Journal of Sustainable Development; Vol. 12, No. 6; 2019
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

Hotel Energy Application Practices in Abuja Nigeria

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Received: September 2, 2019 Accepted: September 29, 2019 Online Published: November 28, 2019

doi:10.5539/jsd.v12n6p27 URL: https://doi.org/10.5539/jsd.v12n6p27

Abstract

The recent increase in prices of energy resources and effects of global warming propelled the growing relevance of improving energy efficiency especially in an energy intensive industry like hotels. This study examines the hotel energy application practices in Abuja Nigeria. The study administered questionnaires to hoteliers in Abuja Nigeria. Data collected was analyzed using descriptive technique. The results indicate hotels in the study area are of divergent physical and operational characteristics implying varying energy consumption and efficiency positions. The respondents aggregated mean ranking on hotel service provision shows all identified services as excellently or very well provided, except for electricity warmed pools which was ranked neutral. Predominantly three types of energy resources were utilized by hotels in the study area which includes grid supplied electricity, diesel and cooking gas respectively. The study recommends the adoption of Demand side management approach to checkmate guest and staff inefficient behaviors' in addition to regular energy audits and employing renewable resources to straighten the track of the hotel's energy consumption towards sustainability.

Keywords: hotel, energy, management, practices

1. Introduction

Energy is a strategic commodity that remains vital for fuelling economic growth and social development. Accordingly, the global energy consumption remains on the increase ensuing variety of environmental issues among which is the greenhouse gases (GHGs) emissions believed to be widely behind the global warming problem (Lai, 2016). An appraisal of global energy consumption by the building sector disclosed 30% to 40% scope, contributing 25% to 35% world's carbon iv oxide ($CO_{2)}$ emission (Batagarawa, 2013; United Nations Development Programme, 2012).

The ratings of energy consuming public buildings ranked hotels among most prominent (Chung & Park, 2015; Järvensivu, 2014; 2015; 2013; Priyadarsini, Xuchao & Eang, 2009). This is ascribable to the nature of their operations that requires energy on a daily basis regardless of season, accommodated number of guests and localisation (Kasim, 2007; Deng, 2005). An estimated detrimental 160kg to 200kg per square meter of room floor area carbon dioxide gas emissions is associated to the various energy resources consumed by the hotels (Bohdanowicz, Churie-kallhauge, Martinac, & Rezachek, 2001; Placet et al., 2010; Solutions, 2011). Moreover, the consumptions of these resources is for meeting the broadened hotels demands for space heating, cooling and ventilation, heating water, lighting, laundry, kitchen, recreation and miscellaneous. However, the consumed energy resources are further defined by hotel's physical and operational parameters (Dascalaki & Balaras, 2007).

Considering the decisive role of the tourism industry in any economy and the Nigerian aspiration of enhancing its clean development mechanism efforts towards efficiency in energy application pattern particularly in energy intensive industries like the hotel industry should be a priority. In view of that the study outlined the following objectives:

i. To determine the dominant hotel features and services in Abuja, Nigeria.
ii. To assess the prevailing hotel energy use profile in Abuja, Nigeria.

2. Literature

2.1 Theoretical Construct

This study is grounded on multiple causation theory which is an update of the Domino/Birds and Lotus theory. Propounded by Peterson (1987) and Heinrich (1931), the theory postulates that behind every accident there are

many contributing factors, causes and sub-causes combined together in a random fashion causing accident. The high energy costs incurred by hotels are believed to have resulted from multiple factors. This perhaps includes hotel features, services, energy use profile, thus an evaluation of these causes is required to clearly reveal the causes and sizes of their effect on hotel energy cost.

2.2 Hotel Features

The hotel features and attendant energy consumption can be considered under physical and operational lineaments. The physical characteristics normally addressing building size, structure and design usually influenced by architectural and construction practices which is often decided by age, geographic and climatic conditions of location. However, type of energy systems installations, method of operation and maintenance, local availability situations of energy and water resources, as well as energy use regulations and cost also influence these physical features (Hotel Energy Solutions, 2011).

Concerning operational parameters that influence energy use in hotels include operating schedules for the different functional facilities in the hotel building, the number of facilities (restaurants, kitchens, in-house laundries, swimming pools and sports centres, business centres, etc.), services offered, fluctuation in occupancy levels, variations in customer preference relevant to indoor comfort, onsite energy conservation practices, as well as culture and awareness of resource consumption among guests and staff (Solutions, 2011).

According to Bohdanowicz *et al.,* (2001) hotel size, category, number of rooms, guest profile, location, climate, as well as the type of services and amenities provided to guests distinguishes hotels and considerably determines their energy consumptions. Furthermore, Priyadarsini, Xuchao and Eang (2009) suggest that the heterogeneous nature of hotels prevailed in their sizes, number of guest rooms, number of floors, star ratings and year of construction plays a role in deciding their energy consumption. However, there was a significant shift in past decade towards energy efficiency particularly in older buildings through major energy efficiency retrofits developed and some developing countries. In addition to the building energy retrofits some hotels incorporated building management systems for heightened energy efficiency(Placet et al., 2010). Moreover, it is worth noting that the level of sophistication related to energy efficiency retrofit and building management systems differ from one hotel to another.

2.2.1 Architectural Zones Related Variations

Architecturally, hotels are considered under three distinct zones in which each distinctly functions differently in use (Bohadanowicz & Martinac, 2008). The fluxes of energy passing in these three spheres are generally very dissimilar. Accordingly these distinct zones need to be handled differently to ensure efficiency. These include:

i. The guest room area: Often regarded as individual spaces, it encompasses bedrooms, bathrooms/showers, and toilets. These spaces have varying energy loads ascribable to the frequent utilization of extensive glazing and asynchronous energy systems.
ii. The public area: these spaces are often recognised with high thermal loses due to the high rate of heat exchange with the outdoor environment and also high internal loads from occupants, appliances, and lighting. These places include the hotel reception hall, lobby, bars, restaurants, meeting rooms' swimming pools, sauna, etc.
iii. The service area: considered as energy intensive areas, these spaces typically demand advanced air handling systems for cooling, ventilation, heating purposes. These spaces include that for offices, kitchen, laundry, store rooms, staff facilities, machine rooms and other technical sections.

2.2.2 Functional Floor Area Variations

Approximately the guest rooms cover an average of 64% of the entire hotel's gross floor area (GFA). However, this percentage is typically low in high luxury hotel category where more spaces are appropriated for leisure activities(Priyadarsini, Xuchao, & Siew, 2009). Furthermore, an average, 5.6% of the GFA are reserved for dining facilities which includes cafe, bar, restaurant and kitchen. However, Xuchao, 2007 point out that in some cases this may range between 1.3% of GFA and 6.4% of GFA.

An evaluation of 29 hotels revealed commitment of an area covering an average 6.4% of hotel GFA for convention facilities or/and spaces for tenanted offices in 27 hotels studied. Moreover, seven (7) out of the studied hotels devoted an average GFA of 15.9% ranging 653 m^2 to 10,362 m^2 as shopping centres. However, this largely applies to hotels situated on high streets, and usually the hotel's first floor is set aside for that purpose. Moreover the remaining spaces in the hotels serves as common areas, back of the house facilities, recreational facilities, and technical service rooms(Farrou, et al., 2012; Priyadarsini et al., 2009).

2.2.3 Air-Conditioning and Indoor Environment (Cooling and Heating Demand Variations)

Location parameter plays a significant role in hotel's cooling or heating requirements. Accordingly constant air-conditioning remains essential particularly in hotels located in hot and humid tropical climates(Bodach et al., 2016). Nevertheless, the Code of Practice mandates for an operating air-conditioning system to be maintained within an indoor dry bulb temperature of 22.5 8C to 25.5 8C range, while average relative humidity of 70% should not be exceeded (Hotel Energy Solutions, 2011)

Typically hotels are mostly centrally air-conditioned, except in boutique hotels where split units are employed for air conditioning the entire hotel building. Moreover, the practice in which hotels operate and maintain separate chiller plants is also common. However, some hotels jointly utilise two district cooling systems while chilled water pumped is billed on the basis of amount of refrigeration supplied to their premises(Chung & Park, 2015).

Other appreciated hotel air- conditioning and ventilation techniques include constant air volume (CAV) and variable air volume (VAV) systems usually employed in hotels' extensive public areas such as lobby and restaurants, while guest rooms are often ventilated using fan coil units (FCU)(Placet et al., 2010).

2.3 Energy Consumption and Occupancy Rate

Hotel occupancy rate is regarded among important factors that define hotel energy consumption. Thus, the necessity for normalizing changes in number of occupants and acknowledging same in base lining facility's monthly energy use positions (Reddy *et al*. 1997).

However, Priyadarsini et al. (2009) view number of occupants as vague parameter for measuring and keeping track of hotel energy consumption regardless of the fact that recording occupancy rate as crucial normal practice in hotel management.

The point of contention for occupancy records constituting relatively good indicator of the hotel population is recognised in usually not counted walk-in guests, such as those seeking restaurant services etc. Moreover, hotel energy use does not necessarily bifold when the number of occupants is doubled, indicating unlikely simple proportional relationship (Papamarcou & Kalogirou, 2007). This was further confirmed by Priyadarsini *et al.* (2009) where no clear exponential relationships could be perceived between occupancy rate and hotel energy consumption.

Additionally, an Australian tourism and resource report, (1999) revealed little effect of occupancy rates on hotel energy consumption even with room occupancy between 70% and 100% however the energy intensity only starts to drop off with below 70% fall in occupancy rates.

The more convincing explanatory factor for intensified energy consumption is guest behaviour towards energy use especially for high-class hotels, in which thermal discomfort and poor indoor air quality are less endured. Hence, high proportion of electricity is used for cooling particularly in tropical climates where continuous air-conditioning on higher temperature of guest rooms even when they are not occupied may have resulted in the electricity consumption insensitivity to occupancy rate(Priyadarsini et al., 2009).

2.4 An overview of Hotel Services and Facilities

Hotels represent buildings where people usually travellers can pay for lodging, meals and other offered services. Thus, to deliver such services effectively hotels must be able to sustain facilities such as constant clean water supply, un-interrupted power supply etc efficiently to serve as alternative homes(Durodola, 2009). However, apart from the fundamental hotels also provide leisure facilities such as swimming pools, squash courts and tennis which also draw not only travellers but also walk in guest to the hotels.

Although hotels represent one small component of the larger hospitality industry, it is arguably an important establishment of any economy.

According to Ali, et al., 2016; Bohdanowicz, 2006; Chan, 2012 hotels typically account for less than 5% of building stock in virtually every nation consisting of over 300 000 facilities providing accommodation to both national and international visitors.

Approximately, 160-200 million international visitors per year is reported in Europe alone inducing high degree of resource utilization such as energy, water, and consumables(Bohdanowicz, 2006) . Moreover, attendant environmental footprint usually greater than other types of buildings of similar size to hotels is attributed to the various resources consumed.

An estimated 55.6 TWh of energy/year consumption was reported in the year 2000 by the entire American

lodging industry including hotels, dormitories and other accommodation facilities(Bohdanowicz et al., 2001). Moreover, the prevailing power generation using fossil-fuel generates commensurate emissions of Carbon dioxide, Particulates, Nitrogen and Sulphur oxides, and other air pollutants(S. Wang, Yan, & Xiao, 2012).

According to Solutions, (2011) approximately a typical hotel releases between 160 and 200 kg of CO_2 per m^2 of room floor area annually, depending on the fuel used to generate electricity, heating, or cooling. These figures illustrate the pressing need for enhanced energy efficient practices in the hotel industry.

2.5 Hotel Energy Use Profile

The exclusive consumption electricity is common with most public buildings such as offices. However, the diverse nature of hotel activities often demands the use of more than one type of energy source (Shiming & Burnett, 2002)

Ordinarily, the hotel energy use mix mainly comprises of electricity, fossil fuel such as diesel and gas. However, renewable energy resources are presently to some extent admitted to the resource mix utilised(Yao, Zhuang, & Gu, 2015).

2.5.1 Electricity

Review of preceding hotel energy consumptions revealed electricity as the main resource utilized for the purpose of powering HVAC systems, lighting, vertical transportation, and nearly all equipments (Priyadarsini, Xuchao & Eang, 2009).

According to Shiming and Burnett (2002); Priyadarsini, Xuchao and Eang (2009) an average 73 to 77% of the entire energy use in hotels is prevailed by electricity use.

Furthermore, Xu et al., (2015) and Panayiota & Santamouris, (2015) determined between 100- 200kWh/m^2 rate of electricity consumption in Beijing hotels, also an average 342 kW h/m^2/year electricity consumption was found in Hong Kong hotels. Incidental growth in the number of hotel properties is anticipated to facilitate future increase in the amount of energy consumed by hotels in these cities. Thus, the overall hotel sector's energy expenditure is effectively determined by the overall quantity of electricity used in hotels. However, both outdoor air temperature and the number of guests were found to influence hotel electricity consumption with the former being the stronger influencing factor(Priyadarsini et al., 2009; Shiming & Burnett, 2002).

2.5.2 Gas

Generally gas use accounts for 8% share of the entire energy use, thus considerably smaller when compared to electricity. This is because gas is solely consumed in the kitchen for cooking purposes, but in some rare instances hotels use gas for boilers (Priyadarsini, Xuchao & Eang, 2009). Although the number of guest and that of food covers made were perceived factors affecting hotel gas consumption, however no strong correlation was obtained between gas consumed and food covers made. Potentially the weak correlation explicates the fact that for most hotels Chinese kitchen practically consumes more gas for different dishes which is significantly different for the same number of food covers made (Shiming & Burnett, 2002).

2.5.3 Diesel

In Singapore diesel use account for 15% of the entire hotel energy use (Priyadarsini, Xuchao & Eang, 2009). Occasional standby electricity generation and hot water or steam generation dominates diesel use in some hotels. However, in the former case insignificant consumption is obtained, often negligible for the purpose of monthly or even quarterly test-running of emergency generator to ensure it is functional (Xuchao, 2007).

Despite the undistinguished diesel use by the hotels when compared to electricity, it as well represents the second most widely resource utilised. This evident in the 15% and about 20% share reported in Singapore and Hong Kong hotels respectively(J. C. Wang, 2012). However, it is worth noting that diesel boilers are responsible for substantial amount of diesel consumed.

2.5.4 Renewables

Clean energy generation is the trending thing today such that a building is required to generate its own energy by using clean renewable sources like energy from water (hydroelectricity), from the sun (solar energy), from wind (wind energy) and others (Barrett, 2012).

The integration of renewable resources for an isolated energy generation in newly constructed buildings and incorporation of same in energy efficiency retrofits gains more popularity. Although the utilization of particular resource is influenced by its availability in the area of application, solar thermal was found to be more affordable than solar photovoltaic with both experiencing advances in popularity(Thiel et al., 2013). Moreover, wind

turbines suitable for use in taller buildings such as skyscrapers are also becoming available and affordable and can be incorporated in green retrofits (Kumbaroglu & Madlener, 2012). Although restrained to limited geographical areas, geothermal energy production and use is projected to be cheaper than solar and deserves aggressive harnessing (Emodi & Ebele, 2016).

Regardless of the influence of location and climatic conditions regulating the solar intensity, wind power, humidity, cloudiness and particles in the air, adoption of renewable energy is perceived to improve the environmental performance and energy efficiencies of buildings (Tam, 2011). An inventory of hotel renewable resource use demonstrates more impressive developments in Greece where the use of solar thermal systems for hot water supply in over 100 hotels was reported, out of which 41.40% are in Crete, 2.1% in Northern Greece while the remaining 56.5% spreads across the rest of the country (Panayiota & Santamouris, 2015).

2.5.5 Hotel Energy Consumption in Relation to End- Uses

Regarded as the largest exclusive hotel energy end-user, space conditioning encompassing heating/cooling, ventilation and air conditioning accounts for roughly half of the entire energy consumption(Yan et al., 2012). Moreover, outdoor weather conditions and floor areas having great influence on indoor temperature levels largely determines the quantity of energy consumed in a hotel building(Hui & Wan, 2013). Domestic hot water is the second largest user usually responsible for up to 15% of the entire energy demand(Placet et al., 2010). However, depending on the hotel category the lighting share fluctuates between 12-18% and up to 40 % of hotel's entire energy consumption. Services such as catering and laundry as well account for significant share of hotel energy consumption especially due to the fact that they usually constitute the least energy efficient services. Similarly, Sports and health facilities also typically constitute high energy consumers(Goldstein & Primlani, 2012)

Similar results have been reported in Greek hotels where 72-75% of the entire energy consumption is used for space conditioning (heating and air conditioning) and for hot water supply, lighting accounts for 8-9% ,while catering accounts for 15% use (Hotel energy solutions, 2011)

In addition, Panayiota and Santamouris (2015) reported that heating and air-conditioning constitute about 48% while catering (kitchen facilities) 25% of hotel sector's energy consumption, making the duo highest energy consuming end-users. Whereas domestic hot water supply, lighting and other electrical appliances represent 13%, 7%, and 7% respectively.

The prominence of (HVAC) and (DHW) in hotel energy consumption demands disintegrating the hotel energy consumption into major end-uses like HVAC, DHW, lighting and vertical transportation with constant monitoring of these systems for enhanced efficiency.

Additionally, HVAC monitored data indicates central plant presents 39% of the electricity use representing the largest consumption share, followed by air handling unit(AHU)and fan coil unit (FCU) which accounts for 24% of electricity use (Priyadarsini et al., 2009).

Backed by availability of year-long data that ensure high accuracy, the energy consumption of district cooling systems and chiller plants are separately metered for billing purpose in the same hotels. The proportions of chillers' plant (inclusive of cooling tower, condensing water pumps) energy consumption were found to be 40%, 44% and 35% of total electricity use in the hotels (Priyadarsini et al., 2009).

Apparently no relationship was found between hotel category and the method of DHW supply employed regarding domestic hot water (DHW) produced using electricity, diesel or gas boilers, since all the three techniques are obtainable in hotels of different categories. However, the diesel boilers are generally perceived to be quite inefficient, even though inadequate information impedes drawing decisive conclusions(Priyadarsini et al., 2009).

3. Methodology

This study used literature from hotel energy management practices to design a structured questionnaire. To establish the validity of the data collection instrument, ten (10) academics pre-test the questionnaire while Cronbach's alpha was used to establish reliability with recorded values of 0.7 and above; revealing it is reliable. Five (5) copies were subsequently administered disproportionately to four (4) senior technical staff of rated hotels within the eight (8) districts of phase I Abuja, Nigeria. The staffs were drawn from 24 hotels out of a sample frame of 25 hotels (Krejcie& Morgan, 1970). They were chosen from operational departments namely; housekeeping, engineering and maintenance, food and beverages, and accounting from each of the 24 hotels. Based on their experience the selected staffs were found knowledgeable in the hotel energy management. The hotels studied are those that conform to the standard descriptions moderated by the Nigeria Tourism

Development Corporation hotel grading and classifications.

The questionnaire records 86% response rate and the data obtained were analysed using SPSS. The analysis conducted was descriptive statistics: frequencies, percentages, mean score rankings, and standard deviation. Respondents were requested to use a 5 point Likert scale: excellent (above 4.00), very good (3.00-3.99), neutral (2.00-2.99), (1.00-1.99) and very poor (< 1.00).

Table 1. Respondents' demographic data analysis

Attributes	Frequency (N=407)	Percentage (100%)
Gender		
1 Male	316	77.6
2 Female	91	22.4
Educational qualification		
1 Informal/Primary Certificate	10	2.5
2 Secondary School/Certificate	8	1.9
3 National Diploma/NCE	115	28.3
4 Bachelor's degree/HND	202	50.0
5 Master's Degree and above	72	17.7
Status in the hotel		
1 Management Staff	278	68.2
2 Technical Staff	114	28.0
3 Auxiliary Staff	15	3.8
Working experience		
1 Under 5years	29	7.0
2 Between 6 – 10 years	137	33.8
3 Between 11 – 20 years	191	47.1
4 Between 21 – 30 years	29	7.0
5 Over 30, years	21	5.1
Hotel classification (category)		
1 0-1 Star	1	0.3
2 2- Star	84	20.6
3 3- Star	234	57.5
4 4- Star	31	7.6
5 5- Star	57	14.0
Source of hotel classification		
1 International tourism body	119	29.3
2 Nigerian tourism board	239	58.6
3 Hotel formulated	49	12.1

4. Results and Discussions

Considering the hotel's building features, the study findings revealed most of the hotels (representing about 60%) were of age ranges 1 to 15 years. While majority of the hotels (about 54%) have gross floor areas between 5,001m^2 and above. Also most of the hotels (more than 96%) have number of floors ranges between 1- 20 floors, while More than half (50%) of the hotels' numbers of rooms are between 1 to 150 rooms. The result also indicated that most of the hotels' buildings' orientations (about 55%) were of East-West and Cross-Nordal window facing openings orientations, Moreover a substantial portion of the hotel(about 45%) are of North –

South window facing openings orientations. The findings further indicate that most of the hotels (about 65%) buildings plan form is compact form type.

Regarding the hotel operational features' the results revealed that of the hotels (more than 70%) have weekly occupancy level of 301 guests and above, While most of the hotels (more than 70%) have number of employees between 201 employees and above. The study also indicated that most of the hotels' (90%) have frequencies of renovation between 5 years and above. The results further revealed that majority of the hotels (89.2%) upgrade existing engineering system/equipments between 5-10 years.

The outcome of the study regarding hotel ages is not surprising due to the fact that Abuja is a new capital city which officially became Nigeria's capital in the year 1991, replacing Lagos. Although development of the city mainly happened in the 80' however, the developments are mostly governments related (Ujoh & Ifatimehin, 2010). Moreover, the hotel ages in Abuja could be linked to the return to democratic rule in 1999 which according to Damilola & Oluwatosin (2017) contributes significantly to the evolution of hotel industry in the last 15 years. This by implication is expected to enhance the hotel energy efficiency because the hotels are expected to have higher insulation thereby reducing energy leakages (Saad, Hewedi, & Abdel-maboud, 2012).

However, the findings on gross floor area indicate varying sizes of hotels in the study area. This also concurs with the study findings of Panayiota and Santamouris (2015); Shiming and Burnett (2002) which revealed that the hotels are of diversified sizes in relation to their gross floor area. Similarly this further explains the differences in the number of floors and number of rooms in hotels across the study area. As such, the hotels will have varying energy consumption as indicated in the study interview results.

In spite the fact that the study findings regarding building window openings orientations shows about 54% of hotels not in harmony with energy efficient orientation, however a significant portion of over 45% are of North and South window facing openings orientations which is regarded as an optimized orientation crucial in reducing direct solar irradiance and supporting energy efficiency compatible with the bioclimatic condition of the study area. This in addition shows that a significant portion of the hotels meet up with the recommendations of Nigerian Energy efficiency guideline which suggests minimizing building orientation in relation to the sun path is important in achieving energy efficient buildings (Federal Ministry of Power, 2016). Nevertheless, the need in that regard for improvement cannot be overemphasized.

Moreover, the finding of the study indicates that most of the hotels (about 65%) buildings plan form is compact form type this could be connected to the increased awareness in bioclimatic design concept among professionals; however there is still need for improvement. The findings of the study supports the study conducted by Eludoyin (2013) which suggests that compact geometry is most preferred and good for passive strategies application in the hot and dry climate which describes the climate of the study area.

Regarding the hotel operational features which the results indicates that most of the hotels (more than 70%) have weekly occupancy level of 301 guests and above, and most of the hotels (more than 70%) have number of employees between 201 employees and above indicating high occupancy level with corresponding high number of employees is expected this is because Abuja is the capital city and the seat of power experiencing high influx of people for government-related businesses and activities. The findings corresponds that of (Lai, 2016) where 85.8% mean was obtained which typically indicates high occupancy rates and significantly anticipated to influence the hotel's energy consumption. Moreover, researches such as that of Reddy et al. (1997) and Priyadarsini et al. (2009) have reported with strong certainty that occupancy rate determines hotel's energy consumption . However, other related studies further described hotel level of occupancy as an unclearly defined parameter to measure and have the most accurate information about. Their argument was based on the fact that occupancy rate records is a normal hotel management practice that commonly does not account for walk-in guests, such as those patronizing the restaurants hence, such record is relatively not a good indicator of the population in a hotel. Moreover, Reddy et al. (1997) and Papamarcou and Kalogirou (2001) observed that a building energy consumption does not necessarily double with a bifold in the number of occupants indicating an improbable simple proportional relationship.

The study findings on frequency of renovation which shows majority of the hotels (about 62%) carrying-out renovation activities between 4-6 years and also majority (about 89.2%) upgrade existing engineering system/equipments between 5-10 years clearly indicates a poor maintenance culture which is expected to impact negatively on the hotel energy consumption and by implication the hotel energy costs.

Moreover, behaviour plays a vital role in the maintenance culture of the society; research further indicates correlation between frequency renovations of buildings and their energy consumption. A study by Lewis et al. (2011) showed the existence of an interdependent link between energy use and maintenance management of the

buildings. Additionally, Lai (2016) found Moderate, positive correlation between the entire raw energy consumption and cost for repair and maintenance (r = 0.4138; sig. 0.0257). The findings revealed little association between maintenance costs and the hotel entire energy consumptions. However, regardless the preceding findings Lai (2016) further observed that rather than hotel maintenance resources, the hotel prevailing physical and operational characteristics determines the amounts of energy they consumed. Such that, whenever a facility uses energy recklessly or wastefully allowed equipments and appliances operating in unoccupied venues, the energy consumption would be high accordingly no matter the amount of resources devoted for the facility's maintenance.

Table 2. Hotel service provision

S/N		Mean	Std. Deviation	Rank
1	Accommodation	4.8790	.32719	1
2	Restaurant	4.6879	.57572	2
3	Internet	4.3439	.63764	3
4	Laundry	4.2420	.99615	4
5	Banquet	4.1975	.95030	5
6	Computer centre	4.1019	.75264	6
7	Leisure	3.9936	1.05306	7
8	Shopping	3.3885	1.22814	8
9	Catering	3.3567	1.32536	9
10	Electricity warmed Pools	2.2102	1.51078	10

The findings from mean ranking of ten (10) key services provided by hotels shows highest services provided by the hotels are accommodation, restaurant, internet, laundry, banquet and computer centre services respectively. However, other services such as leisure, shopping, catering is less provided while electricity heated swimming pools services is the least provided service by hotels in the study area.

The mean ranking analysis results of ten (10) key services provided by hotels which indicated the most common service provided by the sampled hotels in the study area is accommodation with mean of 4.8790 while the least electricity warmed swimming pools with mean of 2.2102 was not surprising because accommodation provision is the primary objective of hotel facilities. The outcome is also consistent with the study findings of Durodola (2009) and Järvensivu (2014) which indicated that accommodation provision is the core product of hotel organizations to which other facilities are adjunct to or are augmented products. Their argument is further substantiated by Bevan (1991) which suggested that hotel facilities are instruments of marketing accommodation.

Other identified key services provided after accommodation include restaurant with mean of 4.6879, internet with mean value of 4.3439, and laundry with mean value of 4.2420 and the least provided services after electricity warmed pools by the hotels in the study area were outdoor catering with mean value of 3.3567 and shopping centres 3.3885 these results were in line with study findings of Durodola (2009) where the findings revealed glaring deficiency in areas of recreation (24%), and shopping facilities (29%) provision in the hotels studied in South-west Nigeria.

Table 3. Hotel energy use profile

SN	Energy Sources	Mean	Std. Deviation	Rank
1	Electricity (Grid)	4.8662	.45426	1
2	Diesel	4.2293	.71497	2
3	Gas	3.7197	.96632	3
4	Petrol	1.9299	.95484	4
5	Renewable	1.2803	.79125	5

The findings from mean ranking of five (5) basic energy resources utilized indicates electricity (Grid supplied), diesel and gas respectively are the major energy sources used in the study area. However, other sources such as petrol and renewable respectively are the least energy resources used by hotels in the study area.

Similarly, water heating and air-conditioning were found to be the high ranking energy consuming end- uses interchangeably in relation to grid supplied electricity consumption and diesel consumption while ventilation rank least end- use respectively. Kitchen for cooking purposes is the highest ranking end-use in relation to gas consumption.

The study finding on the hotel energy use profile which indicated varying combination of energy resources used with electricity (Grid supplied), diesel and gas respectively as the major energy sources used in the study area is expected. This due to the nature of hotel activities which often use more than one type of energy sources to accommodate their diverse activities. The study findings agree with that of Priyadarsini, Xuchao and Siew (2009); Shiming and Burnett (2002) and Xuchao (2007).

Despite the challenges of supply shortages in the country, the study findings revealed that electricity is ranked the most widely used energy resource with mean value of 4.8662. It is used to power HVAC, lighting, vertical transportation, and most of the hotel equipments. The study findings supports that of Priyadarsini, Xuchao and Eang (2009), Kapiki (2010), Panayiota and Santamouris (2015), Shiming and Burnett (2002). However, this relative positive development could be linked to the study findings of Muazu (2012) which indicates that Abuja accounts for over 10% of the total annual electricity delivered from grid, making it the 4th highest consumer and ranking ahead of other older established cities including Port Harcourt, Kaduna, Kano and Jos. In addition to that energy supplies to neighboring settlements were often diverted, in order to complement energy shortages in the capital which calls for an improved infrastructure base to avert imminent significant energy shortages upon completion of subsequent phases of the city.

Contrary to study findings of Kapiki (2010; Panayiota & Santamouris, 2015; Priyadarsini, Xuchao and Eang (2009); Shiming & Burnett, 2002) where gas is the second most widely used resource in hotel facilities after electricity; Diesel ranked the second most widely used energy resource in the study area with the mean value of 4.2293. The outcome was not surprising and concurs with Muazu (2012) observation that almost 12-13 million litres of fossil fuel are consumed daily on diesel powered generators used to supplement the electric energy shortages with all sectors actively pursuing this indulgence despite inherent potential adverse environmental implications. According to study by Priyadarsini et al. (2009), Xuchao (2007) and Shimming & Burnett (2002) in Singapore and Hongkong respectively, hotel diesel use is generally for standby electricity, hot water or steam generation. Moreover, diesel is merely consumed in regular monthly or even quarterly emergency generator test-runs to ensure it works. Therefore, consumption obtained is insignificant often negligible. However, the diesel use situation in the study area revealed soaring utilization which negates the sustainable development goal.

Gas is the third most widely used resource in the study area and mainly used for cooking. Although the study findings similar to that of (Kapiki, 2010; Panayiota & Santamouris, 2015; Priyadarsini, Xuchao and Eang (2009); Shiming & Burnett, 2002) on usage however, differs according to their study in ranking being the second most widely use energy resource after electricity although the share of gas use accounts for only 8% of total energy use and considerably smaller compared to electricity use . This is attributable to the fact that gas is solely consumed in the kitchen for cooking purposes and for gas boilers in some rare instances (Priyadarsini, Xuchao & Eang, 2009).

The study findings revealed renewable resource as the least used energy resource in the study area. Regardless of its description as trending energy generation system by Barrett (2012); its adoption in the study area can be best described as negligible with mean value of 1.2803. The study finding is comparable to that of Panayiota and Santamouris (2015) which generally, reports negligible use any renewable energy resource in the sampled hotels of Attica region of Greece except for solar water heating which accounts for only 10% of the hotels energy use. Although, Karagiorgas et al. (2006) reports the use solar thermal systems in over 100 Greek hotels, however, the use is limited to domestic hot water supply in which Crete region accounts for 41.40%, Northern Greece 2.1% while the remaining 56.5% spreads across the rest of the country.

However, this could be linked to the fact that ultimately, the adoption of renewable energy depends on the local climatic conditions which informs on the solar intensity, wind power, humidity, cloudiness and particles in the air (Tam, 2011). Accordingly this might be the rationale behind the wide variation in hotel renewable energy use between regions of the globe. The HOTRES project discovered 40-60% use in hotels appraised in Spain, Portugal, France and Finland 20-25% in Germany, Austria and Slovenia while 8-10% in Italy and Crete.

According to Hotel Energy Solutions (2011), The Identified reluctance in renewable energy adoption is

attributable to its initial cost intensiveness with extensive payback time which obscured its economic viability.

The study findings on end-use energy consumption revealed that water –heating and air-conditioning dominates the electricity as well as diesel use in the study area with mean values of 4.7898 and 4.7657 as well as 4.6095 and 4.5568 respectively. The explanation for this outcome in the case of the later (air- conditioning) can strongly be connected to the tropical climate of the study area. However, in the former case (Water- heating) the finding was surprising because due to the tropical climate of the study area the demand for water –heating is expected to be relatively low, however, the explanation for this can largely be attributed to guest's behavior towards water heating since majority of the hotels use unit water heating systems and particularly where the guests are at liberty to operate water- heating system with minimal or no management control. The study finding opposes that of Shimming and Burnett (2002) where air conditioning was reported dominating the total electricity use.

The study also finds that ventilation is the least energy consuming end-use for both electricity and diesel sources in the study area with mean values of 2.9371 and 2.9749 respectively. This can be attributed to the fact that most of the hotels in the study area supplement the use of ventilating equipment such as fan for air-conditioning systems. Moreover, lighting and electronics/gadgets where ranked 5 and 6 with mean values of 3.7784 and 3.5949 for electricity source and vice versa for diesel source which indicates them as less energy consuming end-uses. This can be attributed to the use of energy efficient lighting and electronics in most of the hotels revealed by the study findings. The findings are comparable to that of Bohdanowicz (2006) and Hotel energy solutions (2011) conducted in Swedish and Polish hotels which reported significant use of energy efficient lighting and electrical equipments. The study findings also revealed that in both countries over 70% of hotels use energy efficient lighting and between 40-60% of hotels use energy efficient equipments.

5. Conclusions

The hotels in the study area are of divergent physical and operational characteristics which also imply varying energy consumption and efficiency positions. Although the research findings show a fairly favorable energy efficient hotel feature however, there are indications related to such features pointing towards energy leakages and also prodigal use of energy. The services provided by hotels in the study area are limited to the core hotel services and no extra energy consuming services provided, which could have justified the huge amount of energy consumed with attendant immense energy cost.

Predominantly three types of energy resources are used by hotels in the study area. This includes grid supplied electricity, diesel and cooking gas.

The utilization of grid supplied electricity and diesel closely compete due to the fact that diesel is widely used for powering generators used as an alternative source of electricity.

The utilization renewable energy by hotels in the study area is negligible, pointing poor combination of energy resources consumed with respect to sustainability bottom lines. Moreover diesel, a fossil fuel closely competes with grid supplied electricity in terms of wide utilization despite the inauspicious environmental and cost implication negating the path of sustainability.

Water heating and air-conditioning are the high ranking energy consuming end- uses in relation to grid supplied electricity and diesel consumption implying profligate use of energy and hot tropical climate of the study area as explanatory factors for the duo situation.

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