GUIDELINES

ENERGY EFFICIENCY AND ENERGY CONSERVATION IN HOTELS

Mauritius

Energy Efficiency Management Office

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Contents

LIST OF ACRONYMS

AC	Air conditioning
AfDB	African Development Bank
AHRIM	Association of Hoteliers and Restaurants in Mauritius
BMS	Building Management System
CDD	Cooling Degree Days
CEB	Central Electricity Board
CFL	Compact fluorescent lamp
COP	Coefficient of Performance
CRI	Colour Rendering Index
DBM	Development Bank of Mauritius
DC	Direct Current
DFI	Development Finance Institutions
ECMs	Energy conservation measures
EE	Energy Efficiency
EEMO	Energy Efficiency Management Office
EnMS	Energy Management System
EnPI	Energy Performance Indicator
EPC	Energy Performance Contracts
EU	European Union
EUI	Energy Use Intensities
GHG	Green House Gas
GSTC	Global Sustainable Tourism Council
GWP	Green Warming Potential
HDD	Heating degree days
HVAC	Heating Ventilation and Air Conditioning
IE	International Efficiency
IEA	International Energy Agency
IEM	Institution of Engineers Mauritius
ISEAL	International social and environmental accreditation andlabelling
ISO	International Organization for Standardization
KWh	Kilowatt hour
LED	Light emitting diode
LPG	Liquified Petroleum Gas
MDGs	Millennium Development Goals
MUR	Mauritian Rupee
NGO	Non governmental organization
PNEE	Programme National d'Efficacité Energétique
PV	Photo Voltaic
PVC	Poly Vinyl Chloride
ROI	Return on investment
SDGs	Sustainable Development Goals
SME	Small and mid size enterprises
SUNREF/AFD	Sustainable Use of Natural Resources and Energy Fund / Agence Française de Dével-oppement
SWH	Solar Water Heater
USB	Universal Serial Bus
VRV	Variable refrigerant Volume

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FOREWORD

Moving on from the COVID-19 era and the challenging uncertain times that it has given birth to is mind-boggling for stakeholders in all sectors of the Mauritian economy. Glaring opportunities and looming threats are there to be considered before any aftermath strategy is developed. Life and business are no longer as usual, but our resilience in the fight against climate change was, is and will remain unequivocal.

Ever since its creation in the year 2011, the Energy Efficiency Management Office (EEMO) has been devolved with the responsibility of helping to achieve greater prosperity and sustainability through energy efficiency in Mauritius. This guide on energy efficiency and energy conservation in hotels is a well thought and valuable contribution by the EEMO to the hotel industry.

Though the concept was not very clear during the pre-COVID era, it is now more than certain that an energy efficiency culture is a must and will surely help in revamping businesses. The comfort sought by clients come at a price and the rise in green consumerism is an undeniable fact which calls for due consideration by the players in the tourism sector. Moreover, competitiveness at regional and global levels needs an edge. Sustainability measures through energy efficiency and energy conservation are key success factors.

The guidelines put forward by the EEMO are not exhaustive and the prescribed measures are not there to challenge the knowledge and capabilities of those involved either directly or indirectly in the design, construction, promotion, and maintenance of hotels. In fact, the measures are there to accompany them in their day-to-day activities as a reference and reminder that there exist other ways to get things done and help save our planet.

Possibilities of adopting energy efficiency and energy conservation best practices touch and concern building envelopes, ventilation, air conditioning, hot water, lighting, kitchen, laundry, swimming pool, wastewater treatment and motors. The impact of energy efficiency measures can further be monitored through energy performance indicators and there are tools for tracking energy performance. Stakeholders who wish to go the extra mile may even consider complying to international standards such as ISO 50001, Green Globe, Earth Check, Global Sustainable Tourism Council and Biosphere certification standards.

I look forward to the guidelines being unpacked and deployed at all levels in the hotel industry. You can rely on the EEMO as a partner on the journey to make your respective organisations greener and more sustainable.

Liladhur G. Sewtohul

Chairman Energy Efficiency Committee

INTRODUCTION

1. Introduction

1.1 Energy efficiency and conservation

Since 2015, improvements in global energy intensity has been weakening each year following improvements since 2010 of about 3% following various initiatives and policies. Energy efficiency has enormous potential to boost economic growth and reduce greenhouse gas emissions. The set target was to achieve a 3% improvement on average but 2018 registered only 1.2% according to the "Energy Efficiency 2019 Fuel Report". This saving represented USD 1.6 trillion and could have been consistently USD4 trillion.

There have been great improvements in both technology and processes but real gains in energy efficiency are not being recorded due to structural changes in mode of transport and more building area per person. The increase in plug load device ownership has added up to increase in energy demand, decreasing efficiency gains globally.

Countries have been very active to increase their energy security in the last decade which resulted in reduced oil imports since year 2000 (Japan – 20%, South Africa -13%, Germany -11% etc.). If barriers are removed, digitalization could unlock greater efficiency. It allows for more accurate and quicker measurements to achieve flexible loads and ultimate gains in end use efficiency. However, policy flexibility and leadership will need to follow removing regulatory barriers to innovation and balancing data accessibility and privacy.

Multiple benefits of energy efficiency have been recorded over the years and summarized into:

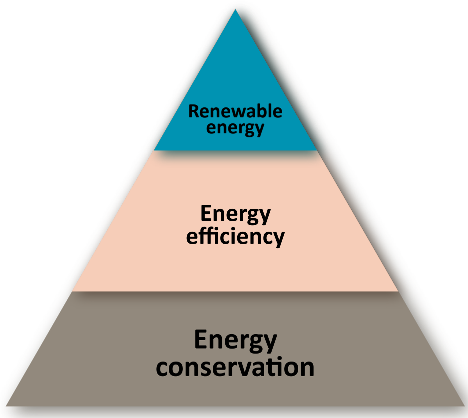

Figure -1- Energy Pyramid

1.2 Global changes and importance of Energy Efficiency

Figure 2: Multiple benefits of energy efficiency

Energy has a longer story, but it gained importance 40 years back in the 70's. What we know today as Energy Efficiency has evolved through multiple phases. Global concern about energy started with tensions in the middle east and the Iranian revolution which impacted on oil prices which increased over folds. Developed countries with energy hungry industries felt the rise in energy prices with great concern and it marked the start of a long battle with different approaches and driving forces.

Energy efficiency gained momentum from 2010 with recognition of the critical role that energy efficiency could play in meeting climate change targets and the resulting economic opportunities it generated. The MDGs became the SDGs (Sustainable Development Goals) with more emphasis on Energy under the "SDG7 – Affordable and clean energy for all". That period also marked major technological advancements and increase in plug load devices. Technology brought energy at the centre of nearly every major challenge and opportunity. The next phase in the energy evolution is foreseen to be focused on energy as a reliable resource with productivity considerations. Energy productivity will gradually replace efficiency considerations and get most economic value out of each unit of energy.

1.3 Energy in hotels and the Tourism sector in general

The tourism sector can derive multiple benefits from adoption of Energy Efficiency measures. Operations cost of hotels are specially impacted by bills but could be potentially reduced to enable higher savings while increasing their competitiveness and sustainability. The tourism sector has always been the first victim of economic downturns. We have recently witnessed that the impact of the COVID-19 pandemic has been very negative on the tourism sector.

Energy efficiency measures in hotels contribute directly to the national "SDG 7 – Affordable and clean energy for all" achievement.

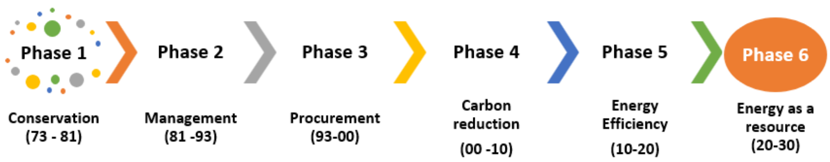

Figure 3: Global changes of energy efficiency

Central importance of Energy Efficiency

Energy efficiency is centrally important to social development, economic growth and resilience, and clean energy transitions. Many countries have successfully implemented energy efficiency policies, resulting in a range of positive outcomes in terms of jobs, health, security, resilience and access. However, IEA analysis shows there is still significant untapped energy efficiency potential and a concerning slowdown of global efficiency progress in recent years.

Immediate Benefit

Energy efficiency's immediate benefits are more important than ever in the current context of the global Covid-19 health crisis and its economic impacts. All governments are facing the economic impact of the crisis, and thinking ahead of ways to stimulate their economies and become more prosperous. Evidence shows well-designed stimulus programmes with efficiency considerations can rapidly support the existing workforce, create new jobs, and boost economic activities in a range of key sectors while keeping track of longer-term objectives of clean energy transitions.

Future Trends

*

Opportunity to engage in a comprehensive discussion of key issues for energy efficiency with a high-level audience from around the world.

*

The IEA's Annual Global Conference on Energy Efficiency will take place online on 23 June. A central element of this year's virtual Conference will be the launch of a set of recommendations from the Global Commission for Urgent Action on Energy Efficiency.

*

These recommendations will show all governments how to stimulate more energy efficiency action, more investment, and more jobs in the context of the Covid-19 economic recovery and beyond.

Figure 4: Energy efficiency in the tourism sector

1.4 Technical Definitions

i. Energy Efficiency

- Reducing the amount of Energy consumed to achieve the same level of output
- No habit change required

ii. Energy Conservation

- Effort made to reduce the consumption of energy by using less of an energy service (save it or switch off practices)

iii. Economic Benefits

- Reduction in energy costs and may result in a financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy-efficient technology.

iv. Impacts of EE measures

- Economic, Social and Environmental impacts of energy efficiency that can measured using relevant indicators

v. Long term Energy investments

- Investments in Energy efficiency measures or equipment that will yield returns in the long term or over 5 years

vi. Energy efficiency gap

- Refers to the improvement potential of energy efficiency or the difference between the cost-minimizing level of energy efficiency and the level of energy efficiency actually realized.

Figure 5: Technical definitions

ENERGY EFFICIENCY

2. Energy Efficiency in the Mauritian Hotel Sector

2.1 Benchmarking of energy consumption

Green Hoteliers benchmarking of energy consumption dated 2008 shows that for tropical climates, electricity consumption in the high category is 250 kWh / m² of serviced space.

Hotel profile	Climate zone and energy type		Energy consumption (kWh/m^2 of serviced space)		
			EXCELLENT	SATISFACTORY	HIGH
Luxury serviced hotels	TEMPERATE	Electricity	< 135	< 145	< 170
		Other energy	< 150	< 200	< 240
		TOTAL	< 285	< 345	< 410
	MEDITERRANEAN	Electricity	< 140	< 150	< 175
		Other energy	< 120	< 140	< 170
		TOTAL	< 260	< 290	< 345
	TROPICAL	Electricity	< 190	< 220	< 250
		Other energy	< 80	< 100	< 120
		TOTAL	< 270	< 320	< 370

Figure 6: Benchmark values for electricity and other energy consumption in luxury, fully-serviced hotels

2.2 The current situation in Mauritius

There are a few proven pathways to achieve energy efficiency:

Figure 7: Pathways to achieve energy efficiency

2.3 The Mauritian Context

Studies conducted in Mauritius by the EEMO (2018), AHRIM (2011/2012), PNEE (2017) and other organisations demonstrated that despite efforts being made and initiatives which have been taken, energy efficiency may further be improved in Mauritian hotels. These reports highlighted:

- It was established that electricity accounted for 69% on energy consumption in the hotels with LPG (26%) and diesel (5%)
- 24% of the hotels have resorted to solar water heaters for hot water production complemented by LPG (16%) and diesel (6%).
- Only 2 hotels have installed grid-tied photovoltaic systems for self-consumption and export. No hotels operate off-grid photovoltaic systems.
- 64 hotels have provided data on their backup standby generating sets. The average installed capacity is 962 kVA and the average running hours is 17.6 per month.
- 7 Hotels out of 73 are equipped with a desalination plant. However only 2 hotels desalinate water consistently with a coverage production of 870m³ per day each.
- The variance between actual and computed average energy consumption based on equipment loads and usage patterns was ± 5% to ± 30%.

The energy consumption profile was as follows:

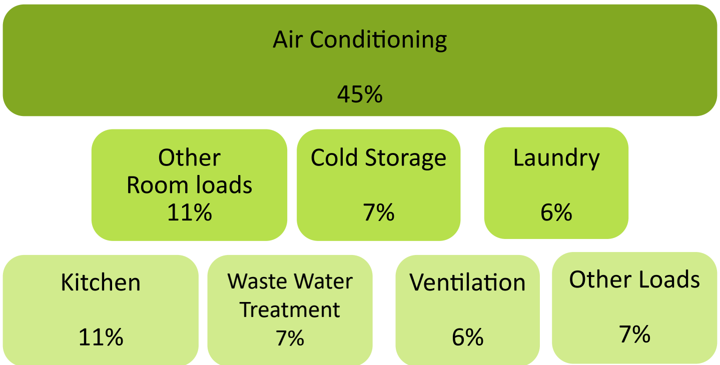

Figure 8: Energy consumption profile

The analysis across all categories has shown that air conditioning is the main consumer with 45%, followed by:

- ◊ Rooms and kitchen at 11% each;
- ◊ Water features at 10%; while
- ◊ Laundry and ventilation are at 6% each

2.4 Recommendations included:

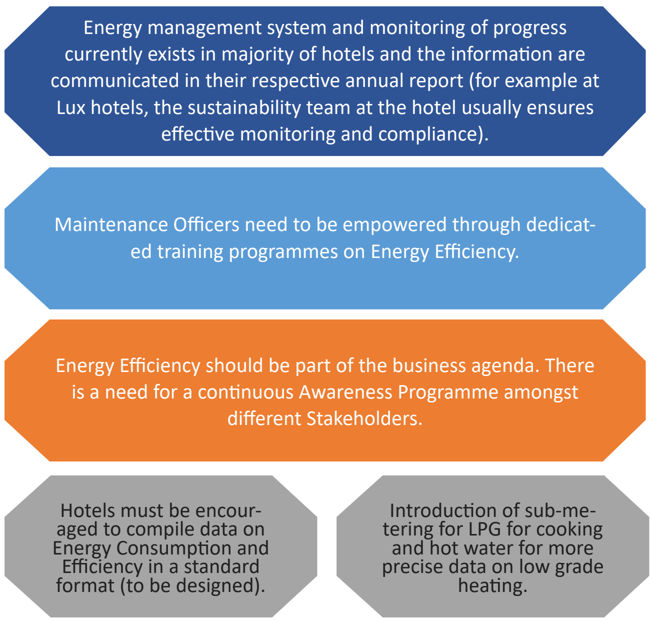

Figure 9: Maintenance managers role in energy efficiency

- ◊ Energy consumption should be measured, sources indicated, and measures to decrease overall consumption should be adopted, while encouraging the use of renewable energy.
- ◊ Water consumption should be measured, sources indicated and measures to decrease overall consumption should be adopted.
- ◊ Energy cost is a significant portion of operation costs that are controllable.
- ◊ Managers are daunted when faced with both urgent need to reduce energy cost and an almost bewildering array of technologies and options to do so.
- ◊ Competing investment priorities: A lighting retrofit with less than 2-year payback and significantly reducing costs MUST COMPETE with e.g. room upgrades for replacing mattresses, curtains that urgently need to be changed.

Demystify energy management and outline what hotel managers can do to set their hotels on an energy efficient path.

- ◊ Entire Management Team must be Energy Aware and continually keep energy management on their agendas.

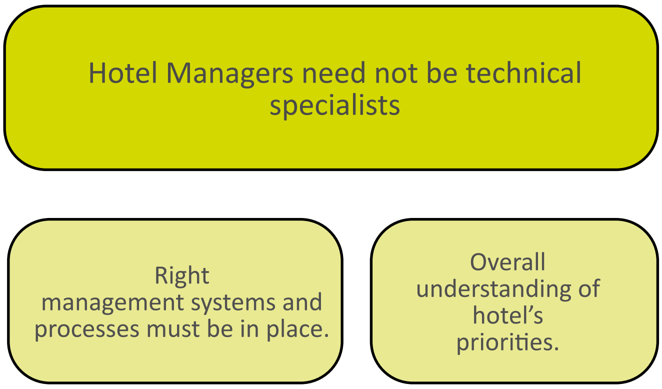

Figure 10: hotel management role in energy efficiency achievement

- ◊ Good energy management will not happen on its own accord without investment. Even for the simplest management goals, hotels will need to invest in staff's capacity and put in place appropriate management structure.
- ◊ Energy costs are high in Mauritius

2.5 Potential Barriers faced by hotels

2.5.1 Energy efficiency value chain key elements

Barriers to EE in hotels have many dimensions and the first one being comprehension and a lack of information about energy efficiency systems and best practices on energy efficiency have been found to be a major barrier to investment by hotels. Further barriers can be attributed to the lack of management commitment, unskilled staff who are not properly trained to run existing energy facilities efficiently, confusion in the market place making it difficult for hotels to assess information provided by suppliers on energy efficiency measures and costs, and poor design of existing buildings resulting in energy losses. Refer to tables on page 17.

The drivers leading to better use of energy efficiency measures can be attributed to:

- ◊ Knowledge of key drivers of energy consumption by hotels,
- ◊ Deep understanding of technical solutions to achieve energy efficiency
- ◊ Better understanding of the costs and benefits of investments in energy efficiency
- ◊ Measures in achieving target levels of cost and client experience
- ◊ Increasing customer concern and awareness on energy use issues

Client focused EE value chain for 4 Star/4 Star Superior Large hotels or Groups				
	What	Who	How	Potential Barriers
1	Understand global client expectations and customize offer	Hotel top Management to review strategic marketing	Achieve expected levels of comfort with the lowest possible carbon footprint	Business as usual mentality and resistance to adapt business model
2	Mobilize finance for Investment in EE measures	Hotel top management to secure Green loan or request shareholder to inject equity	Hotel groups may develop internal capacity for Level 3 Energy Audits or outsource to certified Auditors	Lack of Financial strength to mobilise Equity or inadequate credit worthiness to mobilise loan
3	Implement EE measures	Outsourced to specialists closely monitored by internal maintenance team	Launch procurement to appoint engineers, suppliers and contractors	EE value chain not ready or insufficient capacity to provide specialized EE solutions
4	Implement Energy Management system	Recruit and train dedicated energy management staff	Establish Monitoring and Evaluation Energy performance metrics for Internal and external benchmarking	Lack of commitment for dedicated Energy management function

Table 1: Client focused EE value chain for 4 Star/4 Star Superior Large hotels or Groups

Client focused EE value chain for lower than 4 star and smaller individual hotels				
	What	Who	How	Potential Barriers
1	Understand regional client expectations and adapt cost	Hotel top Management to review strategic marketing	Achieve expected levels of comfort with the lowest possible investment and operating costs	Business as usual mentality and resistance to adapt business model
2	Mobilise finance for Investment in EE measures	Hotel top management to secure Green loan or Invite suppliers and contractors invest under service contracts	Small individual hotels to outsource Level 3 Energy Audits to certified Auditors	Lack of Financial strength to mobilise Equity or inadequate credit worthiness to mobilise loan
3	Implement EE measures	Outsourced to specialists closely monitored by internal maintenance team	Launch procurement to appoint engineers, suppliers and contractors	Suppliers, Engineers and contractors not familiar with Energy service Contracts
4	Implement Energy Management system	Outsource energy management to specialist engineer or contractor	Establish Monitoring and Evaluation Energy and cost performance metrics for Internal and external benchmarking	Lack of commitment for dedicated Energy management function

Table 2: Client focused EE value chain for lower than 4 star and smaller individual hotels

2.5.2 Financing EE Projects

Financing Energy efficiency projects can take many forms and the cheapest one being green loans to finance EE projects which is being managed by MCB, SBM and Afrasia for the SUNREF programme. The local banks retailing the line of credit from SUNREF/AFD are not backed by technical assistance for Energy Audits and establishment of a business case. The Technical assistance provided by SUNREF/AFD in Mauritius has been channelled through Business Mauritius PNEE program which has up till now adopted a top down, ''filiere'' based approach to EE measures and has not provided dedicated level 3 and bankable Energy audits which could provide comfort to both the lender and borrower on the financial viability of measures. Since the Level 2 energy audits outsourced to auditors from Reunion island have not led to actual green loans and implementation, we can conclude that hotel owners and bankers require a higher level of comfort through level 3, certified and investment grade audits to commit finance.

There have been other means proposed by both governmental and private institutions that could assist hotels in their quest to energy efficiency like the DBM, SME Equity funds etc. However, these sources would also require a detailed feasibility study to sanction the financing particularly in the case of SMEs which have a higher risk profile.

2.5.3 Strategic pointers for action based on hotel category and market segment

The key pointers for action to address the barriers identified must be taken across the full value chain and the resulting impact will be determined by the weakest link:

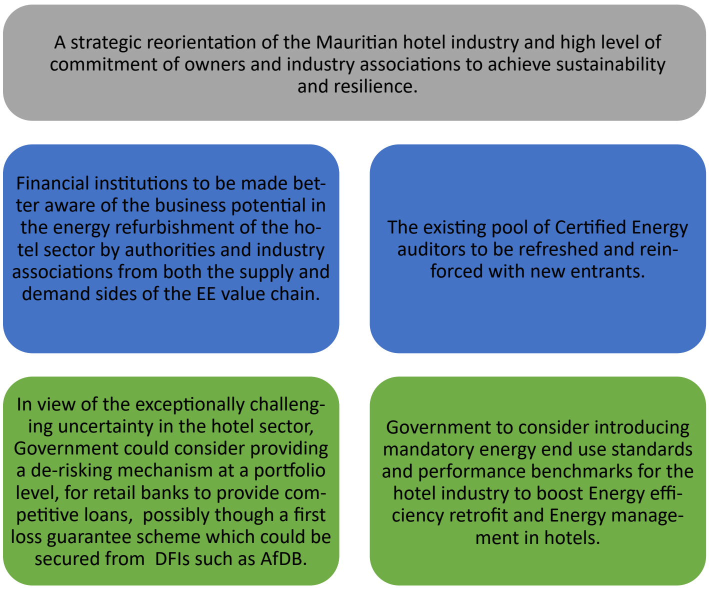

Figure 11: Key pointers for action

2.6 Demystifying Customer satisfaction

2.6.1 Guest comfort and sustainable practices

The hotel sector delivers high quality services but often fail to optimise water and energy usage, simply because it is not their core business. High quality services do not implicate that hundreds of litres of water per overnight stay need to be wasted, that cooling consumption needs to be far above acceptable limits and that electricity loads are out of control. Waste of energy can be identified in the majority of accommodations, even if managers are aware of saving opportunities and have taken initial steps to optimise consumptions.

The efficient use of energy and water in the tourist industry is one of the primary aims for a sustainable sector. Practice shows that improved energy efficiency will improve overall performance and ensure guest comfort. Monitoring consumption data helps to understand the relation between the energy consumption and a certain driver, e.g. outdoor temperatures and indoor climate, number of guests and electricity consumption, individual actions and related improvements. Initial savings turn into long term standards and costs for high quality infrastructure remain under control.

2.6.2 Guest preference and customer perception

Mauritian hotels particularly in the luxury segment have a significantly higher energy consumption than global benchmarks for Luxury fully serviced hotels.

The different sub-tropical micro climates (Coastal wet, Coastal Dry, Highlands Wet and Highlands drier) along with a relatively high diurnal deviation of 10 Degrees Celsius, Sea and land breezes on the coast, Natural ventilation from South East trade winds and Malgache winds are the key climatic characteristics which attract tourists to Mauritius.

Maintaining comfort conditions in this context should be easier than competing locations nearer the equator where higher humidity levels above 80 %, lower diurnal deviations of about 5 Degrees Celsius and higher average year-round temperatures over 25 degrees Celsius require more energy to maintain comfort.

There is a need to adapt the Mauritian hotel industry to reflect its natural climatic endowments, and guests' expectations now more inclined towards sustainability and authentic experiences. Consequently, in the current crisis situation it is a matter of survival for the hotel industry to seriously re-evaluate value creation and adapt to customer preferences and expectations.

2.6.3 The rise of Green consumerism in the post-Covid world

In the post-Covid economic recovery phase, the Mauritian Hotel industry will be affected by the global downturn in the Airline industry, and more because the National carrier faces an uncertain future. Cost for air travel is expected to be higher due to lower aircraft occupancy, and more stringent sanitary measures. On the demand side, the fear of sanitary risks in airports and airplanes, along with the threat of being stranded in a remote location could be a severe deterrent to long haul tourism to Mauritius.

The segment which could be most affected could well be the working-class Europeans who could be tempted to opt for holidays with lower cost short flights and land transport. In this scenario the hotel industry may have to reorient towards higher end clients which is also compatible with the large capacity in the 4star and above category.

The carbon footprint of the flight to Mauritius from Europe especially by indirect flights through Hubs like Istanbul, Joburg, Nairobi and Dubai compare unfavourably to competing destinations such as Seychelles, Maldives, Sri Lanka, and Zanzibar.

Since energy costs only represents 5% to 7% of costs, the main motive for investing in Energy efficiency could be to reduce the carbon footprint of the actual stay to compensate for the emissions for travelling to the Mauritian destination. The global covid pandemic and the resulting de-globalisation may have fundamentally changed the hospitality industry and there is need to adapt to the new realities.

EVOLUTION

3. Evolution of the Tourism Sector/Hotels

3.1 Global Sectoral transformation

The hotel industry represents one of the most important sectors of the travel and tourism industry and is the world's largest single employer.

Compared to most other categories of commercial buildings, lodging facilities are unique as regards to operational plans, the types of amenities and services offered,

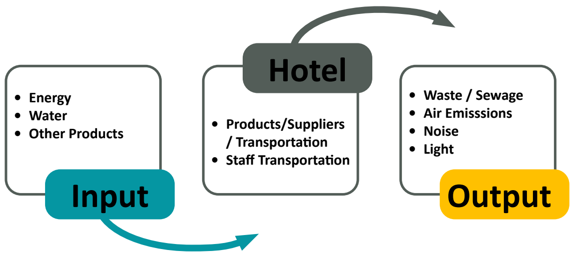

Figure 12: simplified energy life cycle in hotels

as well as the resulting patterns of natural resource use. Many of the services provided by hotels are resource-intensive, resulting in a significant ecological footprint. Indeed, tourism is one of the three main sectors impacting the environment, after industry and agriculture.

Hotels interact with the environment at every stage of their life cycle. A typical life cycle analysis tends to show that the siting of the hotel and the construction phase represent less than 10 % of the total amount of energy consumption over a 50-year period, thus demonstrating the importance of the environmental impact during the hotel's operational phase (Despretz, 2001). Therefore, the main environmental impact is most significant during the operational phase of the hotel, which is why efforts must be made to reduce those environmental impacts.

The following figure illustrates the main environmental elements involved in running a hotel. The "input" describes the material needed for the operation of a hotel; the "output" is the emission or by-product caused by the operations of the hotel. Hotels have a direct influence on the input and output.

3.2 New trends in the sector

3.2.1 Market demand

Based on research conducted in the hotel sector on Energy Solutions published in the Daily Telegraph, the findings can be very much generalized to Mauritian Hotels. The primary customers of Mauritian hotels come from Europe with similar mindsets and attitudes.

◊ 50% Stated that sustainability and energy considerations are important to them

- ◊ Energy efficient measures would appeal to half of the respondents, a clear indication that it can be used by hoteliers for a competitive marketing edge while at the same time reducing their operations costs
- ◊ Guests bring on average 5 plug load devices with them on night stays with demand for WIFI throughout the hotel premises
- ◊ In the quest for customer satisfaction power hungry furnishings have made their way to the sector such as turbocharged showers, bright lighting and air conditioning, universal USB sockets, contactless charging pads etc.
- ◊ A third of hotel users believe that there should be an accreditation system that ranks places to stay on their sustainability
- ◊ Greener hotels represent a premium for guests, while more efficient systems can help keep costs low and margins high. The second is to address the easiest fixes to bring that cost down – such as replacing inefficient bulbs or air-conditioners and minimising wasted heat or light. The third is to put energy at the heart of the business's strategy and to make committed investments that promise long-term reward, such as installing solar panels, or investing in waste heat-recovery systems to slash costs.

3.2.2 Opportunities

The opportunities for energy efficiency are wide and can start from simple measures to more complex investments but the common aim is to remain competitive, reduce costs and at the same time to protect the environment and contribute to fight climate change However, the first two should be appealing enough to trigger the call for action for hoteliers.

3.2.3 Sustainability considerations

Hotel sustainability has become a priority for forward-thinking guests and hoteliers in recent years. With high waste generation and water consumption rates, many hotels have realized the negative impacts they've had on the environment. Hotels around the world are now working to improve their environmental footprint while simultaneously improving the guest experience.

The customer is always the number one priority and that's exactly why hotel sustainability becomes very important. Customers support companies that share their values. Tourists are increasingly seeking out eco-friendly travel options, and some are even willing to pay extra to support a hotel's sustainability program. According to booking.com, 68% of global travellers intended to stay at an eco-accommodation in 2018.

3.3 Smart Energy practices

The range of energy solutions particularly relevant to hotels can help businesses increase their energy efficiency – allowing them to expand the services they offer without hiking costs or their carbon footprint. These range from variable speed drives for machinery – slowing fans or motors to dramatically cut costs – to integrated heating, ventilation and air conditioning, and electric vehicle charging points. Such heavyweight technology is needed to meet the energy-intensive expectation of today's gadget-heavy customers.

3.3.1 Occupancy Sensors

Occupancy sensors installed in common areas toilets enable a simple, hygienic, contact less way to optimise lighting.

Another simple way to control and ensure lighting, equipment and Air conditioning is off when the room is not occupied is a Key card system which cannot be mechanically bypassed by any other card.

3.3.2 Temperature Regulators

Digital temperature regulators offer better opportunities for temperature control but may require a minimal training for guests before they are familiar with their operation. The client facing staff of the hotels should therefore be thoroughly trained in all the functions of these wall mounted or remote controller and explain to the guest upon check in, with a regular follow up in the level of guest comfort.

In hotels equipped with central chilled water systems there are significant opportunities for optimising air conditioning through a central Building Management System (BMS):

- ◊ Rooms can be precooled before guest arrival,
- ◊ Temperature setpoint can be regularly and centrally offset up or down to adapt to ambient temperature variations

3.3.3 Automatic and variable speed drive Pumps

Optimal sizing and operation of pumps is an opportunity which leads to lower running costs and enhanced lifetime and lower maintenance costs

- ◊ In application with varying loads such as chilled water circuits, Variable speed drives enable the optimal energy to be consumed to meet the actual demand.
- ◊ Hotel technical staff and management should be educated about the possibility of upgrading to latest generation electric motor: From IE2 to IE3 or IE4 (IE is a global efficiency index for electric motors)

3.3.4 Viability in Mauritius, Initial and lifetime costs

There is continuous innovation in technology solutions for more sustainable operations in the hospitality sector. The simple ones can be diffused through mandatory standards, promoted by suppliers, or imposed by top management as part of internal and external benchmarking.

However for more complex technology solutions, it is imperative to have recourse to Certified Energy Auditors to customise to the specific context and develop sound operational training and maintenance procedures, and develop a robust business case to justify the benefits from the investment.


LIGHTS
AUTO
MANUAL
Living room
Speaker
Intercom
Broadcast
Thermostat Bedroom
Webcams
Control
Scenes
Automation
Settings

GUIDELINES

4. Guidelines for Energy Efficiency and Energy Conservation in Hotels

4.1 Value addition of this guidelines to existing documentation

The AHRIM guidelines provides a good overview of solutions available and the expected savings in each case. The level 2 energy audits carried out by PNEE under SUNREF funding is a further improvement which has provided the hotels (mostly large hotels and groups) a good indication of savings potential and estimated investment costs.

4.2 Building Envelope, Ventilation, Air conditioning

4.2.1 Learning from the legacy

Thermal comfort is a key factor in client experience, who are often used to cool and dry northern hemisphere climates. There are 2 main drivers of thermal comfort in a room:

- ◊ Radiant heat from walls and roof which is itself determined by the thermal mass of the building
- ◊ Ambient humidity along with cooling effect of transpiration.

Traditional construction techniques in Mauritius up till the Mid of 20th century relied on low thermal mass wooden buildings or high thermal mass stone building with awnings to protect from direct sun, low thermal mass shingles or steel sheet roofing, along with ventilated attics, and cross-ventilated buildings. All the above features along with vegetation around the building contributed to achieving reasonable comfort levels in the different sub-tropical Mauritian microclimates.

The construction techniques based on high thermal mass concrete walls and roof introduced since the 1960's have significantly changed the thermal characteristics of the built environment in Mauritius. The advent of air conditioning since the 1980's has provided a means to achieve thermal comfort by offsetting the accumulated heat in walls and roofs and dehumidifying the air in closed rooms. Over the 1990's and 2000's cheaper air conditioning systems have enabled hotels to be air conditioned often at the expense of high energy consumption. Since the 2010's more efficient AC systems have enabled hotels to achieve thermal comfort at slightly lower running costs.

The time-tested techniques of the past provide the key insights for a more sustainable approach to maintaining comfort in a 3-step approach:

1. by first reducing the demand for air conditioning,
2. then adopting the most sustainable techniques to achieve comfort,

3. then installing or retrofitting the most efficient electrical appliances.

4.2.2 Pathways to reduce the demand for air condition by refurbishing the built environment

One of the misconceptions to correct is transposition of techniques applied in the global north, the main one being use of building insulation. Simulations with data logging have shown that use of insulation in air-conditioned buildings in the tropics increases total energy use. Singapore has banned the use of insulation due to this.

The diurnal deviation (ambient temperature difference between day and night) in Mauritius is about 10 Deg Celsius. which enables buildings to benefit from free cooling at night. Use of insulation prevents this cooling and the walls must be cooled from inside by air conditioning.

Simple techniques to reduce the thermal mass of buildings include painting in a light color preferably white with a locally manufactured paint which contains light reflecting particles.

In some cases, the building and especially North facing walls can be vegetated with special local creepers to create a green barrier to absorb the heat. If creepers are not architecturally acceptable and space is available, the North facing walls of buildings

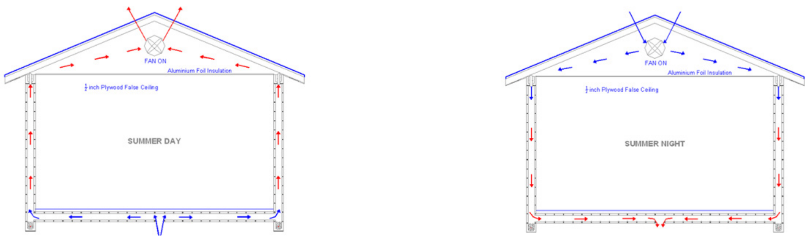

Figure 13: Example of cooling of building envelope by flushing away heat from hollow walls and attic using a small bi-directional fan

and villas should be shelters by planting leafy shrubs and trees which also create a natural cooling effect by evapotranspiration.

In Reunion island where hollow, bottom-less American standards blocks are available, ventilation of this core has enabled the thermal mass of the wall to be significantly reduced.

Flat concrete roofs represent a challenge in terms of thermal mass and often require recurrent and costly water proofing works. Covering the concrete roof with a corrugated steel roof with a well-ventilated attic space significantly reduces the roof thermal mass and provides a definitive solution for the water proofing problem.

All the above measures are either low cost or can be integrated in the maintenance budget for regular painting and water proofing. Indicatively, the cost of a good quality water proofing with a lifetime of about 10 years is of the same order of magnitude as a steel structure, sheet steel roofing attic to protect the roof for the lifetime of the building.

1. Article by Krishna Heeramun in IEM Magazine 2012

In cases of existing non-ventilated attic spaces addition of low power and low noise (30 W) reversible extractor fans can be installed for flushing out hot Air during the day and forcing cool night air into the attic. In the case of a room of about 30 m^2, one extractor fan with simple automated controls, entry and exhaust cowls could cost about MUR 14,000 and have an annual running cost of about MUR 1000.

The interventions described in this section will lower the building thermal mass, leading to reduction in the radiant heat perception from walls especially at Night when guests are sleeping.

4.2.3 Pathways for alternative cooling techniques

Use of Air conditioning requires doors and windows to be closed and recirculation of the air leading to potential issues of Air quality and the need for regular cleaning the filters to avoid cross contamination among guests with air borne diseases such as flu and Corona viruses. Air conditioning of hotel rooms also implies the need to either electrically lock the operation in case doors are kept open or to sensitize guests to avoid such wasteful situations.

Many guests come to Mauritius to enjoy the outdoor Air, the sea or garden view from the balcony, which is inconsistent with staying in a closed airconditioned room. Although this option should be provided for exceptionally hot and humid days and guests who so wish, an alternative cooling pathway could be introduced and promoted to guests as more sustainable and healthy, which is use of Natural sea and land breezes along with assisted mechanical ventilation.

Australian Research has shown that humans perceive the highest level of comfort from a vertical air stream due to the largest number of receptors in the skull. For this reason, the most effective mechanical ventilation is with a ceiling fan directly over the guest. A constant vertical air stream of 1 m/s is the optimum to achieve thermal comfort by facilitating sweating which has a cooling effect.

Another reason for use of Air conditioning in closed rooms is to protect against mosquitoes. Vertical mechanical ventilation has been shown to deter mosquitoes by interfering with their flight. The alternative cooling pathway could consist of creation of a cross ventilation in the room, by opening opposite balcony doors and windows fitted with mosquito nets, along with 1 or 2 variable speed ceiling fans per room. Cross ventilation can also enable the guests to precool the room while they are out dining and then switch to AC cooling mode with closed windows, the AC unit in dry mode and the ceiling fan on.

4.2.4 Simulations between Conventional and Alternative cooling techniques

To demonstrate the benefits, a simulation of alternative cooling techniques v/s conventional air conditioning has been made.

Assume in the base case a hotel room of 25 m^2 equipped with an efficient DC inverter AC unit of 12000 Btu / Hr, 1.1 KWe input power, costing MUR 16,000 to install. If operated for 10 months per year, 16 hours per day, the annual electricity cost would be MUR 15,800 and the 10-year life cycle cost would be MUR 183,400.

This represents the best-case scenario of the most efficient available AC cooling, operated responsibly by the guest in the base case where there is no intervention on the building envelope and represents the upper limit of efficient technology deployment.

In the alternative cooling case we assume that there are building envelope interventions by addition of a steel roof to protect the roof, and painting the walls with a reflective paint, assumed to be part of recurrent building maintenance budget. These measures constitute the passive components of the alternative cooling technique.

The active components consist of addition of a reversible mechanical ventilation to the roof attic, and two high efficiency permanent magnet Ceiling fans along with mosquito nets on doors to allow for free cooling with cross-ventilation.

Baseline scenario conventional AC cooling with no intervention on building envelope	kW	Daily Hours	Cycling Hours	Daily kWh	Annual Operation Months	Days	Annual kWh	Average Cost kWh	Annual Runing Cost MUR	Assumed Lifetime	Total Energy Costs	Estimated Investment and Maintenance Cost	Total Life Cycle Cooling Cost
DC Inverted 12,000 Btu/hr AC Unit	1.1	16	0.5	8.8	10	300	2640	6	15,840	10	158,400	25,000	183,400

Alternative Direct DC Water Heating	kW	Daily Hours	Cycling Hours	Daily kWh	Annual Operation Months	Days	Annual kWh	Average Cost kWh	Annual Runing Cost MUR	Assumed Lifetime	Total Energy Costs	Estimated Investment and Maintenance Cost	Total Life Cycle Cooling Cost
AC Booster Operation	2	2.5	1	5	8	240	1200	6	7,200	10	72,000	65,000	137,000

	Alternative Cooling Technique + Sustainable Use of Efficient AC Unit	kW	Daily Hours	Cycling Hours	Daily kWh	Annual Operation Months	Days	Annual kWh	Average Cost kWh	Annual Running Cost MUR	Assumed Lifetime	Total Energy Costs	Estimated Investment and Maintenance Cost	Total Life Cycle Cooling Cost
1	*1 X Reversible Attic fan 30 W with automated controls*	0.03	24	1	0.72	9	270	194.4	6	1,166	10	11,664	14,000	25,664
2	*2 X Permanent Magnet Ceiling Fan 20W*	0.04	20	0.7	0.56	12	360	201.6	6	1,210	10	12,096	6,000	18,086
3	*Mosquito Nets for Cross Ventilation*												10,000	10,000
4	*DC inverted 12,000 Btu / hr AC Unit*	1.1	8	0.4	3.52	5	150	528	6	3,168	10	31,680	25,000	56,680
												55,440	55,000	110,440

Table 3: Simulations between Conventional and Alternative cooling techniques

Assuming an electricity tariff of MUR 6/ kWh over the 10 year life cycle, total energy costs in the alternative cooling technique is MUR 23,760 which is over 6 times lower than the energy cost of MUR 158,400 in the conventional baseline, that is a saving of 85 %.

This technique could be applicable to the 2 to 3-star hotels which have to compete with Airbnb and guest houses by providing lower rates. Since Airconditioning represents about 40 % of the electrical consumption, the alternative cooling could lead to a savings of 34 % of the electricity bill.

The investment cost of MUR 30,000 in the alternative scenario is only marginally higher than the conventional AC cost at MUR 25,000. The life cycle cost of the alternative scenario at MUR 53,760 is 3.4 times lower than the conventional Air conditioning cooling case at MUR 183,400 which makes a clear case for this more sustainable solution. There could be the option, as already practiced by some guest houses in Rodrigues, to propose the use of air conditioning against an optional extra payment which is value for money for environment conscious guests.

In 3 Star Superior hotels, since Air conditioning systems is used extensively and higher levels of comfort are expected, we have evaluated a hybrid scenario where the 3 measures of the alternative technique are implemented along with sustainable use of Air conditioning. The Attic ventilation system is always on, the ceiling is on whenever the client is in the room, the AC is refurbished to the most efficient DC inverter technology and used occasionally at a higher set point and in dry mode with doors closed.

This hybrid approach of a combination of passive building envelope measures and sustainable use of air conditioning to enhance the comfort condition, shows that the 10-year energy cost of MUR 55,400 is only about 1/3 that of the conventional energy cost of MUR 158 400 (65 % lower) with while the life cycle cost is 40 % lower.

Since Air conditioning represents about 40 % of the electricity cost of hotels, a saving of the order of 65 % could lead to an overall savings in electricity bill of about 25 %.

4.2.5 Technology focused pathways for savings

In cases of large hotels with chilled water-cooling systems and chillers, there are possibilities of upgrading to highly efficient screw type water cooled chillers which have a COP above 6 to replace old reciprocating chillers. There are also savings to be made by replacing the circulating pumps with variable speed drives to adapt to the level of cooling required instead of pumping constant volumes of chilled water with bypass valves at the level of indoor fan coil units.

In the case of VRV (Variable refrigerant Volume) systems, the latest models with smart control systems tend to be at least 20 % more efficient than older models.

For these air-conditioning systems which have complex engineering designs, guidelines can inform on the latest technological innovations but cannot lead to investment decisions. Two broad routes are available:

- ◊ Either the hotel appoints an Energy Audit firm with a mandate to identify air-conditioning and other retrofits leading to more sustainable operations, and propose costed solutions with the evaluation of the financial rates of return,
- ◊ Or appoint an M &E consulting firm for the refurbishment of the air-conditioning systems and tasked to carry out value engineering and propose different options.

4.2.6 Emerging technologies to watch

The refrigerant based cooling systems of the past had a double environmental concern: Green Warming Potential (GWP) and Ozone depletion. In the rush to address the Ozone depletion issue, the Montreal protocol was signed and the Ozone depleting refrigerants (R22) were successfully replaced with safer ones such as R 410a which are used in the latest generation of DC inverter AC and still have a significant GHG potential. There is a need to switch to refrigerants with a low Global Warming Potential such as R 225 ca. Due to the chemical nature of any refrigerant and the pollution potential in their production, use and disposal, there is a global move to shift to desiccant based systems for dehumidification where relevant.

One simple system uses a desiccant wheel which extracts humidity from inside air and is regenerated by rejecting the humidity outside the building. Because such systems are not based on thermodynamic cycles, the energy consumption are significantly lower than the conventional AC used in dry mode. They would also require less maintenance than refrigerant based cooling systems.

4.3 Hot Water demand side management and production

4.3.1 Demand side management measures for hot water include:

- Do not overheat hot water. A temperature of 60°C is ideal: it provides comfortable hot water and is hot enough to kill legionella bacteria
- Consider fitting spray water taps, as they use less hot water and energy
- Make sure that leaking taps are repaired promptly
- Ensure that pipework is well insulated

4.3.2 Barriers for adoption of solar heating for hot water production

The solar hot water heater sector in Mauritius has suffered from an uncoordinated approach to incentive frameworks and standards. The other constraints which affect the adoption of solar water heating are:

- The inherent mismatch between supply and demand for hot water: The highest demand for hot water in winter coincides with the lowest availability of hot water especially during rainy and cloudy days, which requires a backup system to be available.
- Constraints related to architectural issues of placing large water tanks and collectors on the roof, along with the difficulty of routing cold and hot water pipes to and from the roof.
- Moreover, the low-pressure versions of thermosyphon solar water heaters which flows by gravity from the roof, makes it difficult to mix with mains cold water at a higher pressure to achieve the desired warm water temperature.
- Finally, the lack of visibility of the water temperature in the hot tank, leads to the risk of legionella bacteria propagating in the hot water circuit (between 35 to 45 degrees) leading to potential health issues for guests. Attempts to install electric boosters of about 1.5 to 2 Kw to top up the water temperature in many cases have led to overall counter-productive results, due to the difficulty of controlling the booster, which ends up consuming more energy heating water on the roof, which then suffers from losses, than if an instantaneous electric heater was used to provide water at the desired temperature when and where it is required.

All the above factors have contributed to make solar water heating less attractive for hotels. The few cases where solar energy has been successfully mobilised are in the larger hotels where space was available and where professionally designed evacuated tube collector systems transfer heat to central ground mounted storage tanks which have an electric, LPG or diesel heating backup.

4.3.3 Pathways for hotels with decentralised hot water, with existing Solar Water Heater (SWH)

Existing SWH should be evaluated based on the efficiency and performance of the installed SWH, the relative sizing of the collector and storage capacity compared to the demand for hot water, the local microclimate, and the quality of the solar exposure. Ways to compensate for the inadequate hot water is to provide an electrical backup. As highlighted in the barrier section above, use of an electric mains booster is one solution if the booster is controlled in an effective way. The simplest control being a manual switch from the room, which must be switched some time before hot water is required and switched off afterwards. Boosters are normally equipped with a built in Thermostat to cut off when the setpoint temperature is reached. Some SWH designs which use convection of water can allow a reverse thermosyphon whereby the collectors radiate stored heat back to space thus cooling the tank at night. Installing an electric booster in this case is very wasteful as electrical energy to heat water is radiated into space. Evacuated tube systems which use copper rods/conduction to transfer heat tend to minimise this.

Solar PV array of 2 X 250 W for Direct DC electrical booster fitted on steel roof protecting concrete roof. Solar PV array of 2 X 250 W for Direct DC electrical booster fitted on steel roof protecting concrete roof.

300 Litre pressure type Solar water heater with evacuated tube/copper rod collector fitted with Direct DC electrical booster.

Due to the above control issues when installing electric boosters, an alternative direct DC heating from 2 or 3 solar PV panels could be an effective solution to provide free energy after an initial investment. With an initial investment of less than MUR 15,000 hotels could benefit from a long term solution to back up solar thermal heat with Direct DC solar PV. In the case of ventilated attic built to protect the roof, a section of the flat roof can be keep uncovered around the SWH and painted with white reflective paint which also enhances the performance of evacuated tubes.

Standard Electrical booster powered with 60 V DC from direct DC solar Array.

Solar PV array of 2 X 250 W for Direct DC electrical booster fitted on steel roof protecting concrete roof.

300 Litre pressure type Solar water heater with evacuated tube/copper rod collector fitted with Direct DC electrical booster.

Standard Electrical booster powered with 60 V DC from direct DC solar Array.

4.3.4 Pathways for hotels who would like to implement decentralised hot water production but without SWH

A good quality stainless steel thermosyphon pressure type SWH of 300 litres costs around MUR 75,000 Installation on the roof is not compatible with protecting the roof with a ventilated attic which is detailed in the pathway to reduce demand for Airconditioning in section 4.2

Due to water pressure issues as detailed in the above section on barriers, only pressure type systems are recommended. To achieve a longer life and cut down maintenance costs stainless steel of at least grade 304 is recommended, and preferably grade 316 if affordable.

Installation of decoupled (separate tank and collectors) is possible in buildings with attics by building an attic with enough headroom for the tank in the centre. This however implies routing supply and return water pipes through the steel roof to the collector with a circulating pump which requires temperature sensors and a controller for operation. This is a complex electro-mechanical system which is prone to failure, costly to maintain and may not just justify the benefits.

A much simpler system is to install a well-insulated pressure tank of 300 L with 2 electric heaters elements of 3 kW and 2 KW dedicated to Direct DC heating and AC mains heating respectively. The first element is connected to 4 or 5 Solar PV panels of about 300 W each to create an array delivering a peak of 1.2 to 1.5 kW and a DC voltage of 120 to 150 VDC. This array is permanently connected to the direct DC heater which is the derated standard AC heater element. (3 KW AC rated heater element is derated to 1.5 kW when powered with DC). The choice of 4 or 5 solar will depend on the orientation of the roof (North, East and West facing unshaded roof preferred) and the local climate. The size of the DC array is calculated to meet the hot water requirements for around 8 months of the year. For the 4 winter months, the 2nd electric heater connected to AC mains supply with a temperature sensor and controller is used to top up the temperature. These controllers also include routines to automatically heat the water to 60 degrees once per week to kill potential bacteria in the tank.

		MUR
1	*300 L Pressure Tank*	20,000
2	*1500 W Solar PV DC Array*	30,000
3	*2 Boosters and Controller*	15,000
	Total	**65,000**

Table 4: Estimated cost for a simple low maintenance system (no moving parts)

Assuming a conservative annual yield of 1450 kWh/KWp, a 1.5 KWp DC array will produce 2175 KWh annually which is stored in hot water with little losses.

The estimated cost for this simple low maintenance system (no moving parts) is around MUR 65,000.

DC Direct Solar+ Mains heating	
Hot water consumed	*200 litres*
Delta T	*35 Deg*
SHC	*4200 J/Kg/K*
Daily energy for heating	*29400 KJ*
Annual energy	*10,731,000 KJ*
Allow for losses/ efficiency	*0.9*
Total Energy required	*11,923,333 KJ*
Total Energy required	*11.92 GJ*
Total Energy required	*3.31 MWh*
Total Energy required	*3312.04 kWh*

Table 5: DC Direct Solar+ Mains heating

The estimated annual energy for heating 200 litres of water daily from a mix of Direct DC solar heating and mains power is 3312 kWh. A 1.5 KWp DC PV array will contribute 2175 kWh which is 65% of the total requirements. The balance 1136 kWh is required from AC main though the 2nd booster 2 KW top up booster which would operate an average of 2.5 hours daily for the 8 coldest months in the worse case scenario of hotels on the central plateau, and lead to an annual electricity cost of MUR 7,200. For hotels in coastal areas the 2nd AC Booster is expected to be operational for only about 4 colder months.

Alternative Direct DC Water Heating	kW	Daily Hours	Cycling Hours	Daily kWh	Annual Operation Months	Days	Annual kWh	Average Cost kWh	Annual Runing Cost MUR	Assumed Lifetime	Total Energy Costs	Estimated Investment and Maintenance Cost	Total Life Cycle Cooling Cost
AC Booster Operation	2	2.5	1	5	8	240	1200	6	7,200	10	72,000	65,000	137,000

Table 6: Alternative Direct DC Water Heating

The 300 L insulated tank creates a small capacity thermal buffer to cater for partly cloudy days. The life cycle cost for provision of hot water for 10 years through this hybrid direct DC solar heating and mains top up is MUR 137,000.

Hot water consumed	*200 litres*
Delta T	*35 Deg*
SHC	*4200 J/Kg/K*
Daily energy for heating	*29400 KJ*
Annual energy	*10,731,000 KJ*
Assume efficiency	*0.8*
Total Energy required	*13,413,750 KJ*
Total Energy required	*13.4 GJ*
Total Energy required	*3.7 MWh*
Total Energy required	*3726 KWh*
Annual LPG required	*268 Kg*

Table 7: Annual estimate of LPG consumption

The conventional solution for water heating is LPG heating. To have a basis for comparison, a decentralised LPG heating system per hotel room is assumed. The current price of commercial LPG is MUR 72 per Kg. A conservative tariff of MUR 100 per KG is assumed over the 10 year life cycle.

Decentralised LPG eating	kW	Daily Hours	Cycling Hours	Daily kWh	Annual Operation Months	Days	Annual LPG required	Average 10 Year Cost KG LPG	Annual Runing Cost MUR	Assumed Lifetime	Total Energy Costs	Estimated Investment and Maintenance Cost	Total Life Cycle Cooling Cost
Dcentralised LPG Heating				v	12	365	268	100	26,806	10	268,061	25,000	293,061

Table 8: Decentralised LPG heating

An annual estimate of LPG consumption for 200 litres of daily hot water is 268 Kg.

The conventional LPG heating system has an annual energy cost of MUR 26,806 and a 10-year life cycle cost of MUR 293,000

The energy cost of the LPG solution is 3.7 times higher than the hybrid direct DC-Mains heating system and its life cycle cost is 2.1 times higher, which makes a clear case for this system to be implemented.

This direct DC heating solution would also create a secondary market and second life for recycling derated solar PV modules which could bring the implementation further down from the estimated MUR 65,000 which is itself cheaper than equivalent quality evacuated tube SWH.

The shielding of the most exposed roof by solar PV panels also contributes to cool the roof and improve roof thermal comfort.

The proposed Direct DC hybrid system is compatible with the ventilated attic roof proposed and can cut down hot water heating costs by 50 %, while leading to significant economic benefits for trades involved in local manufacturing of pressure tanks and installation of the electrical systems, while building resilience for the sector against future prices of LPG which can increase due to global demand and depreciation of the MUR.

4.3.5 Pathways for hotels with centralised hot water production from LPG or diesel

Centralised hot water systems have the advantage of the averaging effect of supplying a block of rooms. There are opportunities to hybridise the operation of these tanks by introducing an element of direct DC solar PV heating and an element of mains electrical heating to cater for hot water requirements during off peak periods and in summer while keeping the fossil options for peak hotel loads and winter.

The disadvantage of centralised systems for Direct DC solar is that DC wiring must be kept short to minimise losses. However since hotels usually have one central systems to cater for each block of rooms, it is possible to install a Solar DC array on the best roofs available closest to the hot water plantroom and route the DC wiring in PVC conduits which is much simpler and cheaper than hot and cold water piping.

Because hybridisation of central hot water systems depends on a wide range of parameters, it is not possible to provide general guidelines. Each case must be studied, and a customised solution developed which represents a compromise between the Direct DC Solar fraction, the electrical fraction and the fossil backup/ top-up component.

However the basic principles of hybridised electrical heating leading to 50 % reduction on life cyle cost would also be applicable to central systems with the added benefit of optimised sizing due to the averaging effect of room occupancy within a block, economies of scale and ease of maintenance of central systems.

4.4 Lighting loads

4.4.1 Background on the lighting sector

The AHRIM guide already provides a clear catalogue of lighting technologies available and their applications. Simple measures to reduce consumption from lighting include:

- ◊ Install occupancy and daylight sensors so that lights are only on when required
- ◊ Switch to high efficiency lighting by retrofitting fluorescent and older generation LEDS with the ones with highest lumens/ watt rating which also contribute less to the cooking load and air-conditioning costs.

Over the last decade, LED lamps have been introduced by suppliers, with however a wide variability in quality, product lifetime, Luminous efficacy (lumens per Watt), colour rendering index, temperature of the light.

In the absence of minimum performance standards, the focus of lighting refurbishment has been on displacing lights with lower wattage lamps without due consideration to the luminous efficacy and lifetime. In most hotels top management have delegated to maintenance engineers and technicians to carry out lighting refurbishment. The range of LED lights on the market with a wide range of quality parameters has created the conditions for potential governance issues whereby suppliers of substandard lighting may have crowded out more optimal lighting solutions.

4.4.2 Barriers for sustainable and optimal lighting refurbishment in Mauritius

The lifetime of a high-quality LED lamp is 30,000 to 50,000 hours which should lead to lifetimes between 7 to 20 years if the lamp survives power surges.

In the context of recurrent budgets allocated to lighting maintenance it seems that the technical and procurement staff of hotels may not have created the market push for long lifetime LED lamps and have supported the lower end of the market which require recurrent purchases.

Life time hours	Hours per day	Lifetime in years
30,000	7	12
30,000	12	7
50,000	7	20
50,000	12	11

Table 9: Lifetime of high-quality LED lamps

The outcome of this unfortunate situation is multi-faceted:

1. Higher life cycle cost due to premature failure of sub standards lamps,

2. Higher energy costs due to low luminous efficacy (9 W LEDs being used where efficient LEDS of 5 W could provide the same light output)

3. Poor client experience as aggressive white light often used (which have a higher lumen output per Watt than warmer lights)

4. Environmental issues as poor-quality lamps are dumped into landfill as there is no provision for sustainable recycling

In most hotels there is currently a remaining stock of CFLs and LED lamps which in some cases have a colour temperature of 6000 K (Industry white). For the hotel sector apart from technical areas, the colour temperature in rooms should be 4000 K for recessed lights and warmer (3000 to 3500 K) for bedside lamps. Outdoor architectural lamps should be warm white.

There are no barriers in terms of supply deficiencies as there are several suppliers representing global brands who can supply quality LED lamps. The 2 types of barriers noted in the 2 hotels segments are:

1. Top management and boards of large luxury hotels and groups may not be fully aware of the potential of optimal lighting retrofit to create sustainable value, improve client experience, and lower life cycle costs for lighting.

2. Management and owners of smaller and individual hotels are currently not in financial position to invest in optimisation of lighting, nor do they have the in-house expertise of lighting experts.

4.4.3 Proposed pathways for sustainable lighting refurbishment for hotel segments

Specific pathways have been identified which are adapted to the 2 broad hotel segments in Mauritius

1. Top management of large hotels and groups should appoint independent specialist lighting auditors' teams to evaluate their current lighting park, maintenance, and procurement procedures, leading to a business case for phased replacement with optimal quality lamps.

2. The lighting sector is the most appropriate for launching the concept of Energy Performance Contracts (EPC) due to the quick payback. This could take the form of standard EPC contracts, designed to protect the interests of both parties. Small/ individual hotels could invite a short list of suppliers with qualified experts to make competing EPC proposals to retrofit lighting. The format could be for hotels to commit to select one of the short-listed suppliers with the most attractive offer to avoid the risk of hotels using the free expertise to procure substandard lamps from others. There could be a down payment of about 30 % made at the start and monthly payments over a period of 12 to 36 months which would also be covered by a product warranty by the supplier. The scheme could be tailored to be cash flow neutral for the energy savings to pay for the monthly payments after the initial down payment.

Simulations for a lighting retrofit from CFL and low efficiency LED to high efficiency LED, shows that 10 year life cycle cost can be reduced by about 60 % with a savings per lamp of MUR 1000 to 1800 which could amount to a few Million MUR for a hotel of 150 rooms over the 10-year period.

- ◊ The above 2 solutions would also contribute to transform the retail market by improving the critical mass of high-quality lamps and reduce the electronic waste stream from lighting.
- ◊ Such EPC arrangements could also benefit large hotels and groups by transferring cash flow and debt burden to suppliers of equipment.

4.5 Energy conservation and energy efficiency measures in the Kitchen / food preparation areas

The challenges to energy reduction in the foodservice industry include the following:[1]

- ◊ High stress environment where speed of service is key
- ◊ Equipment operators get paid low wages and do not have incentives to reduce energy
- ◊ Some inefficient equipment is easier to operate than energy efficient equipment
- ◊ Energy efficient equipment is more expensive and often requires more maintenance.
- ◊ Saving energy in food preparation starts by being efficient in the cooking process. Better efficiency in the kitchen can help save a considerable amount of energy as well as time.

1. The basic principle of food safety and hygiene is the move forward principle ("La marche en avant") which translates into avoiding that the clean circuit crosses the dirty circuit. To achieve this, it is necessary to arrange the kitchen, from food reception to customer service. Fresh food intended for consumption must not come into contact with dirty products, or those likely to contaminate them. This is a real hygiene issue for restaurants, and it is also a question of food safety to avoid any intoxication or proliferation of bacteria.

2. Food storage consumes a large part of the energy in Kitchens. There is a scope for energy savings though better storage organization and equipment. Food should be stored per category: fish, meat, dairy products, and vegetable should be stored separately) and at the right temperature. It is better to have multiple small cold rooms, than a single one for all. This will also allow for a longer shelf life for some products stored at the precise temperature.

3. Invest in a blast chiller used to cool down different preparations, before storing in cold rooms which ensures that the temperature of cold rooms is not raised when new products are stored, which could introduce a bacterial risk for consumers.

4. Better organization can allow for a delayed start-up of certain energy consuming equipment such as ovens, gas burners, and induction plates. The cooks can turn on ovens 5-10 mins before the preparation and plating is done for some dishes. The practice of turning all equipment on in the morning is very wasteful and can be optimised.

1 https://fishnick.com/ceccook/Energy_Reduction_in_Commercial_Kitchens_SFIA.pdf

5. Inventory management through a well-designed stock of dry and perishable products also allows for energy efficiency gains. Some products do not need cooling or can arrive in the kitchens on the day it's needed which allows for more space in cold rooms.

Figure 15 Vertical Refrigerator

6. Vertical refrigerator versus cold rooms: the vertical refrigerator presents a better operational flexibility for smaller kitchens than cold rooms. There is a temperature gradient, and it is more effective than a set of cold rooms.

7. Use equipment at its maximal potential. Designed through the menus and services, the equipment must be used with its maximum productivity in order to meet the operation. Smaller equipment is more efficient because its usage will be continuous. This allows for several operations in a row, using full capacities. For example, dishwashers must be filled out before starting, combi-ovens/blast chillers/griddles/ should be sized for full use and operated in a more energy-efficient way.

8. Offer Training sessions to kitchen staff. Train them to better understand the move forward principal. Train then to use your new equipment at its maximum potential. Offer them trainings on different cooking methods, and energy saving cooking.

9. Long run cooking recipes such as stocks cooked for 8 hours, or dehydration of produce should be done at night where the electrical load is lower, and the kitchen load will not contribute to peak load demand. Stocks 'sous-vide' meat cooking, drying products in a dryer, oven cleaning programs (high temperature cleaning + steam) should be run at night.

10. Invest in new better equipment which allow for innovation in the cooking techniques, and more efficient cooling, heating devices.

11. Regular maintenance. Equipment that hasn't been cleaned properly has to work harder, using more energy in the process. Make sure all your kitchen equipment is cleaned and well maintained, and all parts are functioning properly. If any parts are damaged replace and repair them as soon as possible. DEFOST regularly Vertical fridges, and small fridges.

12. Use energy efficient lamps as lights are always on in a professional kitchen. The colour rendering index (CRI) of the lamps should be high enough (between 80 and 85) to enable the true colours of the food to be visible.

13. Switch off Air-conditioning in pastry department when not needed or when not working sensitive products that requires a specific temperature to be perfect (chocolate decors, dessert assembly , …). Cool the pastry section at a high temperature for better energy efficiency (23 instead of 21).

14. Switch off equipment at the right time. Don't forget to turn off equipment when leaving the kitchen (combi-ovens/blast chillers/griddles). Install a central switch for all equipment which are used manually to ensure all equipment which are not used are switched off at night.

15. Most advanced ovens are combi ovens which combine convection and moisture cooking. Combi ovens can replace a convection oven and a steamer. Combis in-

ject steam in the cooking cavity either by using an internal pressurized boiler or by spraying a controlled amount of water on a hot fan wheel which vaporizes the water. Power burners, better door seals and fan modulation make combi ovens more efficient and more expensive than convection ovens. Combi ovens allow the operator to maximize the use of space in the kitchen while expanding their menu. Aside from convection ovens, combis can replace steamers and rotisserie ovens. Rotisserie ovens are some of the most inefficient appliances in the kitchen that do not have a sealed cavity causing a lot of the heat to escape which makes them a great potential combi oven replacement.

Figure 16: Baseline Convection Oven

Figure 17: Replacement Combi Oven

16. Griddles or Flattops are used in a variety of restaurants to cook proteins by searing the outer surface. Non-thermostatic griddle efficiency depends heavily on the operator who can waste a lot of energy by forgetting to turn down the burners after an item has been cooked. Thermostatic controls eliminate this problem and often have an indicator showing that the griddle is up to temperature.

Figure 18: Non-thermostatic griddle

Figure 19: Thermostatic griddle

4.6 Guidelines for laundry

A large part of the laundry in hotels is outsourced to specialist dry cleaners. The most effective energy and cost saving strategy for hotels is to run a campaign and develop communication material for guests to reuse their bedsheets and towels as is compatible with hygiene requirements. The basic approach is to sensitize guests on the water scarcity on the island and to encourage them to conserve water by showering instead of having baths, have shorter showers, and use linen longer. Some innovative approaches include the tying up economical use of bedlinen and towels to providing support to NGOs for biodiversity conservation or tree planting campaigns.

For the part of laundry done within the hotel, which often include the kitchen and dining room linen, some simple rules can be applied: Presoaking and highly effective washing powers reduces the length of the washing cycle to achieve good results. The water from the last rinse can be used to presoak the new batch.

4.7 Guidelines for Swimming pool

Swimming pools are equipped with a packaged filtration and recirculation system which runs during the day. The guidelines in section 4.9 on the efficiency class of the recirculation pump are relevant. Because of the long running hours, hotels with older systems should either upgrade to newer equipment or contact the supplier for advice on upgrading to more efficient motors compatible with the pool filtration system.

Heated pools should be covered at night to limit heat loss. Pool covers on reels enable this for rectangular shaped pools. The focus on equipment modernization has been to invest in efficient Heat pumps running on mains power. Since there are no schemes in hotels which enable hotel owners to directly offset their electricity consumption with grid tie solar PV systems, pool heating in winter is feasible for small pools which can be covered.

The Energy cost of pool heating and hot water production can be significantly reduced by investing in Direct DC heat pumps.

Direct DC heat pumps are now available which enable hot water production from solar PV. In cases of smaller regular shaped pools which can be covered at night, based on the service level of the hotel, a business case can be made for investment in a Direct DC heat pump system.

4.8 Guidelines for wastewater treatment

Due to space limitations most hotels have recourse to packaged water treatment plants which include aerators and circulating pumps running 24 hours. This is another area where equipment and systems suppliers can be requested for upgrades leading to energy savings. Please refer to section 4.9 for a guide on European standards on electric motors, which is useful since a large fraction of equipment is imported from Europe, which gives an indication of the energy efficiency class of motors installed in the waste treatement plant. A physical inspection of the nameplate of the motors will show the IE class. Motors as from a few kW which are of class IE1, are old and have no IE class indication or have a history of rewinding should be replaced with at least IE2, particularly if they operate continuously.

The use of recycled water with the necessary sanitisation measures should be encouraged and creates synergies with the use of dense vegetation to provide shading and ambient cooling around the rooms and guest spaces. This is an effective way for the nutrients in the waster water to be absorbed by the plants instead of leaching out to the sea for beach front or sea facing hotels.

4.9 Summary of guidelines for motors

In the context of energy efficiency, the European Directive ErP (Energy Related Products) requires more and more efficient motors. Motors capacity between 0.75 to 375 KW are classified in 4 categories in terms of their energy efficiency.

IE1 : Standard efficiency

IE2 : High efficiency, Mandatory for all new equipment since 2011

IE3 : Premium Efficiency, mandatory in EU for all motors since 2015 for motors above 7.5 kW and since 2017 for motors above 0.75 kW. An alternative compliant solution is an IE2 motors with a variable speed drive.

IE4 : Very high Efficiency motor of permanent magnet type.

Figure 20: Pump and filtration system

IMPLEMENTATION

5. Energy Efficiency Implementation in Hotels

5.1 Energy Management Team

Energy efficiency is achieved based on the principles of continuous improvement or what is commonly known as the Plan-Do-Check-Act cycle. When adapted to energy management in hotels it not only ensures high level commitment to efficiency achievement but also gives management a better overview of the progress and savings that result from energy conservation and efficiency measures that the hotel has invested into.

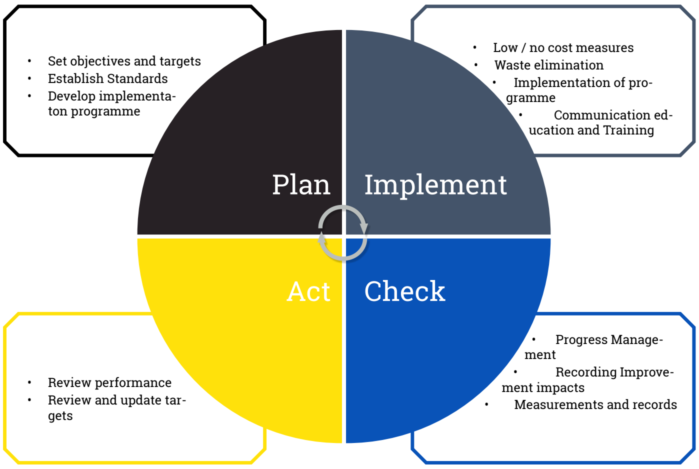

Figure 21: Continuous improvement principles for energy efficiency

Mauritian Hotels need to understand that for changes to occur it should not be the problem of maintenance only nor top management but should encompass the major functions of the establishments. Although roles overlap and teams can be very small but involvement of everyone is essential.

In ideal cases the Energy management team should comprise of the following representatives along with top management commitment:

◊ Facilities / Maintenance Manager (technical person or having basic technical knowledge)

◊ Accounting and finance to translate savings into management dashboards and reports

◊ Food & Beverage being in charge also of restaurants and banquet halls

◊ Kitchen Chef, in charge of kitchen and storage

◊ Housekeeping also responsible for laundry in most cases

◊ Front office being in direct contact with guests and use of common areas

The guidelines are not forcing the responsibility of Energy efficiency on a single person or department but making it central to the needs and operations of Mauritian Hotels. Monthly meetings to review performance should be good enough to create the required motivation for sustained Energy efficiency improvement in phases.

5.1.1 Responsibilities of the Energy Management Team

Energy conservation – the concept of reducing energy consumption through the minimization of activities that consume energy – is often confused with energy efficiency. The main difference between the two concepts is how much the guest behavior will have to be altered to see the impacts. Current practices in Mauritius demonstrated that Energy efficiency in hotels needs to start with the proper conservation measures for immediate and short term impacts followed by energy efficient equipment investments.

Energy efficiency, on the other hand, maintains the same amount or quality of output while using less energy. Neither Energy efficiency nor conservation cause inconvenience with inhibitive restrictions, and both impacts about 20 to 35% of utility bills.

Another misconception is that energy efficient options are not worth buying because they are more expensive than their conventional alternatives. Indeed, efficient options, whether for appliances or hotel equipment, often come with a high price tag. However, energy efficiency should be considered an investment that accumulates savings over time, rather than a typical purchase that is evaluated based on up-front costs.

The utility bill savings generated over the lifetime of an energy efficient upgrade have the potential to offset the total purchase price and can even generate a positive return on investment (ROI). In addition, a long-term energy efficient installment can add value to hotel customer communication with more environmental conscious customers.

A common misconception about energy efficiency is that replacing a couple of appliances will result in significant savings. For substantial utility savings, a holistic approach that strategically targets the most significant sources of energy waste is required. The most efficient solution will be the implementation of at least a level 2 energy audit and development of an action plan to target Energy Efficiency.

For example, electricity consumed by appliances that are turned off or in standby mode, known as the “phantom load”, can add Rs3000 to Rs6000 to annual utility bills. The first instinct might be to replace appliance with a more energy-efficient version, the solution could be simpler. A smart power strip. Smart power strips prevent plugged-in appliances from drawing power by turning off when it senses the appliances are not in use, and effectively eliminates their phantom load.

Another example could be while installing an energy efficient HVAC system can reduce energy bills, savings will be smaller if the area is not sufficiently air sealed or insulated because it will take more energy to maintain the interior temperature at any given level.

5.2 Basic steps to achieve EE

Classification used to present energy efficiency.

Hotel Energy Management • Assess the energy profile of your hotel • Draw up a simple energy policy • Adopt good housekeeping practices • Ensure regular servicing and maintenance of your equipment • Improve energy management by providing information to staff and guests	Involve your guests Involve your staff Make a first assessment
Reduction of the hotel's heating and cooling needs • Most Mauritian hotels are in concrete and insulation will not serve much to reduce cooling needs • Prevent uncontrolled air filtration • Improve microclimate & protect the building from summer heat - Trees help a lot in the case of Mauritian Hotels	Protect the buildings from temperature
Equipment efficiency • Better operational use of current equipment (through equipment control and regulation) • Improve heating efficiency (especially hot water production) • Improve space cooling efficiency • Improve ventilation efficiency • Improve lighting efficiency • Improve (other) electric equipment efficiency • More efficient kitchen equipment	Improve equipment efficiency

Figure 22: Implementing energy efficiency in hotels

5.3 The Operation of the Energy Management team

The objective of the section is to exploit the findings and content in the other sections on the evolution in the hotel industry markets, the new possibilities emerging to propose an methodology customised to the Mauritian context.

A seven step approach has been adapted to the Hotel context to meet the requirements of the sector and offer hoteliers the possibility to achieve efficiency in a continuous and incremental approach while eliminating waste and manage their consumption in the shorter term. The seven step approach also embarks the continuous improvement approach discussed earlier.

The 7 step approach described in the following sections should be designed and monitored by the High level energy management committee at least on a monthly basis. In the Mauritian context experience has shown that commitment to energy management can only be effective if the top management is involved and if the performance appraisal is switched from input based to output based metrics: for example switching to the lifecycle cost of the lighting function instead of switching to LED lighting as detailed in Chapter 4.

1. Article by Krishna Heeramun in IEM Magazine 2012

Figure 23: A seven step approach to achieve energy efficiency

STEP 1: COMMIT TO CONTINUOUS IMPROVEMENT

Commitment towards energy management should not be only delegated to the technical and maintenance team due to the profound changes in the market and technology. The highest ranking officer reporting to the board and shareholders should lead a high level Energy management committee which should include marketing and client facing staff, the head chef, the maintenance manager and his key team.

Progress achieved in the goals set in step 3, decide on new goals based on updated market, and financial status and define communication strategies to recognise achievements and feedback to marketing.

The high level Energy management committee should structure the process to establish an energy policy and program, and create a dedicated energy team. The key person for the liaison between the high level Energy management committee and the dedicated technical Energy team is the Energy manager appointed by the high level committee. This can be a dedicated person for larger hotels but smaller structures can opt for an in house technical person.

The key duties of the Energy manager include:

◊ Coordinating and directing the overall energy program
◊ Acting as the point of contact for senior management
◊ Increasing the visibility of energy management within the organization
◊ Assessing the potential value of improved energy management
◊ Creating and leading the Energy Team
◊ Securing sufficient resources to implement strategic energy management
◊ Assuring accountability and commitment from core parts of the organization

- ◊ Identifying opportunities for improvement and ensuring implementation (including staff training)
- ◊ Measuring, tracking, evaluating, and communicating results

STEP 2: ASSESS PERFORMANCE

Understanding current and past energy use is how many organizations identify opportunities to improve energy performance and gain financial benefits. Assessing performance is the periodic process of evaluating energy use for all major facilities and functions in the organization and establishing a baseline for measuring future results of efficiency efforts.

This step can also be complemented by an Energy audit prior with comprehensive study of the practices and current measurements to support the Energy policy of the hotel.

The key benchmarks for tracking energy performance are listed in section 6. The High level energy management team will base its evaluation when presented with a first outlook of the baseline situation.

Key aspects include:

- — Data Collection and Management- Gather and track data — Collect energy use information and document data over time.
- — Simplest is utility bill compilation for both electricity and fuel used by the hotel like gas (kitchen and boilers) or diesel
- — The amount of units consumed should be compiled along with the costs and occupancy because the energy consumption is assumed to be proportional to the hotel occupancy.
- — Baselining and Benchmarking- Establish baselines — Determine the starting point from which to measure progress.
- — Benchmark — Compare the energy performance of your facilities to each other, peers and competitors, and over time to prioritize which facilities to focus on for improvements.
- — Analysis and Evaluation- Analyze — Understand your energy use patterns and trends.
- — Technical assessments and audits — Evaluate the operating performance of facility systems and equipment to determine improvement potential.
- — Assessing energy performance helps to:
    - » Categorize current energy use by fuel type, operating division, facility, product line, etc.
    - » Identify high performing facilities for recognition and replicable practices.
    - » Prioritize poor performing facilities for immediate improvement.
    - » Understand the contribution of energy expenditures to operating costs.
    - » Develop a historical perspective and context for future actions and decisions.
    - » Establish reference points for measuring and rewarding good performance.

STEP 3: SET GOALS

Performance goals drive energy management activities and promote continuous improvement. Setting clear and measurable goals is critical for understanding intended results, developing effective strategies, and reaping financial gains. Well-stated goals guide daily decision-making and are the basis for tracking and measuring progress. Communicating and posting goals can motivate staff to support energy management efforts throughout the organization.

To develop effective performance goals:

- Determine scope
- Identify strategic organizational, market related parameters for goals.
- Estimate potential for improvement
- Review baselines, benchmark to determine the potential and priorities of upgrades.
- Establish goals
- Create and express clear, measurable goals, with target dates, for the entire organization, facilities, and other units.
- Setting goals helps the Energy Manager
- Set the tone for improvement throughout the organization
- Measure the success of the energy management program
- Help the Energy Team to identify progress and setbacks at a facility level
- Foster ownership of energy management, create a sense of purpose, and motivate staff
- Demonstrate commitment to reducing environmental impacts
- Create schedules for upgrade activities and identify milestones

STEP 4: CREATE ACTION PLAN

With specific targets in place, the energy team is prepared to develop a detailed plan to improve energy performance. While the scope and scale of the action plan is often dependent on the organization, the steps below outline a basic starting point for creating a plan.

- Define technical steps and targets
- Determine roles and resources
- Get buy-in from management and all organizational areas affected by the action plan before finalizing it. Work with the Energy Team to communicate the action plan to all areas of the organization.

STEP 5: IMPLEMENT ACTION PLAN

People can make or break an energy program. Gaining the support and cooperation of key people at different levels within the organization is an important factor for successful action plan implementation in many organizations. In addition, reaching your goals frequently depends on the awareness, commitment, and capability of the people who will implement the projects.

To implement your action plan, consider taking the following steps:

- Liaise with finance and procurement for the contracting and outsourced components of the energy investment.
- Build capacity — You can expand the capacity of your staff through providing training, access to information, sharing of successful practices, procedures and technologies, and sharing of lessons learned.
- Motivate — Create incentives that encourage staff to improve energy performance to achieve goals.
- Track and monitor

- Use the tracking system developed as part of the action plan to track and monitor progress regularly

STEP 6: EVALUATE PROGRESS

Evaluating progress includes formal review of both energy use data and the activities carried out as part of the action plan as compared to your performance goals. Evaluation results and information gathered during the formal review process is used by many organizations to create new action plans, identify best practices, and set new performance goals.

Key steps involved include

- Measure results- Compare current performance to established goals.
- Regular evaluation of energy performance and the effectiveness of energy management initiatives also allow energy managers to:
- Measure the effectiveness of projects and programs implemented
- Make informed decisions about future energy projects
- Reward individuals and teams for accomplishments
- Document additional savings opportunities as well as non-quantifiable benefits that can be leveraged for future initiatives.

STEP 7: RECOGNIZE ACHIEVEMENTS

Providing and seeking recognition for energy management achievements is a proven step for sustaining momentum and support for your program. Providing recognition to those who helped the organization achieve these results motivates staff and employees and brings positive exposure to the energy management program. Receiving recognition from outside sources validates the importance of the energy management program to both internal and external stakeholders, and provides positive exposure for the organization as a whole.

Key steps in providing and gaining recognition include:

- Providing internal recognition — to individuals, teams, and facilities within your organization.
- Receiving external recognition — from guests, government agencies, the media, and other third party organizations that reward achievement.
- Based on the experience achieved, decide on new goals to be set.

MEASURING

6. Measuring the Impact of EE measures

6.1 Energy Performance Indicators

Energy Performance Indicator (EnPI) is a measure of energy intensity used to gauge the effectiveness of your energy management efforts. Regression is commonly used for estimating energy savings and has proven to be reliable when the input data accounts for annual variation in operating conditions. In addition to providing a normalized view of energy performance.

Typical indicators include:

◊ Monthly Energy Consumption Data (preferably separately by type of energy, e.g., electricity, LPG/ gas/Diesel etc.) – kWh as per electricity bill and volume of fuel as per purchase of cylinders per month.

◊ Any variables that affect the energy consumption in a facility including hotel occupancy for the measured period. (e.g., heating degree days (HDD), cooling degree days (CDD), dew point temperature, product output, the moisture content of the product, shift schedule adjustments, etc.)

6.2 Energy Measurement systems

Most of the hotels in Mauritius do not have the required equipment to measure energy consumption per room or per kitchen station. The best approximations that can be used are from the electricity bills delivered by the Central Electricity Board and readings from solar panels control units.

To achieve energy savings, it is important to monitor and track energy consumption, and generate reports on a regular basis. Such a system forms the basis of any ongoing and sustainable energy management program. There are standard software packages available to monitor and track energy and greenhouse gas emissions. However, hotels and hotel groups can easily create their own simple database. Some of the key features required for tracking energy efficiency are:

◊ comparison of energy consumption and key performance indicators; (Occupancy)

◊ bar graphs of energy use and performance index for 12 months over the past few years

◊ comparison of actual energy used against target consumption. The target can be generated according to seasonally adjusted monthly energy use

A simple benchmark for energy consumption in tropical climate are given below:

Rating	Energy Use kWh.year/ square metre
Very Good	*264*
Good	*264 to 303*
Satisfactory	*303 to 344*
Poor	*344 to 383*
Very Poor	*Greater than 383*

Table 10: Benchmark for Energy Consumtption in Tropical Climate

6.3 Monitoring of energy performance indicators

"Measurement and Verification" (M&V) is the process of planning, measuring, collecting and analyzing data for the purpose of verifying and reporting energy savings within an individual facility resulting from the implementation of energy conservation measures (ECMs). Savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions.

M&V activities consist of some or all of the following:

◊ meter installation calibration and maintenance,
◊ data gathering and screening,
◊ development of a computation method and acceptable estimates,
◊ computations with measured data,

As a starting point an excel sheet should serve the purpose of monitoring the consumption as well as comparing with past performance through direct meter reading or billing consumption compilation.

6.4 Maintenance and equipment

Committing to preventive maintenance in the hotel industry involves an extensive knowledge of the hotel's systems, equipment, and utilities, as well as the most effective routes of intervention. Above all, care must be taken not to interrupt the flow of hotel guests. Out of all types of existing maintenance, preventive maintenance is the most effective asset of hotel managers, as well as, the most directly related to satisfaction of the guests. Therefore, the common practice of breakdown maintenance should be phased out in especially small and medium sized hotels in Mauritius.

Maintenance schedules should follow the recommendations of suppliers for each piece of equipment whereby the frequency and parts to replace are specified. In the hospitality industry, there's an unofficial rule which recommends that any hotel should strive to increase their preventive maintenance operations and minimize corrections of failures by the following ratio - 80 percent for planned tasks, and 20 percent for unplanned jobs. The reason behind this division lies in improving the guests experience, and since off-plan interventions are more expensive, it also generates bigger savings.

The 80/20 ratio is an informal rule which was neither imposed not agreed upon by hotel industry maintenance managers. It simply stands to be used as a reference.

A hotel's most important asset are its guest rooms. If maintained to their best, the rooms guarantee an excellent guest experience that needs to be seamless, whatever the length of stay. In other words, preventive maintenance ensures that the hospitality experience is free of surprises and issues with consequences. It should be the highest priority of the maintenance manager to focus their team's efforts on the hotel areas where the commitment to preventive maintenance needs to be higher.

6.5 Simple tools for tracking Energy performance

A simple Excel sheet should be developed and customised to the characteristics of each hotel:

Folio No.	Data from CEB Bills																
	Jan 2020 Total kWh	Feb *2020 Total kWh*	Mar *2020 Total kWh*	April *2020 Total kWh*	May *2020 Total kWh*	June *2020 Total kWh*	July *2020 Total kWh*	August *2020 Total kWh*	September *2020 Total kWh*	October *2020 Total kWh*	November *2020 Total kWh*	December *2020 Total kWh*	2020 Total kWh	Lowest Plactor	Highest Excess KVA	2020 Diesel Litres	2020 LPG Kg
1	*798,380*	707,250	783,240	728,580	593,360	500,270	494,400	514,410	477,610	564,610	600,440	741,770	819,652	0.96	54	110	11,512

Since customization depends on the physical characteristics of the hotel and the mode of operations, this exercise should be done by a dedicated Energy efficiency consultant working closely with the hotel management and staff to get their buy in and ownership.

As an indication, the minimum requirements of this are as per the Formats Hotel Energy Monitoring Excel sheet provided.

The objective is to enforce systematic collection of data and maintenance of an Excel database on a monthly basis which become the basis for reporting to the High level Energy management committee. Monthly data collection and analysis enable seasonal and occupancy related driver of energy consumption to be tracked. Over a few years of data collection and analysis the hotel will be in a position to determine is No-Occupancy comsumption (not related to hotel occupancy) and the marginal contribution of each guest Night

This data averaged over a statistically significant period is critical for benchmarking internally with the baseline of the hotel and with other hotels in the same category in Mauritius and for external benchmarking with competitors of Mauritius in similar tropical destinations.

As a minimum requirement the consumption of all utilities (CEB, CWA, Diesel, LPG, and on site generation from Solar PV) should be tracked on a montly basis.

In parallel the status of rooms available and the actual occupancy of rooms should be tracked on a monthly basis to establish monthly Energy Use Intensities (EUI).

The recommended EUI to be tracked include:

Electricity use:

EUI: Electricity per m2, Rooms, Room-Night		
Total Electricity: kWh/m2	*Total Electricy: kWh/ Rooms*	*Total Electricity: kWh/ Room-Night*

Table 11: Electricity use

Use of diesel and LPG:

EUI: Diesel per m2, Rooms, Room-Night			EUI: LPG per m2, Rooms, Room-Night		
Total Diesel Litres / m2	*Diesel Litres / Rooms*	*Diesel Litres / Room-Nights*	*LPD kG/ m2*	*LPG kG/ Rooms*	*LPG kG/ Room-NIght*

Table 12: Use of diesel and LPG

Due to the very wide range of hotel types and sizes and the different type of equipment installed it is not productive to propose a standard tool to fit the requirements of each hotel which would be too complex for smaller hotels and not enough for larger structures which may already be practicing elaborate energy management and use specialised software.

The objective of this guideline is to raise the profile of Energy management as a strategic activity and to provide an overall framework for each hotel to adapt to its realities and human capacities available.

Folio No.	2020	Total Built Area m2	Total Rooms	Total Room-Nights available	Average Occupancy Month	Average monthly Room Nights occupied	Total Electricity: kWh/ m2	Total Electricity: kWh/ Rooms	Total Electricity: kWh/ Room-Night
1	January								
2	February								
3	March								
4	April								
5	May								
6	June								
7	July								
8	August								
9	September								
10	October								
11	November								
12	December								

Table 13: Electricity consumption monitoring


COMPLIANCE

7. Compliance to International Standards

7.1 Requirements and compliance

The major standard for energy which is internationally recognized is ISO50001. The ISO 50001:2018 energy management standard is intended for manufacturing, commercial businesses or organizations to help manage the use of energy in their operation using a well-defined framework. The standard covers all aspects of energy use and procurement. An Energy Management System or EnMS establishes a disciplined system and strategies to reduce energy costs and reduce greenhouse gas emissions.

The tourism market evolution and changing guest preferences have shifted the attention of guests towards sustainability of destinations and specially hotels. The need for internationally recognized certifications has followed. There are a number of certifications that hotels can aspire for and complying to their criteria before being certified. The most common are:

- ◊ Green Globe
- ◊ Global Sustainable Tourism Criteria
- ◊ Earth Check
- ◊ Biospehere Tourism

7.2 ISO 50001

ISO 50001 is based on the management system model of continual improvement also used for other well-known standards such as ISO 9001 or ISO 14001. This makes it easier for organizations to integrate energy management into their overall efforts to improve quality and environmental management.

ISO 50001 provides a framework of requirements for organizations to:

- ◊ Develop a policy for more efficient use of energy
- ◊ Fix targets and objectives to meet the policy
- ◊ Use data to better understand and make decisions about energy use
- ◊ Measure the results
- ◊ Review how well the policy works, and
- ◊ Continually improve energy management.
- ◊ Certification can be a useful tool to add credibility, by demonstrating that your product or service meets the expectations of your customers. For some industries, certification is a legal or contractual requirement.

The 50001 standard covers:

- ◊ Energy consumption
- ◊ Documentation, measurement and reporting energy use
- ◊ Variables that affect energy efficiency that are monitored by the organization
- ◊ Standard practices for design and procurement practices

7.3 Green Globe

Green Globe's Business Certification is applied to the administration and operational activities of enterprises, ensuring that the methods and procedures employed meet the most rigourous standards for sustainability. There are many benefits provided by Green Globe Businesses Certification:

- ◊ Cost savings from greater efficiencies and reduced utility and resource usage
- ◊ Connection to consumers who now expect verified green credentials
- ◊ Better risk management through regular review of operational processes
- ◊ Joining the leadership group within their industry
- ◊ Employee retention through connection of business objectives to global goals
- ◊ Increased brand reputation and publicity connected to businesses' green directions

In addition to these advantages, Green Globe's certified members also benefit from the promotion of the Green Globe brand which connects with consumers and business leaders around the world. Green Globe and the sustainable achievements of its members are featured in more than 100 news articles everyday via traditional media outlets, online news agencies and social media channel across major international markets.

The Green Globe Standard includes 44 core criteria is supported by over 380 compliance indicators. The applicable indicators vary by type of certification, geographical area as well as local factors. The entire Green Globe Standard is reviewed and updated twice per calendar year. To guarantee compliance to the highest international standards, a third-party independent auditor is appointed to work with clients onsite. The international standard ISO 19011 provides guidance on the management of audit programs, the conduct of internal and external management systems as well as the competence and evaluation of auditors.

7.4 Earth Check

The Earth Check Sustainable Destinations Program is a worldwide network of destinations that aim to achieve world-leading sustainability outcomes. Supported by the EarthCheck benchmarking, certification and performance improvement system, the program uses EarthCheck science to tackle environmental and social problems such as climate change, waste reduction and non-renewable resource management.

Based on the fundamental belief that 'what gets measured, gets managed' the core of EarthCheck's Sustainable Destinations Program is measurement. Only when a destination fully understands its footprint can it make informed decisions to take action.

The EarthCheck program helps destinations measure and monitor their environmental and social impact, and prepare and track that performance against their own targets and the performance of other communities. Members of EarthCheck's Sustainable Destinations program have access to training and capacity building programs together with independent auditing.

BENEFITS:

- A leading-edge online data-entry measurement and benchmarking tool
- An integrated, user-friendly platform
- Support from a dedicated Relationship Manager
- An independent, third-party performance audit
- Annual benchmarking reports with comparisons of baselines and best practice performance
- Environmental leadership
- Enables sustainability to be promoted as a market asset

7.5 Global Sustainable Tourism Council

The GSTC Criteria serve as the global baseline standards for sustainability in travel and tourism. The Criteria are used for education and awareness-raising, policy-making for businesses and government agencies and other organization types, measurement and evaluation, and as a basis for certification.

They are the result of a worldwide effort to develop a common language about sustainability in tourism. They are arranged in four pillars:

- Sustainable management
- Socioeconomic impacts
- Cultural impacts
- Environmental impacts (including consumption of resources, reducing pollution, and conserving biodiversity and landscapes)

The GSTC Criteria have been built on decades of prior work and experience around the world, and they take into account the numerous guidelines and standards for sustainable tourism from every continent. During the process of development, they were widely consulted throughout the globe, in both developed and developing countries, in several languages. They reflect our goal in attaining a global consensus on sustainable tourism. The process of developing the Criteria was designed to adhere to the standards-setting code of the ISEAL Alliance, the international body providing guidance for the development and management of sustainability standards for all sectors. That code is informed by relevant ISO standards.

The Criteria are the minimum, not the maximum, which businesses, governments, and destinations should achieve to approach social, environmental, cultural, and economic sustainability. Since tourism destinations each have their own culture, environment, customs, and laws, the Criteria are designed to be adapted to local conditions and supplemented by additional criteria for the specific location and activity.

7.6 Biosphere Certification Standards

Biosphere has created the standards to guide any entity that wants to develop its activity under the principles of sustainability in all its dimensions, promoting among its customers, users and workers their awareness and the adoption of responsible behavior.

The hotel certification covers the following criteria:

- ◊ Climate Change
- ◊ Environment
- ◊ Social
- ◊ Economy
- ◊ Culture

Through the fulfillment of a series of requirements, it offers the opportunity to entities in the sector to design products and services with a new model of non-aggressive tourism, satisfying the current needs of customers and users, without compromising future generations.

This certification guarantees an adequate long-term balance between the economic, socio-cultural and environmental dimensions of a destination, reporting significant benefits for the entity itself, society and the environment.

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12 Energy Savings Toolbox – An Energy Audit Manual and Tool – Canadian industry Program for Energy Conservation

13 https://www.iso.org/standard/69426.html

14 https://greenglobe.com/standard/

15 https://ec.europa.eu/energy/topics/energy-efficiency_en

16 https://www.energy-community.org/implementation/Serbia/EE.html

Guidelines
Energy Efficiency and Energy Conservation in Hotels

ABOUT US

The Energy Efficiency Management Office (EEMO) was established in 2011 under the Energy Efficiency Act 2011 and operates as a department of the Ministry of Energy and Public Utilities.

As provided in the Energy Efficiency Act, the objects of the EEMO are to:

(i) promote the efficient use of energy; and
(ii) promote national awareness for the efficient use of energy as a means to reduce carbon emissions and protect the environment.