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Evaluation of Energy Efficiency in Residential Buildings in Akure, Nigeria

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Abstract

This paper presents the result of an evaluation of energy efficiency in households in Akure, Nigeria by assessing the metering system used in various residential building types, the energy-intensive behaviour among residential buildings, barriers that hinder the effective implementation of energy efficiency measures, and ways of improving the implementation of energy efficiency measures in the residential buildings. The study adopted a quantitative survey approach with information gathered from occupant within the selected residential building in Akure, Nigeria. Data gathered were analysed using percentage, bar chat, mean score, standard deviation, severity index and significant level analysis. Findings revealed that energy-intensive domestic activities are more prevalent in the postpaid metered building in the study area. The most significant barriers that hinder the effective implementation of energy efficiency measures were none implementation of energy policy, ignorance among energy users of the importance of efficient energy use in buildings and lack of energy efficiency awareness. The study recommends the adoption of measures such as raising energy efficiency awareness campaign, the introduction of the energy-efficient metered system, and implementation of energy efficiency policy.

Keywords: Building; Efficiency; Energy; Evaluation; Meter; Residential.

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1. Introduction

Energy, it is the mainstay for socio-economic development and economic growth in Nigeria [16]. It plays a significant role in the nation‘s international diplomacy and it serves as a tradable commodity for earning the national income, which is used to support government development programmes [18]. It also used for the production of goods and services in the nation ‘s industry, transport, agriculture, health and education sectors, commercial and official activities [2]. The patterns of energy usage in Nigeria's economy can be divided into industrial, transport, commercial, agricultural, and residential buildings (household) sectors [5], while, the residential buildings account for over 80% of the total energy consumed in Nigeria [7]. The authors in [23, 20] revealed that energy used by residential buildings includes electricity, gas, diesel, kerosene, inverters, candles, lanterns, but, usage is dominated by electricity. Nigeria is endowed with sustainable energy resources and is also well endowed with renewable energy sources such as wood, solar, hydropower, and wind, yet it observed that energy utilization in Nigeria is highly inefficient [16]. The authors in [20] revealed using energy inefficiently have some major implications in Nigeria, the investment in major energy supply infrastructure is far more than what the energy demand is and that the environmental problems associated with energy utilization and efficiency are more heightened due to large energy consumption. The authors in [12] revealed that a lot of energy is wasted in Nigeria because households use more energy than is necessary to fulfil their needs. One of the reasons is that they use old and inefficient equipment and appliances [5, 16], they appear to see no need to use energy efficiently through their practice [15]. Energy efficiency does not mean that we should not use energy, but we should use energy in a manner that will minimize the amount of energy needed to provide services [2]. The authors in [15, 2] proposed that if energy is well managed and efficiently utilized, would provide Nigeria with significant economic, environmental, and security benefits. The authors in [6] proposed that instituting energy efficiency practice through policies implementation would reduce the energy demand in households. Currently, there are no mandatory energy efficiency standards and policy for both the building and industrial sector in Nigeria [4, 9]. Hence, the authors in [19, 22] identified the lack of effective energy efficiency policy as a major barrier which particularly hinders the mainstreaming of energy-efficient appliances in a residential building in Nigeria. The authors in [10] identified various barriers that had hindered the implementation of energy efficiency policy in Nigeria which includes, Ignorance and low-level awareness, non-affordability, lack of Government commitment, lack of economic incentive and unreliable electricity supply. Government policies should encourage investments in energy-efficient technologies and practice to improve the efficiency of our homes and conserve the present energy generated in the country using energy-efficient products and the appropriate practices [21]. Also, [7] in their study identified optimized energy-efficient measures for a typical residential building for three cities to account for a wide range of climatic conditions within Nigeria, the optimization results shows that utilizing energy-efficient lighting fixtures and high efficient air-conditioning system was needed to design high-energy performance residential buildings throughout the tropical climatic zones in Nigeria. More so, [1] in his study of energy efficiency in postpaid-prepaid metered homes in Lagos, Nigeria showed that even though there is no mandatory policy in Nigeria, energy efficiency can be imbibed in a household through their metering system, he established that energy consumption and culture differs significantly between the prepaid and postpaid metered household, he found out that prepaid metered household saves energy by 47% than postpaid household. Though, the level of adoption of the prepaid meter is

still very low in Nigeria [14]. A lot of researches have been carried out in the area of energy efficiency in a residential building, for example; the authors in [17] assessed the level of energy culture, attitudes of residential building occupants, perceptions and pattern of energy use and observed their daily energy practices in Ireland. More so, the authors in [11] identified the energy use pattern and behavioural aspects of energy in residential buildings in the Netherlands and Spain. Also, [3] carried out a field trial in Mexico in which a quasi-experimental sample of new homes was provided with insulation and other energy-efficient upgrades and measured the temperature and humidity at high frequency inside residential buildings. Yet the level of awareness of energy efficiency and behavioural patterns among households is still low [3, 11, 17]. Literature addressing the levels of energy efficiency and behavioural patterns among different types of residential building in Nigeria is limited. Studies evaluating energy efficiency and behavioural patterns by various kinds of a residential building in Akure, Nigeria are scanty, hence this study. This study, therefore, examined the energy efficiency and behavioural pattern of households by examining the metering system used in various residential building types in Akure, Nigeria, identified the energy-intensive behaviour among the five types of residential buildings (One general utility, A Room and Parlour General Utility, one room self-contain, two-bedroom flats and more than two-bedroom flats) in the study area, identified and quantified the strength of barriers that hinders the effective implementation of energy efficiency measures, and assessed the various ways of improving the implementation of energy efficiency measures in the residential building in the study area.

2. Methodology

The survey research was conducted in Akure, Ondo State Nigeria. The population of the study are end-users which are residential building occupants in some selected residential building in the study area. A total of seventy (70) well-structured questionnaire administered through a purposive technique to the targeted respondents was used. A total of fifty (50) questionnaire was returned out of the seventy (70) questionnaire that was administered to the respondents, this gives a rate of return of 71.4%. The questionnaire sought to gather information about the respondents and types of residential buildings. It also contains questions to know the meter system used in various residential building types in Akure, Nigeria, the energy-intensive behaviour among the five-building sampled, the barriers that hinder the effective implementation of energy efficiency measures, and the various ways of improving the implementation of energy efficiency policy in a residential building in the study area The data obtained were analyzed using descriptive statistics such as frequency, percentages, bar charts, Mean Items Score (MIS), significant level analysis and relative severity index. However, frequency and percentage were employed to analyze the demographic information of the respondents, while bar chart and percentage were used to rank the meter system used in various residential building and the energy-intensive behaviour among the five-building sampled, severity index was used to ranks the barriers that hinder the effective implementation of energy efficiency measures and mean score and Significant level analysis was also computed to determine and buttress the agreement of the respondents on ways of improving the implementation of energy efficiency measures in residential buildings. The significant level analysis was proposed by [8] and suit the Likert-type scale employed in this study. The significant grading adopted is as follow: “not important” ($M \leq 1.5$), “somewhat important” ($1.51 \leq M \leq 2.5$), “important” ($2.51 \leq M \leq 3.5$), “very important” ($3.51 \leq M \leq 4.5$) and "extremely important" ($M \geq 4.5$). This helped to reinforce all analysis conducted on the ways of improving the implementation of energy efficiency measures in residential buildings.

$$\text{MIS} = \frac{5n_5+4n_4+3n_3+2n_2+1n_1}{n_5+n_4+n_3+n_2+n_1} \quad (1)$$

Where n is the frequency of each of the rankings. Constant weights were assigned to each response in the questionnaire (ranges from 1 for Not important, 2 for less important, 3 for important, 4 for very important and 5 for extremely important). A cut-off point means score > 2.5 on a 5-point Likert-type scale have been declared to be sensible to decide critical or noteworthy variables [8]. Consequently, [13] prescribed 3.50 cut off point on a 5-point Likert-type scale, this was thought to be high when contrasted and different entries. This paper embraced ≥ 2.5 mean scores as a cut-off point.

$$SI = \frac{\sum W}{AxN} \quad (2)$$

where w = weighting given to each barrier by the respondents and ranges from 1 to 5 where '1' is 'not significant' and '5' is 'extremely significant',

A = highest weight (i.e. 5 in this case), and N = total number of respondents.

3. Results and Discussion

Table 1: Showing the Age and Gender of Respondents

Age Category (years)	Frequency	Percentage
Below 20	10	20%
21 – 30	30	60%
31 – 40	5	10%
41 – 50	4	8%
Above 50	1	2%
Total	50	100

Table 1 above represents the age and gender of the respondent. This shows that 80% of the respondents sampled were more than 20 years of age and possesses the required age and experience to contribute their quota effectively in the study.

Table 2: Working Status of Respondents

Working Status	Frequency	Percentage
Employed	12	24%
Unemployed	7	7%
Student	31	62%
Total	50	100%

Table 2 above represent the educational qualification of the respondents. This shows that 62% of the

respondents are students in tertiary institutions and 24% of the respondents are employed.

Table 3: Educational Qualification of the respondents

Designation	Frequency	Percentage
SSCE	35	70%
BSc/ B.Tech	10	20%
M.Sc./M.Tech.	5	10%
PhD.	0	0%
Total	50	100

Table 3 above represent the educational qualification of the respondents. This shows that the respondents possess the minimum required knowledge to contribute their quota effectively in the study.

Table 4: Residential characteristics of the respondent

Type of Building	Frequency	Percentage
One General Utility	10	20%
A Room and Parlour General Utility	15	30%
One Room Self-Contained	8	16%
Two Bedroom Flats	7	14%
More than Two Bedroom Flats	10	20%
Total	50	100%

Table 4 above represent the residential characteristics of the respondents. This shows that 30% of the respondents live in buildings with a room and parlour general utility, 20% living in one general utility, 16% live in one room self-contained, while 14% live in two-bedroom flats and the remaining 14% live in more than two-bedroom flats.

Table 5: Residential characteristics of the respondent

Number of Rooms	Frequency	Percentage
1 – 5	12	24%
6 – 10	26	28%
11 – 15	8	16%
16 – 20	10	20%

Table 3 above shows the residential characteristics of the respondent. This shows that the number of rooms in most of the buildings in the study area is between 1 – 10 rooms (52%), about 16% between 11 – 15 rooms, 20% between 16 – 20 rooms while only about 12% of the buildings have rooms above 20 rooms.

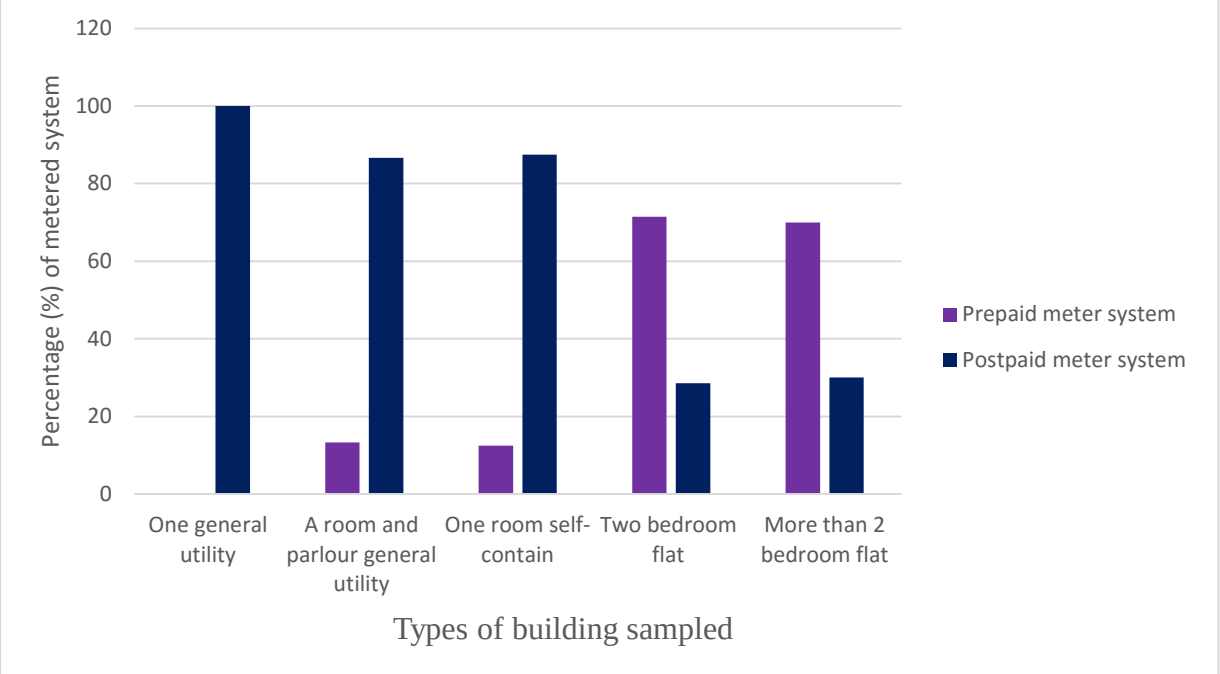

Figure 1: Metered system used in the five types of residential buildings sampled in Akure

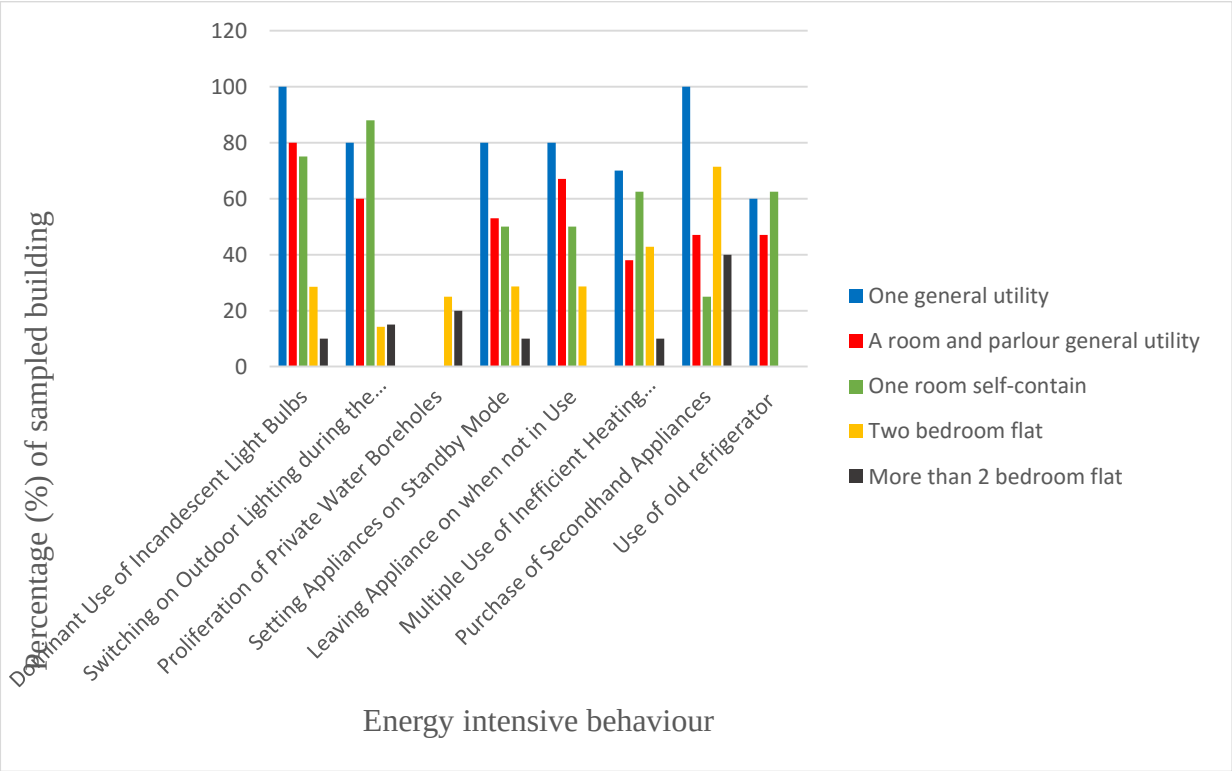

Figure 2: Energy-intensive behaviour among the five-residential building sampled

The result of the metered system used by the five (5) types of residential buildings sampled is shown in Figure 1. This shows that all the one general utility building sampled made use of post-paid meter (100%), in one room and parlour general utility 87% made use of postpaid meter while 13% use pre-paid meter, 87.5% of the one-

room self-contain sampled utilize post-paid meter and 12.5% used pre-paid meter, 28.7% of two-bedroom flats sampled make use of post-paid meter and the remaining 71.42% make use of pre-paid meter, 30% of more than two-bedroom building makes use of post-paid meter and 70% makes use of pre-paid. The result of the Energy intensive behaviour among the five-types of residential building sampled is shown in Figure 1.

Table 6: Barriers that hinder the effective implementation of energy efficiency measures by residential occupants

NO	BARRIERS	SI	SD	Rank
1	Lack of implementation of energy efficiency policy	0.900	0.678	1
2	Ignorance among energy users of the importance of efficient energy use in buildings	0.812	1.096	2
3	Lack of energy efficiency awareness	0.756	0.954	3
4	Lack of knowledge that high energy consumption affect them and the environment in the long run	0.748	1.426	4
5	Lack of information feedback on energy efficiency	0.736	1.096	5
6	The belief that energy supply and demand is a necessity	0.732	1.136	6
7	The poor imposition of penalty on the defaulters	0.724	0.967	7
8	Absence of financial incentives to the energy-efficient occupants	0.720	1.050	8
9	Lack of environmental concern and environmental knowledge about energy efficiency	0.700	0.814	9
10	Level of education, campaign and talks on the need for Saving	0.684	0.992	10
11	Feeling that energy conservation does not benefit them	0.672	1.208	11
12	Low level of connectedness (because you are not paying for energy consumption)	0.660	1.446	12
13	Its implementation is against their lifestyle, belief of the occupants	0.636	1.063	13
14	The belief that their lives will severely be disrupted by prohibiting high power appliance	0.636	0.962	14
15	Lack of environmental concern and environmental knowledge	0.632	1.113	15
16	The belief of occupant that energy conservation has a detrimental impact on their welfare	0.608	0.989	16

This shows that dominant use of incandescent bulb is rampant among the five types of residential building sampled (100% of one general utility, 80% of a room and parlour general utility, 75% of one room self-contain, 28.57% of two bedroom flat and 10% of more than 2 bedroom flat), also switching on outdoor lighting during the day is highly significant among the various building sampled with (88% of one room self-contain, 80% of one general utility, 60% of a room and parlour general utility, 15% of more than 2 bedroom flat and

14.28% of two bedroom flat), more so, proliferation of private water boreholes with (25% of more than two bedroom flats and 20% of more than 2 bedroom flat), also, setting appliances on standby mode with (80% of one general utility, 53% of a room and parlour general utility, 50% of one room self-contain, 28.67% of two bedroom flat and 10% of more than 2 bedroom flat), leaving appliance on when not in use with (80% of one general utility, 67% of a room and parlour general utility, 50% of one room self-contain, 28.67% of two bedroom flat), multiple use of inefficient heating equipment with (70% of one general utility, 62.5% of one room self-contain, 42.85% of two bedroom flat and 38% of a room and parlour general utility and 10% of more than 2 bedroom flat), purchase of secondhand appliances with (100% of one general utility, 71.42% of two bedroom flat, , 47% of a room and parlour general utility, 40% of more than two bedroom, and 25% of one room self-contain) and use of old refrigerator with (62.5% of one room self-contain, 60% of one room general utility, and 47% of a room and parlour general utility). Table 5 presents the rating of the respondents' perceptions of the severity of barriers that hinders the effective implementation of energy efficiency measures in residential buildings in the study area.

Table 7: Ways of improving the implementation of energy efficiency measures in a residential building in the study area.

NO	WAYS OF IMPROVING	Mean	Significant Grade
1	Raising energy efficiency awareness campaign	4.30	Very Important
2	Introduction of energy-efficient metered system	4.18	Very Important
3	Encourage the use of energy-efficient equipment	4.16	Very Important
4	Implementing energy efficiency policy	3.98	Very Important
5	Updated and frequent information and feedback from researchers	3.98	Very Important
6	Subsidies to purchase low energy consuming appliance and Establishment of energy conservation reward	3.96	Very Important
7	Develop standard reporting measures to monitor energy management	3.86	Very Important
8	Improving the design of rooms to ensure energy conservation	3.86	Very Important
9	Provision of insight into particular efficient operation	3.86	Very Important
10	Sustainability workshop during occupancy orientation during Tenancy	3.82	Very Important
11	Frequent Education and campaign on the financial and environmental impact of energy consumption needs and ways to lower energy use	3.78	Very Important
12	In-depth monitoring of policy by all ties of Government	3.62	Very Important
13	Provision of incentive to the occupants	3.60	Very Important

(m<1.5= "not important", 1.51≤M≤2.5= "somewhat important", 2.51≤m≤3.5= "important" 3.51≤m≤4.5= "very

important" m≥4.51= "extremely important")

This shows that the respondents rated all the sixteen barriers that hinder the effective implementation of energy efficiency measures as severe. Lack of implementation of energy policy was rated the highest severe factor with severity index of 0.900, followed by Ignorance among energy users of the importance of efficient energy use in buildings with a severity index of 0.812, Lack energy efficiency awareness with a severity index of 0.756, Lack of knowledge that high energy consumption affects them and the environment in the long run with a severity index of 0.752, Lack of knowledge that high energy consumption affects them and the environment in the long run with a severity index of 0.748, Lack of information feedback on energy efficiency with a severity index of 0.736, Belief that energy supply and demand is a necessity a severity index of 0.732, Poor imposition of penalty on the defaulters with a severity index of 0.724 and Absence of financial incentives to the energy-efficient occupants with a severity index of 0.720. Notably, all the factors have a severity index > 0.600, which suggests that all the factors have a major as opposed to a minor impact in terms of hindering the effective implementation of energy efficiency policy.

Table 7 presents the respondents" perceptions to the Ways of improving the implementation of energy efficiency measures in a residential building in terms of an MS ranging between 1.00 and 5.00, based upon percentage responses to a scale of 1 (Minor) and 5 (Major). Raising energy efficiency awareness campaign (MS = 4.30) is the most important ways of improving the implementation of energy efficiency measures in residential building. Next is introduction of an energy-efficient metered system (MS = 4.18), Encourage the use energy-efficient equipment (MS = 4.16), Implementing energy efficiency policy and updated and frequent information and feedback from researchers (MS=3.89), Subsidies to purchase low energy consuming appliance and establishment of energy conservation reward (MS=3.96). Notably, all the factors have MSs > 3.60, which suggests that all the listed ways are very important in improving the implementation of energy efficiency measures in residential building.

4. Discussion of Findings

The study examined the meter system used in various residential building types in Akure Nigeria, identified and quantified the energy-intensive behaviour among the five types of residential building sampled in the study area, assessed the barriers that hinder the effective implementation of energy efficiency measures, and identified the various ways of improving the implementation of energy efficiency measures in the residential building in the study area. The findings revealed 30% of the building sampled were a room and parlour general utility, one general utility (20%), one-room self-contained (16%), two-bedroom flats (14%) and more than two-bedroom flats (14%). Majority of the building sampled (64%) have between 1-10 rooms, 16% between 11 – 15 rooms, and 20% between 16 – 20 rooms. The study revealed that more than 87% all the one general utility, one room and parlour general utility and one-room self-contain buildings sampled made use of the post-paid meter. The study further revealed that more than 70% of two-bedroom flats and more than two-bedroom building makes use of the pre-paid meter. This finding agrees with [1, 14] who opined that postpaid meter is more prevalent in most of the residential buildings in Nigeria. The study found out that energy-intensive domestic activities which include; dominant use of the incandescent bulb, setting appliances on standby mode, leaving an appliance on

when not in use, multiple uses of inefficient heating equipment and purchase of secondhand appliances is more prevalent in one general utility building, a room and parlour general utility and one room self-contain buildings than any other residential building in the study area. This study also identified that energy-intensive activities are less prevalent in the two-bedroom flats and more than two-bedroom flat sampled. Hence, the metering system could directly account for disparities in energy-intensive behavour among the households in the study area. This finding indicated that levels of energy-intensive activities differ significantly between the prepaid and postpaid metered households, hence, the level of energy-intensive activities in post-paid metered households is higher compared to the prepaid metered household. These findings agree with [1, 5] who opined that the level of energy consumption and inefficiency is higher in postpaid metered households. This study also revealed that the most significant barriers that hinder the effective implementation of energy efficiency measures are lack of implementation of energy policy, ignorance among energy users of the importance of efficient energy use in buildings, lack of energy efficiency awareness, lack of knowledge that high energy consumption affects them and the environment in the long run and lack of information feedback on energy efficiency. These findings agree [10, 19 and 22] who agrees that the lack of energy policy and lack of energy efficiency awareness are the major causes of inefficient use of energy in Nigerian households. If the energy efficiency measures are to be implemented in residential building, then there is need for the adoption of measures such as raising energy efficiency awareness campaign, the introduction of the energy-efficient metered system, implementing energy efficiency policy and updated and frequent information and feedback from researchers, subsidies to purchase low energy consuming appliance and establishment of energy conservation reward. These findings agree with [3, 11], who opined that implementation of energy efficient metered system and energy efficiency policy will reduces the rate of consumption of energy in buildings.

5. Conclusion and Recommendations

This study set out to assess the energy efficiency and behavioural pattern of households to minimize energy-intensive activities in residential building. Using a quantitative survey with information gathered from occupant within selected residential buildings in Akure, the metering system used in various residential building types, energy-intensive behaviour among residential buildings, barriers that hinders the effective implementation of energy efficiency measures, as well as various ways of improving the implementation of energy efficiency measures in the residential building, were identified. Based on the findings of the study, it is, therefore, concluded that level of usage of the prepaid meter is very low in the study area, most of the residential buildings in the study area make use of postpaid meter and that energy-intensive activity are more prevalent in post-paid metered households compared to prepaid metered household, hence, the metering system directly account for disparities in energy-intensive domestic activities in the study area. This study also found that the most significant barriers that hinder the effective implementation of energy efficiency measures were lack of implementation of energy policy, ignorance among energy users of the importance of efficient energy use in buildings and lack energy efficiency awareness. If the energy efficiency measures are to be implemented in residential building, then there is need for the adoption of measures such as raising energy efficiency awareness campaign, the introduction of the energy-efficient metered system and implementation of energy efficiency policy. It is believed that the findings of this study will go a long way in contributing to the adoption of energy efficiency measures in residential building and minimize energy-intensive activities in a residential building in

Akure. The study contributes to the knowledge as it showcases the levels of energy-intensive activities by various building in Akure, some of the key barriers of the use of energy efficiency in households in Akure and the possible ways of improving its implementation. However, despite the immense contribution the study brings, care must be taken in generalizing its findings as it is limited based on the sample size. The study was conducted in Akure, hence further studies can be conducted in other states within the country, to compare results and also garner information on larger sample size.

References

[1]. I.R. Aliu. "Energy efficiency in postpaid-prepaid metered homes: analyzing the effects of socio-economic, housing, and metering factors in Lagos, Nigeria." Energy Efficiency, pp. 1-17, 2020.

[2]. Community Research Development Centre, "Energy Efficiency Survey in Nigeria," 2009. [Online]. Available: https://www.osti.gov/etdeweb/servlets/purl/21328691

[3]. L. W. Davis, S. Martinez and B. Taboad. "How effective is energy-efficient housing? Evidence from a field trial in Mexic." Journal of Development Economics, vol. 143, pp. 1-13, 2020.

[4]. N. V. Emodi, and K. J. Boo. "Sustainable energy development in Nigeria: Current status and policy options. Renewable and Sustainable Energy Reviews." Elsevier, Vol. 51(C), pp. 356–381, 2015. https://doi.org/10.1016/j.rser.2015.06.016.

[5]. Energy Commission of Nigeria, "National Energy Policy," 2003. [Online], Available: http://rea.gov.ng/wp-content/uploads/2017/09/National_Energy_Policy_Nigeria.pdf

[6]. I. U. Hussaini and N. H. Abdul Majid. "Energy development in Nigeria and the need for strategic energy efficiency practice scheme for the residential building sector", Management of Environmental Quality: An International Journal, vol. 26(1), pp. 21 – 36, 2015.

[7]. B. C. Kwag, B. M. Adamu, and M. Krarti. "Analysis of high-energy performance residences in Nigeria." Energy Efficiency, vol. 12, pp. 681-695, 2019.

[8]. T. H. Y. Li, S. T. Ng and M. Skitmore. "Public participation in infrastructure and construction projects in China: from an EIA-based to a whole-cycle process." Habitat International, vol. 36, pp. 47-56, 2012.

[9]. Nigerian Energy Support Programme, "An overview with a special emphasis on renewable energy, energy efficiency and rural electrification" 2015. [Online], Available https://www.giz. de/en/downloads/giz2015-en-Nigerian-energy-sector.pdf.

[10]. Nigerian Electricity Regulation Commission, "Energy Efficiency Survey in Nigeria," 2013. [Online], Available: https://pubs.naruc.org/pub.cfm?id=5384FA06-2354-D714-5117-4BD1D7E58CAA

[11]. L. Niamir, O. Ivanova, T. Filatova, A. Voinov, and H. Bressers. "Demand-side solutions for climate mitigation: Bottom-up drivers of household energy behaviour change in the Netherlands and Spain." Energy Research & Social Science, vol. 62, pp. 1-13, 2020.

[12]. E.C.N. Okafor and C.K.A. Joe-Uzuegbu. "Challenges to the development of renewable energy for the electric power sector in Nigeria", International Journal of Academic Research, vol. 2(2), pp. 211-216, 2010.

[13]. A. Opawole and O. O. Jagboro. "Benchmarking parties; obligation in the execution of concession based PPP project in Nigeria." Journal of place management and development, vol. 9, pp. 27-46, 2016.

[14]. M. Oseni. "Assessing the consumers' willingness to adopt a prepayment metering system in Nigeria."

Energy Policy, vol. 86, pp. 154-165, 2015.

[15]. A. C. Otegbulu. "Economics of Green Design and Environmental Sustainability." Journal of Sustainable Development, Vol. 4, No. 2; pp. 240-248, 2011.

[16]. S.O. Oyedepo, "Energy and sustainable development in Nigeria: the way forward", International Journal of Energy, Sustainability and Society, vol. 2, pp. 1-17, 2012.

[17]. H. Rau, P. Moran, R. Manto, and J. Goggins. "Changing energy cultures? Household energy use before and after a building energy efficiency retrofit." Sustainable Cities and Society, vol. 54, pp. 1-13, 2020.

[18]. A.S. Sambo. "Matching electricity supply with demand in Nigeria", International Association of Energy Economics, vol. 4, pp. 32-36, 2008.

[19]. A.S. Sambo. "Strategic developments in renewable energy in Nigeria." International Association of Energy Economics; pp. 15–9, 2009.

[20]. B. F. Sule, K. R. Ajao, and H. A. Ajimotokan. "A survey of the use of electric lamps and energy consumption in residential buildings in selected estates in Ilorin, Nigeria." Energy Engineering, vol. 108, pp. 57-68, 2011.

[21]. D. A. Umar, and M. M. Abubakar. Effects of Energy Utilization on the Environment, Discovery, vol. 25, pp. 93-99, 2014.

[22]. United Nations Development Programme, "End-use Metering Campaign for Residential Houses in Nigeria," 2013. [Online], Available: https://www.ng.undp.org/content/nigeria/en/home/library/environment_energy/end-use metering-campaign-for-residential-houses-in-nigeria.html

[23]. I. Yohanna, A. H. Iortyer and I. A. Ierve. "Assessment of energy use pattern in residential buildings of Kano and Kaduna Northern Nigeria." American Journal of Engineering Research (AJER), vol. 2, pp. 271-275, 2013.