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ASSESSING THE COST OF ENERGY AND DISTRIBUTION IN INSTITUTIONAL BUILDING (SCHOOL OF ENVIRONMENT)

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Abstract

The study is aimed at assessing cost of energy and distribution in building. (School of environment) Due to the risen cost of energy globally, it is a growing issue accounting for a high percentage of greenhouse emission contributing significantly to global warming; and it peculiarity to Nigeria is far greater and risen higher (Ecree 2010) it effects man and environment. Expenditure on energy as an economic factor is high. As such arise the need to look for possible solution to reduce the cost of running building like building on energy.

Therefore, In hot-dry climate that are characterize by excessive heat and sun glare requires a sustainable approach to building design especially those that consume a lot of energy. To reduce the energy consumption, there is a need necessarily to employ cost saving measures which are environmentally friendly such as passive design principles in school of environment designs so as to enhance energy efficiency and conserve energy. Three building facilities are purposefully sampled; where an energy audit is conducted through the collection of data from two-year bills of utility and back-up sources of electricity supply. Inventory of all energy consuming appliances and systems in the three facilities are also taken to obtain its estimated energy demand. Data collected is analyzed, where cost of energy supply is estimated. Findings revealed that the major actor in energy consumption is the cooling demand, followed by other electrical equipment and lighting respectively. Fulfilling such demand is found to be hindered by lack of regular supply of electricity from the national grid which resulted to a level of dependence on backup power generators, making it an economically unsustainable agent of cost accumulation in management of institutional building.

Keywords: Assessing Energy Cost Consumption Efficiency

RESEARCH BACKGROUND

Assessing the cost of energy consumption for operating institutional buildings is necessary step toward fostering the economic aspect of sustainability directed not just towards any given facility, but its entire setting within a locality. This is because, office buildings from the major building stock of a city's central business district (Mu'azu 2012), thereby playing a role in the challenges that relates the city's cost of energy provision, and distribution. Some of these energy challenges bear a direct impact of the economic boom our world enjoys today; which has significantly raised the level of our basic requirement and living standard, and created a platform for an evident population growth experienced globally (Rai, 2004). This rise in standards of economies has subsequently created the need for more elaborate institution building stock, both in number, scale and basic requirement; putting it in a constant and increasing of intricate energy demand (Ochoa & Capeluto, 2009).

The institutional building is a building typology that requires uninterrupted energy supply within is activity period; hence it is regarded to be amongst the major energy consuming building typologies (Mu'azu, 2012). In terms of energy consumption per meter square, institutional building consume about 70-300KWH/m2 to function effectively, which is 10-20 times higher than the residential sector (Sadrzadehrafiei et al, 2021). This sort of energy requirement entails a great deal of effort to sustain building performance, a task that has been identified as a key area where significant progress towards meeting the global ambitions of energy efficiency can be made (Ausiello & Raimondo, 2014).

Similar studies of assessing the pattern of energy use in institutional buildings have been carried out in the past across Nigeria; an instance is that of Akambami (2010) where he pointed out that, institutional buildings uses 40% of the total energy supply by the National grid, and out of the total energy supply, 40% of it is used for cooling, 12% for lighting while 48% to power appliances.

The aim of this study is to uncover the track record of energy consumption patterns of institutional buildings in Gusau metropolis, and present the estimated cost implication associated with such energy consumption. Information obtained from such exercise can be instrumental in identifying opportunities of improving efficiently; decrease in energy costs (Canadian Industry Program for energy Conservation (CIPEC), 2014). The international Energy Agency (IEA) 2014 states that investment in energy conservation provides a better return than investment in energy supply

ENERGY CONSUMPTION AND NIGERIAN ECONOMY

Numerous research has been carried out with regards the need for the institutional building to live up to the expectations and aspiration of all spheres of sustainability. This study review the economic aspects of sustainable built environment; it centers on the primary aspect of capital investment, management and process of continuous operation of commercial corporate building stock with special regards to economic implications in the cost of energy consumption.

State of Energy Provision and Distribution in Nigeria

Energy requirement is essential for all operation in the institutional building; like in all other sector, it serves as the pillar of wealth creation evident by being the nucleus of operations and engine of growth of Nigeria's economy (Ogundipe & Apata, 2014). The output of the energy sector (electricity and petroleum products) usually consolidates the activities of the other sector, which provide essential services to direct all production activities (Energy Information Administration, 2010).

Unfortunately; even though energy provision in either public or private sector is capital intensive anywhere, it has been found to be facing a more serious challenge in Nigeria (Oyedepo, (2013). this is because study has shown that Nigerian has been found to be a consuming nation rather than producing economy cutting many sectors; where in energy issues, a negative relationship has been found to exist between its consumption and production (Kabir, Zaku, Tukur, & Aikhuele, 2013). Although a major oil producer and investor in the electricity sector, the estimate carried out by the world Factbook (2015), holds the country as low as 69th place in per capita electricity consumption globally; and the 2010th in the list of world countries that exploit the use of electricity from other renewable sources.

Challenges are as stated above are the sum of all reasons stated in the reviewed literature; where it was concluded that cost of energy production enjoys a free fall nature of energy billing with no regular accountability for energy costs, where government budget has to step-in on settling the payment deficit incurred (Muazu, 2012). However, the resultant use of backup generation system for long hours of the day throughout the year, also consequently leads to cost of diesel and other fuels used in running the generating plants by building owners (Umar, 2015).

Economic impacts of Energy Consumption in international buildings

Like in all commercial endeavors running an institutional building entails a lot of financial inferences. Study in this has shown that lower utility rates amount to an increase in net annual income generation as the key factor in commercial buildings has a direct bearing with a countries economy with regards to its net energy consumption. Where it is believed that national income enhances energy consumption (Adnan & Riaz, 2008): although Huang et al (2007) contended that energy consumption is dependent on the type of income group predominant in a given area: where in the low income group, there exists no causal relationship between energy consumption and economic growth; in the middle income group, economic growth leads energy consumptionpositively; and in the high income group countries, economic growth leads energy consumption negatively due to great environment improvement impacts. Arising from this argument, adequate supply of energy this becomes central to the radical transformation of the nation's economy (Energy Information Administration, 2010).

MATERIALS AND METHODS

The context of the study is institutional building in Birnin Kebbi (Kebbi State), Kaura Namoda (Zamfara State) and Sokoto Town (Sokoto State) which falls under the hot and dry climate of north western Nigeria. A very hot and dry air characterizes the climate and ambient temperature range between 27^0C and 39^0C accompanied by continuous low relative humidity (Koenigsberger et al, 1974).

To conduct the study, purpose sampling method was adopted in selecting three institutional buildings Kebbi, Sokoto and Zamfara (Table 1) the selection is made in a manner that it will represent different variety of institutional building based on variation in size (large and small), range in floor heights and total floor area (between 5000m^2 to 500m$^{2)}$, track record of optimum utilization of the facility, types of ownership, and ease of access for data collection. The buildings selected were Wazir Umar Federal Polytechnic Birin Kebi, Federal Polytechnic Kaura Namoda and Ummaru Ali polytechnic Sokoto

Table 1: Criteria for selection and representation in sampling

Name of Building	Ownership	Floor Heights	Total Area	Usage
➢ FED POLY. Kaura Namoda	Federal Government	one Floor	Above 5,000m^2	Full Capacity
➢ Waziri Umar FEDPOLY	Federal Government	One Floor	Above 3,000m^2	Full Capacity
➢ Umar Ali Shinkafi	State Government	One Floor	Above 1,000m^2	Full Capacity

Collection of primary data was carried out mainly through an energy audit exercise; an endeavor used to analyze the energy consumptions produced by a building with the aim of proposing measures to reduce them (Generation 2015; DOE, 2011). To achieve the aim of the research therefore, data collection was conducted through a walkthrough Energy Audit of energy consuming and /or providing equipment and systems in the case studies.

RESULTS AND DISCUSSION

As outlined in the methodology, discussions on the result of all data collected will be discussed and presented under relevant columns as presented below

A walkthrough Inventory of selected Buildings

Table 2 below shows the inventory of each facility studies. The sizes amongst the building is FEDPOLY Kaura Namoda with one floor and 60 rooms in three different blocks next Waziri Umar FEDPOLY Brinin Kebbi building with one floor and 50 rooms while Umar Ali State POLY Sokoto with equally One floor 30 rooms. Two years utility bill and cost of diesel and maintenance were also collected and presented on the table for FEDPOLY Kaura Namoda Building, supply from the National Grid costs 11,236,000NGN/annum while back up costs 15,562,000NGN/annum from a 625Kva generator; utility billing rate for FEDPOLY Brinin Kebbi is to tune of 7,692,000NGN/annum, and 1,869,996NGN/annum from 500kva plant.

Estimated Energy Demand

The total estimated demand for the three buildings based on three categories namely cooling, lighting and a group of other appliance was carried out. Equations 1 and 2 as adopted by Oyedepo et al, (2015) are used progressively during the study. Total energy demand (TED) in kW is given by:

$$TED = \frac{SW}{1000} \; n \times F_d \; (\text{in kW}) \ldots\ldots\ldots\ldots 1$$

Where n is the number of appliance (Cooling, Lighting and Other electricity appliances), SW is the system wattage and F_d is the demand factor. F_d is the assumed average percentage of available appliances used at a building's peak time. In this study, the demand factor is taken at 34%. This is because all appliance except for the exterior lighting are calculated based on the activity period of the buildings, which is eight out of the twenty four hours of the day.

To estimate the total energy consumption of all the appliances therefore equation 2 as stated below is adopted.

$$TEC = \frac{SW}{1000} \; n \times h \text{ (in kW)} \ldots\ldots\ldots\ldots 2$$

Where h is the total hours used by the appliance during the year. Which in this case is assumed to be 2080 hours (8 hours of the day x 260 working days of the year)? This sequence of estimation was carried out on all electricity consuming appliances for each facility studied to determine the disaggregated end use demand.

Estimated Electricity Supply

Electricity supply by both utility and backup source are estimated using the acquired utility bills of two years' and calculating the output of the power generators against the target backup hours laid out by the facility managers. To estimate for the average monthly utility supply, the monthly utility charges are divided by the utility rate per KWh, which is 26.24 NGN. For the backup system, the generator capacity is multiplied by its hours of operation against the number of working days in a month. The total electricity supply therefore' is estimated using a formula adopted from Batagarawa (2013),

Cost of Electricity Supplied from Utility and Back-up Bills

The actual energy consumption paid for by the management of facilities is made up of emoluments from electricity supply by the utility company and diesel generator supply in the buildings. The actual two years bills paid to the utility company are collected and the monthly average determined which in summation give the annual cost in Nigerian Naira (NGN). The same was done from the collected receipts and results of the interview with the plant operators, where the total cost of fuel and oils were generated.

It was discovered that the institution building has the highest rate of consumption of up to 26,798,000.00NGN per annum, a total summation of an average monthly utility bill of 936,333.33NGN and average monthly cost of diesel and maintenance of 1,296,833NGN FEDPOLY Kaura Namoda building has 641,000.00NGN for average utility cost and 155,833.00NGN from backup generation system cost summing up to about 9,561,996.00NGN per annum.

Total Energy Consumption Cost

To determine the cost of energy paid for is commensurate to the actual energy consumed, the total energy consumption cost (TECC) is calculated. As gathered from the interview and physical observation' this stems out of the fact that in all the facilities studied, none has employed the use of the prepaid meters supplied by the utility companies. The bill paid therefore is based on estimations from maximum demand metering or clamp rate of unit supplied. The total energy consumption cost is obtained by inputting the actual rate of unit electricity tariff on the estimated energy demand earlier determined' it is computed as adopted from Oyedepo et al' 2015.

CONCLUTIONS

The study focused on assessing the cost of energy supply and distribution in instituted buildings of Zamfara metropolis. The study confirmed that cooling for thermal comfort for the interior take the highest rate of energy demand in the buildings' it is responsible for about 55% of the energy use index, and therefore has that equal bearing on the resultant cost of energy consumption. Other electrical appliance constitute 33% while lighting has the least with 12% due to the presence of adequate natural lighting during the activity period.

It was observed that there is disparity between energy demand and supply in all facilities, where the estimated annual energy supply falls short of meeting up with the required annual demand in the buildings. This is why the cost of energy supply in the facilities is on the high side, due to insufficient supply from the national grid' which led to alternative dependence on backup supply to cover up the deficit, making the cost of supply economically unsustainable.

Despite the high cost of energy consumption however, the study affirmed the claim highlighted from the literature that electricity supply experiences a free-fall billing against energy consumption in our buildings. The study confirmed that there is a huge gap was between the total cost of electricity supplied from utility and back-up bills. Similar gap was also discovered in the total energy consumption cost, which this proves that the energy consumed, thought massive in term of quantity and cost is not commensurate to the due rates. The normalized energy demand has been found to be within the stipulated range for instituted buildings as highlighted by the literature' where the normalized total energy consumption cost per annum ranges between 2,982NGN/m^2 to 5,027NGN/m^2.

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