Volume 65, Issue 5, 2021
Journal of Scientific Research
of
The Banaras Hindu University

Energy Performance of Hospitality Establishments in Coastal West Bengal and its Geo-consequences

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Abstract: **The energy performance of buildings is an important discourse in the study of sustainability sciences in both research and practice. Since Indian coastal belts are experiencing major tourism-driven hospitality activities, ascertaining the energy performance of these establishments during their operational phase assumes significance. These buildings are resource-intensive, function round the year, and are located in fragile natural environs and therefore have environmental concerns. This paper presents a baseline assessment of the energy performance of the hotels in the sea-front destination of Digha in the East Midnapore district of West Bengal based on a primary survey conducted on 100 nos. small and medium tourist lodges. It was found that their Energy Performance Index (EPI) varied within a range of 41.33 kWh/m^2/year to 159.55 kWh/m^2/year with a mean value of 83.31 kWh/m^2/year. Based on this result, the hotels were grouped into three categories of the low, medium, and high EPI.s, followed by each of their band averages and then comparing with the EPI benchmark recommended by The Energy and Resources Institute and the GRIHA Council, India. The exercise aimed at understanding the energy intensity of the hotel buildings so that appropriate regulations can be devised to reduce their environmental impact for all-round sustainable development.**

Index Terms: Energy, Environment, EPI, Hospitality, Sustainability

I. Introduction

Energy is the driver of our society and all economic activities across various sectors. Energy consumption by the building sector, particularly commercial buildings, has been a subject of serious academic research, wherein building operations have been found to be 80% of their life cycle energy consumption (Lai *et al*., 2019). Hospitality establishments belong to the commercial building sub-sector and generally operate round the clock and round the year, except on rare occasions or special locations. Being one of the cornerstones of tourism infrastructure and one of its key functionaries, these are also important for local, regional, and national economies. Like all other fields, environmental concerns related to sustainability and climate change pose challenges to this segment too, especially as building systems are known to be highly resource-intensive. Sustainable hospitality has emerged as a new research thread in cross-sectoral sustainability studies that aims to examine this topic across all levels of academia, research, and practice (Cavagnaro, 2012; Strickland, 2012). The rapid development of tourism infrastructure coupled with land-use changes and forest clearances have been one of the major causes of environmental degradation and excessive resource consumption, leading to the loss of core values of tourism itself. Sustainable hospitality forms an important cog in sustainable tourism and hence, integration of sustainable management systems in hospitality facilities is essential. This has linkages with environmental management (Muhanna, 2006), environmental certification (Bruzzi, 2014), low carbon economy (Legrand *et al*. 2014), green policy adoption in hotels (Bagur-Femenias, Celma, and Patau, 2016), and sustainable development goals as well as practices (Nwokorie and Obiora, 2018).

Considering the entire lifespan, a typical building worldwide has been found to account for up to 40 percent of energy use, 30 percent of solid waste generation, and 40 percent of CO_2 emissions (United Nations, 2006). The United Nation's Sustainable Development Goals (SDG17) focuses on energy efficiency and renewability as 'energy is the dominant contributor to climate change, accounting for about 60 percent of total global greenhouse emissions' (United Nations, 2015).

United Nations World Tourism Organization (UNWTO) mentions that hotels and other accommodations account for 2 percent of the 5 percent of the global CO_2 emitted by the tourism sector (UNWTO, 2020). UNWTO's Tourism for SDG.s (T4SDG) recognizes its energy-intensive nature and encourages renewable energy share in tourism. Additionally, UNWTO has also initiated the Hotel Energy Solutions (HES) toolkit that aims to support small & medium enterprises (SME) across Europe by recommending energy solutions against their assessed energy performances. It identifies heating-cooling, lighting, and guest services like warm meals, refrigerated drinks, hot water, swimming pool, etc. as major energy-consuming activities (HES, 2011a). It also points out that assessing the energy profile of the hotels is the first step to energy management (HES, 2011b).

Thus, it is important to examine if the hotels are energy-efficient enough in meeting their lighting, heating, and cooling demands and whether its energy consumption is within a nationally accepted threshold. The Energy Performance Index or EPI is used to measure the annual energy consumed by the buildings and is expressed in kWh/m^2/year. EPI can be used to gain an understanding of the energy intensity of these structures so that a regulatory framework could be devised by the concerned authorities. The present paper attempts to assess the energy performance of the hotel establishments in Digha, a popular sea-front destination in the East Midnapore district of West Bengal. The study is based on a primary survey conducted by the authors on 100 nos. tourist lodges of different sizes and scales belonging to the SME bracket. This study documents the baseline energy consumption scenario in the Digha tourism belt and therefore, can be used for informed decision-making by policymakers and stakeholders.

II. Study area: Location and general description

The study area covers the tourism-dominated areas of both Old and New Digha, which is located on the western edge of the Bay of Bengal about 200 km from Kolkata, the state capital of West Bengal, India. Its geographical location is 21°38′18″N 87°30′35″E and came to the fore in the 1920.s through an English businessman. In course of time, the shallow sandy quiet beach grew in popularity and currently, is a well-visited weekend beach destination almost throughout the year, particularly for the domestic tourist traffic. Having good connectivity coupled with easy accessibility, it has also reported a high volume of day-trippers. The destination's attractiveness has been further augmented in recent times with high-end infrastructural developments. Administratively, the tourism belt falls under the Digha Sankarpur Development Authority (DSDA) with its office in Digha (DSDA 2020). The seven km long beach front is crowded with numerous hotels that are only increasing by the day. It's a thriving economy providing employment and livelihood opportunities to many. Plate 1 indicates the location and the density of these tourism establishments.

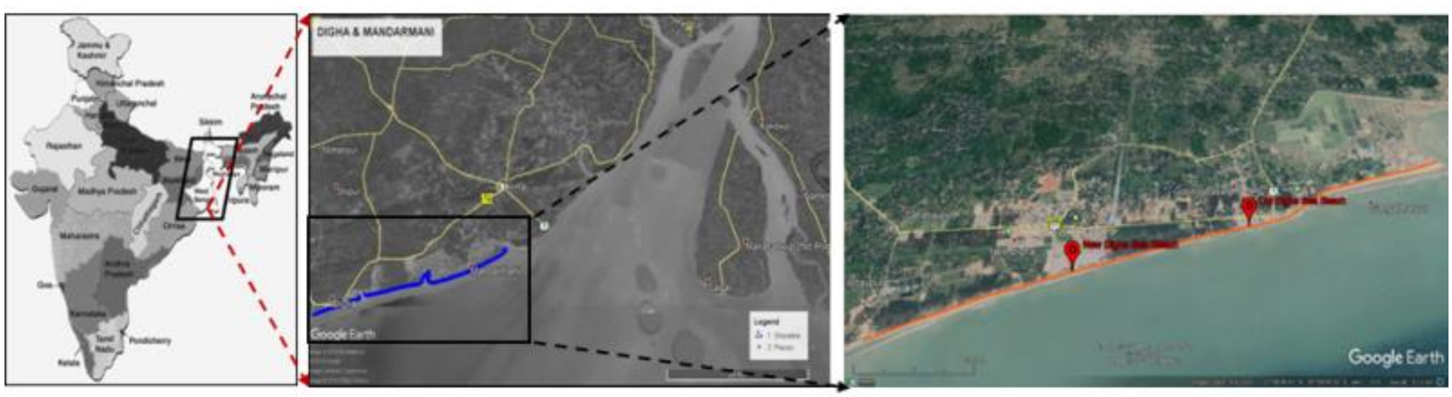

Plate 1. Study area location shown in Google map

III. The methodology of the study

The study involved extensive site visits and surveys, based on a literature review on two parallel tracks - sustainable buildings and information on the Digha hotels. DSDA office provided all major information about tourism inflow and the number of hotels and lodges. It was found that as of date, there are a total of 620 hotels operating in both Old and New Digha, mostly within the SME service sector, with the number of employees not exceeding 50 heads. The second step was to select appropriate hotels that could be studied for their energy consumption intensity. This depended on some objective considerations like size and scale of the hotels (built-up area, no. of floors, and bed capacity) as well as the logistic aspects of receiving support and cooperation from the hotel management in the study. In the process, 100 hotels were selected and surveyed through a predesigned questionnaire that aimed to extract the required data through systematic closed-ended questions. At step three, the following scoping and framework considerations were set up for this study based on preliminary reconnaissance and initial findings:

i. The climate of Digha is warm-humid, with an average temperature of 26.3°C. May is the hottest month with 34.2°C maximum temperature and 76% humidity. The lowest maximum temperature is 25.1°C in January. Humidity varies between 65% in December and 86% in September. (https://en.climate-data.org/asia/india/west-bengal/digha-173654/#climate-graph). Digha experiences high thermal discomfort due to the sultry weather conditions for most of the year. This has a direct impact on the energy demand of the hotels.

ii. All the tourist accommodations have their guest rooms equipped with room air-conditioners to provide adequate thermal comfort to the guests.

iii. These accommodations operate seven days a week and have nearly 80 percent occupancy round the year.

iv. Tourist facilities operate on grid-based electricity supplied by the West Bengal State Electricity Distribution Company Limited (WBSEDCL). The energy bills are issued quarterly and the survey obtained information on the electrical units consumed in a typical quarter.

v. The setups also retain a backup power supply with their diesel generators that are used for a short while each day and kept reserve for major power failure. Further inspection revealed that the generators are used to run the water pump every day to keep these in working condition and hence, prepared for emergencies. The study considered a running time of 30 minutes per day for these generators and consequent energy consumption. A Power Factor of 0.8 was used to calculate the energy generated by the DG sets.

vi. Thus, electrical energy consumption based on the use of purchased electricity and captive generation through the diesel generators has been considered to assess the EPI. Energy usage on account of on-site use of coal, wood, and LPG, if any, are not reflected here.

vii. In Digha, the hotels have both residential and commercial electric meters. This was also taken into account while recording the electrical units consumed.

viii. Questionnaire composition was made in two parts:
(i) Basic information about the hotel, a sample is shown in Table I for a typical hotel,
(ii) Information about energy consumption through electricity and generator, a sample is shown in Table II for the same hotel.
The hotels have been named H1, H2 ... H100 to keep their identity private.

Table I: Basic information about the hotel

i.	Hotel ID & ownership	H1, private ownership
ii.	Total Land Area	434.78 m^2
iii.	Built-up Area (BUA) & No of floors	920 m^2; four
iv.	Bed capacity	160 nos.
v.	Average occupancy in a year	80 percent
vi.	Other comments (as per hotel management)	▪ Air Conditioned rooms are equipped with a geyser. ▪ The hotel does not offer any dining space.

Table II: Information about energy consumption through electricity and generator

i.	Power Supplier & Meter type	WBSEDCL; Commercial	
ii.	Average Units consumed per Quarter (i.e. for three months)	18636.36 units	204.04 units of electrical energy consumed per day on an average
iii.	Generator Capacity	One DG set of 82.5 kVA	Green generator (soundproof)
iv.	Average no of operational hours of the generator	15 hours in a month	30 minutes per day

Finally, at step four, the total energy consumption from electricity and diesel generator (DG) for the particular hotel H1 was calculated by simply adding the two components after accounting for the operational hours of the DG, as presented in Table III.

Table III: Calculation of total energy consumption in the Hotel H1

Energy source	Type	Rating (kVA)	Power Factor 80% (kWh)	Quantity (nos.)	Operational hours per day	Energy used per day (kWh)
		a	a* 0.8	b	c	A
Electrical Meter	Commercial	-		-	-	204.04
Diesel Generator	DG set	82.5	66.00	1	0.5 hours	33.00
TOTAL						237.04 kWh
Total energy used per day per unit BUA of the hotel = ($\sum$A / BUA) = 237.04 /920 m^2 = 0.257 kWh/m^2/day.						
Total energy used per year per unit BUA of the hotel i.e. its Energy Performance Index or **EPI**= 0.257 kWh/ m^2*365 = 93.8 kWh/m^2/year						

IV. RESULTS AND DISCUSSIONS

The methodology was repeated for the hundred hotels and it was found that the EPI ranged from a lowest of 41.33 kWh/m^2/year to 159.55 kWh/m^2/year with an average of 83.31

kWh/m²/year. The hundred EPI values thus obtained were studied closely and were classified under three bands and grouped as low, medium, and high:

[i] Low energy consumption of less than 50 kWh/m²/year

[ii] Medium energy consumption in the range of 50-100 kWh/m²/year and

[iii] High energy consumption of more than 100 kWh/m²/year. These three classes are represented in green, orange, and red bars respectively in figure 1. It is seen that only 6 percent of the hotels studied have a low energy footprint while almost two-third i.e. 66 percent of these fall under the medium energy consumption class and the rest 28 percent are in the high energy consumption band, implying that close to one-third of the hotel facilities lie in the highest EPI band. A scrutiny of the hotels within each range shows that although the EPI is somewhat related to the built-up area or bed capacity of the establishment concerned, it is not exactly proportional.

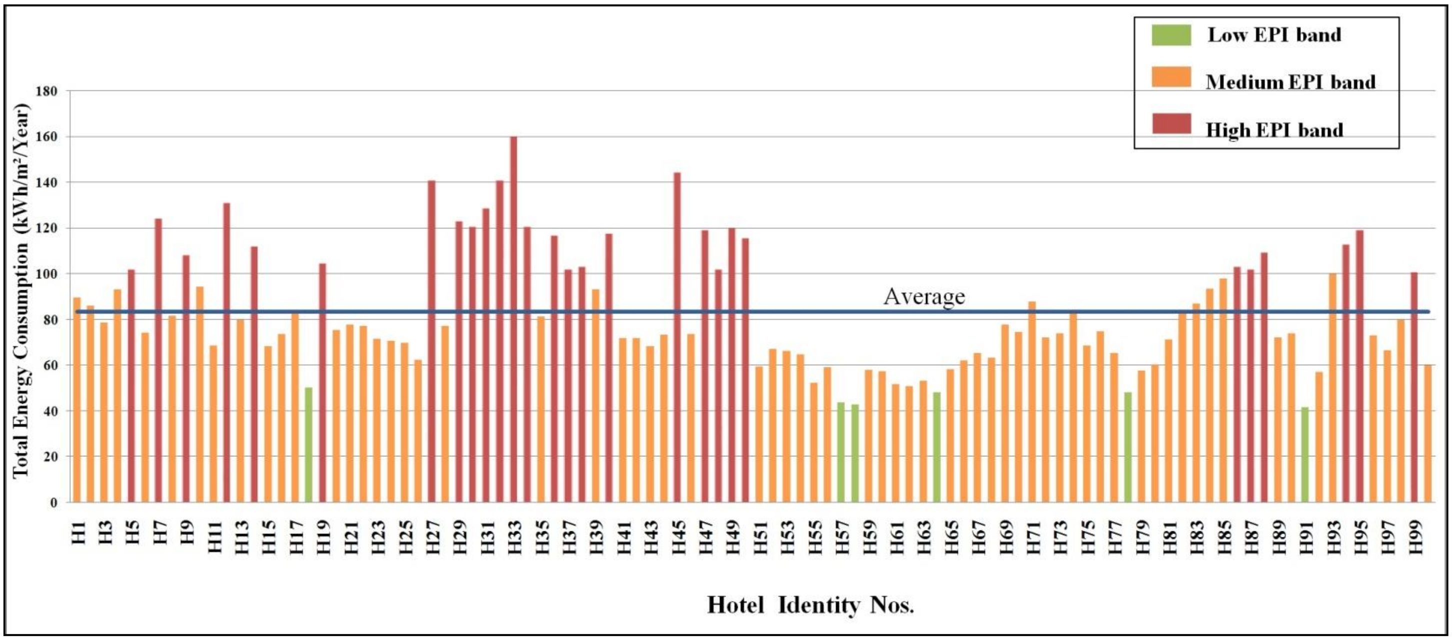

Fig. 1. Energy Performance Index in kWh/ m²/Year of the select 100 hotels of the Digha Tourism belt, W.B.

The architectural design of the hotel, solar exposure and its passive cooling abilities, use of other electrical equipment, and behavioural pattern of the tourists, as well as management, also play important roles in the energy consumption patterns. Tourist facilities having dormitories were found to have a lower EPI owing to increased energy sharing per guest. Similar studies (Bardhan, Chattopadhyaya and Hazra, 2010; Bardhan, 2012) in the Bakkhali coastal area of the Indian Sundarbans found the energy performance index of local lodging facilities to be in the range of 107.17 kWh/m²/year and 198.68 kWh/m²/year that corroborate well with the present findings.

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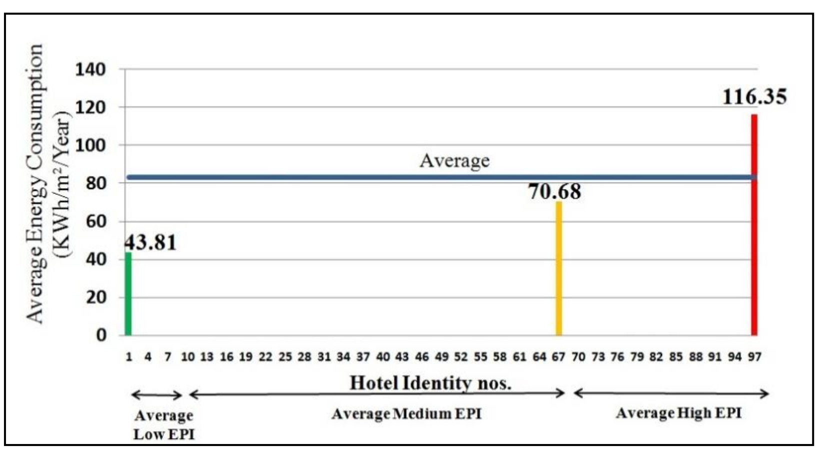

Fig. *2.* Average Energy Performance Index in kWh/m²/*y*ear of the three bands

Figure 2 indicates the average EPI of each band and while the low and medium ranges are relatively low, it is the high EPI band representing 28 percent of the samples that raises sustainability concerns in the coastal tourism scenario. Figure 3 indicates the percentage distribution of the hotels in the three EPI bands. The next step was to compare the results against a nationally acceptable EPI threshold that can be used to assess these in objective terms. The Energy and Resources Institute's Green Building rating tool named 'Green Rating for Integrated Habitat Assessment' or GRIHA- an Indian Green Building rating system has set the EPI ceiling for hospitality buildings operating seven days a week in warm-humid climate zone at 275 kWh/m^2/year (GRIHA, 2019), which may be further modified for lesser occupancy hours per day through a prescribed extrapolation process (GRIHA, 2015).

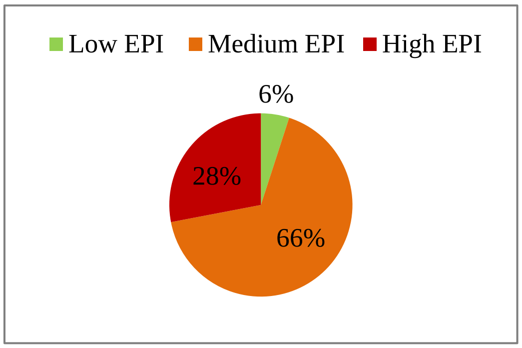

Fig. 3. Percentage of hotels in the three EPI bands

Since tourists spend considerable time outdoors in the sea beach, it may be considered that the air-conditioned spaces of these hotels are occupied for about 10 hours per day on average, meaning that the GRIHA benchmark may be adjusted to [275 x (10/24)] = 114.6 kWh/m^2/year for the hotels at Digha. Inspection of the individual EPI.s of the samples studied shows that about 16 hotels exceed this threshold. These hotels belonging to the high EPI band constitute 57 percent of this class and 16 percent overall. This percentage of the sample study will scale up the number of hotels having higher EPI than the GRIHA benchmark when seen cumulatively. Out of the 620 hospitality facilities operating in the coastal destination, more than 99 facilities are likely to fall in the high energy intensity category.

V. IMPACT ON EARTH AND ENVIRONMENT

Other significant co-findings and observations from this study are:

The energy content or calorific value of diesel is about 10 kWh per Litre and the total energy losses to the environment might be as high as 70% (Gomez and Watterson, 2006) i.e. conversion efficiency of the generator is about 30%. This means 70% of the diesel burnt is escaping into the atmosphere as heat, increasing the entropy. Along with air pollution, diesel generators also add to the micro-climatic rise in temperature and push up the cooling energy demand.

Carbon dioxide (CO_2) is emitted into the atmosphere through fossil fuel combustion. It is the primary greenhouse gas (GHG) that traps heat and has a Global Warming Potential of 1. Since the hotels are using fossil fuel-based energy, the EPI is directly related to the carbon emission caused by the energy end uses. This study converts the mean EPI into its corresponding carbon footprint. This is the product of the EPI and the emission factor i.e. the average emission rate of the particular fuel source/s. The emission factor of electricity was considered as 0.9 kg/kWh CO_2e (IEEE) as it is a coal-based energy supply. Since the captive electricity produced by the DG set is already factored in the EPI, the emission factor of oil-based energy has been omitted in the carbon footprint assessment. The mean carbon footprint works out to be about 75 Kg CO_2e /m^2/year, ranging between 143.6 Kg CO_2e /m^2/year and 37.2 Kg CO_2e /m^2/year. The total carbon emission from hotel energy consumption is, thus, substantial as most hotels occupy fairly large built-up area.

CONCLUSIONS

The paper has presented a baseline study on the assessment of the energy performance index (EPI) of the hospitality buildings in the Digha tourism belt of West Bengal, India. This exercise aimed at understanding the current status of the energy practices of this segment to lead to a robust energy regulation for them.

The study found that the EPI of the one hundred hotel facilities surveyed was between 41.33 kWh/m^2/year to 159.55 kWh/m^2/year. The lodges were then classified under low (6 percent of the total sample), medium (66 percent of the total sample), and high (28 percent of the total sample) EPI categories with EPI averages of 43.81 kWh/ m^2/year, 70.68 kWh/m^2/year and 116.35 kWh/m^2/year respectively, and a mean value of 83.31 kWh/m^2/year. The high EPI lodges were further scrutinized to compare with the recommended EPI benchmark and 57 percent of this band, which is 16 percent overall, was found to be higher than the threshold. Hence, it is essential to introduce energy optimization and management in these hotels. In the climate change context, energy needs are likely to go up, especially for heating and cooling (Cao, 2016) and these energy profiles can serve as the starting point for energy efficiency planning and management. These establishments may gain in realizing that the co-benefits of better energy performance are lower operational costs and improved competitiveness (Kular, 2014).

Building automation and renewable energy retrofits in these buildings will potentially offset a substantial load of fossil-fuel-based energy consumption. Solar Photo Voltaic (PV) applications are the foremost among the renewable as it utilizes solar energy without any noise pollution or emission. PV with its Balance of System (BoS) can allow the use of the energy at night or when required. The energy use pattern also has a direct implication on carbon emission. The mean Carbon footprint of the surveyed hotels was found to be about 75 Kg CO_2e /m^2/year.

The individual emission profiles of all the facilities can be derived from their respective EPI.s to understand their cumulative contribution to global warming. Future studies of these hotel facilities need to cover other equally significant indices involving resources like natural habitat, water consumption, solid waste management, air/water/noise/visual pollution, loss of greeneries and biodiversity, etc. to come up with a wider regulatory framework for the development of a sustainable coastal development model in the country.

ACKNOWLEDGEMENT

The authors thank the management and staff of the hotels for their kind cooperation in this survey. The authors are also grateful for the valuable review comments that helped to improve the paper to a great extent.

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