

Evaluation Of Residents' Perception In The Adoption Of Sustainable Energy-Efficient Building Development And Offsetting Greenhouse Gas Emissions In Abuja, Nigeria

Obiogbu, M. E

Department of Building, Nnamdi Azikiwe University,
Awka, Nigeria

Eneche P. S. U

Department of Geography and Environmental Studies, Kogi
State University, Anyigba, Nigeria

Nnodu, V. C

Department of Environmental Management, Nnamdi
Azikiwe University, Awka, Nigeria

Abstract: An energy efficiency building deals with consumption of less energy while maintaining the comfort conditions for their occupants. This will not only result in less environmental impact but are also economically sustainable. This study was to evaluate residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions in Abuja, Nigeria. This study is delimited to the development of initiatives for energy efficiency in building in FCT, Abuja with particular reference to residential and commercial buildings such as hotel buildings at FCT, Abuja. The research included 300 respondents (177 men, 123 women; age ranging from 30 years and above while simple tables, likert scale and Chi-Square method was used to evaluate residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions in Abuja, Nigeria. The result shows that 42% of the respondents are above 50 years, while 80% of the participants stated that the voluntary use of energy efficiency principles should be encouraged along with the implementation of mandatory building codes with likerd scale value of 4.4. These go along with reduce heating, cooling, and lightening loads for new buildings. However the Chi-square χ^2 value of 50.2 was discovered to be greater than the critical value (15.507), showing that the alternative hypothesis is accepted; residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions in Abuja, Nigeria. To this end, managing energy use in public and commercial buildings as well as creating awareness on reducing energy consumption in existing buildings, and to promote environmental protection, the rational use of resources, occupants' health, all of which helps to improve the sustainability of existing buildings.

Keywords: buildings, energy efficiency, retrofitting, sustainable energy

I. INTRODUCTION

Energy efficiency buildings are those which consume less energy while maintaining the comfort conditions for their occupants compared to standard buildings. Energy efficient buildings result not only in less environmental impact but are also economically sustainable.

Buildings belong to the most fundamental human preferences, together with food, water and clothes. The more a financial system grows, the more people spend time within buildings (approximately 90% of their time in developed parts of the world Camp, A. (2004). Without energy, buildings could not be operated or inhabited. Thus, the construction industry is the main energy consumer of all end-use industries, comprising a third of total energy demand and for a huge part

of Greenhouse Gases (GHG) emissions in all economies Koepfel, S. & Ürge-Vorsatz, U (2007). Furthermore, when it comes to solutions to lower energy consumption, buildings provide the biggest possibility of GHG reductions. As they represent the immediate environment to humankind, buildings will additionally be a crucial area for climate change adaptation. Amazingly little consideration continues to be given to affirming energy efficiency in buildings, in spite of the remarkable impact buildings possess on costs and the environment.

While improvements have been made in insulation, plant, lighting and controls and these are significant features that help towards achieving energy efficient building Wilkinson, P., Kirk, R.S., Sean, B., Cathryn, T. & Tadj, O (2007), there still remains much to be desired as it concerns Nigeria. Frequent power disruption and load shedding in Nigeria, over ten hours a day, amid hot and humid conditions have made the life of city people miserable, with residents alleging that they are experiencing three to five-hour long power cuts, three to four times a day on an average The Daily Star (2009). This load-shedding situation continues to worsen as the excessive heat drives people to use more electricity at homes and offices.

The Power Holding Company of Nigeria (PHCN) has, over the years, provided its inhabitants with inadequate supply of electricity. This has made buildings, especially offices, to fall back on alternative sources of energy (such as generators and inverters) which increases their running cost. This also harbours other negative effects such as air pollution and noise pollution. As a result, most Nigeria households in general and FCT households at the moment have a high level of energy consumption leading to greenhouse gasses being released into the atmosphere and contributing to global warming. Also, buildings in Nigeria are mostly poorly designed in terms of utilizing passive design strategies. For instance, some buildings lack enough illumination to be functional within the day and end up using artificial means. Also offices become too hot due to excess solar heat gain and require alternative cooling methods such as heating, ventilation and air conditioning (HVAC). Thus, development of initiatives for energy efficient buildings is a cost effective measure for buildings with respect to daylight and thermal comfort.

According to European Union (2000) energy efficiency in building is the moderation of energy-end use in buildings which helps in reducing greenhouse gas emissions and pollution produced by the combustion of fossil fuels energy which is used in buildings for various purposes: heating and cooling, ventilation, lighting and the preparation of hot sanitary water among them.

Nigeria is a developing country that aims at developing in sustainable manner. Sustainability allows developing by meeting the needs of present and yet taking into consideration and allowance of the needs of the future generations National Population Commission (NPC) (2006). Therefore the utilization of energy is meant to be efficient, sensible and wise so that the purpose of sustainable development will become manifest.

The most appropriate approach is embraced by means of the application and understanding of thermal comfort, human behavior and energy utilization behavior of buildings. Recently, the level of energy consumption has increased

owing to the substantial growth of the building industries; hence, it is important for Nigeria building industries to organize its development in a sustainable way.

Energy efficiency in building is a straightforward concept which can conceivably be summed up with the saying, "doing more with less," the term is normally associated with how energy is consumed at the point of end use, but the concept of energy efficiency in building can also be applied to how energy is produced and distributed. It mentioned that buildings are accountable for 40% of energy consumption and 36% of CO₂ emissions. Enhancing the energy performance of buildings is a cost effective way of fighting against climate change and improving energy security while at the same time creating job opportunities especially in the building industry.

The Community Research and Development Centre (CREDC) is a non-governmental, non-profit organization registered in Nigeria to provide services that ensure the sustainable management of the environment and environmental resource. CREDC further assert that the energy been produced in Nigeria are from the combustion of fossil fuel such as oil and gas. For every kilowatt-hour (kWh) of electricity we consume; there is an equivalent emission of greenhouse gases (GHGs). Energy efficiency in building initiatives can help reduce the dependency on petroleum and also emission of greenhouse gases and the negative environmental impacts associated with the generation of energy will also be reduced if we use energy efficiently.

Many persons can be hired during intervention programs to change the behavior of people to use energy efficiently but then there are other methods ranging from retrofitting or employing energy efficient appliances to designing an energy efficient building to relate to the environment. In so doing there will be little or no use of energy. Companies involved in the manufacturing of electrical appliances will experience competition among themselves; those who manufacture the most efficient appliances capture the patronage of consumers.

According to Energy Commission of Nigeria (2013) on sustainable design and energy efficiency measures the following initiative/strategies are postulated for offsetting greenhouse gases towards energy efficiency building.

Energy consumption is not just about electricity used in the building, it also has to do with the material used for its construction. Building an environmentally friendly and energy conscious architecture helps to lessen energy consumption and also reduces environmental degradation. Adopting the concept of embodied energy is a way to compare the performance of building materials. The embodied energy of a building material is the energy that has been required to extract, process, and manufacture it and then to transport it to the building site. The embodied energy in the structure of a new building is considerable, exceeding the total energy required to heat that building for the next twenty years Kahu, R. (2014).

A. STUDY AREA

Abuja is the capital city of Nigeria (Fig. 1). It is located in the centre of Nigeria, and lies between Latitudes 8°86'N to 8°95'N and Longitudes 7°18'E to 7°29'E (Fig. 2). The capital city covers about 250 km², and the whole FCT has a land area of approximately 8,000 km², with a population of about

1,406,239 Praznik, M., Butala, V. & Zbašnik-Senegačnik, M. (2013) making it one of the ten most populous cities in Nigeria. The FCT Act of 1976 established the FCT. The establishment of the FCT is an implementation of the report of the Capital Relocation Committee set up by the Federal Government of Nigeria Jatau, B. (2006). The physical development of the Federal Capital City, Abuja began in the early 1980s after the approval of the Abuja Master Plan by the Federal Government and the capital was finally moved from Lagos to Abuja in 1991 Jibril, I.U (2006).

The FCT is made up of six Area Councils: Abaji, Abuja Municipal, Bwari, Gwagwalada, Kuje and Kwali, as shown in Fig. 2, while the map in Figure 3 shows the Districts in the Abuja Municipal Area Council and from which Gwarinpa District is depicted (in red). Gwarinpa which is a 15-kilometer drive from the Central Business District is mainly a residential area though recently some businesses especially service oriented businesses like banks and eateries are springing up very rapidly. Most of these businesses are located on the three major roads in Gwarinpa (i.e. 1st avenue, 2nd avenue and 3rd Avenue. Gwarinpa District was selected among the five districts in FCT in order to accomplish the framework of this study. This area is home to the top bracket sections of society and business, and has the reputation of being very exclusive and very expensive, while Gwarinpa district contains the largest single housing estate in Nigeria. The study was therefore embarked upon in Gwarinpa due to the high levels/numbers of income, population, hotels and residential buildings in the district.

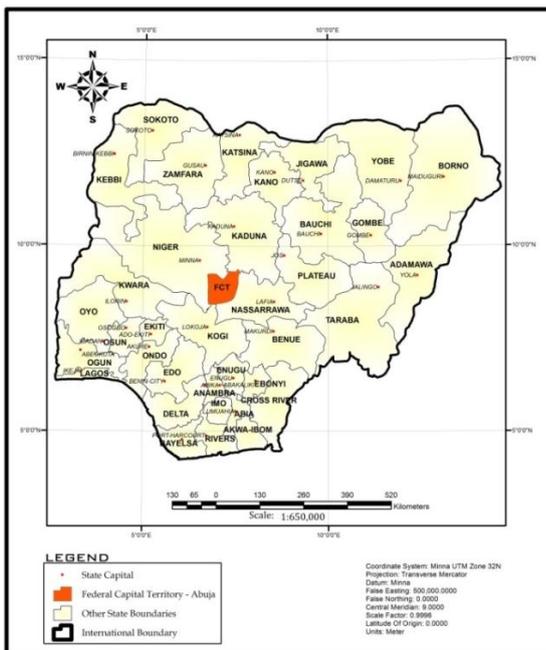


Figure 1: Nigeria Showing Abuja

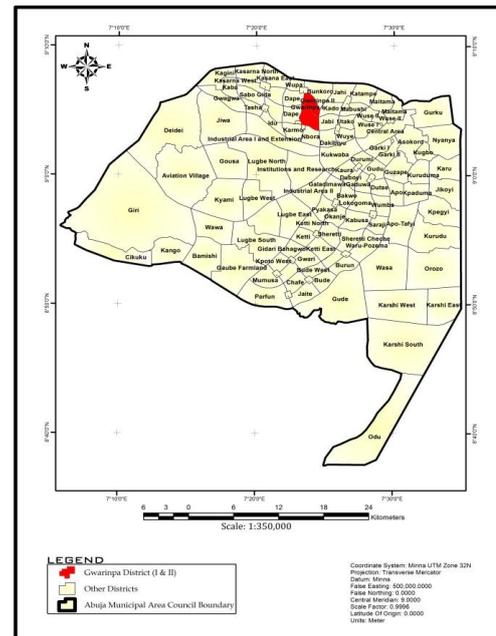


Figure 2: Abuja Showing Abuja Municipal Area Council

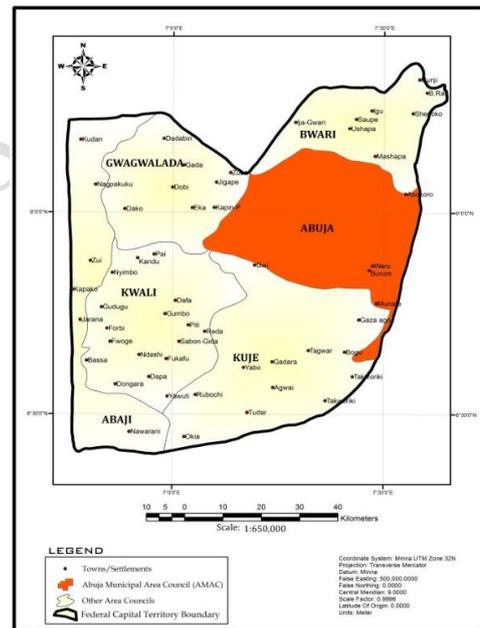


Figure 3: Abuja Municipal Area Council showing Gwarinpa District

II. METHODOLOGY

This research combined aspects of both ‘exploratory’ and ‘descriptive’ approach. It was exploratory in that it sought to establish the existing practices of energy efficiency in building control regulations. It was descriptive by describing and categorizing the various energy efficiency measures being initiated by the local authorities through their building control regulations as Financial/Economical, Behavioural, or Legal among others. The data used in this study was generated from both primary sources (field observation, oral interview and the administering of well-structured questionnaires) and secondary sources (review of published and unpublished

literature, journal materials, seminars, textbooks, magazine, published statistics and synopsis as well as internet exploration).

The questionnaire was structured in two section, A and B. Section A is the bio-data of the respondents while section B is structured on open ended questions (yes and no) and 5-point Likert scale with the following response options: Strongly Agreed (SA), Agreed (A), Undecided (UD), Strongly Disagreed (SD) and Disagreed (D). However, interviews were conducted with urban and regional planners, local government departments, practicing professionals and residents of Gwarinpa Housing Estate Abuja. In this particular research, the population being studied includes the residents of the housing estate in Gwarinpa, the building control regulations departments of the metropolis of FCT.

The entire population of the housing estate in Gwarinpa was considered for sampling. Since the population of the study is finite (total number of population is known to be 5000), the researcher made use of Taro Yameni's formula to arrive at sample size of three hundred and seventy (370) respondents from which thirty six (36) copies were distributed to key representatives of the building control function in the local authorities and key participants in energy efficiency programmes for buildings in FCT, Abuja. Data on hotels were collected mostly from the Sixteen (16) participants from Energy Savings in Building Constructing Company's (ESBCOs) who are specialists in hotels construction in order to assist in the delivery of a sustainable energy efficiency office and with high rating of energy performance. The research approach was conducted in order to check the effectiveness of energy efficient measures or strategies that have been applied to achieve energy efficiency in existing office buildings especially in hotels due to the fact the run a 24-hour business with steady electrical appliances. Two hotels were purposively selected for the study. From the total 370, only 300 were duly filled and returned.

The researcher adopted Kitzinger, J. (2004) approach by combining the advantages of structured and unstructured interviews to allow for a deeper and lengthy probe into organizational and institutional procedures as was required in this research. This was appropriate because the interview respondents were chosen on the basis of their good experience and expert knowledge in implementing building control regulations and/or being leading participants in energy efficiency building practices. Their information was used to gain deeper insight into the subject matter from an expert's perspective and to triangulate and compliment the information from field questionnaire. Additionally, this enabled the research to capture spontaneous information not restricted to a specific set of answers as would be with structured interviews.

The interview guideline outlined four (4) broad areas derived from the four sub-questions of the research for discussion which the interviewer relied on to get information from the respondents. Only one interview guideline was used for all the different categories of the respondents. Multiple respondents were interviewed for the research. This had the effect of increasing information and broadening the point of view of the entire research [16]. The interviews were conducted with section heads/chief officers of the groups named in this chapter.

The interviews were conducted with ten (10) section heads of building control departments in Gwarinpa, FCT. Ten (10) key members of the KPPs group and sixteen (16) chief officers from the ESBCOs group were also interviewed.

Data were subjected to analyses. First, Chi-square (χ^2) was used (at 95% level of significance) to test whether there is significant level of sustainable approach that can be adopted towards developing energy efficiency in buildings in offsetting greenhouse gases in FCT. Using the 5-point Likert Scale analysis which detailed the responses of residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions in Abuja, Nigeria. (Table 1).

III. RESULTS AND DISCUSSION

Data was collected through various instruments of data collection and analyzed with Chi-square (χ^2) method in order to test the level of sustainable approach that can be adopted towards developing energy efficiency in buildings in offsetting greenhouse gases in FCT.

The sex distribution of the respondents is shown in Table 1.

Sex	Frequency	Percentage (%)
Male	177	59
Female	123	41
Total	300	100

Table 1: Gender Distribution of Respondents

Table 1 shows clearly that 177(59%) of the respondents are males whereas 123(41%) are females. Thus, the table shows that occupants of Gwarinpa District who participated in the study were mostly males.

S/No.	Age	Frequency	Percentage (%)
1	30-40	70	23
2	41-50	105	35
3	51-and above	125	42
	Total	300	100

Table 2: Age Distribution of the Respondents

Table 2 shows the distribution of the respondents based on their age categories. It shows that 23% of the respondents are between ages 30-40, 35% are between the ages of 41-50, while 42% are between the ages of 31-50. The above therefore implies that respondents between 41-50 years constituted the major age bracket of occupants living in the study area who were interviewed.

Marital status	Frequency	Percentage (%)
Single	107	36
Married	178	59
Divorced	5	2
Widowed	10	3
Total	300	100

Table 3: Marital Status of the Respondents

Table 3 above shows the distribution of the respondents according to their marital status. It shows that 36% of the respondents are singles, 59% are married, 2% are divorced, while 3% are widowed. Here majority of the respondents are married.

S/No.	Educational Attainment	Frequency	Percentage (%)
1	O-Level	83	28
2	NCE/OND	76	25
3	No formal education	18	6
4	HND/ BSc and above	123	41
	Total	300	100

Table 4: Educational Attainment of the Respondents

Table 4 shows the distribution of the respondents based on their educational attainment. It shows that 28% of the respondents holds either WASC/NECO/GCE, 25% were NCE/OND holders, 6% have no formal education while 41% HND/B.Sc. and above. This implies that majority of the respondents have formal education, are literate and are (expected to be) conversant with the study.

The table diagram below shows the educational attainments of respondents.

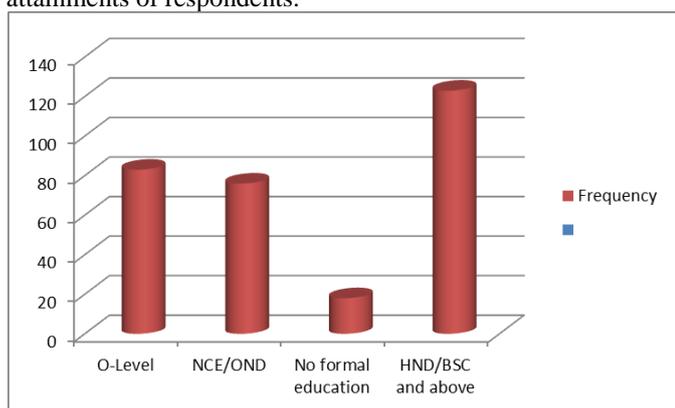


Figure 1

A deeper investigation into residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions in Abuja, Nigeria, particularly in Gwarinpa District, the Likert scale was adopted and computed as shown in Table 5.

Table 5: Result of likert scale opinion of residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions in Abuja, Nigeria.

Components	Scale					Total Score	Mean Score
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
X	90	80	13	70	47	996	3.3
Y	120	90	9	60	21	1128	3.8
Z	89	75	8	60	68	957	3.2

Key

X	Increasing the efficiency of energy-using devices and equipment
Y	Manage energy use in public and commercial buildings
Z	Reducing heating, cooling, ventilating, and lighting loads for new buildings or when renovating existing buildings

Table 5

From Table 5 above, reveals the rating of different responses obtained from respondents in Gwarinpa District. The table however shows that although all the residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions

in Abuja, Nigeria is tended towards (X and Y) but the option (Z strategies) had relatively lower values. Therefore, residents' perception in the adoption of sustainable energy-efficient building development and offsetting greenhouse gas emissions in the study area is increasing the efficiency of energy-using devices and equipment. This is immediately followed by the strategies of managing energy use in public and commercial buildings and reduce heating, cooling, ventilation and lighting loads for new buildings or when renovating.

However, the calculated value is greater than the critical value, $50.2 > 15.507$ (at $\alpha = 0.05$) therefore alternative hypothesis was accepted which state that there is significant level of sustainable approach that can be adopted towards developing energy efficiency in buildings in offsetting greenhouse gases in FCT. This corresponds with Umar. H. A.(2009). Where he mentioned that buildings are accountable for 40% of energy consumption and 36% of CO₂ emissions. Enhancing the energy performance of buildings is a cost effective way of fighting against climate change and improving energy security while at the same time creating job opportunities especially in the building industry.

Also, the Community Research and Development Centre (CREDC) is a non-governmental, non-profit organization registered in Nigeria to provide services that ensure the sustainable management of the environment and environmental resource. CREDC further assert that the energy been produced in Nigeria are from the combustion of fossil fuel such as oil and gas. For every kilowatt-hour (kWh) of electricity we consume; there is an equivalent emission of greenhouse gases (GHGs). Energy efficiency in building initiatives can help reduce the dependency on petroleum and also emission of greenhouse gases and the negative environmental impacts associated with the generation of energy will also be reduced if we use energy efficiently.

The level of sustainable approach that can be adopted towards developing energy efficiency in buildings in offsetting greenhouse gases in FCT was outlisted in table 1. All the respondents were unanimous that writing the building control regulations to include building energy efficiency standards/codes was the starting point of integrating energy efficiency principles in building regulations. In this light, all respondents welcomed the proposed new building regulations and hoped they will inspire the building industry to achieve more than the minimum requirement. They said that this will have a market transformational impact as well and create opportunities for the development and use of market based EE business models like ESCO's in the existing buildings. The respondents also added that energy efficiency regulations should be periodically revised to include principles they will not have covered at inception, like retrofits and building equipment standards which are captured but not effectively implemented and monitored in the legislation, and also to take care of developments in technology and higher energy efficiency requirements in newer developments.

They said that behavioural barriers presented a difficult challenge to address as most EE regulations, hardly target the consumers. Additionally, the respondents said the energy efficiency regulations should be accompanied with a robust informational/educational campaign to sensitize the citizenry

on the benefits of energy efficiency in buildings and get them to buy into it from the beginning.

During the field investigations, documents used for building/construction development approvals were also evaluated. They contained requirements to be fulfilled by the developers before approval for construction and occupation could be granted. These requirements included: approved drawings by a qualified professional, structural soundness certifications, health and safety certifications for the construction and the general public, electrical and plumbing installations soundness certification and construction completion soundness certification.

Up to 80% of the participants stated that the continued use of voluntary energy efficiency principles, especially among the ESCOs, should be encouraged alongside the implementation of the mandatory building codes. They stated that this had the tendency of raising the energy performance of buildings beyond the minimum requirements.

IV. CONCLUSION

Energy efficiency building regulations have been in use in many developed countries for decades. In Nigeria, the end of an era of presumed cheap electric energy as evidenced by the escalating new tariffs, the security of electricity supply problems and the high carbon intensity nature of electricity production have reinforced the importance of the energy efficiency agenda in the economy. In the past, this had been frustrated by perceived low energy prices and lack of clear national strategy among others. It is important that the government introduce or develop an initiative for new energy efficiency strategy which will commits the country to achieve demand reduction in the buildings sector and emphasize mandatory application of regulatory instruments. Flowing from this, the government should prepared new legislation to aid in the implementation of energy efficiency regulations in building.

Energy efficient strategies to be applied include:

- ✓ Strategies that appropriately reduce the whole energy load within the building, that is, adequate fenestration running almost throughout the building and shaded by shading devices at strategic locations (east and west regions).
- ✓ Strategies that adequately improve the efficiency of the systems, that is, adequate use of efficient chiller system, efficient lighting (CFL/BL2 fluorescent lamps).
- ✓ Adequate strategies that involves on-site generation of electricity, that is, street lights powered by solar cells

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