Archives of Current Research International

9(1): 1-12, 2017; Article no.ACRI.35194
ISSN: 2454-7077

An Assessment of Sustainable Energy-efficient Strategies for Retrofitted Building Development in Abuja, Nigeria

V. C. Nnodu[1], M. E. Obiegbu[2] and P. S. U. Eneche[3*]

[1]Department of Environmental Management, Nnamdi Azikiwe University, Awka, Nigeria.
[2]Department of Building, Nnamdi Azikiwe University, Awka, Nigeria.
[3]Department of Geography and Environmental Studies, Kogi State University, Anyigba, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author VCN prepared the objectives and first draft of the study. Author MEO was responsible for data survey and statistical analysis. Author PSUE managed the literature and the final draft. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ACRI/2017/35194
Editor(s):
(1) Wang Mingyu, School of Metallurgy and Environment, Central South University, China.
Reviewers:
(1) Ghada Ahmed Ragheb, Pharos University, Egypt.
(2) Ngakan Ketut Acwin Dwijendra, University of Udayana, Indonesia.
Complete Peer review History: http://www.sciencedomain.org/review-history/20433

Original Research Article

Received 30th June 2017
Accepted 3rd August 2017
Published 9th August 2017

ABSTRACT

Building and construction designs are expected to be smart; characterized with less negative environmental impacts and are to be more or less economically sustainable. In the face of changing climate and thermal discomfort among urban residents, developing energy-efficient structures is imminent. The brunt of this study therefore was to identify sustainable energy-efficient strategies for the retrofitting of buildings in Gwarinpa District of Abuja. This study was however delimited to the development initiatives for energy-efficient buildings, in particular, residential and commercial buildings such as hotels and recreational centres. The research made use of 300 structured questionnaires and a couple of interview sessions with 36 officials from building, planning and energy saving companies and parastatals, while simple tables, Likert scale and Chi-square test were used to analyse the data generated. The result revealed that majority of the officials interviewed in the study area have HND/MED/BSc as their highest qualification (50%), with

**Corresponding author: Email: Enelche.psu@ksu.edu.ng;*

5-10 years experience working with building regulations (50%). Also, it was revealed that the mounting of solar energy devices was rated as the highest strategy employed in the study area to ensure an energy-efficient building (with a Likert scale value of 4.4). This is immediately accompanied by the strategies of putting off electrical appliances when not in use and the use of more VAC-VCR system instead of using split units and the planting of trees. Furthermore, a chi-square statistic, x^2 = 31.41 led to the acceptance of the alternative hypothesis that sustainable energy-efficient strategies for retrofitting buildings in the study area were significant. The study therefore revealed a ready-state for people in Gwarinpa to key-in more into the use of energy-efficient facilities, such as solar devices (which is a clean form of renewable energy) for meeting their daily energy needs. To this end, smart building policies that will reduce energy consumption and thermal discomfort in the face of climate change and global warming are recommended, particularly for other relatively, economically buoyant areas in Abuja.

Keywords: Buildings; energy-efficiency; retrofitting; sustainable energy.

1. INTRODUCTION

1.1 Background of the Study

Buildings belong to the most fundamental human preference, 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) [1]. Without energy, buildings cannot 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 gas (GHG) emissions in all economies [2]. 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.

1.2 Statement of the Problem

While improvements have been made in insulation plant, lighting and controls which are significant features that help towards achieving an energy-efficient building, there still remains much to be desired as it concerns Nigeria [3]. Frequent power disruption and load shedding in Nigeria can get to as high as over ten hours a day. In the face of hot and humid conditions, the life of city people have been made miserable, with residents alleging that they are experiencing three to five-hour long power cuts, three to four times a day on an average [4]. This load-shedding situation continues to worsen as the excessive heat drives people to use more electricity at homes and offices to maintain better physiological or thermal comfort. However, 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.

1.3 Proposed Solutions

According to [5] 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 fuel energy which is used in buildings for various purposes: heating and cooling, ventilation, lighting and the preparation of hot sanitary water among them. Consequently,

[6] confirmed that energy consumption in buildings is a large share of the world's total end use of energy. Globally, buildings account for close to 40% of total end use of energy. Given the many possibilities to substantially reduce buildings' energy requirements, the potential savings of energy efficiency in the building sector would greatly contribute to a society wide reduction of energy consumption. The implications of such potential reduction should not be underestimated, as the scale of energy efficiency in buildings is large enough to influence security policy, climate preservation and public health on a national and global scale. Since buildings consume a significant amount of energy, particularly for heating and cooling (32%), and because existing buildings comprise the largest segment of the built environment, it is important to initiate energy conservation retrofits to reduce energy consumption and the cost of heating, cooling, and lighting buildings.

1.4 Literature Review

Retrofitting refers to the addition of new technology or features to older systems. [7] defined retrofitting as newly developed or modified and upgraded technologies, as well as new design concepts, which need to be developed and their validity confirmed. Although retrofitting an existing building can oftentimes be more cost-effective than building a new facility, it is important for conserving energy. But conserving energy is not the only reason for retrofitting existing buildings. Building Energy Efficiency Retrofit (BEER) provides excellent opportunities for reducing energy consumption in buildings as well as for promoting environmental protection, rational resource use, and better health for the occupants. More so, the goal should be to create a high-performance building by applying the integrated, whole-building design process, to the project during the planning or Clearance phase t hat ensures all key design objectives are met. For example, the integrated project team may discover a single design strategy that will meet multiple design objectives. Doing so will mean that the building will be less costly to operate, will increase in value, last longer, and contribute to a better, healthier, more comfortable environment for people in which to live and work [8].

Sustainable and energy efficiency strategy for retrofitting of buildings has become a future development trend in the building sector. Building energy-efficient and retrofitted structures provide excellent opportunities to reduce 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. Among other solutions, Energy Performance Contracting (EPC) provided by Energy Service Companies is a market mechanism to provide financial and technological support for energy efficiency projects. It is therefore recommended that Nigeria should patronize these companies and also study regulations which have set a specific floor area threshold which when reached in refurbishment must affect energy efficiency measures in buildings. This should be localised to the Nigerian conditions through an early revision of the standards and be implemented through the building control regulations.

1.5 Scope and Justification of Study

As the process of energy building development becomes more of a mainstream phenomenon, it is important to research its progression and the diversity of implementation that has occurred in Nigeria and hence identify a best approach for development. Although, the current situation is being addressed by various initiatives, the Nigerian government have indicated positive outlook as they insist that the current structures are set to change for the better in the near future [8]. Hence, there still exist challenges towards energy-efficient building development in the country. This study assesses the development of such initiatives and tends to seeks to understand the organizational capacity and constraints of housing agencies to provide energy-efficient housing with good living condition. More so, unlike previous research works which evaluated housing in Nigeria without recourse to the underlying retrofitting theories, this study provides an opportunity to assess the validity of the underlying retrofitting theories by examining the extent to which present energy-efficient initiatives of buildings can be deployed by resident and businesses, particularly in Gwarinpa District in Abuja Municipal Area Council (AMAC), FCT Abuja.

1.6 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 km^2, and the whole FCT has a land area of approximately 8,000 km^2, with a population of about 1,406,239 National Population Commission [9] making it one of the ten most populous cities in Nigeria. The establishment of the FCT is an implementation of the report of the Capital Relocation Committee set up by the Federal Government of Nigeria [10]. 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 [11].

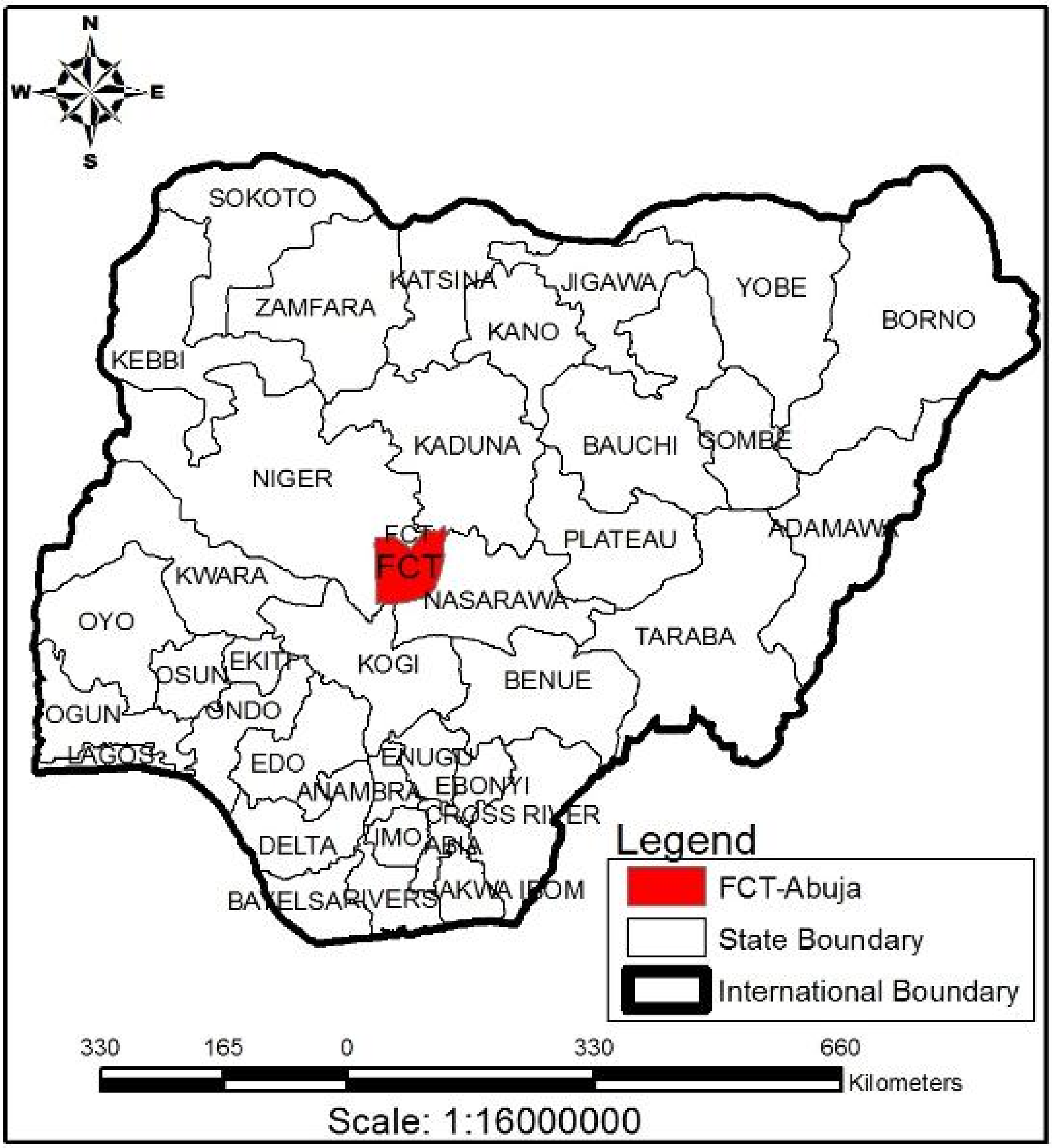


Fig. 1. Nigeria showing Abuja

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 Fig. 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 and contains the largest single housing estate in Nigeria. The study was therefore embarked upon in Gwarinpa due to the high levels/numbers of income of residents, their population as well as hotels and residential buildings in the district.

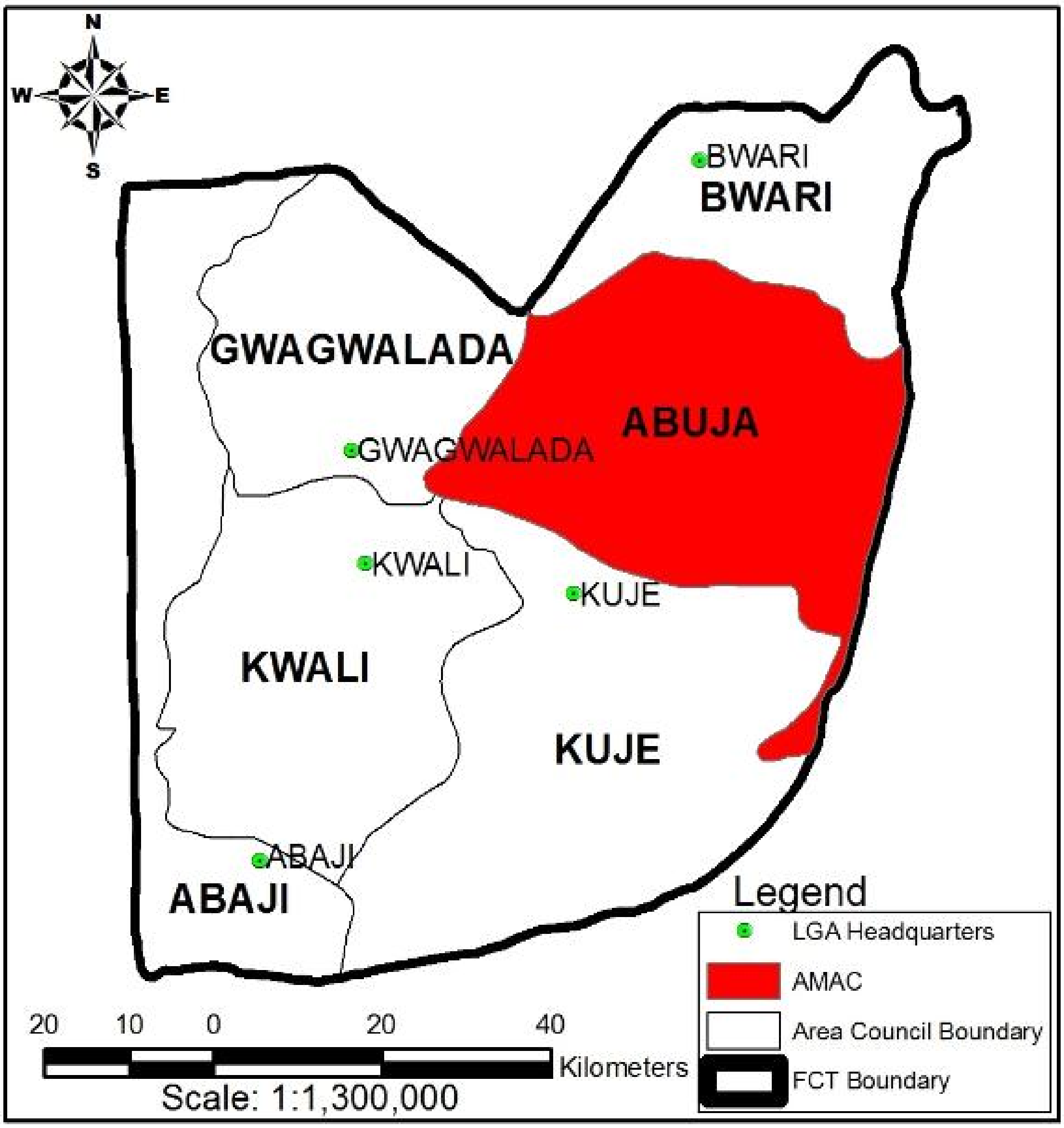


Fig. 2. Abuja showing Abuja municipal area council

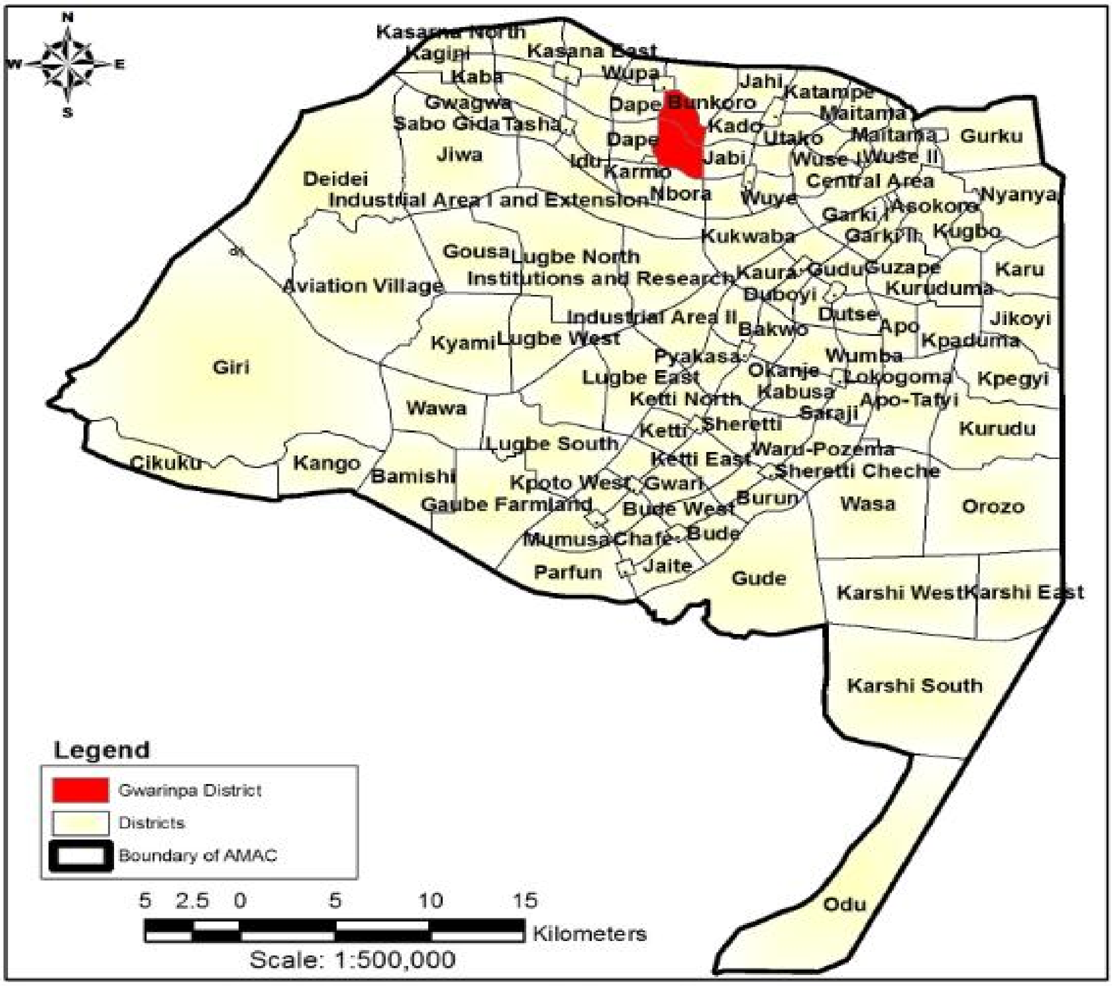


Fig 3. Abuja Municipal area council showing Gwarinpa District

2. METHODOLOGY

This research combined both 'exploratory' and 'descriptive' approaches. It was exploratory in that it sought to establish the existing practices of energy efficiency in building control regulations and was also descriptive by categorizing the various energy-efficient measures being initiated by the local authorities through their building control regulations as Financial/Economical, Behavioural, or Legal bases, among others. The data used in this study were generated from both primary (field observation, oral interview and the administration of well-structured questionnaires) and secondary sources (review of published and unpublished literature, journal materials, seminars, textbooks, magazine and the internet).

However, interviews were conducted with urban and regional planners, local government departments, practicing professionals and residents of Gwarinpa Housing Estate, Abuja. In this research, the population being studied include the residents of the housing estate in Gwarinpa and the building control regulations departments of the metropolis of FCT.

A total of three hundred and seventy (370) respondents from which thirty-six (36) copies of the questionnaire were administered to key representatives of the building control department of 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 in existing residential dwellings, office buildings and hotels. From the total 370, only 300 were duly filled and returned.

The researcher adopted the approach of [12] 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. This 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. Hence, multiple respondents were interviewed for the research, which had the effect of increasing information and broadening the point of view of the entire research [13]. Lastly, the data generated were subjected to analyses using the 5-point Likert Scale and the non-parametric statistical test, Chi-square (χ^2).

3. RESULTS AND DISCUSSION

The data generated from the administration of questionnaires are tabulated and analysed in this section. It gives a brief idea about the respondent: their gender, age, educational attainment and their marital status; their buy-in or adoption of different energy-efficient strategies in building development and/or for retrofitting of existing buildings; rate the strategies based on Likert scale and lastly assess if such strategies in place are statistically significant. The sex distribution of the respondents is shown in Table 1.

Table 1. Gender distribution of respondents

		Frequency	Percent (%)
Valid	Male	177	59
	Female	123	41
	Total	300	100.0

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.

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.

Table 2. Age distribution of the respondents

Age	Frequency	Percent (%)
30-40 years	70	23
41-50 years	105	35
51 and above	125	42
Total	300	100.0

Table 3 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.

Table 3. Marital status of the respondents

		Frequency	Percent (%)
Valid	Single	107	36
	Married	178	59
	Widowed	10	3
	Separated/Divorced	5	2
	Total	300	100.0

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: energy-efficient building development.

Table 4. Educational attainment of the respondents

		Frequency	Percent (%)
Valid	O-Level	83	28
	NCE/OND	76	25
	No formal education	18	6
	HND/BSc& above	123	41
	Total	300	100.0

A deeper investigation into the usage of sustainable energy-efficient strategies for retrofitting buildings in FCT Abuja, particularly in Gwarinpa District, the Likert scale was adopted and computed as shown in Table 5.

Table 5 reveals the rating of different responses obtained from respondents in Gwarinpa District. The table however shows that although all the strategies used for retrofitting were well-known by the respondents, four (4) of the options (i.e. U, V, W and Y strategies) tended towards high agreement but other options (i.e. X and Z strategies) had relatively lower values. Therefore, the most efficient strategy adopted by respondents for retrofitting buildings in the study area is through the mounting of solar energy devices. This is immediately followed by the strategies of switching off electrical appliances when not in use and the deployment of VAC-VCR systems and tree planting activities in the study area.

Furthermore, the result of the Chi-square computed value, 1544.9 and table value of 31.41 (at α = *0.05*) reveals objectively that the alternate hypothesis which states that sustainable energy-efficient strategies for retrofitting of buildings in FCT Abuja) is realistic, hence accepted.

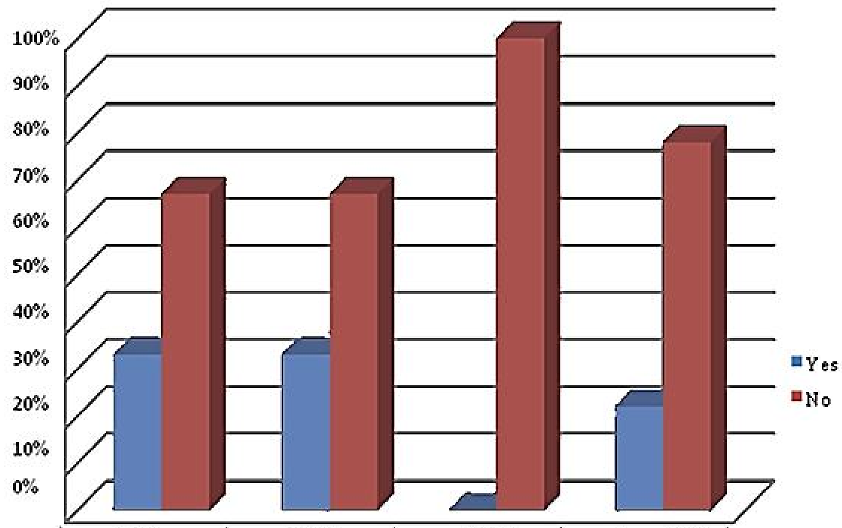
This result is supported by [14]. They used Spearman's Correlation Coefficient analysis to test the strength between energy efficiency and indoor environmental quality, and concluded that three primary energy-efficient strategies for retrofitting of buildings include encouraging the recycling and other waste management practices; encouraging the use of renewable energy technologies; installing motion sensor for lighting system. This result is supported by the works of [15,16] in different parts of Nigeria. These studies [15,16] have in addition, also drawn attention to the use of perlite plaster (in place of the cement plaster) which has helped or improved the cooling of the interiors of buildings and also in the adoption of smart and improved technological installation of efficient appliances, coupled with passive design that have been successful in the reduction of negative impact of buildings to their physical environments. Other studies that support this result include [17,18].

Views of experts in the field as obtained during the investigation showed 78% of the officials who purported that energy efficiency initiatives are not legally required in the current building regulations. In terms of breakdown: of this, 100% of BCAOs and 75% each of KPPs and ESCOs indicated the lack of energy efficiency principles in the current building regulations. See Fig. 4.

Table 5. Result of Likert scaling of respondents' opinion based on their sustainable energy-efficient strategies for retrofitting of buildings

Components	Scale					Total score	Mean score
	Strongly agree	Agree	Undecided	Disagree	Strongly disagree		
U	130	110	5	*30*	25	1190	4.0
V	150	130	5	*7*	8	1307	4.4
W	110	150	0	24	16	1214	4.0
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	Description
U	Putting off electrical appliances when not in use to reduce cost
V	Mounting of solar energy devices
W	More VAC-VCR system instead of split units and planting of trees around the building to assist in cooling of the environment and sun shedding
X	Replacement the existing mechanical ventilation system with a natural ventilation system and reducing heat losses through reduced U-values in roof, façades and windows
Y	Insulating a home such as installing or replacing high voltage bulbs with fluorescent lights
Z	Installation of solar shading devices for windows and doors, as well as those that generate electricity by photovoltaic (PV) devices



	KPPS	ESCOs	BCAOs	Overall (%)
Yes	33%	33%	0%	22%
No	67%	67%	100%	78%

Fig. 4. Requirement of energy-efficient principles/initiatives in building (development control) regulations

However, nearly 61% of the participants were aware of the energy-efficient building guidelines issued by the key local authorities in the study area. The building designers and developers in the respective jurisdictions were actively encouraged to incorporate the above energy-efficient guidelines or perspectives in designs and building plans for building control approvals.

The awareness of the energy-efficient development issues was exhibited by their knowledge of the contents of the energy-efficient design and construction guidelines issued by the Federal Capital Territory and the application of the star rating tool for buildings being implemented by the participants from Energy Savings Company (ESCO) among other ongoing energy efficiency activities in buildings. They (ESCO) also added that this awareness had been gained through industry arranged fora like workshops and conferences/exhibitions. Many of these fora had been arranged by ESCOs and occasionally in collaboration with government departments. 22% who suggested that there was a legal requirement (mostly from either KPPs or ESCO) referred to the National Building Code (NBC) requirements and the energy efficiency building guidelines issued by various local authorities as a legal basis for energy-efficient building principles. Furthermore, all the ESCOs and nearly 60% KPPs claimed collaborative efforts within themselves which had created voluntary energy-efficient building standards which their respective members were required to follow when executing building developments. They however mentioned the Green Star building rating system being implemented by the ESCOs members as one of such efforts. This is a voluntary sustainability rating system that assesses the sustainability of projects at all stages of the built environmental lifecycle. Green Star consists of nine separate environmental impact categories under which specific key criteria are grouped and assessed. These are Management, Indoor Environmental Quality, Energy, Transport, Water, Materials, Land Use and Ecology, Emissions, and Innovation.

Since buildings consume a significant amount of energy, particularly for heating and cooling, and because existing buildings comprise the largest segment of the built environment, it is important to initiate energy conservation retrofits to reduce energy consumption and the cost of heating, cooling, and lighting buildings. But conserving energy is not the only reason for retrofitting existing buildings. The goal should be to create a high-performance building by applying the integrated, whole-building design process, to the project during the planning phase that ensures all key design objectives are met. For example, the integrated project team may discover a single design strategy that will meet multiple design objectives. Doing so will mean that the building will be less costly to operate, will increase in value, last longer, and contribute to a better, healthier, more comfortable environment for people in which to live and work. Improving indoor environmental quality, decreasing moisture penetration, etc. will result in improving the health and productivity of occupants. Further, when deciding on a retrofit, developers are to consider upgrading for accessibility, safety and security at the same time. Also, the unique aspect for the retrofitting of historic buildings must be given special consideration. Designing major renovations and retrofits for existing buildings to include sustainability initiatives will reduce operation costs and environmental impacts, and can increase building adaptability, durability, and resiliency.

Consequently, making a building more sustainable while completing the retrofit could attract higher-paying tenants, which would cause a greater appreciation by the time the owner(s) plan to sell. This is true as properties with Energy Star certification have sold for 2-5% more than buildings without such certification [7].

Existing buildings account for most of the energy used in the building sector, whereas new buildings use only a small percentage of energy. The energy use in commercial buildings is predicted to increase every year for at least two decades. Therefore, it is important to retrofit existing buildings to increase energy savings. This endeavour is very complicated with many considerations, such as maintaining historic features to controlling costs. Therefore, energy-efficient-based planning depends on the scale of opportunity for energy efficiency improvements in existing buildings. A typical building can cut energy use by up to 15% by implementing low cost measures and over 45% by implementing deeper retrofit measures. Such retrofit projects will reduce operating costs, and improve occupant comfort with a host of other benefits. This study has shown that a building doesn't have to be new to be energy-efficient, hence, this form of retrofitting is recommended in developed, currently developing and future building developments – in Abuja and beyond.

4. CONCLUSION

In cities where the building stock is stable or growing rapidly (as obtainable in Abuja), the retrofitting of existing structures and the replacement of old energy-consuming equipment is often recommended for smart and efficient energy gains. By accomplishing such design objectives, the building(s) will be less costly to operate, increase in value, last longer and contribute to a healthier and more productive environment for the users. However, to reach optimum retrofit goals, many factors must be considered, especially by considering the cost of their deployment, installation and their foregone alternative. This study has been able to show that the use of retrofitted building technologies are significant strategies but also showed that, among the respondents there is a high preponderance of adopting and installing solar energy devices than any other strategy found to be in-place. Hence, it is expected that similar studies are to be carried out in other urban centres, so as smart policies can be formulated to guide building development permits – such that will increase liveability and particularly the thermal comfort of residents in the face of climate change and global warming.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Camp A. Counting every drop. Facilities Management. 2005;12(4):16-17.
2. Koeppel S, Ürge-Vorsatz U. Assessment of policy instruments for reducing greenhouse gas emissions from buildings, UNEP–Sustainable Buildings and Construction Initiative, September, Budapest; 2007.
3. Wilkinson P, Kirk RS, Sean B, Cathryn T, Tadj O. Energy efficiency and the built environment. The lancet 370(100) London, UK; 2007.
4. Nigerian's newspaper: The daily star. Power disruption and load shedding in Nigeria, may 13; 2009.
5. European Union. Towards a European strategy for the security of energy supply. Green Paper. 2000;2(1):45-47.
6. Bassioni HA, Price ADF, Hassan TM. Building a conceptual framework for measuring business performance in construction: An empirical evaluation. Construction Management and Economics. 2005;23:495-507.
7. Praznik M, Butala V, Zbašnik-Senegačnik M. Simplified evaluation method for energy

efficiency in single-family houses using key quality parameters. Energy Build. 2013; 67(10):489-499.
8. Olatubara CO, Fatoye EO. Evaluation of the satisfaction of occupants of the Abesan public low-cost housing estate in Lagos State, Nigeria. The Nigerian Journal of Economic and Social Studies. 2007; 49(1).
9. NPC. National Population Commission. Final Census Results. National Population Commission (NPC) Abuja; 2010.
10. Jatau B. Designing a spatial database to improve plot application processing in Abuja, Nigeria. ITC, Enschede. 1991;1(1): 92-93.
11. Jibril IU. Resettlement issues, squatter settlements and the problems of land Administration in Abuja, Nigeria's Federal Capital, 5th International Federation of Surveyors (Fig) Regional Conference. International Federation of Surveyors, Accra, Ghana. 2006;15-16.
12. Kitzinger J. Audience and readership research' in the sage handbook of media studies. London: Sage; 2004.
13. Newcomb H. The Creation of Television Drama' In a Handbook of Qualitative Methodologies for Mass Communication Research (7th Ed.). London and New York: Routledge; 2009.
14. Kahu R. Evaluating energy efficiency in the design of large scale office building in hot-dry climate of Nigeria. An Unpublished thesis submitted to Ahmadu Bello University, Zaria Nigeria; 2014.
15. Oligbinde OS, Odunfa KM, Ohunakin OS, Odunfa VO. Energy efficiency in residential buildings: A case study of 1004 Federal Housing Authority Estate, Victoria Island, Lagos. International Conference of Mechanical Engineering, Energy Technology and Management. 2014;4(2), 45-46.
16. Yasin MN, Abdullah AH, Hamid HA, Wahab NS. Potential retrofit of existing sultan ismail parliament building. Johor to Green Building. ISCEE. 2016;1-7.
17. Lee MC, Mui KW, Wong LT, Chan WY, Lee EWM, Cheung CT. Student learning performance and indoor environmental quality (IEQ) in air-conditioned university teaching rooms. Building and Environment. 2012;49(2):238-244. DOI: 10.1016/j.buildenv.2011.10.001
18. Malaysia Green Building (GBI) Index;2015. Available:http//www.greenbuildingindex.org (Retrieved on June 3, 2016)

APPENDIX I

$$\frac{\text{Total of } 1^{st} \text{ Row X Total of First Column}}{\text{N (Grand Total)}}$$

Calculation of expected frequencies:

$C_{11} = \frac{300 \times 689}{1800} = 115$ $C_{12} = \frac{300 \times 689}{1800} = 115$ $C_{13} = \frac{300 \times 689}{1800} = 115$

$C_{21} = \frac{300 \times 185}{1800} = 31$ $C_{22} = \frac{300 \times 185}{1800} = 31$ $C_{23} = \frac{300 \times 185}{1800} = 31$

$C_{31} = \frac{300 \times 40}{1800} = 7$ $C_{31} = \frac{300 \times 40}{1800} = 7$ $C_{31} = \frac{300 \times 40}{1800} = 7$

$C_{31} = \frac{300 \times 251}{1800} = 41$ $C_{31} = \frac{300 \times 251}{1800} = 41$ $C_{31} = \frac{300 \times 251}{1800} = 41$

$C_{31} = \frac{300 \times 93}{900} = 31$ $C_{31} = \frac{300 \times 93}{900} = 31$ $C_{31} = \frac{300 \times 93}{900} = 31$

Contingency table*

Options	U	V	W	X	Y	Z	Total
Strongly Agree	130(115)	150(115)	110(115)	90(115)	120(115)	89(115)	**689**
Agree	110(31)	130(31)	150(31)	80(31)	90(31)	75(31)	**635**
Undecided	5(7)	5(7)	0(7)	13(7)	9(7)	8(7)	**40**
Strongly disagree	30(41)	7(41)	24(41)	70(41)	60(41)	60(41)	**251**
Disagree	25(31)	8(31)	16(31)	47(31)	21(31)	68(31)	**185**
Total	**300**	**300**	**300**	**300**	**300**	**300**	**1800**

**Computed from table 5 (note the values in bracket)*

Calculated Chi-square (χ^2) = 1544.9
Degree of freedom (d_f) = (C-1) (R-1)
= (5-1) (6-1)
(d_f) = (4) (5) = 20
Tabulated X^2 value = 31.410

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20433