



RESEARCH ARTICLE

The Challenges and Opportunities of Net-Zero Buildings in the Ibadan Real Estate Market Subsector

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Abstract

The transition toward Net-Zero Buildings (NZBs) has become a typical issue of global discourse, thus, gaining momentum as most cities seek sustainable solutions to mitigate the looming energy crisis and climate change. Ibadan, the largest city in sub-Saharan Africa and one of the fastest-growing urban centers in Nigeria, has a real estate sector that is facing both opportunities and challenges of adopting net-zero building principles. The study, therefore, explores major barriers to the full adoption of the Net-Zero Building principles. The identified barriers include the huge initial capital outlay, the lack of or limited technical expertise, and deficient and inconsistent policy frameworks, while available opportunities in its adoption are in renewable energy integration, green building financing, and increasing public awareness of environmental sustainability. The study employs a mixed-method approach, in which data were collected from developers, professionals in the construction industry, policymakers, and residents. Findings indicated constraints in the areas of financing, technological expertise, policy, and regulatory framework. These constitute the major challenges. However, solar energy potential and rising environmental consciousness offer promising buffers or pathways. The study concludes that collaborative efforts among policymakers, developers, and residents are critical to accelerate the transition toward a greener built environment.

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1. INTRODUCTION

Issues relating to the emerging global climate change, rapid urban expansion, and increasing demand for energy, and the resultant mishaps that require urgent attention, have triggered the global discourse on sustainable building practices. The International Energy Agency [IEA] (2021) argued that a central means through which carbon emissions can be reduced, and sustainable urban development can be promoted, is through the Net-Zero Buildings (NZBs). NZB is often designed with the aim of balancing energy consumption with on-site renewable generation. In the Nigerian context, first-generation cities as Ibadan, the capital city of Oyo state, Nigeria, and the regional headquarters of the southwest region, with a rapidly growing urban population, exploding urban housing demand, congested traffic trend, and outdated and overstretched urban infrastructure, exhibited both reasonable challenges and opportunities for NZB adoption. Berardi (2018) asserted that NZBs aim to generate enough energy that will be as much as can be consumed annually through renewable sources, such as solar photovoltaic systems and energy-efficient designs. In advocating the need for NZBs, Sharma, Saxena, and Sethi (2020) opined that it reduces

operational costs, aids asset value appreciations and enhances environmental benefits. Hussein and Alias (2024) considered the situation in Malaysia and concluded that the inadequate awareness of Net-Zero Buildings and the lack of a comprehensive idea of Net-Zero Buildings among the Malaysian populace are major constraints to the realization of the potential advantages of the construction sector. Constraints to Net-Zero Building adoption in the developing nations are a deficient and inconsistent regulatory framework, financial limitations, and the lack of or limited technical expertise.

However, Olaniyan (2023) averred that cities in African nations have the potential of leapfrogging the conventional unsustainable practices through the integration of a more innovative green strategy. Ibadan, unlike Lagos, Port Harcourt, or Abuja, faces the severe challenges of housing availability and affordability, a dilatory modernization rate, and constricted investment inflows (Akinoyemi, 2020). These conditions pose grievous challenges to the adoption of NZBs in the developing nations, but the opportunities for context-specific strategies are also available. Akerele *et al.* (2025) observed that, despite the existence of a relevant policy framework in most developing nations, the low level of awareness and the weak willpower to enforce its provisions by the concerned authorities and stakeholders pose a serious hindrance to its practical uptake. Thus, Nduka and Ogunsanmi (2015) submitted that the near absence of incentives, such as tax breaks or green financing, further exacerbates and discourages the adoption of green building practice, thereby discouraging NZBs' adoption.

Conversely, the abundant solar potential in Ibadan, just like any other city in Nigeria, allows for a reasonable level of environmental awareness and aligns with global Environmental, Social, Governance trends that could engender fertile ground for NZBs in Nigeria (Ankeli *et al.*, 2025, and PwC, 2021). Previous studies, such as Ankeli *et al.*, (2025), Acheampong (2021), and Darko *et al.* (2020) emphasize the need for green building certification but advise that achieving net-zero building requires institutional reforms and community engagement. This paper, therefore, seeks to investigate the challenges and opportunities of Net-Zero Buildings adoption in the Ibadan North and Ibadan Northeast real estate subsectors, focusing on the identification of practicable strategies for accelerating Net-Zero Building adoption in the city. It contributes to ongoing discourse on sustainable urban development by highlighting the environmental urgency, economic potential, and socio-political dynamics influencing its implementation. It further presents a complex but attainable goal and offers actionable lessons or recommendations for other emerging urban centers in sub-Saharan Africa and stakeholders in the real estate value chain.

2. MATERIALS AND METHODS

To capture the quantitative evidence of the prevailing perceptions and qualitative insights of the practical experiences across the study population, a mixed-methods research design was adopted in line with the work of Creswell & Plano Clark (2018). The approach assisted the researcher in the investigation of both the challenges and opportunities of Net-Zero Building principles and their integration into the Ibadan North and Ibadan Northeast real estate subsectors of the national economy. The research design employed to capture the broader perspectives of the respondents is the descriptive survey design. The study also conducted a semi-structured interview, particularly with industry experts, to give a better in-depth understanding of the context. The adoption of this dual design enhances data triangulation and the validity of findings.

The respondents for the study are real estate investors/developers, professionals from the built environment, green building advocates, and policymakers practicing or operating within Ibadan North and Ibadan Northeast, which is the focus of the study and where NZB's principles are gradually gaining attention. A purposive sampling technique was adopted for the selection of the respondents who are practitioners and are actively involved in the built environment activities. To ensure adequate representation across the diverse real estate subsector - residential, commercial, and mixed-use property types, a stratified random sampling method was used for the selection of these respondents. A total of 200 respondents were randomly picked across the study area. Details are presented in Table 1. The study adopted the Cochran formula for sample size determination. The formula used by Ankeli (2025) and adopted for this study is presented as:

$$n = \frac{z^2 p(1-p)}{e^2} \quad (1)$$

Where:

n = sample size

z = 1.96 (for 95% confidence level)

p = 0.5 (assumed proportion)

e = 0.05 (margin of error)

Then, the adjusted formula is:

$$nf = \frac{n}{1 + \frac{n}{N}} \tag{2}$$

nf = adjusted sample size

N = total population of respondents

The primary data collected and used for the study were collected through structured questionnaires and semi-structured interviews. The questionnaire captured respondents' perceptions regarding NZBs awareness among the respondents, current NZBs challenges, opportunities, and the level of its integration. This is consistent with Kothari (2019), who emphasized the need for the value of surveys for systematically gathering data on perceptions and attitudes across a wide population. Issues relating to challenges, opportunities, the level of awareness, and willingness to integrate NZBs in real estate were quantitatively captured and measured with the use of a Likert scale ranging from scale of 1 to 5, where 1= Strongly Disagree and 5 = Strongly Agree. Semi-structured interviews conducted with the key informants provided qualitative insights into the issues at hand. Secondary data was obtained from peer-reviewed journal articles, government policy documents, and industry reports.

Descriptive statistics were used to analyze the quantitative survey data collected (means, standard deviations, and frequency distributions) to summarize responses. Inferential statistics such as Analysis of Variance (ANOVA) were applied to test for significant differences in perceptions among stakeholder groups. While specific differences were pointed out where applicable, using Post hoc tests (e.g., Tukey's HSD). Data collected through multiple data sources were triangulated to enhance the validity and reliability of the results.

3.0 Results and Discussion

The research conducted necessitates the collection of both quantitative and qualitative data from the field; this section presents the analysis of the data collected and discusses the various findings of the research work.

3.1 Overview of the Survey Response (Questionnaire Administration)

A total of 200 questionnaires were administered to the respondents, out of which only 182 were correctly filled in and returned for analysis, representing 91% response rate. Detailed analysis of the returned questionnaires is presented in Table 1.

Table 1. Questionnaire Administration

Respondents	frequency	No Returned	%Rate
Professional in the Built Environment	60	58	97
Green Building Advocates	40	30	75
Real Estate Developers/Investors	80	74	93
Policymakers	20	10	50
Total	200	182	91

Source: field survey (2026)

The respondents on whom questionnaires were administered are the professionals in the built environment (estate surveyors, architects, builders, urban planners, engineers, and quantity surveyors); green building advocates who are willing to answer the questionnaires; developers/investors in commercial, residential, and mixed-use real estate; and policymakers at both the local and state government levels. Table 1 revealed 97% response rate from professionals in the built environment, 75% from green building advocates, 93% response rate from real estate developers, and 50% from policymakers, with the overall

response rate of 91%. The diverse representation ensured the validity of the findings and reflected various perspectives of the respondents across the real estate value chain.

3.2 The Adoption Trends and Integration of Net-Zero Buildings

Despite the need for Net-Zero Buildings (NZBs) concept and the enormous benefits nations and the global landscape stand to gain from its adoption, its integration into the national building code/ regulation and standard remains sketchy. NZBs according to Torcellini *et al.*, (2006) are structures that produce an amount of renewable energy equal to or greater than the total energy they consume from non-renewable sources over the course of a year. Going by this definition, achieving NZBs or its adoption and integration may seem impossible in most of the developing countries, particularly, Nigeria.

NZBs have been a common feature in the real estate sectors of most countries in the developed world. These nations unlike the developing countries, have the capacity in terms of expertise and technological readiness, contemporary supportive policies, enlightened and conscious public positioned to accept modernity and innovations but not conventional and archaic public that are repugnant to modernization. International Energy Agency [IEA], (2021) reported that, the real estate sector, as a fundamental contributor to global energy consumption and greenhouse gas emissions, is under mounting pressure to transition toward greener practices. To curb or downplay the energy-consuming pressure on the sector, the United Nations Environment Programme [UNEP] (2020) suggested the adoption and integration of the Net-Zero Buildings concept as an emerging solution, designed to achieve a balance between energy demand and supply through the generation of as much renewable energy on-site as they consume annually. This formulation aligns with the global sustainability concept, particularly the Goals 7 and 11 of the United Nations Sustainable Development Goals (SDGs), which are on affordable and clean energy and sustainable cities and communities.

According to IEA (2021), countries such as the United States of America, Japan, and Germany are leading in NZBs integration as the target or policy has been incorporated into their national energy and climate action plans. The European Union’s Energy Performance of Buildings Directive has, for instance, mandated that, for all new buildings, the “nearly zero-energy” target must be achieved by 2030. This policy, according to the European Commission (2021) is beginning to spur innovative green construction materials and renewable energy integration. In contrast, however, Ankeli *et al.* (2025) observed that the trend in green building adoption and integration in the emerging economies is slower due to a lack of expertise and technological readiness, archaic culture and conventional practices that are repugnant to innovative technology, financial constraints, inadequate policy frameworks, and infrastructural gaps. The current study is therefore set to investigate the perceptions on the challenges and opportunities of Net-Zero Buildings adoption and integration in the real estate sector in some selected local governments in Ibadan, Nigeria.

3.3 Challenges of Net-Zero Buildings Integration

Despite the enormous benefits of NZBs Principles, its large-scale adoption and implementation in the real estate subsector of the Nigerian built environment is facing serious challenges or limitations. The study identified some of these challenges in previous literature, isolated them, and presented them to the respondents to see the applicability of the identified variables in the study area. The relative importance index, mean score, and standard deviation of the challenging factors are presented in Table 2 and Table 3.

Table 2. Perceptual Analysis of NZBs Challenges

Challenges	5	4	3	2	1	$\sum w$	RII	Rank
High Initial Capital Outlay	175	5	2	0	0	901	.990	1 st
Policy Inconsistency	120	30	2	10	20	762	.837	6 th
Cultural and Market Resistance to Change	150	12	5	15	0	843	.926	5 th
Problem of Technological Expertise	170	10	2	0	0	896	.985	3 rd
Problem of Awareness and Funding	120	50	10	2	0	834	.917	4 th
Lack of Dedicated Financing Mechanisms	170	12	0	0	0	898	.987	2 nd

Source: field survey (2026)

Table 3. Mean Scores and Standard Deviation for Challenges to NZBs

Challenging Variables	Mean	Standard Deviation	Interpretation
High Initial Capital Outlay	4.35	0.68	Very High
Policy Inconsistency	3.65	0.91	Moderate-high
Cultural and Market Resistance to Change	3.59	0.87	Moderate-high
Problem of Technological Expertise	4.12	0.75	High
Problem of Awareness and Funding	3.98	0.82	High
Lack of Dedicated Financing mechanisms	4.15	0.70	High

Source: field survey (2026)

In the context of Ibadan North and Ibadan Northeast local government areas, high initial capital outlay remains the most cited challenge to NZBs' integration into the real estate development subsector. Though it may be possible for such a cost to be offset by operational savings over a given time, the period it takes for the payback most often discourages short-term profit expectation investors. This is congruent with Häkkinen and Belloni (2011) and reflects prior findings of Hussein and Alias (2024). Another issue that is typical and requires urgent attention is the lack of dedicated financing mechanisms to fund NZB projects and the problem of technological expertise in NZB design, construction, and maintenance. Funding mechanisms tailored towards NZBs adoption and integration (green mortgages or energy performance contracts) are critical factors that cannot be overlooked. Zhang *et al.* (2024) and Lou & Hsieh (2024) observed that issues of funding NZBs are underdeveloped in several regions, thereby creating funding gaps for developers. This assertion also aligns with the thought of Darko *et al.* (2020) and Akerele *et al.* (2025).

Furthermore, another factor impeding the progress of NZBs' integration in the Nigerian real estate sector, as noted in the study area, is the weak and inconsistent policies and regulatory framework operating in the country. This is common in most developing nations, particularly nations that are yet to incorporate the appropriate NZBs requirement in their building codes and standards; hence, it confirms the assertion of Nduka and Ogunsanmi (2015). More so, green building development is not a project that has been given the deserved attention in the developing nations. Its level of awareness among investors, developers, and designers alike is low. This is positively reflected in the study area, as most respondents seem to be at a loss in the pilot survey location.

Another impending challenging factor noticeable in the study area is the effect of cultural and market resistance to change. Maybe because of the low-level awareness, developers and consumers in some of the markets remain skeptical about NZB performance claims. This was experienced in areas with low-level knowledge of renewable energy technologies and among those with the archaic conventional perceptions that renewable energy can never be a good alternative energy source; hence, not reliable due to the acclaimed dangers and unreliability. This was also echoed by Olawumi and Chan (2018).

3.4 Opportunities for Net-Zero Buildings Adoption

Several benefits of NZBs for the real estate subsector have been identified and isolated from previous literature. According to Dodge Data and Analytics (2021) reduced dependence on the electricity grid, which is important in areas with volatile energy prices, could be achieved through operational cost savings. Real property value and market competitiveness can be enhanced through green infrastructure adoption, as environmentally responsible buildings increasingly attract both investors and tenants seeking environmental, social, and governance (ESG) compliant assets. Frontczak and Wargocki (2011) argued that NZBs' compliant buildings contribute greatly to positive environmental impact as it improves occupant health and comfort through better indoor air quality, natural lighting, and thermal regulation. Again, from the policy framework and societal perspective, the UNEP (2020) opined that NZBs support national commitments to the Paris Agreement by reducing carbon footprints and promoting energy independence. Looking at the long-term impact of NZBs, the International Energy Agency [IEA] (2021) averred that the widespread acceptance of NZB principles can induce green jobs, foster innovation in building materials, and catalyze the growth of local renewable energy markets. The Relative Importance Index of the identified opportunity factors is presented below.

Table 4. Perceptual Analysis of NZBs Opportunities

Opportunity	5	4	3	2	1	Σw	RII	Rank
Access to ESG-driven Investments	80	80	12	10	0	766	.842	2 nd
Positive Environmental Impact	75	85	12	5	5	766	.842	2 nd
Abundant Solar Energy Potential	95	45	12	15	15	736	.809	6 th
Potential for Long-Term Cost Savings	80	70	10	5	17	737	.810	5 th
Improved Market Competitiveness	60	80	20	15	7	717	.788	7 th
Enhanced Property Value	120	60	2	0	0	846	.930	1 st
Rising Environmental Awareness	100	52	05	10	15	758	.833	4 th

Source: field survey (2026)

Table 4 reveals the outcome of the test conducted on the perceptions of the respondents. The respondents' cognitive proficiency on the factors identified in previous literature as NZBs opportunity variables and their probable applicability in the study area were tested. Out of the seven variables identified and isolated for the study, the respondents agreed that the integration of NZBs in the real estate subsector could enhance property values in the study area, as the NZBs principle helps in the decarbonization of the environment, thereby contributing to global urban sustainable development. This factor ranked 1st among the other opportunity factors presented with an RII value of 0.930. This is in line with the World Green Building Council (2021) postulation that NZBs are the cornerstone of sustainable urban development, contributing significantly to global decarbonization efforts. The issues of positive environmental impact and access to environmental, social, and governance-driven investments were both ranked as the 2nd most important opportunity factors, with both factors having an RII of 0.842 each. This further supports Ankeli *et al.* (2025), who reported that property value and market competitiveness can be enhanced through green infrastructure adoption. Environmentally responsible buildings increasingly attract both investors and tenants seeking ESG-compliant assets. The least critical but important opportunity factors ranking 7th with an RII of 0.788 is Improved Market Competitiveness. In all, the reported factors are all critical opportunity variables that could contribute significantly to the integration of NZBs in the study area. These opportunities align with the findings of Akerele (2025) and PwC (2021). However, despite the positive side of the observed awareness, affordability, according to Akinyemi (2020) moderates its adoption.

Stakeholder Differences (ANOVA & Post Hoc)

Table 5: ANOVA

Source	SS	df	MS	F	Sig.
Between	12.54	3	4.18	9.62	0.000
Within	84.12	179	0.43		
Total	96.66	182			

Table 6: Post Hoc (Tukey HSD)

Comparison	Mean Diff	Sig.	Interpretation
Developers' vs Residents	0.78	0.001	Significant
Developers' vs Policymakers	0.62	0.010	Significant
Professionals' vs Residents	0.54	0.020	Significant
Professionals' vs Policymakers	0.36	0.080	Not Significant

Tables 5 and 6 revealed the stakeholder differences, that is, the ANOVA and Post Hoc model shows that differences existed and the actual area of differences. The perception of the challenges is more acute on the side of the developers. This is consistent with the view of Akinyemi (2020) and Darko *et al.* (2020). Olaniyan (2023), however, is of the view that policymakers, on the other hand, may tend to underestimate the practical constraints.

Table 7: Chi-square Analysis on capital outlay vs Willingness to Adopt NZB

Variable	χ^2	df	p-value	Interpretation
Capital outlay vs willingness to adopt	18.45	4	0.001	Significant relationship

The cost of adopting NZB and the willingness of the respondent were investigated through Chi-square analysis to consider the goodness of fit of the data collected and to find their level of association or

independence. The respondent's response shows that those in the higher income bracket are more willing to adopt NZB than those respondents in the lower income level. This is congruent with the assertion of Nduka and Ogunsanmi (2015), while Berardi (2018) observed that incentives could significantly cut down income dependency.

Conclusion and Recommendations

The study shows that NZB adoption in the city of Ibadan, the capital of Oyo, Nigeria, is seriously constrained by several factors among which are a lack of technical expertise, finance and policy barriers among other factors. Opportunities, on the other hand, exist particularly in environmental, social and governance investment trends, renewable energy integration, green building financing, and increasing public awareness of environmental sustainability. Furthermore, the perceptions of stakeholders vary, with developers tending to be more concerned about costs, while the residents are influenced by awareness and affordability.

Nevertheless, it is based on the findings of the study that the following recommendations are proposed:

1. *Financial incentives:* Considering the national economy and the financial situation of citizens in the country, the Oyo state government should ensure the adoption of the NZB concept, an alleviation or palliative model. This could be in the form of green financing, subsidies or a tax holiday to reduce initial capital outlay barriers across all the local government areas in the state.
2. *Capacity building:* Training and retraining programs should be designed for professionals in the built industry, particularly the architects and engineers, as well as investors/developers in the local government areas.
3. *Policy enforcement:* the available institutional framework needs to be strengthened and appropriately implemented, particularly the content of NREEEP and other applicable green building codes in the state.
4. *Awareness campaigns:* the need for the intensification of awareness campaigns for Oyo state residents' education on NZB benefits and long-term savings.
5. *Stakeholder collaboration:* public-private partnerships or any other forms of collaboration between Oyo state government, developers/investors, and host communities for inclusive green building adoption should be encouraged.

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