renewable forms of energy should be considered for electricity production for the private transport sector (very high priority)**

All renewable forms of energy should be considered for electricity production for the private transport sector otherwise this will impact with peak demand problems being faced currently as there can be shifts of Energy usage patterns in the near future and as Second generation of fuels were on the way and entering into picture by2015. The possible utilization of sugar cane juice for production of ethanol and some equity issues were also raised.

# 5. Land use

## 5.1 INTRODUCTION

During the period 1995-2005, the proportion of land under sugarcane decreased by 6.3%, tea plantations declined by 81.6% and forestry by 17.2%. Land used for other agricultural activities increased by 33.3% while built up areas expanded to 27.7%.
In 2008, some 44 EIA licences were granted of which 12 (27%) were issued to land parceling – Morcellement and 8 (18%) were provided to coastal hotels and related works.
During the same period, 40 Preliminary Environment Reports licences were granted, out of which 16 (40%) were for industrial development projects.

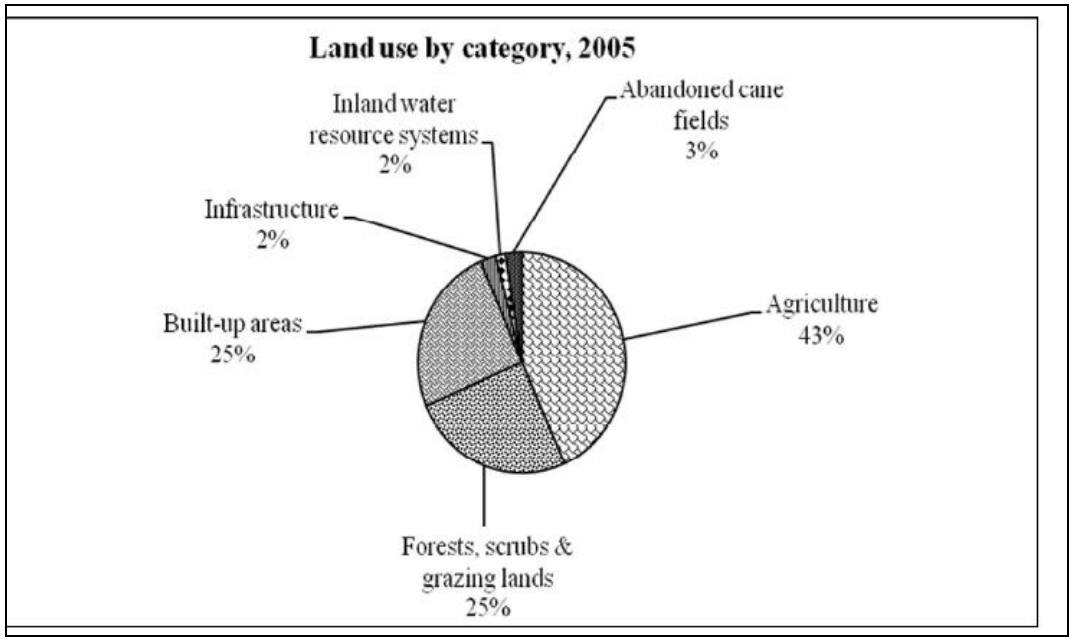


***Figure 2 : Land Use by category in 2005***

## 5.2 STOCK-TAKING

### 5.2.1The existing policies/strategies

- National Development Strategy / Outline Schemes
  - The National Development Strategy is a strategy that sets out broad objectives, strategies and principles to promote an orderly organised development of the overall land resources and also lays down the criteria for an

efficient allocation of land for different uses namely for the conurbation, countryside and the coast, housing, social and community facilities, industry and commerce, tourism, agriculture, forestry and natural resources, the environment and fisheries, transport and public infrastructures. The National Development Strategy has the duty to identify key issues in the town and country planning in Mauritius and thus it devises concepts, strategies and principles so as to assure that sustainable development is attained in every field. Therefore, the strategic vision of the National Development Strategy is *"encouraging economic growth in the conurbation, the country side and the coast whilst maintaining and enhancing the quality of the environment and striving for a more sustainable pattern of development"*

- The Outline Planning Schemes, which are regional plans for a Municipal Council or District Council area, provide the framework for local authorities to plan, shape and control the use of land within their area. Outline Schemes set out broad proposals for the physical development of a planning area, including such matters as the location and extent of areas for housing, commerce and industry activities, the reservation of sites for public facilities and community facilities, proposal for new and improved roads, measures to protect the agricultural areas and areas of attractive landscape. They therefore translate the national strategy to the local level.

- Planning Policy Guidelines
  - National Planning Policy Guidelines (NPPGs) are written statements which set out guidance on particular planning issues. Communities and Local Government determines national policies on different aspects of planning and the rules that govern the operation of the system.
  - National Strategy for housing in Mauritius
  - The formulation of housing policies is very much guided by the objective of '*un toit pour toi* '; the attainment of this goal not only hinges on Government intervention in the process of facilitating access to housing provision for the lower socio-economic strata of the population, but is also dependent on encouraging increased private sector involvement in the provision for social housing. This is achieved through the provision of appropriate incentives which would both reinforce the traditional role of private companies in upmarket housing provision, and stimulate private sector participation through planning obligations.
- A sustainable diversified agri-food sector strategy for Mauritius (2008-2015) :
  - The overall goal of this programme is to facilitate commercial production of crops to ensure food security and quality, foreign exchange savings and sustainable development as well as improving the diet and health of the nation.
- Sustainable Integrated Development Plan for Rodrigues

### 5.2.2 Existing institutional set-up

The different institutions involved in this sector:

- Ministry of Housing and Lands
- Local authorities (Municipal and district councils)
- Morcellement Board
- Town and Country Planning Board
- Ministry of Agriculture

### 5.2.3 Existing legislative set-up

The different legislations in land use planning:

- Town and Country Planning Act
- Planning Development Act
- Business Facilitation Act
- Environment Protection Act
- Morcellement Act
- Building Act
- Local Government Act
- Sugar Efficiency Act

## 5.3 GAP ANALYSIS

The weaknesses of this sector as defined by the WG are:

- Acceptability of our current situation and lack of understanding of dynamics of the country ecosystem: the WG was of the opinion that Mauritians have a tendency to accept our current lifestyle even if they know that it is not sustainable. The example of use of plastic bags was given. Mauritians continue to use plastic bags even when a levy has been imposed and even when they know that this is not a sustainable practice.
- Economy based society – our economy is based on material aspects and there is an over exploitation and over consumption of natural resources. This Mauritian lifestyle is also based on lack of ecological understanding and savvyness.
- Legislation:
    - Some legislation are very old and outdated: example the Town and Country Planning Act of 1954 and penalties are considered to be too minimal and are not deterrent

- There is a fragmentation of legislation and authorities and this is a drawback in implementation and enforcement of policies. As such there is a lack of holistic approach and harmonisation. The strategies of the National Development Strategy Scheme, which promote sustainable development, are not implemented.
- Legislations exist but there is a lack of follow up in the implementation and enforcement mechanism.
- Lack of resources available especially concerning the enforcement and monitoring of existing strategies and policies. Authorities are always short staffed or under equipped and this is a major issue for the WG.

- Mismatch between strategic planning and implementation – the WG is of the opinion that there is a mismatch between government policies and what the government actions (example low density development favoured – non MID - while the government is promoting MID concepts)

  The WG identified actions taken in the actual context which were considered to be NON-MID:
- Conversion of greenfields and prime agricultural areas to concrete
- Shopping malls outside centres are being favoured
- Morcellements projects where no infrastructure available and which are environmentally sensitive areas
- Non sorting of waste
- Increasing dependency and affinity on imported goods
- Use of poor quality goods and Non recyclable goods

## 5.4 Challenges/Emerging issues

The main issue of the WG was that there was not a holistic land use planning in the Republic of Mauritius and if there was an integrated land use planning it was going to be an effective tool for the betterment of the quality of living of the citizens. Land-use planning means the systematic assessment of physical, social and economic factors in such a way as to encourage and assist stakeholders in selecting options that increase their productivity, are sustainable and meet the needs of society.
The WG also noted that there was a fragmentation of powers in Mauritius, and that there was a lack of implementation and enforcement of the existing legislation. The Local Authorities are the enforcing agency for development control and there was a severe lack of resources in these local authorities. Consequently, demand-side management, in particular related to energy, is made a formidable challenge given the current state.

## 5.5 RECOMMENDATIONS

**Targets for land use:**

- Increase forest cover to 33% with endemic species ( location, biodiversity, ecosystem functioning ) in 2015
- Not release additional green field sites for built up – encourage clustered development

  Development should be encouraged in in-fill sites in existing built-up areas and not outside limits of settlement as this put an additional stress on the existing infrastructure.
- Agriculture: a study should be carried out to assess the allocation of land for priority use to attain 60% food security in the country as well as the demands from the other sectors including energy self-sufficiency by 2040. Consideration of potential of marine resources and regional cooperation should be included.

**Recommendation 18**: **The WG recommends that there should be an integrated approach to development in order to have regulations and policies more appropriate to the local context and better enforcement - priority**

**Recommendation**: **The WG recommends that a land use survey should be undertaken for the whole country prior to devising any strategy or policy related to land use by 2015**

- Integrated holistic and ecological approach to development: it was observed that due to the fragmentation of the sector, it was not possible to have a proper land use planning. As such, the WG recommends that there should be an integrated approach to development in order to have regulations and policies more appropriate in the local context and better enforcement. This plan should take into consideration landscape, cultural and ecological aspects the MID concepts and should also take into account the optimal management of water and natural resources, together with waste management, transport and power supply.

The steps to promote this new approach:

**Recommendation 19**: **The WG recommends that higher density development should be permitted in certain localities in the short term**

- Higher density development in selected areas as low density development consumes more resources and encourages urban sprawl. This increases stress on infrastructure and services.

**Recommendation 20**: **The WG recommends that efficient use of abandoned land should be made instead of converting agricultural land in the short term**

- Efficient use of abandoned land instead of converting agricultural land. Development should be encouraged in in-fill sites in existing built-up areas and not outside limits of settlement as this put an additional stress on the existing infrastructure.

**Recommendation 21**: **The WG recommends that developments which are MID compliant should be encouraged by streamlining the administrative procedures.**

- Streamline administrative procedures to facilitate decision making process and to include MID policies in the decision making process. The WG proposes that developments that are MID compliant should be encouraged and the procedures streamlined.

**Recommendation 22**: **The WG recommends that adequate resources should be provided to enforcing institutions especially Local Authorities and that there should be more severe actions against non-compliance in the very short term**

- Appropriate and more severe actions against non-compliance with existing regulations as actually enforcement is a major issue. It was noted that the legislations exist but that enforcement is the major drawback in the Mauritian context. As such, there should be provision of adequate resources to institutions, especially Local Authorities which are the enforcing agencies.

**Recommendation 23**: **The WG recommends that consultations with stakeholders should be led in a pro-active and preventive manner – for example, developers should have an opportunity to discuss their projects with decision makers in a pro-active manner**

- Consultation and planning using strategic, environmental, social and ecological assessment through implementation of Strategic Environmental and social impact assessment. It was proposed that consultations with stakeholders be led in a pro-active and preventive manner.

**Recommendation 24**: **Good governance should be promoted – for example there should be more transparency in decision making on tariffs for energy**

- It was noted with concern, in all sectors, that political interference had a negative aspect on development in the country.

**Recommendation 25**: **The WG recommends that the bottom-up approach should be privileged by empowering citizens and communities to participate in the decision-making process**

- Empowerment of citizens/community in the decision making process as communities have a tendency to accept decisions when they have been part of the decision-making process, instead of having decisions imposed upon them. The bottom-up approach should be privileged.

**Recommendation 26**: **The WG recommends that there should be a review of land use for water shed management taking into account climatic changes in the Short Term**

- Review of land use for water shed management taking into account climatic changes as the actual water sheds were being affected by climate change.

- Education, awareness, new philosophy, in order to promote sustainable lifestyle / quality of life and measures to reduce energy consumptions in buildings

**Recommendation 27**: **The WG recommends that there should be awareness campaigns about MID concepts in order to promote sustainable quality of life – very short term**

- Awareness campaigns: the communities should be made aware about the MID concepts in land use planning (for example, replanting trees...). Communities should be encouraged to participate in campaigns and best practices should be encouraged and rewarded.

**Recommendation 28**: **The WG recommends that there should be awareness campaigns about orientation, ventilation of buildings and bio-climatic architecture as this would help reduce energy consumption (short term)**

**Recommendation 29**: **The WG recommends that Energy+ buildings should be encouraged by giving financial incentives (short term)**

- Create awareness on orientation and ventilation of buildings and the application bio-climatic architecture. People tend to 'copy' the designs from other countries which are not appropriate to the local context. As such, there is more energy used in the households with the use of air conditioners...The government should also encourage the development of exemplary designs/guidelines for the different micro-climates of the republic
- Energy+ buildings should be encouraged by giving financial incentives

**Recommendation 30**: **The WG recommends that there should be campaigns for reforestation and awareness about the negative carbon impacts (short term)**

- Increase forest cover for carbon offset

  As well as reducing our GHG emissions, it is important to contribute to global CO2 sequestration efforts. Reforestation also helps protect our unique fauna and flora, reduces soil erosion, retains flood water, cleans the air and promotes rainfall. Funding will come from local offsetting programmes, particularly the mandatory offsets from new fossil fuel electricity generation. There should be campaigns for reforestation and awareness about the negative carbon impacts.

**Recommendation 31**: **The WG recommends that new technologies could be used to reduce the amount of energy waste in our daily lives (short term)**

- Promote carbon metrics, promote new technologies to save energy: the WG was of the opinion that there was a lot of waste of energy consumption in our day to day lives; homes, offices… As such, it was proposed that new technologies could be used to reduce the amount of waste in our daily lives by using of sensors in public areas, Domotics – smart control in electrical appliances and carbon emissions measures of buildings in order to create awareness.

**Recommendation 32**: **The WG recommends that there should be better monetary /fiscal policy for better planning (Long Term)**

- Better monetary /fiscal policy for better planning: it was observed that the penalty for not adhering to the existing norms and regulation was not enough to deter developers and that it was necessary to give incentives to people in order to make them aware about sustainability issues. For example; reduce fees (development, building,…) for sustainable buildings and better loan rates for sustainable development
- Use of economic instruments for Taxation of energy intensive materials (e.g air conditioners) should be investigated
- Promote local production and consumption

  Historically, Mauritius has achieved indirect food security through the more than adequate foreign currency obtained from sugar exports. More recently, however, the food import bill has increased to more than double the revenues from sugar. The cost of energy and food imports is about equal but while we can be self-sufficient in the former, it is impossible to be so in the latter due to land and climate requirements of grain, rice and animal feed crops.
  The following steps were proposed to assist local planters:

**Recommendation 33**: **The WG recommends that in order to promote local distribution and consumption financial incentives and measures should be given to small planters to adapt to climate change (Long Term)**

- Financial incentives and measures to assist small planters to adapt to climate change and to have an agricultural diversification policy linked with land use and distribution

**Recommendation 34**: **The WG recommends that in order to promote local distribution and consumption, the distribution policy should be reviewed and markets found for local goods so that there is need for less transport of goods (Long Term)**

- Review the distribution policy and find markets for local goods so that there is need for less transport of goods

**Recommendation 35**: **The WG recommends that a study should be carried out to assess the needs of the population and to assess the area needed to attain 60% food security in the country as well as the demands from the other sectors (Short Term)**

- Ensure / Increase food security: Food security is a complex sustainable development issue, linked to health but also to sustainable economic development, environment, and trade. The WG was of the opinion that importance should be given to a level of food security in the country. But there was a debate amongst the group as land was a scarce resource in Mauritius and that there was demand from other sectors including energy – for the growing of bio-crops. It was also agreed that if land was a limited resource, Mauritius could use the help of its regional partners (Madagascar, Mozambique...) and cross-border agreements in order to cater for its needs. As the WG did not have the necessary and relevant data and statistics, it was proposed that a study should be carried out to assess the needs of the population and to assess the area needed to attain 60% food security in the country as well as the demands from the other sectors.

**Recommendation 36**: **The WG recommends that tarred surfaces should be included in the plot cover in order to ensure permeability of soils is preserved (Short Term)**

- Maintain permeability of soils especially so that ground water table will be recharged: it has been observed that the there are restrictions of plot cover for certain types of development (for example in coastal areas, new Morcellements…). It was proposed that tarred surfaces should be included in the plot cover in order to ensure permeability of soils is preserved.

# 6 .Buildings

## 6.1INTRODUCTION

There were 268,200 buildings in 2000 and it represented an increase of 58,300 over the 1990 Census figure of 209 900. This translates into an average growth rate of 2.48% per annum during the ten-year period. During the same interval, residential and partly residential buildings increased by 52,700 from 187,600 to 240,300, representing an annual growth rate of 2.51%.

Parallel with the increase in the stock of buildings there has been an improvement in the type of materials used for construction. Thus, 86.4% of residential and partly residential buildings enumerated in 2000 were wholly in concrete as compared to 70.6% in 1990.

There are actually 300 000 households and the forecast is 405 000 households in 2025. Private ownership of housing units is considered to be very high in the country (98.6% in 1990 and 99.1% in 2000).

## 6.2 STOCK-TAKING

### 6.2.1The existing policies/strategies

- National Strategy for housing in Mauritius
    - The formulation of housing policies is very much guided by the objective of '*un toit pour toi* '; the attainment of this goal not only hinges on Government intervention in the process of facilitating access to housing provision for the lower socio-economic strata of the population, but is also dependent on encouraging increased private sector involvement in the provision for social housing. This is achieved through the provision of appropriate incentives which would both reinforce the traditional role of private companies in upmarket housing provision, and stimulate private sector participation through planning obligations.

### 6.2.2Existing institutional set-up

- Ministry of Housing and Lands
- National Housing Development Corporation

## 6.3 GAP ANALYSIS

The weaknesses of this sector as defined by the WG are:

- Release of agricultural land for development – specially for major developments which consume large areas
- Out of town shopping malls and Morcellements are encouraged and infrastructure has to be provided to these areas, and this increases need for travel.
- Lack of enforcement and implementation of legislation and guidelines even if these exist due to lack of resources. This concerns also construction and planning guidelines/norms. It was observed that the actual political system does not allow to emphasise on regulations.
- Growth rate of development – there is an increase of bigger houses for fewer inhabitants as people are more affluent and as the trend is towards nucleus family.
- Stimulation of development of buildings to dynamise the economy and more energy is required to cater for these constructions.
- Consultancy carried out by foreigners – sometimes their conclusions are not compatible to the Mauritian context – for example proposal of standard design for low cost housing.
- There are very limited materials for construction available on the Mauritian market, especially which are cost effective - (blocks which are not the most effective) and there is lack of research for new local materials which are more appropriate to the local context and which are cost effective.
- Subsidy for concrete roof slabs provided by the government is not the most effective of materials in the local context.
- The costs associated to make buildings more energy-efficient will be a burden to the population as new technologies are generally more costly.
- The post of architect is not provided in Local Authorities. These architects could advise the population on the effectiveness and design of buildings when they apply for permits.
- Design of buildings is not always appropriate to the Mauritian context. Not enough importance is given to natural ventilation, natural lighting… Lighting used for decorative and not functional purposes and this increases consumption of energy in households.
- Concentration of new technologies only for new buildings

The WG identified actions taken in the actual context which were considered to be NON-MID practices:

- Bad design of buildings
- Lack of enforcement and increase of illegal developments

- Business Facilitation Act which is supposed to encourage development was considered to be non-MID
- No solar passive / bioclimatic design

## 6.4Challenges/Emerging issues

One of the major issues identified by the WG was that the buildings in Mauritius are not appropriate to the Mauritian climate, and this causes a stress on the amount of energy consumption in households and even in offices. For example, lighting is used for decoration and the amount of energy consumed for lighting in many households was considered to be a waste of resources. It was also noted that the materials for construction use in the local context (concrete) was not the most efficient and this also had negative repercussions on use of resources.

Lack of enforcement of existing guidelines and legislation due to lack of resources was also a major issue which had to be addressed promptly in the enforcing agencies.

## 6.5 Recommendations

After analysing and assessing the trends in other countries and comparing it with the Mauritian context, the WG comes up with the following targets:

**Targets for buildings**: 20% energy reduction of energy consumption in existing buildings
35% energy reduction of energy consumption in new buildings

After analysing the actual situation in the local context, the WG makes the following recommendations:

- Promotion of energy efficient housing, bioclimatic design
    - Incentives to people and community to adopt sustainable technologies in order to save energy: to use more efficient materials and to use of local materials for construction
    - Appropriate architectural design to take advantage of Mauritian climate which proper care given to ventilation, orientation...
    - Better fiscal policy in line with energy efficiency, taxes. For example subsidies/incentives given when renewable energy is being used, when rain harvesting is being carried out

**Recommendation 37**: **The WG recommends that minimum energy performance standards for equipment should be enforced and that the existing policies and regulations should be made stricter for new developments (Short Term)**

- Minimum energy performance standards for equipments
    - New regulations about energy efficiency for new developments
    - Review policies, regulations and enforcement. EIA regulations stricter

**Recommendation 38**: **The WG recommends that the input of local consultants should be promoted in local projects (Short Term)**

- Land use planning for housing
    - Promotion of mixed-use development, mixed use of buildings specially public buildings should be encouraged
    - Integrated holistic approach to development
- Capacity building , Education
    - Creation of awareness
    - Allocation of resources for training and capacity building
    - Local consultants for new projects
    - Recruitment of architects, legal counsellors... in local authorities in order to empower the local authorities

**Recommendation 39**: **The WG recommends that there should be new regulations for new buildings relative to energy consumption (Short Term)**

**Recommendation 40**: **The WG recommends that there should be new guidelines to promote sustainable development and there should be incentives provided to people in order to encourage them to adhere to these new guidelines (Short Term)**

- Regulations for new buildings
    - Star rating relative to energy consumption– related fiscal policies
    - New guidelines to promote sustainable development and to encourage people to adhere to guidelines – fiscal incentives
    - Encourage Rain harvesting

**Recommendation 41**: **The WG recommends that there should be new regulations for existing buildings relative to energy consumption in order to encourage owners to convert these existing buildings into green buildings (Short Term)**

- Regulations for existing buildings and for conservation of heritage buildings
    - Convert existing buildings to green buildings, Optimise use of existing buildings

# 7 Industrial/Manufacturing processes

## 7.1 INTRODUCTION

Mauritius has successfully diversified its economic base and per capita income has increased continuously, standing at $ 7,100 in 2009, which is about four times higher than the African average. Economic and social indices reveal a prosperous, open and an equitable economy alongside social stability and a conducive environment for businesses. Mauritius has also successfully withstood the global financial crisis, despite a slowing down of the economy. By 2011, it is expected that the economy will return to its growth path of 5% or higher.

Government enacted the Export Processing Zone Act in 1970, which converted the whole island into an export processing zone and provided a range of incentives to promote the development of export processing activities. The co-existence of an import substitution strategy and the export-oriented strategy, as a two-pronged approach, met with considerable success over three decades in diversifying the economy, promoting an industrial culture, generating exports, creating employment and driving economic growth. Manufacturing has, therefore, played a pivotal role, contributing significantly to the GDP, employment, exports and foreign earnings. However, external challenges stemming from trade liberalisation and globalisation have been adversely impacting on the sector, leading to contraction of employment and drop in exports. The sector would need to develop supply-side capabilities to adapt to the more open global environment and optimise on opportunities stemming from, inter alia, enhanced market.

The sector comprises about 92,000 establishments, employs some 209,000 workers and accounts for some 20.8% of GDP (CSO Census of small establishments released in 2007). The major strengths include political stability, dynamic entrepreneurship, favourable trade agreements, strong public/private sector dialogue, and positive economic and social indices.

## 7.2 STOCK-TAKING

### 7.2.1 The existing policies/strategies

- Industrial and SME strategic plan 2010 – 2013

The direction and destination provided by the vision for the industry sector is to build up a strong, diversified and globally competitive industrial sector supported by Knowledge, Science, Technology and Innovation. The direction was also discussed at a consultative workshop which emphasised the need for Mauritius to develop a competitive industrial sector producing high value added products and services and to position itself as a hub for

knowledge, logistics/distribution, finance/business and service oriented activities. This statement defines a corridor of development which provides a long-term guideline for industry and SMEs strategies. In defining its strategies, Mauritius has to inspire itself from the experience of successful East Asian economies that have adopted a structuralist approach underscored by strong Government intervention to steer their economies on a high growth path.

### 7.2.2Existing institutional set-up

- Ministry of Industry and Cooperatives
- Enterprise Mauritius
- Mauritius Export Authority
- Board of Investment

## 7.3 GAP ANALYSIS

The weaknesses of this sector as defined by the WG are:

- Lack of technology/know-how and lack of awareness about efficient use of energy
- No framework to encourage energy saving and the subsidised price of electricity. As such Industries are not encouraged to decrease their electricity consumption.
- Industries do not implement proven solutions as they are not really interested or aware about sustainable development and there is often a technology barrier.
- Lack of capacity building and training & lack of understanding of embodied energy. The concept of embodied energy aims to find the sum total of the energy necessary for an entire product lifecycle. This lifecycle includes raw material extraction, transport manufacture, assembly, installation, disassembly, deconstruction and/or decomposition.
- Comfort requirements of employees: employees are used to a certain level of comfort (air conditioning, ...)
- The sector depends a lot on energy, which has a volatile cost.

The WG identified actions taken in the actual context which were considered to be NON-MID practices:

- Subsidisation of polluting fuels
- A linear throuput economy (cradle to grave)

## 7.4 CHALLENGES/EMERGING ISSUES

One of the major issues identified by the WG was that this sector was benefiting from government subsidies concerning energy. This was a major concern as the industries were therefore not too concerned about making an efficient use of energy consumed or about producing their own energy. The WG was also concerned that there was lack of awareness of concepts of embodied energy.

## 7.5 RECOMMENDATIONS

After analysing and assessing the trends in Mauritian industries and Based on pilot studies in Mauritius where an effective reduction in energy use after an energy audit in Industries, the WG comes up with the following targets:

**Targets**: Energy consumption will be equal or less than of the 2010 level

After analysing the actual situation in the local context, the WG makes the following recommendations:

**Recommendation 42**: **The WG recommends that there should be awareness campaigns about energy efficiency and incentives should be given to industries to establish energy efficiency processes (Short Term)**

- Increase and create awareness about energy efficiency
    - Incentives to establish energy efficiency process/ equipment - fiscal policy or funding mechanism : remove or lower VAT
    - Providing professional input on energy efficiency. Continuous professional development and capacity building were needed to increase awareness about energy efficiency.

**Recommendation 43**: **The WG recommends that there should be new regulations regarding labeling of equipment and minimum energy performance standards for equipments (Short Term)**

- Energy labeling schemes should be established for commonly use energy intensive industrial equipment (boilers, compressors, pumps)
- Minimum energy performance standards should be established for industrial equipment entering the local market.

**Recommendation 44**: **The WG recommends that there should be Energy audits in industries and assistance should be given in the implementation of recommendations (Medium Term)**

- An Energy audit scheme should be established especially with regards to high energy users
- Financial incentives and technical assistance should be provided for implementation of recommendations of audits (it was observed that some organisations which had undertaken energy audits had reduced their consumption of energy drastically in the first year after the audit was carried out as the audit had allowed them to identify the sources of 'wastage'.)

**Recommendation 45**: **The WG recommends that the administrative process for industries using sustainable sources of energy should be facilitated in order to encourage industries to use lesser carbon fuels with less emission (Medium Term)**

**Recommendation 46**: **The WG recommends that industries/warehouses should be encouraged to produce part of their energy and assistance should be provided to help them (Medium Term)**

- Use low carbon fuels
  - Facilitate the administrative process for industries using sustainable sources of energy and encourage industries to use lesser carbon fuels with less emissions
  - Industries/Warehouses should be encouraged to produce part of their energy and assistance should be provided to help them

**Recommendation 47**: **The WG recommends that industries should be encouraged to use waste or by-products of processes to produce energy (Medium Term)**

- Use of waste to produce energy, Use of by-products of processes

**Recommendation 48**: **The WG recommends that industries should adopt Industrial ecology principles and design…ST**

**Recommendation 49**: **The WG recommends that there should be a clustering of shared facilities in order to make an efficient use of the existing facilities: short to medium term**

- Adopt Industrial ecology principles and design: the WG observed that ecology concepts were sadly lacking in the industrial sector. The WG also proposed that there should be a clustering of shared facilities in order to make an efficient use of the existing facilities.

**Recommendation 50**: **The WG recommends that industries should be encouraged to promote a circular economy: medium to long term**

- A circular economy where materials should be reused as new raw materials at the end of their cycle. This is called completing the cycle and there is less consumption of resources and energy in a circular economy.

# Energy - The Supply Side

# 8 Stock-taking of existing policies and projects – supply side

## 8.1 The existing policies, strategies and legislative frameworks

The WG on Energy positions itself relative to the existing policies, strategies, frameworks and projects in the following way:

- It is a bottom-up participative approach, systemic in perspective and based on a shared vision of MID instead of a 'business-as-usual' scenario.
- Economic, social and environmental dimensions must necessarily be reconciled and cross-sectoral implications must be considered holistically at the root of their occurrence.
- Concrete Coherent Common Recommendations stipulated in this document will be integrated in future policies, strategies, frameworks and programmes as appropriate, including beyond the energy sector.

While it is generally accepted that the private sector and civil society have key roles to play in providing access to energy services, it is essential that the public sector is able to regulate and set policy in order to ensure that wider aims (poverty alleviation and environmental protection, for example) are achieved. In many cases, the roles of the various actors and the relationships between the sectors (public, private and civil society) need to be strengthened. The working group is of the opinion that even though legislations exist, the public institutions often either lack suitable structures or the necessary human resources or other means (access to data for example) to implement them. The group considers that there is room for improvement in enforcement of legislations in the Republic of Mauritius.

**List of relevant legislation and policy papers**:

- MID Green Paper, 2011
- Long Term Energy Strategy, 2010 Ministry of Energy
- Renewable Energy Master Plan, 2011 , Ministry of Energy
- Long-Term Transport Strategy Document, 2011, Ministry of Land Transport
- Energy Statistics 2009, CSO
- Blueprint for the Energy Sector, 2010, NESC
- CEB Strategic Plan
- Outline Energy Policy 2007- 2025, MPU
- Presidential Address 2005
- Multi Annual Adaptation Strategy 2006-2015
- National Environmental Strategy 1999
- Port Master Plan 2002-2025
- Energy Efficiency Act
- Environment Protection Act 2002

**According to the Green Paper on MID, Energy is considered a high priority theme as far as the sustainable development of Mauritius is concerned. In view of the increasing global price of fossil fuel and the known ecological impacts, there is an urgency to move towards a sustainable energy future.**

The Ministry of Renewable Energy and Public Utilities, which is also the parent Ministry for the Electricity Utility, holds the national responsibility for energy.
Other stakeholders include the following bodies:

- Ministry of Finance and Economic Empowerment
- Ministry of Public Infrastructure, Land Transport and Shipping
- Ministry of Environment and National Development Unit
- Ministry of Agro-Industry and Fisheries
- Ministry of Industry, Science and Research
- Ministry of Local Government, Outer Islands and Rodrigues,
- Central Electricity Board
- Maurice Ile Durable Fund
- Mauritius Sugar Authority

To encourage competitiveness in the energy sector and in view of enhancing operational efficiency, a Board of the Regulatory Authority is expected to be made operational soon.

Government also envisages to proclaim the Electricity Act 2005 to regulate electricity services and stimulate reforms in the electricity sector, including improvements in the standards of customer service and consumer protection. The current regulatory framework which consists of the CEB Act and the Electricity Act 1939 will be superseded by the Electricity Act 2005 once it is proclaimed. Other relevant legislations pertaining to the sugar industry is the Sugar Industry Efficiency Act, amended in 2007, and the Environment Protection Act 2002 provides us with a local legislative framework to protect the environment.

The role of the regulator is currently being discharged by the Ministry of Public Utilities, however the need for an independent regulator is often felt. To address the issue, the Utility Regulatory Act is expected to be proclaimed by the end of this year.

An Energy Strategy 2011-2025 Action Plan is also in preparation with specific provisions to address some of the major shortcomings in the Energy Sector. This energy strategy will set targets for establishing an Energy Management Office, collaborative plans for capacity building and training of personnel and the setting up of a database on energy efficiency (Observatoire de l'Energy among others).

The target for renewable energy for power generation over the period 2010-2025 as per the Long Term Energy Strategy is shown below in Figure 3.

| **Fuel Source** | | **Percentage of Total Electricity Generation** | | | |
|---|---|---|---|---|---|
| | | **2010** | **2015** | **2020** | **2025** |
| **Renewable** | 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% |
| | Geothermal | 0 | 0 | 0 | 2% |
| | **Sub-total** | **20%** | **24%** | **28%** | **35%** |
| **Non-Renewable** | Fuel Oil | 37% | 31% | 28% | 25% |
| | Coal | 43% | 45% | 44% | 40% |
| | **Sub-total** | **80%** | **76%** | **72%** | **65%** |
| **TOTAL** | | **100%** | **100%** | **100%** | **100%** |

***Figure 3: Renewable Energy Strategy 2010-2025***

## 8.2 CURRENT PROJECTS

According to the Government, the following projects are expected.

**Renewable Energy Projects**

1. **Wind projects**

   **Plaines des Roches :** Wind Farm of 18 MW in two phases: 10 MW in Phase I and 8 MW in Phase II.
   **Curepipe Point:** Setting up of a 20-30 MW wind farm (with an option of a 10 MW wind farm).
   **Bigara:** CEB to set up a wind farm of four wind turbines of 200-300 kW each.
   **Rodrigues**: Wind project will be extended at the following Places: - 3 additional wind turbines at Grenade and Trefle . New wind farms at Anse Quitor and Pompez.

2. **Photovoltaic (PV) Project**

   Expressions of Interest for the setting up of grid-connected solar photovoltaic (PV) energy projects of capacity up to 10 MW in Mauritius by private developers have been launched by the CEB.

   Photovoltaic projects will be extended to Rodrigues as well.

3. **Micro Hydro Project**
   A contract has already been awarded for the setting up of a micro hydro plant of similar capacity at Midlands Dam to be commissioned in March 2012 and to generate some 1 GWh.

4. **Landfill Gas Project at Mare Chicose**
   3 MW land fill gas-to-energy unit at Mare Chicose by Sotravic/Bilfinger to generate some 110 GWh over a period of 5 years will be operational in July 2011.

5. **Small Scale Distributed Generation (SSDG)**

   To democratize the electricity sector, the CEB has embarked on the SSDG Scheme in December 2010 for residential, commercial and industrial consumers to produce their own electricity from renewable energy sources, comprising wind, solar and mini-hydro technologies, and export any excess to the CEB grid.

6. **Geothermal Energy project**

Request for proposals has been sent to 10 shortlisted firms.

**Electricity Supply**

7. **Fort Victoria Power Station**

The installation and commissioning of 2x 15 MW diesel generating sets at Fort Victoria Power Station have been completed in September 2010. Installation of four additional units is in progress at the Fort Victoria Power Station and commissioning of the units is expected in July 2012.

A recent survey has demonstrated that people in Mauritius are willing to shift from private cars to common transport provided it is reliable, comfortable and cost competitive.

It was observed that many cars travel with single occupants in peak hours. However there was a need for further studies on the overall impact of buses on our road network system as compared to cars.

# 9 GAP ANALYSIS, CHALLENGES AND EMERGING ISSUES – supply side

## 9.1 Introduction

Total energy requirements have grown steadily at around 5% yearly during the last decade. While the rise in the energy demand may be attributed to the pace of economic development, the consequences are reflected in the financial burden which the country has to face, coupled with the negative environmental implications of consuming fossil fuels.

Energy demand has been growing faster over the than GDP over the past decade. While GDP has grown by 85% from 1992, electricity sales have grown by 166% over the same period. (Outline Energy policy, 2007)

The working group questioned whether a DECOUPLING had started already with energy growth and demand.

Given that 80 % of our energy comes from fossil fuels which are becoming scarce – the question raised was: 'Was it time to move towards **a mix of renewable energy'**. Should the government opt for Renewable Energy Technologies, what would be the potentials for the Republic of Mauritius?

Instead of hedging funds to safeguard versus oil price hikes, the WG was of the view that 'why not invest' or 'hedge' in this way on RET?

The WG was also concerned with the upcoming ISO national policies, relevant measures that developing countries and SIDS will be required to take to implement such policies. The idea of an 'Integrated development' as a possible future solution was raised. It was also noted that cost of solar panels was going down in some countries and this would change the future of solar PV.

Energy considerations should however not be limited to the generation of electricity but rather considered as energy requirement for transport (48-50%), heat (25%) and electricity (25%).

**Members noted that the total forecast for 2025 for Renewable energy has been set at 35% according to the current strategy. There was general consensus that the target set for Renewable Energy was low and more should be achieved given the various potential that exists. It was argued that we can work towards a REALISTIC higher figure – this will make more sense towards sustainable development.**

## 9.2 Primary energy requirement

The total primary energy requirement is the sum of indigenous production (hydro, fuelwood and bagasse) and imports less re-exports and bunkering, after stock adjustments. Final energy consumption is the total amount of energy required by end users as a final product. End–users in Mauritius are categorised into six sectors, namely manufacturing, transport, commercial and distributive trade, households, agriculture and other.

The total primary energy requirement of the country decreased by 4.1 % from 2008 to 2009 (from 1,404 ktoe to 1,347 ktoe). The WG considers that the decrease is mainly due to a shift from energy intensive sector to less energy intensive processes (e.g. reduced activity in the textile sector and increased activities in the IT sector) as well as slowing of economic activity.

## 9.3 Local production

The local production comprises of renewable including bagasse (92.2%), hydro /wind electricity (4.5%), and fuelwood (3.3%). Total energy production from renewable decreased by 10.6% from 264 ktoe in 2008 to 236 ktoe in 2009. This was primarily due to a reduction in the production of bagasse. However, production of hydro/wind electricity increased from 9.3 ktoe in 2008 to 10.7 ktoe in 2009. Some members were of the opinion that the decrease in land area available for cultivation did not reconcile with the valorisation of the bagasse.

It is imperative to manage environmental impacts associated with the energy production. Not only the $CO_2$ emissions cause damage to the environment, but also coal ashes have to be properly managed as well.

The WG considers that it was crucial to reflect on Climate Change and their opportunities/barriers towards low carbon pathways.

**How can we use our energy sources in a sustainable way?**

The pursuit of efficiency in the use of energy usually in the form of DSM is a high priority, when it comes to meeting increasing electricity demands. Energy efficiency measures can usually be taken immediately and often without major investment, especially at the end-user level. It is widely known truth that the cheapest KWh is the **one saved.**

**Sustainable energy growth**: everyone agreed that 'whatever the source of energy that we had, we would have to look at the optimal use of all the available resources of Mauritius'.

**Optimisation of available resources / renewable energy**: currently optimisation of bagasse was the prime focus, but in the near future we would need to consider other issues about future potentials like wind and sun, molasses, ethanol (we are exporting about 30 million litres of ethanol). It was also agreed that it was important to take a holistic approach and not to take only a product view or a sector view in this aspect.

## 9.4 Imports of energy sources

Imported fuels account for 82.5% of our total primary requirement, which is very high as compared to the locally available source supplies (accounting for the remaining 17.5 %).

One member pointed out that a recent study demonstrated that the ratio of 'Imports of Mineral fuel and lubricants' to 'Export of Good and Services' was currently 1:5 (or 20%). If this is increased to 30%, the saving rate of the country will fall from 12 % to 0 % and this will be disastrous for the local economy.

*(IMFL/EGS %)

IMFL: Imports of mineral fuel and lubricants

EGS: Export of goods and services

It was considered important for the MID process to understand that the over arching dynamic is the depletion of oil and coal. A member pointed out that the probable occurrences of peak oil and peak coal would be in the years 2015 for oil, 2020 and 2040 for coal. China is currently producing and consuming 50% of world's coal. It is expected that in 10 years China will double its consumption of coal and thus reduce its availability on the market for other users.

## 9.5 Electricity sales, consumption and generation

The importance of sugar-cane sector was acknowledged. However, it is true that bagasse will eventually have a physical limit (decrease of cultivation of sugar cane due to market forces). Members were of the opinion that in the long run, the sugar industry could be transformed from a sugar-base industry to be more a bio-mass industry. However there was no guarantee that the resulting industries would be as sustainable and there will need to be more research to respond to such queries.

There was general consensus that our priority would be to consider a transition away from coal and oil.

**Electricity sales, consumption**: Electricity sales have increased and the per capita consumption of electricity sold per annum stood at 1,623 kWh (C.S.O, 2009).

### Energy consumption and transport

Biofuels are reliable sources of energy for both private cars and public transportation in Mauritius. Given that there can be shifts of Energy usage patterns in the near future (less private cars), the demands for energy will also be changed.

There was general consensus that Mauritius is not on a sustainable trajectory at the moment and that our lifestyle was too much energy intensive. Increasing the pace of consumption moves us towards the depletion of resources.

It is a fact that Mauritius has to go towards Renewable Energy but we have many concerns about the current wastage of energy e.g. from the transport industry and domestic sector.

Members expressed that there are significant opportunities in areas for Sustainable Consumption and Production.

All renewable forms of energy should be considered for electricity production for the private transport otherwise this will impact with peak demand problems being faced currently.

It was reported that second generation of fuels were on the way and entering into picture soon.

The issue of possible utilisation of sugar cane juice for production of ethanol and some equity issues were also raised.

## 9.6 Agriculture

Energy consumption is mainly for irrigation purposes and diesel oil is used for mechanical operations in fields. Some members expressed that in order to promote sustainable energy, the agricultural sector should be diversified. It was reiterated that as fossil fuels will become scarcer, food security will become a serious issue. Members strongly believed that agriculture and energy are closely interlinked. Future energy decisions will certainly impact on the current agriculture.

## 9.7 Gender and energy

Energy has an important role in women's lives as regards their domestic responsibilities as well as their entrepreneurship, social and community activities. Members were of the opinion that there needs to be more capacity building programmes to enable women to participate in the energy sector through partnerships and networks among grassroots level, NGO's and energy policy makers at the national, regional and international level. ***It was felt that websites were reachable to the educated mass whereas it is not much reachable to 'grassroot' women.***

## 9.8 Main Energy Indicators

- Among the main energy indicators used for Mauritius, we note that the following: total primary energy requirement, total primary energy requirement index, import

dependency, GDP, Energy intensity, Mid year population, Per capita primary energy requirement and final energy consumption.

- There was general agreement that GDP only cannot be a measure of energy sustainability for the Republic. First, given the highly volatile global economic environment it is hard to predict GDP, sufficiently accurate, for the medium and the long-term. Even the one-year lead GDP projection is reviewed on several occasions during the planning year. Given this condition, the suitability to use GDP as a predictor eventually weakens.

# 10 RENEWABLE ENERGY SOURCES

Renewable energy sources were discussed and a SWOT analysis was conducted for each of the sources that the WG recommends. A summary of the outcomes is presented below and the main points in the SWOT analysis for each RE source is also listed

## 10.1 Bagasse / cane biomass

Sugar cane cultivation has been practiced for more than three centuries in the country and there is sufficient local expertise to run the plants in the most economic and efficient way. A decline in the land area under sugarcane cultivation is observed. To address this issue, several incentives have been given to small planters to stay in this business.

The cane biomass production potential in Mauritius is normally above 100 t/ha on an annually renewable basis in a normal year (when cane crop is not severely affected by a cyclone or drought).

Mauritian sugar factories process around 5.2–5.8 million tonnes of cane annually and during the sugar extraction process for the recovery of sugar, about 1.8 Mt of bagasse is produced as a by-product, or about one third of the sugarcane weight (MAIF, 2005).

However, it is forecasted that an annual potential of 750 GWh is possible if the optimum amount of electricity is derived from each unit of bagasse through state-of-the-art cogeneration plant (Seebaluck, et al., 2007).

The electricity generation capacity from sugarcane biomass can be further increased by cogeneration of the total sugarcane biomass that is cane tops and leaves based on a proper collection system.

In a configuration of cogeneration, efficiency is above 80 % with coal and bagasse. For a mixed bagasse coal process, the efficiency of the plant in condensing mode is 26% instead of 30-32% when it is used in a pulverized coal fired boiler with an optimal thermodynamical cycle .

The contribution of bagasse, in itself represents a potential national foreign exchange saving of some 20 Million USD in the annual energy bill.

S: Locally and easily available resource; wide experience in the sugar industry in its use; can be used at will for power production; manageable electricity output; stable source of supply of energy; vast potential to explore other by products of the sugar can industry; scope for improved efficiency through co-generation.

W: Limited to one crop season, limited storage (shelf-life) of bagasse, low efficiency / under-utilised efficiency of coal, issue of equity and ownership of the resource.

O: To cogenerate at higher pressure for bagasse (upgrade efficiency of the plant; To convert actual plants into gasification and combined cycle generation; Pelletisation of bagasse; Torefaction – converting bagasse into coal like pellets ( need investment in new technologies); Land use recovery; To do more research in producing high fibre content cane; Recover trash and generate electricity (additional biomass); Convert actual trash in 'ballot de pailles' for future use; Cane tops still provides as organic nutrient to soil as it is left in the fields.

T: Urbanisation, land converted for other developments than sugar cane growing; As bagasse is a by-product of sugar cane industry, it is dependent of the international market price of sugar, fluctuation of which can affect its production; Sugar cane industry is highly dependent on transport which is in turn dependant on the fossil fuels; production cost of sugar may rise; Politically sensitive; Increase in price of fossil fuel will increase.

## 10.2 Wind

Wind power has come of age during this decade. If it fulfils its promise it could provide as much as 5 % of the world's electricity by the year 2040.

Researchers from Harvard and Tsinghua University have found that China could meet all of their electricity demands from wind power through 2030.

Mauritius is for the major part of the year exposed to windy conditions of the South East Trade Winds, and this is conducive for wind energy exploitation. The wind regime in some areas has an annual average speed of 8.1 m/s at 30 m above ground level. Pilot projects in the mid 1980's were not successful as the wind turbines were damaged by cyclones after about two years of operation.

The recent pilot project in Rodrigues, comprising three wind turbines each of a capacity of 60 kW, has proven to be a success.

A memorandum of understanding has been signed with the Government of India for renewable energy development in Mauritius and Mauritius will benefit from technical assistance in terms of appropriate studies in this area.

The energy produced by a wind turbine is proportional to the swept area of the turbine and is also proportional to the cube of the wind speed. Wind energy is most cost effective when average wind speeds exceed 7.8 metres/second at a site.

Wind turbines now have fewer components and greater reliability with more controllable output and grid compatibility. Variable speed systems with synchronous generators now integrate better in existing grid systems leading to potentially higher penetration even on weak grids. Wind energy has become more predictable leading to a higher value for the capacity credit given to wind power and thus a higher value due the electricity produced.

Energy generation costs of wind power are dictated by four major factors:

1 local average wind speed
2 energy output of the system
3 project turn-key cost
4 life span of the wind farm

S: Local and free resource; Little environmental impact; Proven technology; Minimal carbon footprint; Low maintenance; Land use still permissible under the wind mills (dual use of land)

W: Localised and site dependant; Variability; Electricity storage; Non despatchable (unless it is stored); Noise pollution can be significant; Visual impact; Beyond specific heights, it is not suitable to be positioned near airports; Non-availability of a local wind atlas (a requirement for most international promoters) ; Not more than 150 MW; Need to take into consideration conflicting future land use and land developments; We do not have offshore technologies

O: To study development of wind technology off-shore; Can be an incentive for small promoters who are willing to operate Micro wind turbines as an off grid system or hybrid off grid and on grid systems;

To explore higher capacities: Open tender

T: Impact of marine ecosystem for offshore developments; Extreme weather conditions; Destabilisation of the grid; Equity issue (ownership of the system); 20 MW – landuse equivalent is approx. 60 hectare

## 10.3 Solar / PV

There are four major solar energy processes:

1. Photovoltaics involve the direct conversion of sunlight into electricity, through a modular arrangement of solar cells in flat plate or concentrators.
2. Low temperature solar thermal systems are used to heat water, air or other medium.

3. High temperature solar thermal systems produce high-temperature heat that is then converted to electricity in a conventional cycle, through a concentrator system. There are no systems producing electricity by this method in Mauritius.
3. Passive solar systems seek, by design, to reduce space cooling (heating) and lighting (Some buildings are now designed to take advantage of daylight (glass-covered roof)

**PV**

Photovoltaics are solar cell devices that absorb light and convert it into electricity through the use of semi-conducting materials. Sunlight has a maximum power of 1000 W/ $m^2$, so solar cells must cover a large area in order to collect important amounts of power. At the international level, the main field of PV application in the last decade was the basic electrification of mostly rural households with Solar Home Systems. Only if, and when, PV comes into economic reach of the utility power market, will there be rapid growth. Internationally, PV has developed a market niche in telecommunications, signalling, leisure, water pumping and stand- alone rural electrification. However, large-scale penetration of PV is happening in many parts of the world and is expected to progress further.

The most direct application of solar energy is conversion of sunlight to heat. Solar water heaters for domestic and industrial use, such as hotels and hospitals, are the most frequent use of this technology in Mauritius. Some 30,000 households from a total of about 330,000 use solar water heaters for domestic water heating. The WG is of the opinion that the status of the grant scheme for solar water heaters is unknown. Due to the abundance of the solar energy resource in Mauritius, photovoltaic systems can be the prominent renewable energy technology on the island. However, this technology has some barriers for further expansion. The solar power is in fact more expensive that other methods of producing electricity.

S: Local and free resource; Little environmental impact; Proven technology; Minimal carbon footprint; More widely installed; Less susceptible to damage by cyclone; Scalable; Wider applications; Can be used on roof tops; Much higher energy density; Minimal technical maintenance

W: Quality of supply; Variability; decreasing efficiency over the years / at the end of lifetime

O: New technologies even more efficient; Recyclable PV after decontamination; Massive potential at all scales, must be further explored in Mauritius

T: Large solar power plants can have conflicting land use with other future land developments

## 10.4 Geothermal

Geothermal resources can be found in areas of high volcanic activity in many parts of the world. It may be categorized as hydrothermal, geopressured, hot dry rock and magma. Although considered as a well established and commercially available technology, its application to the local context is site dependent. Exploitation costs are very high as deep drilling is required to access the thermal source.

S: Source of firm power; Can be applicable to heating

W: Potential unknown; High cost of energy production; Ongoing study

O: Unknown

T: Exploitable sites can be protected sites and thus permit for development will be restricted: Digging can emanate gases to the atmosphere

## 10.5 OTEC Technology

This has not been commercialized yet and the government future strategy will depend on its adoption by other countries in the medium and long term.

## 10.6 Land Based Oceanic Industry

An innovative project which will be developed with the participation of the private sector operators after the exploitation of the deep sea water for air conditioning of green data centres at Flic en Flac.

## 10.7 Marine Biomass and any form of biomass except bagasse

Biomass may be defined as any organic substance other than oil, natural gas, and coal, i.e. fossilized sources. Biomass, mainly in the form of agricultural and industrial waste, burned to fuel conventional steam turbines to produce electricity, has been in use for many years.

Biomass is often regarded as “non-polluting” despite the large emission of carbon dioxide and other pollutants, because the amount of carbon dioxide emitted in the combustion process equals the amount absorbed from the atmosphere during the growth of plants and photosynthesis of atmospheric carbon dioxide.

Growing biomass for energy in an environmentally sensitive manner can provide a livelihood for farmers and help in restoration of lands.

Biomass electricity generating plants have tended to be small because of the dispersed nature of the feedstock. Biomass plants often rely on low or zero cost of the biomass fuel to be operated economically. With the advent of biomass-integrated gasifiers/gas turbines the unit cost of electricity production will decline in the future.

Biomass also has a problem of seasonality. A large quantity of biomass matter may be available in agricultural communities during the season following harvest, such as after the processing of sugar cane, but become scarce during the growing season. Adequate planning is required in order to effect a continuous supply of the biomass, to assure a steady output from the power plant. Biomass for energy will not play a significant role in oil substitution in the short-term.

Most developed countries have no immediate need, and consequently only long-term interest in developing certain biomass technologies.

Even so, some developed countries, although with abundant fossil fuel reserves, have already embarked on vigorous biomass production for energy use. General SIDS can lack the financial resources to expend on biomass development and thus most prioritize biomass projects by using rigid criteria such as the energy contribution potential, risk and pay-off time of each project.

Assessment, development, and utilisation of biomass resources should coexist with optimisation of oil usage, and energy conservation. Integrated waste disposal/energy generating projects are of special interest.

Positive benefits which obtain from solving environmental problems can offset some of the costs of energy generation from wastes.

The Mauritian biomass sources can include:

- Agricultural by-products e.g., sugar cane tops;

- Agro-industrial waste, e.g., vinasse (dunder) from the sugar industry;
- Municipal, domestic and animal waste, e.g., garbage, sewage, dung;
- Aquatic biomass e.g., water hyacinth; seaweeds
- Wood and woody materials, including wood chips from the lumber industry.

## 10.8 Cane juice / molasses / biodiesel

Biofuels till now under consideration are mainly of two types, namely ethanol (obtained locally from molasses) and biodiesel (made from imported/locally grown palm oil). Until now ethanol has been produced either for export or for use in the manufacture of rum. With the increase in oil prices, ethanol is becoming a viable alternative to gasoline for use in vehicles or even for imported diesel.

## 10.9 Biogas (methanisation of animal or other waste)

Animal dung (from cattle, chickens and pigs) and sewage are the resources for biogas. Mixed in a slurry of about 95 % water, they are fed into a specially built digester where digestion is allowed to take place for two to eight weeks. The bacterial action generates heat and the ideal process temperature is at least $35^{o}$ C. A well-run digester can produce 200-400$m^3$ of biogas with methane content of more than 50% or each dry tonne of input. This is about 65% of the fuel energy of the original dung. Even at lower conversion efficiencies the process may be worthwhile in order to obtain a clean fuel and dispose of wastes. The remaining effluent is also useful as a fertiliser.

S: Feedstock available; Flexible generation; Firm power; Proven technology; Can be used in existing coal boiler; Can have decentralised generation; Environment friendly; Possibility of Energy storage; Local experience available; Residue is a good fertilizer

W: Mostly for local application

O: Use of residue in agriculture; Wastewater pre-treatment; Methanisation from vinasse

T: Industrial compost; Competing use of vinasse (vinasse can be used for electricity production)

Actually vinasse is being used in fertiliser production

## 10.10 Hydro

The technology for small and mini hydropower can be regarded as being mature and reliable. Potentials for cost reduction refer to new materials and the application of the latest technology for the control and regulation of the plant.

Hydropower does have some environmental impacts that can be grouped in three main headings:

- Hydrological effects such as water flows, ground water, water supply and irrigation needs.
- The ecological effects – on plants and animals as well as the land itself.
- The social costs on landowners and displaced persons.

There is still little agreement on how to translate environmental gains into the economic data that are used in comparing options. One issue of current pertinence is the costing of long term compensation for people displaced or their productivity adversely affected by new hydroelectric installations.

It was acknowledged that only an enumeration of the SWOT could be done at this stage, however further study is required to qualify the arguments.

S: Local resource ; mostly despatchable; highly flexible; free resource

W: Limited potential; seasonal ; consumes large land areas; in building dams

O: Min / micro hydro; Potential of reuse of water downstream; Pump storage Possibility to rehabilitate old mini hydro plants in old sugar mills (existing civil works); To exploit hydro potential in Rodrigues (seasonal)

T: In future we will need to compromise water usage for domestic purposes versus power production from hydro (conflicting use)

## 10.11 Waste to Energy

The incineration of municipal waste was mainly considered here. An Integrated Solid Waste Management Strategy was stated as the foremost priority before consideration of any incineration possibility. Other existing sources such as incineration of sludge from fuel plants in incinerators together with waste were also considered. Members took note that medical waste incineration was becoming a problem and as an option, a centralised waste burning plant to incinerate fuel sludge and medical waste could become a topic for further

discussion. Dissenting comments were made from a member who considered that this energy source had no strength at all.

S: Valorisation of waste and reduced need for landfilling

W:Produces toxic emission and damage to the environment (dioxins and toxic ashes); low efficiency; risk of corrosion of tubes; 60% of green waste goes to incinerators can be composted ; Nutrients are destroyed if the organic matter is incinerated; low calorific value will require input of fossil fuel to increase efficiency; discourages recycling; expensive tipping fee; needs subsidies from government; site and location – a social issue ; our island is small and does not have enough buffer to cater for the pollution

O: there is an increase in waste per capita every year; It supports electricity generation; Incineration after sorting can have better potential; Production of biofuels from thermal depolarisation of waste can be an option; Burning of fuel sludge and clinical waste in a centralised system

T: Disposal of ashes; associated health problems with the emissions emanating from the incinerators; Siting and location can reduce property value of land in the vicinity of the incinerator; Current suggested technologies were not very promising in terms of emission controls; Lack of enforcement capacity to control the emissions

# 11 RECOMMENDATIONS – Supply-side

We are assuming that annual demand will have to be limited to 3% up to 2025 and to 2% from 2025 to 2040. This is the very implication of sustainability and this figure compares with that of economies achieving optimal energy management. The decoupling of economic growth and energy demand, if it has any meaning, will require that we meet such objectives at least. It is to be noted that in developed economies 1% GDP growth is driven by 1 % of energy demand growth, compared to 2% energy demand growth needed in emerging and developing economies.

Sweden has a remarkable example of decreasing/stable energy demand even with increasing GDP. Switzerland wants to do same with 2 kW per capita. Rather than energy demand, Kyoto-target committed countries may refer to GHG emissions instead of energy reminding us that we can increase energy demand whilst not producing GHG by having more RE.

But the cost implications during the energy transition make us retain energy rather than GHG as our reference. In no case does this mean having GDP as sole indicator for development.

This is all based on the discussions that took place where bioenergy was put highest on the agenda for our energy future along with smart grid , DSM and wind / solar PV.·

Sustainability criteria should be respected strictly.

- Future research should clearly determine whether or not a potential of geothermal and of ocean energy can be fully exploited within the set time-frame.
- In case the feasibility of the latter is proven, 100 % renewable energy target will be attained early and reliance on LNG, not to say fossil-fuels, will be reduced faster, subject to compliance with sustainability criteria.·

- The projections for the energy mix under MID should be finalised by consultants as per the recommendations made below on the orientations recognized by the WG as MID compliant.
- A range target is preferred in view of the consideration of sustainable criteria including food security considerations and the time required in the implementation of projects.
- Many countries have today revised their fixed targets. Besides, the flexi-factory or bio-refinery concept at the heart of the discussed strategies allows for variation in outputs.
- Biomethane and Biofuels can be also used flexible ways (transport or power). Smart grid also blurs the barrier between producer and consumer (the latter become a prosumer).
- MID-compliant options include advanced Biofuels, waste-derived fuels after integrated waste management, biomass-derived fuels, advanced gasification technology with cogeneration/trigeneration potential according to sustainability criteria including food security.
- Institutional and regulatory reforms towards a more comprehensive role for the Energy Regulator should go beyond the electricity domain. Roles and responsibilities of producers, distributors, suppliers and users should be defined.
- The promulgation of the Utility Regulation Act should be a first immediate step. Promotion of intelligent systems (smart grids) on the basis of a study to determine the framework to achieve ‘’démocratie énergétique’’, with clearly defined roles of market players including service providers, utilities, local authorities and small communities as well as individual users should be done. The set targets for connection of smart-meters and producer-consumers (prosumers) will have to be finalised at the beginning of the study in line with set objectives. Feed-in tariff should be reviewed to reflect the set objectives, including other sources like bio-energy, with emphasis on small domestic prosumers (producer-consumer) of less than 10 kW with transparent, sustained, inflation-adjusted indexation of tariffs.

*New national indicators*

**Recommendation 1: New sustainable indicators for national development**

Instead of only GDP, a set of sustainable indicators should be introduced to gauge the progress of the Republic towards the MID vision. Sustainability criteria will include integrated consideration of environmental and social dimensions, not just economic factors. In particular, sustainable energy indicators should be adopted. While GDP growth has served us well in the past as a proxy measure of improving national well being, it is not appropriate in the new era of MID as the exclusive measure of progress. The process of defining such new indicators should start immediately as an exercise of participative democracy

*Reducing the threats posed by fossil fuels*

**Recommendation 2: All petroleum imports for local consumption be displaced by local substitutes by 2040.**

Mauritius has no known fossil fuel resources and therefore we must import 100% of consumption. Given the threats that high oil prices and supply interruptions pose to our economy and way of life, it is vital to decouple our economy from them as quickly as possible. Peak oil occurrence, as well as climate change are additional compelling reasons. Suitable substitutes for electricity generation are numerous renewable energy sources; for transportation and manufacturing – electricity and biofuels; and for fertilisers – recycling nutrients from societal waste. Such a strategy should be linked to the promotion of a green economy.

**Recommendation 3: Contingency plans be drawn up to cope with significant interruptions or reductions in petroleum-based fuel imports.** These would include such measures as car pooling, giving priority to public buses over private cars and rationing.

**Recommendation 4: All coal imports be displaced by local substitutes by 2040.**

Like other Small Island Developing States and low lying coastal nations, the Republic of Mauritius is extremely vulnerable to global climate change driven by GHG emissions. Therefore it is vital that we join countries like Bangladesh and the Maldives in calling for

dramatic reductions in global GHG emissions and in claiming compensation for the economic losses that they cause us. Such actions will be ignored if we continue to use coal, the most polluting fuel in terms of $CO_2$ emissions. Suitable substitutes are the same as for petroleum-based imports. A strategy decision is needed such as the one that Japan or Germany has taken relative to nuclear power. In the past, a similar resolution was shown for saving the Ferney Forest.

**Recommendation 5: A moratorium on new coal-fired electricity generation, possibly until carbon capture and storage or other control technologies are made commercially available.** In addition to $CO_2$ emissions, coal-fired power stations are relatively inflexible. This is a significant liability when trying to integrate variable renewable energies such as wind and solar PV, particularly in the context of smart grid or intelligent systems. This recommendation, however, was not approved by some members; it would imply for instance the impossibility to go ahead with optimal bagasse use in coal-bagasse plants.

**Recommendation 6: In order of priority, the following options are favoured for base-load power generation in the short/medium term**:

1. Biomass
2. Bagasse/Coal
3. LNG
4. Coal (high efficiency generation in terms of emissions /kWh) {This last option, ie coal-only, was not unanimously accepted. It was considered that it would be contrary to the MID vision and should, therefore, not be reckoned as a possible option in any event.}

[Cogeneration should be favoured wherever possible and sustainability criteria applied. In all events, Energy Management programmes with emphasis on energy efficiency should be forcefully implemented to avoid the need for additional capacity]

**Recommendation 7: If a transition fuel be necessary, LNG be considered subject to analysis in terms of investment, infrastructure, safety and sustainability criteria.**

In any event, by 2040 it should be phased out and replaced by alternatives like biomethane or Biofuels using the same installed facilities with appropriate modifications, if any.

*Energy from waste*

**Recommendation 8: The full potential of generating energy from societal "green" waste be exploited within the next 10 years.** Anaerobic Digestion (AD) is an appropriate, mature technology that generates biogas for electricity production while also producing a high value fertiliser (if necessary, after further composting) for food and energy crops. It is possible to add a "dry" AD process to the national composting facility. Setting up smaller plants on a municipal/district level to reduce transportation costs is also an option.

**Recommendation 9: The replication of the sludge digester at St Martin across all waste water treatment facilities as from next year.** This is a "wet" AD process that generates biogas for electricity production and a high value fertiliser (after further composting) for energy crops. Ideally, industrial effluent would be cleaned on-site to remove contaminants such as heavy metals before disposal into the waste water network. Biogas generation can be significantly increased by supplementing the feedstock with green waste. It is highly desirable that the electricity generators be put under the control of the CEB so that their flexibility can be utilised as peaking plant. Solid waste and liquid waste must be subject to the 3Rs.

**Recommendation 10: To consider production of energy of order of at least 5 % from biomethane by 2025.**

Biomethane is a clean form of energy that can be used also off-grid.

Further studies are also required to find the energy potential of SW remaining after sorting at source. An integrated solid waste management system needs to be put in place as soon as practicable.

**Recommendation 11: The implementation of high flow AD for secondary waste water treatment within the next five years.** Upflow Anaerobic Sludge Blanket digestion is an appropriate, mature technology that generates biogas to supplement the output from the sludge digester. Additionally, it reduces the amount of subsequent aerobic treatment

required, hence saving energy. By applying tertiary treatment, such as that used at St Martin, the cleaned water can be used for irrigating energy crops.

*Energy from Solar PV / Wind*

**Recommendation 12: Installed wind turbine capacity be continually increased in line with the maximum that can be supported by the network.** Wind turbines are a mature technology and economically competitive with conventional electricity generation. Detailed wind maps and land studies will be required to confirm this, including in Rodrigues and Agalega as priority. The integration of wind turbines requires a highly flexible and responsive demand/supply network. Some Hawaiian islands have an installed capacity approaching 40% of their night-time demand (plus export capacity) with plans to increase this to 80%. Our network will require significant enhancement to achieve similar values.

**By 2025 to increase our target for power production from Wind Energy and Solar Energy to 20 % through the promotion, particularly, of smart or intelligent systems.**

Subject to conditions: land use, sustainability criteria, accessibility and stability criteria (e.g storage)

Further studies will be required to consider viability of off-shore wind systems. Material scarcity may occur and hence increase price of solar panel. New design of panel and new technology are expected to lower future costs.

**Recommendation 13: Installed solar PV capacity be continually increased in line with the maximum that can be supported by the network with early measures to promote smart or intelligent systems.** The potential land-based installed capacity is far in excess of what we will ever need but is limited by land use conflicts. The integration of solar PV requires a highly responsive demand/supply network and installed capacities in excess of midday demand (minus installed wind capacity) require electricity storage capability. We fully expect the cost of solar PV to significantly reduce over time; therefore we consider that subsidies to improve the flexibility of the network are a higher priority. Investigations are needed to determine if it is possible, and under which conditions, storage technology can be implemented to optimise use of solar PV.

*Energy from Hydro*

**Recommendation 14: Investigating and exploiting the full potential of hydroelectricity.** Potential increases can come from replacing inefficient equipment, refurbishing unused head turbines in streams and the water supply network. While much electricity generation will be dependent on rainfall and end-use, the rest will be dispatchable. This latter capacity has very fast response times which can increase the flexibility of the demand/supply network. Stored hydro potential should also be investigated. Even if the share of hydropower may decrease with time, in absolute terms it will be an important input particularly during peak hours.

**The set target of power production from hydro was: to maintain a 2% power production from this source until 2025.** There is also an urgent need to improve efficiency of actual production plants, taking into account change in rainfall patterns. However there may be conflicting water use with other sectors which have to be considered.

*Energy from agriculture*

**Recommendation 15: Agricultural land be optimised for the production of energy crops without compromising food security.** Energy crops are a store of solar energy; therefore they can be used to flexibly generate electricity or can be converted into transport fuels. Sugar cane is grown on nearly all our agricultural land, primarily as a food crop for export and so is optimised only for sugar yield. The by-products of sugar production (bagasse and molasses) are used for energy (electricity and ethanol respectively). There is significant scope to increase the total energy content, without affecting sugar production, by planting different varieties. Alternatively, agricultural land could be split between dedicated energy crops and food crops that contribute to local food security. Because of the importance of agricultural land to both energy and food security, it should only be converted to other uses in the most compelling circumstances.

**Recommendation 16: Abandoned and marginal agricultural land be dedicated primarily to the production of energy crops, subject to sustainability conditions.** The value of energy crops will almost certainly increase. Therefore, landowners should be encouraged to grow energy crops, if necessary by the use of subsidies or other incentives

that can be removed later. Should this land be converted for other uses, then the island's potential for flexible energy production will be reduced.

**Recommendation 17: The nutrients from harvested energy crops be recycled to fertilise food crops.** The nutrients in energy crops do not contribute to electricity or transport fuel production, indeed they can be damaging to high temperature machinery. Therefore, they should be collected and processed into a form that makes them available as fertiliser for food crops. In combination with fertilising energy crops with processed sludge from waste water treatment, this closes loop in nutrient recycling, eliminating the need for imported fertilisers.

**Recommendation 18: Electricity production from energy crops be optimised through the use of new technologies when they become available.** We note that the best efficiency with which the energy in bagasse is transformed into electricity in Mauritius is currently less than 30% in the condensation mode. This is by direct combustion. Indirect methods are possible whereby the energy crops are first gasified, either as syngas ($H_2$ + CO) or synthetic natural gas ($CH_4$). We understand that efficiencies of around 50% can be achieved through the use of Combined Cycle Gas Turbines (CCGTs) and that efficiencies in excess of 70% are expected using fuel cells. Flexible operation to accommodate the variability of wind and solar PV will result in efficiencies that are slightly less. While such technologies are not yet commercially available, they will become a vital component in displacing fossil fuels. In the meantime, integrated gasification combined cycle should be an area of strategic research. Biomethane can also be a substitute for LNG in the future and can be used in varied applications, including transport.

**Recommendation 19: Methods be explored to ensure the year round availability of electricity from energy crops.**

Torrefaction is a promising technique however it is not yet commercially available. Alternatively, the need for storage can be eliminated by the use of energy crops that can be harvested throughout the year or by recourse to pelletisation. These methods should be researched as an immediate priority.

**Recommendation 20: To maintain (increase if possible) the current land area of 60,000 hectares under agriculture.** There is a need to maximise yield from land (by using crops yielding more biomass).

It was acknowledged that will be competing land use (for food production, cultivation of biocrops for energy , inter alia any other land developments). Any biodiversity issues that will arise must be tackled promptly. A thorough study on competing land use should be undertaken. The optimal but sustainable use of marine resources and co-development in partnership with regional countries should also be looked into.

**Recommendation 21 (Bagasse/biomass): Target will depend on the policy which is to be driven by MID recommendations.** Within the framework there is a need to encourage producers to produce more bagasse or biomass in general.

An ambitious but realistic targets were set to 17 % power production from bagasse and up to 40% electricity production from bagasse/biomass by 2025. {Subject to sustainability criteria}

*Other sources*

**Recommendation 22 (Geothermal / Ocean energy) : We need to continue to investigate in this field and more future studies needed.** It was acknowledged that there is no generation of electricity from this source currently.

*Transport fuels from energy crops*

**Recommendation 23: Immediate decision to be taken concerning 30 million litres of hydrated ethanol available locally.** To promote the use of ethanol or synthetic Biofuels for public transport rather than private owned vehicles

**Recommend 24: To explore/ produce the mix of transport fuels that will meet our long term needs**. The choice of running buses on ethanol or diesel derived from energy crops will depend on and influence the mix of energy crops that are grown.

DISCLAIMER: RECOMMENDATIONS 25 - 40 have been made by members and need further consideration

*Energy for manufacturing*

**Recommendation 25: The manufacturing sector to phase out the use of fossil fuels by 2025**. Dependence on fossil fuels can be eliminated by improvements in efficiency, replacing diesel engines with electric ones and making strategic shifts to higher technology industries that do not require them at all. Businesses that require continuous heating (and/or cooling) and electricity can be co-located and supplied with both by combined heat and power (or trigeneration) facilities powered with renewable fuels.

*Transitional capacity replacement and expansion*

**Recommendation 26: Priority be given to investing in energy efficiency rather than new electricity generating capacity.** Generally, it is more cost effective to save electricity than to generate it. Any form of generation has environmental costs that are external to its finances and that are borne by society. Therefore, it is appropriate to subsidise efficiency improvements to encourage their implementation in order to avoid capacity expansion.

**Recommendation 28**: Detailed studies to be undertaken immediately to determine the most appropriate means of meeting our transitional requirements for capacity replacement and expansion (e.g, consideration of LNG)

**Recommendation 29**: New fossil fuel-based power generators be contractually obligated to displace at least 50% of their fuel requirements with local, sustainable substitutes by 2025.

*Improving network flexibility and stability*

**Recommendation 30: Implementing smart grid technologies before 2015**. The concept of a smart grid is evolving, but in essence it is an intelligent system for balancing supply and demand and ensuring network stability and resilience. It requires the deployment of communication technologies, software models which monitor and predict network changes, automated control systems and electricity storage. One important set of information, which

should be collected in real time, is the output from the variable sources so that their impact on the network can be monitored and compensated for.

**Recommendation 31: Implementing smart car charging**. The charging of electric cars will add on to the local electricity demands. The implementation of smart charging will allow the integration of a higher proportion of wind and solar PV as their variable output can be compensated for by dynamically switching chargers on and off.

**Recommendation 32: Investment in flexible generation.** Flexible generation means the capability to start and stop at short notice, to change output rapidly and to operate at low output levels with acceptable efficiency. This should be applied to both the private and public sector, to new installations and through modifications to current ones.

**Recommendation 33: Integrating emergency generators into the network in the shortest delay.** Emergency generators are located in hotels, hospitals and other buildings requiring security of supply. To maintain their reliability, it is necessary to start them on a regular basis. By making them dispatchable by the network, its peaking capacity can be significantly improved in a cost-effective manner.

*Removing barriers*

**Recommendation 36: Charging levies on fossil fuels to fund investments in the smart grid**. This both encourages the transition away from fossil fuels and pays for the technologies that allow the implementation of emission-free wind and solar PV in a direct and transparent manner and without recourse to public finance.

**Recommendation 37: Regulating the energy sector in a way that promotes the objectives of MID**. There is a perception that the CEB, acting as electricity generator, distributor, purchaser and supplier, suffers from conflicts of interest and is not always

transparent in its decision-making. Such problems can be eliminated by setting up an independent energy regulator who serves the national interest and is publicly accountable.

**Recommendation 38: To remove all subsidies on fossil fuels**. Assistance should be given to lower income groups. Removing subsidies will encourage efficiency and the transition to renewable energy.

**Recommendation 39: Removing all subsidies and cross subsidies on electricity prices**. Again assistance should be to lower income groups. Prices will then reflect the actual costs of production and ancillary services. It will encourage efficiency, especially in the manufacturing sector which is, at present, effectively subsidised by the commercial sector.

**Recommendation 40: Adopting electricity procurement practices that encourage private sector investment in flexible generation**. By paying a premium for load following and capacity payments for hot standby and spinning reserves, the private sector will be encouraged to invest in the flexibility required for the future.

**Recommendation 41: The WG recommends that the target of 2 million tourists be reconsidered**. The WG is of the view that high tourist arrivals can have negative impact on the sustainable future of the island within the proposed short-term period.

**Recommendation 42: The WG recommends that the target of tripling GDP in 2020 be reconsidered.** The WG is of the opinion that this target does not tally with MID concepts.

**Recommendation 43: The WG recommends that '24/7 concept' be reconsidered** as this concept is against MID concepts.

# 12 RODRIGUES

A working session was held in Rodrigues and the working group in Rodrigues made a SWOT analysis in order to assess the current situation in the island and to make recommendations for the WG on Energy.

The WG on Energy found that Rodrigues had its own specificity with its strengths and weaknesses. The strengths are:

- 8% annual electricity from wind
- Topography / wind regime favourable ( South East Trade Winds)
- Solar radiation
- ARER Report 2007 Rodrigues Ile Solaire
- Biomass – green waste
- CFL programme successful e.g Roche Bon Dieu
- Avoiding air-conditioning so far

The weaknesses were considered to be :

- No wind map
- No solar map
- Small-island grid integration limit
- Little avail of Solar water heater subsidies
- Lack of legal framework e.g on land-use and planning
- Poor enforcement e.g transport-related issues
- Too centralised on Port-Mathurin

**TARGET: to reach 75% of renewables in electricity mix by 2025 and self-sufficiency in energy by 2040**

## 12.1 Recommendations

- To store excess energy from renewables and use for pumping water and desalination with due attention to environmental issues.
- To produce solar and wind maps in order to make efficient use of these renewable resources (IMMEDIATE)
- To apply Building Code, transport and land-planning regulations ( IMMEDIATE)
- To promote hybrid vehicles through incentives, green procurement and CSR
- To make Port-Mathurin a pedestrian and/or restricted parking area within coherent transport and land-planning legislation – this could be used as a role model for other towns and villages in Mauritius
- To undertake Energy Management projects in airport, port and cold storage which are the highest consumers of electricity on the island
- To install off-grid applications in all remote areas
- High-rise buildings to be discouraged / banned
- To undertake full study on climate change impacts and adaptation
- To promote energy equity through dedicated programmes with respect to disconnection, low-income groups and woman participation
- To assess the potential of bioenenergy (green waste, biomass, coconut oil, jatropha, etc). The WG had reservations about the plantation of jatropha to be used as biodiesel. It was explained that this plant had been used in different countries (India, Mozambique) and it had not given the expected yields and it depleted the nutritional resources of the land. As such, the plantation of jatropha was not recommended in small island states and its use should be considered to be a threat.
- Integrated farming had also been carried as a pilot study in Rodrigues where waste was used to produce biomass and for fish rearing. Entrepreneurs lacked the resources and the know how to carry out such projects and it was proposed that there should be an integrated support to entrepreneurs.
- Promote good control enforcement and implementation of the policies in order to have a sustainable planning and development as resources were very scarce on the island

# 13 CONCLUSION

The Working Group on Energy has come up with concrete recommendations in each theme which will feed in the process of formulation of the MID Policy, Strategy and Action Plan. The participatory approach towards elaborating a strategy for sustainable development was an important exercise as it demonstrated that there is a general consensus and commitment among the citizens of the Republic of Mauritius on the need for a well designed land use planning and a national energy strategy.

It was agreed by all that the challenge is two-fold:

- Demand side: to reduce consumption of transport energy and decrease our dependency on fossil fuels
- Supply-side: to find the right mix of renewable energy options

By shaping the pattern of development and influencing the location, scale, density, design and mix of land uses, planning can help achieve sustainable development in many ways and will be an important tool in reducing the demand for energy.

There was also a general agreement that the population of the Republic of Mauritius needs to be more aware about the concepts of sustainability and be more conscious about the impacts of its actions especially when these actions do not lead to a healthy lifestyle. It was also to be noted that the geographic scale and positioning of the main island and the surrounding outer islands were not considered to be weaknesses but an opening towards great potentials for an integrated transport/ land use planning and renewable energy sources.

And the more public and private stakeholders are involved and the earlier the stakeholders' view is integrated in the decision making process and its development, the better will be the output whether it be for the Energy strategy, the transport strategy or the land use strategy. If given proper resources and organisation, such types of forums should be allowed to operate

on an ongoing basis and the Republic will certainly benefit from the interactions among industry, governments, environmental groups and broader community.

The recommendations made are meant to shed light on the orientation of the Energy policy that is considered MID-compliant according to stakeholders. It is not a prescriptive set of measures imposed on the authorities, but a clear expression of the direction we need to take to promote optimal energy efficiency, renewable sources as well as sustainable lifestyle.

The importance of a new MID economic paradigm as well as the need to respect sustainability criteria, including consideration of food security, are self-evident truths. These must be addressed in all urgency.

It is now required from the policy-makers to demonstrate clearly that the Republic has moved into a new MID era by adopting as soon as possible the first crucial decisions towards making the MID vision a reality.

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