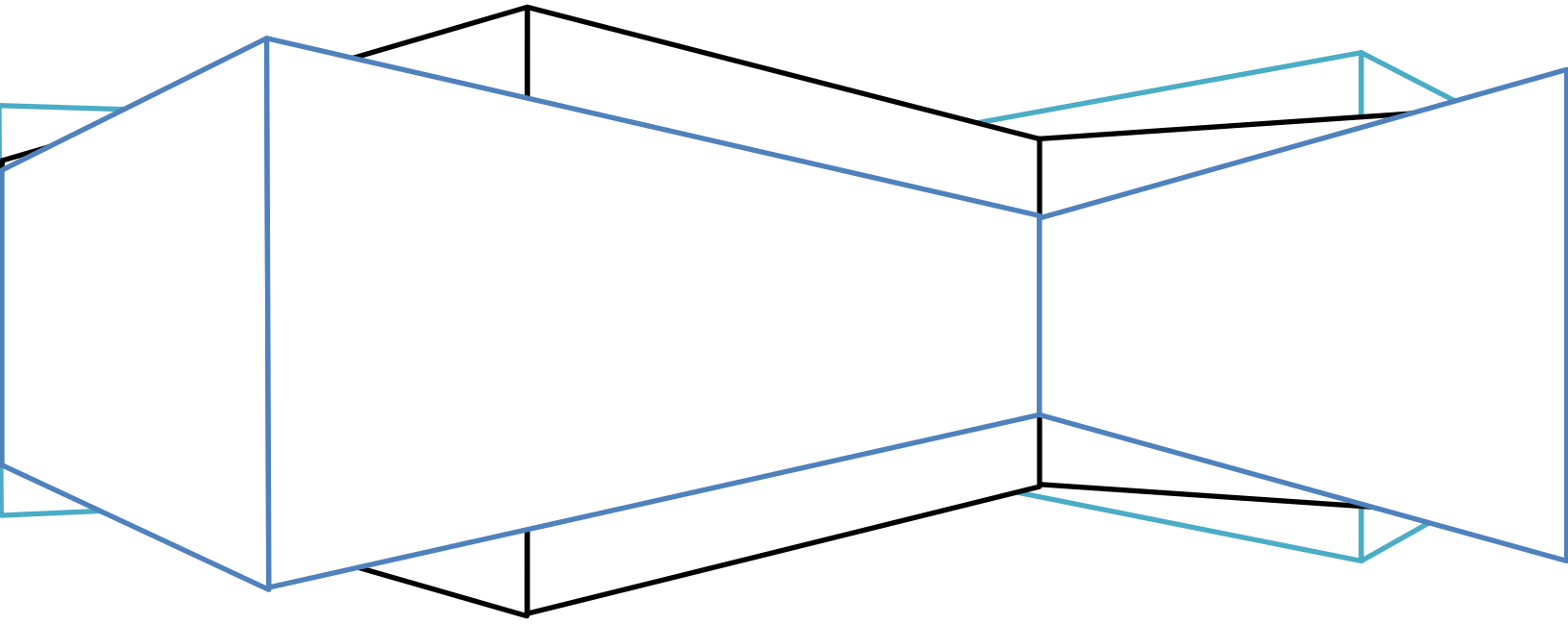
REPORT

A Coordinated Research Perspective on Sustainable Buildings in Mauritius

National Energy Research Group

February, 2012



Mauritius Research Council

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LIST OF ABBREVIATIONS

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie
CST	Centistokes
EAMS	Energy Audit Management Scheme
EEMO	Energy Efficiency Management Office
FM	Facilities Management
GEF	Global Environmental Fund
GHG	Green House Gas
ICT	Information, Communication and Technology
LPG	Liquid Petroleum Gas
MAURITAS	Mauritius Accreditation Service
MEPS	Minimum Energy Performance Standards
MITD	Mauritius Institute of Training and Development
MoTESRT	Ministry of Tertiary Education, Science, Research and Technology
MPI	Ministry of Public Infrastructure, National Development Unit, Land Transport and Shipping
MRC	Mauritius Research Council
MSB	Mauritius Standard Bureau
NERG	National Energy Research Group
RCx	Retro-Commissioning
SIDS	Small Island Developing States
VOC	Volatile Organic Compound

ACKNOWLEDGEMENT

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The Mauritius Research Council would also like to put on record its deepest appreciation for the following Guest Speakers for their participation and valuable contribution during the workshop on "Coordinated Research Perspective on Sustainable Buildings in Mauritius" held on 8th September 2011 –

- Dr P M K Soonarane, Ministry of Energy and Public Utilities
- Mr V Bhujun, ProDesign Sustainability & MEP Engineers
- Mr Tony Lee Luen Len, ECOSIS Ltd
- Mr R Ramjit & Mr D Seeburrun, Ministry of Public Infrastructure, NDU, Land Transport and Shipping

Lastly, the Council would like to thank all the participants of the workshops held on 8th September 2011 and the final consultative meeting held on 2nd February 2012 for their views and comments, which has helped us in finalizing this report.

Mauritius Research Council
February 2012

EXECUTIVE SUMMARY

Being an issue of national importance, the Ministry of Tertiary Education, Science, Research and Technology is of the view that the Research Community of Mauritius should assist in addressing the energy issue. It is in this context and at the request of the Ministry of Tertiary Education, Science, Research and Technology (MoTERST), the Mauritius Research Council (MRC), gathered experts and researchers from several public and private institutions dealing with energy issues, including sustainable buildings, to discuss on ways in which the Research Community can assist in the long term sustainability of the island. This ***National Energy Research Group (NERG)*** *was officially launched by Dr The Honourable Rajeshwar Jeetah, Minister for Tertiary Education, Science, Research and Technology, through a workshop on the 8th of September 2011.*

The real challenge of this century is how to balance the consumption of natural resources and extend the built environment in a restorative manner. At present, in Mauritius, existing buildings consist of more than 85% of the building stock. With the growing demand for services like air-conditioning, heating, computers and electric equipment, energy use in buildings has increased considerably during the past years.

Greening of buildings is therefore becoming a necessity to drive energy consumption down in Mauritius. However, until now, the majority of existing buildings in Mauritius have been built without or with very little consideration laid on sustainability. An analysis of the energy and construction issues in Mauritius was therefore carried out and a list of prioritised themes, such as, Building Design & Materials, Heating/Cooling Systems, Green Electricity Generation, Green Building Technologies & Environment and Building benchmarking and improvement strategies and a list of prioritised topics under each theme has been drawn (Annex I). The NERG will now call for research proposals on these areas and will coordinate and facilitate the research work.

It is envisaged that these studies will provide valuable information to help the country meet its objectives for long-term sustainability, and contribute in the realisation of the Maurice Ile Durable vision.

1. INTRODUCTION

The challenges our planet is facing nowadays, particularly climate change and sustainable development, are global in nature and thus require global solutions. A major part of this global problem is the building sector. The latter consumes as much as 40% of the world's energy, 12% of its potable water and contributes up to 70% of solid waste[1].

In Mauritius as well, buildings and construction works have a key role to play in overall resource use (energy, water, and materials), wastage and pollution emission. As such, buildings are coming under closer governmental scrutiny and regulations. To respond to this, the Government is now looking at better ways to manage our production and deliver highly efficient energy solutions.

As the environmental impact of buildings becomes more apparent, a new field called "green building" is gaining momentum. In essence, a green or sustainable building focuses on increasing the efficiency of resource use, while reducing building impact on human health and the environment during the building's lifecycle through better design, construction, operation and maintenance. The design and construction are made to high environmental standards, thereby minimising energy requirements, reducing water consumption, using materials which have low environmental impact, reducing wastage, conserving the natural environment, enhancing occupant comfort, health, productivity and well-being.

Besides improving quality of life and safeguarding human health, green buildings can increase building valuation and Return on Investment (ROI). It has been estimated that green investment could pay for themselves in about 3 years, annual ROI 25-40%.

Since sustainable development is a human centred development, the involvement of all key stakeholders, professionals and population at large is of paramount importance. Hence, the Ministry of Tertiary Education, Science Research and Technology (MoTERST) was of the view

[1] GSA Public buildings service (2008), Assessing Green Building Performance

that the Research Community should also provide its support to come up with potential measures or solutions to address the issue of sustainable buildings in Mauritius.

To this effect, and as directed by the Ministry of Tertiary Education, Science, Research and Technology, the Mauritius Research Council set up a National Energy Research Group (NERG), comprising experts from the public and private sectors to address the energy issue from a coordinated research perspective. The NERG proposes to act as a vehicle for the inputs from the Research Community regarding the energy issues including sustainable buildings in Mauritius, among other areas. This National Energy Research Group (NERG), officially launched by Dr The Honourable Rajeshwar Jeetah, Minister of Tertiary Education, Science Research and Technology through a workshop on the 8th September 2011, has the following main objectives:

1.1. OBJECTIVES OF THE NERG

The NERG has the following objectives:

(i) To take cognizance of the existing initiatives/measures on sustainable buildings with emphasis on positive renewable energy buildings in Mauritius

(ii) To establish a dynamic energy research alliance in Mauritius regrouping private and public sector stakeholders

(iii) To identify research gaps, overlapping/critical research issues on sustainable and positive buildings in Mauritius

(iv) To prioritise research themes in sustainable and positive buildings

(v) To coordinate and facilitate research activities on sustainable and positive buildings in Mauritius

(vi) To make recommendations to the policy makers with respect to the research findings

1.2. MEMBERS FOR THE ENERGY RESEARCH GROUP

Representatives of following institutions were represented in the NERG:

1. Central Electricity Board (CEB)
2. Ecosis Ltd
3. Mauritius Architects Association (MAA)
4. Mauritius Port Authority (MPA)
5. Mauritius Research Council (MRC) - *Coordination*
6. Mauritius Standards Bureau (MSB)
7. Ministry of Energy and Public Utilities (MEPU)
8. Ministry of Environment & Sustainable Development (MoESD)
9. Ministry of Housing and Lands (MH&L)
10. Ministry of Local Government & Outer Islands (MLG&OI)
11. Ministry of Public Infrastructure, Land Transport & Shipping (MPI)
12. National Housing Development Company Ltd (NHDC)
13. Prodesign Sustainability
14. United Nations Development Program (UNDP)
15. University of Mauritius (UOM)
16. University of Technology, Mauritius (UTM)

1.3. CONSULTATIVE PROCESS FOR IDENTIFICATION OF PRIORITISED RESEARCH THEMES AND TOPICS

The members of energy research group met to take stock of the existing initiatives/ measures on sustainable building. The members were requested for their views on critical issues and proposed research areas related to Sustainable Buildings in Mauritius and any existing information available.

Thereafter, the Mauritius Research Council (MRC) organised a workshop entitled "A Coordinated Research Perspective on Sustainable Buildings in Mauritius" on 8th September 2011 to take stock of the existing initiatives/ measures on sustainable building, to identify research gaps and propose research issues. The participants of the workshop comprised experts

and researchers from several public and private institutions as in Annex II (List of Workshop Attendees) and Section 2 of this report summarises the presentations of the different Guest Speakers of the workshop.

Analysis of the energy and construction issues in Mauritius was carried out, a list of prioritised projects was drawn and a draft report prepared on the issues highlighted along with the emerging research themes and areas on sustainable building.

A final consultative meeting was held on 2nd February 2012 to seek the views of the research community and validate the findings.

1.4. SOME ONGOING NATIONAL PROJECTS/ INITIATIVES RELATED TO SUSTAINABLE BUILDING

1. Removal of Barriers to Energy Efficiency and Energy Conservation in Buildings:

   This Project has been initiated by the UNDP in July 2008 with an initial funding by the GEF. Additional funding will be provided by SIDSDock and the project is expected to end by December 2012. The project is being nationally executed by the Ministry of Energy and Public Utilities.

   The project is comprised of 3 components focusing on policy:-

   (i) Component 1: building regulations and codes, functioning markets;
   (ii) Component 2: stimulating demand and supply of technology and services;
   (iii) Component 3: information, knowledge and awareness.

   The overall project goal is to reduce greenhouse gases (GHG) emissions sustainably through a transformation of the building energy efficiency market for existing and new buildings.

   The main achievements of the project up to now have been summarized below:-

   - An Energy Efficiency Bill has been enacted and proclaimed;
   - An Energy Efficiency Management Office has been set up;

- Documentation for an Energy Audit Management Scheme has been drafted;
- An a energy audit software tool, the Mauritius Building Energy Audit Tool (MBEAT), has been developed for the energy auditing of non-residential buildings;
- 45 Building Energy Auditors have been trained on the use of MBEAT, but the Energy Auditors have yet to be certified;
- A new Building Control Bill has been drafted, whereby inter-alia, an Energy Efficiency Building Code and Energy Efficiency Building Regulations have been developed for the energy-efficient design of buildings with total floor area > 500 m2;
- Energy-Efficient Design Guidebooks for targeted residential and non-residential buildings of total floor area < 500 m2 , are being developed

2. The Ministry of Environment and Sustainable Development is at present undertaking the implementation of the National Programme on Sustainable Consumption and Production (SCP). Sustainable Buildings is a key priority area identified under the National Programme on SCP and as such there are several project dedicated to that particular field.

   The National Programme on SCP comprises of a series of 44 projects to be implemented over a duration of 5 years (2008 - 2013).

   At present, with the financial support of the European Union, the Ministry of Environment and SD is at present undertaking a consultancy on "Sustainable Buildings and Constructions". Under this project, 2 of the 44 SCP projects will be implemented:
   1- Develop a shared vision on the sustainable buildings
   2 - Develop guidelines and a rating system

3. Maurice Ile Durable Working Group on Energy (Ministry of Environment and Sustainable Development, 2011): The objective of the Working Group was 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 group took stock of the existing policies/ strategies and institutional set-up of the building sector in Mauritius. Identified gaps and made recommendations on reducing energy consumption in existing and new buildings.

4. A leaflet promoting energy efficient residential building layout and orientation by the Ministry of Housing and Lands
5. Planning Policy Guidance (PPG) for Hotels & Integrated Resorts describes a number of design criteria that may be taken into consideration to minimize the use of energy (Ministry of Housing and Lands)
6. Planning Policy Guidance on Sustainable Development and Energy Efficiency (Ministry of Housing and Lands /ongoing): a national planning instrument prepared with the objectives to guide land developer and help local authority to determine applications and to control development
7. Review of the existing Planning Policy Guidance (PPG) on Residential Development with particular emphasis on design for climate and energy efficiency (Ministry of Housing and Lands / ongoing)
8. Mid-term review of the National Development Strategy to include strategies on formulation of energy efficiency in spatial development (Ministry of Housing and Lands/ to be launched)

2. SUMMARY OF PRESENTATIONS

This section summarises the presentations of the different Guest Speakers of the workshop held on 8th September 2011.

2.1. ENERGY EFFICIENCY IN BUILDINGS – PARADIGM SHIFT

Presented by: Dr P.M.K. Soonarane, Ministry of Energy and Public Utilities (MPU)

2.1.1. Increase Energy Efficiency

Mauritius is an independent insular country with no known oil, natural gas or coal reserves, and therefore depends heavily on imported petroleum products to meet most of its energy requirements. The country imports some 1 million tons of petroleum products, comprising 380 Cst and 180 Cst heavy fuel oil, gasoline, diesel, kerosene and LPG, and 660 000 tons of coal annually. The imported petroleum products and coal account for 83 % of the primary energy requirements and about 18.54% of the island's total imports. Local and renewable energy sources are biomass, hydro, solar and wind energy. Biomass energy consists mainly of bagasse, a by-product of the sugar industry, and contributes about 17 % of the primary energy supply. Fuel wood and charcoal are minimally used. Hydropower plants, with a combined installed capacity of 59 MW, are virtually the entire hydro potential. Government policy is to promote the use of renewable energy with a view to reducing dependency on imported energy carriers due to volatility of oil prices and also to respect both local and international environmental commitments.

2.1.2. Constraints/Barriers to Energy Efficiency

- No clear policy until recently
- No legal and institutional framework
- Slow technology penetration
- No functional Energy Efficiency services market
- Lack of awareness
- Economics/benefits
- Cross-sectoral, many actors and institutions

2.1.3. Targets for Energy Efficiency gains in Electricity Sector compared to the 2008 electricity consumption

- 2015 - 4%
- 2020 - 6%
- 2025 - 10%

2.1.4. Energy Efficiency Act

Government is working in close collaboration with the UNDP to implement a programme under a GEF Funding, named Removal of Barriers to Energy Efficiency and Energy Conservation in Buildings. The programme is being implemented by the UNDP and consists of a series of projects, all aimed at increasing Energy Efficiency on Building and Efficient Energy Consumption. International Consultants were appointed for the formulation of an Energy Efficiency Bill that would deal with Energy Efficiency in household equipment, labelling systems for Energy Efficiency. The project was implemented by October 2009.

This has translated into the new 2011 Energy Efficiency Act. This Act aims at regulating the energy efficiency of the following high energy-consuming and commonly-used household appliances in particular:

- Refrigerators, Air Conditioners and Washing Machines - 2013
- Electric lamps, Electric Ovens, Clothes Dryers – 2014
- Electric water heaters (instantaneous & storage types) and Dishwashers - 2015

As stipulated in the Energy Efficiency Act, it will be mandatory for designated large Energy Consumers of the non-residential sector to audit their buildings as from 2013.

2.1.5. Building Control Bill

Another project is the appointment of an International Consultant for the Review of the Building Act and Regulation and drafting of a new Building Control Act incorporating the Building Act and Building Regulations and Codes in Mauritius. The intent of the project is to

improve Energy Efficiency in both Residential and non-residential building through sustainable design and planning of buildings and settlements.

The application of this new bill will ensure that all buildings exceeding 500m^2 adhere to a proposed energy code by 2013. It will also assist and encourage draughtsmen, architects and engineers in the construction sector towards passive designs and to incorporate more renewable energy sources such as solar heating and cooling in their designs. In order to improve the energy efficiency of buildings, the new Building Control Bill also provides guidelines on the following features which will be applicable as from 2013:

- Building orientation
- Natural ventilation
- Fenestration
- Shading
- Roof insulation
- Optimal use of daylight
- Solar passive features
- Rainwater harvesting solutions

2.1.6. Energy Efficiency Management Office

In order to enforce the Energy Efficiency Act and promote the efficient use of energy and national awareness on the subject as a means to reduce carbon emissions and protect the environment, the Ministry of Energy and Public Utilities will set up an Energy Efficiency Management Office (EEMO). The latter will be entrusted with the following roles:

- To implement Energy Efficiency programmes
- To monitor Energy Efficiency and energy consumption
- Observatoire de l'energie- ARER
- To regulate energy auditors
- Development of courses and curricula
- To foster regional and international cooperation
- To develop and enforce labelling & MEPS
- To enforce mandatory energy audits
- To develop sustained awareness
- Depository of Energy Efficiency matters
- Central registry of energy audits of buildings

- Assistance from Agence Française de Developpement / SIDSDock

2.1.7. Projects in Public Sector

The Ministry of Energy and Public Utilities has in line several projects to promulgate the efficient use of energy in the public sector. These include:

- Auditing of all important buildings to enforce the following:
  - Use of efficient lighting systems
  - Proper setting of low threshold temperatures
  - Higher Energy Efficiency ratios
  - Carry out awareness campaign
  - Promote solar water heating as a substitute to electrical water heating
  - Use of solar water heating in hospitals (Rs.20M and Rs.25M to be invested in 2011 and 2012 respectively)
  - 50000 Compact Fluorescent Lamps (CFL) / Super High Pressure (SHP) for secondary roads lighting
- Energy Efficiency Procurement
  - Life cycle cost in procurement
  - Energy cost included

2.1.8. Conclusions

- Energy Efficiency in Buildings can enhance our energy resilience.
- Ambitious targets have been set for efficient use of energy to reduce our carbon emissions.
- Barriers exist to Energy Efficiency and these have to be eliminated through new frameworks so that we can build thereon for sustainable buildings.
- A proper coordination of initiatives is also vital to achieve sustainable building.

2.2. TOWARDS SUSTAINABLE AND ENERGY POSITIVE BUILDING

Part 1: Sustainable Building ***Presented by: Mr Dhinesh Seeburrun***

Architect's Section, Ministry of Public Infrastructure, National Development Unit, Land Transport & Shipping (MPI)

2.2.1. Building Industry and its Challenges

The construction sector, be it in Mauritius or elsewhere, consumes 40% of all resources generated globally, i.e. 40% of water, 40% of energy and 40% of all other resources. As a consequence, it is responsible for about 40% of all Green House Gas (GHG) emissions. The challenge of this century is how to balance the consumption of natural resources and the enlargement of the built environment in a restorative manner. Building sustainably involves:

- "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs".

  World Commission on Environment and Development, UN Brundtland Report, 1987

- design, build and operate buildings with low ecological impacts while enhancing the health, welfare and quality of life for the people that live in them.
- work towards having a positive ecological impact.

2.2.2. Deconstruction

Deconstruction is the selective dismantlement of building components, specifically for reuse, recycling, and waste management. It focuses on giving the materials within a building a new life once the building as a whole can no longer continue.

2.2.3. Waste Colour Coding

On construction sites in the United Kingdom, United States of America and Australia it has been found beneficial to segregate construction waste materials at the source by colour coding:

White: Gypsum	Red: Asbestos	Blue: Metal
Orange: Hazardous	Black: Mixed	Brown: Packaging
Grey: Inert	Yellow: Clinical	Green: Wood

2.2.4. Tender guidelines for construction and demolition projects

In order to implement better waste management systems, tender applicants for construction/demolition projects are required to incorporate an integrated waste minimisation scheme in their proposals. They need to show how their plans can best deal with waste avoidance, building for disassembly and the use of recycled and recyclable materials. Such tender applicants will be encouraged to develop innovative practices to eliminate or minimise waste in their projects, which will promote sustainable building as well as reduce their own costs.

2.2.5. Innovation & Research in Local Context

The MPI is of view that several research possibilities exist in Mauritius in order to improve buildings and make them more sustainable. These research areas as identified by the MPI focus mainly on building materials and have been classified as follows:

- ***Concrete Blocks***
    - Recycling of concrete blocks for land-fill, road construction, etc.
    - Cavity double wall for insulation due to air being a good insulator
    - American blocks
    - Plastered blocks
- ***Wood***
    - Use of coconut wood as structural wood as already implemented in Agalega
    - Use of Pine wood and Bamboo in construction
    - Possibility for recycling of wood and wood products locally
- ***Glass***
    - Use of glasscrete
    - Use of recycled glass blocks/bricks

- ***Concrete***
    - Use of green concrete (addition of fly ash in concrete)
    - Possibility of mixing crumb rubber from recycled tyres with concrete
    - Recycling of concrete
- ***Sugarcane Straw***
    - Sugarcane straw can be treated and compacted into good insulation boards and used in buildings.
    - Can be mixed with cement for plastering – good insulation properties

Part 1: Energy Positive Building ***Presented by: Mr Raj Ramjit***

Architect's Section, Ministry of Public Infrastructure, National Development Unit, Land Transport & Shipping (MPI)

For both new projects and renovations 'Bioclimatic Architecture' is a cornerstone element of today's sustainable and energy positive buildings especially in our local context. It is important to consider the local climate during the first stage of building design. An energy conscious design which results in an energy efficient building has to be based on the local climate and condition and as far as possible built with local building materials.

2.2.6. Thermal Comfort and Energy Savings

In order to improve natural thermal comfort in buildings and optimise energy saving, the MPI has identified 4 priority areas as follows:

Priority 1: Natural Ventilation of all buildings by defining proper orientation

Priority 2: Solar protection to limit solar radiation and heating of the building

Priority 3: Use of equipment having low energy footprint - energy labelling

Priority 4: Self-sufficient in energy by using PV cells or other mode of renewable energy

Ceiling fans can be used to improve ventilation and provide a cooling effect at comfort levels, provided their installation and operation meet certain criteria. In order to operate in a comfort

zone, the fan speed must not exceed 2m/s. Furthermore, the fans must be installed such that the minimum distance between the blades and the ceiling is 30cm and the minimum distance of the tips of the blades from the walls is 1m.

2.2.7. Indoor Air Quality

If the outdoor air pollution is no longer a mystery, the revelation that of the indoor air is more recent and now established. In the past thirty years, advances in the chemical industry have provided us with all sorts of practical, efficient and effective products and materials, without knowing or caring for their impact on the environment and individuals.

The building materials emit all kinds of particles that affect the quality of air. Volatile organic compounds (VOC) - chemicals in products and materials such as laminated flooring, compressed wood, glues, varnishes, paints, waxes, wallpaper, carpets, fabrics, etc. – dust, fiber can cause headache, allergies and respiratory problems. Moreover, although moisture is not a pollutant itself, it is considered as a contributing factor to aggravating other pollutants.

2.2.8. Means of Attenuating Solar Radiation

- minimize or protect the surface area of the north facing façade;
- Protect the surface area of the west facing façade preferably by planting of trees;
- Provide for natural lighting but avoid sun rays in the building;
- use the roof as an active skin;
- Allow permeability of the building for proper ventilation.

2.2.9. Innovation & Research in local context

- Roof insulation with local material
- Wall insulation with local material
- Local wood for louvers to protect the openings
- Local wood for sun breakers
- Internal Floor Finishes
- Local wood for Wooden deck

2.3. THE GREENING OF THE EXISTING BUILDING STOCK

Presented by: Mr Tony Lee Luen Len, Ecosis Ltd.

Until now, the majority of existing buildings in Mauritius have been built without or with very little consideration laid on sustainability. However, today, many new buildings have started integrating green technologies and are becoming more energy and water efficient.

At present, existing buildings consist of more than 85% of the building stock. With the growing demand for services like air-conditioning, heating, computers and electric equipment, energy use in buildings has increased considerably during the past years.

Greening of buildings is therefore becoming a necessity to drive energy consumption down in Mauritius. The term 'greening of buildings' basically means to make use of resources (energy, water and materials) efficiently, reduce waste and effluents, improve the indoor environmental quality within the building and to ensure that maintenance of the building does not affect the environment.

2.3.1. Steps to greening a building

1. Determining a baseline
2. Reviewing the building maintenance and operational issues
3. Establishing targets and goals
4. Deciding on appropriate level of refurbishment
5. Selecting optimal upgrade initiatives

2.3.2. Determining the baseline

- **Baseline**

  The essential baselines for buildings are *energy and water consumption, occupant satisfaction, facilities management operation, condition of the building, waste generation* and*, security and indoor environment quality*.

These baselines can be established by performing audits and, results compared against benchmark for improvement.

- **Energy audit**

  The aim of an energy audit is to identify areas which are contributing the most to the energy bill. Savings target can then be established by applying reduction strategies, knowing the different sources of energy usage.

Waste audit

A waste audit is done to determine:

- the different sources of waste generation
- the total amount of waste generated,
- the type of waste generated,
- the quantity being recycled and
- the amount sent to landfill.

Once a waste audit is carry out, waste minimisation strategies can then be applied.

- **Indoor environment quality audit**

  Poor thermal comfort, air quality, air tightness, noise levels and lighting etc. can have several undesirable effects on the occupants of a building. These include eye irritation, nasal stuffiness, wheezing, skin irritation or even asthma episodes. The term used to describe these impacts is the 'Sick Building Syndrome'. The indoor environment quality audit involves physical inspection, sampling and analysis, and an inventory of all chemicals currently used.

- **Occupant satisfaction audit**

  A survey to highlight aspects of the building like the building condition, facilities or day to day performance that falls under occupants' expectations needs to be conducted. In essence, the occupant's satisfaction will depend on thermal comfort, acoustic, floor planning, ventilation, amenities and management regimes. The audit has to be carried out in such a way that the results can be compared to well-established benchmarks.

- **Water audit**

  The aim of water auditing is to determine areas consuming large amounts of water and apply strategies for improvement. This audit also includes reviewing of water bills to check for any abnormal variations in consumption.

- **Condition audit**

  The aim of condition auditing is to determine the actual condition and future economic life of a building component. It is a tool that produces a complete inventory of a building and its equipment, along with its deficiencies. Components to be examined comprise the structure of the building, external walls and roof, mechanical, electrical and IT systems, hazardous materials and life safety.

- **Facilities Management (FM) audit**

  Building owners are sometimes not aware of the performance of their FM supplier. However, the effectiveness of the latter often determines the satisfaction of an occupant. Thus, an effective FM audit provides an understanding of every part of the FM operation and identifies areas for improvement.

- **Security audit**

  During a security audit, the building and its surrounding are reviewed, the risks are assessed and measures to mitigate these risks are established. Some measures which can be highly effective are passive surveillance and discreet access control systems.

- **Rating existing buildings**

  This step is optional; once data on energy and water use etc. have been collected, these can be benchmarked by means of several schemes used around the world for rating existing buildings.

2.3.3. Reviewing building maintenance and operational issues

- **Review**

  Reviewing one's FM strategies can determine whether one is doing enough to protect his/her investment or whether updating is required to provide effective standards and assurance.

  Thus, Retro-Commissioning (RCx) should be considered where well-intentioned but uninformed modifications were made on buildings. RCx is a process that endeavours to determine operating problems, enhance comfort, optimise energy use and identify retrofits for existing buildings. It can directly benefit:

  - the electricity demand
  - the fuel use
  - the water use
  - the system performance
  - the carbon emissions
  - the O & M costs
  - the plant lifespan
  - the occupant satisfaction/wellbeing

- **Housekeeping and FM**

  In order to maximise cost savings, both housekeeping and FM must be coordinated together. In this way, monitoring energy and utility cost can be automated using smart meters and by setting performance envelopes. Opportunities to save energy by resetting control values whilst sustaining comfort levels can be also explored.

- **Energy purchasing**

  Advanced assessment of potential technical alterations such as intelligent peak lopping or reduction of reactive energy charges can further improve savings.

2.3.4. Establishing the targets and goals

- **Using the process**

  Understanding the business is important as it enables the individual to know what he/she stands for, why the business exists and what parts of the market it satisfies. This in turn

helps the individual to identify what he/she really needs to enhance the performance of the building assets to support the business objectives.

- **The targets**

  The targets chosen will reflect the business needs and the priorities should be identified. These might include: brand value, building value, cash flow, image and reputation, productivity, profitability, rental value, shareholder value and stakeholder value.

  From the set priorities, one may wish to consider setting targets in some or all of the following areas:

  - Building condition and performance
  - Building efficiency
  - Carbon footprint
  - Corporate social responsibility
  - Customer experience
  - Disposals and acquisitions
  - Energy consumption
  - ICT
  - Innovation
  - Water consumption
  - Operating cost
  - Transport
  - Quality standards

2.3.5. Deciding on appropriate level of refurbishment

- **Level of refurbishment**

  The following tables are used to assess the performance and condition of an existing building and determine the level of refurbishment required to make the building competitive with new buildings.

The audit data from Step 1 is used to rank the overall performance grade of the building using table 1.

Table 1: Performance Grading of Buildings

Performance Grade	Excellent	Good	Poor	Very Poor
Energy Consumption kWh/m^2/year	<140	<250	<350	>350
Water Consumption m^3/m^2/yr	<0.35	<1.0	<1.4	>1.4
Thermal comfort (air-conditioned building)	PMV* less than +/-0.5	PMV* less than +/-1	PMV* less than +/-2	PMV* greater than +/-2
Thermal comfort (naturally ventilated buildings)	Less than 1% operating hours over 28°C	Less than 2% operating hours over 28°C	Less than 5% operating hours over 28°C	More than 5% operating hours over 28°C
Mechanical Systems	100% planned availability and meeting current functional demands. No standing alarms, no losses or events. Fully meets design functionality	95 –100% planned availability. Fit for service for the next 3 years with routine maintenance applied. Some minor defects	50 –95% planned availability. Near misses. Defect levels & significance increasing, will not remain fit for service for next 3 years with only routine maintenance	Must be replaced within the next 12 months. Frequent system trips. Significant losses and events. Fails to meet design function. Many defects affecting functionality
Electrical/IT/ Communications systems	100% availability.	>95% availability.	>50% availability.	<50% availability.
Staff satisfaction	Few complaints Below average absenteeism	Some minor complaints, easily rectifiable Average absenteeism	Many complaints, difficult to rectify. Above average absenteeism	Tenants leaving/ untenanted. Potential legal action due to poor building performance
Percentage usable area with >2% daylight factor	>60%	30 -60%	15 -30%	<15%
Flexible floor plate	Very Flexible. Multiple exits, no internal columns or obstructions, easily subleased	Flexible. Multiple exits, minimal internal obstructions	Less Flexible. Exits from one end of the space, many internal obstructions, restrictive footprint	Inflexible. Significant internal obstructions, restrictive building footprint
Amenity	Many facilities in the building or within 100m	Some facilities in the building or within 200m	No facilities in the building. Some within 500m	No facilities within 1000m

The audit data from step 1 is used to rank the overall condition grade of the building using table 2.

Table 1: Condition Grading of Building

Condition Grade	Excellent	Good	Poor	Very Poor
Mechanical systems	High standard of material condition. System defect free. Condition monitoring parameters in specification	No investment needed for material condition for at least 3 years	Investment required for material condition within 3 years. Increased consumption. Multiple modifications waiting implementation	Less than 10% of life remaining on specific equipment / or life expired
Electrical/ICT/ Comms systems	As new > 90% life Physically defect free	Minor physical defects	Requires attention. Increasing maintenance burden. Multiple modifications waiting implementation.	Significantly degraded. Potential safety hazard
Structure and Fabric	Sound structure, well maintained in as-new condition requiring only normal routine maintenance. No deformation or settlement	Displaying signs of minor wear and tear. Requires some minor repairs in addition to normal routine maintenance. No undue deformation or settlement. No inappropriate modifications to non-critical elements. Needs to be re-inspected in the medium term.	Structure stable and functioning but needs investment to maintain in a safe condition. Deformation of primary members or indications of undue settlement. Significant design defects, inappropriate modifications to critical elements, serious misuse or impact damage to critical elements.	Unsafe to use requires immediate action to make safe and replacement as soon as practical. Major design defects, inappropriate modifications, serious misuse or impact damage likely to compromise the safety of the structure.

Based on the grades obtained from tables 1 & 2, level of refurbishment needed for the building is found using table 3.

Table 2: Building level of refurbishment required

		Building Condition			
		Excellent	**Good**	**Poor**	**Very Poor**
Building Performance	**Excellent**	**Maintain**	**Level 1**	**Level 2**	**Level 3**
	Good	**Level 1**	**Level 2**	**Level 3**	**Level 3**
	Poor	**Level 2**	**Level 3**	**Level 3**	**Level 4**
	Very Poor	**Level 3**	**Level 3**	**Level 4**	**Level 5**

The grade obtained is compared to the targets set in step 3 and the level of refurbishment is decided to match the targets.

Table 3: Level of refurbishment for buildings

Level of refurbishment	Typical examples to illustrate the degree of intervention
Level 1 Tune up and minor refurbishment	Carry out health on BMS and controls, revise layout to improve daylight and flexibility, low energy IT option on replacement. Recommission building services
Level 2 Intermediate refurbishment	Renew lighting and control system. Remove false ceilings to expose thermal mass. Replace sanitary ware with low water use fittings
Level 3 Major refurbishment	Replacement of major plant and services, floor finishes, raised floors, and internal walls. Installation of external solar control
Level 4 Complete refurbishment	Only substructure, superstructure and floor structure retained. Structural and façade alterations. Possible relocation of cores and risers
Level 5 Demolition	Consider demolition and rebuild

2.3.6. Selecting optimal upgrade initiatives

- **200 initiatives to improve buildings**
  The right initiatives to be applied to a building can be chosen from the 200 initiatives given which has been grouped in categories for easier selection:
  - Management
  - Economic
  - Safety, security and code compliance
  - Business continuity
  - Energy/Lighting
  - Energy/electrical
  - Energy/HVAC
  - Energy/fitout
  - Energy/Building fabric
  - Building modifications and alterations
  - Indoor Environment Quality (IEQ)
  - Materials
  - Waste
  - Emissions
  - Water
  - Site
  - Transport and Accessibility
  - Community Issues
  - Additional features

Each initiative is ranked according to the level of intervention required, its cost and its benefit for the environment, the occupants and the building owner.

Once the level of upgrading needed has been obtained from step 1-4, appropriate initiatives can be selected to address building's objectives.

- **Choosing the initiatives**

  All the initiatives should be looked into and those that address the objectives of a building should be selected. For example, if a building's electrical consumption must be reduced, then initiatives under categories Energy/lighting, Energy/electrical and Energy/fit-out should be considered. The cost and benefit indicators help to further narrow down the selection of initiatives to be applied to the building.

2.3.7. Using the survival strategy

- **Demonstrating the business case**

  The success of an initiative lies in the demonstration of the returns of investment, be it financial or non-financial (reputation or security or on-site facilities) but these are no less important

- **Benchmarking the building**

  Setting up of baseline parameters is the first step to demonstrate value (e.g. comparing the energy consumption of your building to the best performers)

- **Establishing the costs**

  The cost of a proposed intervention must be determined and it must be 'tuned' to fit the particular circumstances of the building.

- **Assessing returns**

  Interventions on building are done to make cost savings; however, this is not always the case. Green Buildings are poorly operated when systems are not well understood by those

responsible for running it. Thus, assessment of savings, that takes into account the best possible outcomes and also factors that can reduce the benefits, needs to be carried out.

- **Determining sequence of interventions**

  Interventions must be assessed on their own merits and they must be considered as part of a programme.

- **Implementing the initiatives**

  After choosing the best initiatives for the building, the next step is to implement them. Initiatives not involving changes in the building can be done by the facilities management team. However, for larger projects a professional design team and a contractor should be appointed.

- **Common pitfalls**

  Refurbishment of building is not always easy and straightforward. It includes pitfalls such as:

  - Uncovering unforeseen physical problems such as structural defects
  - EIA (Environmental Impact Assessment) requirements
  - Internal resistance to change from occupants
  - External resistance to change from community

  These issues may lead to longer work and be more costly than expected.

- **Post-completion involvement**

  The designer and builder should be involved after building is handed over to the clients to ensure users get the best out of their buildings by advising clients during the initial period.

- **Monitoring, verification and evaluation**

  - This step is important to ensure continuous improvement
  - Comparison of actual savings to targeted ones helps to prioritise initiatives in future projects
  - Regular checks must be done to ensure energy efficiency measures continue to operate as intended.

3. FOCUS FOR MAURITIUS

Sustainable buildings will be called upon to play an increasingly important part in driving Mauritius towards achieving its energy security as they can lead to a positive primary energy balance on a yearly basis. The sustainable or positive-energy concept combines energy saving and electricity production using on-site renewable resources namely wind, solar, biofuel or geothermal. Also, through advanced building design, material choices and innovative approaches to building management, the net amount of energy used can be reduced.

However, at present, the sustainable building movement is suffering a crisis of overhype and from focusing too often on new buildings. We have seen an upsurge of ideas, legislation, measurements and examples of new green buildings in recent years, but very little to do with how we make existing buildings more sustainable. Considering that existing buildings make up more than 85% of our stock, it seems we have been spending most of our efforts tackling 15% of the problem. Making existing buildings more sustainable will be the next big focus for the design industry, by default, as new build opportunities are limited by the economic downturn and as landlords consider how best to market empty properties or as occupiers fit out or refurbish their offices to sweat their existing assets and simultaneously to respond to the wishes of staff, customers or shareholders to be green (Ken Giannini, Sep 2009).

Making our existing building stock more sustainable may also be the best way for the design industry to contribute to helping meet the aggressive government targets for carbon reduction and 65% energy autonomy by the year 2028 (MID Project).

4. DISCUSSION AND RECOMMENDATIONS

The NERG workshop provided a platform whereby several research ideas from both the public and private sectors regarding sustainable buildings in Mauritius were discussed. Although the scope of work of the group covers the entire energy issue, the initial initiative of the group was restricted to energy-efficient buildings due to the vastness of the topic.

Buildings consume a lot of energy, materials and natural resources. In recent years, various international forums have provided evidence that sustainable buildings and construction can cut down about one-third of the world's greenhouse gas emissions, hence being able to play a key role in combating and addressing climate change.

Built–up areas are estimated to cover about 25% of the land in Mauritius and this percentage is increasing every year. Between 7, 000 and 10, 000 building permits are granted each year for residential as well as non-residential development purposes. The increasing importance of new investment sectors of activity such as business activities, intelligent parks, tourism/Integrated Resort Schemes (IRS) developments are bringing profound modifications to our land regime, raising issues of long term environmental sustainability.

Residential, public and commercial buildings account for a large part of material and energy use of the economy. So far, the main focus of the government has been to provide decent and affordable housing to Mauritians as well as ensure the rational planning and optimal use of land.

A number of barriers have been identified in the building sector as listed in the *National Programme on SCP for Mauritius, (MoESD/UNEP, 2008)*, namely:-

- Lack of a shared vision on sustainable buildings for Mauritius
- Appraisal/permitting process does not give credit to sustainable building
- Absence of building codes and incentives to promote sustainable buildings
- Existing Building Act does not set the standard for sustainable buildings
- Lack of proper enforcement of guidelines and legislation

- Lack of public awareness and lack of client demand - 80% of all buildings designed without architects
- Cultural resistance to change in the way buildings are done
- Lack of analytical tools and data to evaluate the socio-economic benefits of sustainable buildings

The focus now needs to be shifted to address the sustainability of the built environment in Mauritius. Appropriate measures need to be taken to reconcile current boom in the construction industry with its sustainability.

The NERG appreciates the commendable efforts made by the relevant authorities so far to incorporate and promote sustainability and energy efficiency in buildings. However, long-term sustainability cannot be achieved if we limit ourselves to the use of renewable energies. The government, banks as well as insurance companies are providing huge financial support to the population only to promote renewable energies both domestically and industrially.

Nevertheless, prior to engaging into the application of such resources which are also very expensive, it might be more worthy to re-evaluate our designs, methods and procedures for building constructions, taking into account the surrounding environment. In this context, the NERG has compiled a list of projects (listed in Annex I), which have been classified according to the following five priority themes:

- *Building Designs and Materials*
- *Heating/Cooling Systems*
- *Green Electricity Generation*
- *Green Building Technologies & Environment*
- *Building benchmarking and improvement strategies*

5. FINAL CONSULTATIVE MEETING OF NATIONAL RESEARCH GROUPS

A final consultative meeting was held on 2nd February 2012 to present an overview of the report prepared by the NERG and seek the views of the research community and validate the findings, that is, the priority themes/areas and topics identified by the NERG. The meeting was officially opened by Dr The Honourable Rajeshwar Jeetah, Minister for Tertiary Education, Science, Research and Technology.

The audience comprised Government Officials, representatives of the Private Sector, members of the Scientific Community, NGOs and other interest groups. The NERG members present included the Ministry of Public Infrastructure, NDU, Land Transport & Shipping (MPI), Ministry of Energy & Public Uitilities (MEPU), Ministry of Environment and Sustainable Development (MoESD), University of Mauritius (UoM), Ecosis Ltd, Mauritius Standards Bureau (MSB), University of Technology Mauritius, amongst others. Comments and suggestions were encouraged in order to validate the report and these are listed below.

During the discussion the following issues were raised –

- A proposal made to the NERG to study/assess building resistance to earthquakes in Mauritius and to include such studies in future building designs.
- There is a severe gap in baseline/standard data related to building materials and component design (e.g. wall thickness, etc.). These can provide potential research avenues.
- The development or retrofitting of health institutions should incorporate patient needs into their designs.
- Further research is required to study sick building syndromes in high-rise buildings in Mauritius.

Way Forward

The NERG will now call for research proposals in the priority themes/ areas and topics identified. Thereafter, sub-research groups will be assembled within the NERG to coordinate and facilitate the research work. It is envisaged that these studies will provide valuable information to help the country meet its objectives for long-term sustainability, as well as contribute to the realisation of the Maurice Ile Durable (MID) vision

References

1. Long term Energy Strategy (2009-2025), Ministry of Energy and Public Utility
2. Maurice Ile Durable working group report on Energy, Ministry of Environment and Sustainable Development, 2011
3. National Development Strategy, Ministry of Housing & Lands (2003)
4. National Programme on Sustainable Consumption and Production (SCP) for Mauritius - UNEP/ Ministry of Environment and Sustainable Development, 2008.
5. Towards a Coherent Strategy for the Development of the Energy Sector in Mauritius – Outline of Energy Policy (2007-2025), Ministry of Energy and Public Utility
6. Towards a National Policy for a Sustainable Mauritius, Green Paper on Maurice Ile Durable, Ministry of Environment and Sustainable Development, 2011

ANNEX I – PRIORITISED RESEARCH THEMES PROPOSED BY THE NERG

ORDER OF PRIORITY	CRITICAL ISSUES	RESEARCH AVENUES	CURRENT STATUS/ADDITIONAL INFO
THEME 1: BUILDING DESIGNS & MATERIALS			
1	***Assessing benefits of green roofs in Mauritius***	Natural cooling and lowering our carbon footprint	• How to best utilise green roofs in a tropical island, possibly for natural cooling
2	***R&D into potential locally-derived sustainable materials for the construction industry***	Develop innovative local materials, better adapted for the local climate to keep temperature and relative humidity at comfort levels	• Review of materials that can be grown in Mauritius and have suitable properties • Standard methodology to test the required properties of these materials • Recycled concrete, Sugarcane straw, Local wood/recycled wood, Recycled glass, etc.
3	***Baseline data collection & Best practices***	Which data to collect, how they are collected and how they are analysed to provide standardised valuable information	• No adequate locally-defined baseline/standard available

ORDER OF PRIORITY	CRITICAL ISSUES	RESEARCH AVENUES	CURRENT STATUS/ADDITIONAL INFO
THEME 2: HEATING/COOLING SYSTEMS			
1	***Assessing the impacts of air-conditioners and ways to reduce our dependency***	National strategy towards an air-conditioner free society	• To assess current use, efficiency, influence on electricity demand, relation to sick-building syndrome, LCA, economic and environmental impacts. • To propose alternative holistic solutions in line with MID
2	***Application of funnelling effect***	Control of indoor climate	• Keep temperature and relative humidity at comfort levels
3	***Baseline data collection & Best Practices***	Which data to collect, how they are collected and how they are analysed to provide standardised valuable information	• No adequate locally-defined baseline/standard available
4	***Study the best paints and insulating materials for heat reflection***	Control of indoor climate	• Keep temperature and relative humidity at comfort levels

ORDER OF PRIORITY	CRITICAL ISSUES	RESEARCH AVENUES	CURRENT STATUS/ADDITIONAL INFO
THEME 3: GREEN ELECTRICITY GENERATION			
1	***Assessment of wind energy locally to develop wind maps***	Facilitate implementation of renewable energy plants	• Analysis of climatic and geographical factors for representative regions in the island
2	***Baseline data collection and Best Practices***	Which data to collect, how they are collected and how they are analysed to provide standardised valuable information	• No adequate locally-defined baseline/standard available
3	***Geothermal Energy***	Optimisation on energy efficiency and lowering our carbon footprint	• Generating soil thermal properties/ground water map for the island to help in ground source and ground-coupled heat pump systems

ORDER OF PRIORITY	CRITICAL ISSUES	RESEARCH AVENUES	CURRENT STATUS/ADDITIONAL INFO
THEME 4: GREEN BUILDING TECHNOLOGIES AND ENVIRONMENT			
1	***Baseline data collection and Best Practices***	Which data to collect, how they are collected and how they are analysed to provide standardised valuable information	• No adequate locally-defined baseline/standard available
2	***Study the best plants for shadow purposes***	Natural cooling and improve indoor air quality	To determine: • Actual temperature loss recorded in a building when cooling is performed • Impacts of earth cooling on indoor air quality

ORDER OF PRIORITY	CRITICAL ISSUES	RESEARCH AVENUES	CURRENT STATUS/ADDITIONAL INFO
THEME 5: BUILDING BENCHMARKING AND IMPROVEMENT STRATEGIES			
1	***Determining aspects of building to be benchmarked***	Study different aspects of building to be benchmarked, such as, water, waste, indoor environment quality etc.	• Considerable work on-going on benchmarking energy consumption in buildings
2	***Determining baselines***	Determine essential baselines for buildings , such as, energy and water consumption, occupant satisfaction, facilities management operation, condition of the building, waste generation and security and indoor environment quality	• Considerable work on-going on energy audits
3	***Baseline Data collection and Best Practices***	Determining which data to collect (e.g. for water audit - potable water consumption, use of water from other source, storm water runoff, etc.)	• No adequate locally-defined baseline/standard available
4	***Development of methodologies for data collection***	What are the methodologies to collect data to be able to have set of comparable data	• Lessons to be learnt from local and international best practices
5	***Study of possible initiatives for improvement***	What are the initiatives that can be taken for improvement and the cost/benefits thereof corrective actions	• Lessons to be learnt from local and international best practices
6	***Contingent support mechanisms for conducting audits and for implementation of corrective actions***	To perform audits and compare the results against benchmark for improvement and remedial actions	• No adequate locally-defined benchmark / audit data available

Note: This list of projects is not exhaustive. New proposals will be considered and taken on board in time.

ANNEX II – NERG WORKSHOP ATTENDEE LIST

Title	Name	Surname	Organisation
Mr	A. Fouad	Uteene	Bhunjun & Sons Ltd
Mr	Shameem	Jeehoo	Agricultural Marketing Board
Mr	Jeelany	Mamodebaccus	Agricultural Marketing Board
Mr	Shashikant	Pandoo	Agricultural Research and Extension Unit
Mr	Vikash	Aodhora	AHRIM
Mr	Reaz	Kodaruth	Air Mauritius
Mr	Pynee A	Chellapermal	Alternet Research and Consulting
Mrs	Dhamayshwaree	Hurkoo	Betonix
Mr	A	Thacoor	CEB
Mr	Rajiv	Boodhun	Dry-Mixed Products Ltd
Mr	Tony	Lee Luen Len	Ecosis Ltd
Mr	Madev	Balloo	EU Delegation
Mr	Dhaneshwar	Jhugaroo	Irrigation Authority
Mr	Gulshansingh	Bhoojedhur	Mahatma Gandhi Institute
Mr	Kaviraj	Gooljar	Mauritius Film Development Corporation
Dr	Rajendra	Ramyead	Mauritius Institute of Health
Mr	Pravesh	Sawon	Mauritius Institute of Training and Development
Mr	Shiva	Coothen	Mauritius Police Force
Mr	David	Chan Yook Fo	Mauritius Ports Authority
Mr	Serge Karl	Keble	Mauritius Post
Mr	Robin	Phoolchund	Mauritius Qualifications Authority
Mr	Intish	Goreeba	Mauritius Revenue Authority
Mr	Donald	Dhondee	Mauritius Standards Bureau
Mr	Jugdis	Bundhoo	Mauritius Sugar Authority
Mr	Khreereeraz	Mahadeb	Mauritius Sugar Terminal Corporation
Mr	Ravin	Autar	Mauritius Telecom
Mrs	R	Azaree	MIE
Mr	Ambilall	Busawon	Ministry of Agro-Industry and Food Security (Engineering Division)
Mrs	Neeru	Goolooa	Ministry of Civil Service and Administrative Reforms
Mr	Vijay Anand	Beemud	Ministry of Education and HR
Dr	Pradeep	Soonarane	Ministry of Energy and Public Utilities
Mr	Ashley	Purmanund	Ministry of Energy and Public Utilities

Mrs	Moonawwara	Outim	Ministry of Environment and Sustainable Development
Mr	R	Seenauth	Ministry of Environment and Sustainable Development
Mrs	Bibi Aisha	Golamaully	Ministry of Environment and Sustainable Development
Miss	Sharona	Mauree	Ministry of Gender Equality, child Development and Family Welfare
Mrs	Venkata Ratnam	Bumma	Ministry of Housing and Lands
Mr	Hurrydeo	Bholah	Ministry of Public Infrastructure, NDU, LT&S
Mr	R	Ramjeet	Ministry of Public Infrastructure, NDU, LT&S
Mr	D	Seeburrun	Ministry of Public Infrastructure, NDU, LT&S
Mr	Dhanraj	Kissoon	MSCL Caroline
Mr	Oudesh	Domah	Municipality of Curepipe
Mr	Parvesh	Balloo	Municipality of Quatre-Bornes
Mr	Paul	Moolee	National Parks and Conservation Services
Mr	Sachindev	Jugoo	NHDC
Mr	Pierre	Sagnier	Omnicane Thermal Energy Operations Ltd
Mr	Jean-Claude	Bellepeau	Pre-Mixed Concrete Ltd
Mr	Vikram	Bhujun	ProDesign Sustainability & MEP Engineers
Mr	Kevin	Appadoo	Ragoo Associates Ltd
Mr	Hirji	Jadav	Servansingh Jadav and Partners Consulting Engineers Ltd
Miss	Zaheera	Nurudin	Tourism Authority
Dr	Nalini	Heeralall-Issur	University of Mauritius
Assoc Prof	Manta Devi	Nowbuth	University of Mauritius
Mrs	Yashwaree	Baguant-Moonshiram	University of Mauritius
Dr	Chandradeo	Bokhoree	University of Technology Mauritius
Mr	Sunanda	Jugessur-Sungker	Vallée d'Osterlog Endemic Garden Foundation
Mr	Mahendra Kumar	Bissessur	Water Resources Unit (Ministry of Energy and Public Utilities)
Dr	Richard	Munisamy	We Love Mauritius
Mr	J.Pierre	Levasser	Prisons Dept
Mr	R	Beegun	Radioplus
Mr	Chankar	Bheekhun	Mauritas
Mr	Albert	Salomon	R.R.A
Mr	Laval	Wong	MEF

Mr	Shaan	Kundomal	Ecobiotech
Mr	Riche	Naudd	Le Dimanche
Mr	Ronny	Naudd	Le Dimanche
Mrs	Meera	Koonjul	Ministry of Fisheries and Rodrigues
Mr	Ashwin	Seegolam	MCB
Mr	Ravin	Ghurburrun	OIDC
Mr	Shashi	Pooloogadoo	Airmate Ltd
		Deak	AFD
	Reena	Bangaroo	TEC-Collaborative Mauritius
Mrs	Manta Nowbuth		UOM
Mr	Oumesh	Domah	Ministry of Local Government
Dr	Mahendra	Gooroochurn	Prodesign Ltd
Mr	Reza	Badal	MOI
Mr	Muzamul	Moosafeer	UOM
Mr		Chutel	MoTESRT
	Shailaja	Oolun	NCB
	N	Veeramootoo	MTE
Mr	Goind	Gunesh	Nursing Association
Mr	Yusuf	Rusai	Ministry of Health and Quality of Life
Mr	Tangavelu	Ramasawmy	CWA
Mr	Oomar	Dooreemeah	UOM
Mr	Zubeir	Peer	UOM
Mr	Krishna	Heeramun	BA Investment