

# **ENERGY EFFICIENCY: MITIGATING EFFECTS OF IMPLEMENTING GREEN BUILDINGS FOR GREEN DESIGN AND CONSTRUCTION IN NIGERIA**

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## **ABSTRACT**

A considerable amount of energy consumption and CO<sub>2</sub> emission comes from the building sector which today accounts for 40% of the world's energy use. This study explores the potential of energy efficiency in mitigating the environmental impacts of green buildings in Nigeria. This review is about the role of green design and construction in reducing energy use, lowering carbon emissions, and promoting sustainable development. The study is analytical in nature and based on secondary sources of data like published articles, books and different websites regarding this topic. Key obstacles include high installation cost, limited awareness and knowledge, and a lack of technical expertise, but potential solutions such as financial incentives, training programs, and public-private partnerships are identified. This study concludes that widespread adoption of green building practices can significantly enhance energy efficiency, mitigate climate change effects, and foster sustainable urban development in Nigeria. However, the need for policy reforms, stakeholder collaboration, and increased investment is crucial for the widespread implementation of green building practices across the country.

**Keywords:** Buildings, Construction, Energy efficiency, Green building, Green design,

## 1.0 INTRODUCTION

There are growing evidences in the scientific literature that the construction industry is by far the greatest carbon emitter, surpassing both transportation and industry (Shamang *et al.*, 2021). Scientist have declared that energy efficiency has become a critical global issue due to increasing concerns over climate change, resource depletion, and rising energy costs. In Nigeria, the demand for energy continues to grow, driven by rapid urbanization, population growth, and economic development (Allu, 2014; Alabi & Olaniyan, 2018; Owonubi & Orewere, 2018; Orewere *et al.*, 2021; United States Environmental Protection Agency, 2023). As posited by Adewolu (2023a) and Owoicho (2024), the country faces significant challenges in meeting its energy needs, with much of its electricity generation relying on non-renewable resources, leading to environmental degradation and high carbon emissions.

Consequently, integrating green buildings, designed and constructed with energy efficiency and environmental sustainability in mind, offer a viable solution to these challenges (Jat & Mane, 2019). By incorporating sustainable materials, renewable energy sources, and energy-efficient technologies, green buildings aim to reduce energy consumption, lower greenhouse gas emissions, and promote healthier living environments. In Nigeria, where conventional construction methods dominate, there is growing interest in adopting green design principles to address both environmental and energy-related concerns (Nduka & Ogunsanm, 2015; Onososen *et al.*, 2019).

Green building also known as sustainable construction is a form of practice(s) in which buildings are designed and built without causing environmental degradations throughout the entire building lifecycle exhibiting high level of environmental, economic and social performance. (Omar *et al.*, 2016; Saliu *et al.*, 2016; Onososen *et al.*, 2019). As reported in literatures, there are no adverse side effects of applying green building practices in construction projects. As posited by Çiner & Doan-Salamtimur, (2019) there are different ways of integrating greenery systems on buildings include roof greening, vertical greening, terrace planting and sky gardens (indoor and outdoor) especially in the design of high-rises to accommodate vegetation.

## **1.1 Statement of the Problem**

Most buildings in Nigeria lay more emphasis on the aesthetic values with little or no thought for energy efficiency. Furthermore, most buildings are characterized by poor design in relation to the climate, which requires a great deal of energy for cooling during climatic extremes. Today, there is a large demand for new buildings and then the general goal is to build them energetically more efficient than the current practice (Ngague *et al.*, 2019; Jegede *et al.*, 2020). It is important therefore, that built environment professional and our government design buildings using concepts that consume less energy. Green architecture in fact is increasingly focusing on green buildings as a means to restore the environmental integrity of urban areas, biodiversity and sustainability (Jegede *et al.*, 2020).

This paper therefore seeks to address how implementing green design and construction can mitigate these challenges and promote sustainable development. From the literature, there is paucity of information on this aspect of the research in Nigeria. Consequently, the objectives are to: (1) explore the concept of energy efficiency and its importance in green building design and construction, (2) examine the potential environmental and economic benefits of adopting green building practices in Nigeria.

## **1.2 Sustainable Development Goals (SDGs): A Framework for an Enabling Environment**

As established by the United Nations General Assembly, Sustainable Development Goals (SDGs), provides a framework for sustainable development, focusing on social, economic, and environmental sustainability (United Nations, 2023). SDG 7 sub-titled: (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (Climate Action), can be achieved with the use of environmentally friendly construction grading systems (Adewolu, 2023a). The building sector accounts for 30% of the emissions of greenhouse gases worldwide, and her services sector is an important contributing factor to these problems (Adegbie, 2016; Skripnuk *et al.*, 2019). As opined by Adewolu, (2023a) using green building grading systems can assist lessen how damaging structures are to the natural world as well as promote sustainable building practices in Nigeria. A structure for environmentally friendly growth is provided by the SDGs, which can supplement Nigeria's efforts toward achieving economic, social, and environmental sustainability. According to Fadairo *et al.*, (2006) to achieve the equitable and sustainable futures, quite different methods of achieving high quality life style will be needed.

This will lead to new approach of different buildings, built environments and agro-urban relationships, thereby serving as the central challenge for design and designers of the built environment while sustainability and sustainable features will be available only through a purposeful design.

## **2.0 METHODOLOGY**

This study is largely based on a literature of green buildings. This research made use of academic articles, conference papers, internet materials, textbooks and publicly available materials on green buildings and energy efficiency. To retrieve relevant articles for this study, a systematic literature search was conducted using the Scopus and Google scholar search engines. Prior studies have used in similar reviews (Ayanniyi *et al.*, 2018) and it has also been adjudged as most effective search engines for conducting a review of a topic. Suitable search keywords used include “*Built environment, Construction, Energy efficiency, Green architecture, Green building, Nigeria*” The initial search resulted in the identification of a total number of 70+ articles. Therefore, it was necessary to filter out unrelated articles, hence, a brief review of the abstracts. After filtering, 30 articles were found to be most relevant and considered valid for further analysis. The 30 relevant articles are reviewed, presented and discussed in the next section of the paper.

## **3.0 DISCUSSION OF FINDINGS**

This section of this study’s theoretical discuss is divided into four sub-sections in order to highlight the relationship between the keywords. These sections are presented as follows: energy efficiency, energy efficiency importance in green building design and construction, environmental and economic benefits of adopting green building practices and obstacles hindering implementing green building rating system for energy saving. These are further discussed in section three and thereafter, the conclusion is drawn and some recommendations are suggested.

### **3.1 Energy Efficiency: An Overview**

Energy efficiency refers is defined as the practice of using less energy to perform the same function or achieve the same level of comfort, productivity, or utility (Raji *et al.*, 2015; Ochedi *et al.*, 2016). While in the context of green building design and construction, it refers to the strategic use of design, materials, and technology to minimize the amount of energy required

to operate a building while maintaining comfort, functionality, and performance (Ngague *et al.*, 2019; Mobolade *et al.*, 2020). The importance of energy efficiency in green buildings lies in its ability to decrease operational costs, reduce environmental impact, and promote sustainability. By minimizing energy use, green buildings contribute to mitigating climate change, conserving resources, and fostering healthier living environments. These benefits not only enhance the long-term value of buildings but also align with global efforts to achieve energy sustainability and reduce the carbon footprint of the construction industry (Ngague *et al.*, 2019).

### **3.1.1 Aspects of enhancing energy efficiency in green building design**

The results of the studies carried out by Suhaida, *et al.*, (2013), Akinwolemiwa *et al.*, (2015), Raji *et al.*, (2015), Ngague *et al.*, (2019) in residential, commercial and institutional areas have put forward some strategies for enhancing energy efficiency in green building design:

- i. Energy-efficient appliances and systems:** Incorporating energy-saving technologies, such as LED lighting, energy-efficient HVAC systems, and smart thermostats, to lower electricity consumption.
- ii. Renewable energy integration:** Incorporating solar panels, wind turbines, or other renewable energy sources to reduce dependence on non-renewable, grid-based energy.
- iii. Optimized building orientation and layout:** Designing buildings to maximize natural light, ventilation, and heat retention, thereby reducing the need for artificial lighting, heating, or cooling.
- iv. High-performance insulation and materials:** Using materials that improve the thermal performance of the building, reducing heat loss or gain and minimizing energy use for temperature regulation.
- v. Sustainable water and waste management:** Implementing systems that minimize water usage and promote recycling, which indirectly contributes to energy conservation in water treatment and waste management.

### **3.2 Energy Efficiency importance in Green Building Design and Construction.**

In promoting sustainable energy efficiency practices in green building design construction Adegbie, (2016) Ochedi *et al.*, 2016) and Owoicho (2024) listed the following importance:

- i. **Reduction of Energy Consumption:** Energy-efficient green buildings use less energy for heating, cooling, lighting, and other functions, leading to lower energy demand and reducing the strain on the power grid.
- ii. **Lower Operational Costs:** By consuming less energy, green buildings result in significant cost savings over time for homeowners, businesses, and governments through reduced utility bills.
- iii. **Environmental Benefits:** Energy efficiency helps minimize the reliance on fossil fuels, thereby reducing greenhouse gas emissions and mitigating climate change. It also conserves natural resources like water and energy used in traditional power generation.
- iv. **Improved Indoor Comfort and Health:** Green buildings are designed with better ventilation, natural lighting, and temperature control, providing healthier and more comfortable indoor environments, which can enhance occupant well-being and productivity.
- v. **Long-Term Value:** Energy-efficient buildings often have higher market value due to their lower operating costs and positive environmental impact. They are also more attractive to eco-conscious buyers and tenants.
- vi. **Contribution to Global Sustainability Goals:** Energy-efficient green buildings align with international sustainability efforts, such as the Paris Agreement, by promoting reduced carbon emissions and resource conservation

### 3.3 Environmental and Economic Benefits of Adopting Green Building Practices

Several authors (Akinyemi, *et al.*, 2017; Ahmed, *et al.*, 2018; Ayanniyi, *et al.*, 2018; Idowu, *et al.*, 2018; Adewolu, 2023b) opined that green building rating systems will gradually strengthen the perspective of all local practitioners towards embracing sustainable development. Green buildings have several benefits over the design and construction of standard buildings namely:

#### 1. Environmental Benefits:

- i. **Reduction in Carbon Emissions:** Green buildings significantly lower energy consumption by incorporating energy-efficient technologies and renewable energy sources, leading to a reduction in greenhouse gas emissions.

- ii. **Conservation of Resources:** The use of sustainable materials and designs in green buildings minimizes the depletion of natural resources, such as water and raw building materials, and encourages the recycling of waste.
- iii. **Improved Environmental Quality:** Green buildings help reduce air and water pollution through eco-friendly construction practices, contributing to cleaner surroundings and healthier ecosystems.

## 2. Economic Benefits:

- i. **Lower Operating Costs:** Energy-efficient buildings have reduced energy and water consumption, leading to lower utility bills and operating costs over the building's lifespan.
- ii. **Increased Property Value:** Green buildings tend to have higher market value due to their sustainability features, energy efficiency, and appeal to eco-conscious buyers or tenants.
- iii. **Job Creation:** The growing demand for green building construction creates opportunities for jobs in sustainable architecture, renewable energy systems, and eco-friendly material production.
- iv. **Long-Term Savings:** Although the initial costs of green building design may be higher, the long-term savings from reduced maintenance, energy consumption, and operational efficiency outweigh the upfront investments.

## 3. Social Benefits:

- i. Improvement in the quality of life
- ii. Improved aesthetic qualities in the neighbourhood
- iii. Minimize strain on local infrastructure
- iv. Improvement of occupant comfort and health status

As posited by Owoicho (2024), in addition to these benefits, in the case of IHE, green buildings can provide opportunities for students (e.g. as a learning tool, leading by example and showcasing technology) and communicate the benefits of green buildings to a wide range of users, including the community in which the university operates.

### **3.4 Obstacles Hindering Implementation of Green Building Rating System for Energy Saving**

The studies carried out by Ahmed, *et al.*, (2018), Adewolu, (2023a) and Owoicho (2024) have identified some obstacles that hinders implementing green building rating system for energy saving in the country.

#### **i. Lack of professional capacity and technical skills**

The absence of professional capacity and knowledge to adopt and uphold green building grading systems is another issue. This is particularly true for smaller building projects that may not have the necessary resources or expertise to manage the implementation of these systems effectively.

#### **ii. Absence of drivers- government policies/laws in support of environmental ethics.**

Due to the absence of law enforcement, it is challenging to compel building developers and property owners responsible for implementing these processes, which reduces their efficacy.

#### **iii. Dearth of information on the effectiveness of green building rating system**

Due to dearth of information on the effectiveness of green building rating system stakeholders are not able to ssess these systems and determine whether to adopt and execute them.

#### **iv. Insufficient knowledge and materials market on green building technologies.**

Nduka, *et al.*, (2015) and Adewolu, (2023a) infers that investment in green building will not only create, expand, and shape markets for green product and services but also provides business opportunity for architects, developers, contractors and almost all stakeholders in the built environment.

#### **v. High installation cost and use of adaptable rating systems**

According to Adewolu, (2023a) the cost of installing green building rating systems is high. In most cases, building owners and developers may not have the financial resources to invest in these systems, particularly as the country is presently witnessing an “economic crunch”. Moreover, developers tend to have difficulty in implementing such schemes due to uncertain monetary rewards or government subsidies.

### **3.5 Strategies Required in Implementing Green Building**

Some strategies have been put forward for implementation of a green building which would gradually strengthen the perspective of all local practitioners towards embracing sustainable development (Adewolu, 2023a).

#### **i. Green construction policies**

Policies on greening construction/buildings should be introduced with the government championing implementation. Such policies could include energy and water efficiency, environmental quality of building materials and resources, indoor environmental quality and innovation in design.

#### **ii. Established government laws and policies in support of environmental ethics.**

Green buildings are eco-friendly construction practices for energy saving, reduction of emissions, reuse, recycling of materials and resources. With the implementation of GBRs's techniques for pollution reduction and cost are minimized.

#### **iii. Funding and government support**

Government's support such as promulgating relevant laws and policies, and providing financial incentives are critical in promoting Green Building Concept in Nigeria. There are varying regulatory approaches employed by lawmakers and different levels of government (e.g., federal, state, and local) to develop green buildings.

#### **iv. Creating more awareness strategies**

Building public confidence and creating a forum where the exchange of ideas on reliable GBRs information and feedback from stakeholders is attained ensures full acceptance. Certainly there will be doubts, disagreements and disputes at the initial stage from stakeholders due to various interpretations.

## **4.0 CONCLUSION**

This study underscores the critical role of energy efficiency in promoting sustainable development through the implementation of green building practices in Nigeria. As the country grapples with significant energy challenges and environmental concerns, transitioning to green building design offers a viable pathway to mitigate these issues. The findings highlight that energy-efficient green buildings can substantially reduce energy consumption, lower greenhouse gas emissions, and improve indoor environmental quality.

Moreover, the economic benefits associated with adopting green practices such as reduced operating costs, increased property values, and job creation demonstrate that sustainability is not only an environmental imperative but also a sound economic strategy. The potential for long-term savings and resource conservation further emphasizes the importance of integrating green design into the construction sector. This study serves as a call to action for stakeholders in the construction industry, policymakers, and the community to collaborate towards creating a sustainable built environment that addresses both current and future energy and environmental challenges.

## **5.0 RECOMMENDATIONS**

Based on the findings of this study, the following recommendations are put forward:

1. There is the need to increase public awareness campaigns and education talks to inform the general population about advantages of green practices and encourage building developers and property owners to adopt them.
2. There is need to introduce green building practices in curriculum of the education sector, in order to increase knowledge and skills to spread green practices.
3. Government can introduce rules and regulations which provides incentives and support for the implementation of green building practices in the country.
4. There is need to set up African network to foster exchange between experts, professionals, decision makers and the private sectors and to assist emerging green building councils in the region.

## **6.0 CONTRIBUTION TO KNOWLEDGE**

This study aimed at evaluating the potential of green building practices to enhance energy efficiency in Nigeria's construction industry with a view to develop a sustainable implementation plan for Nigeria, and offers a significant contribution to knowledge in the area of the research at academic and non-academic levels.

At the practical level, given the cooperation of the Nigerian government, it will stimulate growth and evaluate processes that may be modified and adapted for use in the Nigerian setting by built environment professionals and stakeholders alike. While, academically, it has revealed the benefits of implementing green buildings for energy saving as well as the obstacles that has hindered the implementation. Strategies were put forward to overcome these obstacles.

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