INDIAN OCEAN
COMMISSION

Mapping of Energy Efficiency Potential in Cold Use Applications in the Commercial and Industrial Sectors – Seychelles

Proposal for a Global Strategy

October 2019

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Table of Contents

Figures

Tables

List of Acronyms

AC	Air Conditioning
CHCP	Combined Heating Cooling and Power
CR	Cold Rooms
EA 2019	Energy Audits 2019, see also bibliography reference 1-6 or footnote 1
EE	Energy Efficiency
EE study 2016	Energy Efficiency study 2016, see also bibliography reference 7 or footnote 2
EMS	Energy Management System
EPS	Energy Policy for Seychelles
GEF	Global Environment Facility
GOS	Government of Seychelles
HVAC	Heating Ventilation and Air Conditioning
IEPF	Institut de l'énergie des pays francophones (now IFDD – Institut de la francophonie pour le développement durable)
IOC	Indian Ocean Commission
IOT	Indian Ocean Tuna (factory)
MEPS	Minimum Energy Performance Standards
NATCOF	National Consumers Forum
NCCC	National Climate Change Committee
PUC	Public Utilities Corporation
PV	Photovoltaics
SBS	Seychelles Bureau of Standards
SCR	Seychelle Rupees
SEC	Seychelles Energy Commission
SFA	Seychelles Fishing Authority
SSDS	Seychelles Sustainable Development Strategy
SSI	Société Seychelloise d' Investment
STB	Seychelles tourism board
STC	Seychelles Trading Company
UNDP	United Nations Development Program

1. Objectives

The current work is the mapping of the energy efficiency (EE) potential in cold use applications in the commercial and industrial sectors in Seychelles, on behalf of the Indian Ocean Commission (IOC). Cold uses include cooling and refrigeration in food industries and commercial installations (supermarkets) as wells as cooling systems in hotels.

An energy efficiency strategy has to be proposed for cold use applications in commercial and industrial sectors in Seychelles, as required by the projects Terms of Reference. The strategy will be based on the results of the six (6) energy audits executed within the framework of the current project by Thelcon[1] (see bibliography ref. 1-6) as well as previous studies, mainly the *"Energy Efficiency in large consumers in industry and tertiary sectors in Seychelles: National Mapping Study",* draft final report, AETS-ARTELIA, 2016[2].

Hence, the goals following energy audits with emphasis on cold production are as follows:

- Extrapolate the findings of the audits to the national sector,
- Estimate the potential savings at the national sector including, quantity of electricity and primary energy saved, associated carbon emission savings and required investments.

Methodological nota: The energy audits ("EA-2019") conducted during the current study, were targeted to a sample of food and tourism associated installations. Their results have been combined with "EE study – 2016", to improve the strategy, based on results from existing installations. Of course, as the audit sample increases, so does the accuracy of predictions.

[1] "EA – 2019" used as abbreviation
[2] "EE study – 2016" used as abbreviated title

2. Seychelles' Energy Context

2.1 Energy efficiency context in Seychelles

The Seychelles Energy Policy for 2010-2030 was approved by the Cabinet and adopted as an official government policy in 2010. It includes energy efficiency, renewable energy and reduction of the dependence on oil to improve energy security, as a 5% and 15% share of renewable energy for 2020 and 2030 respectively [3]. It is not a planning document.

The Seychelles Sustainable Development Strategy 2012-2020 (SSDS) is a national instrument adopted in 2011 with the ultimate objective of improving sustainable development management in Seychelles. It exposes national strategies and action plans elaborated by a team of experts under the supervision of a lead drafting expert, at the demand of the Ministry of Environment, Energy and Climate Change.

The document describes objectives and actions in the thirteen thematic areas identified to implement the strategy. Annex 1 is a selection of actions that are linked to EE in cold uses.

Detailing measures per sector or targets, as for the cold use in commercial and industrial sectors that are necessary to reach the goals of both the Seychelles Energy Policy and the SSDS.

2.2 Electricity consumption in Seychelles

The Seychelles Energy Commission (SEC) provides the following information and data (for 2015):

- Services and industry represent 28% of final energy consumption,
- Electricity represents 22% of Seychelles final energy consumption,
- The Seychelles Public Utilities Corporation (PUC) has produced 377.6 GWh,
- More than 97% of this electricity (369.3 GWh) is coming from Petroleum Fuel, that is to say fossil fuel.
- The final electricity consumption in Seychelles in 2015 was 337 GWh, according to "EE study 2016". Hence 40.6 GWh are losses or not accounted for.

[3] source: https://www.iea.org/policiesandmeasures/pams/seychelles/name-37155-en.php

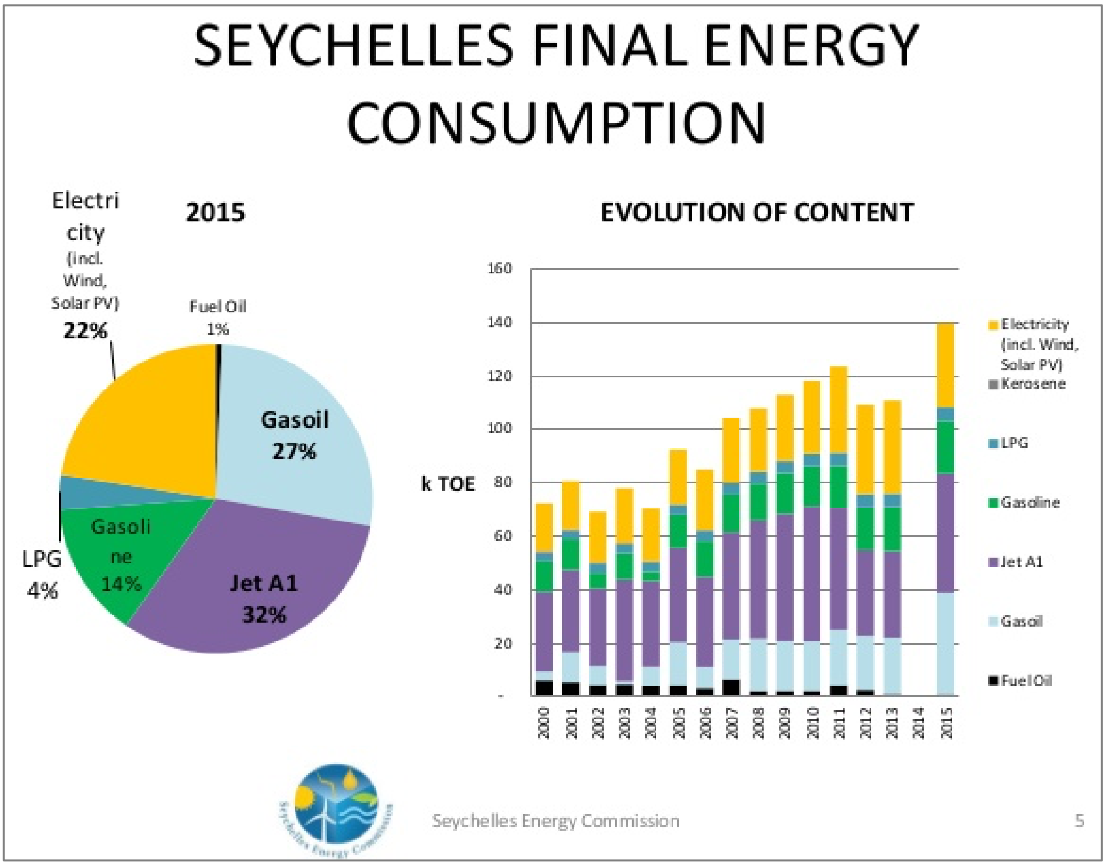

Figure 2-1:Seychelles Energy Consumption

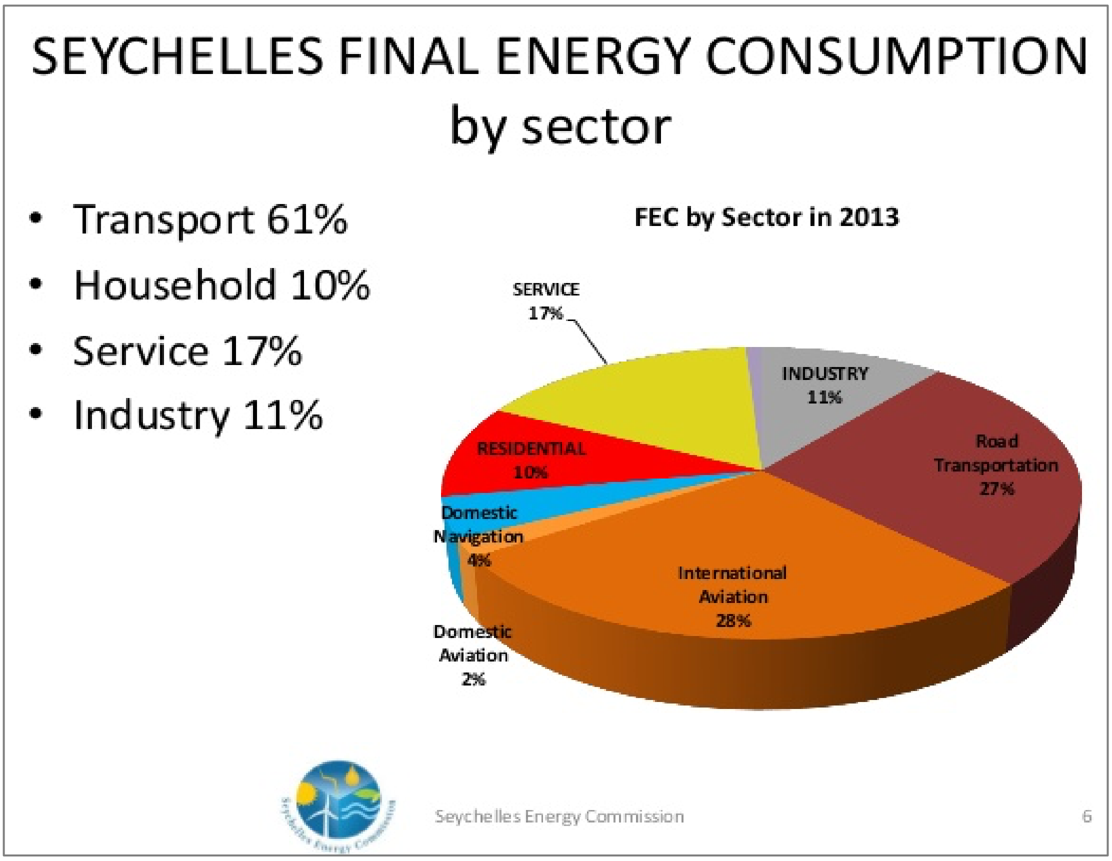

Figure 2-2:Seychelles Energy Consumption by sector

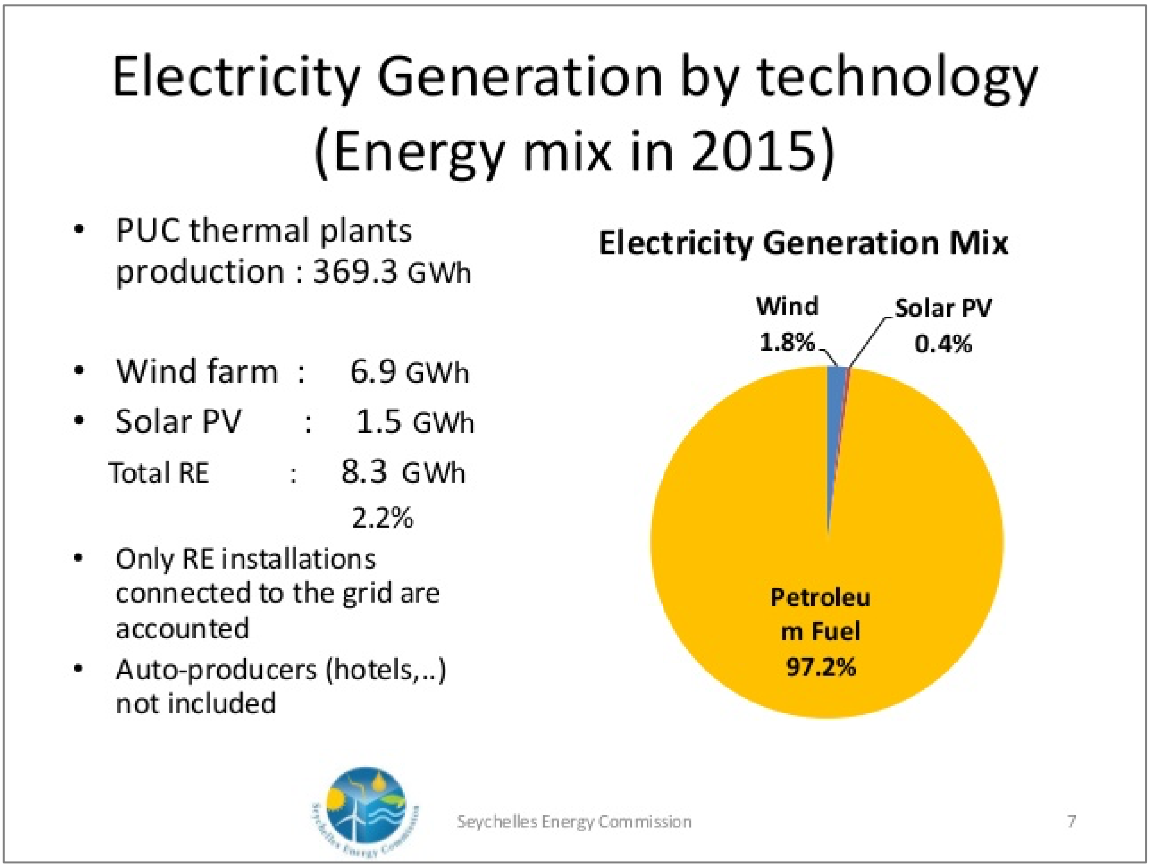

Figure 2-3:Seychelles energy production

"EE study – 2016" also indicates that the electricity consumption of the commercial and industrial sector itself, in 2015, was 195 GWh representing 58% of electricity sales. This does not consider the electric consumption of the auto-producers, especially large hotels using Gas Oil power production.

Cold production in Seychelles uses only electricity.

2.3 List of large electric consumers

According to "EE study – 2016", large electric consumer is defined as consumer with a consumption over 200,000 kWh/year (extracted from the file provided by PUC).

The large commercial consumers are given in the table below:

Types of consumers	Number of meters	Electricity consumption kWh/year	Electricity bill in Euro/year (AERE calculation)	Electricity consumption %
Indian Ocean Tuna (IOT) and Seybrew	3	28,033,638	8,587,082	20%
Food and related businesses	21	14,435,131	4,367,883	10%
Large hotels	44	49,427,033	14,971,420	34%
Other industries and businesses	12	6,858,812	2,078,868	5%
Large buildings	27	19,302,757	5,828,852	14%
Non identified activity[4]	4	1,148,262	336,845	1%
Out of the scope of the study	6	23,049,679	7 099,174	16%
Total large commercial consumers	**117**	**142,255,310**	**43,270,124**	**100%**

Table 2-1: List of large electric consumers Source: "EE study – 2016"

The total electricity consumption of large consumers represents 142 GWh/year, which is 73% of the consumption of the commercial sector.

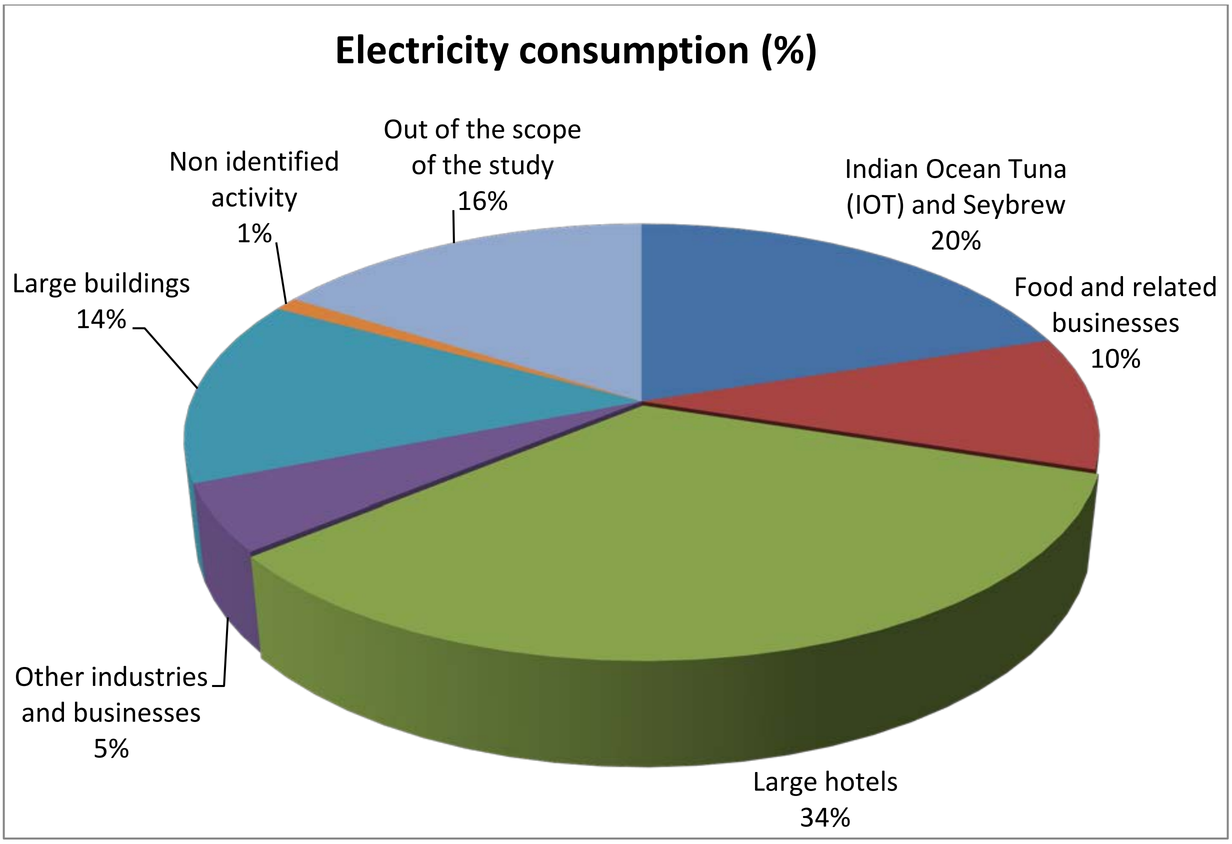

Figure 2-4: Electricity consumption of large consumers

[4] Covering activities such as shops, offices, etc.

2.4 Typology of large electricity consumers

"EE study - 2016" mentions the following consumer typology:

- **Two large industries**
  - IOT (Indian Ocean Tuna) and Seybrew represent 20% of the total of the electric consumption of the large commercial consumers.

- **Several small food industries and food products related businesses**
  - This category includes:
    - Food processes: FoodPro (meat process), Oceania (fish process), catering
    - Food products import and distribution, requiring cold rooms: ISPC, Global Supplies, Hospitality Supplies, APEX, STC (Seychelles Trade Company) Meat and Fruit & Vegetable units, two supermarkets
    - Seychelles Fishing Authority: our understanding is that a large part of the consumption in SFA comes from ice machines, producing ice for the fishing boats.

- **Medium to large hotels**
  - 40 hotels with consumption over 200,000 kWh/year; this is close to the number of hotels with more than 20 rooms (44).

- **Other industries and businesses**
  - This category is referring to businesses which are neither related to food industry, large buildings and hotels; they may have equipment and processes specific to the activity which may represent a significant part of energy. Two examples are coming from the survey:
    - In the company Granite, even if part of the energy consumption is due to AC and lighting, the main consumption comes from equipment specific to the company's activity: flat polisher in granite process, air compressor, and derrick crane.
    - In the company CCCL (quarry and manufacturing concrete blocks), the main electric consumption comes from crushers and batching plant.

- **Large buildings**
  - This category includes consumers which are not hotels and in which the main consumption is related to usual building needs: air conditioning, lighting, Information and Communication Technologies.
  - We include in this category business that may require specific needs in communication equipment (communication operators, TV operators, etc.).
  - If large buildings are identified and ready to contribute to an energy audit, they could be supported for it (this is the case for SCAA for instance); an option could be to associate large buildings to the group of audits targeting large hotels, considering that main recommendations will focus on AC and lighting.

- **Non-identified consumers**
  - For 4 consumers, there is no information of their activity.

2.5 Use of electricity in cold production by type of consumer

For this work, we are focusing on two uses of electricity for cold: air conditioning, and cooling systems for cooling and refrigeration. Energy use for lighting, office equipment, data processing etc., are not included.

The share of electricity per type of consumer for cold usages is indicated in the table below.

Type of consumer / Energy consumption	Air conditioning	Cooling systems for cooling and refrigeration
Hotels & restaurants - Offices	40 to 60%	5 to 10%
Industry & other consumers	5 to 10%	40 to 60%
Food related businesses (IOT, Seybrew)		40 to 60%
Importers & wholesalers of food products (STC, ISPC)		60 to 90%
Supermarkets food retailers		30 to 50%

Table 2-2:Electricity for cold usages - Source: "EE study 2016"

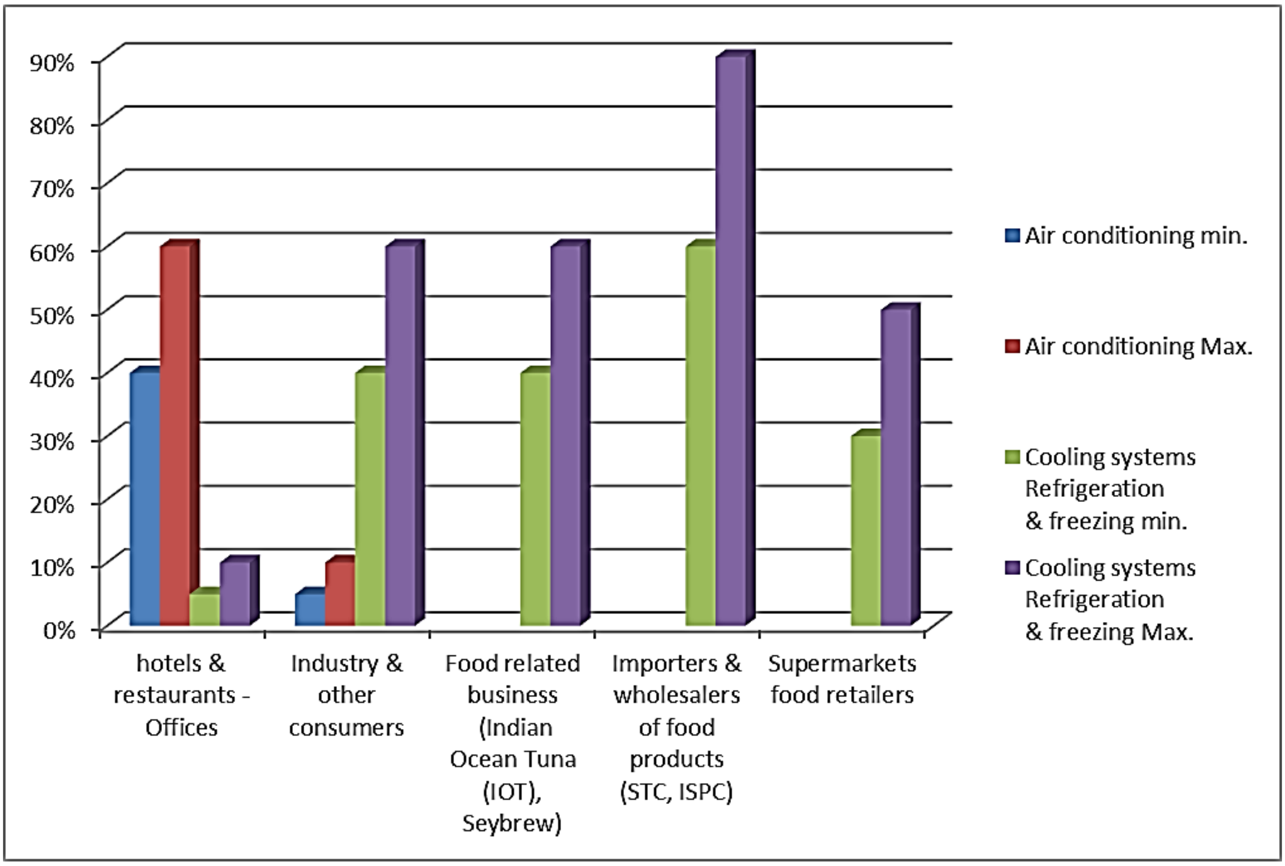

Figure 2-5: Percentage of electric consumption by type of consumer

3. Potential for Energy Efficiency in Cold Use for large consumers

3.1 Global Analysis

As mentioned earlier, the six energy audits conducted during this study, were targeted to a sample of food and tourism associated installations. Their results have been combined with “EE study – 2016”, to improve the strategy, based on results from existing installations. Of course, as the audit sample increases, so does the accuracy of predictions.

“EE study – 2016” defines 3 types of Energy Efficiency Actions:

- **Short term,** with no cost or very low cost, with immediate payback, less than 0.5 year,
- **Medium term,** with payback between 6 months up to 7 years,
- **Long term** with payback time over 7 years, up to the maximum lifetime of equipment

Actions are classified from based on the savings when new equipment is purchased, or a new process is designed.

The energy audits revealed that for Seychelles, there are no long-term energy investments. This is due to the fact that electricity prices are very high - which is typical for isolated island production - while fuel prices are kept low. Typical results for electricity and fuel prices, from the “EA -2019” audits are given below.

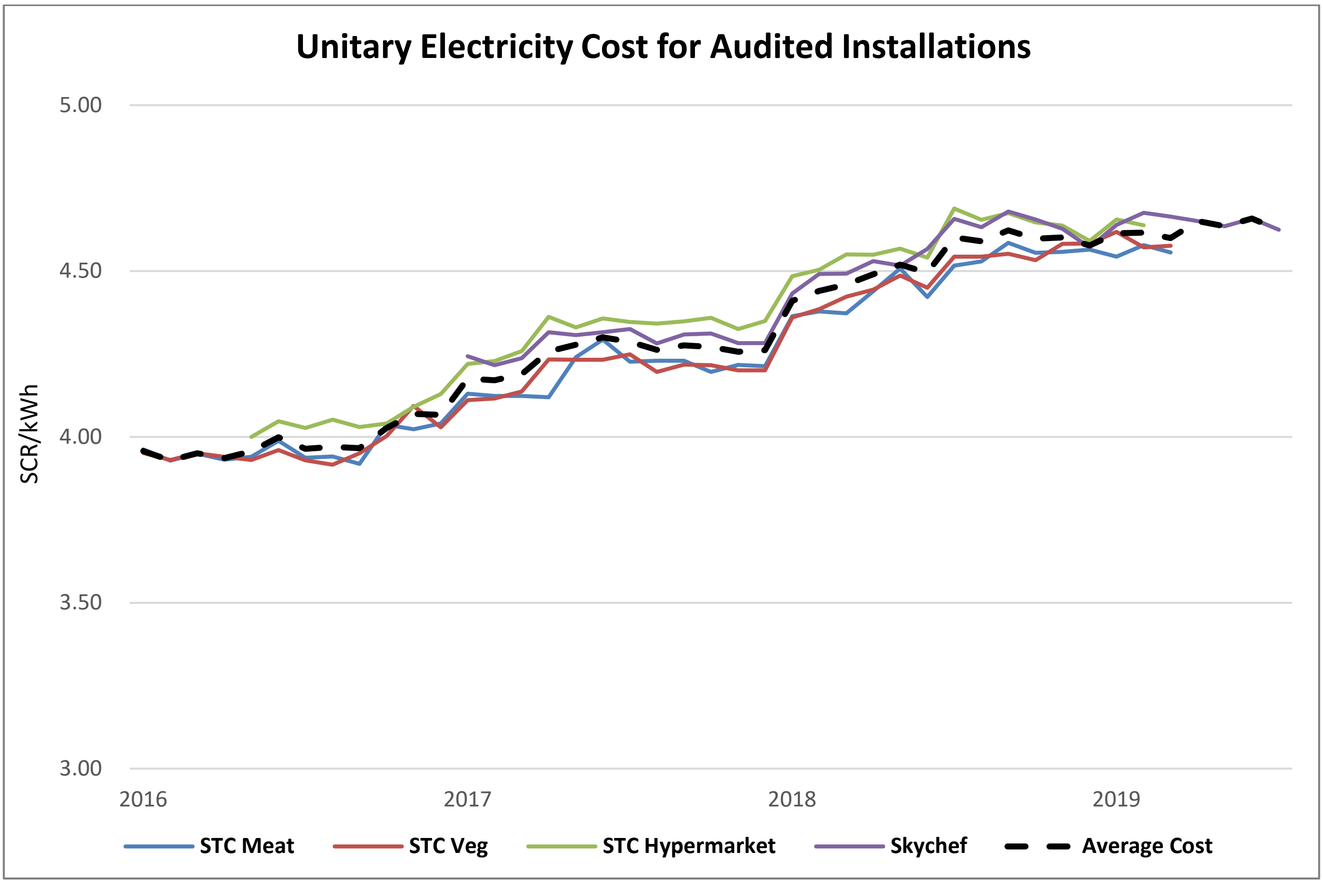

Figure 3-1: Electricity price development over the last 3-year period (resultant of 6 energy audits)

While for fuel price development is:

Year	Diesel for Gensets cost Seypec (€/L)
2017	0.556
2018	0.664
2019 (Jan-Apr)	0.618

Table 3-1: Diesel prices (Ref. 4. Energy audit: Indian Ocean Tuna)

Typology of energy efficiency actions in AC systems suggested in “EE study – 2016” are listed in the following table. Additional actions are suggested in this document and have been added in blue. For reasons mentioned above “long term” actions of the previous study have been combined with “medium term” ones.

Short term	Medium - Long Term
Monitoring of evaporation and condensation pressures Maintenance and cleaning heat exchangers	Automatic control of the production, with adequate operation of compressors in relation to the needs. Replacement by new equipment of high energy class of air conditioning (eg split), compressors, Optimized design of the global system
Strategy of compressors operation (size and time linked with actual needs)	Automatic control of needs: timers, temperature control, presence sensors, etc. Re-designing the network, separating the systems in relation to temperature, etc.
Procedures for stopping AC when not needed, or for increasing set point temperatures	Automatic control of auxiliaries (fans and pumps), Variable Speed Drive motors on pumps and fans Cooling storage
Procedures for controlling the temperature	Thermal insulation of roofs Insulation of walls, double glazing, with properly designed AC and ventilation to avoid condensation
Procedures for control of openings, doors, undesired inlet air and humidity	Reflective films on glass surfaces, solar protection, etc. Appropriate location of condensing units with properly designed AC and ventilation (to be designed room per zone)
In case of centralised air treatment: manual control of fresh air flow.	Improving centralised air treatment units, with humidity control and heat recovery Shifting from air condensation to water condensation
	Building Management System Heat recovery on condensation to produce hot water

Short term	Medium - Long Term
For all HVAC systems above a certain power (ex:12 kW) the HVAC design must be made by a chartered engineer in the Field of HVAC.	Application of adiabatic Cooling in air conditioning systems., design of HVAC & Refrigeration systems by qualified engineers Variable speed applications for the compressors in commercial cooling and refrigeration installations

Typology of energy efficiency actions in systems for cooling and refrigeration suggested in “EE study – 2016” are listed in the following table. Additional actions are suggested in this document and have been added in blue.

Short term	Medium - Long Term
Monitoring of evaporation and condensation pressures. Maintenance and cleaning heat exchangers	New heat exchangers, cooling towers, compressors
Strategy of compressors operation (size and time linked with actual needs)	Automatic control of the production, with adequate operation of compressors in relation to the needs Re-designing the network, separating the systems in relation to temperature, etc.
Procedures for stopping cooling when not needed, or for increasing set point inside temperature	Automatic control of auxiliaries (fans and pumps), Variable Speed Drive motors on pumps and fans Utilisation of cooling storage
Procedures for controlling the temperature (product, rooms, etc.)	Automatic control of needs: time, temperature Change walls to upgrade Insulation of cold rooms
Procedures for control of openings, doors, undesired inlet air and humidity	Thermal insulation of systems: pipes, valves, heat exchangers, etc. For buildings with no thermal insulation, realisation of thermal insulation of walls, double glazing
In case of centralised air treatment: manual control of fresh air flow	Reflective films on glass surfaces, solar protection, etc. Shifting from air condensation to water condensation
In negative cold rooms: procedures for defrosting	Improving centralised air treatment units, with humidity control and heat recovery

Short term	Medium - Long Term
	Decentralising the cooling production
	Heat recovery on condensation to produce hot water Energy Management System
Design of Refrigeration system done by a chartered engineer in the field, study of the viability in terms of energy efficiency in the case of natural refrigerants (ex: CO_2)	Change working fluids to environmentally friendly ones and eventually to CO_2

Table 3-2: Energy efficiency actions – Source "EE study – 2016"

3.2 Conclusion

Please note that "The following figures are given for providing an order of size of the potential; and they cannot be used to evaluate the potential at an individual consumer level" extract from "EE study – 2016". The calculations are not detailed, they are the best guesses we can use, as the audits are concentrated on some enterprises and cold usages only.

According to "EE study – 2016", hotels, with a significant size, own an electricity generator, mainly using gas oil. Electricity is the main source of their energy bill: "*Considering that 90% of the Gas Oil is for electricity production, electric needs represent 967 M SCR/year (63,73 M Euros/year) [209.6 GWh/year], which is 90% of the energy bill."* The study has evaluated the electricity savings: "*On this total cost of electricity in large commercial consumers and small hotels (967 M SCR/year, 63.73 M Euros/year), there are potential savings due to EE:*

- *Average potential through Short Term actions (with very low cost, Pay Back less than 6 months):* ***5%*** *(potential saving: 48.35 M SCR (3.19 M Euros))*

- *Average potential through Medium Term actions (with Pay Back from 6 months to 7 years):* ***5%*** *(potential saving: 48.35 M SCR (3.19 M Euros))*

Annually, there is a total potential to save 6.38 M euros on the electricity bill through short and medium-term actions."

4. On field experience from audits analysis

The following figure shows the weight of the audited companies from an electric energy consumption point of view, that is to say:

- 8% of the Seychelles total electricity consumption,
- 14% of the commercial and industrial electricity consumption,
- 30% of the large hotels, foods and related businesses.

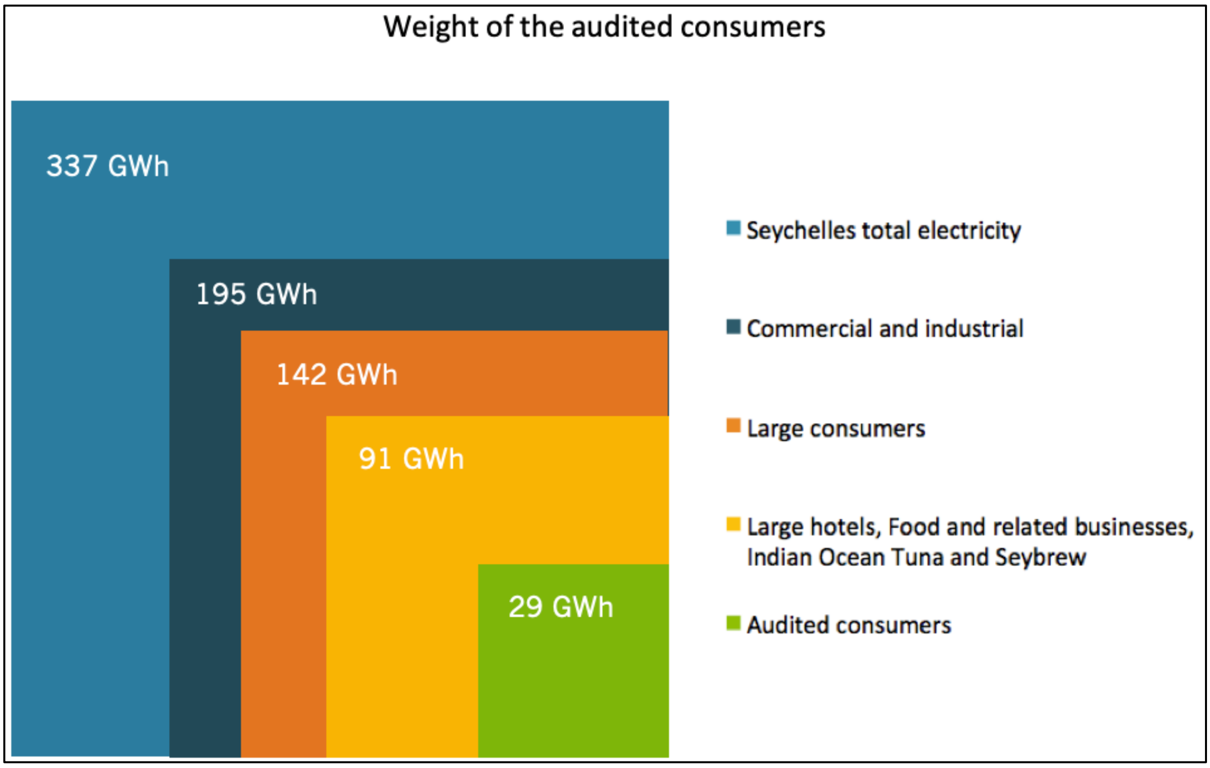

Figure 4-1: Weight of the audited consumers

4.1 Summary of audits

The EE measures and their saving potentials, from the Thelcon "EA-2019" audits, are summarized in the following table:

<table>
<tr><th>Type of EE Measure</th><th>Specific EE Action</th><th>Type of consumer</th><th>Visited Consumer for Energy Inspection</th><th>Investment Cost (€)</th><th>Simple Payback Time (years)</th><th>Savings potential in cooling & refrigeration (%)</th><th>Savings potential in total consumption (%)</th></tr>
<tr><td rowspan="5">Energy Monitoring & Management System</td><td rowspan="5"></td><td rowspan="4">Food-related businesses</td><td>STC Meat Cold Rooms</td><td>15,000 €</td><td>1.5</td><td>5.0</td><td>5.0</td></tr>
<tr><td>STC Vegetable Cold rooms</td><td>15,000 €</td><td>1.5</td><td>4.0</td><td>4.0</td></tr>
<tr><td>SSI Hypermarket</td><td>25,000 €</td><td>2.8</td><td>1.5</td><td>1.5</td></tr>
<tr><td>SkyChef Servair</td><td>12,000 €</td><td>1.2</td><td>2.0</td><td>2.0</td></tr>
<tr><td>Indian Ocean Tuna</td><td>Indian Ocean Tuna</td><td>15,000 €</td><td>0.8</td><td>0.9</td><td>0.3</td></tr>
</table>

Type of EE Measure	Specific EE Action	Type of consumer	Visited Consumer for Energy Inspection	Investment Cost (€)	Simple Payback Time (years)	Savings potential in cooling & refrigeration (%)	Savings potential in total consumption (%)
			(canning of fish)				
		Large Hotels	**Eden Bleu Hotel**	25,000 €	2.3	2.0	2.0
User Behaviour	Improved User Behaviour programme	Food-related businesses	**STC Meat Cold Rooms**	10,000 €	0.6	5.0	5.0
			STC Vegetable Cold rooms	10,000 €	0.9	4.0	4.0
			SSI Hypermarket	10,000 €	1.2	1.4	1.4
			SkyChef Servair	10,000 €	1.4	1.5	1.5
		Indian Ocean Tuna & Seybrew	**Indian Ocean Tuna (canning of fish)**	15,000 €	1.6	0.5	0.2
	Improvements of AC system operation	Large hotels	**Eden Bleu Hotel**	-	0.0	2.7	1.7
Partial improvement of insulation	Replace cold room walls and doors	Food-related businesses	**STC Meat Cold Rooms**	34,000 €	1.4	10.0	9.3
	Replace cold room walls with insulated and air-tight wall panels		**STC Vegetable Cold rooms**	20,000 €	1.1	10.0	8.7
	Doors installation on cabinets		**SSI Hypermarket**	10,000 €	1.5	0.7	0.5

Table 4-1: EE measures and associated saving potentials (Source: "EA 2019" Thelcon audits)

Type of EE Measure	Specific EE Action	Type of consumer	Visited Consumer for Energy Inspection	Investment Cost (€)	Simple Payback Time (years)	Savings potential in cooling & refrigeration (%)	Savings potential in total consumption (%)
Automation controls	Automation controls on doors	Food-related businesses	**STC Meat Cold Rooms**	8,000 €	0.3	10.5	9.8
			STC Vegetable Cold rooms	12,000 €	0.6	11.2	9.8
	Automation controls for refrigeration		**SSI Hypermarket**	154,790 €	1.8	20.3	14.0
	Refrigeration control sequencing improvements	Indian Ocean Tuna & Seybrew	**Indian Ocean Tuna (canning of fish)**	Equipment on site	-	4.3	1.5
Energy saving on lighting	LED lighting in cooling cabinets	Food-related businesses	**SSI Hypermarket**	4,443 €	1.6	1.8	1.3
Cooling system improvement	Refrigeration equipment improvements	Food-related businesses	**STC Meat Cold Rooms**	-	< 1	3.0	2.8
	A/C & Chiller improvement		**SkyChef Servair**	65,500 €	3.7	18.0	3.7
	Operation of evaporators	Indian Ocean Tuna & Seybrew	**Indian Ocean Tuna (canning of fish)**	200,000 €	3.0	2.9	1.0
	Absorption chillers for waste heat of electricity generators (trigeneration)			412,500 €	1.3	14.6	5.0
New water heating system	Solar collectors + Heat pumps for hot water	Large hotels	**Eden Bleu Hotel**	50,000 €	1.5	10	6.2

Table 4-2: EE measures and associated saving potentials (Source: "EA 2019" Thelcon audits)

By summing the energy saving potentials of the different measures for each type of consumer estimated in Thelcon Ltd audits, we obtain the following table:

	STC Meat	STC Vegetables	SSI Hypermarket	SkyChef Servair*	Indian Ocean Tuna	Eden Bleu Hotel
Calculated Share of energy saving in each consumer's electric consumption **of cold uses** %	32.5%	29.0%	21.0%	20.2%	22.7%	15.9%
Calculated Share of energy saving in each consumer's total electric consumption %	30.2%	25.3%	18.7%	7.1%	8.0%	9.6%

** Due to required, time consuming, health exams to enter facilities only outer chiller units were examined. Total EE potential in Cold is certainly higher.*

Table 4-3: Global calculated share of energy savings for audited consumers[5]

4.2 Conclusion of audits

The audits allowed us to distinguish measures with a short payback time (< 1 year) and those with a longer payback time (1 to 3 years).

1. Examples of materials for short term actions (quick-win measures)
   Audit reports have pointed out the following short-term actions:
   - A lack of refrigerant in air conditioning systems can have an impact on their energy consumption. Working with the manufacturer so that the systems are filled with the proper quantity is a very low-cost action. For large hotels, it can result in up to 3% in savings potential in cooling and refrigeration (Thelcon "EA-2019").
   - Implementing improved user behavior programs can be done at a relatively low cost. For example, in food-related businesses equipped with many cold rooms, it can result in up to 5% savings potential in total consumption with a payback time lower than a year.
   - For some food-related businesses, making sure that cold rooms have automation controls can offer a saving potential of more than 8% in total consumption, with a return on investment lower than 8 months.
   - A general maintenance plan may be implemented including for example a regular checkup of the refrigerant quantity, the introduction of automated control for doors, monitoring the energy consumption in order to identify eventual disorders.

2. Examples of materials for medium – long term actions

[5] Percentages are calculated based on annual energy savings (kWh/yr)

Audit reports have pointed out the following medium-long term actions:

- For all types of consumers, energy reports point out the need for an Energy Monitoring & Management System. Depending on the type of business, savings potentials can represent up to 4% of the total consumption, and the payback time can be lower than 3 years.
- Cooling system improvement can represent an important investment cost (up to 415,000 €) with a savings potential up to 14% in cooling and refrigeration. It can be repaid in 3 years with the generated energy savings.
- In some large hotels, savings potential in cooling, refrigeration and hot water can be up to 15%, replacing heating water systems using electric resistances by systems using solar collectors and heat pumps. Combined Heat Cooling and Power (CHCP) otherwise known as Trigeneration is an issue that should be looked both as a country and as f.ex. hotel level. Provided of course that the existing relation of electricity to fuel prices remain as they are now. But companies in Seychelles are generally hesitant to use CHCP or even absorption cooling. They use electricity generation and "waste" the heat produced.

The following tables summarize the measures identified in the audits of this mission by:

- Establishment
- Type of measure
- Payback time.

Cold Rooms

	Behaviour - Maintenance			Efficiency		
	Type of EE	**Specific EE action**	**Savings potential in total consumption (%)**	**Type of EE**	**Specific EE action**	**Savings potential in total consumption (%)**
Payback Time <1 year	User Training	Improved User Behaviour Programme	4.50%			
	Automation Controls	Automation controls on doors	8.34			
Payback Time from to 1 to 3 years	Energy Monitoring System		4%	Partial Improvement of insulation	Replace cold room walls and doors	7.80%
					Replace cold room walls with insulated and air-tight wall panels	7.60%

Hypermarket

	Behaviour - Maintenance			Efficiency		
	Type of EE	Specific EE action	Savings potential in total consumption (%)	Type of EE	Specific EE action	Savings potential in total consumption (%)
Payback Time from to 1 to 3 years	User Behaviour	Improved User Behaviour Programme	1.40%	Partial improvement of insulation	Doors installation on display cabinets	0.48%
	Energy Monitoring & Management System		1.50%	Energy saving on lighting	LED lighting in cabinets	1.27%
	Automation Controls	Automation Controls for refrigeration	14%			

SkyChef Servair

	Behaviour - Maintenance			Efficiency		
	Type of EE	Specific EE action	Savings potential in total consumption (%)	Type of EE	Specific EE action	Savings potential in total consumption (%)
Payback Time from to 1 to 3 years				A/C & Chiller Improvement	Improve/replace chiller for A/Cand CRs	3.71%
	User Behaviour	Improved User Behaviour Programme	1.50%			
	Energy Monitoring System		2%			

Indian Ocean Tuna & Seybrew

	Behaviour - Maintenance			Efficiency		
	Type of EE	Specific EE action	Savings potential in total consumption (%)	Type of EE	Specific EE action	Savings potential in total consumption (%)
Payback Time <1 year	Energy Monitoring & Management System		0.30%			
Payback Time from to 1 to 3 years	Automation Controls	Refrigeration controls	1.43%	Cooling System Improvements	Operation of evaporators	1%
	Energy Monitoring System		0.15%		Combined Heat Cooling and Power (CHCP) - trigeneration cooling	5%

	Hotels					
	Behaviour - Maintenance			**Efficiency**		
	Type of EE	**Specific EE action**	**Savings potential in total consumption (%)**	**Type of EE**	**Specific EE action**	**Savings potential in total consumption (%)**
Payback Time <1 year	Improvements of A/C system operation		1.67%			
Payback Time from 1 to 3 years				Replace Electric heaters for DHW	Install heat pumps & solar panels for HW	6.23%
	Energy Monitoring System		2%			

4.3 Extrapolation to national level

The results from the audits were then extrapolated to the other industries, **for cold use only**. The ratio of energy saving was calculated based on the total electric consumption, given that this value was available. We consider we can use the audits values, as representative of Seychelles industry, rather than “EE study – 2016” values.

Consumer Category	Estimated Share of energy saving in cold uses as % of **total electric consumption**
Food and Related Businesses	18%
Indian Ocean Tuna & Seybrew	8%
Large hotels	9.5%
Other industries & businesses	9%
Large buildings	9%
Non identified activity	9%
Out of the scope of the study	9%

Table 4-4: Estimated share of energy saving in cold uses per type of consumer

Concerning the “Large hotels” category, the audit of Eden Blue did not study the possible savings on lighting and other energy uses (laundries, cooking, office equipment, etc.). The latter is typically in the order of 40-50% of the consumption of a hotel.

In addition to this, this extrapolation assumes that other large hotels are at similar energy efficiency status.

Indeed, Eden Bleu Hotel, which was selected as a sample for large hotels, does not accurately represent all similar-scale hotels. The facility is recently constructed, operating with new-technology refrigeration and HVAC equipment, so there is a restriction of how high the EE potential can be. In fact, energy savings potential for large-hotel buildings can be substantially higher, which cannot be verified in the present study. Auditing an older touristic installation from a generic perspective and not only with respect to HVAC or refrigeration systems will lead to more EE proposals and therefore more attractive savings potential.

Considering the weight of the consumption of each industry (consumptions from “EE study – 2016”), the potential energy savings, carbon dioxide emissions reduction and economic gains were estimated.

Estimated gains	Large consumers - National Extrapolation
Estimated Share of energy saving in cold uses pondered by total electric consumption %	9.3%
Estimated Potential Energy savings (kWh/year)	13,215,717
Estimated Potential Carbon Dioxide emissions reduction [tCO_2/y]	8,894
Estimated Economic gains (€/year)	3,964,715

Table 4-5: National extrapolation of the estimated gains for cold use

No more precise extrapolation can be done with the current values.

These results were calculated considering that:

- 1 kWh of electricity emits 0.673 kg of carbon
- 1 kWh of electricity costs 0.3 cents (€) or 4.5 SCR.

Hence the estimated share of energy saving is inferior to the estimation given in “EE study – 2016” which amounts to 10%. This can be explained by the fact that the current study focuses on the saving potential in cold uses, whilst the study in 2016 gave an estimation for all uses.

Indeed, if the saving potential in cold uses is 9.3%, the global saving potential is expected to be much greater than the cold saving potential.

Furthermore, the current study is much more accurate and reliable given that it is based on detailed audits of representative companies. As a reminder, the audited companies represent 15% of the consumption of the commercial and industrial companies in the Seychelles.

5. Barriers and Proposal elements for EE strategy for Seychelles cold use in industrial and commercial sectors

5.1 Analysis of barriers

Electricity energy prices are quite high (Fig. 4-1) and hence EE actions have very good payback periods. This will help greatly in the attempt for EE actions.

Several barriers that impede the realization of the EE potential were identified in 2016 and are confirmed and extended by the audits of the current study.

The basic barrier identified during the audits is the lack of awareness of energy issues by many companies, especially the ones operating only in Seychelles. Managerial personnel on one hand, consider energy cost as inelastic expense and no attempt is made to optimize it. Workers on the other hand, do not associate their behavior with energy waste and make no serious attempt to save energy.

Seychelles is a destination for high income people and hence it is easier for some companies to increase hospitality and goods prices rather than making attempts and plans to save energy. As competition increases within the country and for companies operating internationally, energy consumption is gaining importance and gradually becomes a vital issue.

One barrier was the lack of confidence in energy saving technologies, such as metering, controls and absorption cooling. Based on detailed audits, this project shows that the estimated savings can reach 30% of the initial energy consumption. This potential considers the different measures that can be applied and not only new technologies. The positive impact the automation controls can have is considerable for the Food and Related Businesses. Introduction of Absorption cooling can save significant energy for electricity producers.

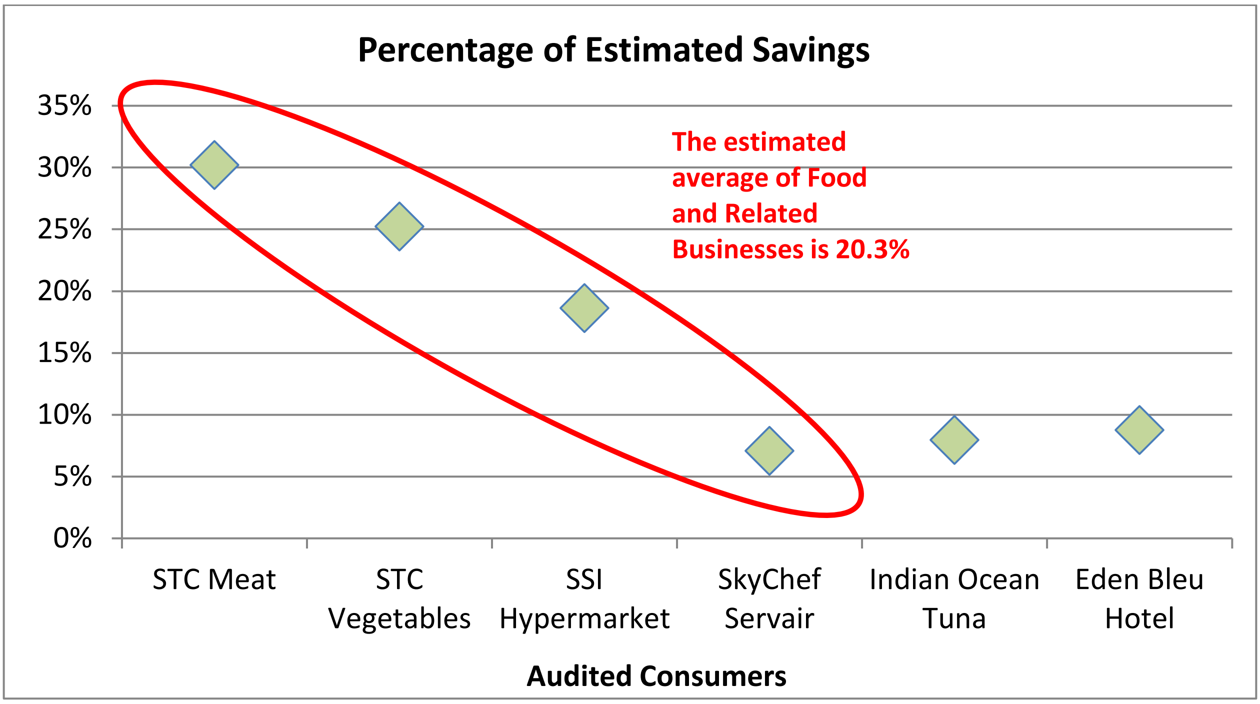

Figure 5-1: Percentage of estimated savings

The other identified barriers currently remain:

- Insufficient knowledge of the energy cost in the final product.

- Insufficient access to information about EE solutions and audits.
- In a small and isolated market, with rare maintenance service or spare parts supplier, a main driver for decision makers is the easiness of the maintenance, leading to avoid sophisticated technologies.
- The market is small, and importing efficient equipment is expensive.
- Lack of technical skills and competences, for audits, optimisation and maintenance.

At their level, working alone, the main aim of the companies is to secure their production, without failure and interruption of production, energy consumption and energy savings is a minor subject, with no one working on it.

Hence, we suggest measures at different scales, for different stakeholders in order to instil a national dynamic and encourage EE measures.

5.2 Global vision of the strategy

The strategy is proposed according to the next steps, according to a logical path, with legislative, informative, supportive and monitoring elements:

1. Reinforcement of state's capacity building, with complements, laws and decrees, to the 2010-2030 Seychelles Energy Policy
   (see *https://www.iea.org/policiesandmeasures/pams/seychelles/name-37155-en.php*)
    Enforce mandatory energy audits in the Seychelles
    Adapt the tariffs of electricity to encourage EE measures
    Modify the Seychelles Sustainable Tourism Label (SSTL) and encourage hotels to implement the certification. Hotels should, first of all, monitor their energy consumption from energy bills or monitoring systems and report on a yearly basis. Personnel should be trained on energy issues
    Development of building thermal regulation
    Please note that SEC is currently working on the draft EE legislation (which was not provided to our team)
2. Awareness raising of companies
    Awareness raising - Information of CEOs, directors and technical departments
    Benefit from energy efficiency experience at company level in neighboring countries such as Réunion
    Benefit from energy efficiency experience at national level in neighboring countries such as Réunion
3. Education and training of EE experts, both inside and outside the companies;
    Training of maintenance, repairing, technical people inside the companies
    Capacity building - Training of maintenance, repairing, technical employees for specialized companies in EE. Communicate on and value the specialized companies
    Capacity building - Training of auditors
4. Financial support of actions
    Develop new financing/support models dedicated to energy efficiency in companies
5. Follow up and monitoring of actions
    Monitor EE developments of companies by developing an energy efficiency database
    Establish a detailed energy analysis of the Seychelles

Establish a new unit in the Seychelles Energy Commission to support companies and carry out projects on EE and other related subjects

The following diagram shows this global strategy. The suggested stakeholders and general measures that can help companies to improve their EE are represented schematically in the diagram and detailed in the following parts.

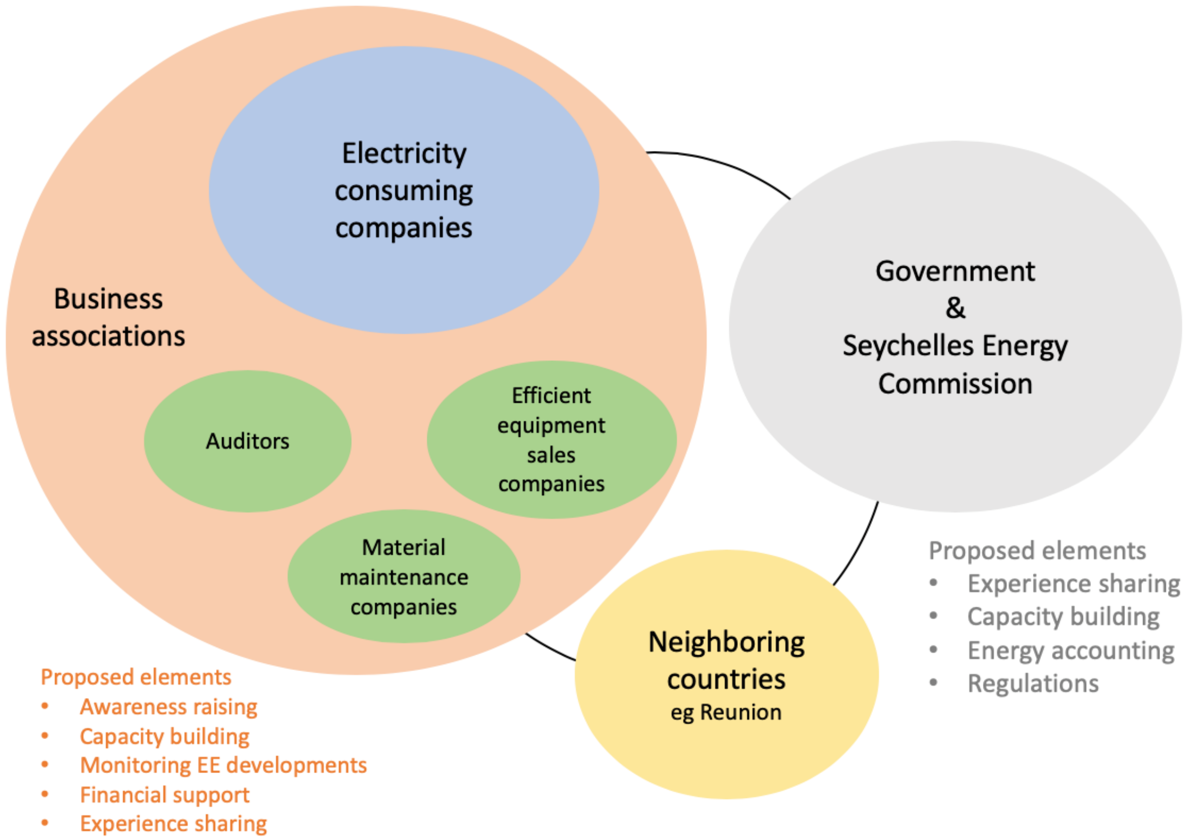

Figure 5-2: Global energy efficiency strategy for cold uses

5.3 Details of actions for the strategy

The strategy can be described as followed.

5.3.1 Reinforcement of state's capacity building

This is covering complements, laws and decrees, to the 2010-2030 Seychelles Energy Policy.

1. **<u>Enforce mandatory energy audits in the Seychelles, above a certain level of electricity consumption</u>**

   We propose to SEC to prepare a decree stating that:
   - energy audits are mandatory above a certain threshold of consumption;
   - an energy audit should be periodically conducted (eg. every 4-5 years);
   - during the first periods of the decree application, the target is the enterprises consuming all together 91 GWh (large hotels, Food and related businesses, IOT and Seybrew);

- after the first period of 4-5 years, the target is the enterprises consuming all together 142 GWh, that is to say 117 enterprises (list indicated in table 1).

Energy use audits will help entrepreneurs choose the actions that are best adapted to their specific trade and production process. The audits will in this way be a valuable decision aid. Auditing a company consists in:

- Studying the energy consumption of the establishment (overview of the biggest consumers, analysis of the evolution of the consumptions, measurements of energetic performances of equipment, estimation of pollutant emissions due to energy consumption)
- Identifying the potential energy saving or energy substitution (per consumer)
- Suggesting an action plan (recommending measures and estimated economic and environmental gains, audit report made available).

2. **Adapt the tariffs of electricity to encourage EE measures**
   Electricity tariffs are one of the keys to promote demand side management, decrease peak of consumption, encourage electricity savings. Tariffs can be managed thanks to the rate and to the cost of electricity (day-night tariff, peak hours – off peak hours tariffs, etc.).

3. **Modify the Seychelles Sustainable Tourism Label (SSTL) and encourage hotels to implement the certification**
   The certification as it is today is lenient from an energy point of view. Out of 109 criteria, only 22 are mandatory and the energy theme consists of 12 criteria with only one mandatory criterion. In addition to this, energy monitoring and heat pumps are not mentioned and the AC recommendations could be stricter (For example: all the assessment guidelines with “at least 50%” could be made more ambitious, with “at least 75%”, at least 75% of rooms show minimum temperature higher than 26°C). The results of Thelcon’s “EA-2019” should be shared to all hotels.
   Out of the 481 hotels registered in the Seychelles, only 21 are certified. This clearly puts forward the fact that the label needs more visibility.

Nevertheless, the study report “EE study - 2016” recommends basing this program on the “stick and carrot” principle. All actions can be prepared like this one.

The stick could be:

- Increase the energy tax
- Threat to develop mandatory regulations if results are not achieved by the voluntary program

The carrot could be:

- Recognition and advertising through labelling
- Decrease the energy tax
- Subsidy to EE project
- Subsidy to energetic audit
- Applicants receive technical assistance and information

From international experiences, the SSTL, as a voluntary program, is a good way to prepare the market for future regulation. For instance, audits could be performed for hotels beyond a certain consumption threshold. Moreover, energy is a significant target from an environmental point of view, but also for the economic benefits it brings through the reduction on the energy bill.

4. **Development of building thermal regulation**
   Building insulation is a key factor for EE improvement: the better the insulation and shading, the lower the energy needed for cold production. Building thermal regulation can be established on a progressive way: at first only commercial and industrial buildings (or only dwellings), or only for the roof insulation, then the energy system (boiler, distribution, etc.). Then the values of insulation can be progressively reinforced, as the share of renewable energy produced on the building.
   The implementation of a thermal building regulation in Europe has shown a tremendous beneficial impact on energy savings in countries such as Germany, France and Austria, reducing the need for heating and cooling.

5. **Employment of Trigeneration and/or Absorption cooling**
   Electricity in Seychelles, both in PUC as well as in several hotels and partly in the Indian Ocean Tuna, is produced using electricity generators. For such generators, approximately 40% of fuel energy is converted to useful electric energy, while the rest 60% is thermal energy (cooling jacket fluids and exhaust gases). This 60% is wasted in Seychelles.
   Thermal losses are the primary reason for the high electricity prices on the island.
   The country should strongly promote technologies which capture the heat water and convert it to useful energy. Such technologies are cogeneration of Heat and Power (CHP), where hot water or steam is produced by the generator and Trigeneration, otherwise known as Cogeneration of Heat Cooling and Power (CHCP). Waste heat should be recovered and for the climate of Seychelles, utilized by Absorption chillers to produce cooling water. Chillers could be single stage or double stage (perhaps utilizing sea water) with efficiency in the range of 80-110%.
   In our discussions with technical directors we realized great hesitation to use such technology, mainly due to the fact that it is not used on the island.
   Very significant amounts of energy could be recovered using such chillers. The city of Victoria f.ex. wastes approximately 100 MW in form of heat at peak electricity loads. This could give many decades of MW of cooling water (depending on technologies used) to the city.
   A more detailed explanation of an application is given in the "Energy Audit of the Indian Ocean Tuna" report.

5.3.2 Awareness raising campaigns

6. **Awareness raising - Information of CEOs, directors, Technical directors**
   - First of all, it is essential that the top management be convinced of the benefits of implementing an EE strategy. They will then allocate budgets to improve the EE in their businesses.

- Associating the Chamber of Commerce and Industry to this action will allow to have an impact on an important number of companies. The Chamber of Commerce and Industry can organize events to bring awareness on the topic of EE.
- Exemplary companies can be identified beforehand to bring their experience and feedback to other companies in these events. The sharing of experience is important to show that EE is feasible and to show the benefits of EE. Company visits may be organized, if the industrial and commercial secrecy allows this type of practice.
- The Seychelles Energy Commission may also be associated to these events to bring a broader picture of the energy situation in the country.
- From our experience, the private sector is usually interested by information on renewable energies for its known economic benefits. This subject can be a way to attract companies to these events to promote renewable energies *and* EE.

The information given at these events will be:

- tailored to specific sectors, using the information channels specific to each trade, and carrying precise, synthetic data, using appropriate trade terms, and targeted on the measures most appropriate to each branch of activity;
- based on concrete examples;
- action oriented, showing businessmen what the next step for them would be: action to take; information sources; people to contact for more information.

The awareness raising actions will be differentiated according to the size of enterprises. For micro and small enterprises, where the entrepreneur takes all decisions himself, the action will focus on simple, specific measures that the enterprise can carry out by itself, using the information tools made available. For medium size enterprises, where decision making is divided among several people, awareness raising will be carried out through a multi-faceted approach, focused on the principal functions within the enterprise that are responsible in some way for energy efficiency: the owner; the financial officer; the production manager; the maintenance engineer.

7. **Benefit from energy efficiency experience at company level in neighboring countries such as Réunion**
   The main work of this action will be to contact Réunion companies or business associations to understand the benefits of the audits, which solutions were chosen and which efficient EE measures they applied.

8. **Benefit from energy efficiency experience at national level in neighboring countries such as Réunion**
   This is the same actions, at governmental and institutional level, to contact Réunion stakeholders to understand national policies which help the implementation of EE.

5.3.3 Education and training of EE experts, both inside and outside companies

9. **Training of maintenance, repairing, technical people inside the companies**
   Those people need to know how to keep the existing equipment at its top condition.
   They need to know the impact on the energy cost of malfunctioning equipment.

10. **<u>Capacity building - Training of maintenance, repairing, technical employees for specialized companies in EE. Communicate on and value the specialized companies</u>**
    Bring awareness and inform on the importance of a performant maintenance.

11. **<u>Capacity building - Training of auditors</u>**
    Auditors are needed to assess the existing situation and offer customized solutions for EE. Develop a web base training tool and improve capacity through a web-based training tool and other material as a first step, then conduct audits with the future auditors, to complete their training. Ideally the energy auditor will be a charted engineer or a member of a renowned association. The auditors can be associated when designing installations. They will necessarily be associated for energy efficiency certifications.

5.3.4 Financial support of actions

12. **<u>Develop new financing/support models dedicated to energy efficiency in companies</u>**
    Associate banks and financial institutions. This model could distinguish projects depending on the project scale and complexity:

- Technology- driven projects: simple and small-scale projects
- Energy Audit-driven projects: Larger and more complex projects based on the recommendations of an energy audit.

5.3.5 Follow up and monitoring of actions

13. **<u>Monitor EE developments of companies by developing an energy efficiency database</u>**
    This task is proposed for SEC, starting with the data collected with the audits in this project. The main idea is to improve knowledge on energy consumption (at first by the largest companies), and of the EE measures implemented in the companies.

14. **<u>Establish a detailed energy analysis of the Seychelles</u>**
    It is important to have a clear understanding of the needs, the usage and the type of energy consumed in order to identify efficient and relevant measures. Indicators of consumption (energy per unit of production for instance) can be based on international indicators, allowing international comparison of the performances of the enterprises.

15. **<u>Establish a new unit in the Seychelles Energy Commission to support companies and carry out projects on EE and other related subjects</u>**
    This task will support the awareness raising of companies. The advice is to promote the support of this unit through the help of the Chamber of Commerce and Industry, so they can produce best practice documents and videos for implementation. Adapted human resources should be checked too, and if necessary increased.

6. Bibliography

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5. *"Energy Audit report – Eden Bleu Hotel",* Thelcon, Sept 2019
6. *"Energy Audit report – Skychef",* Thelcon, Sept 2019
7. *"Energy Efficiency in large consumers in industry and tertiary sectors in Seychelles: National Mapping Study",* draft final report, AETS-ARTELIA, 2016

Note
References 1-6 are referred as "EA – 2019" (Energy Audits – 2019)
Reference 7 is referred as "EE study 2016" (Energy Efficiency study – 2016)
Energy Audits contain sensitive data and have to be requested by audited companies.

Annex 1: Seychelles Sustainable Development Strategy

The global strategic objectives to promote sustainable energy demand and supply are:

1. Promote EE in all sectors of the economy
2. Promote alternative and renewable energy at national level
3. Prepare a long-term energy plan
4. Monitor the environmental impact of the energy sector and to undertake mitigation measures
5. Build capacity at all levels

Listed hereafter are the strategic objectives and detailed activities which were suggested for the SSDS action plan and which have a strong link with Cold Uses.

Strategic objective 1 (2): Promote EE in building and construction

Outcome: more EE new building and more efficient use of air-conditioning (AC)

Lead implementing agency: Seychelles Energy Commission (SEC)
Cost: SCR 8,000,000
Timeline: 2020
Applicant policy: Energy Policy for Seychelles (EPS)
Sources of funding: GOS, UNDP/GEF, Bilateral cooperation
Examples of activities:

Activities	Responsibilities	Verifiable indicators
Carry out Energy Audit in large AC buildings to established a baseline information	SEC, S4S, PUC, NATCOF	N° of energy audits completed
Develop AC regulations/code and undertake a public awareness	SEC, PUC, Planning Authority	Availability of a draft AC regulations
Establish MEPS (minimum energy performance standards) for AC	SEC, PUC	Availability of a draft MEPS for AC
Enforce law to ban import of inefficient AC	Customs, SEC, PUC	Number of efficient AC imported and used

Strategic objective 1 (3): Promote EE in Hotels & Industry

Outcome: more efficient use of energy in hotels and industry (H&I), more informed and more EE conscious consumers

Lead implementing agency: SEC
Cost: SCR 1,000,000
Timeline: 2020
Applicant policy: Energy Policy for Seychelles (EPS)
Sources of funding: GOS, UNDP/GEF, Bilateral cooperation

Examples of activities:

Activities	Responsibilities	Verifiable indicators
Promote energy auditing in H&I, established baseline energy consumption	SEC, STB, PUC, private operators	N° of hotels and industry audited
Workshop on EE for H&I and present energy audits finding	SEC, PUC, STB, large H&I	N° of workshop having components on EE in H&I
Promote the scheme of a mandatory Energy Manager, energy auditing and energy reporting	SEC, PUC, STB, private operators	Number of H&I having adopted this scheme
Promote EMS (energy management standards)	SEC, SBS, ISO, Dep. Of industry, STB/SSTS	N° of public awareness activities and seminars on EMS
Promote cogeneration in hotels and industry for production of hot water or industrial process	SEC, PUC, STB, private operators	N° of meetings held on cogeneration

Annex 2: Extract of the SSTL label – Energy theme criteria

THEME 4. ENERGY

Section	Criteria Number	Criteria	Possible Score	Awarded	Assessment Guidelines	Evidence sighted	Corrective Action
12. Conserving Energy	12,1	The enterprise has developed and implemented an energy management plan that is suited to its scale. Sources of energy are indicated.	Must		a) plan should include: i) main energy uses (e.g., a/c, lighting, cooking); ii) quantity currently used; iii) time-bound targets for reduced usage b) at least two pieces of evidence to suggest the plan has been implemented For small enterprises, the plan can be part of the sustainability policy		
	12,2	Energy efficient lighting fixtures have been installed	3		a) at least 50% of lighting in rooms OR two areas of the enterprise (e.g., garden and kitchen) are using energy efficient light bulbs		
	12,3	Energy-efficient appliances are installed	3		a) at least 50% of large appliances in kitchen area are energy-efficient labelled		
	12,4	Electric equipment is turned off (not on standby) when guest room is not occupied	2		a) functional power key card or notice to guests to switch off lights, and evidence that housekeeping staff confirm that they switch off appliances after cleaning room		
	12,5	The enterprise provides fans as an alternative to air-conditioning in guestrooms with air conditioners	1		a) at least 50% of rooms with a/c also are equipped with fans		
	12,6	All air conditioning units have their minimum temperature set at 23 degrees C	1		a) at least two rooms show minimum temperature higher than 23 b) housekeeping staff can confirm correct temperature for rooms		
13. Renewable Energy	13,1	The enterprise has installed solar panels and/or wind turbines	3		a) renewable energy devices sighted and functional		
	13,2	The enterprise uses alternative energy heating systems for all hot water	3		a) water heating with renewable energy is demonstrated		
14. GHG	14,1	The enterprise documents its total annual green-house gas (GHG) emissions from business-related energy consumption (not including guest-travel) using a nationally or internationally accepted GHG calculator	3		a) results of current year's GHG calculations and how these were made		
	14,2	The enterprise documents its purchase of verified carbon offsets and mitigate 51% or more of its total net annual greenhouse gas emissions	3		a) results from 14.1 b) receipts from carbon offsets showing more than 51% carbon has been offset Section 15 offers additional points for use of local carbon offset program		

	14,3	The enterprise seeks to reduce transportation requirements and actively encourages the use of cleaner and more resource efficient alternatives by customers, employees, suppliers and in its own operations	**1**		a) Customers, staff and suppliers are aware of practical measures/opportunities to re duce transport related greenhouse gas e missions.		
15. Other Energy-Related Practices	15,1	Enterprise demonstrates evidence of implementing other approved energy conservation practices	**3**		a) evidence of innovative approaches to energy conservation and/or renewable energy use e.g. energy generated is transferred to national grid, water is desalinated using solar power, solar power lighting systems are used, bicycles are available for guest use, only non-motorized water recreation is provided b) one point each practice up to three points		

Total Must Criteria in Theme	**1**	0
Total Possible Points	**26**	0
Total Points Scored		**0**

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