Solar Water Heating Systems and Other RETs in Hospitality Sector – A Factsheet

Prepared by
The Energy and Resources Institute

Under
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Ministry of New & Renewable Energy
Government of India

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Executive summary

To explore the amount of energy being consumed for various purposes in hospitality sector and to understand the energy profile of hotels across categories and regions, a questionnaire based survey was conducted. It was a close ended questionnaire survey that was distributed among all hotel and restaurant members of FHRAI, across various star category and region. A total of 3326 members were contacted for this survey. Total responses received were 178.

This Energy factsheet gives a snapshot of the energy requirements in hotels, the fuels used, their energy-related expenditure, and deployment of various renewable energy technologies/energy conservation measures across various star categories and climatic zones. The factsheet is completely based on the responses received during the survey.

Section 1 of this report provides a detailed classification of fuel and energy system being used in the hospitality industry. This information has been further classified on basis of climatic zone and the star rating of the hotels. Electricity, LPG and diesel account for a major part of the energy bill and their prices vary significantly from location to location.

Section 2 gives an overview of the solar water heating sector in the hospitality sector. Processed information has been presented on size of solar water heaters installed, savings and type of systems set up.

Section 3 combines the information about other renewable energy systems including solar steam systems, solar PV and biogas systems installed in the hospitality industry.

Section 4 covers the details of energy conservation measures adopted in the sector as well as an analysis of the potential that still exists.

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1. Introduction

Classification of hotels

For the purpose of data collection and analysis, hotels were classified as per

- their respective climatic zones, and
- their category (star rating)

Figure 1 and 2 summarises the responses received based on star rating and climate zone, respectively. Maximum responses were received from warm and humid region followed by composite. Least responses were received from cold region. Also, the number of responses from each star and non-star category is not homogeneous. Some inconsistency has been found in data generated by the hotels. However, it lies within a particular range for each query, irrespective of climate zone and hotel category.

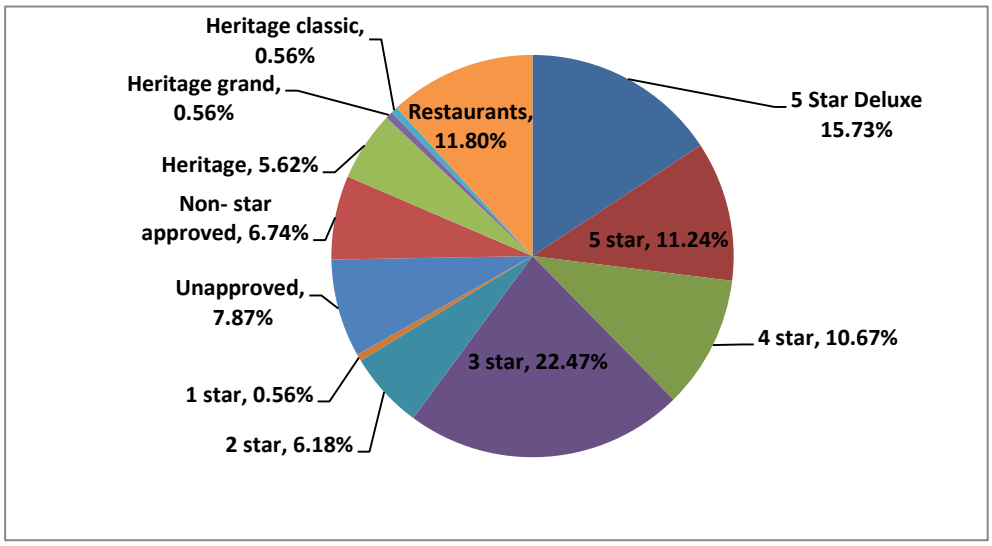

Figure 1: Responses received based on star category

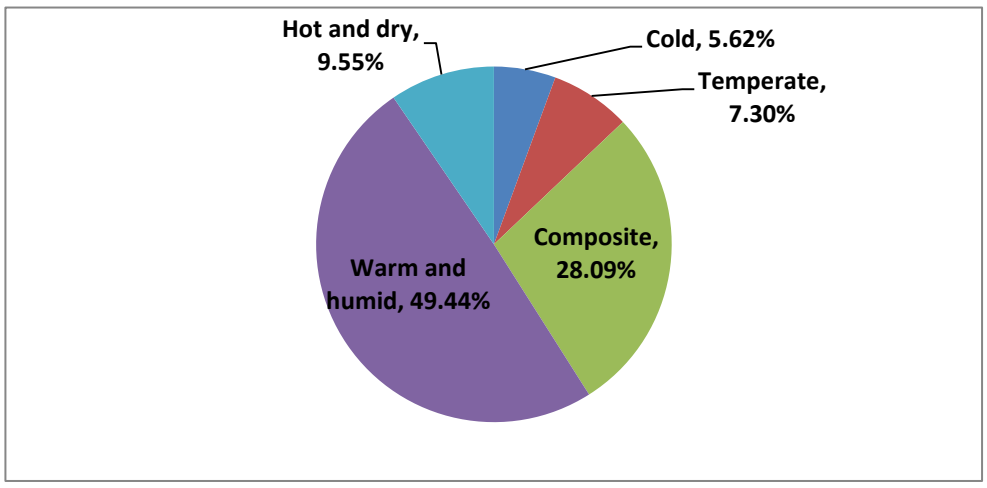

Figure 2: Responses received based on climate zone

Type of fuels consumed

Study of fuels consumed in hospitality sector revealed that electricity is the most common source of energy, followed by diesel and LPG (figure 3). Other fuels to meet the energy demand include coal, kerosene, charcoal, PNG etc. Fuels like wood, LDO (light diesel oil), furnace oil, CNG and solid fuel are also used as energy fuels in hotels. They have been categorised as others constituting 5.1% of the total different types of fuels consumed. Table 1 summarises the annual expenditure incurred on major fuels used by hotel industries.

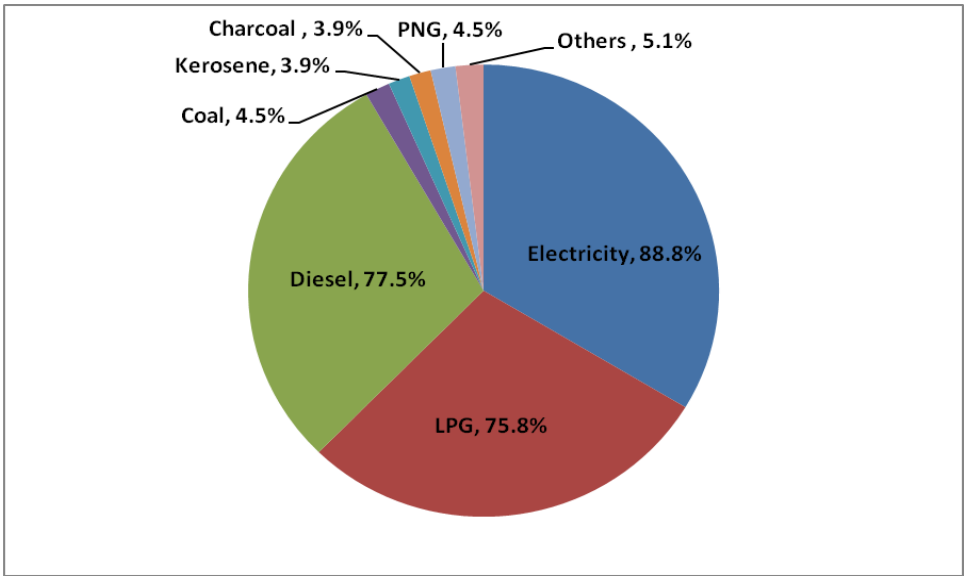

Figure 3: Fuels used in hospitality sector

Table 1: Annual expenditure on various major fuels

	Electricity	LPG	Diesel
Unit cost (`/unit)	3.25 - 12.36	30 - 100	32.5 - 65
Annual Expenditure	up to 30,00,00,000	up to 3,30,00,000	up to 7,00,00,000

Hot water demand

Study reveals that hot water demand is directly proportional to the star category type i.e. it increases with increasing star rating. Thus, as shown in the figure 4 below, 5 star deluxe and 5 star category has the highest average hot water demand followed by heritage type and 4 star and so on. In case of non-star category, heritage type has the highest hot water demand.

The most common fuel used for producing hot water in the hospitality sector is Diesel/HSD followed by electricity. Other fuels used are PNG, LPG, LDO and wood.

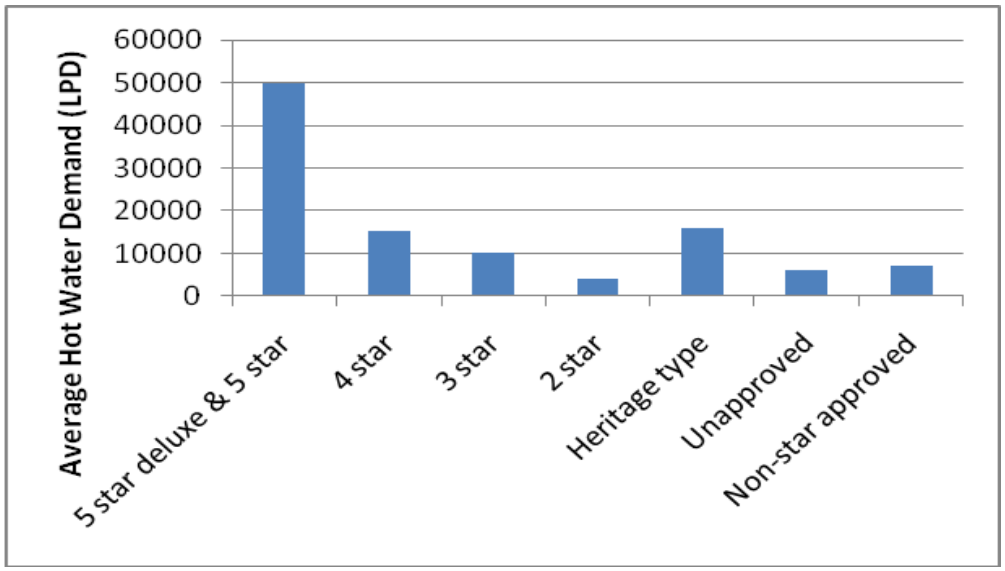

Figure 4: Hot water demand by various hotel categories

Swimming pools in the hotels

Survey revealed that most of the hotels (about 77%) of the hotels have swimming pools installed in their facility. They primarily belong to star category of up to 3 star. Some of the heritage type belong to this category and a very few non-star approved hotels. While most of them have minimum, one swimming pool, hotels of higher star category like 5 star deluxe, and 5 star have more than one pools going up to 2 or 3. These pools may or may not be different in capacity. The capacity of these swimming pools vary from minimum 15 cubic metres to up to 5000 cubic metres, average being 200 – 300 cubic metres. Besides, some hotels are also found with one main swimming pool and other small sized plunge pools.

Production of organic waste

Figure 5 below illustrates the amount of organic waste produced by various hotels across star and non-star category.

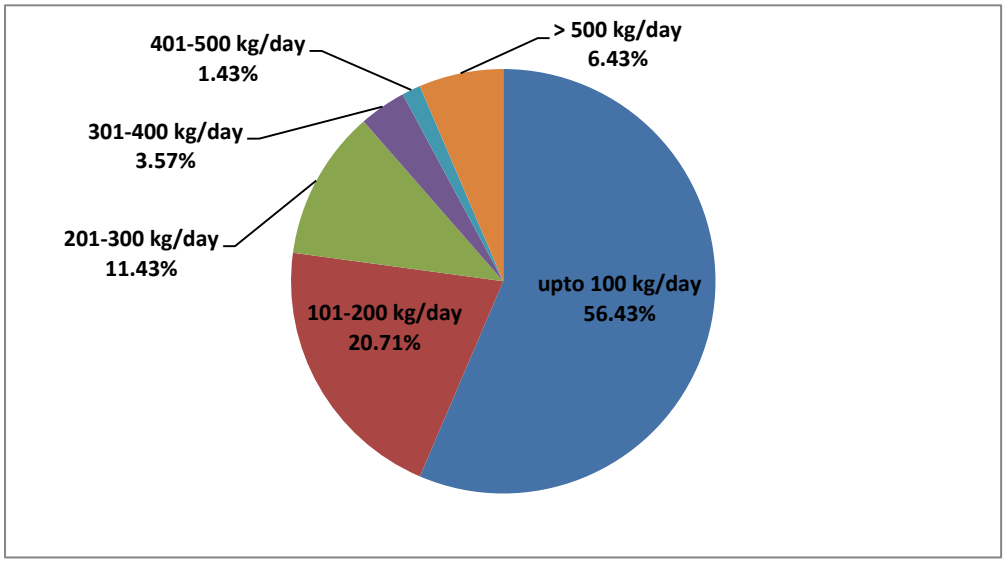

Figure 5: Production of organic waste in various hotels

Most of the hotels have reported to produce up to 100 kg/day of organic waste across various star and non-star categories. Further, it is seen that as the star category increases, larger amount of waste is reported to be produced. Organic waste production of more than 500 kg/day has also been found in about 6% of the hotels. The maximum amount of waste produced is about 3200 kg/day. This is found in 5 star deluxe category of hotels. About 41% of this organic waste consists of both kitchen as well as horticultural waste. Rest, of it is chiefly the kitchen waste.

Air conditioning

It is seen that 80% of the hotels are air conditioned (as shown in figure 6). The energy efficiency (COP) of the centralized plant is higher than the de-centralized plant. Majority of the hotels are using centralized plant that itself ensures lower energy consumption in HVAC system. Vapour compression type of technology is found to be mostly adopted in case of both centralised and decentralised air conditioners.

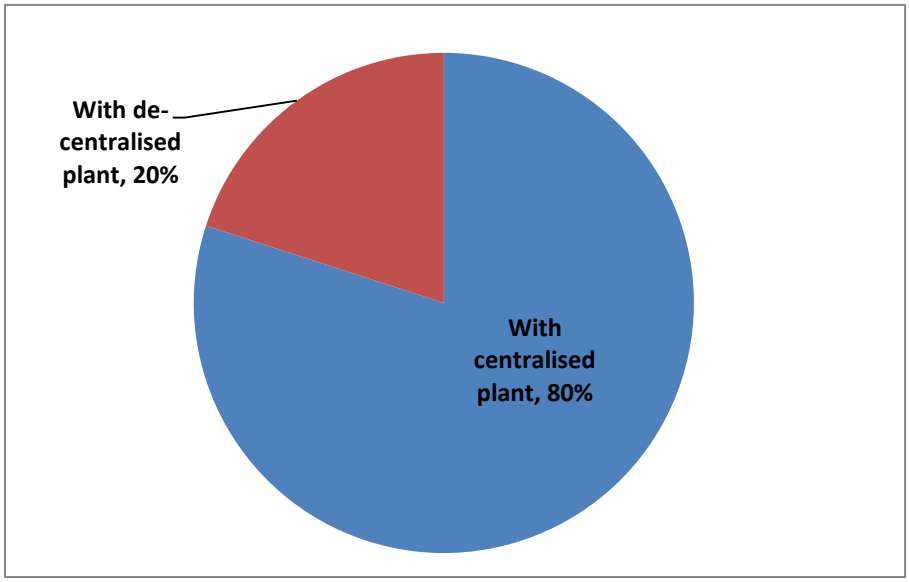

Figure 6: Air conditioning in hotels

Acceptance of SWHS and other RETs by hospitality sector

Survey suggests about 86% of the respondents are willing to take up renewable energy technologies and other energy conservation measures to reduce their energy load. However, 13% respondents are hesitant about adoption.

When reasons of unwillingness were studied, it was found that the most common reason of unwillingness of adoption or why many hotels have not been able to adopt and avail benefits of this technology is the space constrain in their facility (see figure 7). Other reasons found common among respondents were high capital cost, lack of awareness and problems of maintenance.

Among those who would like to have RETs in their facility mostly want to have solar water heater (46.5%) installed in their facility followed by Solar PV systems (22.93%), biogas plants (19.75) and solar thermal concentrator (0.83%), respectively (see figure 8.)

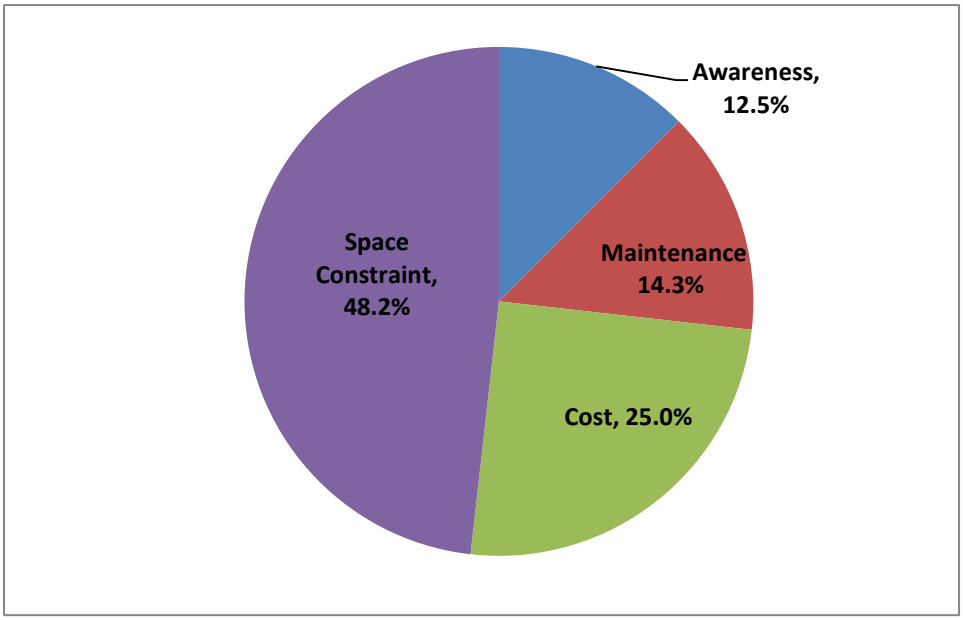

Figure 7: Reasons of unwillingness in adoption of RETs

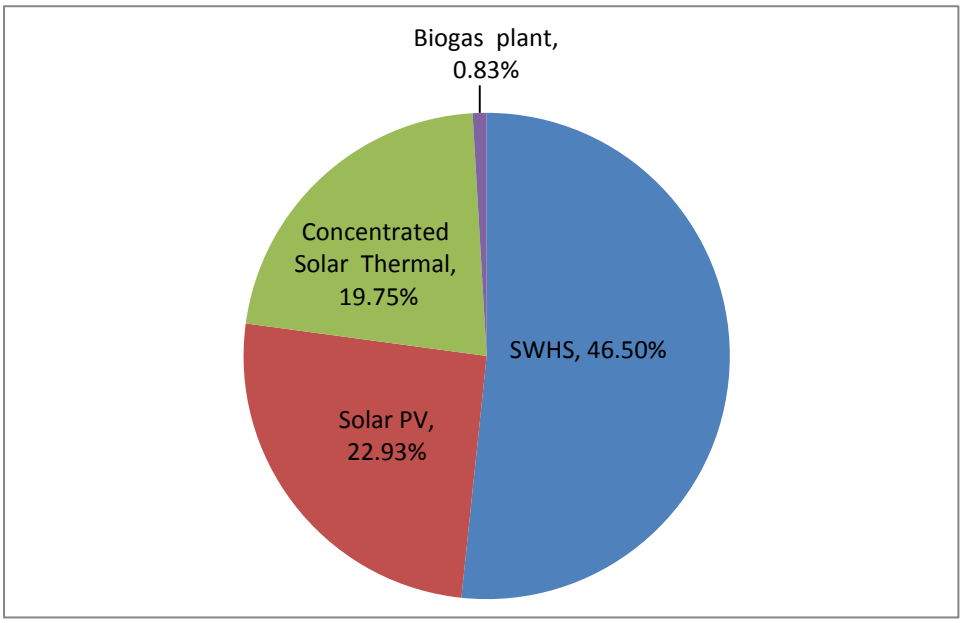

Figure 8: RETs preferences of hoteliers based on responses

2. Solar water heating systems

SWHS installation status

Based on the data collected, it could be seen that approximately 34% of the hotels surveyed had solar water heating systems installed i.e. 60 hotels of the ones that responded have installed solar water heaters in their facility (figure 9). Out of 122 hotels that have not yet installed it, it was found that 2 hotels were in process of installation and one required guidance on the technology. This shows that there is significant awareness in the hospitality sector about SWHS.

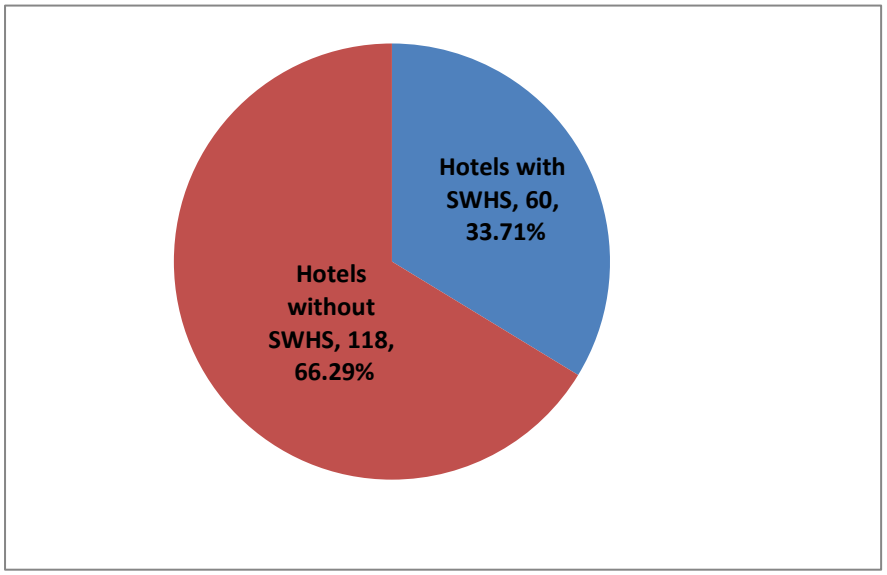

Figure 9: SWHS installation in various hotels

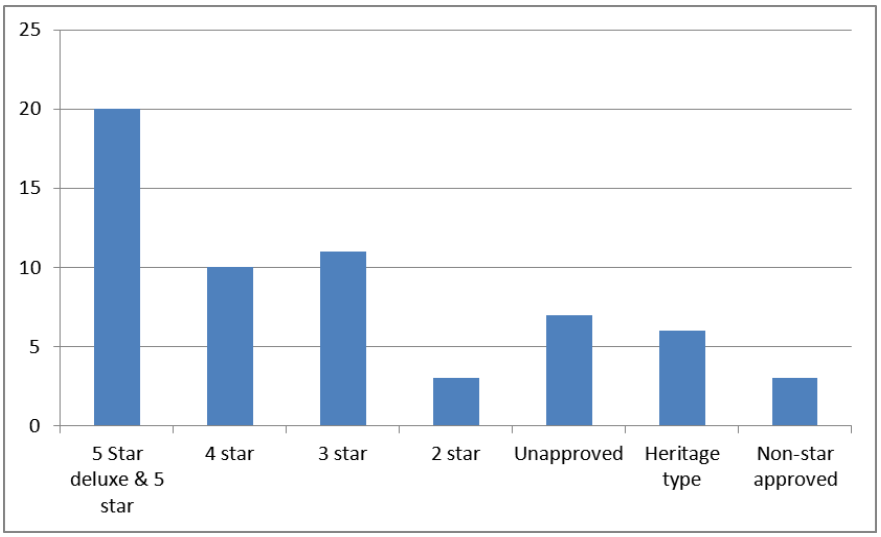

Figure 10: Hotel category wise SWHS installation

Further, when these 60 hotels were analysed, it was seen that, these systems are commonly found in star category hotels. Among star categories, 5 star deluxe and 3 star hotels have

highest number of installations, out of the responses received. It is seen that 33.3% and 18% of respondents from 5 star deluxe and 3 star, respectively have installed solar water heaters (figure 10)

Type of SWHS installed

Amongst the hotels with solar water heating systems installed in their premises, a preference was seen for Flat Plate Type collectors (FPC) over Evacuated Tube Type Collectors (ETC), as is seen from the analysis presented below in figure 11.

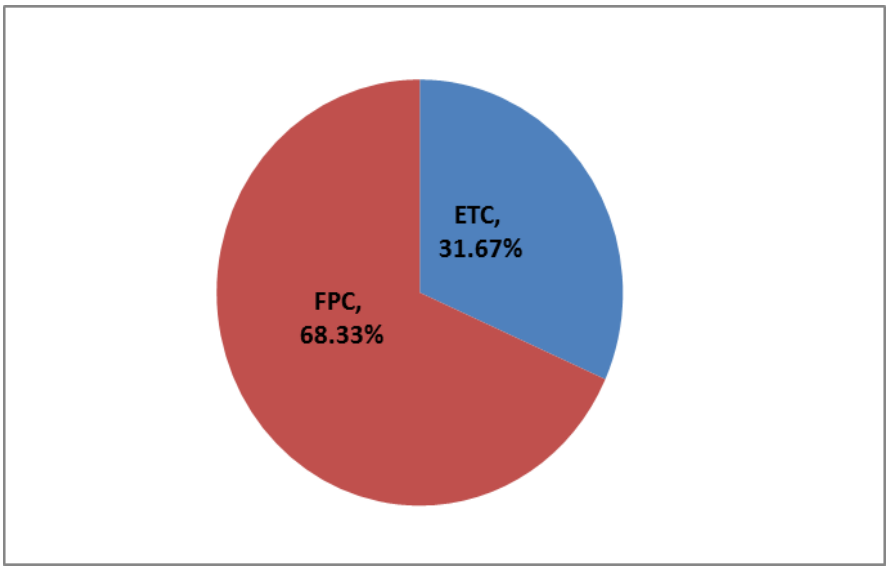

Figure 11: Status of type of SWHS in hotel sector

Installed capacity of SWHS

As can be seen from figure 12, most of the systems installed fall in the category of 1001-10000 Litres per day (LPD). These sized systems are found mainly in 4 star and 3 star category hotels. Besides, these sized systems are also found in non-star and unapproved hotels. Large sized systems of category 10000-20000 LPD and more are found commonly in 5 star category and heritage type. Further, study tells 5000 LPD sized systems are found to be most common (figure 13).

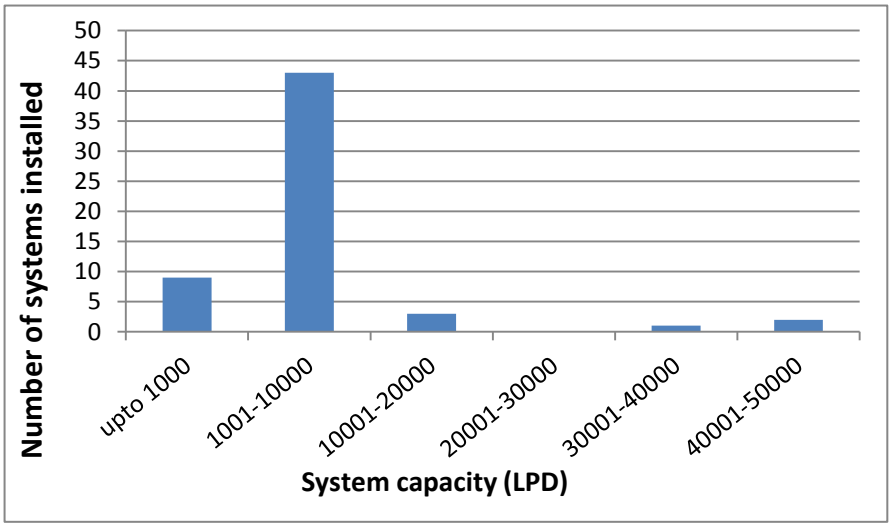

Figure 12: System installation up to 50000 LPD

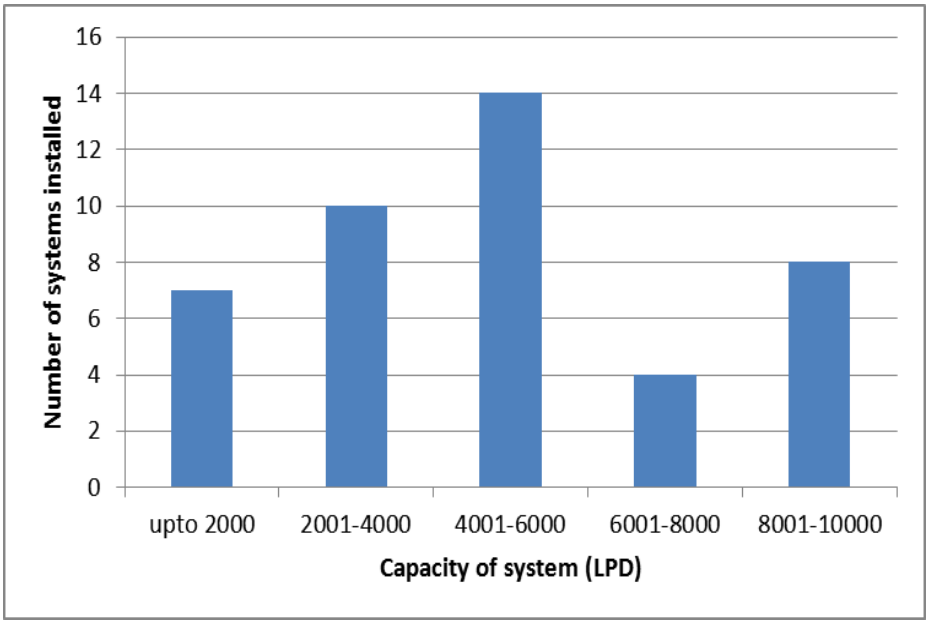

Figure 13: Installed capacities within 1001 – 10000 LPD systems

As seen in the figure 14 below, two things can be very well inferred. Firstly, there is an increasing trend of adoption of SWHS in the hospitality sector. The lower value in the class 2000-2005 can be attributed to limited number of responses received.

Secondly, this trend of adoption can be traced back to 1990 or even before that.

All these systems have been found to be 100% functional. Survey also revealed that these systems have been adopted by hospitality sector as early as in 1972 and they seem to be functional until now.

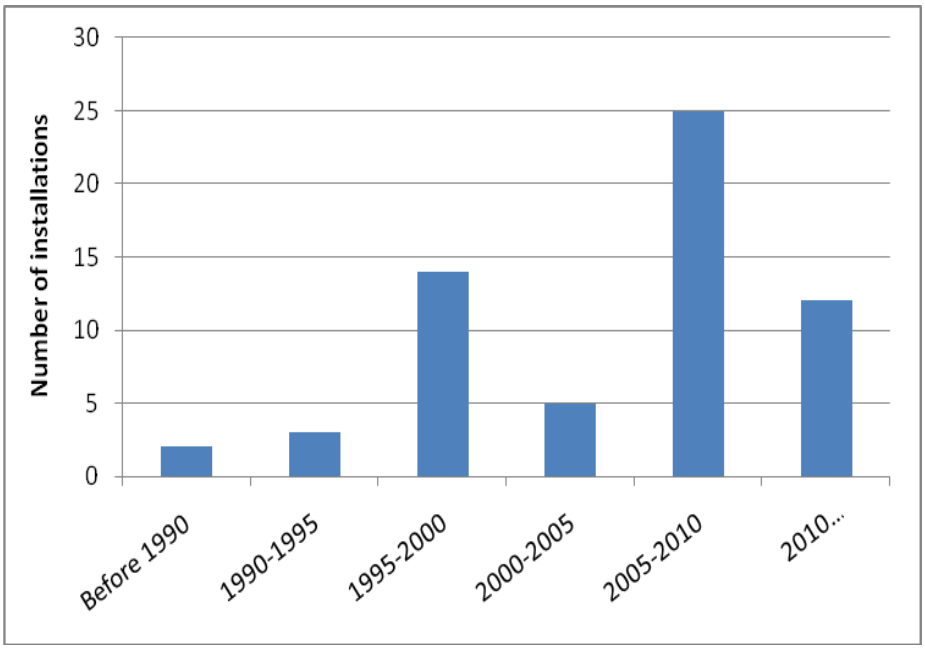

Figure 14: Year wise installation of SWHS

Savings

Figure 15 below shows the savings incurred by the hotels that have installed SWHS in their facility. Clearly, up to 59% of the respondents have shown to save an annual amount of up to Rs 5, 00,000, starting with Rs. 18,000 p.a. Savings have been reported to be more than Rs30, 00,000 p.a. in some cases. This clearly shows that there is a huge potential of energy saving that can be incurred by installation of solar water heaters.

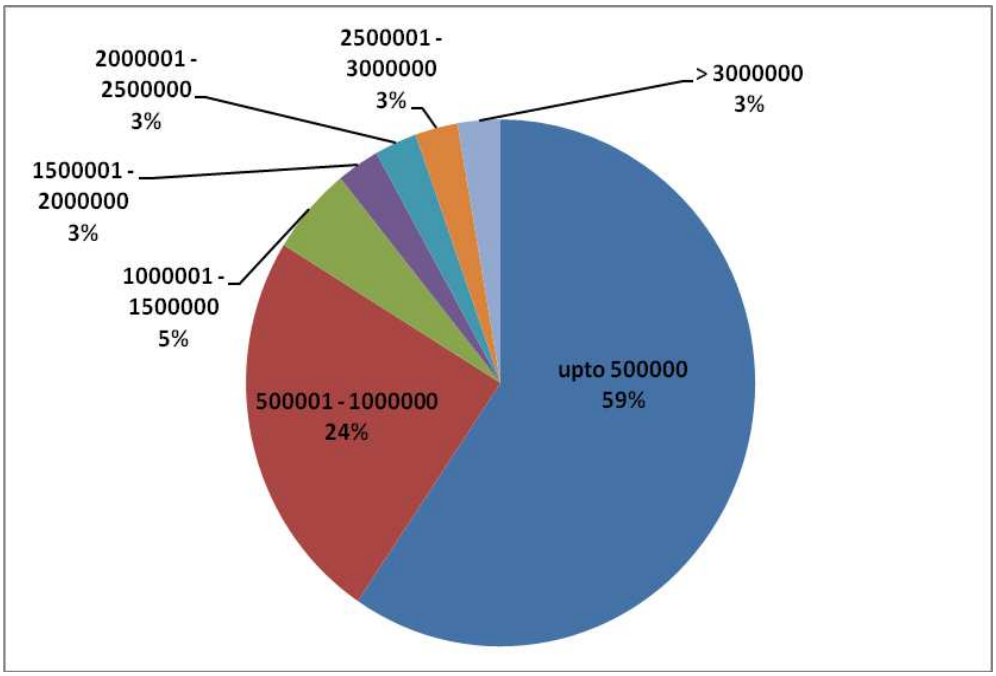

Figure 15: Annual savings by various hotels with SWHS

3. Other renewable energy systems

Solar photovoltaic systems

- Through the survey, it has been found that Solar Photovoltaic is also not an uncommon technology in the hospitality sector. Survey revealed the adoption of this technology in 6 hotels out of which 1 has its system yet to be commissioned.
- The installed capacity has been ranging from 80 W to 24 kW.
- Up to Rs. 10,000 per month have been found to be saved by installation of this technology.

Solar steam generation

- Currently conventional fuels are deployed to generate steam. HSD/diesel is the most common fuel being used to generate steam, followed by electricity. LPG and PNG are also used to generate steam. Besides these, smaller fraction is also occupied by Furnace oil and LDO (figure 16).
- Temperature requirement for generating steam for various applications varies from 150 ˚C – 170 ˚C.
- None of the respondent has solar steam system installed in their facility. However, ITC Maurya, Chanakyapuri, Delhi is the first of its kind which has installed solar thermal concentrators in their facility to meet their steam requirements. 2 parabolic and 8 Scheffler dishes have been installed in their campus which generates steam at 350˚C and 125˚C, respectively. They are able to save up to 100 scm per day and Rs. 3500 per day.

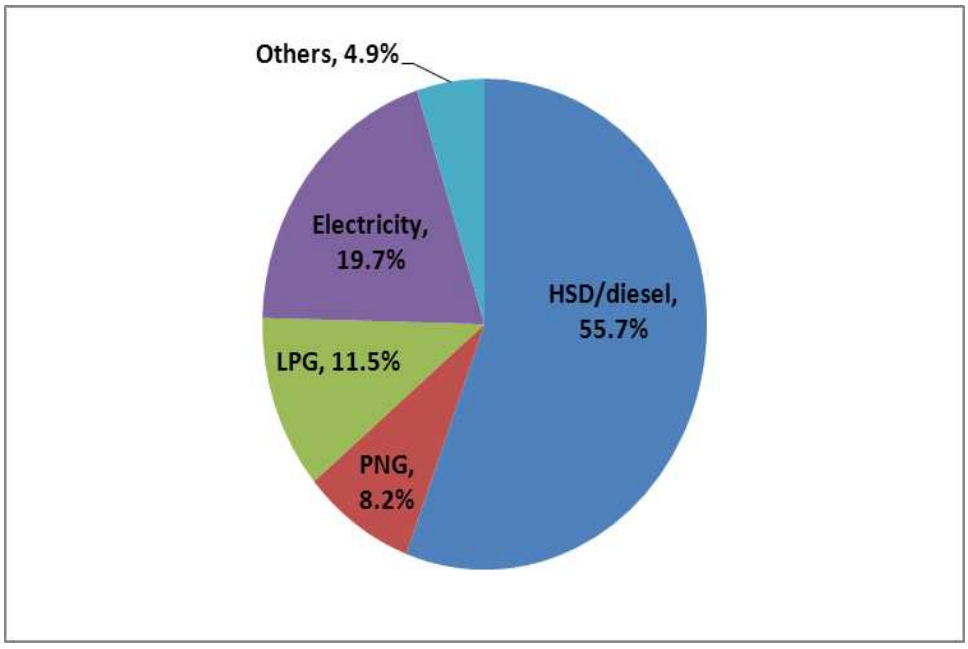

Figure 16: Fuels used for generating steam in hospitality sector

Biogas plants

- In organic waste survey, it was found that all the respondents produce kitchen waste and most of them have horticultural waste.

- Survey suggests that 4 hotels have installed the biogas plant in their facility with the following features.
  - The capacity of plant varies from 150 – 500 kg of waste/day.
  - Production of biogas varies from 4.23 m^3 – 12.5 m^3 per day.
  - The savings incurred from the installation varies from Rs 150/day – 750/day based on the capacity of system installed
  - All these systems have been found to be 100% functional.
  - The waste that is getting processed is generating biogas as the main product which is being used in the kitchen for cooking purpose and/or for burning lamps.
- Majority of the respondents (174 out of 178) were found not to have biogas plant.
- When their waste management was analysed, it was found that most of the waste is being collected by the third party or is being dumped at government garbage site. Some of them are practicing the composting and some are selling it off to piggeries (see figure 17).
- The data on waste generation from kitchen and garden was analysed. Since there was no consistent data on waste generated from different hotels and restaurants, it was difficult to arrive at a quantity of waste being generated by a particular class of hotel to assess the potential. In order to overcome this ambiguity, it was decided to take the total number of rooms of hotel into account for estimation of waste being generated. Total number of rooms under different star category i.e. 2, 3, 4, 5 star and 5 star deluxe respondents is 9101, generating a total of 18271 kg organic waste on a daily basis. It works out to be, an average of 2 kg/day/room within a range of ± 20% (because of floating population, seasonal nature of occasions). In a study conducted by TERI in hotel industry, it is seen that average quantities of waste produced in 5 star and 4 star category hotels are 500 kg/day, 400 kg/day, respectively. Table 2 below summarises the average waste produced against each category of hotels based on the responses received.

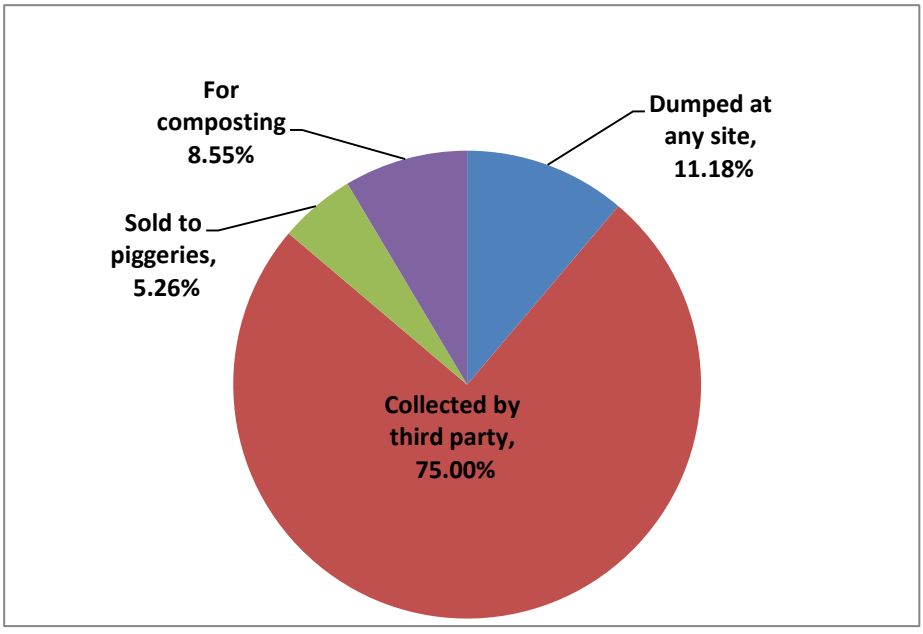

Figure 17: waste management by various hotels

Table 2: Summary of waste production hotel category wise[1]

Hotel Category	Average waste produced (in kg/day)
5 Star deluxe and 5 star	356 + 20% 356 – 20%
4 star	236 + 20% 236 – 20%
3 star	144 + 20% 144 – 20%
2 star	120 + 20% 120 – 20%

Thus, we see that there is a large amount of unprocessed bio-waste produced by each hotel which has a huge potential for biogas generation to meet the energy demands.

[1]Due to lack of data, analysis for non-star categories has not been furnished.

4. Energy conservation measures in hospitality sector

Current status of ECM in hospitality sector in India

1. There are approximately 23% of hotels are certified under various rating system, such as – Green Globe, LEED, ISO14001, Orange, Lacon GMBH 2092/91 (figure 18)

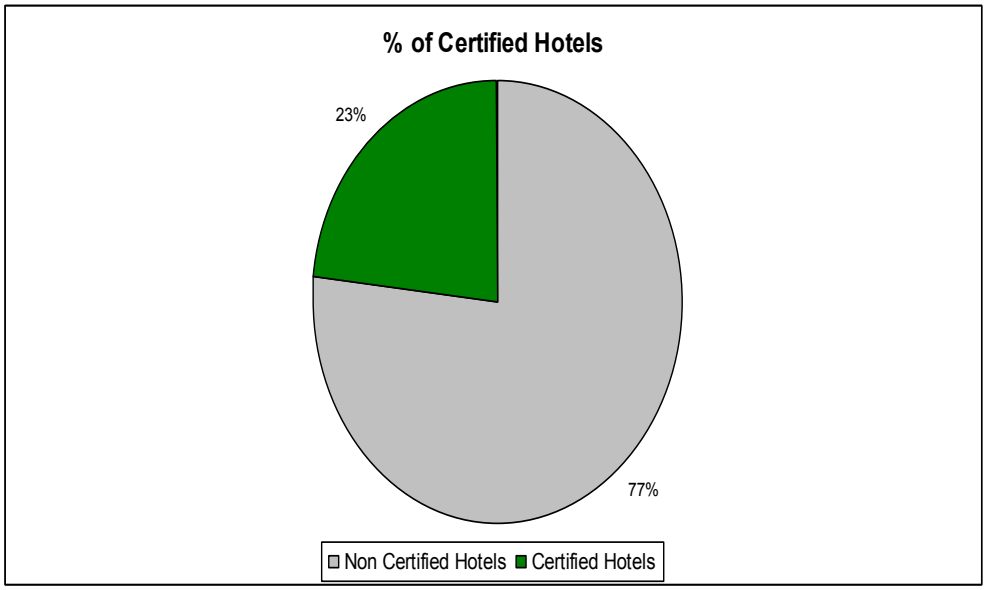

Figure 18: Percentage of certified hotels

The percentage of Green Globe rating system is highest in the hotel industry in comparison to other rating systems as shown below in figure 19.

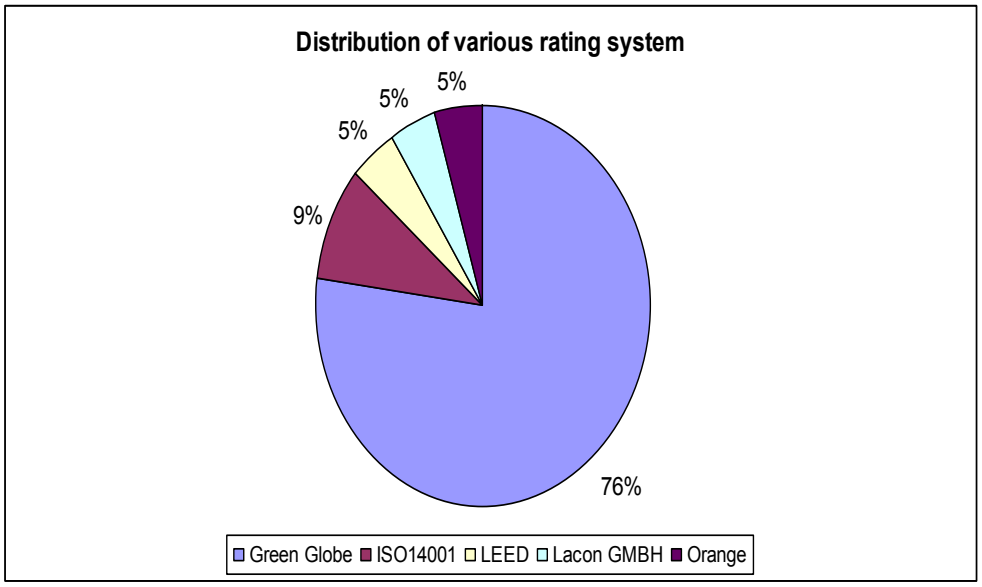

Figure 19: distribution of various rating system

2. Approximately 41% of the hotel buildings have optimum orientations as the longer facades of the buildings are oriented towards North & South. From this data, it can be concluded that 41% of the hotel buildings have adopted the very first measure of solar passive building design; i.e. Optimum orientation (figure 20).

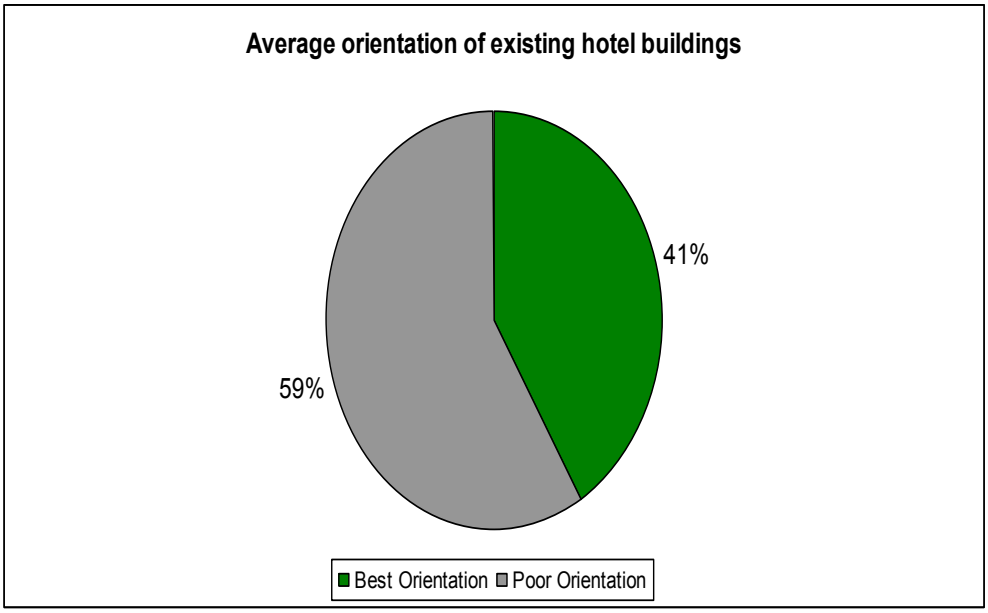

Figure 20: Average orientation of existing hotel buildings

3. The status of low energy design features adopted in the hotel buildings of India has been summarized in the following graph 21. It has been observed that roof insulation is the widely adopted ECM in the hotel buildings followed by occupancy sensor, DGU, window shading & roof shading.

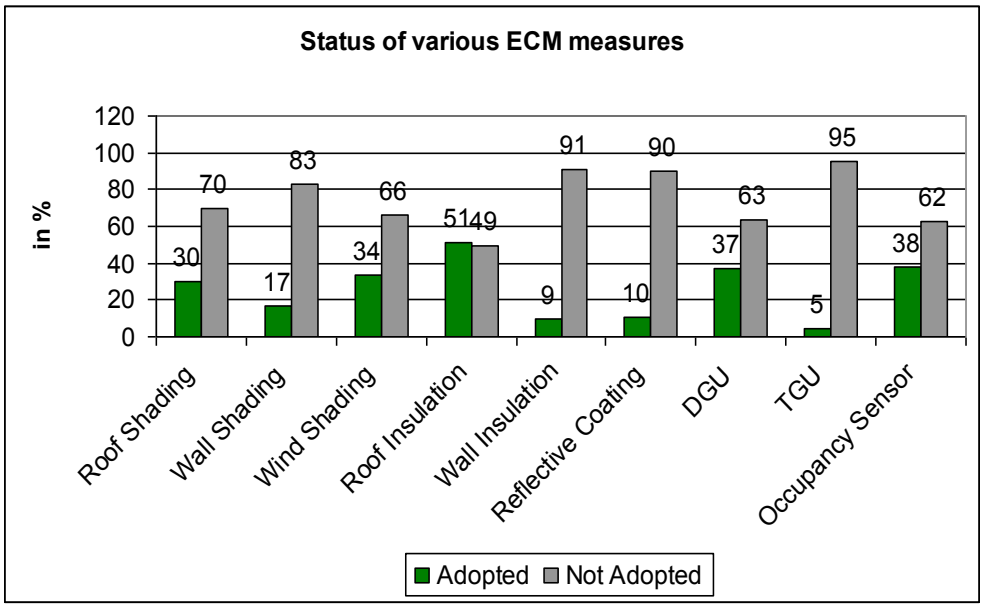

Figure 21: Status of various ECM measures

4. The survey report recorded a significant number of willingness to install the ECM measures in the hotel vicinity by the authorities. The priority of interest can be easily

identified from the following figure 22. Day lighting is the most neglected design parameter in the hotel buildings and the requirement of daylight inside hotel spaces is again debatable. But this surveyed data proved that majority of the hotel owners and managers are willing to incorporate the benefits of day lighting in their buildings and save excess of consumption of electricity in artificial lighting.

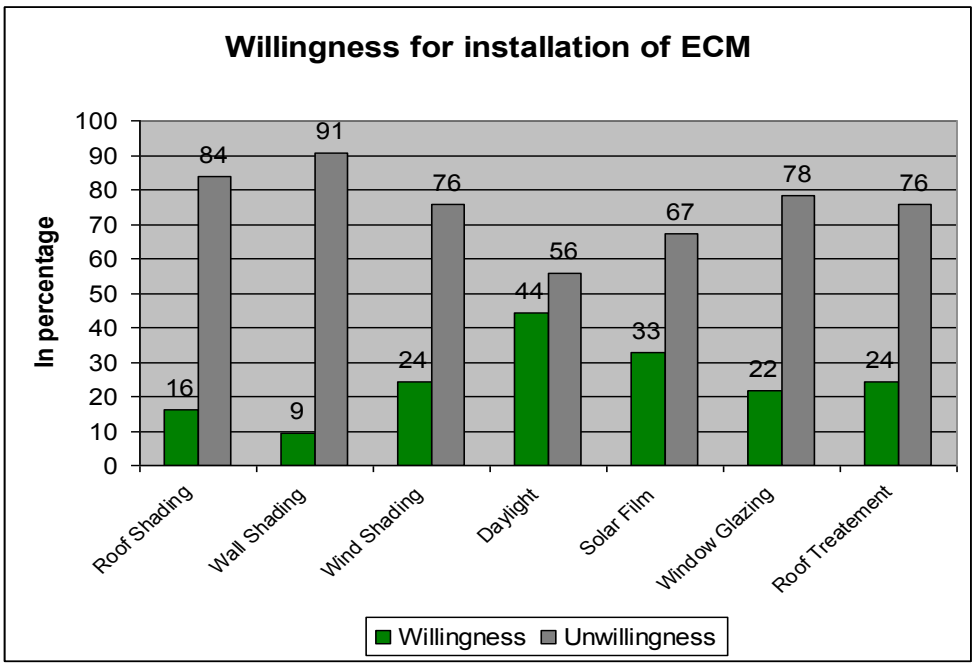

Figure 22: Willingness for installation of ECM

5. The per cent of power generated by DG is 15% of the total power consumed in the hotel industry as shown in the figure 23 below.

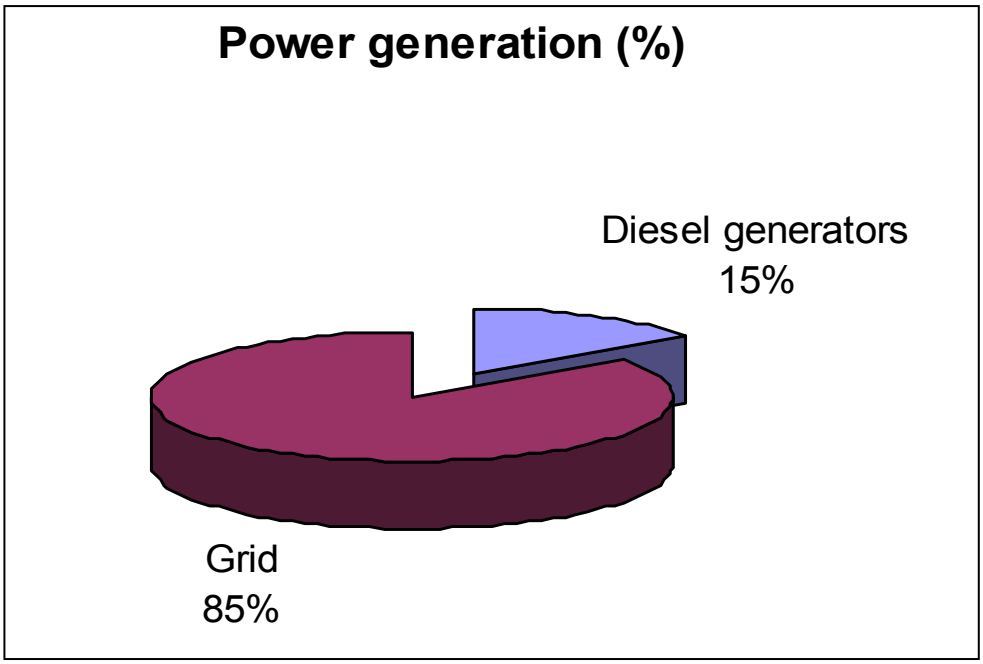

Figure 23: Power generation

6. The average energy performance index (EPI)* of different categories of hotels is shown in figure 24.The 5-star deluxe and 5-star hotels have higher EPI in comparison to the lower star hotels. But it has been studied that each category of hotel has potential to reduce 20-25% of its energy consumption by adopting appropriate ECM measures.

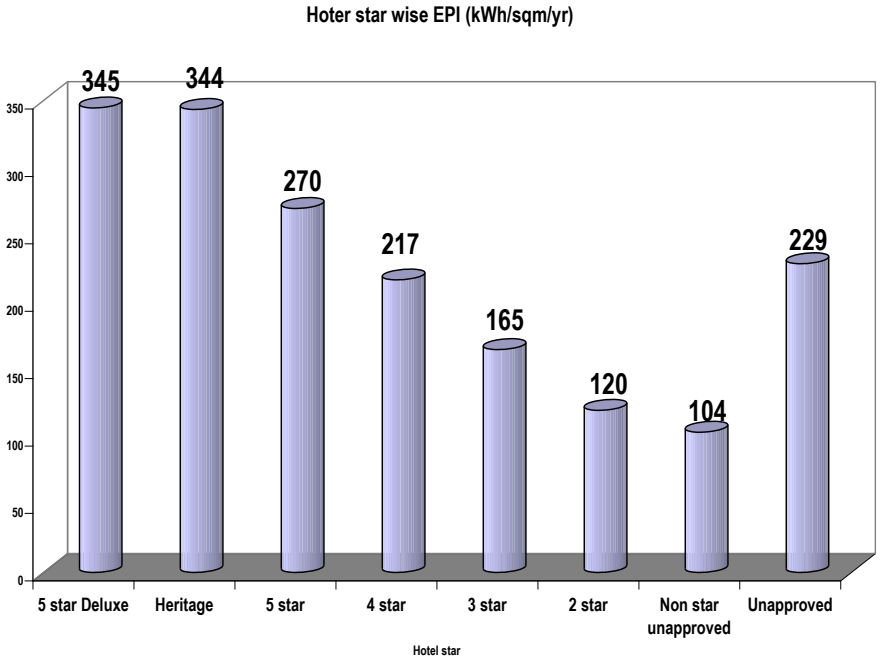

Figure 24: Hotel wise EOI (kWh/sqm/yr)

Note: * Energy Performance Index (EPI -kWh/m²/year) is calculated by dividing total energy consumption (kWh) with total built up area (m²).

Annexure:
Questionnaire – Project Hospitality

1. HOTEL PROFILING

1.1. Name of the Hotel …….…….

1.2. Membership number…..……..

1.3. Address……..…….

…….City……State …….……...Phone No……

1.4. Type of Hotel (Please tick √ the right option)

□ 5 Star Deluxe	□ 5 Star	□ 4 Star	□ 3 Star
□ 2 Star	□ 1 Star	□ Heritage	□ Heritage Classic
□ Heritage Grand	□ Government approved non-star category		□ Unapproved

1.5. Please specify the total number of rooms_____

1.6. Please specify the following with regard to the hotel:

- □ Total site area …….....(in square metres)
- □ Total built-up area……..……...(in square metres)
- □ Number of storeys ……...
- □ *Available roof area……...……..(in square metres)

* *This implies roof area that is presently not occupied and available for any possible Renewable Energy System installation*

Total Number of Restaurant	Name of each restaurant	Seating capacity of each restaurant	Average Occupancy
	1.	1.	1.
	2.	2.	2.
	3.	3.	3.
	4.	4.	4.
	5.	5.	5.

1.7. Please specify the following about in-house restaurants

1.8. Please specify the following about in-house banquet halls

Total Number of Banquet Halls	**Name of each banquet hall**	**Seating capacity of each banquet hall**	**Average Occupancy**
	1.	1.	1.
	2.	2.	2.
	3.	3.	3.
	4.	4.	4.
	5.	5.	5.

1.9. In case, there are any swimming pools in the hotel, please specify the number of swimming pools and water capacity of each swimming pool.

Total Number of Swimming Pools	_____
Water Capacity of each swimming pool	1._____ cubic metre 2._____ cubic metre 3._____ cubic metre

1.10. Please specify the total air-conditioned area of the hotel?

_____ (in square metres) (Note: write zero in case there is no air-conditioned area)

1.11. Is the hotel building certified under any green rating system?

- ☐ Yes
- ☐ No

1.11.1. If yes, please specify:

☐ GRIHA	☐ LEED	☐ Green Globe	☐ Any other ……

2. DETAILS OF FUELS CONSUMED

Type of Fuel	**Average Annual Consumption**	**Cost per Unit Consumption**
	Units	Rs./Unit (Please specify the unit)
Electricity	……...……kWh	……..(Rs./kWh)
LPG	……..kg	……....(Rs./kg)
Diesel	……..Litres	……...(Rs./litre)
Kerosene	...……...Litres	……...(Rs./litre)
Biogas	……m^3	……...(Rs./ m^3)
Other fuel_____	……	……
Other fuel_____	……	……

3. BUILDING EFFICIENCY MEASURES ADOPTED BY THE HOTEL

3.1. What is the orientation of the hotel building (that is, which direction does the longer façade of the hotel building face?)

☐ North -South	☐ East-West
☐ North West – South East	☐ South West – North East

3.2. Which of the following features have been adopted in the hotel as part of the building energy efficiency measures?

☐ Roof shading	☐ Wall shading
☐ Window shading	☐ Roof insulation
☐ Wall insulation	☐ Reflective coating on roof
☐ High performance glazing ☐ Double Glazing ☐ Triple Glazing	☐ Occupancy sensors for lighting
	☐ Any Other (Please specify _____)

4. HOT WATER/ STEAM REQUIREMENT FOR THE HOTEL

4.1. What is the hot water requirement for this establishment?

Hot Water Requirement_____(Litres per Day)

4.2. What is the steam requirement for this establishment?

Consumption Details	Rated Capacity (Tonnes per Hour)	Temperature	Pressure	Average Number of Hours of Consumption per Day
Steam Requirement				

4.3. What are the sources of hot water and steam for the hotel? Please tick (√) the correct options.

Source →	Boiler (Specify the fuel_____)	Electrical (Grid supply)	LPG	Other Gas	Solar water heater (ETC or FPC)	Solar thermal system (concentrator type)	Any other fuel (please specify _____)
For Hot Water							
For Steam							

4.4. Please specify the capacity of solar thermal systems installed in the hotel?

Solar Thermal Systems	**Year of Establishment of the system**	**Number of Units Installed**	**Total Installed Capacity of the system (No. of Units X Capacity per Unit)**	**Is the system functional or non-functional ?**	**Specify the no. of Solar thermal units that are functional**	**If functional, specify the actual savings because of this system (in monetary terms) (in Rs.)**
Evacuated Tube Collector (ETC) based Solar Water Heater			……..…(Litre per Day)			
Flat Plate Collector (FPC) based Solar Water Heater			…….. (Litre per Day)			
Solar Thermal System Concentrator Type			……..….(kWthermal)			
Any Other (Please specify_____ _____ _____)						

5. Are there any Solar PV Systems installed within the establishment?
   - ☐ Yes
   - ☐ No

5.1. If yes, please specify which type of the PV system has been installed and of what capacity?

Type of Solar PV System Installed	**Number of units installed**	**Total Installed capacity of the System (No. of Units X Capacity per Unit) (in kW)**	**Year of Establishment of the System**	**Is the system functional or non-functional?**	**Specify the no. of Solar PV units that are functional**	**If functional, specify the actual savings because of this system**	
						Savings in energy units (in kWh)	**Savings in monetary terms (in Rs.)**
Rooftop PV System							
Individual Street Lighting PV System							

6. Are there any air conditioning system(s) installed in the hotel?
   - ☐ Yes
   - ☐ No

6.1. If yes, please specify the type of air conditioning system installed, source of energy and installed capacity (Tick√ the right option and provide details in the remaining columns accordingly)

Type of Air Conditioning	**Type of technology for air-conditioning**	**Source of Energy**	**Total Installed capacity (TR)**
Centralized	□ Vapour compression □ Vapour absorption	□ Electricity □ Piped Natural gas (PNG) □ HSD □ Solar □ Any Other (Specify_____)	
Type of Air Conditioning	**Type of technology for air-conditioning**	**Source of Energy**	**No. of units installed & Capacity per Unit (TR)**
Decentralized	□ Vapour compression	□ Electricity □ Piped Natural gas (PNG) □ HSD □ Any Other (Specify_____)	

7. KITCHEN WASTE BASED QUESTIONS

7.1. What is the average quantity of organic kitchen waste generated on daily basis in the hotel?

_____ (in kg/ day)

7.2. Are there any horticultural wastes from Hotel Garden/ plantation?

□ Yes
□ No

7.3. If yes, please specify the average quantity of horticultural waste generated per day within the hotel premises?

_____ (in kg/day)

7.4. What is being done with the organic waste obtained from kitchen and garden?

□ Dumped at any site	□ Paying for collection by third party
□ Used for generating biogas	□ Any other application (please specify _____)

7.5. In case, the organic waste is being collected by third party, please specify the average payment being paid per kg of waste?

_____ (Rs. / kg)

7.6. In case biogas is being generated using the organic waste in the hotel, please specify the following in the same regard:

Year of Establishment of the Biogas Plant	Capacity of Biogas Plant	Is the system functional or non-functional?	If functional, Actual Production of Biogas from the Plant (in m^3/day)	Application of biogas produced	Savings because of in-house generation of biogas (in monetary terms) (in Rs.)

7.7. Is there any composting plant within the establishment?

- ☐ Yes
- ☐ No

8. WILLINGNESS AND CONSTRAINTS

8.1. Are the hotel authorities willing to install Renewable energy based systems within the establishment?

- ☐ Yes
- ☐ No

8.2. If yes, please specify which all systems are the authorities willing to install among the following:

☐ Solar water heating system	☐ Solar thermal concentrator for steam generation
☐ Solar PV system	☐ Biogas system
☐ Building energy conservation system (please choose the right options) ☐ Roof shading ☐ Wall shading ☐ Window shading ☐ Solar film on windows ☐ Window glazing replacement ☐ Roof treatment (e.g. reflective coating on roof) ☐ Any other (please specify _____)	

8.3. If no, please specify the reasons for lack of willingness to install Renewable energy based systems within the establishment?

☐ Lack of awareness	☐ Cost	☐ Space constraint
☐ Maintenance problem	☐ Any other (Please specify _____)	

9. Please write in brief about any renewable energy based system adopted by the hotel establishment other than those discussed above?

_____

_____

_____

_____

10. Please fill-in the following details:

Name of the Respondent ……	Signature of the Respondent……
Designation ……	Seal of the Hotel……
E-mail ……	Date……
Phone Number……	
Mobile……	

RENEWABLE ENERGY AT TERI

The Renewable Energy Technology Applications (RETA) area at TERI focuses on a range of services in various fields such as solar photovoltaic, solar thermal, wind, and renewable based hybrid systems. The thrust areas and capabilities of the group include:

- *Renewable energy resource assessment*
- *Product development and demonstration*
- *Performance evaluation and field testing*
- *Renewable energy policy and planning*
- *Regulatory interventions for renewables*
- *Project development under clean climate initiatives*
- *Distributed generation and delivery models for electricity in rural areas*
- *Training and capacity building*

Particularly in the field of solar power space, TERI has been working with research institutes, technology suppliers, industry, as well as the governments; especially looking at solar power technology due diligence, resource assessment as well as detailed feasibility studies. Apart from these, TERI focuses on the complete value chain of solar power from the point of view of localization of its component The experts have extensive experience in developing solar energy related research infrastructure – in TERI as well as outside TERI. Moreover, TERI is in a position to exploit its excellent association with the research institutions of international repute like Solar Institute, Julich, Germany; Fraunhofer Institute for Solar Energy Technologies (ISET), Germany; and Institute of Energy Technologies (IFE), Norway.