SEMARAK ILMU PUBLISHING

Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage: https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943

Drivers, Enablers, Barriers and Technologies (DEBT) For Low-Energy Public Housing Delivery in Nigeria

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ARTICLE INFO

Article history:
Received 6 December 2022
Received in revised form 28 December 2022
Accepted 19 January 2023
Available online 10 February 2023

Keywords:
Low energy; Public housing; Renewable technologies; Nigeria

ABSTRACT

Nigeria, as a developing country, has vast and varied energy resources, both renewable and non-renewable. In spite of these resources, an estimated 75% of her population of close to 200 million faces serious energy poverty problems due to shortfalls in energy supply compared to its energy demand. Consequently, a large portion of the population lives without access to adequate electricity. Hence, the country encounters unprecedented struggles with incessant power outages, unemployment, a low human development index (HDI), and poverty. This paper examines the drivers, enablers, barriers, and technological considerations for low-energy integration in the provision of housing for Nigeria's huge population. The objective is to harness the varied energy resources to aid in the delivery of environmentally friendly and sustainable housing in a developing economy such as Nigeria. This is critical in light of rising energy costs, environmental degradation, global warming, greenhouse gas emissions, and energy consumption. Reduced energy use in housing is highlighted as a critical issue in environmental management. The paper highlighted several factors that need to be appropriately addressed for a paradigm shift to low-energy integration to achieve sustainable housing delivery in Nigeria. It recommends the application of energy conservation measures in mass housing construction, the full exploitation and promotion of renewable energy resources, and energy efficiency practices in housing provision, among others. The paper concludes that these should be given adequate attention during planning, designing, and delivering sustainable housing.

1. Introduction

There is increasing international pressure to reduce carbon emissions, and nations are being urged to pursue "greener growth options". Built environment specialists' concerns about the excessive use of energy and non-renewable natural resources, the emission of green gases, climate change, and environmental disasters have steadily increased as a result of their recognition of the seriousness of environmental degradation caused by environmental problems. As a result, environmental protection has emerged as a crucial social issue [1,2] which has given rise to the

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https://doi.org/10.37934/araset.29.3.115127

importance of environmentalism in business even as consumers increasingly understand the value of environmental protection [3]. As a result, more people are engaging in environmentally beneficial behavior as a result of increased knowledge of how serious environmental problems are [4].

By 2050, however, buildings may be responsible for 70% of CO_2 emissions in the building industry if existing inefficient building techniques are not changed. According to [5] predictions, the majority of the population growth in the world over the next twenty years will be concentrated in less developed nations' metropolitan centers. For instance, three-quarters of the world's urban population currently resides in low- and middle-income countries, and the majority of this population is most at danger from the negative effects of climate change [6]. Therefore, access to inexpensive, dependable, modern, and sustainable energy services is a necessary condition for reducing poverty and promoting human development in these countries.

In Nigeria, an estimated 60 million people make their own electricity using power generating units, which cost an estimated N1.56 trillion ($13.35m) annually to run. Nigeria experiences an inadequate supply of usable energy as a result of the economy's emerging characteristics—rapidly rising demand. Ironically, the nation has access to abundant and sustainable conventional energy supplies such coal, lignite, oil, and natural gas. Additionally, it has abundant access to renewable energy (RE) resources such as wind, solar, hydropower, and wood [7]. Nigeria's economy can be broken down into industrial, transport, commercial, agricultural, and residential sectors in terms of energy consumption patterns [8]. Around 65% of the nation's energy consumption is consumed by the household sector. However, due to the high cost of alternative energy sources, low-income households urgently require homes that are energy efficient.

Finding housing solutions that don't have a negative impact on housing affordability while also addressing the expanding carbon footprint of the built environment is urgently needed. These solutions must also avoid pushing more households toward levels of carbon emissions that are unsustainable in terms of operational and embodied carbon burdens, as is the case right now. Notably, the Nigerian government and its various agencies are implementing a number of programs aimed at regenerating the urban fabric, maintaining environmental quality, and boosting the availability of housing. While these initiatives are excellent, it appears that they are not well coordinated with regard to giving low-income families low-energy homes.

Although there has never been a shortage of homes for the higher class, public housing for the poor has remained a contentious subject since different government initiatives have not been able to close the gap in housing availability. The purpose of this paper is to investigate the technological concerns, challenges, enablers, and drivers for integrating low-energy housing for Nigeria's enormous population. This is done with the intention of utilizing the many energy sources to help build ecologically friendly and durable houses in a developing nation like Nigeria. The objectives were to:

i. look at the motivations for and advantages of low-energy housing delivery in Nigeria, and
ii. find out what barriers and difficulties stand in the way of low-energy housing delivery in Nigeria and how to best overcome them and
iii. investigate the factors that make low-energy housing possible in Nigeria.

2. Review of the Literature

Due to the shocks in the energy supply, the 1973 first global oil crisis brought attention to difficulties with energy security [9]. Many oil-importing economies suffered significant economic losses as a result of this crisis, and many nations experienced political instability [10]. Hence, due to its crucial role in helping society address the concerns of climate change, socioeconomic stability, and energy security, access to energy and its efficiency have emerged as a matter of contemporary concern in developing countries. The significance of energy security on a worldwide scale is highlighted by this event [9,11,12]. Energy security is the capacity to provide energy services on a consistent basis over a long period of time. It is recognised as a critical component of the sustainable growth of contemporary society. The recent price spikes for fossil fuels have created several obstacles for many countries to acquire energy, resulting in repercussions on inconsistent power supply, distorted development progress, affected economies inflation, and raised the price of raw commodities [11].

Numerous studies, including those by [13-15] have shown that investing in energy infrastructure is greatly reduced in nations that increase energy efficiency and the delivery of energy to households. Benefits of such action include improving energy affordability for low-income households, reduces global pollutants and improves the lives of locals, particularly the poor. However, in Nigeria, compliance with regulations for energy reduction has been patchy, despite the attention paid to the energy problems plaguing the nation. For instance, the majority of building plans do not even integrate energy-efficiency measures in the final buildings. The implementation issue, however, might be resolved by policies other than the National Packages and building codes, like attaching the provision of energy efficiency to occupancy licenses. The definition of sustainability has also placed limitations on the problem of low-energy buildings.

In Nigeria, low energy construction regulations hardly ever address sustainability on a scale greater than the level of a single building. One could argue that low energy construction regulations all around the nation are overly focused on building components and site-specific measures while frequently ignoring bigger issues like site selection, urban design, and neighborhood connections. This narrowness may be explained by the fact that larger issues, such location and economic and social concerns, are considerably harder for governments to solve through legislative measures and much harder for private building owners and developers to deal with. Because they can cover so many different problems, low energy buildings have been challenging to define. Similar to sustainable buildings, low-energy buildings have expanded beyond environmental considerations to encompass economic and social issues.

2.1 The Requirement for Public Housing to Optimize Its Energy Use

The major contributor to the rise in energy consumption in public housing is the increased reliance on electricity, the majority of which is used for lighting, space heating and cooling, and water heating. The majority of the nation's urban housing stock dates from periods when energy use was different from what it is today. There is currently a limited understanding of sustainability in Nigeria, with an emphasis on housing, new development, and energy challenges. Since Nigeria's independence in the 1960s, energy use reduction has not been the primary focus of its building regulations. The emphasis on low energy consumption in public housing has not been strengthened over time, despite the fact that the National Packages contain criteria for numerous environmental issues like water and air quality. The fact that energy efficiency has not been a handy focus point for optimization in public housing and performance-based laws may be the cause of this scenario.

2.1.1 Energy technologies for sustainable development in Nigeria

It is becoming increasingly obvious that the new regime of renewable energy sources—and to some extent, natural gas-based systems—will drive future expansion in the energy sector, rather than conventional oil and coal sources. Based on the use of regularly accessible local resources, renewable energy sources like biomass, wind, sun, hydropower, and geothermal can offer sustainable energy services. In order to determine the potential of renewable energy sources in Nigeria, Onyebuchi [16] calculated the technical potential of solar energy in Nigeria at 15.0 1014 kJ of useable energy per year. This is equivalent to the country's current yearly production of fossil fuels, which is 258.62 million barrels of oil equivalent. Additionally, this will result in an annual power production of roughly 4.2 105 GW/h, which is roughly 26 times the nation's current annual electricity production of 16,000 GW/h. As the cost of solar and wind power systems continued to diminish, while the price of oil and gas has continued to vary, a switch to renewable energy systems is becoming more and more possible.

These conventional fossil fuel-based energy sources are coming under growing pressure on a number of environmental fronts, with the Kyoto Protocol's greenhouse gas (GHG) reduction targets posing the biggest threat to coal's continued usage. It is now obvious that, barring drastic carbon sequestration measures, any endeavor to keep atmospheric CO_2 levels below even 550 ppm cannot be based primarily on an economy driven by oil and coal. The potential of renewable energy sources is immense because, in theory, they could supply all of the energy required by the world's population. In their work on the potential of solar energy in Nigeria, Chineke and Igwiro [17] indicated that Nigeria receives a lot of solar energy with an average yearly daily solar radiation of roughly 5.25 kW h/m2 per day that can be harnessed. According to [18] with an average annual solar energy intensity of 1,934.5 kW h/m2 /year, Nigeria's entire geographical area receives 6,372,613 PJ/year (or roughly 1,770 TW h/year) of solar energy on a yearly basis. It is imperative to provide the country's unreliable energy sector with a sustainable source of power supply through solar energy in order to advance the country's development trend.

Furthermore, the development of renewable energy systems will make it possible to complete the tasks that are currently the most important, such as enhancing the reliability of the energy supply and the organic fuel economy, addressing issues with the local energy and water supply, raising the standard of living and ensuring the sustainable housing development. Hence, several researchers [19-21] have looked at the availability of wind energy resources in Nigeria with the goal of putting them to use if there is a chance that they would be needed. Each studies demonstrates that there are numerous opportunities for Nigeria to harvest wind for the production of electricity, particularly in the core northern states, the mountainous regions of the central and eastern states, as well as the offshore areas, where wind is abundantly available all year long. The challenge is for the nation to consider how to channel resources towards building wind farms in various areas and zones that have been identified as having the potential to generate wind energy.

3. Methodology

The study's main subject is public housing in Nigeria, which spans six geopolitical regions. A thorough study of the literature was done on the subject of the paper utilizing the online databases Web of Science, PubMed, Compendex, AIRBASE, and Cambridge Scientific Abstracts (including these sub-databases: Environmental Sciences and Architectural Periodicals). Along with an assessment of policy instruments, a critical review and systematic analysis of the literature on energy efficiency was conducted. This literature included peer-reviewed journal publications, research reports, policies, standards, and grey literature. The reviews mentioned in this work and other recovered resources contained references to additional papers. The papers that met the requirements for publication in peer-reviewed scientific journals were chosen from the identified papers for initial screening.

Numerous publications were analyzed in total, and those that did not discuss energy were disqualified from further analysis. Each work was ultimately categorized into one of the following categories after a general examination.

i. relevant and informative (conclusive) — providing adequate information on low energy consumption
ii. relevant but noninformative — lacking necessary details about low energy use or imperfect data processing or reporting pertinent to the topic of the review
iii. suggestive — not conclusive but suggestive of an association or lack of an association
iv. irrelevant — not relevant to the subject of the review
v. irrelevant— missing data and not covering a topic covered in the review. The final consensus statement and conclusions were formed using the papers that were considered to be conclusive.

4. Fuel Poverty: Nigeria's Proponents and Drivers of Low-Energy Public Housing

Stevenson [22] defined drivers as a factor that contributes to the emergence of a certain occurrence. Anywhere in the world where poverty exists, the phrase "fuel poverty" is appropriate. According to [23] fuel poverty is when a household's required fuel expenses are higher than the median level and, after paying for the necessary fuel, would still have a residual income that was below the statutory poverty line. The phrase "energy poverty" is occasionally used in Eastern Europe [24]. In comparison to the national average, a higher percentage of households in Nigeria live in fuel or energy poverty. Therefore, it could be argued that fuel poverty is a motivator for low-energy housing. If a household's required fuel costs are more than average (the national median level), and if they were to spend that much on energy, their remaining income would be below the official poverty level, they are said to be in fuel poverty. The energy efficiency of the home (i.e., the energy required to heat and power the home), the cost of energy, and household income are the main variables that might cause fuel poverty.

The number of households in Nigeria facing fuel poverty is increasing every year for the reasons listed below:

i. As energy prices rise, more money must be spent from household income to cover energy costs.
ii. A significant portion of the population resides in homes that waste a lot of energy. Additionally, it is challenging for them to make their homes more energy efficient, which would have decreased their expenditures, because they do not have much extra money.
iii. As a result of increased living expenses, people's finances are under pressure. Nigerians consequently suffer from some of the worst types of energy poverty. The number of Nigerians living in fuel poverty is thought to have doubled as a result of the significant increase in fuel prices that began in 2016. The cost of using electrical energy to run a home has an impact on whether or not a family is fuel poor. Therefore, Nigerians view the need to use less energy to operate their homes as a driver that is more urgent and important.

Over 15 million public housing units in Nigeria do not currently have access to grid electricity, and for those that have, the national grid's supply is, at best, inconsistent. Thus, public housing experiences the greatest lack of electricity. In Nigeria, energy insecurity extends beyond a shortage of electricity. Contrary to what was anticipated in the 2003 National Energy Policy, growing poverty has compelled a reversal in the shift to contemporary, efficient energy sources.

4.1 Enablers for Low Energy Housing in Nigeria

Du Plessis [25] highlighted three categories of interdependent enablers for the expansion of the construction sector: technological, institutional, and value system. Technological enabler is defined as a tangible or intangible product that may be used to better the industry, while institutional enabler is the middleman who facilitated the absorption of the technology into the sector, according to [26]. The stakeholders' actions and forces for change are referred to as the value system [26]. A low energy housing sector must be developed, and each enabler has a part to play. For instance, institutional enablers promote development and change through laws, regulations, and many other means. However, without the aid of technology and knowledge, the changes will not be achievable. If people are not prepared to put the information and technology at their disposal to use, they will be useless. Therefore, internal behavior is essential. Low energy housing must, however, be in demand for people to be interested in it. The adoption of low-energy homes will be challenging without demand.

One of the key institutions that significantly affects the growth of any industry is the government. Institutional enablers' main responsibilities are to direct changes and promote growth. Shen and Yao [27] claim that the movement by governments throughout the world to enact various rules and regulations to stop environmental degradation has spurred additional efforts by other stakeholders to follow suit. Pitt *et al.,* [28] emphasized the significance of building regulation in bringing about society transformation; in contrast [29] claimed that societal consensus is necessary for governmental regulations. Therefore, cooperation between the government and other institutions such as professional organizations, research institutes, and the corporate sector is necessary [25].

According to a number of authors [30-32] collaboration between the government and other institutions is essential for developing and promoting green technologies and innovation in certain areas. These include implementing stricter restrictions, amending laws and policies (such as introducing construction codes and regulations), encouraging voluntary acts, providing financial incentives, establishing rating systems, and starting model projects. According to [33] the UK Government's monetary incentives have encouraged the construction industry to lower carbon emissions from existing buildings and promote the use of renewable energy. Some of the cost (or perceived cost) issues may be resolved by the implementation of financial incentives and subsidies for low-energy buildings. To include sustainable practices into construction methods, incentives such as tax breaks for low-energy dwellings and subsidies for energy efficiency could be encouraged.

The government, a major client of the sector, will put pressure on the actors in the building business to study and use green construction knowledge and technology. Changes at the national level will result from the government's role as regulator in strengthening and enforcing sustainable-related regulations. These jobs will encourage the actors in the construction industry to look for new systems, technologies, and expertise. With government assistance, professional organizations, academic institutions, and the industry itself might develop the necessary technologies (materials and products), frameworks (rating systems and standards), and know-how (research and development) needed to provide low-energy public housing.

4.2 Housing with Low Energy Use in Nigeria: The Barriers

The implementation of low energy housing regulations faces several, intricate challenges that must be overcome if they are to be successful. By creating less difficult goals or include strategies in their plans that can lessen the effects of barriers, policymakers can take into account the presence of barriers. Different forms of impediments (such as behavioral, informational, technical, economic, political, and institutional) can be found when looking at the adoption of low-energy housing [34]. Considering its correlation with numerous barriers, adopting low energy housing can generally be seen as a favorable action. Concentrating on the obstacles found. Bhuyan *et al.,* [35] state that policy monitoring is necessary to track outcomes, identify obstacles, and be aware of unintended consequences or injustices. Policy monitoring begins with policy creation and continues throughout policy implementation. Policy design, on the other hand, is described by [36] as the deliberate and intentional endeavor to establish policy goals and to tie them to tools anticipated to fulfil those concerns.

Political-institutional impediments are under the category of obstacles to low-energy housing in Nigeria. According to [9,37-39] this is divided into three categories: political blockage, inconsistencies in the structure of the government, and a lack of coordination across policies. Conflicting policies in the government structure refer to the existence of competing interests among various government departments in the nation. For instance, an economic growth ministry and an environmental protection ministry may have different goals and preferences with regard to the rate, type, and scope of energy access and efficiency. In such a scenario, the department in charge of energy access and efficiency governance may have an effect on more general conflicts between departments due to the possibility of power sharing across these departments [9].

The failure and deterioration of national policy coordination falls under the third category of political-institutional impediments to energy availability and efficiency. As a result, [34] identified a variety of impediments to the adoption of low-energy housing, including behavioral, informational, technological, and economic constraints. In general, adopting low-energy housing is a beneficial step when taking into account how it relates to information and economic factors. In the literature, 43% of the papers that were reviewed had information, whereas 40% of the evaluations contained economic justifications. Low energy home adoption may occasionally be influenced by attitudes, behavioral restrictions, and/or values. But when it comes to obstacles, financial limitations and technological problems are the ones that are most frequently researched.

Numerous authors [40-42] have named low and unstable finance availability as well as significant risk for investors and financial institutions as economic hurdles. While other researchers, including [41-44], define behavioral barriers as low awareness of energy efficiency and non-energy benefits, a lack of information or abnormal behavior in information processing, a lack of trust. The literature does, however, somewhat favor economic, informational, and attitudinal factors. Institutional obstacles frequently pose considerable obstacles to the spread of energy-efficient technologies, compromising the effectiveness of governmental control [9]. Literature highlights the importance of streamlining procedures for energy efficiency initiatives to oppose institutional impediments [9]. The goal of administrative procedure simplification is to lessen the complexity and unpredictability of regulatory requirements as well as the administrative difficulties they impose. Other obstacles include subpar project design, installation delays, a lack of facility knowledge, subpar equipment design, and subpar performance [45,46]. Additionally, there may be regulatory risks related to the (unfavorable) outcomes of changing governmental regulations.

Building codes that were put in place a long time ago may also present obstacles to efforts to streamline the application of cutting-edge technologies. Low energy housing is not subject to the same regulatory restrictions as high energy buildings, despite building codes having a number of policy tools for regulating minimum energy standards for new buildings regarding design and construction (and repairs). Due to the aforementioned obstacles that prevent the adoption and use of low-energy public housing, these obstacles—namely, financial limitations, techno-economic, political and institutional, market, and incentive- and knowledge-related obstacles—must be removed.

4.3 Renewable Technologies: Potential Adoption for the Delivery of Low-Energy Public Housing

Low energy building design and construction technologies are extensively developed and widely accessible in most nations. According to [47] low energy building projects are fundamentally different from their conventional counterparts from a technical standpoint. Technical enablers serve two key purposes:

i. establishing the knowledge foundation required to motivate stakeholders to take action; and
ii. building technical capabilities to support and advance action. In comparison to ordinary homes, low energy buildings offer significant energy savings of up to 60% depending on the climate such as hot summer/cold winter climates, the Mediterranean, tropical, and frigid climates [48]. The technologies of renewable energy (RE) are recognised to be less competitive when compared to conventional power utility generating due to their intermittent supply and relatively high maintenance costs [49]. The use of renewable energy sources, however, has a number of benefits, including a high potential approach to reducing carbon emissions to the climate and a decrease in dependence on fossil fuel resources [50].

Knowledge and information, such as databases, benchmarks, guidelines, manuals, and handbooks, are technological enablers that spread knowledge, deepen understanding, and offer direction for specific operations. Sustainable technology installation calls for new skill sets and knowledge. According to [51] the failure to deliver sustainable buildings is hampered by a lack of knowledge, information, and understanding. The utilisation of renewable energy (RE), such as solar photovoltaic (PV), is one of the most prevalently shared ideas based on the fundamentals of sustainable development [52] cited [53] and significantly important strategy for reducing the amount of energy consumed by buildings [54] cited in [53]. The following renewable technologies are accessible and might be used in Nigeria for low-energy dwellings.

4.3.1 Wind energy

Nigeria has wind energy available in all but the farthest northern and southern regions. In the south, the wind blows between 1.4 and 3.0 m/s. Northern Nigeria experiences stronger winds, ranging from 4.0 to 5.12 m/s [55]. Nigeria has a lot of potential when it comes to developing and using wind energy to produce power. The southern and northern coastal parts of the nation are potential viable locations for wind energy utilization.

4.3.2 Wind turbines

Although expensive to connect to a central source, wind turbines are useful for power generation in remote locations where energy is required. They are especially well suited for the development of electricity in Nigeria's rural villages.

4.3.3 Solar power

Solar collectors are manufactured tools that are used to capture solar energy. Both thermal and photoelectric (photovoltaic) processes can use the energy that is collected. Solar energy is utilized to heat a gas or liquid during a thermal process. Without the use of any intermediary mechanical devices, solar energy is turned directly into electrical energy through the photovoltaic process. Nigeria is blessed with abundant solar energy that can be used; the strength of the sun's rays ranges from 7.0 kwh/m2 in the far north to 3.5 kwh/m2 in the far south. These numbers are adequate for solar and thermal applications [55]. The Energy Commission of Nigeria's (ECN) prediction of Nigeria's total final energy demand in 2030 is approximately 23 times the amount of solar energy that is currently accessible [8]. It is imperative to provide the country's unreliable energy sector with a sustainable source of power supply through solar energy in order to accelerate the development trend there.

4.3.4 Geothermal power

Geothermal energy comes from heat that is generated in the earth's crust. According to a report, 250 geothermal power plants in 22 different countries produced over 9,000 megawatts of electricity in 2004. Over 60 million people, largely in poor nations, received power from these facilities. A few African nations have already begun investigating the energy possibilities provided by this renewable energy source. There are currently two significant geothermal energy resource locations recognized in Nigeria. Nigeria has some potential to harvest electricity from this kind of renewable energy. They are located in Bauchi State's Wikki Warm Spring and Ondo State's Ikogosi Warm Spring. Other sites in the Lagos sub-basin, including the Okitiputa Ridge, Auchi-Agbede inside the Benin Flank/Hinge Line, and the Abakaliki Anticlinorium, have been discovered in addition to these two major sites [56]. This energy source has the benefit of having a very high rate of security. Additionally, it is accessible throughout the year, twenty-four hours a day. Geothermal power stations can have capacities between 20MW and 60MW. Additionally, it doesn't hurt the environment, meaning it doesn't add to the issue of climate change [56].

5. Contribution to the Body of Knowledge

It was discovered throughout the literature review that there was little existing research on low energy housing in Nigeria. This study offers an up-to-date assessment at the potential integration of low energy into the provision of public housing in Nigeria and explains why it hasn't been taken into account in any efforts to produce public housing. Understanding how different housing distribution methods differ is made possible by the various nature of dwelling types.

6. Practice implications

In order to provide a catalyst for the delivery of low energy housing in Nigeria, the barriers and constraints highlighted and the associated ways of optimization proposed by this article are very useful information for practitioners and policy makers. The recommendations are as follows:

i. From the outset of a project, design teams, contractors, and clients should collaborate more;
ii. The government and industry should priorities educating the public about the advantages of and need for low energy housing for Nigerians as a way to create market demand.
iii. By promoting alternate delivery methods, the building sector should attempt to lessen the overreliance on volume of houses delivered. Rather more attention should be paid to the delivery of more energy efficient residential housing in Nigeria.

7. Recommendations

The most crucial stage in creating a low energy house with a comfortable inside climate is the architectural design. As a result, the following can be done to save energy:

i. design simplicity
ii. energy conservation
iii. passive design
iv. orientation
v. keeping it undersized
vi. natural landscaping
vii. effective lighting
viii. handling of waste
ix. considering power
x. create a flexible system
xi. wholesome air
xii. conservation of water
xiii. emissions reduction
xiv. resource effectiveness
xv. either design or operation and upkeep.
xvi. considering power

New, well-designed structures will increase thermal comfort indoors and offer a chance to promote behaviour and mental patterns that are resource- and energy-wise. Orientation, larger windows, overhangs, and non-electric water heating are possible additional factors. Well-designed walls, smart design (e.g., proper orientation for solar access), low energy appliances and cooling systems, water-saving gadgets, water recycling and harvesting, and financial incentives for building occupants to conserve water and energy are a few examples of possible areas.

8. Conclusions

The supply of low energy public housing in Nigeria can be aided by a number of drivers, facilitators, barriers, and technology approaches that have been highlighted by this study. This study demonstrates the numerous difficulties that many Nigerian households encounter while trying to obtain enough electricity to power their homes. These include:

i. having low or declining incomes despite having a job
ii. living in homes with lower energy efficiency and paying greater energy costs
iii. receiving projected bills with increasing charges
iv. not knowing how to cut their energy use and bills

Due to their lack of access to fuel, many households' health and well-being suffer. Government, energy providers, and experts in the built environment must consider ways to enhance living conditions in connection to fuel poverty. This paper makes a strong case for increasing public housing's accessibility to low-energy dwellings. In order to advance this paper, it may be necessary to:

i. access support to increase energy efficiency, lower energy costs, and create more comfortable and healthy public housing, as well as
ii. co-produce practical workshops that include easily accessible and understandable education and information on energy efficiency, reducing energy use, and saving money
iii. develop information, training, and support for built environment professionals.

Acknowledgement
This research was not funded by any grant.

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