



Energy
Efficiency
Management
Office



ENERGY USE AND ENERGY EFFICIENCY IN HOTELS AND HOTELS DE CHARME

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StraConsult Ltd



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ABBREVIATIONS

AHC	Association des Hôtel de Charme
AHRIM	Association des Hôteliers et Restaurateurs de l'île Maurice
BMS	Building Management System
CEB	Central Electricity Board
EEMO	Energy Efficiency Management Office
EUI	Energy Use Intensity
HC	Hôtel de Charme
IEA	International Energy Agency
MEPU	Ministry of Energy and Public Utilities
SM	Statistics Mauritius
TA	Tourism Authority
TAHC	Tourism Authority Hotel Classification
ToR	Terms of Reference
UH	Unclassified Hotels

COLLABORATORS



Organisations & Associations

1. AHRIM
2. Association Hotels de Charme
3. CEB

Hotels and Hotels de Charme

1. 20 Degrés Sud
2. Ambre Hotel
3. Anelia Beach Resort & Spa
4. Angsana Balaclava
5. Astroea Beach
6. Belle Mare Plage The Resort
7. Canonnier Beachcomber
8. Casuarina Resort & Spa
9. Club Méditerranée, La Plantation D'Albion
10. Club Méditerranée, La Pointe aux Cannoniers
11. Coin de Mire Attitude
12. Dinarobin Beachcomber
13. Emeraude Beach Hotel
14. Four Seasons Resort
15. Friday Attitude
16. Garden Lake Villa
17. Hennessy Park Hotel
18. Heritage Awali Golf & Spa Resort
19. Hilton Mauritius Resort & Spa
20. Intercontinental Mauritius Resort
21. La Palmeraie Hotel
22. La Pirogue Hotel
23. Labourdonnais Waterfront Hotel
24. Laguna Beach Hotel & Spa
25. Lakaz Chamarel
26. Le Cardinal Exclusive Resort
27. Le Meridien, Ile Maurice
28. Le Morne Peninsula Hotel
29. Le Pearle Beach
30. Le Preskil Beach Resort
31. Le Prince Maurice
32. Le Recif Attitude
33. Le Suffren Hotel & Marina
34. Le Telfair Golf & Spa Resort
35. Long Beach Hotel
36. Lux Belle Mare
37. Lux Grand Gaube
38. Mahe Holiday Resort
39. Manisa Hotel
40. Maradiva Villas Resort & Spa

41. Maritim Crystals Beach Resort & Spa
42. Maritim Hotel Mauritius
43. Merville Beach Hotel
44. Outrigger Resort & Spa
45. Paradis Beachcomber
46. Paradise Cove Hotel
47. Pingouinvillas
48. Radisson Blu Azuri Resort & Spa, Mauritius
49. Radisson Blu Poste La Fayette Resort & Spa
50. Ravenala Attitude
51. Royal Palm Beachcomber
52. Sands Suites Resort & Spa
53. Sensimar Lagoon Mauritius
54. Shandrani Beachcomber
55. Shangri-La's Le Touessrok Resort & Spa
56. Sofitel L'Imperial Resort & Spa
57. Sofitel So Mauritius
58. Solana Beach
59. Sun 7 Bungalow
60. Tamassa Hotel
61. The Address Boutique Hotel
62. The Oberoi Mauritius
63. The St Regis Mauritius Resort
64. Trou aux Biches Beachcomber
65. Veranda Grand Baie
66. Veranda Palmar Beach
67. Veranda Pointe aux Biches
68. Veranda Tamarin
69. Victoria Beachcomber
70. Voila Bagatelle
71. Voile Bleue
72. Westin Turtle Bay
73. Zilwa Attitude

EXECUTIVE SUMMARY

This survey on energy use and energy efficiency in the hotel sector is the first of its kind in Mauritius. The target sample was a list of 106 hotels and hotels de charme. Out of the 106 hotels and hotels de charme, 95 could be effectively contacted and 73 participated in the survey by providing some form of data.

The hotels were segregated along 4 categories:

1. *Unclassified* : *Category 0*
2. *2 and 3-star hotels* : *Category 1*
3. *3-star superior to 4 star hotels* : *Category 2*
4. *4 star superior to 5 star hotels* : *Category 3*

Out of the 73 respondents, the data from 70 hotels could be used for analysis of energy use per source of energy. Data from 51 hotels could be exploited for Energy Use Intensity (EUI) based on occupancy figures provided and data from only 18 hotels were comprehensive and coherent enough for breakdown of consumption per end use. The analysis has shown that electricity represents 69% of the energy consumption of hotels, while LPG and diesel represents 26% and 5% respectively.

The data has shown that 60% of the hotels generate part or all their hot water from LPG, while the corresponding figure for Diesel is 30%. Only 24% of the sample of 70 hotels has installed solar collectors for domestic hot water production, while 16% and 6% of the sample use LPG and diesel to complement solar water heating respectively. Only 2 small hotels have installed solar PV for self-consumption and export to grid. No hotel reported installation of off grid solar PV system.

Only 64 hotels provided data on generating sets. The average installed capacity of standby generator (genset) in this group was 962 KVA, with an average monthly running hour of 17.6 hours. Only 7 out of the 73 hotels are equipped with a desalination plant. Only 2 hotels consistently desalinate water at an average of around 870m³ per day each.

Based on a sample of 70 hotels, the average number of rooms per hotel was 141 with an average built up area of 55 m². The occupancy level was calculated as Room Nights sold during the month / Room Nights available during the month. Based on a sample of 51 hotels, the average occupancy across all hotels and for the 12 months was 76%.

An energy model was developed to estimate the annual energy consumption based on equipment loads and usage patterns reported. The calculated consumption was compared to the actual consumption figures and was found to be within $\pm 5\%$ to $\pm 30\%$.

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%;
- cold storage, waste water at 7%;
- laundry and ventilation are at 6% each and
- external lighting and restaurant lighting at 2% each

The analysis of consumption for Category 1 has shown that the percentage for basic functions were higher than the sector average with 49%, 18% and 18% for air conditioning, kitchen and laundry respectively.

As we move up the category and star rating of hotels, the basic functions assume a lower proportion of the total while comfort and luxury related functions such as architectural lighting, external lighting, pools and spa, assume higher proportions.

The data for EUI per m² and per room-night is summarized in Table 1 for electrical and total energy consumption.

Category	Average number of rooms	Average built up area per room	kWhe/m ²	kWhe/Room-Night	kWheq/m ²	kWheq/Room-Night
Category 0	15	53	146	7	198	74
Category 1	85	41	220	35	742	132
Category 2	157	47	567	86	926	137
Category 3	176	65	546	132	651	159

Table 1 : EUI per m² and per room-night

The data shows that the average number of rooms and average built up area per room increases steadily as we move up categories. The electrical and total energy consumption are highest for category 2 with 567 kWhe/m² and 926 kWheq/m² respectively due to the more compact nature compared to more luxurious category 3 hotels.

Both the electrical and total consumption per room-night increase steadily across categories which shows that EUI based on room nights provides a more reliable benchmark of energy consumption. There is a 3-fold increase in electrical energy consumption per room night from category 1 to 3 compared to a 20% increase in total energy consumption which shows that luxury and comfort related features are linked to electrical energy consumption while thermal energy is linked to more functional applications such as hot water production and cooking.

Recommendations have been made based on the lessons learnt during the data collection process and on the results of the survey. There is need to focus on training on energy management particularly in the lower category hotels. The profile of energy management must be raised by empowering internal energy managers with knowledge and resources for the energy management functions to be effectively implemented.

Recommendations were made on the scope of data collection to enable more in-depth analysis during future surveys.

1. OBJECTIVE OF THE SURVEY

The **general objective** of the assignment was to assist the Energy Efficiency Management Office (EEMO) set up under the Energy Efficiency Act 2011 and which is under the aegis of the Ministry of Energy and Public Utilities, in achieving the following functions, necessary to attain its objects in the hotel sector:-

1. *collect and maintain data on energy efficiency and consumption*
2. *establish energy consumption standards; and*
3. *issue guidelines for energy efficiency and conservation*

1.1 *Specific Objectives of the survey*

The **specific objectives** of the survey were to: -

1. carry out on site surveys to obtain data on the energy use in all hotels in Mauritius to obtain the breakdown of the individual components thereof, including electricity, fossil fuels, renewable energy sources such as solar hot water and solar photovoltaic generators as may be applicable;
2. collect details on the renewable energy installations (photovoltaic and solar water systems), standby generator(s) and desalination plant(s) that are installed at the hotels;
3. obtain the breakdown of energy use in hotels according to different end use (for example, air conditioning and ventilation, catering, domestic hot water, lighting, refrigeration (cold room) and pumping);
4. determine the level of energy efficiency of hotel facilities, through the calculation of Energy Use Intensity (EUI)

1.2 Terms of Reference

The Terms of Reference of survey were: -

Task 1 : gathering and compiling data on:-

- i. total annual energy use in all hotels, including where necessary instrumented measurements (service provider to make necessary arrangements for the supply and installation of the instrument), with breakdown showing electricity consumption, fossil fuel use and renewable energy use;
- ii. the surface area (in m²) and peak capacity of photovoltaic installations, the area in m² of collectors for solar water heaters installed for each hotel;
- iii. average annual electricity generation from solar PV system and consumption of such generated electricity
- iv. the number and individual capacity of fresh water production in m³/hour of desalination plant(s) installed at hotels (if present) and the energy source(s) and energy consumption/year for the desalination plant(s)
- v. the total capacity of the standby generator(s) installed on site, the average number of hours run per month and total electricity generated;
- vi. the total built area (in m²);
- vii. the number of rooms; and
- viii. the average annual room nights

Task 2

Provide the breakdown of energy consumption in hotels for heating and air conditioning, catering, domestic hot water, lighting (internal and external separately) and other.

Task 3

Determine the Energy Use Intensities (EUI) in hotels. The EUI is defined as the site energy consumption per total built area, per number of rooms and per room night. EUI shall be provided according to each source of energy namely: electricity, fossil fuel and hot water as well as the total EUI for the hotel. EUI shall be provided in annual kWh/m².

Task 4

Investigate and display through appropriate charts the relationship of EUI to (a) hotel category, and (b) hotel occupancy rate

Task 5

The average energy use per tourist according to the different categories of hotels in terms of kWh/tourist/night.

1.3 Targeted groups for the survey

1. Hotels de Charme registered with Association des Hotels de Charme
2. Hotels registered with AHRIM

1.4 Hotel Classification

For the purposes of the survey, the prescribed Tourism Authority (Hotel Classification) Regulations 2015 was used.

Classifications are as follows:-

1. Two Star
2. Three Star
3. Three Star Superior
4. Four star
5. Four star superior
6. Five star
7. Five star superior

2. INTRODUCTION

It is practically impossible to describe the beauty of Mauritius in words since the island is rich with lush forest, wild waterfalls, unique wildlife, rocky mountains, white sand beaches and breathtaking crystal clear turquoise lagoons. Mauritius is turning out to be one of the most preferred holiday destinations for tourists from all over the world, who are seeking high-end holidays and perfect wedding destination on a tropical paradise island.

Mauritius offers a wide range of natural attractions as well as many man-made attractions, allowing tourists to enjoy a sub-tropical climate, vibrant postcard beaches, calm sea conditions, tropical fauna and flora complemented by a multi-ethnic and cultural population. The island offers lot of possibilities for discovering various leisure activities, like, underwater activities, catamaran cruises, horse riding, nature and adventure activities, quad biking activities, swimming with the dolphins, safari wildlife adventures, sightseeing tours, attractions and parks visits, helicopter tours, sea and water activities, deep sea fishing, hiking and trekking, diving, sky diving, canyoning and speed boat trips to neighbouring islands. All these form part of Mauritius' main strength, since they are supported by world-class beach resorts and hotels, reliable and operational services and infrastructures.

The Mauritian hotel industry is very well-organized and has relentlessly improved the quality of accommodation to cater for the growing demands of tourists. Many resorts and hotels are equipped with the latest technology and services for the indulgence of tourists, with their large variety of services like the sauna, massages, private Jacuzzi, well-designed gardens, providing fairylike atmosphere.

Beside of being a holiday destination, Mauritius is also an emerging destination for business meetings, conferences and events. Mauritius offers range of facilities for the business community such as: great personal service, luxurious accommodation, finest gastronomy, world class amenities, state-of-the-art telecommunications infrastructure, safe environment and conference facilities.

2.1 Tourists travelling to Mauritius

Tourists travelling to Mauritius have nearly doubled from 2000 to 2016. In year 2000, Mauritius recorded a total arrival of 915,203 while this number has reached 1,775,462 in 2016. Figure 1 shows the evolution of arrivals from year 2000-2016.

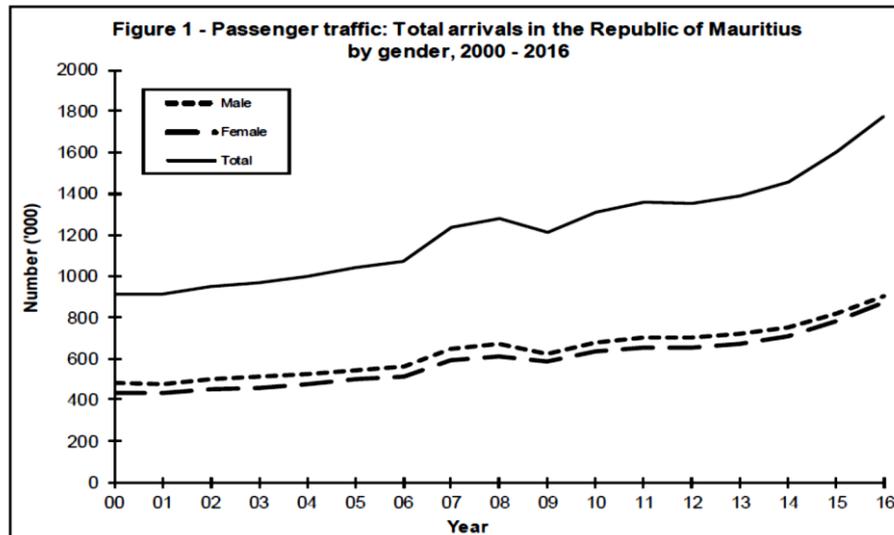


Figure 1 : Passenger Traffic – Total arrivals in Mauritius by gender – from 2000 to 2016

Source: Digest of International Travel and Tourism Statistics 2016 – Statistics Mauritius

3. MAURITIUS PRIMARY ENERGY REQUIREMENT

Table 2 indicates the trend in primary energy consumption from 2015 to 2016 which shows a reduction in the share of renewables resulting from a lower contribution from bagasse and hydro.

	2015			2016		
	Tonne (except Hydro,Wind, Landfill gas & photovoltaic in GWh)	Ktoe	%	Tonne (except Hydro,Wind, Landfill gas & photovoltaic in GWh)	ktoe	%
Imported (Fossil fuels)		1,283.2	83.6		1,323.6	85.4
Coal	720,784	446.9	29.1	734,418	455.3	29.4
Petroleum products		836.3	54.5		868.3	56.0
Gasolene	150,960	163.0	10.6	165,677	178.9	11.5
Diesel Oil	207,494	209.6	13.7	208,376	210.5	13.6
Dual Purpose Kerosene	120,427	125.2	8.2	142,715	148.4	9.6
<i>Kerosene</i>	<i>872</i>	<i>0.9</i>	<i>0.1</i>	<i>800</i>	<i>0.8</i>	<i>0.1</i>
<i>Aviation Fuel</i>	<i>119,555</i>	<i>124.3</i>	<i>8.1</i>	<i>141,915</i>	<i>147.6</i>	<i>9.5</i>
Fuel Oil	270,026	259.2	16.9	259,953	249.6	16.1
LPG	73,339	79.2	5.2	74,910	80.9	5.2
Local (Renewables)		251.3	16.4		226.8	14.6
Hydro	<i>GWh</i> 122	10.5	0.7	100	8.6	0.6
Wind	<i>GWh</i> 3	0.2	0.0	18	1.5	0.1
Landfill Gas	<i>GWh</i> 20	1.8	0.1	19	1.6	0.1
Photovoltaic	<i>GWh</i> 26	2.2	0.1	30	2.6	0.1
Bagasse	1,437,947	230.1	15.0	1,287,976	206.1	13.3
Fuelwood	17,117	6.5	0.4	16,885	6.4	0.4
Total		1,534.4	100.0		1,550.4	100.0

Table 2 : Primary Energy Consumption from 2015 to 2016

Source: Statistics Mauritius

4 SURVEY ON ENERGY USE AND ENERGY EFFICIENCY IN HOTELS AND HOTEL DE CHARME IN MAURITIUS

The survey started in March 2017 and targeted 106 hotels and hotels de charme. All of them were contacted. Out of the 106, contacts were made with only 95. The remaining could not be contacted for the following reasons:-

- a. Closed down
- b. Closed for renovation
- c. No contact details
- d. Could not be located through site visits

4.1 Grouping of the hotels and hotels de charme

For analysis purposes, the hotel classifications have been categorized into unclassified, category 1, category 2 and category 3. Table 3 shows the grouping of the hotels and hotels de charme.

<i>Hotel de Charme</i>	<i>Category 0</i>
<i>Hotels with two and three stars</i>	<i>Category 1</i>
<i>Hotels with three star superior to four stars</i>	<i>Category 2</i>
<i>Hotels with four star superior to five star superior</i>	<i>Category 3</i>

Table 3 : Grouping of hotels and hotels de charme

Out of the 95 hotels and hotels de charme contacted, 73 participated to the survey. Table 4 shows the responses received by category:-

Category 0	6
Category 1	13
Category 2	25
Category 3	29

Table 4 : Number of hotels & hotels de charme which participated in the survey

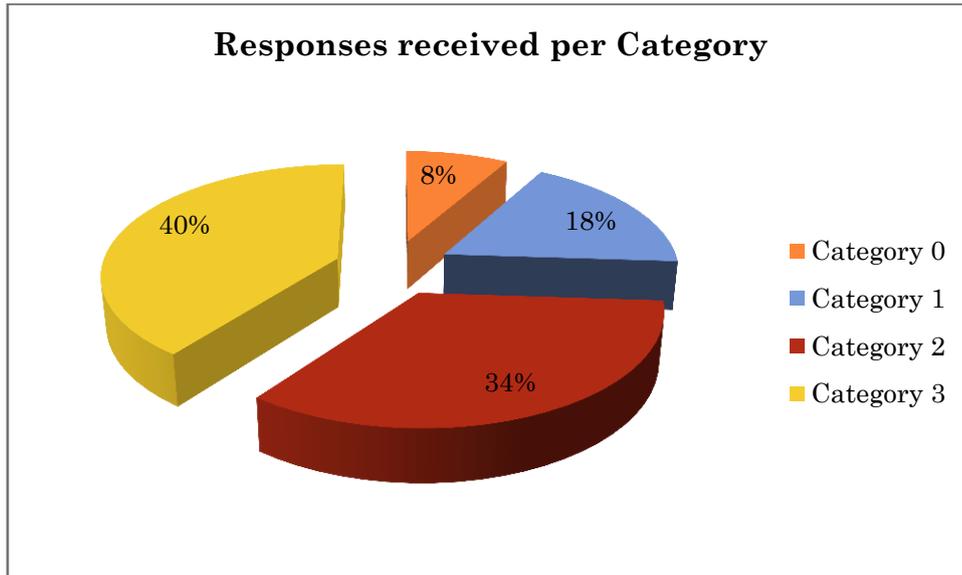


Figure 2: percentage of hotels & hotels de charme which participated in the survey

Observation : Categories 2 and 3 had a better response rate due to dedicated staff allocated to maintenance and sustainability issues.

5. METHODOLOGY OF DATA COLLECTION AND ANALYSIS

5.1 *Design of Questionnaire*

A comprehensive questionnaire (see Appendix I) was designed by StraConsult and approved by EEMO. Most of the questions relate to task 2 to obtain a breakdown of energy use. Although this type of analysis is typically carried out in a detailed energy audit, there was an effort to collect as much data as possible to complete this task.

The questionnaire was sent to the contact person at the hotel, with a request to collect and send the data. A follow-up campaign was carried out by StraConsult to obtain the filled-in questionnaires.

5.2 *Team Composition*

5.2.1 *Technical*

The Team Leader of the Survey was **Dr. Krishna Heeramun**. Dr. Heeramun holds a Ph.D in Management as well as a Diplome d'Etudes Approfondies (DEA) in Industrial Engineering and a Master's Degree in Electrical Engineering. He was assisted by Mr Judex Soulange who holds CEng.

5.2.2 *Administrative Support*

The Technical team was assisted by Mr Louis Amedee Darga, Managing Partner of StraConsult and Project Director for the survey and Mrs Pamelah Gungaram, Project Administrator at StraConsult.

5.3 *Assistance to hotels*

Visits were scheduled by the support engineer to the hotels to explain and assist hotel staff mainly in the maintenance department to fill-in the questionnaire. Most of the forms were filled-in during face to face meetings.

The data collected in the paper questionnaires were then transferred on an excel sheet and basic screening was carried out to detect and correct inconsistent figures and data capture errors.

An excel tool was developed with calculations based on the raw data to respond to the 5 tasks in the ToR.

The following sections provide details on the rationale of the data structures and analysis methods implemented in the excel analysis tool developed:-

5.3.1 Electricity consumption

The electricity consumption from January to December 2016 was requested. The 2 sources of electricity consumption are data from CEB and data from the hotel survey questionnaires. In most cases, the figures were close and the CEB data was chosen as actual consumption.

In some cases, the consumption reported by the hotel was higher than the CEB data. The reason could be that the hotels have more than one meter and the other meters are registered on a different trading name. In these cases, the data reported by the hotel was chosen.

5.3.2 Electricity generation from standby generator (genset)

The data on generation from genset was not complete in many cases. Consequently, electricity generated from the genset was calculated by 2 methods using:

- a typical specific consumption figure adapted for the genset capacity, where fuel consumption was reported
- the running hours and assuming a genset loading of 75% where annual running hours were reported assuming the genset to be run on load which is the recommended practice.

In cases where the values from the 2 methods were comparable, the higher value was taken as the energy obtained from genset.

In most cases, the annual running hours figures of 30 to 80 hrs reflect the hours of CEB outages and scheduled on-load operation of the genset as part of maintenance routines. Data obtained from the survey indicated that diesel consumption figures reported could be lower than the consumption from running hours. This is due to diesel already in the storage tank.

In some cases, the total diesel usage was provided while diesel is also used for hot water supply. The estimation of diesel used from running hours enabled the estimation of the amount of diesel consumed by hot water in cases where hot water from diesel was reported.

5.3.3 Breakdown of energy consumption

In order to obtain the breakdown of energy consumption, a model of energy consumption was built from the data on installed equipment quantities, nominal power and operating hours in the form of hours per day x days per week x weeks per annum.

The calculated energy consumption was modulated with the calculated average occupancy across months to reflect actual consumption. For the consumption of air conditioning of common areas, a climatic and hotel rating factor was added to reflect actual cooling demand to fine tune the energy model.

The calculated energy value was compared with the actual energy consumption obtained from 5.3.2 above to assess the quality of data supplied. Differences between 5% to 30% were obtained for most of the cases.

5.3.4 EUI ratios and further analysis

The calculation of Energy Use Intensities (EUI) provides the basis for benchmarking energy consumption across hotel categories and for benchmarking future improvement with historical data.

In addition to the EUI ratios requested, it is recommended that the following analysis is proposed for future analysis:

- a linear regression between independent variables such as date of last renovation, and the most reliable EUI ratios to obtain deeper insights from the data collected
- a specific consumption analysis to establish the no load consumption of hotels. This could be carried out as a follow-up exercise in a few cases where both the occupancy and consumption figures were accurately and comprehensively captured.

6. RESULTS OF TASK 1: BASIC ANALYSIS OF ENERGY SOURCES AND USAGE

6.1 Total energy use by source of energy

The data from 70 hotels out of a total of 73 hotels shows that the electrical energy from CEB is the main source with 69.25%, followed by LPG 25.45% and Diesel 5.27%. Only 2 hotels had solar PV systems installed.

CEB Electricity Supply (kWh)	221,931,649	221,931,649	69.25%
LPG (kg)	5,972,148	81,579,548	25.45%
Diesel (litres)	1,521,941	16,893,549	5.27%
Renewable Energy	83,725	83,725	0.03%
Total		320,488,471	100.00%

Table 5 : Total energy use by source of energy

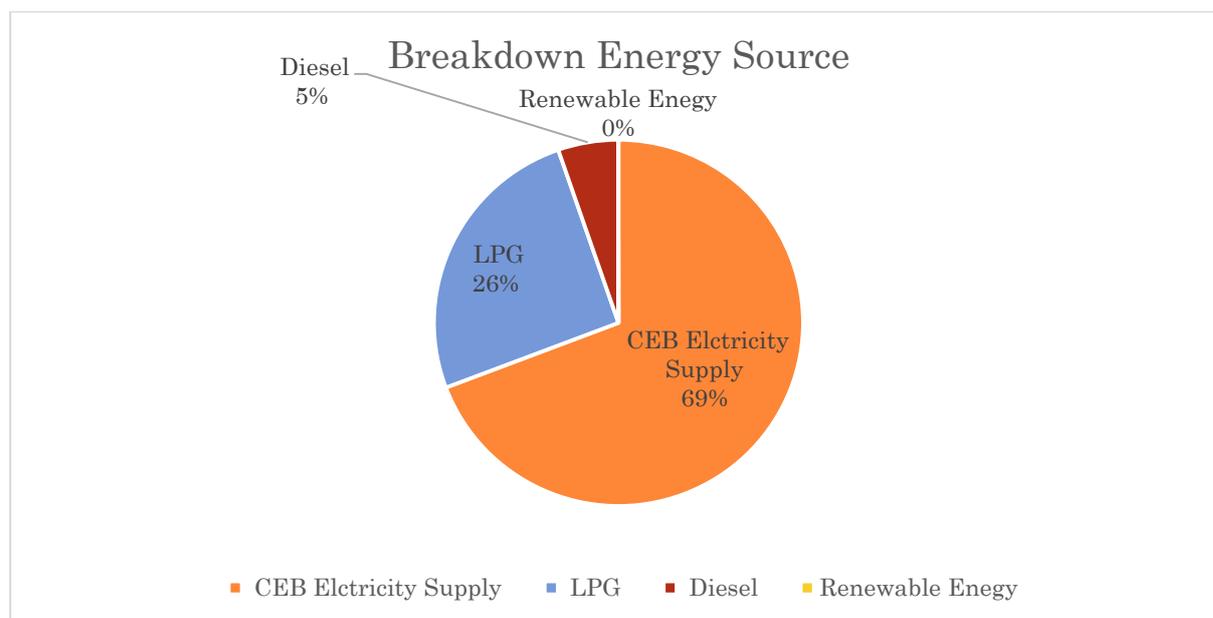


Figure 3 : Breakdown Energy Source

There is no breakdown or sub metering arrangements for segregating LPG used for cooking and for hot water. This could be part of recommendations for the sector to enable the quantification of LPG used for low grade heating.

Although a majority, 60% of the sample, use LPG for hot water production, 19% still use both fuels for the same purpose and 30% use diesel.

Energy Source for Hot Water Production	Number of Hotels	%
LPG	42	60%
Diesel	21	30%
Both LPG and Diesel	13	19%
Did not report on fossil fuel	20	29%
Solar thermal collectors	17	24%
LPG and Solar	11	16%
Diesel and Solar	4	6%
Total sample size	70	

Table 6 : Energy source for hot water production

Only 24% use solar energy for hot water production, while 16% use solar energy with LPG as backup and 6% use solar energy with diesel as back up.

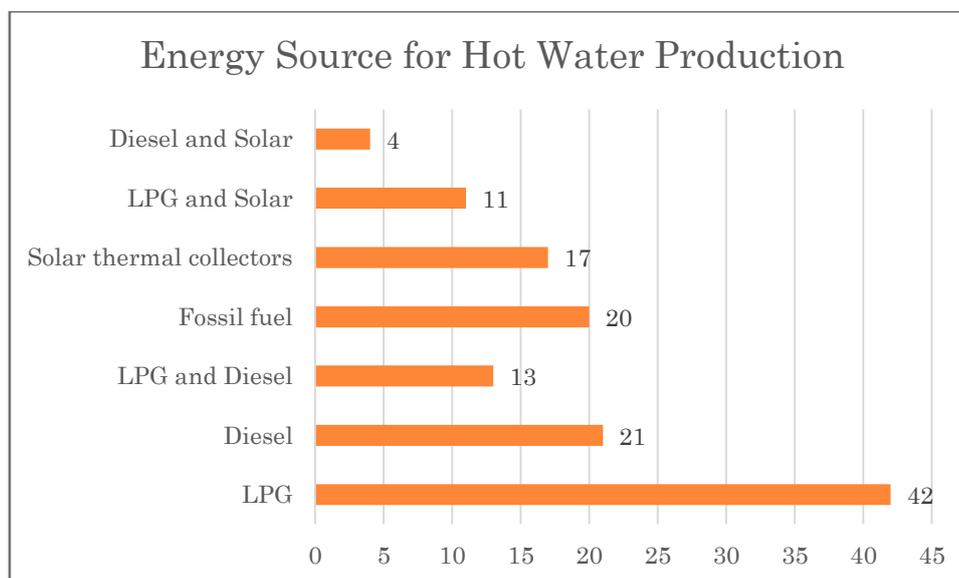


Figure 4 : Energy source for hot water production

6.2 Solar Energy for electricity

Only 2 hotels reported the use of solar energy for electricity namely a small guest house in the North with 3.5 kWp installed and a medium sized hotel in the West with 42.5 kWp installed.

6.2.1 Use of solar Energy from photovoltaic generators

	Solar capacity Installed kWp	PV Annual Energy generated from production meter kWh	Annual Energy specific Yield kWh/ kWp	Annual NET consumption kWh	CEB Share of Solar Energy to Net consumption
Small Guest house in the North	3.5	5,250	1,500	10,833	48.46%
Medium sized hotel in the West	42.5	78,475	1,846	293,577	26.73%

Table 7 : Use of solar Energy from photovoltaic generators

The analysis of energy from the 2 on-grid PV systems installed shows that the specific yield varied between 1500 to 1846 kWh/kWp. The yield depends on site specific factors such as ventilation and shading as well as overall system performance, age and soiling of modules.

Due to the configuration of the point of common coupling which is between the point of use and CEB meter, the daytime load or part of it is supplied by the PV system.

6.2.2 Desalinated water

Out of the 73 hotels only 7 are equipped with a desalination plant with only 2 hotels which consistently desalinate water at an average of around 870 m³ per day each.

Hotel	Desalination Equipment Capacity Installed m ³ /day	Technology Used	Annual Volume of Water Produced m ³	Energy Consumption kWh/ m ³	Daily average production m ³
Hotel 1	N/A	Thermal	320,000	4.08	871.97
Hotel 2	6	Reverse Osmosis	318,269	N/A	49.32
Hotel 3	1600	Reverse Osmosis	-	4.06	876.71
Hotel 4	3.5	N/A	-		
Hotel 5	12	Reverse Osmosis		N/A	
Hotel 6	43	Reverse Osmosis	18,000	N/A	-
Hotel 7	18.75	Reverse Osmosis	110,877	3,6	303.77

Table 8 : Use of desalinated water

The capacity of 18.75m³ per day reported by hotel 7 is inconsistent with the reported annual production of 110,877m³. Idem for hotel 2 where the daily capacity of 6m³ is not consistent with the reported 18,000 annual m³.

The latest generation Reverse Osmosis plant installed at hotel 7 has a specific energy consumption of 3.6 kWh/m³ compared to older equipment installed at another hotel of the same group.

6.3 Standby generator analysis

64 Hotels out of the sample of 73 have a genset and reported the genset capacity. The average installed capacity of this group of 64 hotels is 962 kVA with a total installed capacity of 61,588 kVA.

As explained in section 5.3.2, the reported running hours data was cross-checked with the reported diesel consumption. In cases where running hours was not provided but diesel consumption was provided, the running hours was estimated from diesel consumption and typical specific consumptions chosen for the genset capacity installed. The average monthly running hours was 17.24 hours.

Running on no-load has not been taken into consideration since the diesel consumption is marginal.

The total annual energy generated from the total installed capacity of 61,588 KVA was 8,739,714 kWh.

$$\begin{aligned} \underline{\text{Total Annual kWh}} &= 8,739,714 \\ &= 0.8 * \text{Total KVA} * \text{Load factor} * \text{Average running hours} \end{aligned}$$

The average load factor estimated from the above formula is 86%.

6.4 Built Area and Number of rooms

From a sample of 70 hotels which provided built up areas and number of rooms the following statistics were compiled:

For a sample of 70 hotels	Built up area m²	Number of Rooms	Average built up area per hotels room m²
Total	543,647	9,882	55
Average	7,766	141	

Table 9 : Average built-up area per room

The average number of rooms is 141 with an average built up area per room of 55m².

6.5 Average annual room nights

The monthly occupancy level was calculated from the room nights available divided by the rooms nights sold and occupied. An average was calculated for each hotel across the months. The occupancy level was calculated as room nights sold during the month / room nights available during the month. The average occupancy for all hotels across months and across hotels was calculated at 76%.

For the 50 hotels which provided occupancy figures, the total room nights available for 2016 was 2,969,133 while the total room nights sold was 2,300,995, leading to an average occupancy level of 77% calculated from total room nights.

Total room nights available	2,969,133
Annual room nights sold	2,300,995
Average 2016 % occupancy	77%

Table 10 : Average Occupancy for 2016

7. RESULTS OF TASK 2: BREAKDOWN PER END USE

7.1 Breakdown across all categories

As highlighted in the methodology, the request for breakdown of consumption data was time consuming and only 18 hotels have provided comprehensive data to enable a breakdown of consumption.

An energy model has been elaborated with 8 consumption categories in Table 11. A 9th component has been added to adjust the model to take care of loads not modelled such as waste water treatment, water pumps, and cold storage.

	Total annual consumption 18 hotels kWh	% of total calculated Electricity bill	Average annual consumption per hotel kWh
Modulated Common AC	28,761,466	45.18%	1,597,859
Ventilation KWh	3,603,050	5.66%	200,169
Room Consumption at average occupancy KWh	6,744,334	10.59%	374,685
Restaurant Lighting KWh	1,241,504	1.90%	68,972
Lighting external KWh	1,116,539	1.75%	62,030
Kitchen KWh	6,802,651	10.68%	377,925
Laundry KWh	4,064,018	6.38%	225,779
Water Pools and features KWh	6,553,712	10.29%	364,095
Other: Water, Cold Storage, Waste water)	4,778,697	7.51%	265,483
Calculate Electricity Bill KWh	63,665,971		3,536,998

Table 11 : Summary of data from the 18 hotels

The model has been enhanced by modulating the common AC consumption which includes the chiller and common areas air conditioning by the average occupancy level calculated for the hotel for 2016 and by a climatic and hotel rating factor as shown in Table 12 for a 4-star hotel. 4-star and 5-star superior rating along the coast have the highest **Climatic and Star rating factor** due to the high cooling demand to maintain temperature and humidity conditions.

Category Classification as per T A Regulation	Annual consumption at full load all seasons kWh	Loading factor based on average occupancy of the hotel	Climatic and star rating factor	Modulated common AC consumption KWh
4 Star	1,438,871	87.85%	0.9	1,137,660

Table 12 : AC Consumption in 4 star hotel

Similarly, the total room consumption which is based on actual occupancy has been moderated by the calculated average hotel occupancy to reflect actual loads. Due to most of the 18 hotels being 4 and 5-star hotels with central chiller-based air conditioning systems, the AC load for room is small and consists in most cases of fan coil unit consumption as shown in Table 13.

AC kWh	Ventilation kWh	Lighting kWh	Others kWh	Total Rooms at full load KWh
140,999	25,072	57,893	154,627	378,592

Table 13 : Total rooms consumption at full load

The breakdown of consumption across all categories shows that air conditioning consumes 45% of the energy followed by rooms and kitchen at 11% each and water features at 10%. 15 out of the sample of 18 hotels have a laundry which represents 6% of consumption. External lighting and restaurant lighting represent 2% each. Ventilation and toilet extraction represent 6% of the total.

In cases where split system is used for air conditioning, the consumption is reflected in the room load.

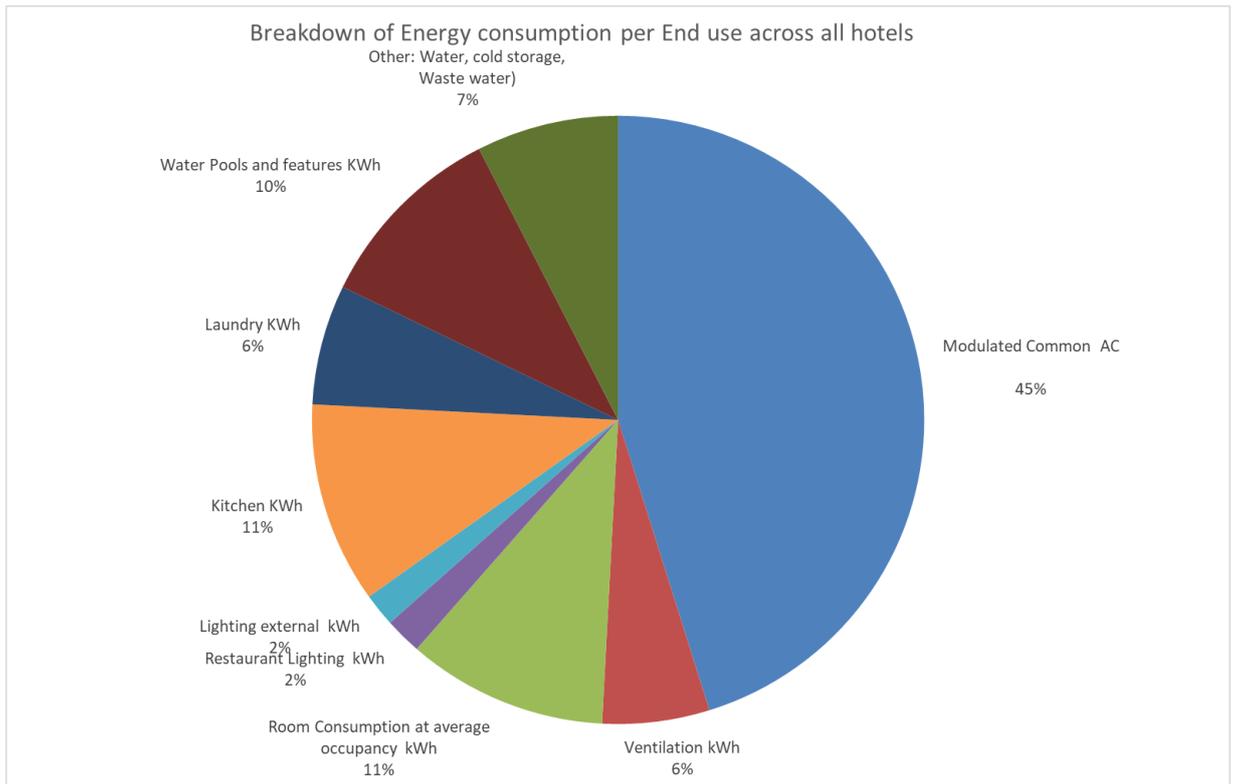


Figure 5 : Breakdown of energy consumption per end use across all hotels

7.2 Breakdown per category

The breakdown per category was carried out for 3 segments: 3-star, 4-star & 4-star superior and 5-star.

Breakdown for 3-star hotels

3 out of the 18 hotels are 3-star. The breakdown of consumption shows that the proportion of air conditioning, kitchen and laundry is higher than for the whole sample. The proportion for water features, ventilation, restaurant and external lighting are lower than for the whole sample. One of the reasons for lower lighting consumption is a lower need for lighting and the use by 3-star hotels of LED lights to lower operating expenses.

Modulated Common AC kWh	1,127,746	48.8%	375,915
Ventilation kWh	88,463	3.8%	29,488
Room Consumption at average occupancy kWh	229,259	9.9%	76,423
Restaurant Lighting kWh	5,927	0.3%	1,976
Lighting external kWh	7,489	0.3%	2,616
Kitchen kWh	412,765	18.3%	140,588
Laundry kWh	247,325	18.3%	140,588
Water Pools and features kWh	72,727	3.1%	24,242
Other: Water, Cold Storage, Waste water)	109,583	4.7%	36,528
Calculated Electricity Bill kWh	2,310,645		770,215

Table 14 : Average kWh for 3-star hotels

	Calculated Electricity Bill kWh	Actual Annual electricity consumption from CEB kWh	Actual Annual consumption from survey kWh	Overshoot: Calculated - Actual kWh
Total kWh	2,310,645	2,380,839	2,380,839	-70,194
Average kWh	770,215	793,613	793,613	-23,398

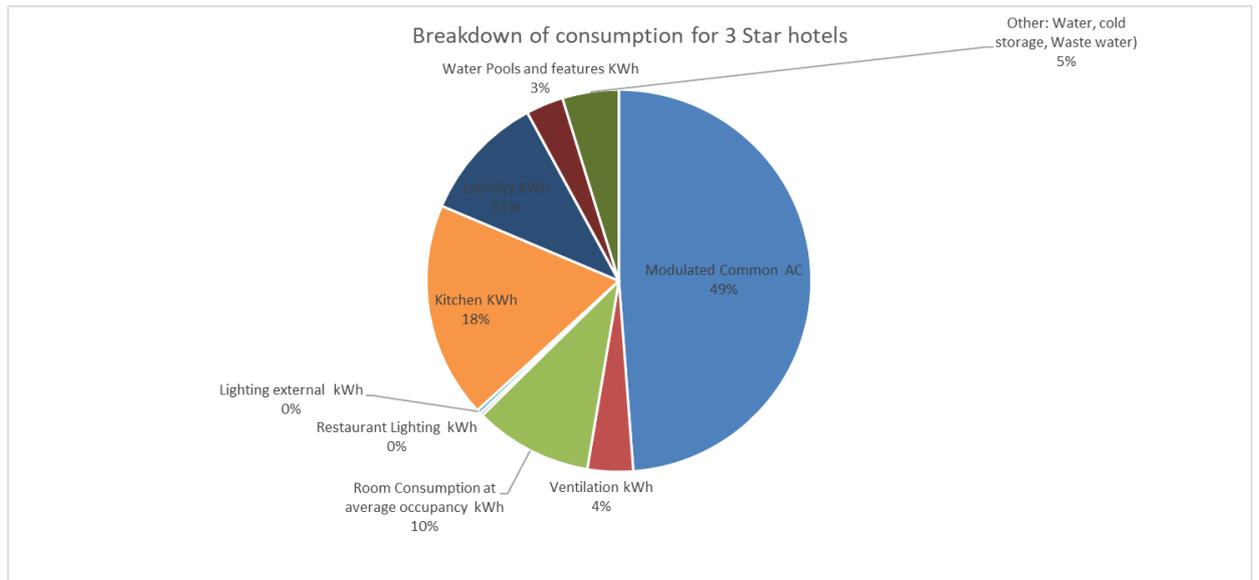


Figure 6 : Breakdown of consumption for 3 star hotels

Breakdown for 4-star hotels

7 out of the 18 hotels are in the 4-star category. The breakdown shows a similar pattern with however a higher consumption for comfort and luxury features such as external lighting, water features, air conditioning but a lower consumption for kitchen and laundry than 3-star hotels.

	Total kWh	% of Total	Average kWh
Modulated Common AC	9,092,575	42.4%	1,298,939
Ventilation kWh	1,344,232	6.3%	192,033
Room Consumption at average occupancy kWh	2,518,947	11.7%	359,850
Restaurant Lighting kWh	180,424	0.8%	25,775
Lighting external kWh	148,093	0.7%	21,156
Kitchen kWh	2,965,831	13.8%	423,690
Laundry kWh	1,757,872	8.2%	251,125
Water pools and features kWh	1,527,848	7.1%	218,264
Other water, cold storage, waste water	1,902,202	8.9%	271,743
Calculated Electricity Bill kWh	21,438,024		2,267,698

Table 15 : Average kWh for 4-star hotels

	Calculated Electricity Bill kWh	Actual Annual electricity consumption from CEB kWh	Actual Annual consumption from Survey kWh	Overshoot: Calculated - Actual kWh
Total kWh	21,438,024	22,283,336	22,283,336	-845,312
Average kWh	2,267,698	3,183,334	3,183,334	-120,759

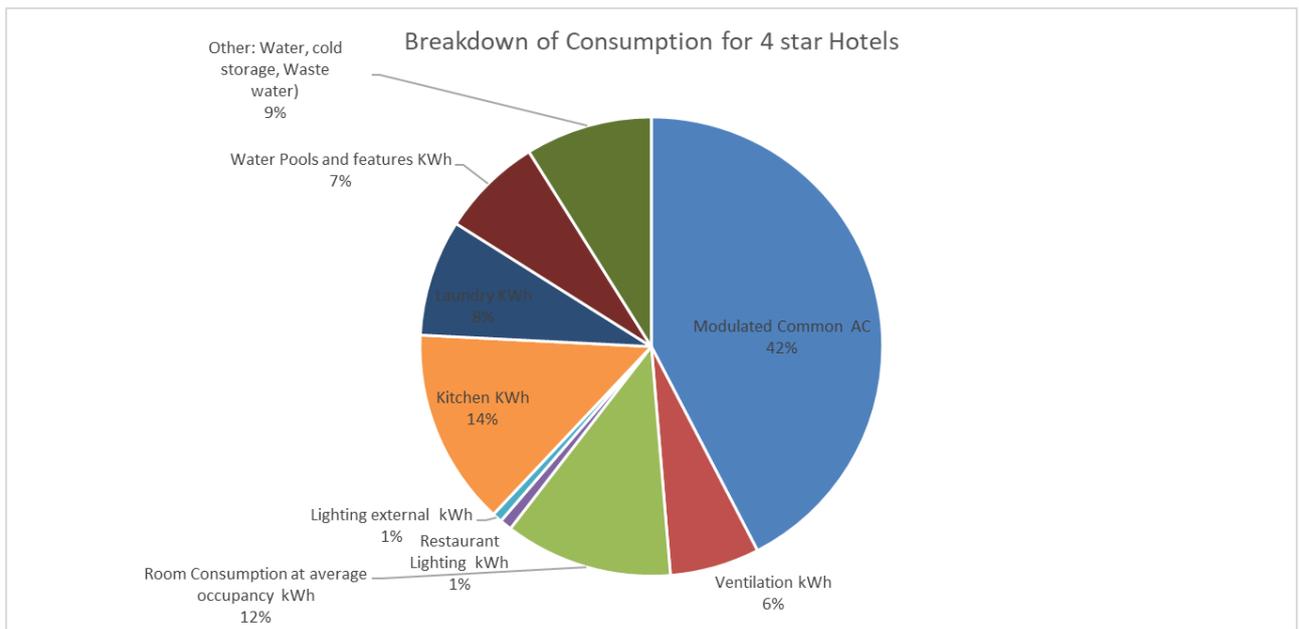


Figure 7 : Breakdown of consumption for 4 star hotels

Breakdown for 4 star plus and 5 star hotels

There are 8 hotels in the category of 4-star superior and above. The breakdown shows that the comfort and luxury features such as common area air conditioning, water features, external and restaurant lighting are higher than for 4-star, but kitchen and laundry are lower in proportion.

	Total kWh	% of Total	Average KWh
Modulated Common AC	18,541,145	46.4%	2,317,643
Ventilation kWh	2,170,355	5.4%	271,294
Room Consumption at average occupancy kWh	3,996,128	10.0%	499,516
Restaurant Lighting kWh	1,055,152	2.6%	424,861
Lighting external kWh	960,597	2.4%	120,075
Kitchen kWh	3,415,055	8.6%	705,250
Laundry kWh	2,058,820	5.2%	257,353
Water Pools and features kWh	4,953,136	12.4%	619,142
Other: Water, Cold Storage, Waste water)	2,766,912	6.9%	345,864
Calculate Electricity Bill kWh	39,917,302		4,989,663

Table 16 : Average kWh for 4-star plus and 5 star hotels

	Calculated Electricity Bill kWh	Actual Annual electricity consumption from CEB kWh	Actual Annual consumption from Survey kWh	Overshoot: Calculated - Actual kWh
Total kWh	39,917,302	38,446,261	38,446,261	1,471,041
Average kWh	4,989,663	4,805,783	4,805,783	1,870,718

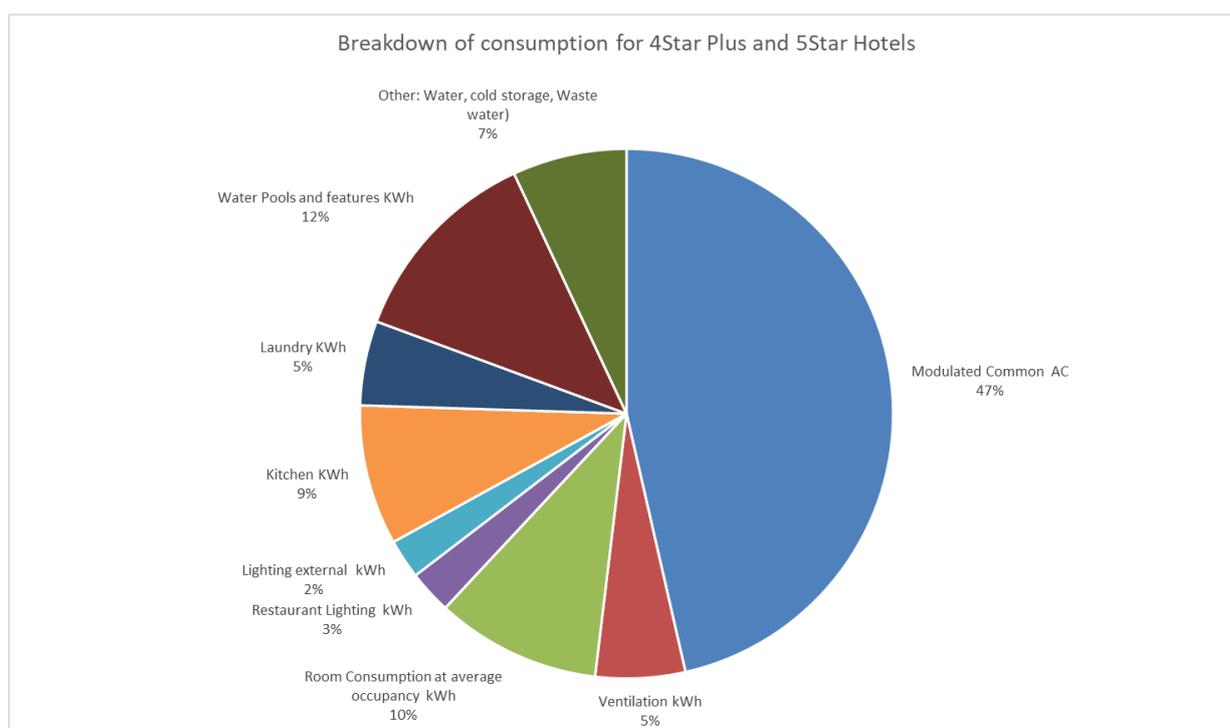


Figure 8 : Breakdown of consumption for 4 star plus and 5 star hotels

8. RESULTS OF TASK 3: ENERGY USE INTENSITIES (EUI)

8.1 EUI across all categories per energy source

To obtain the EUI across all categories per energy source, the following definitions have been used:

- Total Electricity = Total annual electricity imported From CEB + from generator + from on-site solar PV
- Total Diesel = The maximum between diesel consumption reported, and the diesel consumption calculated from genset running hours

Tables 17, 18 and 19 summarise the average values for the 70 hotels. For EUIs with Room nights, the data is based on only 51 hotels which reported occupancy figures.

Total annual Electricity used : kWh/m ²	Total annual Electricity used : kWh/Rooms	Total annual Electricity used : kWh/Room- nights
464	21,606	593

Table 17 : Total annual electricity used kWh/room-nights

Total annual Diesel Litres / m ²	Annual Diesel Litres /Rooms	Annual Diesel Litres /Room-Nights
2.8	149	3.0

Table 18 : Annual litres of diesel used/room-night

Total annual LPG kg/m ²	Annual LPG kg/Rooms	Annual LPG kg/Room-Nights
20	780	19

Table 19 : Annual kg of LPG used/room night

The total energy used (kWheq) has been calculated using the following conversion factors: 11.1 kWheq per litre of diesel and 13.66 kWheq per kg of LPG. Table 20 shows the **average** Total Energy Use Intensities for 70 hotels.

Average of Total Annual Energy consumption per hotel kWheq	
Total EUI kWheq per m ²	730
Total EUI kWheq per Room	31,692
Total EUI kWheq per Room-Night	769

Table 20 : Average total annual energy consumption per hotel kWheq

8.2 EUI per category across all sources of energy

The EUI data for 70 hotels has been sorted into 4 categories as per Tourism Authority categories:

Star rating	Category	Category Coding
Hotel de Charme	Unclassified Hotels	0
Hotels with two and three stars	Category I	1
Hotels with three stars superior to four stars	Category II	2
Hotels with four stars superior to five stars superior	Category III	3

Table 21 : Category coding of star rating

Unclassified Hotels

Hotel Code	Total Built Area m ²	Total Rooms	Total Room-Night available	Average Occupancy 2016	Average annual room nights occupied
UH 1	351	7	2,604	35.7%	931
UH 2	356	20	620	0.0%	0
UH 3	675	25	570	0.0%	0
UH 4	2,448	17	527	60.0%	316
UH 5	195	7	2,604	72.8%	1,895
Average value across unclassified category	805	15	1,385	33.7%	628

Table 22 : Average annual room nights occupied for unclassified hotels

Hotel Code	Total Electricity: kWh/ m ²	Total Electricity: kWh/ Rooms	Total Electricity: kWh/Room-Nights	Total annual Energy consumption kWheq	Total EUI kWheq per m ³	Total EUI kWheq per Room	Total EUI kWheq per Room-Night
UH 1	9	426	3	82,743	236	11820	89
UH 2	624	11,103		237,622	667	11,881	
UH 3	14	377		9,558	14	382	
UH 4	1	146	8	39,839	16	2,343	126
UH 5	83	2,300	8	10,855	56	1,551	6
Average Value across Unclassified Category	146	2,870	6.3	76,123	198	5,596	74

Table 23 : Total EUI kWheq per room night for unclassified hotels

Hotel Code	Total diesel litres/ m ²	Diesel litres/rooms	Diesel litres/room nights	LPG kg/ m ²	LPG kg/Rooms	LPG kg/Room night
UH 1				3	57	
UH 2	0.01	0.286	0.00106			
UH 3				1	161	9
UH 4				17	834	6
UH 5						
Average values across unclassified category	0.01	0.286	0.00106	7	350	7.5

Table 24: LPG consumption per room night for unclassified hotels

The results show that unclassified hotels having an average of 15 rooms have a low EUI of 7 kWh per room night for electricity increasing to 74 kWh_{eq} per room night when LPG and diesel consumption is included. The low electricity consumption is due to basic rooms which are mostly not air conditioned and the low level of comfort features offered. These hotels however do include cooking facilities and on-site dining which increases the total energy use.

2 star to 3 star hotels

Hotel Code	Total Built Area m²	Total Rooms	Total Room-Night available	Average Occupancy 2016	Average annual room nights occupied
H***1	1,979	16	5,856	79.6%	4660
H***2	2,539	61	22,326	41.7%	9301
H***3	4,531	122	3,782		
H***4	2,000	70	2,170		
H***5	1,066	42	1,302		
H***6	4,600	131	4,061		
H***7	2,513	76	27,146	91.1%	24733
H***8	9,760	214	78,538	85.2%	66952
H***9	5,594	66	2,244		
H***10	3,772	94	2,914		
H***11	3,341	77	28,105	89.5%	25,162
H***12	2,660	118	42,971	72.1%	30,977
H***13	877	22	8,042	58.8%	4730
Average value across 2 to 3 star categories	3,479	85	17,651	74%	23,786

Table 25 : Average annual room nights occupied for 2 to 3 star hotels

Hotel Code	Total Electricity: kWh/ m ²	Total Electricity: kWh/Rooms	Total Electricity: kWh/Room-Nights	Total annual Energy consumption kWheq	Total EUI kWheq per m ²	Total EUI kWheq per Room	Total EUI kWheq per Room-Night
H***1	61	7,492	26	145,534	74	9,096	31
H***2	188	7,805	51	583,953	230	9,573	63
H***3	154	5,710		951,410	210	7,798	
H***4	121	3,462		225,242	113	3,218	
H***5	350	8,883		336,760	316	8,018	
H***6	369	12,949		2,866,577	623	21,882	
H***7	287	9,495	29	15,998,320	6,366	210,504	647
H***8	347	15,833	51	5,254,756	538	24,555	78
H***9		8		1,665		25	
H***10	197	7,914		1,087,336	288	11,567	
H***11	238	10,315	32	782,368	234	10,161	31
H***12	424	9,568	36	1,316,739	495	11,159	43
H***13	127	5,045	23	137,442	157	6,247	29
Average value across 2 to 3 star categories	239	8,037	35	2,283,700	804	25,677	132

Table 26 : Total EUI kWheq per room night for 2 to 3 star hotels

Hotel Code	Total Diesel Litres/ m ²	Diesel Litres/ Rooms	Diesel Litres/Room-Nights	LPG kg/ m ²	LPG kg/ Rooms	LPG kg/ Room-Night
H***1				1	125	0.43
H***2	0.02	1	0.01	3	133	1
H***3	10.7	398		4	154	
H***4	0.04	1				
H***5	0.09	2		3	73	
H***6				19	657	
H***7	0.55	18	0.06	445	14,725	45
H***8	8.49	387	1.24	13	599	2
H***9	0.03	2		7	269	
H***10	0.03	1				
H***11	0.03	1				
H***12	1.88	42	0.16	5	117	0.45
H***13	0.34	14	0.06	2	80	0.37
Average values across 2 and 3 star categories	2	79	0.3	50	1,693	8

Table 27 : LPG consumption per room night for 2 to 3 star hotels

The results show that 2 to 3 star hotels having an average of 85 rooms have an EUI of 35 kWh per room night for electricity increasing to 132 kWh per room night when LPG and diesel consumption are included.

3 star superior to 4 star hotels

Hotel Code	Total built Area m ²	Total Rooms	Total Rooms nights available	Average Occupancy 2016 (%)	Average room night occupied
H****1	1,440	36	1116		
H****2	8,834	297	108,702	83.9	91,245
H****3	7,390	135	4,185		
H****4	21,508	284	103,944	83.9	87,199
H****5	7,962	109	39,894	79.7	31,812
H****6	1,110	42	1,302		
H****7	1,450	50	18,600	89.4	16,628
H****8	6,515	108	38,988	85.1	33,183
H****9	8,312	286	237,876	73.3	174,299
H****10	2,765	60	21,960	73.4	16,122
H****11	4,450	210	76,860	84.2	64,735
H****12	6,180	248	90,768	81.8	74,266
H****13	2,265	64	1,984	80	1,587
H****14	16,595	265	96,990	87.9	85,207
H****15	11,155	175	5,425		
H****16	6,590	200	73,200	85.7	62,731
H****17	1,348	100	36,600	64.8	23,717
H****18	13,240	91	33,306	90.4	30,120
H****19	4,590	182	45,136	46	20,774
H****20	5,368	117	42,822	78.1	33,440
H****21	18,830	272	101,184	66.2	66,998
H****22	2,784	102	34,272	25.8	8,825
H****23	4,926	115	41,975	90.9	38,158
H****24	11,780	214	78,110	89.4	69,816
Average Values across 3-star superior and 4-Star	7,391	157	55,633	77	51,543

Table 28 : Average annual room nights occupied for 3 star superior to 4 star hotels

Hotel Code	Total Electricity kWh/ m ²	Total Electricity kWh/ Rooms	Total Electricity kWh/Room night	Total Annual Consumption kWheq	Total EUI kWheq/ m ²	Total EUI kWheq /room	Total EUI kWheq/ Room night
H****1	513	20,524		742,618	516	20,628	
H****2	587	17,461	57	5,805,109	657	19,546	64
H****3	70	3,846		514,377	70	3,810	
H****4	194	14,657	48	4,252,000	198	14,972	49
H****5	131	9,592	33	1,099,892	138	10,091	35
H****6	1,828	48,298		2,028,533	1,828	48,298	
H****7	572	16,586	50	9,528,670	6,609	191,653	576
H****8	344	20,734	67	2,846,407	437	26,356	86
H****9	511	14,861	24	4,443,085	535	15,535	25
H****10	246	11,324	42	708,262	256	11,804	44
H****11	1,178	24,955	81	7,308,996	1,642	34,805	113
H****12	544	13,364	45	4,182,689	677	16,866	56
H****13	287	10,160	410	888,744	392	13,887	560
H****14	225	14,064	44	5,332,486	321	20,123	63
H****15	292	18,625		3,229,560	290	18,455	
H****16	1,897	62,492	199	16,792,821	2,548	83,964	268
H****17	2,179	29,373	124	3,107,464	2,305	31,075	131
H****18	109	15,801	48	2,061,436	156	22,653	68
H****19	281	7,083	62	2,193,756	478	12,054	106
H****20	267	12,269	43	2,325,335	433	19,875	70
H****21	164	11,387	46	3,710,266	197	13,641	55
H****22	734	20,039	232	2,529,528	909	24,799	287
H****23	232	9,932	30	1,711,938	348	14,886	45
H****24	217	11,952	37	3,371,536	286	15,755	48
Average Values across 3 star superior and 4 Star	567	18,316	86	3,782,064	926	29,397	137

Table 29 : Total EUI kWheq per room night for 3 star superior to 4 star hotels

Hotel Code	Total Diesel litres/ m ²	Diesel litres/ Rooms	Diesel litres/ Room-Nights	LPG kg/ m ²	LPG kg/ Rooms	LPG kg/ Room-Night
H****1	0.35	14				
H****2	0.46	14	0.04	5	152	
H****3						
H****4	0.23	18	0.06		14	
H****5	0.31	23	0.08		33	
H****6						
H****7	0.31	9	0.03	442	12,813	39
H****8				7	418	1
H****9	7.74	225	0.37	2	47	
H****10	0.07	3	0.01	1	49	
H****11	1.69	36	0.12	33	702	2
H****12	1.06	27	0.09	9	229	1
H****13	0.79	28	1.13	7	257	10
H****14	0.25	16	0.05	7	435	1
H****15	0.02	1				
H****16	2.22	73	0.23	48	1,580	5
H****17	0.78	11	0.04	10	131	1
H****18	0.10	14	0.04	1	563	2
H****19	0.10	3	0.02	15	374	3
H****20	0.39	18	0.06	12	533	2
H****21	0.21	15	0.06	2	166	1
H****22	58.25	1,590	18.38	13	348	4
H****23	0.51	22	0.07	8	351	1
H****24	0.36	20	0.06	5	292	1
Average Values across 3 star superior and 4 Star	3.6	103.7	1.1	35	975.4	4.9

Table 30 : LPG consumption per room night for 3 star superior hotels to 4 star hotels

The results show that 3-star superior to 4 star hotels having an average of 157 rooms have an EUI of 86 kWh per room night for electricity increasing to 137 kWh per room night when LPG and diesel consumption are included.

4 star superior to 5 star hotels

Hotel Code	Total built Area m ²	Total Rooms	Total Rooms nights available	Average Occupancy 2016 (%)	Average room night occupied
H*****1	3,640	54	1,674		
H*****2	9,965	279	8,649		
H*****3	14,400	172	63,344	85.1	53,874
H*****4	12,989	136	48,562	67.2	32,627
H*****5	5,480	193	5,983		
H*****6	13,607	266	95,585	62.3	59,518
H*****7	730	13	4758	70.3	3,345
H*****8	9,455	105	36,602	84.3	30,844
H*****9	22,507	255	86,137	93.2	80,307
H*****10	16,639	225	94,095	84.5	79,485
H*****11	11,080	186	5,766		
H*****12	11,396	186	72,096	79.5	57,300
H*****13	4,340	65	23,790	67.3	16,014
H*****14	16,705	215	78,690	87	68,494
H*****15	9,761	72	26,277	64.1	16,848
H*****16	14,056	177	66,122	81.9	54,183
H*****17	14,080	298	144,227	47	67,839
H*****18	4,965	67	24,455	86.4	21,117
H*****19	8,170	89	2,759		
H*****20	3,815	99	3,069		
H*****21	7,387	69	25,304	58.6	14,824
H*****22	13,750	327	10,137		
H*****23	18,115	147	69,524	80.8	56,168
H*****24	9,450	172	62,952	62.3	39,234
H*****25	36,426	432	126,284	84	106,135
H*****26	10,832	158	57,828	66.7	38,544
H*****27	5,155	190	69,600	78.2	54,403
H*****28	11,350	258	94,428	86.5	81,725
Average values across 4 star superior to 5 star	11,437	176	50,312	75	49182

Table 31 : Average annual room nights occupied for 4 star superior to 5 star hotels

Hotel Code	Total Electricity kWh/ m ²	Total Electricity kWh/Room	Total Electricity kWh/Room night	Total Annual Consumption kWh	Total EUI kWh/m ²	Total EUI kWh/room	Total EUI kWh/Room night
H*****1	532	35,863		2,257,465	620	41,805	
H*****2	729	26,037		7,262,304	729	26,030	
H*****3	885	74,129	237	9,053,688	629	52,638	168
H*****4	759	72,512	302	9,887,803	761	72,704	303
H*****5	960	27,271		8,371,124	1,518	43,094	
H*****6	394	20,145	90	5,759,395	423	21,625	97
H*****7	422	23,708	92	361,476	495	27,806	108
H*****8	279	25,105	85	3,218,812	340	30,655	104
H*****9	210	18,560	59	6,431,251	286	25,221	80
H*****10	452	29,479	95	9,600,099	577	37,647	121
H*****11	759	45,207		7,889,385	712	42,416	
H*****12	401	24,571	80	6,549,089	575	35,210	114
H*****13	826	55,154	224	3,893,641	897	59,902	243
H*****14	320	24,859	78	6,199,361	371	28,834	91
H*****15	315	42,736	183	4,579,723	469	63,607	272
H*****16	374	29,661	97	8,529,100	607	48,187	157
H*****17	535	25,275	111	8,650,574	614	29,029	128
H*****18	217	16,055	51	1,782,682	359	26,607	84
H*****19	461	42,338		4,607,165	564	51,766	
H*****20	595	22,943		2,449,653	642	24,744	
H*****21	534	57,119	266	4,924,149	667	71,364	332
H*****22	476	20,012		8,143,162	592	24,903	
H*****23	276	34,028	89	10,267,266	567	69,845	183
H*****24	721	39,615	174	8,003,266	847	46,531	204
H*****25	343	28,928	118	16,846,190	462	38,996	159
H*****26	412	28,223	116	5,752,623	531	36,409	149
H*****27	1,656	44,919	157	9,521,777	1,847	50,115	175
H*****28	445	19,574	62	6,044,913	533	23,430	74
Average values across 4 star superior to 5 star	546	34,072	132	6,670,826	651	41,112	159

Table 32 : Total EUI kWh per room night for 4 star superior to 5 star hotels

Hotel Code	Total Diesel Litres/ m ²	Diesel Litres/ Rooms	Diesel Litres/ Room-Nights	LPG kg/ m ²	LPG kg/ Rooms	LPG kg/ Room-Night
H*****1	0.69	46		7	494	
H*****2	1.42	51			6	
H*****3	0.41	34	0.11	3	281	1
H*****4	1.89	181	0.75			
H*****5	2.16	61		41	1,158	
H*****6	12.56	642	2.87	2	108	
H*****7	1.10	62	0.24	6	326	1
H*****8	4.27	385	1.31	5	419	1
H*****9	0.45	40	0.13	5	480	2
H*****10	0.35	23	0.07	9	591	2
H*****11	1.37	82				
H*****12	12.21	748	2.43	13	779	3
H*****13	2.45	163	0.66	5	327	1
H*****14	0.32	25	0.08	4	286	1
H*****15	17.33	2,350	10.04	11	1,488	6
H*****16	0.68	54	0.18	17	1,368	4
H*****17	15.78	746	3.28	6	271	1
H*****18	0.05	4	0.01	11	792	3
H*****19	7.94	728		7	602	
H*****20	0.15	6			158	1
H*****21	0.54	58	0.27	10	1,037	5
H*****22	0.83	35		8	339	
H*****23	3.81	470	1.23	22	2,633	7
H*****24	5.47	301	1.32	9	506	2
H*****25	0.40	34	0.14	9	731	3
H*****26	0.43	30	0.12	9	591	2
H*****27	0	0		38	1,038	4
H*****28	1.26	55	0.17	6	280	1
Average values across 4 star superior to 5 star	3.57	274	1.27	11	658	3

Table 33 : LPG consumption per room night for 4 star superior to 5 star hotels

The results show that 4-star superior to 5-star hotels having an average of 176 rooms have an EUI of 132 kWh per room night for electricity increasing to 159 kWh_{eq} per room night when LPG and diesel consumption are included.

Table 34 summarises the EUI from the 4 categories and Figures 9, 10 and 11 show the evolution across the categories. The average built up area per room was derived by dividing the total built up area for the category by the total number of rooms in the category. It provides an indication of built up area per room inclusive of common areas and back office.

	Average number of rooms	Average built up area per room	kWhe/m ²	kWhe/Room-Night	kWheq/m ²	kWheq/Room-Night
category 0	15	53	146	7	198	74
category 1	85	41	220	35	742	132
category 2	157	47	567	86	926	137
category 3	176	65	546	132	651	159

Table 34: EUI from the 4 categories

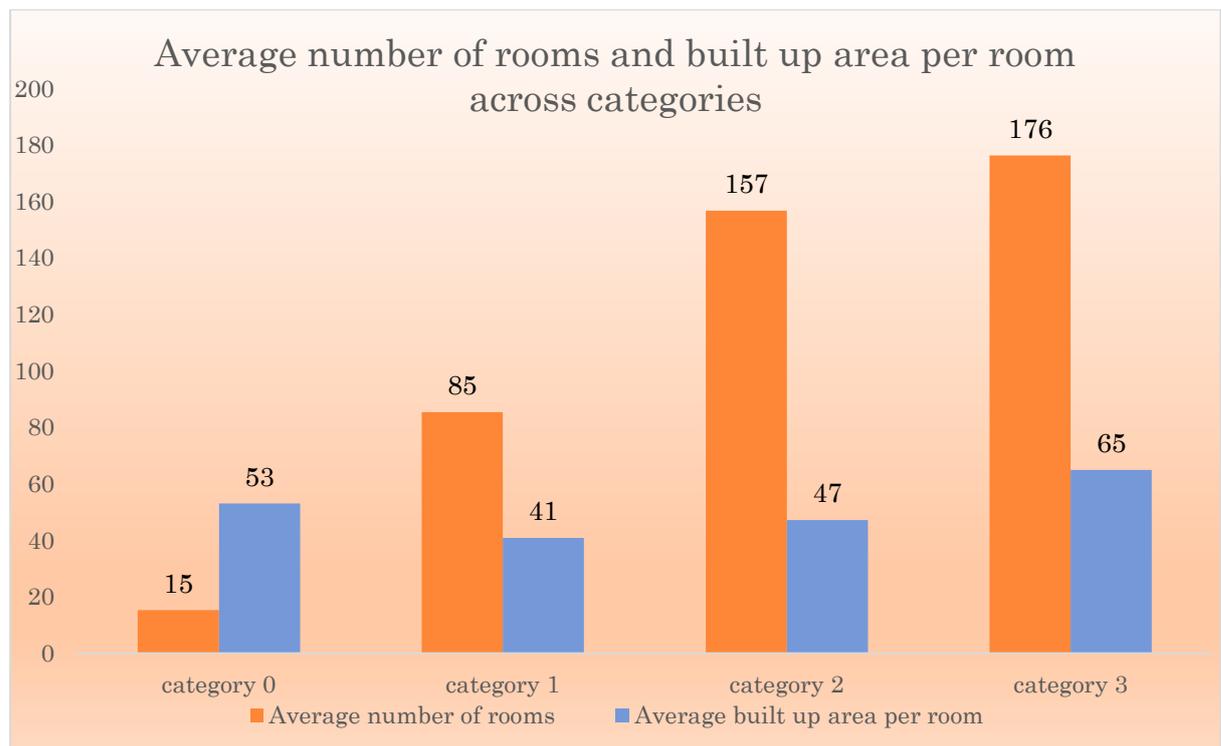


Figure 9: Average number of rooms and built-up area per room across all categories

The data shows that the average number of rooms increase steadily with more luxurious categories. However, the average built-up area is lowest for category 1 made up of 2 and 3 star hotels and increase progressively with the category.

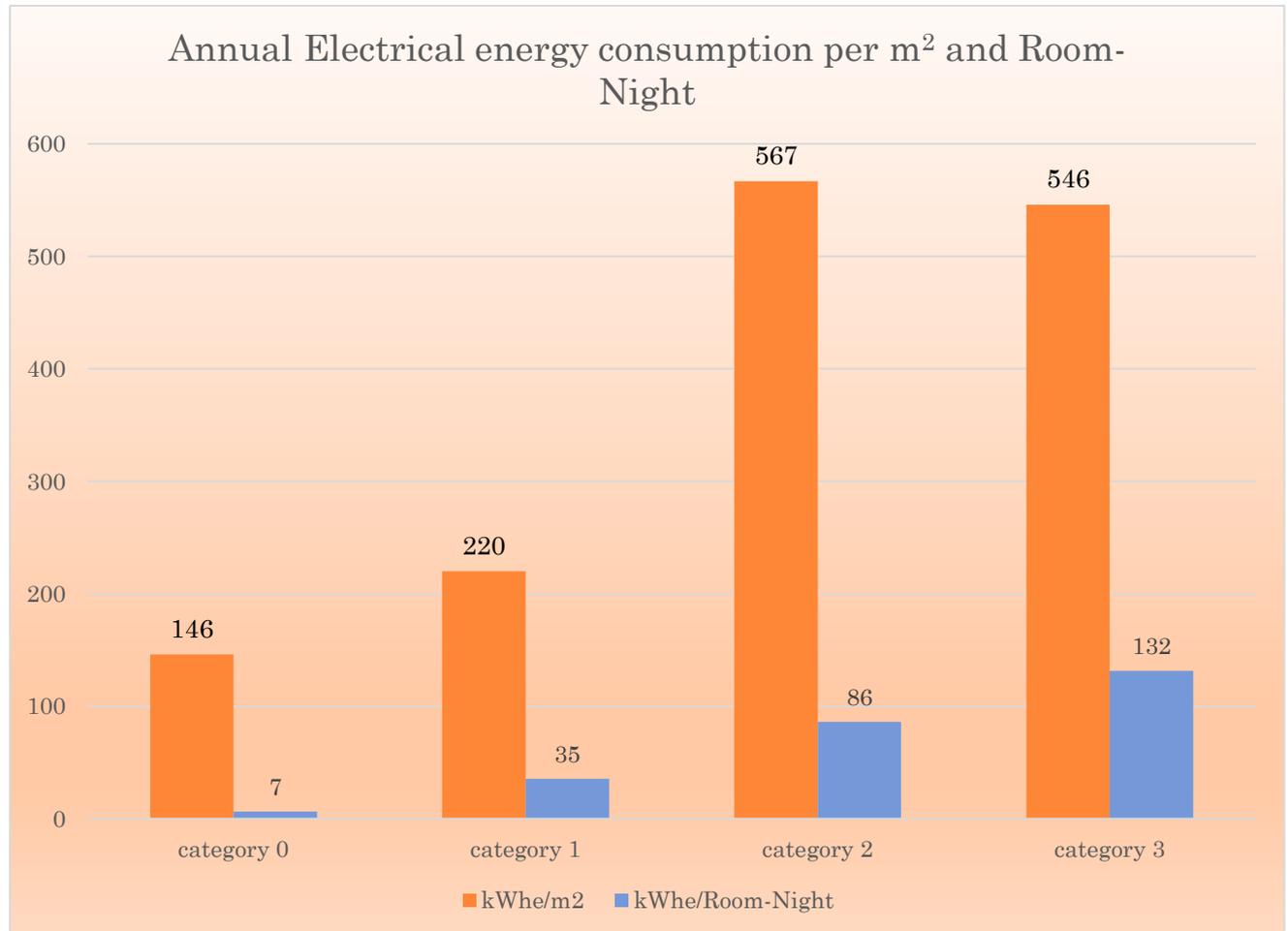


Figure 10 : Annual Electrical energy consumption per m² and Room-Night

The electrical energy consumption per m² is highest for category 2 made up of 3-star superior to 4-star hotels, which the consumption per room-night increases steadily from category 0 to category 3.

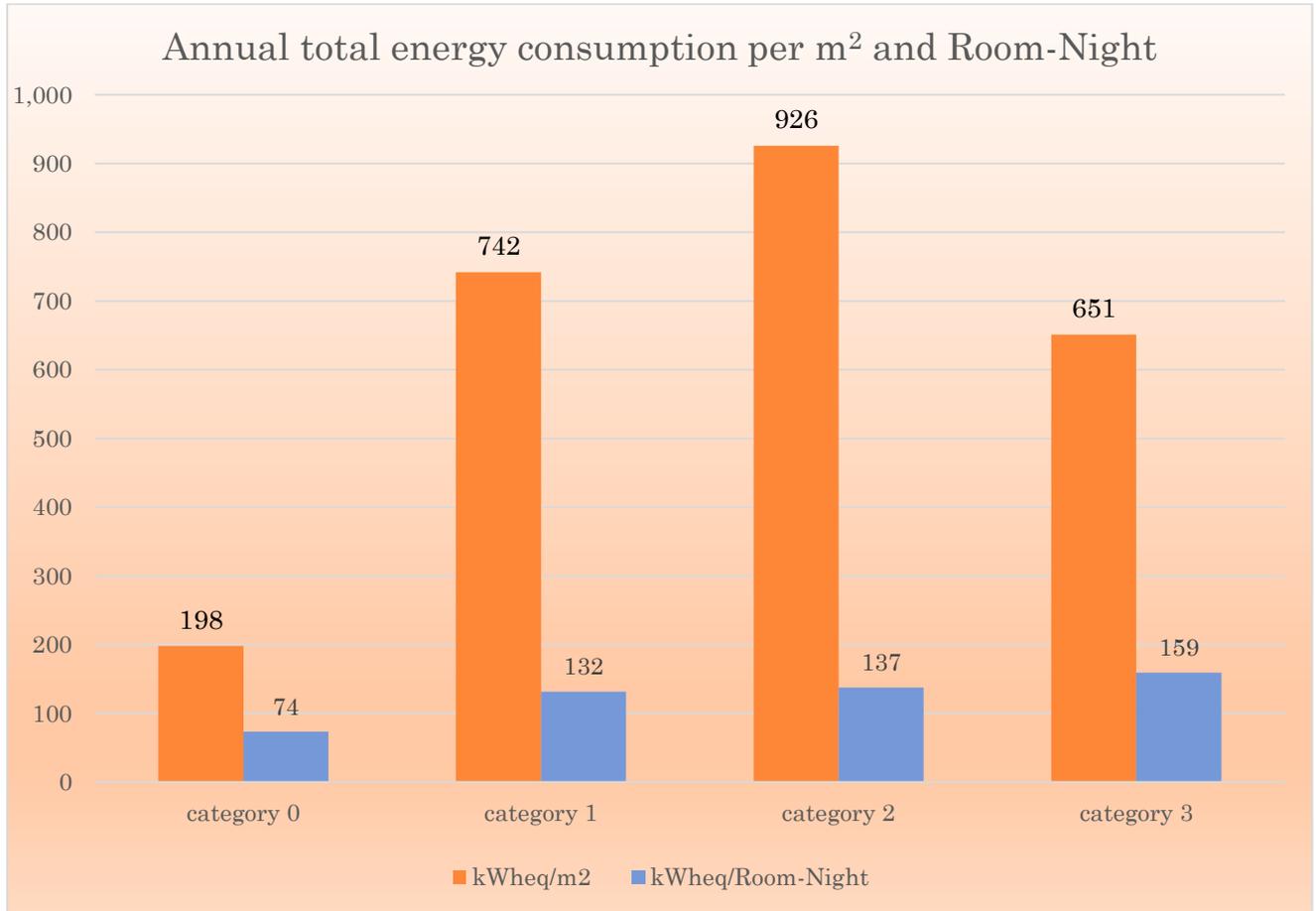


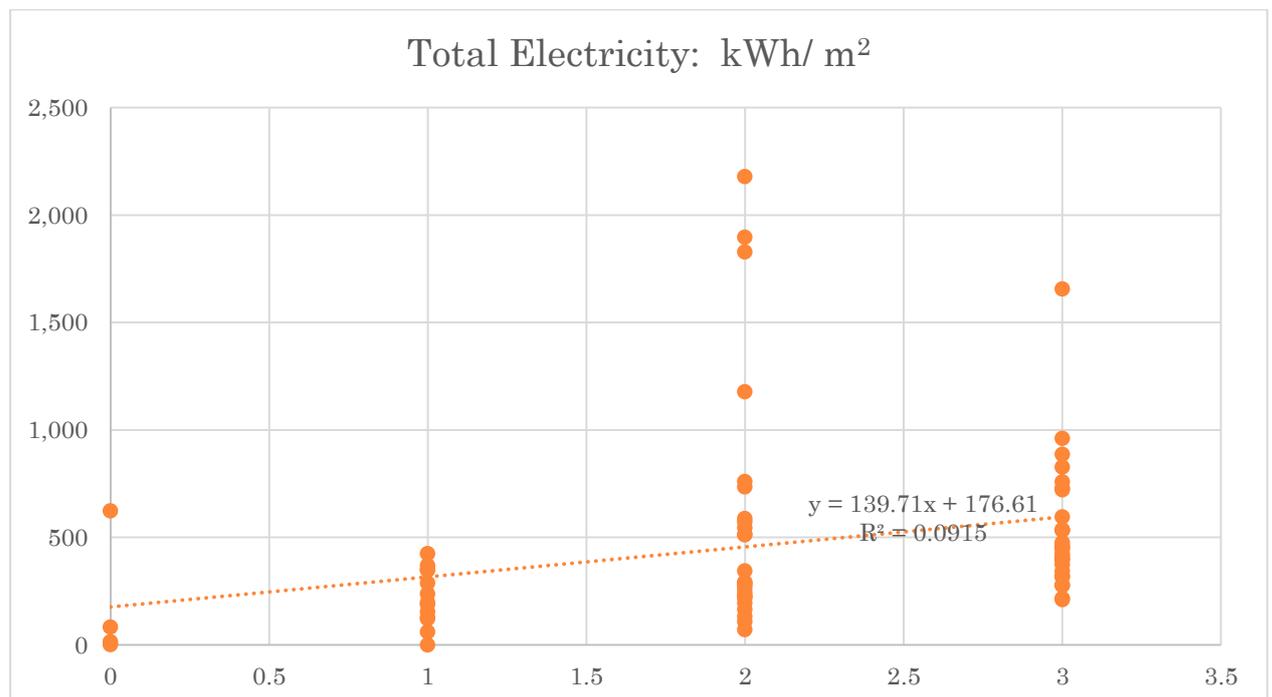
Figure 11 : Annual total energy consumption per m² and room-night

The data shows that the total energy consumption increases with category but with a lower increase than for electricity consumption. This shows that thermal energy use for cooking and hot water tend to saturate with higher category whereas electrical energy consumption for comfort and luxury features such as architectural and external lighting, private pools and jacuzzi tend to increase more than 3 folds from category 1 to category 3 compared to a 20% increase for electrical consumption from category 1 to category 3.

9. RESULTS OF TASK 4: CORRELATION BETWEEN EUI AND HOTEL CATEGORIES AND OCCUPANCY

9.1 Correlation between EUI and Category

Using as per task 3, kWh/m² per annum should be used as the EUI benchmark. Scatter plots of EUI against the 4 categories were plotted: The total electrical energy kWh/ m² and total equivalent energy kWh_{eq}/m² were used as EUI :



Scatter plot of EUI in kWh/m² for the 4 categories.

(0= Unclassified hotels, 1,2,3 for the categories as per TA ratings)

Figure 12 : EUI in kWh/m² for the 4 categories

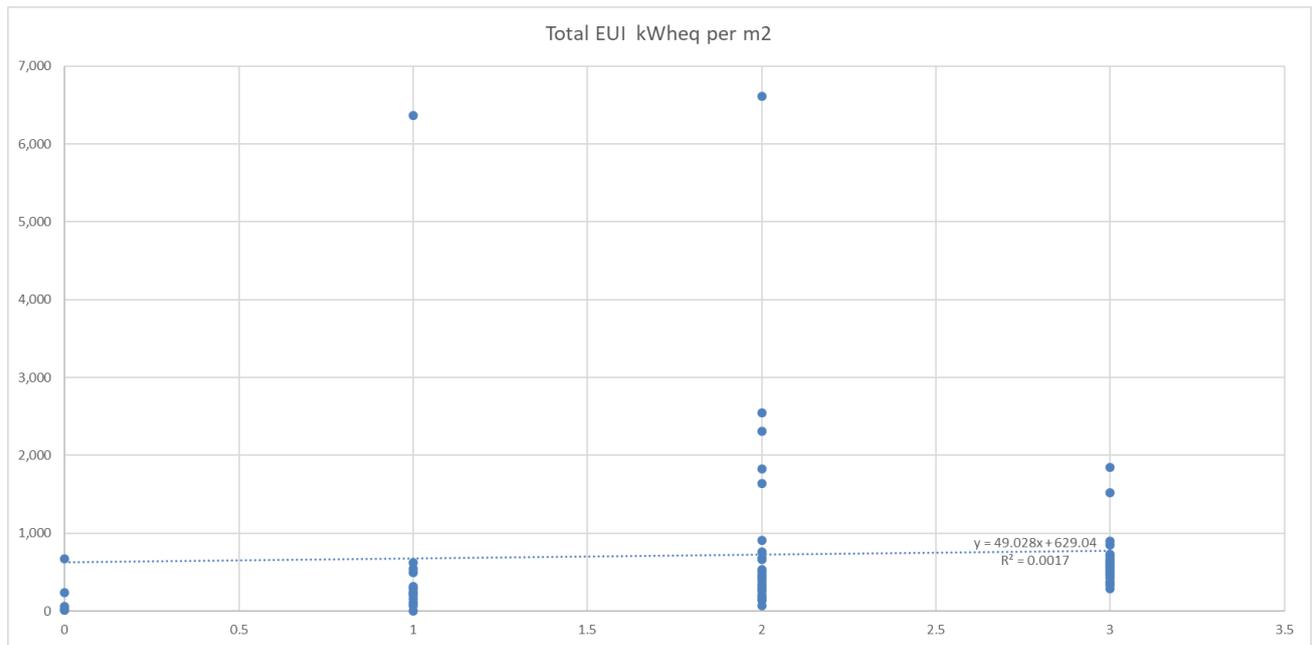
Figure 12 shows the distribution of EUIs for the 4 categories. Category 1 with the 2 and 3 star hotels have a compact distribution with an EUI of less than 500 kWh/m².

Category 2 with 3 star superior to 4 star have a much wider spread with some hotels around 2000 kWh/m².

Category 3 which have the highest average room capacity have a compactly distributed EUI of less than 1000 kWh/m².

Although the R^2 value of the linear regression is weak, the line of best fit indicates that moving to an upper category adds around 140 kWh/m² to the EUI

The same plot with the total energy consumption (Electricity + Diesel + LPG) shows the same pattern with a wider spread due to the large Diesel and LPG consumption of some hotels in the category 1 and 2.



Scatter plot of EUI in kWh/m² for the 4 categories.

(0= Unclassified hotels, 1,2,3 for the categories as per TA ratings)

Figure 13 : EUI in kWh/m² for the 4 categories

9.2 Correlation between EUI and Occupancy

The hotels which did not provide occupancy data are indicated as 0% occupancy. The majority of the hotels are located in the occupancy range of 60 to 85 % with an EUI of less than 500 kWh/ m².

Although the R² is weak, each % point in occupancy seems to decrease the EUI by 0.23 kWh/m².

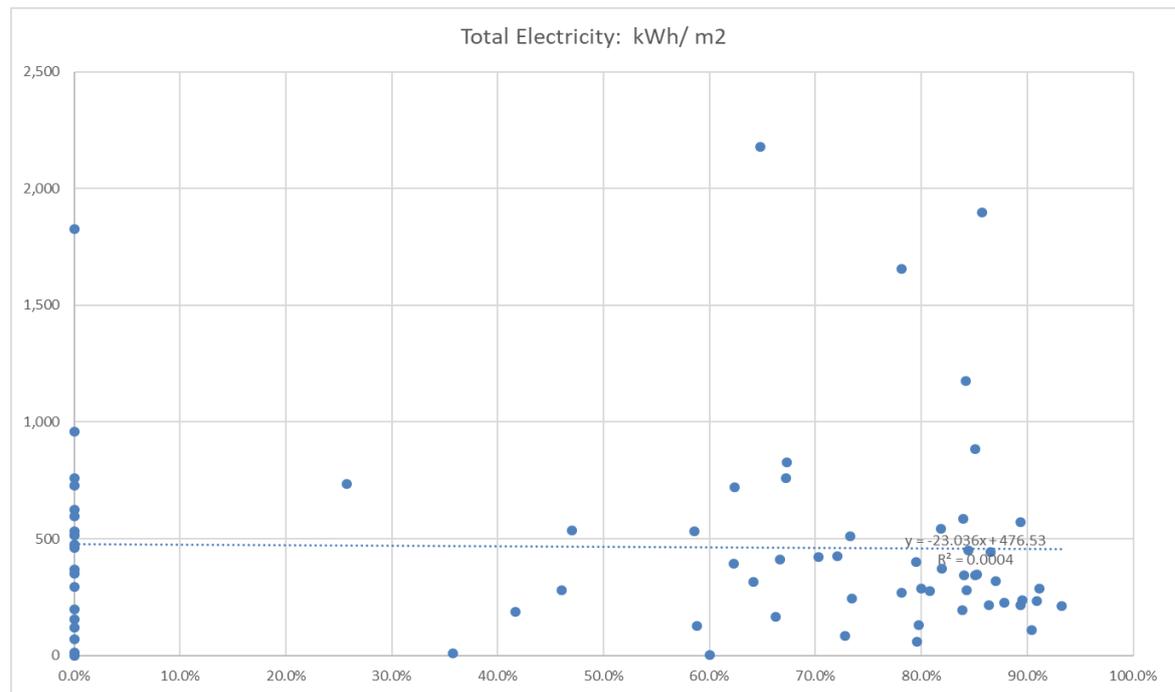


Figure 14 : EUI in kWh/m² against occupancy

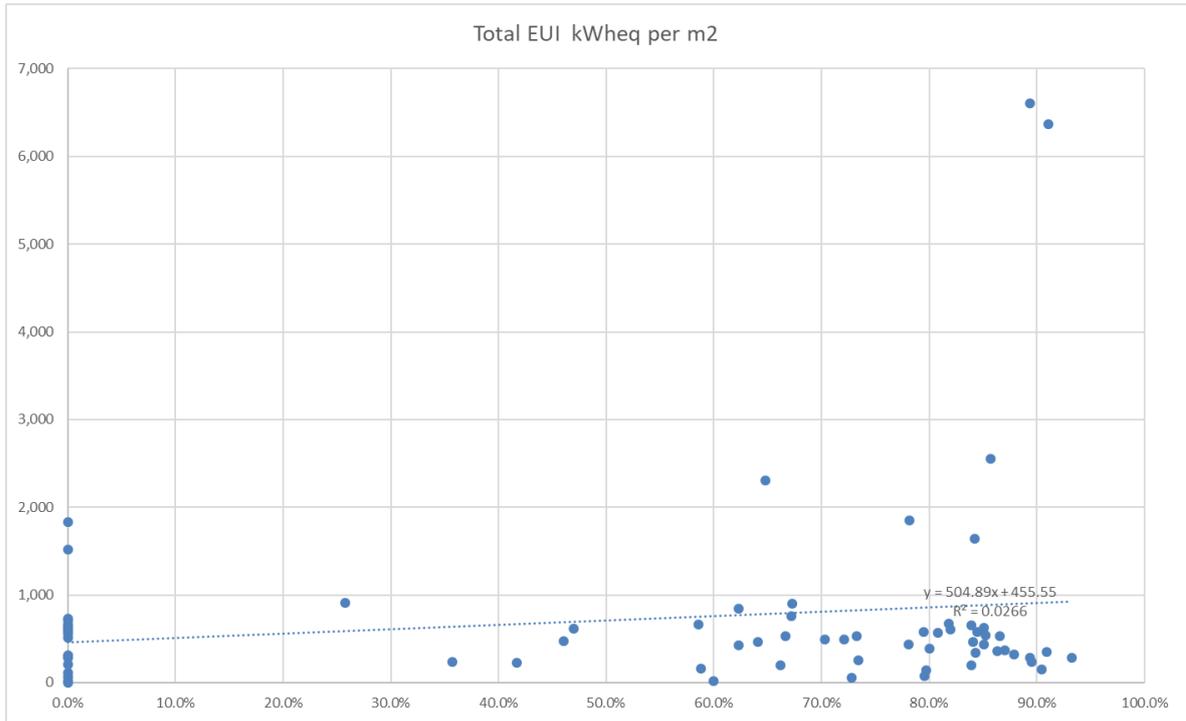


Figure 15 : Total EUI in kWhq/m² against occupancy

The kWhq/m² EUI is more strongly correlated with occupancy and there is an increase of 5.04 kWhq per % occupancy point.

10. RESULTS OF TASK 5: AVERAGE ENERGY USE IN HOTELS

10.1 Specific consumption calculations

Only 18 hotels provided consistent data on the Guest Night occupancy. Because of the different and smaller set of data, the values of EUI are different even for Room Nights. There were no hotels from the unclassified category. The analysis of average values of EUI are as follows: -

The results show that there is a ratio of 3.2 between EUI for Room-Night and EUI for Guest-Night for category 1. This ratio decreases to 2.1 for category 3.

	Total EUI kWheq/Room- Night	Total EUI kWheq/Guest- Night	Ratio EUI Room- Night/Guest-Night
Category 1	45	14	3.2
Category 2	188	67	2.8
Category 3	181	84	2.1

Table 35 : Total EUI room night, guest night & Ratio EUI room night/guest night for category 1 to 3

Results show that category 1 hotels tend to have 3.2 persons on average per room while this decreases to an average of 2.1 persons per room in category 3 hotels.

Detailed analysis for the 3 categories other than unclassified hotels is as follows.

- Tables 36, 40 and 44 summarise the data on electrical consumption, area, number of rooms and occupancy figures;
- Tables 37, 41 and 45 summarise the analysis of EUI for Electricity consumption
- Tables 38, 42 and 46 summarise the analysis of EUI for Diesel and LPG consumption
- Tables 39, 43 and 47 summarise the analysis of EUI for KWheq consumption which include all forms of energy.

CATEGORY 1: 2-STAR TO 3-STAR HOTELS

Category Classification as per TA Regulation	Total Electricity Consumed kWh	Total Built Area m ²	Total Rooms	Total Rooms nights available	Average Occupancy 2016	Average annual room nights occupied	Average Guest Night 2016
3-star	476,120	2,539	61	22,236	41.7%	9,301	19,590
3-star	794,218	3,341	77	28,105	89.5%	25,162	141,442
3-star	1,129,029	2,660	118	42,971	72.1%	30,967	169,024
Average Values	799,789	2,847	85	31,104	67.76%	21,810	110,019

Table 36 : Total electrical consumption, area and occupancy for 2 and 3 star hotels

Category Classification as Per T A Regulation	Total Electricity: kWh/ m ²	Total Electricity: kWh/ Room	Total Electricity: kWh/ Room-Night	Total Electricity: kWh/ Guest –Night
3 star	188	7,805	51	24
3 Star	238	10,315	32	6
3 Star	424	9,568	36	7
Average Values	283	9,229	40	12

Table 37 : Specific electricity consumption per unit values for 2 and 3 star hotels

Category Classification as Per T A Regulation	Total Diesel Litres / m ²	Diesel Litres / Room	Diesel Litres / Room-Night	LPG kg/ m2	LPG kg/ Room	LPG kg/ Room-Night
3 star	0.02	1	0.01	3	133	1
3 Star	0.03	1				
3 Star	1.88	42	0.16	5	117	
Average Values	0.64	15	0.085	4	155	1

Table 38 : Specific diesel and LPG consumption per unit values for 2 and 3-star hotels

Category Classification as Per T A Regulation	Total annual Energy consumption kWh	Total EUI kWh per m ²	Total EUI kWh per Room	Total EUI kWh / Room-Night	Total EUI kWh / Guest-Night
3 star	583,953	230	9,573	63	30
3 Star	782,368	234	10,161	31	6
3 Star	1,316,739	495	11,159	43	8
Average Values	894,353	320	10,297	45.6	14.6

Table 39 : Specific total energy consumption per unit values for 2 and 3-star hotels

CATEGORY 2: 3 STAR SUPERIOR TO 4 STAR HOTELS

Category Classification as per TA Regulation	Total Electricity Consumed kWh	Total Built Area m ²	Total Rooms	Total Rooms nights available	Average Occupancy 2016	Average annual room nights occupied	Average Guest Night 2016
3 Star Superior	829,306	1,450	50	18,600	89.4%	16,628	36,945
4 Star	3,726,943	16,595	265	96,990	87.9%	85,207	160,108
4 Star	679,468	2,765	60	21,960	73.4%	16,122	31,645
4 Star	1,142,149	4,926	115	41,975	90.9%	38,158	86,291
4 Star	5,240,596	4,450	210	76,860	84.2%	64,735	141,465
4 Star	2,043,970	2,784	102	34,272	25.8%	8,825	156,476
Average values	2,277,073	5,495	134	48,443	75.26%	38,279	102,155

Table 40 : Total electrical consumption, Area, and Occupancy for 3-star Superior to 4 star Hotels

Category Classification as Per T A Regulation	Total Electricity: kWh/ m ²	Total Electricity: kWh/ Rooms	Total Electricity: kWh/ Room-Nights	Total Electricity: kWh/ Guest –Night
3 Star Superior	572	16,586	50	22
4 Star	225	14,064	44	23
4 Star	246	11,324	42	21
4 Star	232	9,932	30	13
4 Star	1,178	24,955	81	37
4 Star	734	20,039	232	13
Average Values	531	16,150	80	22

Table 41 : Specific electricity consumption per unit values for 3 star Superior to 4 star hotels

Category Classification as Per T A Regulation	Total Diesel Litres / m ²	Diesel Litres / Rooms	Diesel Litres / Room-Nights	LPG kg/ m ²	LPG kg/ Rooms	LPG kg/ Room-Night
3 Star Superior	0.31	9	0.03	442	12,813	39
4 Star	0.25	16	0.05	7	435	1
4 Star	0.07	3	0.01	1	49	
4 Star	0.51	22	0.07	8	351	1
4 Star	1.69	36	0.12	33	702	2
4 Star	58.25	1,590	18.38	13	348	4
Average Values	10	279	3.11	84	2,450	9.4

Table 42 : Specific diesel and LPG consumption per unit values for 3 star superior to 4 star hotels

Category Classification as Per T A Regulation	Total annual Energy consumption kWhq	Total EUI kWhq per m ²	Total EUI kWhq per Room	Total EUI kWhq / Room-Night	Total EUI kWhq / Guest-Night
3 Star Superior	9,582,670	6,609	191,653	576	259
4 Star	5,332,486	321	20,123	63	33
4 Star	708,262	256	11,804	44	22
4 Star	1,711,938	348	14,886	45	20
4 Star	7,308,996	1,642	34,805	113	52
4 Star	2,529,528	909	24,799	287	16
Average Values	4,528,980	1,681	49,678	188	67

Table 43: Specific total energy consumption per unit values for 3 star superior to 4 star hotels

CATEGORY 3: 4 STAR SUPERIOR TO 5 STAR SUPERIOR HOTELS

Category Classification as per TA Regulation	Total Electricity Consumed kWh	Total Built Area m ²	Total Rooms	Total Rooms nights available	Average Occupancy 2016	Average annual room nights occupied	Average Guest Night 2016
4 Star Superior	3,076,963	9,761	72	26,277	64.1%	16,848	47,351
5 Star	3,584,997	4,340	65	23,790	67.3%	16,014	34,489
5 Star	4,459,188	10,832	158	57,828	66.7%	38,544	77,490
5 Star	5,250,057	14,056	177	66,122	81.9%	54,183	124,388
5 Star	5,050,200	11,350	258	94,428	86.5%	81,725	179,603
5 Star	5,358,639	13,607	266	95,585	62.3%	59,518	69,975
5 Star	8,534,671	5,155	190	69,600	78.2%	54,403	136,604
5 Star	7,532,017	14,080	298	144,277	47%	67,839	181,645
5 Star Superior	3,941,231	7,387	69	25,304	58.6%	14,824	28,710
Average values	5,198,662	10,063	173	67,023	68.07%	44,877	97,806

Table 44: Total electrical consumption, area, and occupancy for 4 star superior to 5 star superior hotels

Category Classification as Per T A Regulation	Total Electricity: kWh/ m ²	Total Electricity: kWh/ Rooms	Total Electricity: kWh/ Room-Nights	Total Electricity: kWh/ Guest – Night
4 Star Superior	315	42,736	183	65
5 Star	826	55,154	224	104
5 star	412	28,223	116	58
5 star	374	29,661	97	42
5 Star	445	19,574	62	28
5 Star	394	20,145	90	77
5 Star	1,656	44,919	157	62
5 Star	535	25,275	111	41
5 Star Superior	534	57,119	266	137
Average Values	610	35,867	145	68

Table 45: Specific electricity consumption per unit values for 4 star superior to 5 star superior hotels

Category Classification as Per T A Regulation	Total Diesel Litres / m ²	Diesel Litres / Rooms	Diesel Litres / Room-Nights	LPG kg/ m ²	LPG kg/ Rooms	LPG kg/ Room-Night
4 Star Superior	17.33	2,350	10.04	11	1,488	6
5 Star	2.45	163	0.66	5	327	1
5 star	0.43	30	0.12	9	591	2
5 star	0.68	54	0.18	17	1,368	4
5 Star	1.26	55	0.17	6	280	1
5 Star	12.56	642	2.87	2	108	0
5 Star	0.00	0	0.00	38	1,038	4
5 Star	15.78	746	3.28	6	271	1
5 Star Superior	0.54	58	0.27	10	1,037	5
Average Values	6	512	2	12	723	3

Table 46: Specific diesel and LPG consumption per unit values for 4 star superior to 5 star superior hotels

Category Classification as Per T A Regulation	Total annual Energy consumption kWheq	Total EUI kWheq per m ²	Total EUI kWheq per Room	Total EUI kWheq / Room-Night	Total EUI kWheq / Guest-Night
4 Star Superior	4,579,723	469	63,607	272	97
5 Star	3,893,641	897	59,902	243	113
5 star	5,752,623	531	36,409	149	74
5 star	8,529,100	607	48,187	157	69
5 Star	6,044,913	533	23,430	74	34
5 Star	5,759,395	423	21,652	97	82
5 Star	9,521,777	1,847	50,115	175	70
5 Star	8,650,574	614	29,029	128	48
5 Star Superior	4,924,149	667	71,364	332	172
Average Values	6,406,211	732	44,855	181	84

Table 47 : Specific total energy consumption per unit values for 4 star superior to 5 star superior hotels

LIMITATIONS

The following observations were made throughout the survey:-

1. There is a lack of awareness on the Energy Efficiency Act 2011
2. Not all data were provided by respondents which limited the in-depth analysis for Task II and for Room-Night and Guest- night EUIs
3. The Maintenance Managers/Officers were highly taken up in their day to day activities and found it time consuming to fill in the questionnaire.
4. The questionnaire required data from various departments of the hotels and the internal coordination was lengthy.
5. Due to day and night shifts, it was difficult to have officers of various departments at the same time.

RECOMMENDATIONS

1. Over and above the EUI ratios requested it is recommended that the following be considered:
 - *a linear regression between independent variables such as date of last renovation, and the most reliable EUI ratios to obtain deeper insights from the data collected.*
 - *a specific consumption analysis to establish the no load consumption of hotels. This could be carried out at a later stage in a few cases where both the occupancy and consumption figures can be accurately and comprehensively captured.*
2. Maintenance Officers need to be empowered through continuous dedicated training programme on Energy Efficiency
3. Energy Efficiency should be part of the business agenda. There is need for a continuous Awareness Programme amongst different stakeholders
4. Design standard Form (for continuous collection of data) which could be circulated to institutions/organisations which have participated in any survey carried out by EEMO
5. It is recommended that the hotels have a sub metering to segregate LPG used for cooking and hot water. The sub metering will enable the quantification of LPG used for low grade heating

APPENDIX 1: SURVEY QUESTIONNAIRE

Survey on Energy use and Energy Efficiency in Hotels

1. General Information

1	Name of Hotel			
2	Address			
3	Contact Person for Study			
4	Mobile of contact person			
5	Landline of hotel			
6	Email of contact person			
7	Category classification as per Tourism Authority regulations 2015	Two Star 1 Three Star ... 2 Three Star Superior ... 3 Four Star ... 4 Four Star Superior ... 5 Five Star ... 6 Five Star Superior ... 7	Association des Hotel de Charme ... 8 Unclassified ... 9 Classification in progress ... 10 Oher ... 11 Please specify	
8	No of RoomsSuites Premium Standard		
9	Number of employees	Male		Female
10	Scope of Services (Circle all that apply)	Swimming pool ... 1 Golf course ... 2 SPA ... 3 Sauna ... 4	Hamam ... 5 Restaurant ... 6 Conference center ... 7 Other, please specify	
Please provide the following information to enable accurate billing information to be retrieved from CEB. A sample copy bill for each meter should be collected.				
11	Business Partner Number			
12	Contract Number			
13	Meter No.			
14	Meter No.			

1. ENERGY AND UTILITIES CONSUMPTION PER MONTH IN UNITS CONSUMPTION EQUIVALENT COST.

In order to establish the energy balance of the entity we must collect the historical energy and utilities consumption over a period of 12 months to capture seasonal variations.

	Month /Year	Electricity			Diesel	LPG
		Total kWh	Power factor	Excess KVA demand	Litres	Kg
2.1	January 2016					
2.2	February 2016					
2.3	March 2016					
2.4	April 2016					
2.5	May 2016					
2.6	June 2016					
2.7	July 2016					
2.8	August 2016					
2.9	September 2016					
2.10	October 2016					
2.11	November 2016					
2.12	December 2016					

2. ADDITIONAL INFORMATION ON UTILITIES PRODUCTION AND CONSUMPTION:

CEB tariff subscriptions

2.1 CEB Tariff number :

2.2 Tariff type: Medium Voltage supply ... 1

Low voltage supply 2

3 Phase 3

Single phase 4

2.3 Total Transformer installed capacity: KVA

2.4 Electricity subscribed capacity: KW

Grid tie Solar Photovoltaic systems installed

2.5 Total capacity of PV modules installed: kWpeak

2.6 Total capacity of inverters installed: KW

2.7 Year Installed:.....

2.8 Type of module: **(Circle ONE only)**

Polycrystalline 1

Monocrystalline 2

Thin film, other 3

2.9 Annual production meter reading: kWh

Details of off grid solar PV systems installed

2.10 Capacity of modules: kWp

2.11 Battery Inverter: kW

2.12 System voltage: **(Circle ONE only)**

12 V 1

24 V 2

48 V 3

Other 4 Please specify

2.13 Total Battery capacity:AH or kWh

2.14 Use of energy from off grid PV: **(Circle all that apply)**

IT Server ... 1

WIFI 2

Modem ... 3

Lighting ... 4

Other ... 5 Please specify

UPS capacity installed

2.15 Capacity of Inverter :kW

2.16 Type of UPS:

Single Phase 1

3 Phase 2

2.17 Autonomy:mins

2.18 Total Battery capacity:AH or kWh

2.19 Use of energy from UPS: **(Circle all that apply)**

IT Server 1

WIFI 2

Modem 3

Other 4 Please specify

Solar Water heater system

2.20 Type of solar collector: **(Circle all that apply)**

Thermosyphon ... 1

Evacuated tubes 3

Manifold 2 Flat bed 4

2.21 Total capacity of Collector panels installed:kWth OR M²

2.22 Total capacity of storage tanks:M³.

2.23 Capacity of electric booster: KWe

2.24 Year Installed:.....

2.25 End use of hot water: **(Circle all that apply)**

Rooms 1 Laundry ... 4

Kitchen ... 2 Sauna ... 5

Pool 3 , Other 6 Please specify

Boiler

2.26 Boiler capacity:KWth

2.27 Hot Water Storage capacity:M³

2.28 Fuel used:

Diesel 1 Electric ... 3

LPG ... 2 Other 4 Please specify.....

2.29 Use of Hot water / Low pressure steam: **(Circle all that apply)**

Rooms 1 Pool heating 4

Kitchen 2 Other5 Please specify
.....

Laundry 3

Standby Genset

2.30 Capacity of genset installed:KVA

2.31 Average annual running hours of gensets:Hours

2.32 Average annual Diesel consumption for gensets:Litres

2.33 % of hotel load accommodated by Gensets:

Annual consumption of other sources of energy:

2.34 Wood:Kg

2.35 Charcoal:Kg

2.36 Kerosene:Litres

Annual amount of water used (M3):

2.37 From CWA mains:

2.38 Pumped from borehole, Well:

2.39 From desalination plant:

4. INVENTORY REGISTER WITH NAMEPLATE RATINGS, USAGE PATTERNS

In order to complete the use side of the energy balance, we must build a model of energy consumption and match it to the observed energy consumption.

To achieve this objective, we require a detailed list of all installed equipment, the loading of the equipment, and the usage pattern in the form of hours of use per day, days per week and week per year.

As far as possible a picture of the nameplate should be taken for the main equipment.

4.1 Air conditioning equipment:

	Equipment type and characteristics	Type of refrigerant	COP/EER	QTY	Nominal power	Usage pattern Hours per day X days per week X week per year
1	Conventional split					
2	DC Inverter split					
3	VRV system					
4	Water Chiller					
5						
6						
7						

4.2 Ventilation system

	Equipment type and characteristics	QTY	Nominal power	Usage pattern Hours per day X days per week X week per year
2	Toilet extraction			
3	Ceiling fans			
4	Wall fans			
5	Desk fans			
6	Stand Fans			
7	Air Coolers			
8				

4.3 Lighting and small power Rooms

	Equipment type and characteristics	QTY Per room X number of rooms			Nominal power			Usage pattern Hours per day X days per week X week per year		
		Standard	Premium	Suites	Standard	Premium	Suites	Standard	Premium	Suites
1	Fan coil units									
2	Ventilation Fan									
3	LED lights									
4	Fluorescent tubes									
5	Halogen lights									
6	Incandescent Lights									
7	TV , pl specify size									
8	Mini Bar									
9	Others									

4.4 Pool, Spa Gym sauna

	Equipment type and characteristics	QTY	Nominal power	Usage pattern Hours per day X days per week X week per year
1	Swimming pool			
2	Water feature			
3	SPA			
4	Sauna			
5				

4.5 Restaurant other areas

	Equipment type and characteristics	QTY			Nominal power	Usage pattern Hours per day X days per week X week per year
		Restaurant 1	Restaurant 2	Restaurant 3		
	LED lights					
	Fluorescent tubes					
	Halogen downlights					
	Incandescent Lights					
	Small power					

4.6 External Lighting

	Equipment type and characteristics	Specify type: Sodium, Fluorescent, Incandescent, LED, Other	QTY	Nominal power	Usage pattern Hours per day X days per week X week per year
1	Street lights				
2	Bollards				
3	Tree lights				
4	Other Lights				
5					

4.7 Kitchen equipment

	Equipment characteristics type and	QTY	Nominal power	Usage pattern Hours per day X days per week X week per year
1	Oven			
2	Microwave			
3	Lights			
4	Kitchen extraction			
5	Small kitchen equipment			
6				
7				

4.8 Laundry equipment

	Equipment characteristics type and	QTY	Nominal power	Usage pattern Hours per day X days per week X week per year
1	Washing machine			
2	Electric drier			
3	Calandre			
4	Ironing, pl specify.....			
5				

4.9 Cold storage

- a) Cold rooms:m3
- b) Type: Positive 1 Negative 2
- c) Thermal rating:kWth
- d) Electrical rating:kWe
- e) Refrigerant used: R407 1 Other 2 Please specify

4.10 Electric Mobility

- a) Number of Electric buggy:.....
- b) Number of Electric Golf carts:.....
- c) Average Battery capacity:AH
- d) Battery voltage:V
- e) Usage per day(hrs use per day)
- f) Water pumping system:

- g) Type of pump:
- Single Booster pump ... 1
 - Duty standby 2
 - Transfer pump 3
 - Other4 Please specify

h) Electrical rating:.....kWe

4.11 Desalination plant

- a) Desalination equipment Capacity installed:.....m3/hr
- b) Type of desalination: Reverse Osmosis, thermal, other
- c) Annual volume of water produced:M3
- d) Energy consumption:.....kWh /m3

4.12 Waste Water treatment plant:

- a) Treatment capacity installed:m3/day
- b) Type: Rotating disk ... 1
 - Aerobic sludge ... 2
 - Other 3 Please specify
- c) Electrical rating:.....kWe
- d) Annual Waste water treated:M3
- e) Connection to sewer mains: Yes .. 1 No ... 2
- f) Level of treatment: Primary ... 1 Secondary ... 2 Tertiary 3
- g) Please specify use of treated water:

5. HOTEL OCCUPANCY INFORMATION

The data on occupancy figures must be compiled over the same period as for the utilities.

This enables the Energy Use Intensity (EUI) to be calculated for each month and is used as a reference point for future improvements proposed.

5.1 Total Restaurant capacity available:seat capacity (Couverts)

5.2 Annual number of meals served in hotel: (Total for breakfast, Lunch, Dinner, room service).....

	Month /Year	Room		Guest Nights Sold
		Room nights Available	Room Nights sold	
1	January 2016			

2	February 2016			
3	March 2016			
4	April 2016			
5	May 2016			
6	June 2016			
7	July 2016			
8	August 2016			
9	September 2016			
10	October 2016			
11	November 2016			
12	December 2016			

5.3 HOTEL BUILDING CHARACTERISTICS

Total area of site:M2

	Description	QTY	Unit area m2	Total m2
2	Standard rooms			
2	Deluxe Rooms			
3	Suites			
4	Restaurant 1			
5	Restaurant 2			
6	Restaurant 3			
7	Kitchen			
8	Front office			
9	Back office			
10	Laundry			
11	Others			
	Total Built Area			

5.4 Maximum number of storeys of buildings:G only,G + 1,G + 2,G + 3,other

5.5	Type of external building walls	% of external walls
1.	Concrete blocks	
2.	Stone	
3.	Wood	
4.	Other	

5.6	Type of Roofing	% of roofs
1.	Concrete only	
2.	Concrete with (black) waterproofing	
3.	Concrete with (other colour) waterproofing	
4.	Concrete with insulation	
5.	Steel sheets	

6. Shingles	
7. Thatch roofs	

5.7 Type of Windows	% of windows
1. Single glazing	
2. Double glazing	
3. Double glazing with special gas filling	
4. Selective filter film	
5. Protective awnings	
6. Other	

6. DESCRIPTION OF EXISTING ENERGY EFFICIENCY MEASURES.

6.1 BMS installed: Yes 1 No ... 2

6.2 Sub metering: Yes ... 1 No ... 2

6.3 Lighting control:

6.3.1 Control of external Lighting: (Circle one)

Manual 1

Timer 2

Timer + photo Cell 3

Other 4 Please specify

6.3.2 Lighting in toilets: (Circle one)

Always on 1

Manual switch 2

Presence detector 3

6.4 Set point of air conditioning in vacant rooms:

AC kept off or AC set at Degrees

6.5 Set point of air conditioning in occupied rooms:

AC set point left to client, or AC set at Degrees centrally or Set point limited to Degrees

6.6 Energy saving measures:

Power enabled with room card 1

Terrace door sensor to shut down AC ... 2

Others ... 3 Please specify

6.7 Rain water harvesting:

a) Total storage capacity: m3

b) Usage of harvested water:

6.8 Sensitization of Guests on energy savings: Yes ... 1 No ... 2

Details:.....

.....