International Journal of Science Academic Research
Vol. 02, Issue 06, pp.xxx, June, 2021
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

Research Article

BARRIERS TO LOW ENERGY FOR PUBLIC HOUSING DELIVERY IN NIGERIA

***Emechebe, L.C., Akande, O. K., Ahmed S. and Lembi, J. J.**

Department of Architecture, Federal University of Technology, Minna, Nigeria

Received xxx 2021; **Accepted** xxxx 2021; **Published online** xxxx 2021

Abstract

In Nigeria, energy-saving opportunities in the public housing have remained a matter for speculation over the years due to uncoordinated efforts at addressing issues relating to energy efficiency and management. The dream of having low energy in housing is the most important factor for a sustainable development in many economies in the world. This great dream is being obstructed by some factors which make energy delivery poor and substandard. This study aims at analyzing the barriers to low energy in public housing delivery in Nigeria. The objective is to examine some hurdles and difficulties that affect the delivery of low energy buildings. It shows some strategies adopted by Federal Government in order to achieve low energy buildings in Nigeria. Literatures reviews were used to identify the various factors that hindered the adoption of low energy housing within the Nigeria's public housing. Findings identify the barriers which include lack of drive to implement policies, little awareness, lack of trained personnel on energy efficiency delivery for housing projects, Ignorance of long term cost effectiveness of energy efficiency, Inadequate research focus on low energy use for public housing, Complete absence for energy rating of public buildings, Lack of research materials on low energy efficiency and Importation of used machines. The study recommends adoption of sustainable factors that will prevent the barriers in order to drive towards achieving low energy housing. Adequate measures should be taken to ensure that the barriers are prevented to ensure efficient low energy production in public housing in Nigeria.

Keywords: Barriers, Energy Delivery, Low Energy, Nigeria, Public Housing.

INTRODUCTION

Low-energy buildings have gained attention and moved towards a large-scale introduction in the housing sector. During this process, national and international criteria for energy use in buildings have become stricter and the European Union has through the Energy Performance of Buildings Directive imposed on member states to adapt their building regulations for 'Nearly Zero Energy Buildings', which by 2021 should be standard for new buildings (Persson, 2014). Low energy in buildings as becomes a focal point in global discourses towards sustainable development (Mu'azu, 2019). It plays an important role in the nation's international diplomacy, and it is very marketable commodity for earning the national income, which is used to support government development programs. Improving energy efficiency is often seen as the fastest and most cost-effective way to achieve global greenhouse gas emission targets (IEA, 2008). Consequently, strategies for obtaining more energy services such as heat, light or mobility with the same or less energy input have recently attracted increased attention from policymakers and academics alike (Schleich, 2009). The issue of energy has become one of the most sensitive discourses of our time; and as a result, the world is starting to accept the possibility of change in the patterns of consumption, leading to energy conservation measures and more rational use of existing energy sources to ensure sustainability (Hussaini, 2018). According to Horsley *et al*., (2003) one of the most significant environmental impacts of buildings occurs through the consumption of energy during their operational lives. The presence of the barriers has brought about a complete state of apathy in the energy sector in Nigeria, particularly in the area of housing, with the accompanying energy inefficient households in all parts of the country (Hussaini, 2018).

Corresponding Author:** ***Emechebe, L.C.,
Department of Architecture, Federal University of Technology, Minna, Nigeria.

Low-energy building is characterized by an energy-efficient design and technical features which enable it to provide high living standards and comfort with low energy consumption. The low energy efficiency has been affected by many issues that made low energy production poor and inefficient. The objective of this research includes (i) To assess the various types of barriers to low energy efficiency in the public housing delivery in Nigeria. ii) To elicit strategies adopted by the government in achieving low energy housing. iii) To identify commercially and behaviorally low cost way of reducing energy consumption in the residential, public and private sectors in Nigeria. These issues need to be addressed in order to achieve all possible measures to ensure that buildings use of energy is minimal i.e. Heating, Ventilation, Air conditioning and Cooling (HVAC); and Lighting systems are to use methods and products that conserve energy or reduce energy use.

Reflection of energy efficiency and ways of adoption

Energy efficient house is any type of house that uses less energy than a regular one. It is generally assumed that low energy building should consume significantly less energy to provide the same service (Rosen, 2008). Optimization of energy consumption and best possible use of available energy is not new idea. Similar to modern time, in the ancient time people dealt with a problem of constructing buildings with appropriate thermal comfort, and the main question was how to make a house warm during winter and cool during summer (Davor, 2015). There is no global definition for low-energy house because national standards vary considerably; 'low energy' developments in one country may not meet 'normal practice' in another. Improving energy efficiency is considered one of the basic keystones of the main national and international strategies to reduce greenhouse gas emissions with acceptable economic costs (Medina *et al*., 2017). The

total energy consumption in Germany (or primary energy, not temperature-corrected) declined 6% between 2000 and 2016, a fall from about 344 to 322 Million or mega tonnes of oil equivalent (Mtoe) in 2016 (Lopez, et al., 2018). In low-energy buildings, the heat gains from lighting, equipment, dwellers and the incoming solar radiation are to a large extent used to achieve a good indoor climate (Persson, 2014). Low-energy buildings typically use high levels of insulation, energy efficient windows, low levels of air infiltration and heat recovery ventilation to lower heating and cooling energy and they may also use passive solar building design techniques or active solar technologies (Davor, 2015). There are two important ways to approach the efficient use of energy in buildings. The first one is the technological approach while the second is the behavioural approach (Uyigue *et al*., 2009). The technological approach is the adoption of Sustainable Technologies for Sustainable upgrade of energy efficiency will aid in addressing high energy demands without posing negative effects to the environment (Dadzie *et al.,* 2018). Any technology that exceeds the benchmark of conventional systems in reducing energy can be classified as a sustainable technology (Syed, 2012). Thus, Smith, (2007) provides a range of various sustainable technologies. They include solar thermal, low-energy techniques for cooling, geothermal, wind energy, photovoltaic cells, and bioenergy. There are other types of sustainable technologies: the green roof and renewable technologies such as solar panels and solar hot water systems(Wilkinson, 2009; Boxwell, 2012). The green roof technology is generally considered a passive approach used to reduce energy consumption in buildings (Dadzie *et al.,* 2018). The examples of technological approach include:

(i) Introduction of Solar architecture/solar passive systems which involves energy saving bulbs, solar fridges, solar water pumping, solar fan, etc.).
(ii) Cooling and Heating: The use of modern and energy efficient air conditioner and heating equipment.
(iii) Providing incentives for purchasing energy efficiency products have been used to change the behaviour of consumers to promote energy efficiency.
(iv) The use of Renewable Energy Technologies (RETs) example solar heater to provide hot water in the house can help to reduce the amount of electrical energy spent on heating water.

The behavioural approach entails changing the ways we do things. An example is switching off appliances when not in use and adoption of tree planting, shrub or vine in our homes to provide shades and act as windbreak (Paone & Bacher, 2018). Energy efficient buildings are mostly achieved through bioclimatic architecture, high performance building envelope, and controlled ventilation (Nwofe, 2014). This can help to reduce the energy we spend on cooling, since the shade from these trees can keep our home cool.

Energy demand and consumption in Nigeria building Sector

The building and construction sector has undoubtedly contributed too much to this increase, due to energy consumption, which in this sector represents between 20% and 40% of the energy consumed in developed countries, and more than 30% of total greenhouse gas emissions (Pérez-Lombard *et al*., 2008). To reduce the energy consumption of buildings, almost all governments have opted for the adoption of measures aimed at improving energy efficiency in buildings for public use (Cruz-Lovera *et al*., 2017). Energy consumption is rapidly increasing due to the increase in population and urbanization. Residential energy requirements vary from region depending on climate, dwelling type and level of development. The buildings and buildings construction sectors combined are responsible for 36% of global final energy consumption and nearly 40% of total direct and indirect CO2 emissions (IEA, 2019). Energy demand from buildings and buildings construction continues to rise, driven by improved access to energy in developing countries, greater ownership and use of energy-consuming devices, and rapid growth in global buildings floor area, at nearly 3% per year (IEA, 2019).
In Nigeria, there is a shortage of reliable data on energy consumption in buildings, partly due to poor metering of mains electricity and also due to the fact that most buildings also generate electricity using petrol and diesel generators (Arup & Macharm, 2016). This is recognized as a major barrier to energy efficiency. Studies show that office air-conditioning (VAC) accounted for 40- 68% of electrical consumption, with the other important uses being lighting (13-37%) and office equipment (12-25%) (Roth *et al*., 2002). This is probably fairly typical for an air conditioned office in Nigeria, although office equipment consumption will depend heavily on the number and type of computers and other equipment in the building (Arup and Macharm, 2016). Table 1 describes the energy demand based on the different sectors.

Table 1. Energy Demand by Economy Sector, Millions of tonnes of oil equivalent (Mtoe) for 2005

Sector	Energy Demand	% Share
Industry	4.80	14.8
Transport	9.90	30.5
Household	15.82	48.7
Services	1.98	6.0
Total	32.50	100

Source: Nigeria: Rapid Assessment and Gap Analysis (SE4ALL, 2010)

The overview of the main energy consuming sectors in Nigeria is presented in Table 1 which shows that housing demand more energy of 15.82 representing 48.7% while services had the least energy demand of 1.98 representing 6.0%. This implies that housing generally have more demand of energy than any other sector and as such consumes a lot of energy. According to Table 1, housing being the highest demand of energy, should be critically addressed towards providing energy efficiency material and also prevents all the barriers in order to achieve low energy housing. Studies has shown that annual electricity consumption in Nigeria in 2009, 2010 and 2011 stood at about 2.27 GWh, 2.38 GWh and 2.43 GWh respectively(SE4ALL, 2010).The percentage share of electricity consumption by sector is residential (53.9%, commercial (25.4%), industrial (20.65%) and Street lighting 0.05%) as shown in Table 2.

Table 2. Energy Demand by Economy Sector, Millions of tonnes of oil equivalent (Mtoe) for 2010

Sector	% of Electricity consumption
Residential	53.9
Commercial	25.4
Industrial	20.65
Street Lighting &others	0.05

Source: (NBS, PHCN, ECN, 2010)

Globally, energy consumption in buildings takes up the largest proportion of world‘s energy production. This consumption is more in developing countries including Nigeria and least

developed economies than the developed worlds. Energy consumption patterns in the world today shows that Nigeria and indeed African countries have the lowest rates of consumption (Oyedepo, 2012). Nevertheless, Nigeria suffers from an inadequate supply of usable energy due to the rapidly increasing demand, which is typical of a developing economy. Paradoxically, the country is potentially endowed with sustainable energy resources. Nigeria is rich in conventional energy resources, which include oil, national gas, lignite, and coal. The Nigerian economy can be disaggregated into industry, transport, commercial, residential (household), and agricultural sectors (ECN, 2003). The household sector accounts for the largest share of energy use in the country - about 65% (Oyedepo, 2012).This is largely due to the low level of development in all the other sectors. The major energy-consuming activities in Nigeria's households are cooking, lighting, and use of electrical appliances (Oyedepo, 2012). Cooking accounts for a staggering 91% of household energy consumption, lighting uses up to 6%, and the remaining 3% can be attributed to the use of basic electrical appliances such as televisions and pressing irons (ECN 2005).

Barriers to low energy housing and design principles

Nigeria as a nation has being battling with energy crisis for decades in the form of inadequate power supply and inefficient utilisation of the end-use energy (Hussaini, 2018). To combat this issue, persistent efforts are being made by the government, the private sector and Non-governmental Organization (NGO), to eliminate the situation yet there still persist the inability to overcome the energy inefficiency in the country (Majumdar, 2002). Low energy buildings are designed in a way that ensures the use of energy at a reduced cost in a sustainable and conserved manner (Hussaini, 2018). Low energy building is dependent up continued economic, social, and technological factors. These three main factors have a significant effect towards adopting of low energy building in Nigeria. The awareness of low energy by the general public will form the market-driven power developments especially in the country. However the difficulties and barriers to achieving low energy housing include: lack of trained professionals, lack of awareness, poverty, poor government policies, ignorance, hidden Cost, access to capital, risk and uncertainty, and many others.

Building materials have been playing an important role in the construction industry, no field of engineering is conceivable without their use (Akanni, 2006; Udosen and Akani 2010). Low energy designs are credited partly to the adoption of climate and environmentally conscious design principles by the creation of reduced energy loads in buildings (Hussaini, 2018). Architects can achieve energy efficiency in building designs by studying the macro and micro climate of the site and applying bioclimatic architectural principles to combat the adverse conditions, and taking advantage of the desirable conditions (Majumdar, 2002). Some common design elements have been identified to directly or indirectly affect the thermal comfort and visual conditions of building occupants and thereby the energy consumption of buildings (Ahsan, 2010., Watson & Lab, 1983., Mallick, 1996). These elements listed below are the basis for design of the housing evaluation form.

i. Planning / design consideration: this involves the building site, building typology/ plan form, building orientation, functional distribution, room orientation, landscaping and the design process.
ii. Buildings envelop which involves the external walls and finishes, fenestration and shading, thermal insulation and roof.
iii. Other services which includes the building materials, electrical and lightning and air conditioning installation

Strategies adopted by Federal Government in achieving low energy building

The Federal Government through the Energy Commission of Nigeria (ECN) recognizes energy efficiency and conservation measures as a key element in the nation's efforts to reduce the imbalance between energy supply and demand (Se4all, 2010). One of the main objectives of the National Energy Policy (NEP) of Nigeria is to guarantee an efficient and cost effective consumption of energy resources; and to ensure the importation and manufacture of the most energy-efficient equipment and machinery, as well as promoting public awareness about the benefits of improved energy efficiency (Se4all, 2010). The strategies adopted by FG towards achieving low energy building activities in Nigeria include: Millions of High Quality Compact Fluorescent Lamps (CFL) Pilot Project on the Replacement of Incandescent Lamps;

Table 3. Barriers to low energy for public housing

S/N	Barriers to low energy for public housing	Sources
1	Low energy Technical Know How (Low energy requisite knowledge among the Built environment Professionals & the scarcity of Energy efficiency certified professionals) Lack of Trained Personnel and Energy Efficiency Professionals.	(Uyigue, et al., 2009); Schleich, 2009; Awawdeh& Tweed, 2014.
2	Ignorance or Illiteracy	(Uyigue , et al., 2009); Nwofe, 2014; Schleich, 2009; Awawdeh & Tweed, 2014, (Dadzie et al., 2018).
3	The proliferation of imported second-hand appliances may hinder the use of efficient appliances.	(Uyigue , et al., 2009); (Schleich, 2009)
4	Lack of research materials and data that will guide the development of policy that will strengthen the efficient use of energy.	Uyigue , et al., 2009; Awawdeh& Tweed, 2014; Schleich, 2009
5	Inefficient Metering System and Low Electricity Pricing: The metering system in Nigeria is very inefficient and does not encourage consumers to pay the correct amount for the energy they consume	Uyigue, et al., 2009; Awawdeh& Tweed, 2014.
6	Proliferation of Inefficient Equipment and Desire to Minimize Initial Cost: The desire to minimize initial cost force many consumers to purchase cheap and inefficient appliances.	Uyigue, et al., 2009; Awawdeh& Tweed, 2014.
7	Low income or poverty: About 70% of Nigerians leave below the poverty line of $2 per day. Many are not able to afford the cost of efficiency appliances which are sometime more expensive than the less efficient ones	Uyigue , et al., 2009); Nwofe, 2014; Schleich, 2009; Awawdeh & Tweed, 2014.
8	Access to capital	(Schleich, 2009), (Dadzie et al., 2018).
9	Lack of Government policy and implementation barrier	(Schleich, 2009); Nwofe, 2014; Awawdeh & Tweed, 2014.
10	Inadequate Research focus and Materials on Energy Efficiency: There is lack of research materials and data that will guide the development of policy that will strengthen the efficient use of energy.	(Uyigue et al., 2009); Nwofe, 2014; Awawdeh & Tweed, 2014.

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National Awareness Creation/Capacity Building; Energy Efficiency Awareness Campaign through Posters, leaflets, handbills, radio, TV displays (Se4all, 2010). Also the Federal Government of Nigeria made several policies in the energy sector that aimed to encourage uptake of renewable energy (RE) and energy efficiency (EE). Within the building sector, this policy proposed developing energy efficiency building codes so that buildings are designed in line with bio-climatic design concepts and incorporate other energy saving measures (Arup & Macharm, 2016).

METHODOLOGY

The methodology is based on secondary data collection approach which presents a systematic literature review on the barriers to low energy in public housing delivery. Relevant materials were consulted from referred journal articles, government report, books, theses, research reports; seminar / workshop papers, Newspapers, magazines and internet sources were consulted to review literatures on barriers to low energy housing. This helps in identifying and narrowing the various factors that hindered achieving low energy building. Also literature was reviewed on some strategies adopted by Federal Government in achieving low energy building and possible way forward to prevent the barriers to low energy.

Data Collection and Methods of Assessment

The data used for this assessment were collected from secondary sources. The data collected was subjected to a way forward approach and necessary suggestion to prevent the barriers to low energy efficiency in public housing.

Way forward to prevent the barriers to low energy

Low energy buildings aims to reduce the demand for energy consumption in buildings by; avoiding wastes and employing energy-saving measures in the building architecture. The use of sustainable low energy-saving devices helps to reduce GHG emission to the barest minimum. To promote low energy buildings in public housing delivery in Nigeria, the author strongly suggest the following measures:

1. Government at all levels (Federal, State and Local) should do more to reduce the high rate of illiteracy on low energy in Nigeria by educating people on the way to prevent the barriers to low energy. It is only when illiteracy is reduced that people will understand the need for low energy housing and works toward to preventing the barriers that could lead to it.
2. Government should intensify to create awareness on the advantages of using energy efficient buildings materials and also introduction of renewable energy technology. This could be done through media, newspaper, schools; mobile communications, training and also help to trained personnel on way to achieve low energy housing. Inadequate trained personnel and professional is a great barrier toward achieving low energy housing.
3. Policy and implementation of the barn of proliferation of imported second-hand appliances may hinder the use of efficient appliances and also private and public institutions should also be encouraged to make their own policy to promote the efficient use of energy. The government can make it mandatory for public, large and small scale private organizations to establish an energy management department or unit. Indiscriminate waste of energy by leaving light bulbs on indefinitely in streetlights and in most homes and public buildings in Nigeria should be addressed.
4. Government at all levels (Federal, State and Local) should try and reduce the poverty rate in Nigeria by opening up more job opportunities. About 70% of Nigerians live below the poverty line of $2 per day. Many are not able to afford the cost of efficiency appliances which are sometime more expensive than the less efficient ones.
5. Finance or capital is a great barrier towards achieving low energy housing. Government should provide the finance that will cover any incremental cost to achieve low energy housing.
6. Establish an agency to promote the use of energy-efficient products and ensure the appropriate practices.

SUGGESTION AND RECOMMENDATION

In view of the findings from this study, the following recommendation are hereby put in place for necessary action to prevent barrier will gear towards energy efficiency. i) Establish an agency to promote the use of energy-efficient products and ensure the appropriate practices. ii) Develop and imbibe energy efficiency technologies. iii) More efficient passive and full usage of solar technologies in the residential, commercial, and industrial sectors. iv)Develop policies on energy efficiency and integrate them into the current energy policies. A comprehensive and coherent energy policy is essential in guiding the citizens towards an efficient usage of its energy resources. v) Government should barn the importation of second hand appliance that consumes lot energy and hinder energy efficiency. vi) Introduction of bioclimatic architecture principles that can make climatic condition of a building favourable.vii), Government should adopt the suggested ways to prevent the barriers of low energy housing especially incorporating development authorities' on policies and legal framework on how to achieve or adopt low energy housing in Nigeria. Adherence to these recommendations could result to prevent the barriers to low energy, promote energy efficiency and consequently leads to successful energy delivery. Despite that government has demonstrated several strategies to achieve low energy buildings there are still no strong policies that will back up the started policies towards achieving low energy buildings.

CONCLUSION

This paper has explored factors hindering low energy production in building in the delivery of successful energy efficiency in Nigeria. The study has shown the barriers towards achieving low energy deliveryin public housing in Nigeria and also stated ways to achieve low energy housing.The impact of the barriers makes energy efficiency very poor which result to Global warming and Climate change. This results to the use of more mechanical/electrical devices to achieve thermal cooling in tropical areas and thermal heating for cold regions. These devices require enormous energy input and also generate greenhouse gases. Also the costs of these devices are very exorbitant and not many people can afford it. The comfort of people in such buildings is in jeopardy. Also the barriers cause energy inefficiency poor which result to low production and poor economy.Also due to cost of energy efficient materials, individual finds it very difficult to achieve a low energy house

due to poverty. Government should assist in subsidizing the cost of energy efficient materials to help low income earners have access to the materials in order to aid in achieving this great dream.

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