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Barriers to Nigeria's Energy Transition: Financing, Infrastructure and Governance Challenges

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ABSTRACT: Nigeria's Energy Transition Plan (ETP) is a major policy initiative to address Nigeria's longstanding energy-access challenge, reliance on fossil fuels, infrastructure limitations, and escalating climate-development pressures. But, financial, infrastructure, institutional, technological and political barriers still limit the translation of transition ambitions into measurable energy outcomes. This work explores the main challenges to implementing Nigeria's ETP and opportunities to address them to achieve Sustainable Development Goal 7 (SDG 7). This study used a mixed methods design with a questionnaire survey of 150 stakeholders (including energy policy makers, energy professionals and project developers); 12 key informant interviews conducted in a semi-structured manner; and secondary data from national and international energy institutions. Descriptive statistics, mean scores, correlation and analysis of variance were used for quantitative analysis and thematic analysis for qualitative analysis. The results show that the highest barrier is financing constraints with a mean score of 4.50, followed by regulatory incoherence (4.20), political instability (4.00) and technological capacity gaps (3.80). Other evidence pointed to the fact that the electricity infrastructure and constraints

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on the electricity grid were another significant constraint, and a repeat survey placed a mean score of 4.30 on it. The qualitative evidence also suggests that funding constraints, lack of institutional responsibilities, and local lack of R&D capabilities and political continuity are mutually reinforcing, not independent barriers. Respondents also saw international climate finance (4.30), strengthening regulatory and governance capacities (4.30), greater private sector involvement (4.20), and technical capacity development (4.10) as areas that could help to accelerate implementation. It is therefore concluded that Nigeria's transition to energy is not just a problem of availability of renewable energy but also one of capacity to implement renewable energy, financial architecture, infrastructure and institutional coordination. It suggests a combination of integrated transition financing, acceleration of grid modernization, harmonization of regulations, increased federal-state coordination, greater use of decentralized renewable energy systems, and local technical capacity development and risk-sharing mechanisms that can crowd-in private investment. This article makes a contribution to the energy-transitions literature by elucidating the interplay of financial, infrastructural and governance factors in determining the implementation of energy-transition policy in a developing economy heavily dependent on fossil fuels.

Keywords: *Energy transition, SDG 7, Financing and Infrastructure.*

Introduction

Turning away from carbon-intensive energy systems to an affordable, reliable, sustainable and modern energy is one of the key development challenges of the twenty-first century. According to Sustainable Development Goal 7 (SDG 7) of the United Nations (2015), sustainable development goal 7 involves making sustainable, reliable, modern and affordable energy available for everyone, with its target setting highlighting renewable energy, energy efficiency and international cooperation. The world's evidence, however, suggests that this is far from the case, especially in the developing regions where the intersection of energy poverty and a lack of infrastructure, fiscal capacity and institutional strength remains. The 2026 Tracking SDG 7: The Energy Progress Report reinforces energy access, renewable energy and energy efficiency as the three pillars of the global energy debate.

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Nigeria has a special place in this debate. The nation has significant renewable energy resources, such as solar, hydro, biomass and wind, but is also very dependent on fossil fuels (Magaji et al., 2026; Ismail et al., 2026). The presence of significant energy resources and long-standing energy poverty highlights that simply having the resources is not enough for energy access and energy transition. On the contrary, results rely on the institutional, financial, technological and infrastructural systems via which resources are transformed into reliable energy services (Sadiq et al., 2025; Tanko et al., 2025).

This background is the context of Nigeria's Energy Transition Plan (ETP). The plan aims to set out a national strategy to tackle energy poverty and to work towards long-term decarbonisation and a just transition. The main objectives of the official ETP framework are improved energy access, poverty reduction, modern energy services, employment, and a sustainable transition and legislative coordination. It is applicable to 5 key sectors: power, transport, oil and gas, cooking, industry. Nigeria then adjusted its medium- to long-term trajectory for a net-zero to 2050-to-2060 trajectory, in recognition of the country's financial, technological and socioeconomic needs.

The challenge is however, to get from policy ambition to action delivery. While a transition plan might have relevant goals, these goals are only effective if governments, private investors, utilities, regulators, development institutions and communities have the financial and institutional resources to achieve them. Financing is indeed the central theme of energy transition which is recognised by the Nigerian ETP itself. Official estimates suggest that investment on the scale needed to meet the long-term net-zero pathway will be several orders of magnitude greater than business-as-usual investment, while the ETP also calls out private sector capital, concessional finance, blended finance and public/private partnerships as critical elements of the capital mix.

A similar challenge is infrastructure. The ETP highlights five areas where electricity-access challenges, unreliable electricity supply, affordability issues, electricity transmission and distribution losses, and insufficient electricity network capacity and regulatory uncertainty are seen as obstacles to electricity-sector transformation. It will not be possible to sustainably scale up renewable electricity without more efficient additions in transmission, distribution, storage, metering and system management. Empirical studies also show that

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Nigeria's transition to renewables has been hampered by the interplay between weak infrastructure, regulatory issues and fossil-fuel systems (e.g., Ole, 2020; Adelaja, 2020).

A third and in this case a crucial dimension of the implementation problem is governance. The process of energy transition is a multi-ministerial, multi-regulatory, multi-utility, multi-financial, multi-state and multi-actor, multi-investor process. If the institutional responsibilities are distributed across institutions and/or the regulatory requirements are not clearly defined, transaction costs rise and investment becomes more challenging. A study by the International Institute for Applied Analysis (IAA) on Nigeria's renewable-energy governance has recently been conducted which indicates that poor planning, accountability and transparency are still key challenges for grid-based renewable-energy development in the country.

The results of the present empirical study confirm these concerns. The dissertation evidence reveals that funding deficits were perceived as the most significant challenge in implementing ETP, followed by regulatory incoherence and political instability, and technological gaps. The survey results also show that weak governance and institutional frameworks had a mean score of 4.20, and outdated infrastructure and grid limitations had a mean score of 4.30. These results indicate that the transition challenge in Nigeria is multi-faceted and systemic.

In this backdrop, this article explores the challenges to the implementation of Nigeria's ETP, focusing on financing, electricity infrastructure, governance and regulation, technological capacity and political-institutional conditions. Also discusses opportunities identified by stakeholders to address such barriers. What are the key challenges to implementing ETPs? What is the interplay between financial, infrastructural and governance constraints? What policy and institutional interventions could enhance implementation and speed up progress towards SDG 7?

Literature Review

Conceptual Review

Concept of Energy Transition

Energy transition refers to a “reconfiguration” or “revolution” in an energy system away from conventional fuels and towards cleaner, more efficient, environmentally friendly and

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sustainable energy alternatives. The sources of energy are classified as traditional and alternative, traditional energy sources are firewood, charcoal, coal, Kerosene, petrol, diesel and natural gas while alternative energy sources are solar, wind, hydropower and other low emission technologies. This transformation includes energy production and distribution and consumption, as well as technology, government policies, infrastructure, and socioeconomic activities. Energy transition is a more than a shift in energy sources and a shift in energy efficiency, it is a shift in energy access and a shift to sustainable economic growth and a reduction in greenhouse gas emissions (Al-Amin et al., 2025).IEA (2023) notes that the global energy system needs to be accelerated by investing more in and deploying clean energy technologies, including solar, wind, hydropower and modern bioenergy. Enhanced energy efficiency, more electrification and better energy infrastructure also need to be built to facilitate such transformation. These measures are crucial to lower the environmental impacts of energy generation and use and secure the energy needs of domestic demand, industry and other commercial activities.

Likewise, the Intergovernmental Panel on Climate Change (IPCC, 2022) holds that substantial shifts in energy production and use are necessary to achieve the significant reductions of GHGs that are needed. These changes encompass a decrease in fossil fuel use, increased adoption of low-carbon technologies and increased economy-wide energy efficiency. Energy transition is consequently an important component of climate change mitigation, environmental conservation and the promotion of sustainable development.

Energy Transition

Energy transition at a household level means using cleaner energy sources instead of the more common traditional sources like firewood, charcoal and agricultural residues, including liquefied petroleum gas (LPG), electricity, solar energy and biogas (Malabu et al., 2025). This process might not be fully or evenly distributed among households, however. There are disparities in income, fuel costs, availability, cultural habits, cooking preferences and energy supply, which leads to some households continuing to use traditional energy sources alongside modern ones. Thus, household energy transition can be achieved by both the installation of modern energy technologies and by the continued use of traditional fuels for specific domestic activities.Energy transition is especially important in developing countries like Nigeria, where many households rely on traditional

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biomass as their primary source of energy for cooking and other household activities. Firewood and charcoal can be easily accessible in some communities and may also be relatively inexpensive, but can lead to indoor air pollution and to the reduction of forest cover and environmental damage, particularly if the biomass resources are being taken unsustainably (Odenu et al., 2025). The shift towards cleaner household energy sources thus demands more than just the implementation of alternative energy technologies (Ibrahim et al., 2025). It also requires the strengthening of the purchasing power of households, more access to energy, better infrastructure and environmental management.

Moreover, energy transition can be regarded as a socioeconomic process, as economic and social factors affect the potential of the household to change their energy consumption pattern. Households can have different types of energy that they can access, and their ability to use them regularly, depending on their income, education, occupation, and where they live and how far from energy infrastructure. For example, a rural household with electricity supply problems and low household resources may have more trouble making the transition to using an electric cooking stove than a rural household with sufficient income and access to electricity. This shows that the energy transition outcomes are the product of technology development, public policy, socioeconomic factors as well as the presence of appropriate energy alternatives.The concept of energy transition in this study is defined as the process by which households shift their energy decisions and energy use patterns to lessen reliance on traditional and high-emission energy sources and increase their use of cleaner, more efficient, affordable and sustainable energy sources. Understanding this conceptualisation is relevant to the study of household energy choice and consumption pattern in rural and urban settings of Niger state, Nigeria, because it forms the basis for investigating the variations in the adoption of the energy sources in the study area; the socio-economic factors influencing the use of the various energy sources in the study area; and the household consumption pattern in the study area.

Sustainable Development Goal 7

Sustainable Development Goal 7 (SDG 7) is one of the 17 Sustainable Development Goals set by the United Nations under the 2030 Agenda for Sustainable Development that was adopted in 2015. The objective is to ensure access to affordable, reliable, sustainable and modern energy services to all. It sees the role of energy in economic development, poverty

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reduction, quality of life, technology development and protection of the environment. To achieve the goals of development, access to adequate and sustainable energy is seen as a prerequisite for achieving the development goals of households, commercial establishments, industries and public institutions (United Nations, 2015).SDG 7 aims to tackle the big energy issues such as poor electricity access, the continued use of unclean cooking fuels, and underuse of energy and limited access to clean energy technologies. Promoting the greater use of renewable energy, increasing energy efficiency and expanding the infrastructure for providing modern energy services to various groups of people. The objective is particularly relevant to developing countries, where poor electricity reliability and high energy costs, coupled with reliance on traditional biomass, can have negative implications on household welfare, economic productivity and environmental sustainability (United Nations, n.d.).

The achievement of SDG 7 calls for increased access to modern energy services, more renewable energy for the global energy supply and greater energy efficiency, according to the United Nations (n.d.). It also encourages cooperation, investments in clean energy research and innovation and the investment in energy infrastructure, especially in developing countries. These priorities show that, rather than simply aiming to boost electricity supply, the objective is to make energy services available, affordable, reliable and environmentally friendly. Therefore, SDG 7 cannot be achieved unless action is taken jointly by the government, private organisations, development partners and local communities. At the household level, SDG 7 is all about making sure that people and families have access to affordable and reliable energy to satisfy their needs in a way that does not bring undue financial stress or disproportionate health and environmental risks. These encompass provision of electricity for lighting and powering household appliances, and of a cleaner cooking fuel and technology which lowers exposure to harmful smoke and air pollutants. The access, cost and reliability of these affects household conditions and energy use patterns and decisions. Thus, SDG 7 offers a convenient lens to explore the drivers behind household energy decision-making and the shift from traditional to modern energy sources.

SDG 7 is relevant in Nigeria as reflected in the disparities in access to electricity supply and clean cooking technologies by geography and socioeconomic status. The UN Statistics

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Division (n.d.) reported that the Nigeria population's access to electricity grew from 43.2% in 2000 to 61.2% in 2023. Similarly, the proportion of the population primarily relying on clean fuels and technologies increased from 0.7% in 2000 to 26.2% in 2023. Although there has been progress in energy access, these figures show how many problems still lie ahead in achieving universal access to electricity and the promotion of cleaner household cooking. They also highlight the importance of examining electricity access and cooking energy separately when evaluating Nigeria's progress towards achieving SDG 7.

SDG 7 is an appropriate context to be used to explore household energy sources availability, affordability and use in rural and urban communities of Niger State. In rural areas, a lack of electricity and/or commercial fuels can mean reliance on firewood and charcoal. Conversely, urban households might be better able to access electricity supply providers and commercial fuel markets, but they may also be limited in their options by high prices and unreliability of electricity and financial access. These variations indicate geographical, income, infrastructural and availability of alternate energy sources effect on household energy consumption. Hence, it is important to understand the linkages between these factors to be able to account for differences in energy choice and energy use between rural and urban areas.In the context of the present study, SDG 7 is considered as an international development framework aimed at increasing the availability of energy services that can improve equitable access to affordable, reliable, modern and environmentally sustainable household energy for the promotion of clean cooking technologies, renewable energy, energy efficiency and adequate energy infrastructure. Through this conceptualisation, the current understanding of household energy choices and consumption pattern in rural and urban Niger State, Nigeria is analysed. It also provides an evaluation of how well the household energy access and use is aligned to broader sustainable energy access goals and identifies social-economic and geographical barriers that can impede the transition towards clean and sustainable energy.

Concept of Financing of Energy Transition

Financing energy transition is a process of acquiring, mobilizing, distributing and managing the financial resources required to change the existing energy system to cleaner, more efficient and environmentally friendly alternatives. It encompasses financial resources for renewable energy development, electricity generation and distribution, clean

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cooking technologies, energy saving equipment, energy storage and other investments that enable sustainable energy development (Magaji et al., 2025). It also covers costs for research, technological innovation, project implementation, infrastructure, maintenance and training of qualified personnel to implement the transition (Suleiman et al., 2025).The IEA (2021) points out that the right investment amount is required to speed up the deployment of clean energy technologies, especially in emerging and developing economies. Many of these countries have problems because there is not enough domestic capital, high interest costs, and are not easily attracting private capital. The solutions to these problems will involve government funding, private sector investment, domestic funds and international development assistance. Public institutions and development finance organisations can play a crucial role in enabling investment by mitigating financial risks and making clean energy projects more attractive to private investors.

There are various sources of finance for energy transition, such as government budgets, commercial bank loans, private investments, and international grants and development finance. Public financing is the application of government resources to support energy projects and programmes, and private financing is investment of funds by businesses, commercial banks, institutional investors and individuals. International financing refers to financial support by development banks, climate funds, donor agencies and other organisations that support sustainable energy development. These funds can all be combined to address financial needs associated with energy transition projects.Furthermore, there are a number of financial instruments that could be employed to promote the uptake of sustainable energy systems. They include concessional loans, grants, green bonds, loan guarantees, public private partnerships and blended finance. Blended finance merges public or development finance resources with private finance to shift the financial risk and catalyze investment in projects that may not be able to secure investment. In this regard, the IEA (2021) emphasises the critical role of such instruments in developing countries where investment risks are high and financing is not easily available.

Financing is also essential in deciding if households can afford to make use of modern energy technologies (Musa et al., 2025). Initial investment and installation costs may pose a barrier to low-income households adopting solar systems, LPG equipment, electricity

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connections and energy-efficient appliances because of the long-term benefits they may offer. These can be lowered by financial interventions, like targeted subsidies, affordable credit facilities, grants and flexible payment arrangements. Financing energy transition thus requires both funds for large infrastructure projects and access to and adoption of cleaner energy technologies by individual households.Financing is an integral part of implementing the national Energy Transition Plan, meant to respond to energy poverty and climate change, among others, and to support the path toward economic development and net-zero emissions in Nigeria by 2060. The Federal Government of Nigeria has recognized that investment in electricity generation, transmission, distribution, clean cooking, transportation and industrial energy systems are vital to meeting these goals. To mobilise adequate resources, the private sector, public private partnerships, concessional financing and development finance institutions (DFIs) support must be engaged (Federal Government of Nigeria, n.d.).

The financial resources available to support the transition to energy technologies that are cleaner and more efficient can be viewed from the household energy decision-making perspective. The use of traditional fuels instead of modern ones can be influenced by household income, availability of finance, energy prices, the cost of buying equipment etc. That is, when a household uses LPG or solar energy, but still uses firewood because of lack of funds for buying equipment or regular fuel supply.Financing of energy transition refers to the process of bringing and making financial resources available for the adoption, use and maintenance of cleaner, more efficient and sustainable energy sources. It includes government spending, private investment, foreign aid, and household demand for and financial support of modern energy technologies. This definition is applicable to the analysis of household energy choices and energy consumption pattern in rural-urban Niger State as household income and credit availability, energy prices and investment opportunities can affect modern energy use and adoption.

Concept of Infrastructure of Energy Transition

Energy transition infrastructure is physical infrastructure, technical infrastructure and distribution infrastructure that can be used to produce, store, transmit, distribute and make use of energy in an efficient and sustainable way. It is the base for decreasing reliance on traditional energy sources and increasing access to modern energy services. This

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infrastructure includes renewable energy systems, electricity generation plants, transmission lines, distribution systems, battery storage systems, mini-grids, solar home systems, clean cooking systems and fuel systems.The International Energy Agency (IEA, 2021) acknowledges that significant investment in electricity generation, transmission and distribution, electrification and energy efficiency are needed for energy system transformation. While expanding renewable electricity production is one of the most important steps in ensuring the reliable supply of electricity to people, it is not sufficient without proper infrastructure to deliver renewable electricity to consumers. Thus, it is important that the energy transition is accompanied by the coordinated development of energy generation facilities, transmission networks, distribution networks and the development of technologies that allow efficient delivery of energy to the homes and other users.

Electricity infrastructure is a large element of energy transition. It comprises power stations, transmission lines, substations, transformers, distribution networks and electrical metering systems. These facilities provide power generation and distribution to homes, businesses, industries and public institutions. Developing electricity infrastructure can increase the reliability of electricity supply, decrease technical losses and make better integration of renewable energy into electricity network possible. But failure to have sufficient grid capacity, lack of maintenance, and distribution problems can constrain the advantages of investments in clean energy generation.Another key aspect of energy transition is the deployment of renewable energy infrastructure. It includes solar PV plants, wind farms, hydropower plants, battery storage and control systems. These systems will be used to supply and generate energy in alternate ways and decrease reliance on traditional fossil fuels. For households and community facilities in communities where distribution and transmission of electricity from the national grid are challenging or costly, decentralized electricity supply systems such as mini-grids and off-grid solar power can be practical options.

Clean cooking and fuel infrastructure is also of critical importance. It contains LPG storage, fuel distribution, biogas, improved cooking stove, and electric cooking. Households are able to sustain their use of cleaner cooking technologies based on the availability of these facilities. If the cooking appliance itself is accessible but the fuel

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needed to run it is not available, expensive or hard to find, there is a limit to the value of the cooking appliance. Clean cooking is mentioned as one of the critical strategies to cut emissions and increase energy access in the Federal Government of Nigeria's Energy Transition Plan (Federal Government of Nigeria, n.d.).

Another key aspect of sustainable energy infrastructure is energy storage, which also plays a role in modern energy management systems. Renewable sources such as solar and wind depend partly on weather conditions, resulting in variations in electricity generation. There is the possibility of storing electricity for future use through battery storage systems, and smart meters and energy management systems can enhance monitoring, distribution and consumption. These systems will be effective if they are affordable, technically sound, require minimal maintenance, and are appropriate for local conditions. Energy infrastructure in rural areas is not always available, or might be inadequate or of poor quality. Urban communities may also be more likely to have larger electricity grids and to access commercial electricity providers, while rural communities may be more likely to have smaller electricity networks and longer distances to fuel markets, as well as less access to technical support. Some of these challenges can be solved using decentralised renewable energy systems, but installation costs, equipment quality, technical skills and availability of replacement components can make or break its success. Infrastructure development is critical to the National Energy Transition Plan's goals in Nigeria. The investments in electricity generation, transmission and distribution, metering, renewable energy and clean cooking facilities are important for increasing access to modern energy services. Off-grid electricity systems and solar mini-grids can also support access to electricity in communities that are poorly served – such as where grid expansion is challenging or costly (Federal Government of Nigeria, n.d.).

Energy transition infrastructure, from the perspective of a household, includes the facilities, technologies and supply chains that households can access and safely, reliably and conveniently use modern energy sources. With electricity, or solar power and cleaner cooking methods, the uptake of these technologies by households not only relies on their financial capacity but also on the availability of the required infrastructure in the communities. For example, a family can afford to buy an electrical cooking stove but cannot operate it properly due to the unavailability of electricity. Some definitions are

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given for the purpose of the present study: the infrastructure of energy transition is considered to be represented by the availability, accessibility, adequacy and reliability of the physical facilities and technological systems used for production, distribution and use of modern and sustainable energy. Examples of these facilities are electricity networks, renewable energy installations, storage technologies, clean cooking facilities and fuel distribution systems. The conceptualisation is applicable when analyzing the infrastructure and energy choices and consumption by the household in rural and urban areas of Niger State as it can influence the choice of energy source used by the household, the frequency and affordability of using the energy source by the household and its willingness to adopt cleaner energy source.

Theoretical Framework

Energy Transition Theory

This study builds on the theory of energy transition, in particular the Multi-Level Perspective (MLP) as put forward by Geels (2002). The theory describes how the energy systems evolve over time as a result of interactions between given technological and institutional configurations, innovations, and external pressures. It is defined as a process of complex technological development, economic activity, government policies, social practices and institutional arrangements. The shift from traditional energy to renewable energy can thus not be considered only as a technological development, but involves a change in the structures and practices related to energy production and use.

Geels (2002) recognizes three interdependent levels, that shape sociotechnical transitions: technological niches, sociotechnical regimes and the sociotechnical landscape. Technological niches offer opportunities for new technologies and innovative practices to emerge, whereas sociotechnical regimes are the existing practices, infrastructures, institutions and systems that shape a given sector. Renewable energy technologies (such as solar energy, biogas, and other clean energy technologies) in Nigeria may be considered emerging innovations that have the potential to revolutionize energy use. The current energy system, however, is impacted by traditional biomass usage, legacy fossil fuel systems, and the energy supply-demand chain.

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The theory also suggests that the growth and diffusion of RE could be inhibited by the robustness of conventional energy systems. Slow adoption of alternative energy sources can be caused by inadequate funding, poor infrastructure, government policies that change from time to time, technology difficulties and institutional interests. Meanwhile, broader landscape forces like climate change, population growth, increased energy demand, energy price volatility and international sustainable development commitments can push for change within the current energy regime. Energy transition thus happens when new innovations become sufficiently supported and interact with other drivers and stresses on the system to break through the constraints of the prevailing systems (Geels, 2002).

The Multi-Level Perspective is relevant to the present study, Analysis of Household Energy Choices and Consumption Patterns in Rural and Urban Niger State, Nigeria in the sense that it is a framework for understanding the factors that affect the choices of energy for adoption by the household. Household decisions are also influenced by income, affordability, access to renewable energy resources, energy supply infrastructure, culture and habit, and the reliability of energy supplies. The theory thus helps understand certain differences between the energy use of rural and urban households. It also supports the view that a shift towards cleaner household energy sources requires more than just access to renewable energy technologies; it also requires supportive policies, sufficient investment, better infrastructure, and transformations in the way people use energy at home.

Conceptual Framework and Analytical Model.

The article theorises the implementation of ETP as a process dependent on five overlapping groups of constraints:

Availability and affordability and predictability of transition finance;

Technical challenges to the infrastructure such as generation, transmission and distribution problems, storage and metering constraints; and

Governance and regulatory constraints – institutional fragmentation, policy incoherence, regulatory uncertainty and accountability;

Technological and human-capacity constraints — skills, research, technology adaptation and maintenance capabilities; and

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Policy instability and political uncertainty, stakeholder participation and social acceptance.

The analytical relationship that results is:

ETPI=f (FIN, INF, GOV, TECH, POL)…… (1)

Where:

ETPI score = effectiveness of Energy Transition Plan implementation score; and

FIN = financing conditions;

INF = infrastructure readiness;

GOV = governance and regulatory coherence;

TECH = technological and human capacity; and

POL = political and socio-institutional stability.

An extended empirical specification could be written as:

$$ETPI_i = \beta_o + \beta_1 FIN_i + \beta_2 INF_i + \beta_3 GOV_i + \beta_4 TECH_i + \beta_5 POL_i + \varepsilon_i \ldots\ldots\ldots\ldots (2)$$

Financing is expected to be positively related to expected improvements in financing, governance and technical capacity, and negatively related to political instability, while a positive relationship is expected between governance and technical capacity and between technical capacity and implementation effectiveness, and vice versa.

The model was not presented as a regression estimate as its empirical analysis in the dissertation was mostly descriptive data, ANOVA, correlation and thematic analysis, not estimation of the values of the above regression coefficients.

Methodology

Research Design

A mixed-methods research design was used. The quantitative part was based on a structured questionnaire, which was filled in by the stakeholders in the energy policy, planning, development and implementation process. The qualitative portion was comprised of semi-structured interviews with key stakeholders. National and international energy institutions were used as secondary sources.

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A mixed-methods approach was deemed appropriate as implementation barriers consist of both measurable perceptions and institutional experiences that must be interpreted in the context. Qualitative evidence helped to provide an estimate of the relative importance of barriers whilst interviews helped to provide explanations of how and why these barriers arise.

Population and Sample

The survey was conducted with 150 respondents from among policy makers, energy professionals, developers and other stakeholders. A series of semi-structured interviews were conducted with 12 key informants from government, renewable energy development, policy analysis, academia, international development and community perspectives.

A 75% survey response rate, and a purposive sampling of respondents who knew first-hand about energy-transition activities.

Data Collection Instrument

The quantitative instrument used consisted of a 5-point Likert scale that ranged from strongly disagree to strongly agree. The questionnaire asked about perceived challenges in ETP implementation, financing constraints, infrastructure limitations, governance, technology, and political conditions and opportunities for strengthening ETP implementation.

High internal consistency was obtained through reliability testing, with generally good Cronbach's alpha values between 0.87 and 0.89.

The semi-structured questions used in the qualitative instrument focused on eliciting the experiences of stakeholder about the implementation barriers and intervention options.

Data Analysis

Data analysis techniques used for quantitative data were frequencies, percentages, means, standard deviations, correlation and analysis of variance. The perceived differences were assessed using ANOVA among the various stakeholder groups. There are statistically significant differences between stakeholder groups, including differences with respect to perceptions of implementation challenges, reported in the dissertation.

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Thematic analysis was used to analyse qualitative data, following the approach of Braun and Clarke (2006). Recurring themes identified through NVivo coding were funding gaps, technological barriers, policy fragmentation and political instability. The inter-coder reliability is good (about 0.85) and is reported in the dissertation.

The triangulation method was later used to cross-validate survey data, interview data and secondary data.

Results and Analysis

This document outlines the key challenges to the adoption of ETPs.

The main barriers identified from the original barrier analysis are summarised in Table 1.

Table 1: Key Barriers to Implementation of Nigeria's ETP

Barrier	Mean	Standard Deviation	Interpretation
Funding shortages	4.50	0.80	Very high barrier
Regulatory incoherence	4.20	0.90	High barrier
Political instability	4.00	0.70	High barrier
Technological gaps	3.80	1.00	Moderately high barrier

Source: *Author's computation based on dissertation survey data, 2026.*

The mean score for funding shortages was the highest, 4.50. This means that the overwhelming majority of respondents saw a lack of funding as the most serious issue facing ETP implementation. 85% of respondents agreed that funding was a significant challenge, according to the dissertation.

The mean score for regulatory incoherence was 4.20. This indicates that institutional and regulatory fragmentation was almost as significant as financial constraints for respondents. The connection seems obvious: when regulations are not clearly defined, financing is more challenging because there are increased policy and transaction risks.

The mean of political instability was 4.00, which suggests significant worry about policy continuity. Technological gaps scored 3.80 and showed that the use of technology and skills were important, but somewhat less constraining than finance and governance.

The assessments of Infrastructure and Governance were expanded.The assessments of Infrastructure and Governance were expanded.

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The survey has expanded to include more evidence on the institutional and infrastructural aspects of the issue.

Table 2: Expanded Survey Assessment of ETP Implementation Barriers

Barrier	SA	A	N	D	SD	Mean
Financial constraints	42	33	16	6	3	4.10
Weak governance and institutional frameworks	47	28	16	6	3	4.20
Outdated infrastructure and grid limitations	52	33	11	2	2	4.30
Limited private-sector participation	32	38	21	6	3	4.00
Low awareness and rural resistance	37	38	16	6	3	4.00

Source: *Author's computation, 2026.*

The new evidence reinforces the importance of infrastructure. The highest mean score in this table was for outdated infrastructure and grid restrictions (4.30) with 85% agreeing or strongly agreeing that this is a major barrier.

Weak governance and institutional frameworks had a mean of 4.20 and financial constraints had a mean of 4.10. These findings indicate that financing deficit is not the only way to explain implementation. However, once finance is available, poor governance and weak infrastructure may hinder the conversion of funds into projects that are operational.

The mean values of the private-sector participation and of the awareness were 4.00 and 4.00, respectively. This means that market development and social acceptance are also required for the implementation of transitions.

The Principal Constraint is financing.

Financing is the most prevalent barrier identified in the evidence. The initial analysis showed a mean of 4.50, and the subsequent analysis still identified financial constraints as one of the main issues.

The qualitative evidence describes why it is hard to obtain financing. The causes cited by the interviewees included not enough funding because of the dominance of oil revenues in public finance; not enough investment in renewable energy; few project pipelines and problems in securing private funding.

This is in line with the official ETP financing framework which points to the lack of bankable project pipelines, a lack of demonstration projects, financial innovation, skills, governance and weak data on climate change as barriers to private-sector investment.

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The financing problem can thus be resolved in at least four ways: lack of public resources, lack of cheap long-term capital, high risk of investment and poor project preparation. Taking action on one of these dimensions is not likely to create a lasting investment.

Grid and Infrastructure Constraints

Additionally, infrastructure in the expanded survey was one of the most significant constraints with a mean score of 4.30.

This finding has important implications for renewable-energy policy. Solar and other renewable technologies can boost electricity generation, but need to rely on transmission, distribution, storage, and demand management infrastructure to reach a national energy access target.

The ETP itself has singled out the unreliable power supply, power sector high transmission and distribution losses, and lack of system capacity as the major barriers in the power sector.

The results thus corroborate for a dual-track infrastructure policy. Nigeria should have modernisation of the grid and decentralised systems. Significant investment in transmission and distribution is required for improving the reliability of the national system, with mini-grids, solar home systems and hybrid systems being required in communities where grid extension is economically and/or technically challenging.

A lack of regulation or institutional integration.Lack of institutional or regulatory integration.

In the original barrier assessment, regulatory incoherence had a mean of 4.20, and in the expanded survey, weak governance and institutional frameworks had a mean of 4.20.

Interviews highlighted that institutional duties were scattered and "siloed," and stakeholders attributed this disconnection in duties to challenges in the implementation of energy transition projects.

This is congruent with recent research. Studies on the deployment of grid-connected renewable energy in Nigeria suggest that weak governance and lack of accountability are responsible for the slow deployment of renewables. Similarly, studies on decentralised

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renewable energy point to a lack of institutional integration and regulatory support as hindrances to scaling up renewable energy systems.

Regulatory reform is thus not just about designing new regulations but about aligning and clarifying institutions' mandates, and defining a clear approval and procurement process.

The image of political instability and policy continuity.The image of political instability and policy continuity.

The mean of political instability was 4.00. Political instability was associated with election periods and project continuity breaks during interviews.

The importance of this finding is related to the long-termness of investments in energy. The investment cost of renewable-energy infrastructure often has a long payback period. Uncertainty about the policies can thus lead to increased risk premiums and private capital disincentives.

The suggestion is that the implementation of ETP should be institutionalised beyond the individual administrations. There needs to be statutory mechanisms, clear monitoring and multi-year investment programmes, and predictable regulatory frameworks to support long-term transition targets.

Technological Capacity

A mean of 3.80 was obtained for technological gaps. While this was lower than finance, governance and political instability, it is still a significant obstacle.

The mean score is 3.80, with the concern being strongly supported by the finding that only 25% strongly agreed and 40% agreed that there was enough local expertise to manage the deployment of renewable-energy technology.

Access to technology is not the only problem, then. Nigeria has a need for local skills to design, install, run, maintain and customise energy technologies. In addition, being able to hire local capacity can limit reliance on outside contractors and help to establish local renewable-energy supply chains.

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Areas where the Barriers can be overcome.

While numerous challenges exist, stakeholders were generally positive about several intervention strategies.

Table 3: Opportunities for Strengthening ETP Implementation

Opportunity	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Mean
Increased private-sector participation	37	43	16	2	2	4.20
International climate finance	42	33	16	6	3	4.30
Capacity building and technical training	32	48	11	6	3	4.10
Strengthening regulatory frameworks and governance	47	33	16	2	2	4.30

Source: *Author's computation, 2026.*

International climate finance and regulatory/governance strengthening had the highest mean scores of 4.30, respectively, and the highest median values of 4.50 and 4.55, respectively.International climate finance and regulatory/governance strengthening had the highest mean scores of 4.30, respectively, and the highest median values of 4.50 and 4.55, respectively. It was found that there was an increase in the participation of the private sector with a score of 4.20 and an increase in the capacity building with a score of 4.10.

The results indicate that the respondents do not see government as their sole source of financing their transition. Instead, they prefer a system where public capital de-risks investments and attracts private and international capital.

Public-Private Partnerships and Blended Finance

The results of the interviews are robust in favour of public-private partnerships (PPPs) and blended finance and risk-sharing mechanisms. Stakeholders urged government to set forth predictable incentives, and private sector to provide capital, innovation and project-development skills.

This is in line with the ETP financing framework, which highlights that complementary financing mechanisms include commercial capital, blended structures, public-private partnerships and concessional development finance.

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Public finance becomes crucial in projects that are intended for low-income and distant communities, since these projects might not offer the immediate commercial return these communities are accustomed to. IRENA (2024) also notes that public finance can de-risk investments, fill energy access deficits and reach out to underserved communities.

Discussion

The results of this study show that Nigeria's energy transition barriers are interdependent. Limited infrastructure investment due to financing constraints, reduced bankability of projects due to inadequate infrastructure, higher investment risk due to regulatory uncertainty, lower investment due to political instability, higher reliance on foreign technology due to technological-capacity gaps.

This is important as the interconnectedness of these barriers could mean policies that only address one of them may have a limited impact. In other words, if finance is available but regulatory uncertainty is not addressed, then it may lead to underutilisation of finance. Likewise, if renewable-energy systems are installed but the grid is not upgraded, then there may be integration issues. If training is provided but there is no certainty of a profitable market for renewable energy investments, it may lead to skill underutilisation.

The findings are consistent with the findings of Energy Transition Theory since they show the resistance of established sociotechnical regimes. The fossil-fuel dependent infrastructure and institutions in Nigeria make the transition towards renewable technologies more challenging. Geels (2002) proposed that niche technologies are only transformative if technological innovation links with institutional and landscape change.

The governance findings also support institutional theory. The lack of certainty and the fragmentation of the regulatory system raise transaction costs and investor uncertainty. North's 1990 institutional approach can thus offer an explanation for the technical feasibility of renewable energy projects to persist in being unable to become commercially and institutionally viable.

The results of the financing are especially noteworthy. The ETP's own financing architecture acknowledges that Nigeria needs huge investments on a large scale in generation, transmission and distribution, clean cooking, transport and other sectors. The

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challenge is to not only add more money, but to create an investment environment where projects are bankable, risk is properly assigned and returns are sufficiently predictable.

The infrastructure findings further reinforce Nigeria's need to not consider centralised and decentralised power systems as alternatives. There needs to be coordinated investments in transmission and distribution, and scaling up of mini-grids, solar home systems and other decentralised technologies if a national transition strategy is to be realised. This is particularly true for under-served and rural communities.

The results of the study on the importance of private sector participation and climate finance are promising. International climate finance scored 4.30 and private-sector participation scored 4.20. In these results, stakeholders view external capital and private investment as important complements of government resources.

Policy Implications

The results have several policy implications.

First, the financing of energy transition needs to be seen as a financial architecture, not as a collection of projects. Nigeria must have mechanisms that can be used to monetise public, development and concessional finance, guarantees, private equity and commercial debt. Blended finance and risk sharing are already widely recognised in the official ETP framework as essential means to mobilise private capital.

Second, the preparation of the project needs to be a function of the central government. Investors need bankable projects and not general policy statements. The Government should therefore facilitate feasibility studies, environmental assessments, financial modelling, and technical designs and procurement preparation.

Third, grid modernisation needs to go hand-in-hand with the deployment of renewable energy. The transmission and distribution network, metering, storage and digital grid-management systems can be considered strategic transition infrastructure. This is further supported by the ETP's high transmission and distribution losses and inadequate network capacity.

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Fourthly, harmonisation of regulations is necessary. Nigeria should minimise overlapping institutional mandates, streamline licensing processes and define clear and consistent rules for renewable-energy procurement, grid connection, and private investment.

Fifth, the national access strategy should incorporate decentralised renewable energy as a main stream activity. In addition to grid expansion, mini-grids and solar systems can be used in rural and under-served areas to complement grid expansion. This is aligned with the broader SDG 7 financing literature that highlights the need for public funding of last-mile access.

Sixth, investments in human-capital formation should be part of energy-transition investment planning. Engineers, technicians, project developers, regulators and financial professionals are recommended as groups to be targeted in training programmes. Capacity development should also be used to help support local manufacture, assembly and maintenance of components.

Seventh, governance of transitions should be separated from short term political cycles. Long-term targets should be formalized with legislation, monitoring, multi-year financing and institutional accountability.

Conclusion

Nigeria's Energy Transition Plan is an important strategic plan for tackling energy poverty and transitioning to a low carbon energy system. But the plan's effectiveness is not necessarily a function of policy ambition, but is more likely to be determined by institutional, financial, technological and infrastructural capacity to carry it out.

Financing is the most significant barrier with a mean score of 4.50, while regulatory incoherence ranks at 4.20, political instability at 4.00 and technological gaps at 3.80. Old age of infrastructure and grid constraints are another key constraint, and scored a mean of 4.30.

The qualitative results corroborate quantitative results by showing that these barriers are linked to each other. Fewer projects, fewer investors due to funding shortage; regulatory fragmentation leads to financial risk; poor grid infrastructure reduces the capacity to

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integrate renewables; technology gaps impede project implementation; and political instability poses a risk of project disruption.

Meanwhile, the results reveal significant opportunities. International climate finance and governance strengthening were the two most salient identified and rated as having a mean score of 4.30, followed by private sector participation at 4.20 and capacity development at 4.10.

The key argument is hence the implementation capacity issue associated with the energy transition in Nigeria. While the country has good potential for renewable energy, there is also a growing policy system, but these assets will not deliver SDG 7 outcomes by themselves. An integrated finance, infrastructure, governance, technology and political continuity system is necessary for successful transition.

Recommendations

Based on the results, the following recommendations are made:

A comprehensive financing mechanism, which involves mobilisation of various funding streams, should be put in place to facilitate the execution of Nigeria's Energy Transition Plan (ETP). These should comprise public-sector spending, climate financing, financial guarantees, concessional loans, blended finance and private-sector investment. Priority programmes can be financially backed by government funding and early-stage projects will have lower financial risk with concessional resources and climate finance. Financial guarantees and blended finance can also help incentivize private investors to invest, by mitigating investment risk and project viability. An integrated financing mechanism would then facilitate the mobilization of sufficient resources, the sharing of financial risks, and sustainable financing of transition programmes in the long-term.

In addition, the government should create a national pipeline of bankable energy transition projects to draw in domestic and international investors. This pipeline should prioritize and identify projects based on technical feasibility, economic benefits, environmental sustainability, and the potential for contributing to national energy access. Project developers would be assisted in preparing proposals to address requirements of investors and financial institutions through feasibility studies, technical assessments, environmental

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evaluations and financial structuring, all of which would be government-funded. This is essential support for renewables projects with high social and economic value but which are less likely to attract capital due to the high capital cost of renewable energy or because the project information is not current and reliable. A well-prepared pipeline would help build trust among investors, advance project implementation, and channel existing financial resources towards energy transition initiatives that are viable.

The other key priority is the modernisation of Nigeria's electricity transmission and distribution (T&D) network, and the expansion of decentralised renewable energy (DRE) systems. Transmission lines, electricity distribution networks, substations and electricity infrastructure could be upgraded to lower technical losses and increase the reliability of electricity supply, as well as facilitate the integration of renewable energy into the national electricity grid. Bringing reliable electricity to all communities, however, could take a long time and a significant amount of investment. Thus, RE decentralised solutions, such as solar mini-grids, solar home systems and other locally adapted RE technologies should be promoted in rural and under-served communities. These systems can enhance access to electricity for households, schools, healthcare institutions, and small businesses, decrease the need for expensive or polluting energy sources, and improve the energy efficiency of these systems. Modernisation of the grid and decentralised renewable energy development would help drive a more inclusive and flexible energy transition.

Furthermore, better coordination of government regulations in the energy industry should be achieved to ensure a more stable and efficient investment climate in Nigeria. This needs to be done by establishing clear responsibilities for the various ministries, regulatory bodies, government organisations and other stakeholders engaged in energy planning, financing, generation, transmission, distribution and renewable energy development. Consolidation of the regulations and administrative processes would eliminate excessive duplication, delays and increase the transparency and ease of understanding applicable regulatory requirements for investors and project developers. Better co-ordination should also help to facilitate the exchange of information, better policy implementation and monitoring and effective management of energy transition programmes. The government should strengthen accountability, minimize uncertainties and provide conducive

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environment for PPPs and sustainable development of Nigeria's energy sector by making clear institutional mandates and a coherent regulatory framework.

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