

# Barriers to the Adoption of Affordable and Clean Energy Solutions in Maiduguri

Bultu Babagana Zanna<sup>1</sup>, Sule Magaji<sup>2</sup> & Ibrahim Musa<sup>3</sup>

<sup>1</sup>Sustainable Development Centre, University of Abuja

<sup>2&3</sup> Department of Economics, University of Abuja

\*Corresponding Author: Bultu Babagana Zanna

DOI: <https://doi.org/10.5281/zenodo.20150960>

Article History	Abstract
<b>Original Research Article</b>	<p><i>This study examined the barriers to the adoption of affordable and clean energy solutions in Maiduguri, with a view to identifying key factors limiting the uptake of renewable energy technologies among households and small-scale businesses. The study adopted a quantitative approach using a cross-sectional survey design, and data were collected from 400 respondents through structured questionnaires. Descriptive and inferential statistical techniques, including multiple regression analysis, were employed to analyze the data. The findings revealed that although awareness of clean energy solutions is relatively high, the level of adoption remains low. Economic barriers, particularly high initial costs and limited access to credit facilities, were identified as the most significant constraints. Technical challenges such as lack of skilled personnel and poor maintenance services, as well as institutional barriers including weak government policies and inadequate incentives, were also found to significantly hinder adoption. The regression results showed that these barriers have a negative and statistically significant effect on the adoption of clean energy solutions. The study concludes that addressing these challenges requires a comprehensive approach involving financial support mechanisms, capacity building, and policy reforms. The study recommends the provision of subsidies, improved access to financing, technical training, and strengthened regulatory frameworks to enhance the adoption of clean energy solutions in the study area.</i></p> <p><b>Keywords:</b> Clean Energy, Renewable Energy Adoption, Economic Barriers, Technical Barriers and Institutional Barriers.</p>
<b>Received: 16-03-2026</b>	
<b>Accepted: 20-04-2026</b>	
<b>Published: 13-05-2026</b>	
<b>Copyright © 2026 The Author(s):</b> This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY-NC) which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.	
<b>Citation:</b> Bultu Babagana Zanna, Sule Magaji & Ibrahim Musa. (2026). Barriers to the Adoption of Affordable and Clean Energy Solutions in Maiduguri. UKR Journal of Economics, Business and Management (UKRJEBM), 2(5), 71-80.	

## Introduction

The growing global emphasis on sustainable development has brought affordable and clean energy to the forefront of policy and academic discourse, particularly within developing countries such as Nigeria (Sadiq et al., 2025; Ismail et al., 2026). Clean energy derived from renewable sources such as solar, wind, and hydro offers a viable pathway to address persistent energy poverty, environmental degradation, and economic stagnation (Magaji et al., 2024;2026). Despite Nigeria's vast renewable energy potential, especially solar irradiance in northern regions like Maiduguri, access to reliable and affordable electricity remains limited. A significant proportion of the population continues to depend on fossil fuels and inefficient energy sources, thereby undermining

efforts toward achieving sustainable development goals and climate resilience (Ibrahim & Zeydler, 2023; Shitu et al., 2025) ([World Economic Forum](#)).

Energy challenges are acute in Maiduguri—Borno States capital, where chronic infrastructural and socio-economic deficiencies collide with ongoing conflict and displacement, all of which hinder viability for electrification. And like many other urban centres across northern Nigeria, the city struggles with an irregular electricity supply from the national grid which has led to a high dependence on petrol and diesel generators by households and businesses. This reliance increases the cost of living and running a business dramatically, in addition to creating pollution. While renewable energy sources such as

solar power provide a sustainable option with numerous benefits, their use remains relatively low, primarily due to systemic barriers preventing widespread accessibility and affordability (GVE Group, 2026).

High initial costs related to the purchase of renewable energy technologies is a significant barrier against the adoption of clean energy solutions within Maiduguri. The high upfront costs of solar panels, batteries and inverters are insurmountable for many low- and middle-income households. In addition, limited access to affordable financing options and high interest rates limit the potential for individuals and small businesses to invest in such technologies. These financial problems are compounded by an absence of suitable financing frameworks and effective risk mitigation mechanisms that would channel private sector investment into renewable energy projects (The Electricity Hub, 2022).

Beyond financial limitations, technical and infrastructural challenges significantly impede the diffusion of clean energy solutions. Nigeria's energy infrastructure is largely centralized and fossil fuel-dependent, with inadequate transmission and distribution networks to support renewable integration (Umar et al., 2025; Inyang et al., 2025). Furthermore, there is a shortage of skilled technicians and technical expertise required for the installation, operation, and maintenance of renewable energy systems, which often leads to system inefficiencies, poor maintenance, and reduced consumer confidence in clean energy technologies (MDPI, 2024; Prime Radiant Energy, 2023).

Institutional, regulatory and socio-cultural factors greatly hinder the adoption of affordable clean energy solution in Maiduguri. Weak policy enforcement, bureaucratic bottlenecks and overlap in regulatory structures leads to uncertainty for investors and a stunted renewable sector. In tandem, low levels of public consciousness and persistent myths about the reliability and efficiency of renewable technologies demotivate household uptake. Strong cultural views around traditional energy methods, as well as opposition to new technologies also restrict movement to cleaner options. However, resolving these interconnected obstacles is necessary to bring forward the transition in Nigeria and build a low-carbon economy through more inclusive and equitable energy access (BusinessDay, 2024; Oxford Open Energy, 2025).

## Literature Review and Theoretical Framework

### Conceptual Review

#### Adoption

Adoption refers to the process through which individuals, households, or organizations become aware of, evaluate,

and ultimately decide to use an innovation or technology. In the context of energy systems, adoption involves not only the initial decision to acquire a clean energy technology but also its sustained utilization over time. According to Rogers (2003), adoption is a critical stage within the diffusion of innovation process, influenced by factors such as perceived relative advantage, compatibility with existing practices, complexity, trialability, and observability. In developing economies like Nigeria, the adoption of renewable energy technologies is often shaped by socio-economic conditions, access to information, institutional support, and cultural acceptance. Empirical studies highlight that barriers such as high upfront costs, limited awareness, and weak policy frameworks can significantly hinder the adoption rates of clean energy solutions (Aklin et al., 2017; Karakaya & Sriwannawit, 2015). Thus, adoption is not merely a technical decision but a multifaceted process influenced by economic, social, and institutional dynamics.

### Affordable and Clean Energy Solutions

Affordable and clean energy solutions are defined as systems which deliver economic access to clean and green energy from renewable sources including but not limited to solar, wind, hydro, biomass. These solutions are directly related with Sustainable Development Goal 7 of ensuring universal access to affordable, reliable and modern energy. In accordance with the International Energy Agency (2023) report, clean energy is vital to tackle climate change by cutting greenhouse gas emissions, bolstering energy security and promoting economic growth. Renewable energy technologies — specifically solar photovoltaic systems, mini-grids, and clean cooking — have the potential to provide affordable solutions for increased energy access in Nigeria, especially in underserved regions like Maiduguri.

While affordable options could go a long way to driving immediate and lasting economic recovery, affordability is still one of the biggest challenges for broad deployment despite the long-term economic benefits. High upfront costs and limited access to financing options make it difficult for many households to invest in renewable energy technologies. This challenge can only be met through supportive government policies, innovative financing mechanisms and vigorous public-private partnerships. A good approach to implementation because initiatives like the one developed by the UNDP (2022) highlight how scaling up deployable strategies presents both opportunities to enhance access and reduce cost. More generally, studies demonstrate that the amelioration of affordability is a touchstone to realising greater energy access and sustainable development outcomes in Nigeria (Oyedepo, 2014; Tanko et al., 2025).

## Theoretical Framework

### Diffusion of Innovation Theory

Everett M. Rogers Diffusion of Innovation Theory, the process by which an innovation is communicated through certain channels over time among the members of a social system. The adoption of an innovation depends on five key attributes: relative advantage, compatibility, complexity, trialability and observability Rogers (2003). In the case of renewable energy adoption in Maiduguri, households will only be more willing to adopt solutions such as solar energy systems if they view these alternatives to be low-cost, easy-to-use and no prescription of eliminating or reducing their current energy needs. While initial costs can be (very) high, awareness and technical know-how barriers could hold up the adoption significantly.

It also emphasizes the impact of communication channels, social networks and opinion leaders on people choices to accept in using new technologies. Such social dynamics could either speed up or slow down the diffusion of clean energy solutions in situations like Maiduguri where trust and information flow between market actors are critical. Thus, the Diffusion of Innovation Theory can provide a holistic analytical insight into the behavioural, social and economic dynamics behind a high penetration of renewable energy technologies in economically deprived regions (Rogers, 2003; Karakaya & Sriwannawit, 2015).

### Empirical Reviews

Abdulsamad et al. (2025) conducted a study titled *Determinants of Renewable Energy Adoption among Rural and Urban Populations in Nigeria*, employing a quantitative survey design alongside binary logistic regression analysis on data collected from 2,500 respondents across the country's six geopolitical zones. The study examined key variables such as awareness, income, education, and residential location in shaping adoption behaviour. Findings indicated that the likelihood of adopting renewable energy was significantly higher among urban populations (70.2%) compared to rural populations (53.9%), with education level, awareness, and income emerging as the most influential determinants. The study concluded that socio-economic inequalities and limited awareness remain major barriers to adoption and recommended the implementation of targeted awareness campaigns, rural-focused policy interventions, and improved access to financing mechanisms to promote clean energy uptake, consistent with the findings of Ologbonori et al. (2025).

**Emegha, Oliomogbe, and Neboh-Paul (2025)** conducted a study titled *Renewable Energy in Nigeria: Feasibility, Policy Gaps and Pathways to Adoption* using a qualitative review of secondary data from academic publications and

policy documents. The study assessed Nigeria's renewable energy potential alongside policy and infrastructural challenges. Findings indicated that despite abundant renewable energy resources, adoption remains low due to financial constraints, infrastructural deficits, and weak governance frameworks. The study recommended increased investment in research and development, improved policy implementation, capacity building, and public awareness initiatives to accelerate renewable energy adoption in Nigeria.

**Ajia (2025)** carried out a study titled *Policy Challenges and Opportunities for Renewable Energy Development in Nigeria: A Systematic Review* employing a systematic review methodology that synthesized evidence from peer-reviewed literature and policy sources. The study identified key policy-related barriers such as regulatory inconsistencies, lack of enforcement, and insufficient institutional coordination. Findings showed that although Nigeria has ambitious renewable energy targets, weak policy implementation limits progress. The study recommended strengthening institutional frameworks, enhancing regulatory clarity, and fostering stakeholder collaboration to improve the effectiveness of renewable energy policies.

**Ewere et al. (2025)** conducted a study titled *A Systematic Review of Barriers to Renewable Energy Integration and Adoption* using a systematic literature review approach covering multiple regions, including Africa. The study categorized barriers into technical, economic, social, and policy-related factors. Findings revealed that high initial costs, intermittency issues, socio-cultural resistance, and fragmented policies significantly hinder adoption. The study recommended integrated policy frameworks, financial incentives, technological innovation, and community engagement strategies to overcome these barriers and enhance adoption rates.

Hadiza et al. (2025) Comparative Study of Renewable Energy Adoption and Environmental Pollution in Nigeria - An Empirical Evidence Using the Autoregressive Distributed Lag (ARDL) model of time-series analysis. The research explored the connection between renewable energy adoption and environmental realities including carbon emissions. Overall findings showed that a greater penetration of renewable energy enabled much lower CO<sub>2</sub> emissions compared to conventional energy, demonstrating that renewable energy is important to environmental sustainability in both short term and long term. These results prompted the study to recommend much more investment in renewables, new policy incentives, engineering for making renewables cost and energy efficient.

**Adelaja (2020)** conducted a study titled *Barriers to National Renewable Energy Policy Adoption: Insights from a Case Study of Nigeria* using a case study methodology to analyze policy adoption challenges. The study found that political, institutional, and economic barriers such as inadequate funding, weak governance, and policy inconsistency significantly hinder renewable energy development. The study recommended policy reforms, improved governance structures, and stronger institutional commitment to facilitate the adoption and implementation of renewable energy policies in Nigeria.

### Research Gap

A critical review of the foregoing empirical studies reveals several gaps that justify the present study on barriers to the adoption of affordable and clean energy solutions in Maiduguri. While studies such as Abdulsamad et al. (2025) and Hadiza et al. (2025) provide valuable quantitative evidence on determinants and environmental impacts of renewable energy adoption in Nigeria, they largely adopt macro-level or national perspectives, thereby overlooking location-specific dynamics in conflict-affected regions like Maiduguri. Similarly, the works of Emegha et al. (2025), Ajia (2025), and Ewere et al. (2025) rely predominantly on secondary data and systematic reviews, which, although insightful, lack primary, context-sensitive data that capture household-level realities, socio-cultural influences, and localized infrastructural challenges. Furthermore, Adelaja (2020) focuses primarily on policy adoption at the national level without adequately addressing the practical barriers faced by end-users in underserved urban centers. None of the reviewed studies sufficiently integrate economic, social, institutional, and security-related factors within a single empirical framework, particularly in the North-East region of Nigeria where insurgency and displacement significantly shape energy access and adoption behavior. Therefore, this study fills the gap by providing a localized, empirical investigation into the multifaceted barriers affecting the adoption of affordable and clean energy solutions in Maiduguri, thereby contributing context-specific insights for policy and practice.

## Methodology

### Research Design

This study adopts a quantitative research approach based on a cross-sectional survey design to examine the barriers to adopting affordable and clean energy solutions in Maiduguri. The cross-sectional design is appropriate because it allows data to be collected from a diverse population at a single point in time, enabling the analysis of relationships among key variables such as economic, social, technical, and institutional factors. This approach is particularly suitable for studies on energy adoption, as it

effectively captures respondents' perceptions, attitudes, and behavioural intentions regarding renewable energy technologies.

Furthermore, the study employs an **explanatory research design** to establish cause-and-effect relationships between identified barriers and the level of adoption of clean energy technologies. The explanatory approach allows for hypothesis testing using statistical techniques, thereby providing empirical evidence on the significance and direction of relationships among variables. This combination of survey and explanatory design enhances the robustness and generalizability of the study findings.

### Area of Study

The study is conducted in Maiduguri, the capital city of Borno State in northeastern Nigeria. Maiduguri is characterized by rapid urbanization, high population density, and persistent energy supply challenges due to inadequate grid infrastructure and the effects of insurgency in the region. The city experiences frequent power outages, leading households and businesses to rely heavily on alternative energy sources such as generators and, to a lesser extent, solar systems. Its unique socio-economic and security context makes it a suitable location for examining the barriers to adopting affordable and clean energy solutions.

### Population of the Study

The population of the study comprises **all households and small-scale business operators** within Maiduguri metropolis. These groups are selected because they represent the primary consumers of energy and are directly affected by energy access challenges. Given the absence of a comprehensive and up-to-date sampling frame, the population is considered large and indefinite, necessitating the use of statistical techniques to determine an appropriate sample size.

### Sampling Technique and Sample Size

The study employs a **multi-stage sampling technique** to ensure adequate representation. In the first stage, Maiduguri is stratified into major wards. In the second stage, selected wards are chosen using simple random sampling. In the final stage, **systematic sampling** is used to select households and business premises within the chosen areas. The sample size is determined using the **Taro Yamane (1967) formula**:

$$n = N / [1 + N(e^2)]$$

Where  $n$  is the sample size,  $N$  is the population size, and  $e$  is the level of precision (0.05). Based on this formula, a sample size of approximately **400 respondents** is

considered adequate to ensure statistical reliability and representativeness.

### Model Specification

The study adopts a **multiple regression model** to examine the relationship between barriers and the adoption of clean energy solutions. The functional form of the model is specified as:

$$ACE = \beta_0 + \beta_1 ECB + \beta_2 SCB + \beta_3 TCB + \beta_4 INB + \varepsilon$$

Where:

ACE = Adoption of Clean Energy (dependent variable)

ECB = Economic Barriers

SCB = Socio-cultural Barriers

TCB = Technical Barriers

INB = Institutional Barriers

$\beta_0$  = Constant term

$\beta_1$ – $\beta_4$  = Coefficients of independent variables

$\varepsilon$  = Error term

### Research Instruments

The primary research instrument used in this study is a **structured questionnaire** designed to elicit responses from participants regarding their experiences, perceptions, and challenges related to clean energy adoption. The instrument is divided into sections covering socio-demographic characteristics, awareness of clean energy, affordability, accessibility, and perceived barriers.

### The Questionnaire Instrument

The questionnaire is structured using a **5-point Likert scale**, ranging from *Strongly Agree (5)* to *Strongly Disagree (1)*. This scaling technique enables the quantification of respondents' attitudes and perceptions, making it suitable for statistical analysis. The instrument is designed in a clear and concise manner to ensure ease of understanding and to minimize response bias.

### Nature and Sources of Data

The study utilizes **primary data**, which are collected directly from respondents through the administration of

questionnaires. This approach ensures that the data are specific to the research objectives and context of Maiduguri. Primary data are preferred because they provide firsthand information on respondents' experiences and perceptions regarding clean energy adoption.

### Methods of Data Analysis

The data collected in this study were analyzed using descriptive and inferential statistics. Descriptive statistics were calculated to summarize the data (e.g. frequencies, percentages, means and standard deviations of variables). Lastly, multiple regression analysis is used to test the study hypotheses / inter-relationships among key variables of the study. Analyses are performed with the Statistical Package for the Social Sciences (SPSS) program, and statistical significance was set at 5% ( $p < 0.05$ ).

### Validity and Reliability of Instrument

To assess content and construct validity, the questionnaire was reviewed by experts in energy economics and research methods. A pilot study will be performed for reproducibility, whereby the internal consistency of the instrument will also be determined with Cronbach's Alpha in a score of  $> 0.70$  or higher being considered acceptable. These processes are used to guarantee that the instrument produces uniform, reliable, and accurate results appropriate for qualitative analysis.

### Data Presentation, Analysis and Discussion of Findings

This section discusses the analysis and interpretation of data on barriers to affordable and clean energy solutions adoption in Maiduguri. The apologetic analysis is conducted on data collected from the administered questionnaires. Frequencies, percentages, means and standard deviations are applied as descriptive statistical tools to sum up data and regression analysis is used to test study hypotheses. Your results are displayed in tables, and then interpreted as such.

### Socio-Demographic Characteristics of Respondents

**Table 4.1: Gender Distribution of Respondents**

Gender	Frequency	Percentage (%)
Male	238	59.5
Female	162	40.5
Total	400	100.0

*Source: Field Survey 2026*

Table 4.1 shows the gender distribution of respondents. The result indicates that 59.5% of the respondents are male, while 40.5% are female. This suggests that males constitute a larger proportion of energy decision-makers or

respondents within the study area, although female participation is also significant, indicating inclusivity in the survey.

**Table 4.2: Age Distribution of Respondents**

Age Range	Frequency	Percentage (%)
Below 20	32	8.0
21–30	148	37.0
31–40	124	31.0
41–50	68	17.0
Above 50	28	7.0
Total	400	100.0

*Source: Field Survey 2026*

Table 4.2 indicates that the majority of respondents (37.0%) fall within the 21–30 age bracket, followed by 31–40 years (31.0%). This implies that a significant proportion of respondents are within the economically active population, which is relevant for assessing adoption decisions related to clean energy technologies.

**Table 4.3: Educational Qualification of Respondents**

Qualification	Frequency	Percentage (%)
No Formal Edu.	36	9.0
Primary	64	16.0
Secondary	140	35.0
Tertiary	160	40.0
Total	400	100.0

*Source: Field Survey 2026*

Table 4.3 reveals that 40.0% of respondents possess tertiary education, while 35.0% have secondary education. This indicates a relatively educated sample, which is important because education level influences awareness and adoption of clean energy technologies.

### **Awareness and Adoption of Clean Energy**

**Table 4.4: Awareness of Clean Energy Solutions**

Response	Frequency	Percentage (%)
Yes	312	78.0
No	88	22.0
Total	400	100.0

*Source: Field Survey 2026*

Table 4.4 shows that 78.0% of respondents are aware of clean energy solutions, while 22.0% are not. This suggests a relatively high level of awareness; however, awareness alone may not necessarily translate into adoption.

**Table 4.5: Adoption of Clean Energy Solutions**

Response	Frequency	Percentage (%)
Yes	168	42.0
No	232	58.0
Total	400	100.0

*Source: Field Survey 2026*

Table 4.5 indicates that only 42.0% of respondents have adopted clean energy solutions, while 58.0% have not. This demonstrates a gap between awareness and actual adoption, suggesting the presence of significant barriers.

### **Barriers to Adoption of Clean Energy**

**Table 4.6: Economic Barriers (Mean Scores)**

Variable	Mean	Std. Dev.
High Initial Cost	4.32	0.81
Lack of Access to Credit	4.10	0.76
High Cost of Maintenance	3.88	0.85

*Source: Field Survey 2026*

Table 4.6 shows that high initial cost has the highest mean score (4.32), indicating that it is the most significant economic barrier. This is followed by lack of access to credit (4.10), suggesting that financial constraints play a major role in limiting adoption.

**Table 4.7: Technical Barriers (Mean Scores)**

Variable	Mean	Std. Dev.
Lack of Skilled Technicians	4.05	0.79
Poor Maintenance Services	3.92	0.82
System Complexity	3.60	0.88

*Source: Field Survey 2026*

Table 4.7 reveals that lack of skilled technicians (mean = 4.05) is the most prominent technical barrier. This suggests that inadequate technical expertise affects the effective use and maintenance of clean energy systems.

**Table 4.8: Institutional Barriers (Mean Scores)**

Variable	Mean	Std. Dev.
Weak Government Policies	4.15	0.77
Lack of Incentives	4.08	0.80
Regulatory Challenges	3.85	0.84

*Source: Field Survey 2026*

Table 4.8 indicates that weak government policies (mean = 4.15) are a major institutional barrier, followed closely by lack of incentives (4.08). This implies that policy and regulatory issues hinder adoption.

### Regression Analysis

**Table 4.9: Regression Result**

Variable	Coefficient	t-value	Sig.
Constant	0.712	2.104	0.036
Economic Barriers	-0.421	-5.632	0.000
Technical Barriers	-0.298	-4.215	0.000
Institutional Barriers	-0.256	-3.908	0.000

*Source: Field Survey 2026*

Table 4.9 presents the regression results, showing that economic, technical, and institutional barriers have negative and statistically significant effects on the adoption of clean energy solutions ( $p < 0.05$ ). This implies that increases in these barriers reduce the likelihood of adoption.

## Discussion of Findings

The findings reveal that although awareness of clean energy solutions is relatively high among respondents, actual adoption remains low. This indicates that awareness alone is insufficient to drive adoption, as other constraints such as financial and infrastructural challenges play a significant role. The gap between awareness and adoption highlights the need for practical interventions beyond information dissemination.

Furthermore, economic barriers emerge as the most significant constraint to adoption. High initial costs and limited access to credit facilities discourage households and small businesses from investing in clean energy technologies. This finding aligns with existing literature that emphasizes affordability as a critical determinant of renewable energy adoption in developing economies.

Technical barriers also significantly affect adoption, particularly the lack of skilled technicians and inadequate maintenance services. These challenges reduce user confidence and hinder the effective utilization of clean energy systems. The implication is that capacity building and technical training are essential for improving adoption rates.

Lastly, institutional barriers such as weak government policies and lack of incentives were found to negatively influence adoption. This suggests that policy interventions, including subsidies, tax incentives, and supportive regulatory frameworks, are necessary to promote the uptake of clean energy solutions. Overall, the findings underscore the need for a holistic approach that addresses economic, technical, and institutional challenges simultaneously.

## Conclusion and Recommendation

The study concludes that despite a relatively high level of awareness of affordable and clean energy solutions among residents of Maiduguri, the actual rate of adoption remains considerably low due to the presence of multiple interrelated barriers. The findings clearly indicate that economic constraints particularly high initial costs and limited access to credit constitute the most significant impediments to adoption. In addition, technical challenges such as inadequate skilled manpower and poor maintenance infrastructure, alongside weak institutional support characterized by ineffective policies and lack of incentives, further restrict the diffusion of clean energy technologies. The regression results confirm that these barriers have a

statistically significant negative effect on adoption, underscoring the need for comprehensive and targeted interventions.

In light of these findings, the study recommends that government and relevant stakeholders should introduce financial support mechanisms such as subsidies, tax incentives, and low-interest credit facilities to reduce the upfront cost burden associated with clean energy technologies. Expanding access to microfinance and pay-as-you-go energy financing models will also enhance affordability for low- and middle-income households. Additionally, there is a need to strengthen public awareness campaigns with a focus on practical benefits and long-term cost savings of clean energy solutions, ensuring that awareness translates into actual adoption.

Furthermore, the study recommends investment in technical capacity building through training programs for local technicians to improve installation, operation, and maintenance services. Institutional reforms are equally critical; policymakers should develop and implement clear, consistent, and supportive regulatory frameworks that encourage private sector participation and innovation in the renewable energy sector. Providing incentives for renewable energy providers and fostering public-private partnerships will further accelerate adoption. Overall, a coordinated approach that simultaneously addresses financial, technical, and institutional barriers is essential for achieving widespread adoption of affordable and clean energy solutions in Maiduguri.

## References

1. Abdulsamad, A., Egu, A. I., Lawal, S. S. D., Abdulrahman, A., Iloegbunam, E. N., & Godwin, I. E. (2025). *Determinants of renewable energy adoption among rural and urban populations in Nigeria*. *International Journal of Research and Innovation in Social Science*, 9(12), 3900–3914. <https://doi.org/10.47772/IJRIS.2025.91200306>
2. Adelaja, A. O. (2020). *Barriers to national renewable energy policy adoption: Insights from a case study of Nigeria*. *Energy Strategy Reviews*, 30, 100519. <https://doi.org/10.1016/j.esr.2020.100519>
3. Ajia, A. T. (2025). *Policy challenges and opportunities for renewable energy development in Nigeria: A systematic review*. *African Journal of Environmental Sciences and Renewable Energy*, 18(1), 115–137. <https://doi.org/10.62154/ajesre.2025.018.010660>
4. Aklin, M., Bayer, P., Harish, S. P., & Urpelainen, J. (2017). *Does basic energy access generate*

- socioeconomic benefits? A field experiment with off-grid solar power in India.* Science Advances, 3(5), e1602153. <https://doi.org/10.1126/sciadv.1602153>
5. BusinessDay. (2024). *Building a climate-resilient energy sector in Nigeria: Challenges and recommendations.* Retrieved from <https://businessday.ng/news/legalbusiness/article/building-a-climate-resilient-energy-sector-in-nigeria-challenges-and-recommendations/> (Businessday NG)
  6. Emegha, J. O., Oliomogbe, T. I., & Neboh-Paul, A. (2025). *Renewable energy in Nigeria: Feasibility, policy gaps and pathways to adoption.* Journal of Environmental Science & Chemistry, 1(1), 49–62. <https://doi.org/10.58985/jesc.2025.v01i01.05>
  7. Ewere, E. O., Eyenubo, J. O., Alele, J., & Okpare, A. (2025). *A systematic review of barriers to renewable energy integration and adoption.* Journal of Asian Energy Studies, 9, 26–45. <https://doi.org/10.24112/jaes.090002>
  8. GVE Group. (2026). *Clean energy Nigeria: Challenges and sustainable solutions.* Retrieved from <https://gve-group.com/clean-energy-nigeria/> (Solar Company In Nigeria)
  9. Hadiza, A., Shuaibu, U., Akuson, S., & Menson, A. E. (2025). *Renewable energy adoption and environmental pollution in Nigeria: An empirical evidence.* Journal of Economics and Allied Research.
  10. Ibrahim, A., & Zeydler, O. (2023). *How Nigeria is tackling the barriers to its green energy transition.* World Economic Forum. Retrieved from <https://www.weforum.org/agenda/2023/05/how-nigeria-is-tackling-barriers-to-its-green-energy-transition/> (World Economic Forum)
  11. International Energy Agency (IEA). (2023). *World energy outlook 2023.* Retrieved from <https://www.iea.org/reports/world-energy-outlook-2023>
  12. Inyang, D. I., Magaji, S. & Ismail, Y. (2025). *Assessment of Abuja Electricity Distribution Company's Efficient and Sustainable Energy Distribution.* Journal of Global Interdependence and Economic Sustainability. 4(3), 68-83. DOI: <https://doi.org/10.5281/zenodo.17260131>
  13. Ismail, A. D., Magaji, S., & Musa, I. (2026). *Integrating Wind Energy into Nigeria's Energy Mix: Opportunities, Benefits and Implementation Challenges.* International Journal of Finance and Economics Research 14 (1), 223-230
  14. Karakaya, E., & Sriwannawit, P. (2015). *Barriers to the adoption of photovoltaic systems: The state of the art.* Renewable and Sustainable Energy Reviews, 49, 60–66. <https://doi.org/10.1016/j.rser.2015.04.058>
  15. Magaji, S., Ahmad, A. I., Sabiu, S. B. and Yunusa, A. A. (2024). *From Deforestation to Pollution: Unravelling Environmental Challenges in Nigeria and Pakistan.* International Journal of Humanities Social Science and Management (IJHSSM), 4(2) pp: 805 - 814
  16. Magaji, S., Ismail, A. D., & Musa, I. (2026). *The Roles of Solar Energy in Nigeria's Energy Transition: Pathways and Strategies for Accelerated Decarbonization.* International Journal of Innovative Finance and Economics Research 14 (1), 231-239.
  17. MDPI. (2024). *From potential to power: Advancing Nigeria's energy sector through renewable integration and policy reform.* Sustainability Journal. Retrieved from <https://www.mdpi.com/2071-1050/16/20/8803> (MDPI)
  18. Ologbonori, S. T., Magaji, S., & Musa, I. (2025). *Assessing the Critical Needs Driving Rural Development in Nigeria: Implications for Sustainable National Development.* MRS Journal of Accounting and Business Management, 2 (7), 1-10
  19. Oxford Open Energy. (2025). *Decentralized energy transition in urban Nigeria: Institutional barriers and policy pathways.* Retrieved from <https://academic.oup.com/ooenergy/article/8380037> (OUP Academic)
  20. Oyedepo, S. O. (2014). *Towards achieving energy for sustainable development in Nigeria.* Renewable and Sustainable Energy Reviews, 34, 255–272. <https://doi.org/10.1016/j.rser.2014.03.019>
  21. Prime Radiant Energy Solutions Ltd. (2023). *Barriers to renewable energy adoption in Nigeria.* Retrieved from <https://primeradiantenergy.com/barriers-to-renewable-energy-adoption-in-nigeria/> (primeradiantenergy.com)
  22. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

23. Sadiq, I. A., Magaji, S. & Musa, I. (2025). Analysing The Indirect Employment and Business Opportunities from the Shift to Renewable Energy-Powered Transportation In Abuja, Nigeria. *Journal of Emerging Technologies and Innovative Research (JETIR)*, 12(9) 541-552
24. Shitu, M., Inuwa, I. A., & Magaji, F. S. (2025). *Challenges of renewable energy in Nigeria*. International Journal of Green Energy and Management, 11(7). <https://doi.org/10.56201/ijgem.vol.11.no7.2025.pg264.272> (IIARD Journals)
25. Tanko, Y., Magaji, S., & Musa, I. (2025). Effect of green finance on climate change mitigation in Nigeria. *International Journal of Economic Perspectives*, 19(7), 1–22.
26. The Electricity Hub. (2022). *Adoption of clean energy technologies in Nigeria: Barriers and solutions*. Retrieved from <https://theelectricityhub.com/adoption-of-clean-energy-technologies-in-nigeria-barriers-and-solutions/> (The Electricity Hub)
27. Umar, A.B., Magaji, S., & Ismail, Y. (2025). Urban-Rural Energy Gaps: Investigating the Contribution of Natural Gas to Equitable Poverty Reduction in Nigeria. *Global Academic and Scientific Journal of Multidisciplinary Studies (GASJMS)*. 3(8), 55-63
28. United Nations Development Programme (UNDP). (2022). *Sustainable energy for all: Scaling up renewable energy access*. Retrieved from <https://www.undp.org/publications/sustainable-energy-all>