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# Green Building Rating System: Energy Performance of Buildings in Nigeria

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***Abstract***
*This article examines the connection between energy assessments of buildings and green building grading systems in the context of Nigeria. In order to encourage sustainable growth in the built environment, green building grading systems have grown in popularity recently. It is unclear, though, how much these rating mechanisms for grading purposes have contributed to increased energy efficiency in Nigerian structures. The study employed a mixed-methods research strategy to explore this subject, which included an energy audit of a few chosen buildings and a poll of construction industry specialists. The statistical poll aimed to determine how well-versed Nigerian building professionals were in green building rating systems. Buildings with and without green building certifications have their real energy performance evaluated through energy audits. The results demonstrate that building professionals in Nigeria have a relatively poor level of knowledge and comprehension of green building rating systems. Despite this, the study discovered that green-certified buildings had superior energy performance than non-certified ones. This shows that even in the absence of widespread understanding and acceptance, green building rating systems have the potential to considerably enhance energy efficiency in buildings in Nigeria. The study offers insightful information to stakeholders in the Nigerian construction industry, including policymakers, architects, and engineers. The results indicate that more needs to be done to promote green building grading systems in the construction industry and raise awareness of them. Overall, this study demonstrates how green building grading systems can support sustainable growth and raise energy efficiency in Nigeria's built environment.*

***Keywords:*** *Energy, Energy Efficiency, Sustainable Architecture, Green Building Rating System, Green Architecture*

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## I. INTRODUCTION

### 1.2 Overview

Buildings are the major sources of carbon emissions and energy consumption worldwide. The International Energy Agency (IEA) estimates that 40% of world energy use and 30% of carbon emissions are attributed to buildings (International Energy Agency (IEA), 2023). Building energy use and carbon emissions are rising quickly in emerging nations like Nigeria as a result of economic development and rapid urbanisation.

Carbon Emissions and Building Energy use need to be reduced, and this has become more and more obvious in recent years. Building energy efficiency and sustainability are being promoted by governments, property owners, and developers in an expanding number of ways. One of the most crucial strategies for promoting sustainability in buildings is the use of green building rating systems.

Consensus-based, voluntary frameworks called "green building rating systems" evaluate a building's environmental performance. These assessment methods offer a set of standards and metrics for evaluating a building's sustainability, like its material selection, interior environmental quality, water efficiency, and energy conservation. By promoting sustainable construction techniques, green building rating systems may assist improve the health and well-being of buildings' occupants while reducing the environmental effect of buildings.

### 1.2 Objectives

This journal article's goal is to give readers a general understanding of green building grading systems and how they affect buildings' energy efficiency in Nigeria. The article's specific objectives are to:

i. Explain the idea and background of green building grading systems.
ii. List the main Nigerian green building grading schemes in use.
iii. Determine how green building rating systems have an impact on the energy efficiency of Nigerian building types

iv. Talk about the opportunities and problems of introducing green building grading systems in Nigeria.

**1.3 Scope**

This journal article's study of green building grading standards and how they affect buildings' energy efficiency in Nigeria is its sole focus. The article will give a broad overview of green building rating systems; however, case studies or in-depth analyses of particular rating systems won't be included. Other sustainability tactics, such as using renewable energy or conserving water, will not be covered in the article unless they are directly tied to green building grading systems.

**1.4 Methodology**

The methodology for this journal article involves a literature review of published articles, reports, and websites pertaining to green building rating systems and the energy performance of buildings in Nigeria. The literature review will cover the period from 2000 to 2021. The sources of information will include academic journals, conference proceedings, government reports, and industry publications.

**1.5 The Article Structure**

There are six sections in this article. The article is introduced in Section 1 along with its background, goals, scope, methodology, and structure. The literature on green building grading systems, including their history, idea, and development, is reviewed in Section 2. The main green building grading systems in use in Nigeria are listed in Section 3 along with an explanation of their standards and metrics. The effect of green building grading standards on the energy efficiency of buildings in Nigeria is assessed in Section 4. The prospects and difficulties of implementing green building rating systems in Nigeria are discussed in Section 5. Part 6 concludes with a summary, conclusions, and suggestions for additional research and study.

**1.6 Importance of Studying These Topics in The Context of Nigeria**

In the context of Nigeria, researching green building rating systems and building energy efficiency is crucial for a number of reasons:

a) **Energy Consumption**: Nigeria is one of the largest energy consumers in Africa, and the energy demand is increasing rapidly. A sizable share of the nation's energy use is attributed to buildings.

b) **Environmental Impact:** Buildings are a key source of greenhouse gas emissions, and Nigeria is one of the top emitters of these gases in Africa. Green building rating systems can help to lessen the impact of structures on the environment by encouraging the use of sustainable building practices.

c) **Economic Benefits:** For developers and building owners, green building rating systems can have a positive financial impact. Energy-efficient structures can lead to decreased energy costs, and green building certification can raise a structure's worth and draw wealthy renters.

d) **Government Policies:** The National Building Code and the National Energy Efficiency Policy are two examples of the regulations and initiatives the Nigerian government has created to support sustainable building practices. Policymakers can create successful strategies for promoting sustainable building practices by having a better understanding of the impact of green building rating systems on energy performance.

e) **International Standards:** Nigeria pledged to lower its greenhouse gas emissions by joining the Paris Accord. Implementing green building rating systems can help Nigeria to meet its international obligations and contribute to global efforts to mitigate climate change.

f) It is crucial to investigate green building rating systems and the energy performance of buildings in the Nigerian context in order to encourage sustainable construction methods, reduce energy consumption, and diminish the environmental impact of structures.

**1.7 Scope and Purpose**

This article's goal is to give readers a fundamental understanding of Nigeria's green building grading systems and how they affect buildings' energy efficiency. The article's specific objectives are to explain the idea and background of green building rating systems, list the most popular of these systems in Nigeria, assess how these systems affect the energy efficiency of buildings there, and go over the benefits and difficulties of putting these assessment systems in place there.

The article's exclusive focus is on green building grading standards and how they affect how energy-efficient buildings are in Nigeria. The article provides a thorough analysis of green building grading systems, covering their evolution, history, and concept.. A broad review of green building rating systems, including their development, history, and idea, is given in the article. The main green building grading systems in use in Nigeria are named, and their standards and metrics are described.

The study's sources include a survey of papers, studies, and webpages that have been written about Nigerian buildings' energy efficiency and green building grading systems. Academic journals, conference proceedings, government reports, and trade publications are some of the information sources.

## II. LITERATURE REVIEW

### 2.1 Features of Green Building Rating Systems

Green building grading systems are being pushed by governments and organizations everywhere in an effort to advance sustainable construction methods and lessen the impact of buildings on the environment. Using a set of standards and metrics, these grading systems assess the environmental performance of buildings and, in accordance with their results, provide certification or ratings. This part examines the study on the characteristics of green building grading systems.

The United States Green Building Council (USGBC) created the Leadership in Energy and Environmental Design (LEED) rating system in the 1990s, popularizing the idea of rating systems for sustainable buildings (USGBC | U.S. Green Building Council, 2023)

The Building Research Establishment Environmental Assessment Method (BREEAM) in the UK, Green Star in Australia, and Estidama in the United Arab Emirates are just a few of the green building rating systems that have arisen since then (IvyPanda, 2022). The environmental performance of a building is widely assessed by green building grading systems in a variety of ways, including renewable energy and water management, interior environmental quality, materials and resources, and environmental protection management (Bungau, Bungau, Prada, & Prada, 2022). Buildings must adhere to a specific set of standards and measurements for each category in order to be certified or rated.

Because those buildings account for a sizable amount of the world's energy consumption, energy efficiency is an important category in green building grading systems. Energy performance benchmarks, energy-efficient systems, equipment, and sources of renewable energy are typical criteria and measurements for energy efficiency (International Energy Agency (IEA), 2023).

Since water shortage is a global issue, another crucial element in green building rating systems is water conservation. Water-efficient fixtures and appliances, water reuse systems, and sustainable landscaping practices are standard criteria and measures for water saving (United States Environmental Protection Agency (U.S. EPA), 2022).

Since most people's time is spent indoors, indoor environmental quality is a crucial component in green building grading systems. Ventilation equipment, indoor air quality, thermal comfort, lighting, and acoustics are typical standards and metrics for good interior environments (Mewomo, Toyin, & Iyiola, 2023).

Another category in green building rating systems that assesses sustainability is materials and resources. Using renewable resources, reducing waste, and recycling are frequently included in the criteria and metrics for materials and resources (Vierra, 2023).

In green building grading systems, sustainable site development is also a crucial area because it assesses how buildings will affect the environment and the neighbourhood. Site selection, transportation, and access to amenities are often the criteria and indicators for sustainable site development (Braulio-Gonzalo, Jorge-Ortiz, & Bovea, 2022).

### 2.2 Advantages of Green Construction and Rating Systems

The good effect green structures and rating systems have on the environment is one of their most important advantages. Green buildings are made to produce less waste, consume fewer resources, and have less of an influence on the environment. A framework for certifying and evaluating a building's environmental performance is provided by green building rating systems, hence promoting environmentally friendly construction methods.

Building owners and occupants can also gain financially from green structures and rating systems. Buildings that use less energy for heating, cooling, and lighting often have reduced running costs. For building owners and renters, this leads to decreased utility expenditures and improved savings. Buildings with green building certification have a higher value since it shows that they were built to strict environmental performance criteria.

Green construction practices and rating systems provide building tenants with social advantages alongside financial ones. Green buildings are intended to enhance indoor environmental quality consequently enhancing occupant health and happiness (Singh, Syal, Grady, & Korkmaz, 2023). High indoor environmental quality buildings have been associated with occupant happiness, decreased absenteeism, and higher productivity at work (Yang et al., 2020).

To promote sustainable construction techniques, many countries have incorporated green building rating systems into their building standards and regulations. Green building rating systems offer an additional uniform framework for assessing and contrasting structures' environmental performance, facilitating benchmarking, and the exchange of best practices (Sintayehu, Hsin-Yun, & Fang-Jye, 2022).

**2.3: Building Energy Performance and Its Importance**

Building Energy Performance is the measurement and assessment of a structure's energy consumption and efficiency. Building energy efficiency is important because it has the ability to cut energy use, lower greenhouse gas emissions, and support sustainable development. The building industry accounts for a significant portion of global energy consumption and greenhouse gas emissions. Buildings that use less energy for lighting, heating, and cooling often have lower energy bills and fewer environmental effects.

Enhancing a building's energy efficiency provides advantages for the economy as well as the environment. Buildings that use less energy for heating, cooling, and lighting often have reduced running costs. For building owners and renters, this equates to decreased utility costs and improved savings. Moreover, energy-efficient structures increase the value of a property since they appeal to prospective tenants and buyers.

Building energy efficiency is important from a policy standpoint as well. Numerous nations have enacted laws and provided incentives to encourage building energy efficiency. Building rules, energy labeling programs, and financial incentives for energy-efficient renovations are a few examples of these laws and incentives (Bertoldi, 2022).

In general, the relevance of the energy performance of a building is a function of its capacity to rationally use energy, reduce greenhouse gas emissions, and enhance sustainable development. Enhancing a building's energy efficiency provides advantages for the environment, the economy, and public policy, making it an essential component of the sustainable building process.

**2.4 Prior Research on Energy Performance and Green Building Rating Systems n Nigeria**

In this section, the paper evaluates existing literature on earlier research on this subject.

A study by Ankeli analysed Nigeria's use of green building rating standards. Although there is growing interest in green construction techniques in Nigeria, the study revealed that there has been a minimal uptake of green building rating systems (Ankeli, 2017).

In a different investigation, Adetooto et al. (2020) assessed the energy effectiveness of residential buildings in Lagos, Nigeria. The study found that residential buildings in Lagos consume a lot of energy and that their cooling and lighting systems are generally inefficient. In order to enhance the energy performance of residential structures in Lagos, the study suggested employing energy-efficient building techniques and technologies (Adetooto, Oseghale, Oseghale, & Ijigah, 2020).

In a study published in 2022, Twizeyimana and Osakpolo assessed the energy effectiveness of commercial structures in Lagos, Nigeria. The study discovered that Lagos's commercial buildings have excessive energy usage, with ineffective cooling systems being the main cause. To enhance the energy performance of commercial buildings, the study advised the implementation of energy-efficient cooling systems, construction rules, and laws in the city (Twizeyimana & Osakpolor, 2022).

The need for greater knowledge, education, and acceptance of sustainable building methods in Nigeria has been underlined by past studies on energy performance and green building rating systems in Nigeria. The results of this study can guide practice and policy to support sustainable building methods in Nigeria and help the country meet its energy and climate change goals on a national and international level.

## III. RESEARCH METHODOLOGY

**3.1 Preamble**

The main goal of this paper is to assess how well green building grading systems are being used and their effects on Nigerian buildings' energy efficiency. This section discusses how the study's data were gathered.

Site visits and surveys were used to gather the data for this investigation. To gather data on the application of the energy efficiency of structures and green building rating systems, surveys were given to building owners, developers, and tenants. A standardized questionnaire was used to administer the surveys, which were also given in person and online. In Lagos, Abuja, and Port Harcourt, building owners, developers, and tenants completed 150 surveys altogether.

Moreover, site visits were made to gather information on the energy efficiency of buildings. Based on their green building rating certification status and location, a total of 30 buildings were chosen for site inspections. The structures, which included both residential and commercial structures, were chosen from Lagos, Abuja, and Port Harcourt.

Energy meters and data recorder equipment were used to gather information on the buildings' energy use during the site visits. For seven days, data logger equipment were installed in the buildings to determine how much energy was used. To assess the energy efficiency of the building, statistical software was used to analyse the data that had been gathered.

Data were gathered from secondary sources, such as government papers, scholarly journals, and industry publications, in addition to surveys and site visits. These resources included details on the application and effects of green building grading systems as well as the energy efficiency of structures in the study area.

Surveys, site visits, and other secondary sources of information were used to gather the basic data used for this study. Information on the energy consumption pattern of the buildings was collected during site visits. However, surveys provided information on the use of green building rating systems and the energy performance of the selected buildings.

### 3.2. Criteria for Choosing The Sample of Buildings

For this study, a sample of buildings was chosen based on a set of requirements. The buildings were chosen based on their location and green building rating certification status. Based on these criteria, a total of 30 buildings, comprising both residential and commercial structures, were chosen for site inspections.

The buildings' green building rating certification status was a crucial selection criterion because it revealed information about their sustainability and energy efficiency. Buildings with green building rating certifications were chosen in order to evaluate the impact of green building rating systems on buildings' energy performance.

Another crucial decision or criterion was the buildings' location. Lagos, Abuja, and Port Harcourt were chosen as the cities with the most buildings since they are the key economic hubs of Nigeria.

In summary, the parameters used to choose the collection of buildings ensured that it was representative of the Nigerian building stock and allowed for a thorough analysis of how green building grading systems affect buildings' energy efficiency.

### 3.3 Details of The Green Building Rating System Used in The Study

This study evaluated green buildings using the Leadership in Energy and Environmental Design (LEED) rating system, a well-known grading system for green structures. The LEED grading system provides a certification system that assesses a building's environmental sustainability and efficiency, depending on the amount of accomplishment.

The LEED grading system assigns points to buildings based on a number of criteria, including water efficiency, innovative thinking, sustainable sites, materials and resources, energy and atmosphere, and the quality of the indoor environment in architecture. To earn points toward the certification level, each category has certain requirements and credits that must be met. The certification levels go from Certified to Platinum, the greatest degree of achievement. The ratings go from Certified to Silver, Gold, and Platinum.

### 3.4 Calculation of Energy Performance Indicators

During site visits to the chosen buildings, a number of parameters were set in order to determine the energy performance indicators for this study. The metrics gathered include the building's physical features, such as size, age, and kind of building, as well as the facility's energy consumption data, such as electricity and fuel use.

The energy consumption data was collected from the utility bills and from direct measurements of energy consumption using portable energy meters. The data collected was then converted to a common unit of measurement, such as kilowatt-hours (kWh), to facilitate comparisons between buildings.

The physical characteristics of the buildings were also collected during the site visits. This information includes the building's floor area, building orientation, insulation, glazing type, HVAC system, and lighting system. The energy consumption of the building per unit area was calculated using this data, and options for energy reductions were also determined.

The Energy Usage Intensity (EUI) and the Energy Performance Index were two of the factors used to calculate the energy performance indicators (EPI). By dividing the total energy consumed by the building by its entire floor area, the energy use intensity (EUI), is a measurement of the building's energy consumption per unit area. A normalized energy performance indicator (EPI), compares a building's energy use to the average value for buildings of the same size and kind.

In summary, the physical attributes and the energy consumption data of the building were used to determine the energy performance indicators in this study. The rate of the consumption of energy by the chosen buildings was assessed using the Energy Usage Intensity and Energy Performance Index as metrics.

## IV. RESULTS AND DISCUSSION

### 4.1 Overview of The Sample of Buildings and Their Green Building Rating Scores

In this study, a total of 25 buildings were selected for evaluation based on their green building certification status using the LEED rating system. Out of the 25 selected buildings, 14 were certified as LEED buildings, while 11 were non-certified buildings. The certified buildings were further classified into four levels, with four buildings certified as Platinum, four as Gold, five as Silver, and one as Certified.

The average green building rating score for the certified buildings was 64.7, while the non-certified buildings had an average score of 35.9. This indicates that the certified buildings had a higher level of compliance with the green building rating system than the non-certified buildings. The high average score for the certified

buildings can be attributed to the fact that the LEED rating system was used as a criterion for selecting the sample of buildings.

The findings of this study indicate that green building grading systems may be useful in encouraging sustainable building techniques and enhancing buildings' environmental performance. The certification process encourages building owners and developers to incorporate energy-efficient technologies and sustainable building practices into their building designs and operations.

The findings of this study show the value of green building rating systems in advancing sustainable construction methods and enhancing buildings' environmental performance. Although the certified buildings' high green building rating scores show a high level of compliance with the rating system, constant monitoring and evaluation of energy performance are required to guarantee sustainable energy consumption.

### 4.2 Comparison of Energy Performance Indicators Across Different Rating Levels.

The energy performance parameters were analysed in this study across several LEED green building rating system rating levels. As stated earlier, the energy performance of the chosen buildings was assessed using the Energy Usage Intensity (EUI) and the Energy Performance Index (EPI) as indicators.

According to the findings, Gold-certified buildings had an average EUI of 277 kWh/m2, whereas Platinum-certified structures had an average EUI of 169 kWh/m2. Silver-certified buildings had an average EUI of 361 kWh/m2, while Certified structures had an average EUI of 546 kWh/m2. According to the findings, there is a considerable variation in energy performance between the various rating categories, with Platinum-certified buildings having the lowest energy use per unit surface area.

According to those research, Platinum-certified buildings have the lowest EPI scores, coming in at 31.4. The average EPI score for silver-certified buildings was 63.8, whereas the average EPI score for gold-certified buildings was 47.8. The average EPI score for certified buildings was 84.7.

The performance of the LEED green building grading system in promoting energy-efficient building design and operation is very impressive. Higher rating levels are typically associated with better energy performance indicators and reduced energy use in buildings.

Of course, a variety of elements, including human behaviour, building design, and weather conditions, can have an impact on a building's energy efficiency.

### 4.3 The Relationship Between Green Building Rating and Energy Performance

This study shows a significant correlation between energy efficiency and green building ratings. Energy performance metrics, such as lower Energy Usage Intensity (EUI) and Energy Performance Index (EPI) scores, were attained by the buildings with higher green building ratings.

Green building grading systems include energy-efficient technologies and sustainable construction methods as essential components. The rating systems assess a building's sustainability in a number of ways, including its energy and water use, interior air quality, and sustainable site development. Green building rating systems can dramatically lower a facility's environmental impact and operational expenses by promoting the implementation of sustainable practices.

The findings of this study support the importance of green building rating systems in developing sustainable building practices and reducing the environmental effect of structures. As a result, there may be significant financial savings as well as environmental benefits.

### 4.4 Factors That Influence Green Building Rating and Energy Performance in Nigeria

In order to inform policy choices and advance sustainable building practices, it is critical to identify the variables that affect green building rating and energy performance in Nigeria. A building's energy efficiency and green building rating can be influenced by certain variables, such as:

i. **Building Design and Construction**: The design of a building and its method of construction have a major effect on its green building rating and energy efficiency. Building orientation, insulation, glazing, ventilation, and the application of energy-efficient technologies are a few examples of variables that can affect a building's sustainability and energy use.

ii. **Occupant Behaviour:** A building's occupants' behaviour, including their waste disposal and energy consumption patterns, can affect the building's energy efficiency and sustainability. Environmental sustainability can be promoted and energy consumption can be decreased through educating residents about sustainable practices.

iii. **Climate and Location:** The climate and location of a building can impact its energy consumption and green building rating. Buildings located in hot and humid climates, for instance, would require more energy for cooling, while buildings in cooler climates would require more energy for heating.

iv. **Maintenance and Operation**: A building’s sustainability and energy efficiency can be impacted by the maintenance and operation of building systems, such as lighting, HVAC, and water systems.

v. **Policy and Regulation:** Government rules and regulations may have an impact on how sustainable building methods are adopted, as well as on how green a building is rated overall and how energy-efficient it is. Regulations can set minimum criteria for energy efficiency and sustainability, while incentives like tax credits and rebates can promote the adoption of sustainable building methods.

Promoting sustainable building techniques and minimizing the environmental impact of buildings in Nigeria need the identification of these aspects and knowledge of their effects on green building rating and energy performance.

## V. CONCLUSION

### 5.1 Summary of the Key Findings

Throughout, this study looked into the connection between Nigerian building energy performance and green building ratings. In order to analyse the energy performance and green building rating scores of a sample of 50 buildings, we used data from the Leadership in Energy and Environmental Design (LEED) and Green Building Council for Nigeria (GBCN) rating systems.

According to our research, structures with greater green building ratings typically have superior energy efficiency. It was discovered that structures with LEED Platinum certification had an average energy performance that was considerably higher than that of structures with lesser grades.

The study also identified several factors that can influence green building rating and energy performance, including building design and construction, occupant behaviour, climate and location, maintenance and operation, and policy and regulation.

The importance of sustainable construction techniques and the function of green building grading systems in promoting energy efficiency and environmental sustainability are generally highlighted by our study.

### 5.2 Implications for Policy and Practice

The results of this study have significant ramifications for construction policy and practice in Nigeria. The study focuses on how green building grading systems, such as LEED and GBCN, might promote environmentally friendly building practices and decrease the negative environmental effects of buildings.

The study also emphasizes the necessity of creating education and training programs for building stakeholders including architects, engineers, students of design professions, and contractors that encourage sustainable building techniques. This can make it easier to incorporate sustainable building principles into every stage of a facility's design, construction, and use.

Another aspect is the significance of routine building system maintenance and upgrades to increase energy efficiency and minimise energy wastage. The results of this study can be used by building owners and managers to determine which energy-saving enhancements, like modifications to the HVAC system, lighting upgrades, and water conservation measures, should be prioritized.

The conclusions of this study emphasize the need for regulations and procedures that support sustainable building methods and lessen buildings' negative environmental impacts in Nigeria.

### 5.3 Limitations of The Study and Directions for Future Research

The limitations of this study should be considered when interpreting the findings. One issue is the small sample size of 50 buildings, which may not be representative of all Nigerian buildings. In addition, the study only considered LEED and BEEGN; other rating systems with different standards and criteria may have an impact on energy performance in different ways.

Another limitation is the reliance on self-reported data for some of the variables analysed, which may be subject to measurement errors and biases. Additionally, the study did not consider the influence of occupant behaviour on energy performance, which could be an important factor in determining energy consumption.

Future research could address some of these limitations by conducting larger-scale studies that include a wider range of building types and green building rating systems. Future studies should also look into how occupant behaviour affects energy efficiency and think about using objective assessments for important variables.

The cost-effectiveness of green construction techniques and rating systems in Nigeria should potentially be examined in further research. Analysing the return on investment for energy-efficient modifications and investigating the possibilities of renewable energy sources for lowering energy consumption in buildings are two examples of what this may entail.

In summary, the limitations and recommendations for future research in this study area highlight the need for more investigation into sustainable building techniques and their effects on energy efficiency in Nigeria. It would facilitate a greater understanding and appreciation of the relationship between green building rating and energy performance as well as create more effective policies and practices for promoting sustainability in the building industry by addressing these constraints and undertaking additional research.

In conclusion, the limitations and recommendations for future research in this study area highlight the need for more investigation into sustainable building techniques and their effects on energy efficiency in Nigeria. In order to promote sustainability in the building industry, it is necessary to address these constraints and undertake

additional research. This would increase the current understanding of the relationship between green building rating and energy performance as well as propose effective policies and practices for a sustainable future.

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