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Policy and Regulatory Frameworks for Accelerating Renewable Energy Integration in Nigeria's Power Sector

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ABSTRACT

Purpose: Nigeria sits on massive renewable potential, yet clean power barely trickles into the national grid. This paper digs into why the transition keeps stalling despite the Electricity Act 2023 handing states the keys to their own power markets. Rather than celebrating the new legal framework, it examines the commercial and technical friction that is blocking developers from connecting to the grid.

Methodology: This study used a qualitative policy review to examine Nigeria's renewable energy regulatory framework by reviewing key legal documents alongside relevant academic and industry publications. The selected materials, published mainly between 2023 and 2026, were examined through a structured narrative analysis to identify policy gaps affecting renewable energy policy readiness.

Findings: The findings show that Nigeria has made important legal and policy progress, but implementation remains weak. The electricity market is fragmented, and renewable-energy developers continue to face challenges such as unclear federal-state coordination, limited grid capacity and flexibility, non-cost-reflective tariffs, and insufficient use of smart-grid, storage, and circular-economy technologies. The preliminary assessment produced a readiness score of 2.33 out of 6, suggesting that while policy ambition is evident, the conditions needed for effective market delivery are still inadequate.

Unique Contribution to Theory, Practice and Policy: The six-pillar framework gives researchers a concrete diagnostic for measuring transition readiness beyond checkbox compliance. For industry players, it highlights exactly where projects get stuck between permitting chaos and unbankable contracts. For policymakers, the paper makes the case for binding federal-state coordination treaties, mandatory storage and digital standards, aggressive mini-grid scaling, and placing consumer affordability at the absolute center of market design rather than treating it as an afterthought.

Keywords: *Renewable Energy Integration, Nigeria Power Sector, Electricity Act 2023, Energy Transition, Energy Justice*

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I. INTRODUCTION

1.1 Background of the study

The global transition toward cleaner energy has become increasingly urgent because of escalating climate risks, the pursuit of the United Nations Sustainable Development Goals, particularly SDG 7 on affordable and clean energy, and the need to balance the energy trilemma of security, equity, and environmental sustainability (World Energy Council, 2024). These challenges are particularly pronounced in sub-Saharan Africa, where energy poverty, inadequate infrastructure, and climate vulnerability coexist with substantial renewable-energy resources that could support sustainable development and economic growth (Nunoo, 2025).

Nigeria reflects this broader regional challenge. As Africa's most populous country and a major oil producer, it has committed to net-zero emissions by 2060 and updated its Nationally Determined Contribution under the Paris Agreement, emphasizing renewable-energy development, reduced fossil-fuel dependence, and a just transition that addresses energy-access deficits (Akpata et al., 2022). Despite these commitments, Nigeria ranked 94th in the 2023 World Energy Trilemma Index, with a score of 39.2, indicating persistent weaknesses in energy security, equity, and sustainability (World Energy Council, 2024). Inadequate generation capacity, recurring grid collapses, transmission and distribution losses, and unreliable electricity access have left millions of households and businesses dependent on diesel and petrol generators. This dependence imposes substantial economic costs through fuel and operating expenses while contributing to air pollution, health impacts, and reduced competitiveness (Zero Emissions Generators [ZE-Gen], 2026; World Bank, 2023; Williams et al., 2024).

At the same time, Nigeria possesses significant renewable-energy potential. Solar resources are particularly strong in the northern regions, with average daily radiation estimated at approximately 3.5–7.0 kWh/m² and commonly around 5.5 kWh/m²/day. The country also has considerable hydropower and biomass resources, including an estimated 11–24 GW of large-hydro potential and approximately 3.5 GW of small-hydro potential, much of which remains undeveloped. Wind resources provide further diversification (Nigeria Energy, 2023; Adeshina et al., 2024). Greater exploitation of these resources could strengthen energy security through diversification, improve energy equity through grid, mini-grid, and off-grid solutions, and enhance environmental sustainability by reducing reliance on fossil-fuel generators.

Nigeria has introduced several policy and regulatory measures to address these challenges. The National Renewable Energy and Energy Efficiency Policy (NREEEP, 2015) established a framework for removing barriers to renewable energy and energy efficiency, setting targets for hydro, solar, wind, and biomass while supporting grid-connected and off-grid systems, rural electrification, and investment (Federal Republic of Nigeria, 2022; Federal Ministry of Power, 2015). The Nigeria Energy Transition Plan (ETP), launched in 2022, builds on this policy foundation and provides a pathway toward net-zero emissions by 2060. It establishes emissions-

reduction trajectories across power, transport, oil and gas, cooking, and industry; promotes large-scale renewable deployment; and identifies natural gas as a transitional fuel for baseload supply and grid stability as renewable capacity expands. It also highlights investment opportunities in renewable energy and electrification and seeks to mobilize domestic and international capital (Dioha, 2022).

The Electricity Act 2023 represents a particularly important institutional development. By repealing the Electric Power Sector Reform Act 2005, it established a broader framework for the Nigerian Electricity Supply Industry and introduced greater decentralization. Following constitutional amendments, states can establish regulatory frameworks for electricity activities within their territories, while interstate and international electricity matters remain under federal jurisdiction. This creates opportunities for states to develop electricity markets suited to local conditions, attract private investment, and expand renewable projects, mini-grids, and embedded generation according to available resources and demand (PwC Nigeria, 2024; Emmanuel, 2025; United Nations Conference on Trade and Development, 2023).

The Act can facilitate renewable-energy integration through investment incentives, renewable generation or purchase obligations, feed-in tariffs, tax measures, and local-content requirements. These mechanisms can improve revenue certainty and project bankability while encouraging private participation in solar, hydro, biomass, and wind development (PwC Nigeria, 2024; United Nations Conference on Trade and Development, 2023). Decentralized regulation can also support distributed renewable systems, including mini-grids and hybrid generation, which may improve local reliability and reduce pressure on the national grid. In combination with the ETP's transitional role for gas, a more diversified generation mix could improve system resilience compared with continued dependence on centralized thermal generation and diesel backup systems (Grantham Research Institute on Climate Change and the Environment, 2023; Dadzie & Daggash, 2026).

Within this framework, renewable-energy integration involves the technical, economic, regulatory, and institutional incorporation of renewable sources such as solar, wind, hydropower, and biomass into grid-connected, off-grid, and hybrid electricity systems while maintaining reliability and managing operational, economic, and environmental effects (Kroposki, 2017; Martinot, 2016; Sinsel et al., 2020). This is particularly important for variable sources such as solar and wind, which require adequate flexibility to manage fluctuations in generation and demand. The energy trilemma similarly requires policymakers to balance reliable supply, affordable and equitable access, and environmental sustainability (Pliousis et al., 2019; Fang et al., 2021).

The Electricity Act also supports a decentralized or multi-tier regulatory structure, under which states may regulate intrastate generation, distribution, supply, and trading while NERC retains authority over activities within federal jurisdiction, including interstate and national-grid electricity activities (Adeyemi, 2024; Nigerian Electricity Regulatory Commission [NERC], 2023). Two relevant policy instruments are feed-in tariffs (FiTs) and renewable purchase obligations. FiTs provide eligible renewable generators with predetermined payments for

electricity supplied to the grid, improving investment certainty, although their effectiveness depends on tariff levels, contract duration, technology differentiation, and regulatory design (Azhgaliyeva & Mishra, 2022; Couture & Gagnon, 2010). Renewable purchase obligations require specified electricity-sector participants to obtain a prescribed share of electricity from renewable sources and are internationally also known as renewable portfolio standards or renewable obligations (Cory & Swezey, 2007; Lyon, 2016). In Nigeria, the Electricity Act 2023 provides a statutory basis for such obligations and empowers the Commission to determine the applicable percentage; section 167 further permits qualifying bulk customers to purchase a specified percentage of renewable electricity or pay a prescribed premium.

Overall, the NREEEP, ETP, and Electricity Act 2023 provide a stronger foundation for renewable-energy integration than the former centralized framework. They seek to remove structural barriers, mobilize investment, utilize Nigeria's renewable resources, advance climate commitments, and address energy poverty (Adeshina, 2024; Salami, 2023). However, legislation and policy alone cannot ensure rapid renewable deployment or reliable electricity. Their effectiveness will depend on federal–state coordination, regulatory capacity, grid modernization, accessible financing, enforcement of renewable obligations and incentives, and resolution of persistent issues involving tariffs, metering, and system losses. These implementation considerations therefore form a critical basis for examining how Nigeria can use its evolving policy and regulatory framework to accelerate renewable-energy integration while simultaneously improving energy security, equity, and environmental sustainability.

1.2 Problem Statement

Nigeria has the legal tools to support a renewable energy transition. The reality on the ground, however, tells a different story. A massive gap persists between policy ambition and actual power generation. This gap stems from a web of interconnected failures. Broad clean energy targets lack enforceable legal duties, leaving developers guessing about who is accountable. The physical grid is also dangerously unprepared. Variable renewable power from solar and wind requires storage and flexible dispatch rules that simply do not exist in Nigeria. Market risks terrify investors just as much. Without cost-reflective tariffs and reliable revenue recovery, clean energy projects are viewed as financially hazardous (Adebowale & Makinde, 2023).

The recent push for decentralization brings its own headaches. Early successes like improved industrial power in Abia State and better access in Ekiti State prove the reform's potential (Emmanuel, 2025). However, massive coordination issues remain. Poor alignment between the Nigerian Electricity Regulatory Commission (NERC) and newly formed state regulators creates severe uncertainty for project developers (Onyekwere, 2024). Finally, the digital systems needed to manage a modern grid are often treated as an afterthought rather than a core regulatory requirement.

1.3 Aim and Objectives of the Study

The aim of this paper is to critically examine how targeted policy and regulatory reforms can accelerate the integration of renewable energy into Nigeria's power sector.

The specific objectives are to:

1. Evaluate Nigeria's current policy framework following the enactment of the Electricity Act 2023.
2. Identify the technical, financial, institutional, and social barriers blocking implementation.
3. Synthesize lessons from recent literature on energy transition, smart grids, and decentralized power.
4. Develop a practical "Renewable Energy Integration Policy Readiness Framework" tailored to Nigeria.
5. Recommend specific regulatory actions to create a fairer, more reliable, and investment-friendly market.

1.4 Research Questions

This study seeks to answer the following questions:

1. How do current laws and policies impact renewable energy integration in Nigeria?
2. What specific regulatory and infrastructural gaps are stalling the execution of these policies?
3. How can the Nigerian grid be modernized to absorb higher levels of variable renewable energy?
4. What financial mechanisms and market designs are necessary to attract private investment?
5. How should federal and state regulators coordinate to prevent market fragmentation?

1.5 Scope and Significance of the Study

The study limits itself to the policy and regulatory architecture of renewable energy integration in Nigeria. Grid-connected systems, mini-grids, embedded generation and storage fall within its reach. Shifting federal–state powers are examined strictly through a governance lens. However, engineering simulations and grid modelling are left aside. The analysis stays socio legal.

This study matters. Policymakers gain a direct diagnosis of the barriers still stalling reform. Investors see the regulatory risks that undermine bankability. The work also steers energy-trilemma debates toward equity, so the turn to decentralised renewables improves affordability for those least able to bear continued blackouts.

2. LITERATURE REVIEW AND THEMATIC SYNTHESIS

2.1 Energy Transition Governance and Institutional Quality

Effective energy transitions depend not only on ambitious targets but also on strong institutions, clear legislation, stable markets, and effective implementation. Nigeria's Electricity Act 2023

represents a major shift toward decentralized electricity governance by allowing states to establish their own electricity markets (Practice, 2023). However, implementation remains challenging. Uneven state capacity and potential overlaps between federal and state regulatory jurisdictions may limit the effectiveness of decentralization (Abubakar & Agbafo, 2025). Similarly, Daudu and Idehen (2025) emphasize the institutional capacity required to implement Nigeria's renewable-energy laws, while Olujobi and Abangu (2026) identify a robust and enforceable legal framework as fundamental to sustainable energy transitions.

2.2 Grid Readiness, Storage, and the Circular Economy

Large-scale renewable integration requires a flexible electricity system capable of managing the variability of solar and wind generation. Nigeria's existing grid remains a major constraint, while energy storage is increasingly important for maintaining system flexibility and reliability (Ajia, 2025; Baidoo et al., 2026). Emerging Power-to-X technologies could further support the transition by converting surplus renewable electricity into alternative energy carriers (Marvin & Sarkinbaka, 2024). Sustainability also requires attention to the lifecycle of renewable technologies. Unegbu and Yawas (2025) identify significant gaps in Nigeria's adoption of circular-economy practices, particularly material recovery and renewable-energy waste management, highlighting the need for innovation and government incentives.

2.3 Digitalization and Smart-Grid Regulation

Digitalization is increasingly essential to modern electricity systems. Smart meters, sensors, and data analytics can improve the management of variable renewable generation and distribution networks. However, Nigeria's transition to smart grids requires substantial infrastructure modernization (Ohiri et al., 2025). It also creates regulatory concerns involving data governance, interoperability, and cybersecurity (Benitez, 2026; Saxena et al., 2025). These issues indicate that smart-grid regulation must address digital risks alongside traditional electricity-sector regulation.

2.4 Decentralized Energy and Local Markets

The Electricity Act 2023 creates opportunities for decentralized generation through state electricity markets, mini-grids, rooftop solar, and embedded generation (KPMG, 2023). Such arrangements can encourage local participation and ownership in renewable-energy projects (Khorrami et al., 2025). Their success, however, depends on clear rules governing tariffs, grid access, licensing, and dispute resolution. Effective regulation is therefore necessary to balance investor interests with the needs of local communities.

2.5 Renewable Energy Finance and Investment

Financing remains a major obstacle to renewable-energy deployment. Public resources alone are unlikely to fund the generation, transmission, distribution, and digital infrastructure required for Nigeria's transition. Although the Electricity Act 2023 creates new investment opportunities, private capital depends on predictable and bankable market conditions, including cost-reflective

tariffs, secure power-purchase agreements, and currency stability (Onuh et al., 2024; Adebowale & Makinde, 2023). Financing constraints therefore remain a central implementation challenge (Onyekwere, 2024), and sustainable development through renewable energy will depend on effective mechanisms for reducing investment risk (Ogbodo-Nathaniel et al., 2024).

2.6 Natural Gas and Nigeria's Transition Pathway

Nigeria's transition differs from pathways based primarily on replacing coal because natural gas currently provides much of the dispatchable generation needed for grid reliability. Tax reforms remain important for attracting investment in the gas sector (Ogbonna et al., 2023), while natural gas is expected to remain a transition fuel in the short to medium term (Kiishi & Idrakisyah, 2026). Rather than treating gas and renewables as mutually exclusive, Nigeria could integrate renewable energy with existing oil and gas infrastructure to develop a hybrid transition pathway (Onukogu & Nwadinobi, 2025). Gas can therefore provide dispatchable support while renewable capacity expands.

2.7 Research Gaps

The literature reveals a significant gap between Nigeria's statutory ambitions and practical implementation. Although recent studies recognize the decentralization introduced by the Electricity Act 2023, limited attention has been given to the practical coordination of federal and state regulators, particularly regarding tariffs and grid interconnection. Similarly, smart-grid regulation and circular-economy requirements are often treated primarily as technical issues rather than immediate regulatory priorities. Renewable-energy finance also tends to emphasize investment mobilization without sufficiently addressing energy justice and affordability. A transition that attracts private capital but excludes low-income consumers would undermine the objectives of sustainability and equity. This study addresses these gaps by bringing together institutional governance, grid readiness, digitalization, finance, natural-gas transition, and social inclusion within a unified framework for assessing Nigeria's readiness for renewable-energy integration.

3. CONCEPTUAL FRAMEWORK

3.1 Renewable Energy Integration Policy Readiness Framework

Renewable-energy integration in Nigeria is not solely a generation challenge; it requires coordinated legal, infrastructural, financial, digital, and social systems. This study therefore adopts a Renewable Energy Integration Policy Readiness Framework based on Nigeria's post-2023 electricity reforms as shown in figure 1. The framework identifies six interdependent pillars needed to translate Nigeria's renewable resources into a reliable, inclusive, and investable electricity system: legal and regulatory clarity, grid readiness and technical standards, market and tariff design, finance and investment support, digital governance and smart-grid readiness, and energy

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justice and social inclusion. It also incorporates feedback to support adaptive policy learning as conditions change.

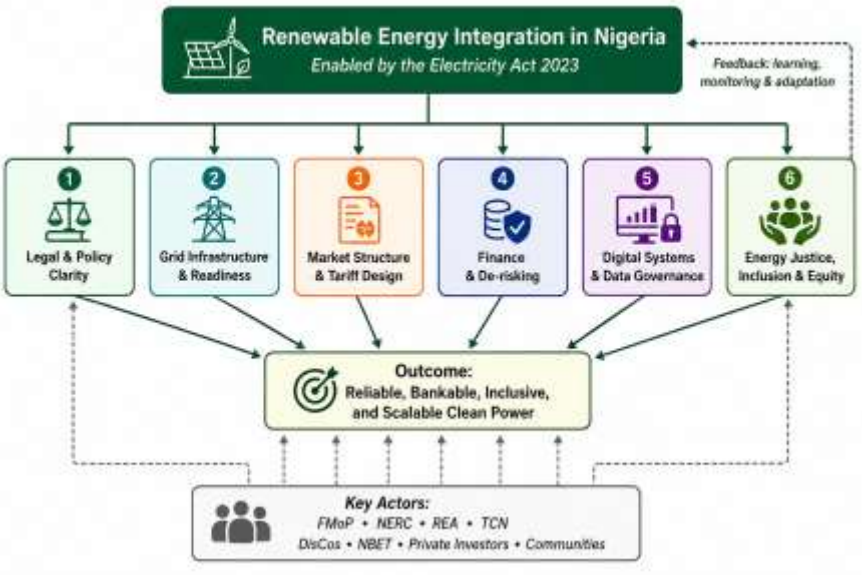

Figure 1: presents the framework and its principal implementing actors, including the Federal Ministry of Power (FMoP), Nigerian Electricity Regulatory Commission (NERC), Rural Electrification Agency (REA), Transmission Company of Nigeria (TCN), electricity distribution companies (DisCos), and Nigerian Bulk Electricity Trading Plc (NBET).

The pillars are mutually dependent. For example, investment may not translate into projects where federal and state authorities have unclear responsibilities for grid interconnection, while well-designed state renewable-energy policies may fail to attract investment where tariffs cannot support cost recovery.

3.2 Legal and Regulatory Clarity

This pillar assesses whether legislation clearly defines institutional responsibilities, licensing procedures, regulatory jurisdiction, and dispute-resolution mechanisms. The Electricity Act 2023 decentralized electricity governance by transferring significant regulatory responsibilities to states (Practice, 2023). However, effective implementation requires clear boundaries between federal and state jurisdiction and mechanisms for resolving disputes between NERC and state electricity regulators. Regulatory uncertainty could otherwise undermine investor confidence.

3.3 Grid Readiness and Technical Standards

Grid readiness evaluates whether Nigeria's transmission and distribution infrastructure can accommodate variable renewable generation while maintaining reliability. It includes interconnection requirements, dispatch procedures, network expansion, and the regulatory treatment of energy storage. Technical standards should also incorporate circular-economy

considerations, including solar-panel recycling and material regeneration, rather than treating renewable-energy waste as a secondary environmental issue (Unegbu & Yawas, 2025).

3.4 Market and Tariff Design

Market and tariff design determines how renewable electricity is procured, priced, transmitted, and sold. Key mechanisms include procurement auctions, power purchase agreements (PPAs), wheeling charges, and net metering. Effective design must provide investors with predictable revenues and payment security while maintaining affordability for consumers (Adebowale & Makinde, 2023). Poor tariff design can therefore undermine both investment and energy equity.

3.5 Finance and Investment Support

Renewable-energy infrastructure requires substantial upfront investment, making financial de-risking essential. Relevant instruments include partial risk guarantees, green bonds, concessional finance, and tax incentives. These mechanisms are particularly important in Nigeria because currency volatility and liquidity constraints increase project risk. Without structured financial support, ambitious climate and renewable-energy policies may remain difficult to implement (Onuh et al., 2024).

3.6 Digital Governance and Smart-Grid Readiness

Modern renewable-energy systems increasingly depend on digital infrastructure, including smart meters, real-time data, and automated grid management. Digital governance therefore assesses data-sharing arrangements, interoperability, privacy, and cybersecurity. As electricity networks become more digitally connected, cybersecurity must receive the same regulatory attention as physical infrastructure because failures can threaten both system reliability and consumer protection (Ohiri et al., 2025).

3.7 Energy Justice and Social Inclusion

Energy transition policies must ensure that clean electricity is accessible, affordable, and distributed. The Electricity Act 2023 includes mechanisms such as the Power Consumer Assistance Fund to support vulnerable consumers (KPMG, 2023). However, energy justice also requires consumer protection, effective complaint resolution, fair billing, and meaningful participation of rural communities in the benefits generated by local mini-grid projects (Coomassie, 2025).

3.8 Policy Readiness Index

To operationalize the framework, the study proposes the Renewable Energy Integration Policy Readiness Index (REIPRI) as a diagnostic measure of regulatory readiness:

$$REIPRI = (LC + GR + MD + FI + DG + EJ) / 6 \quad (1)$$

Where LC = legal and regulatory clarity; GR = grid readiness and technical standards; MD = market and tariff design; FI = finance and investment support; DG = digital governance and smart-grid readiness; and EJ = energy justice and social inclusion.

Each pillar is evaluated and scored on a scale from 1 (Very weak / non-existent) to 5 (Very strong / Fully enforceable) as shown in Table 1. While inherently qualitative, this index forces regulators to look at the entire system. A high score in Legal Clarity is meaningless if Grid Readiness scores a zero.

Table 1: Policy Readiness Scoring Scale

Score	Meaning	Interpretation
1	Very weak	Policy is absent, unclear, or not implemented
2	Weak	Policy exists but has major gaps
3	Moderate	Policy exists, but implementation is uneven
4	Strong	Policy is clear and mostly implementable
5	Very strong	Policy is clear, enforceable, coordinated, and monitored

4. METHODOLOGY

4.1 Research Design

This study adopts a qualitative policy-review design combining document analysis, legal review, and structured policy-gap assessment to evaluate Nigeria's regulatory and institutional readiness for renewable energy integration.

4.2 Data Sources

The study draws on two categories of documentary sources. The first comprises primary Nigerian legal and policy instruments, including the Electricity Act 2023, the National Renewable Energy and Energy Efficiency Policy, the Nigeria Energy Transition Plan, and relevant regulations and guidelines issued by the Nigerian Electricity Regulatory Commission (NERC). The second category comprises peer-reviewed academic literature and practitioner analyses addressing renewable energy regulation, smart grids, energy justice, transition finance, and electricity-market development. Practitioner sources include reports and legal analyses published by KPMG (2023), Advocaat (2023), Udo Udoma & Belo-Osagie (2023) and, Adebowale and Makinde (2023). These sources are used to supplement the interpretation of regulatory provisions with evidence concerning market, financing, and compliance considerations.

4.3 Inclusion and Exclusion Criteria

The literature and documentary sources were selected according to predefined criteria relating to subject matter, geographic relevance, methodological relevance, publication period, and evidence

quality. These criteria were applied to maintain alignment between the evidence reviewed and the study's objective of assessing policy and regulatory readiness for renewable energy integration.

Table 2: Inclusion and Exclusion Criteria

Criterion	Included	Excluded
Subject focus	Renewable energy, electricity regulation, grid integration, energy storage, smart grids, finance, circular economy, and energy justice.	Studies focused on unrelated sectors, such as aviation and tourism, or on purely petroleum-engineering issues.
Geographic relevance	Nigeria, Sub-Saharan Africa, developing economies, and selected international cases relevant to comparative policy and market design.	Studies whose geographical context provides no transferable policy or regulatory insight for Nigeria.
Method relevance	Policy analysis, legal review, governance studies, financial assessments, and energy-system planning.	Purely technical engineering studies without a substantive policy, regulatory, governance, or market dimension.
Time frame	Primarily sources published between 2023 and 2026, reflecting the post-Electricity Act 2023 regulatory environment; earlier seminal works were included where conceptually necessary.	Sources presenting repealed or superseded legislation, such as the EPSRA 2005, as the current regulatory framework.
Evidence quality	Peer-reviewed articles, official government and regulatory documents, and established corporate or legal advisory reports.	Unsupported opinion pieces, unverified blogs, and speculative materials lacking identifiable evidentiary support.

4.4 Analytical Procedure

The study employs structured qualitative document analysis. Relevant legal, policy, academic, and practitioner sources were reviewed and screened according to the inclusion criteria, after which material directly related to renewable energy integration was extracted and organized according to the study's analytical framework. The analysis then compared existing regulatory provisions and policy objectives with identified institutional, commercial, and technical requirements for renewable energy deployment. Where policy objectives were not supported by sufficiently defined legal mechanisms, institutional responsibilities, implementation procedures, or market arrangements, the issue was classified as a policy or regulatory gap.

4.5 Policy-Gap Matrix

A policy-gap matrix was used to systematize the assessment and ensure consistency across the areas examined. The matrix links each assessment item to a specific guiding question and corresponding category of policy or regulatory gap.

Table 3: Policy-Gap Analysis Matrix

Assessment Item	Guiding Question	Type of Gap Identified
Renewable targets	Are federal and state renewable-energy targets supported by defined legal obligations and implementation timelines?	Implementation gap
Licensing and permits	Are licensing and approval procedures sufficiently clear for renewable-energy developers, particularly where activities involve multiple jurisdictions?	Regulatory clarity gap
Grid connection	Do existing interconnection requirements adequately address the characteristics of variable renewable-energy sources?	Technical regulation gap
Storage and circular economy	Are battery storage, end-of-life management, and material recycling adequately classified and regulated?	Legal classification gap
Tariffs and procurement	Do tariff-setting and procurement mechanisms provide sufficient certainty to support private investment and project finance?	Market design gap
Federal-state coordination	Are the respective roles of NERC and state electricity regulators sufficiently defined, including mechanisms for inter-jurisdictional coordination and dispute resolution?	Institutional coordination gap
Digital systems	Are smart metering, cybersecurity, and data governance adequately addressed within the electricity regulatory framework?	Digital governance gap
Energy justice	Does the regulatory framework adequately address rural access, affordability, and consumer protection?	Social inclusion gap

4.6 Trustworthiness

Trustworthiness was enhanced through source triangulation across primary legislation and policy documents, peer-reviewed academic literature, and established practitioner analyses. The findings were assessed comparatively across these sources to identify areas of convergence and divergence and to reduce reliance on any single institutional or interpretive perspective.

4.7 Limitations

The study is limited by its reliance on documentary evidence and therefore does not capture primary perspectives from regulators, grid operators, investors, project developers, or electricity consumers. In addition, the policy-readiness assessment is a qualitative diagnostic rather than a statistically validated measure of regulatory performance. The analysis is also subject to changes in Nigeria's electricity-sector governance following the Electricity Act 2023, particularly the development of state-level electricity markets and associated regulatory instruments. Accordingly,

the findings represent an assessment of the regulatory environment within the period covered by the study.

5. ANALYSIS

5.1 Nigeria's Renewable Energy Policy Landscape

The Nigerian power sector is undergoing a constitutional reformation. For nearly two decades, the market was rigidly centralized under the Electric Power Sector Reform Act of 2005. That era is over. The enactment of the Electricity Act 2023 has fundamentally rewritten the rules of the game (KPMG, 2023). By decentralizing the market, the Act grants state governments the unprecedented power to legislate, regulate, and manage their own electricity markets (Practice, 2023).

This regulatory shift is designed to break the national grid's monopoly and flood the market with private investment. We are already seeing early proof of concept. The approval of the National Integrated Electricity Policy and the establishment of the Nigeria Independent System Operator (NISO) represent massive leaps forward. State-level successes such as the delivery of more reliable industrial power in Abia State and expanded access in Ekiti State demonstrate exactly what this decentralized model can achieve (Emmanuel, 2025).

Yet, a brilliant legal framework does not automatically wire a country. Deep structural hurdles remain. Inadequate financing, tariff inconsistencies, and legacy infrastructure deficits constantly threaten to derail these new policies (Onyekwere, 2024). Table 4 depicts energy relevance in Nigeria.

Table 4: Key Nigerian Policy Instruments and Relevance

Instrument	Relevance to Renewable Energy Integration	Main Policy Issue
Electricity Act 2023	Repeals 2005 Act; decentralizes generation and distribution to state governments.	Severe need for regulatory coordination between federal and state authorities.
National Renewable Energy Policy	Sets the overarching direction for clean energy adoption.	Targets lack binding enforcement mechanisms.
Nigeria Energy Transition Plan	Links emissions reductions to economic growth and gas transition strategies.	Requires massive capital mobilization and tax reform implementation.
NERC Mini-grid Regulation	Provides the licensing structure for localized off-grid power.	Needs scaling, faster approval timelines, and deeper consumer trust.

5.2 Legal and Regulatory Clarity

Udo Udoma and Belo-Osagie (2023) noted that while the Electricity Act 2023 illuminates the path toward sector transformation, the actual commercial environment remains murky. The primary friction point is federal-state coordination. NERC historically controlled everything. Now, power is shifting to newly established state electricity boards. Abubakar and Agbafo (2025) question the true extent of this decentralization, pointing out that state readiness is wildly uneven. A developer trying to build a solar farm that crosses state lines, or taps into the national transmission infrastructure, faces overlapping jurisdictions. Who sets the tariff? Who resolves the dispute? Daudu and Idehen (2025) emphasize that without an explicit, unified protocol governing how federal and state regulators interact, investors will simply view the new laws as an added layer of bureaucratic risk.

5.3 Grid Readiness and Technical Standards

You cannot mandate renewable energy if the physical wires melt under the load. Nigeria's grid capacity is notoriously fragile. Solar and wind power introduce aggressive variability; the power surges when the sun shines and drops when clouds roll in. Grid readiness goes beyond just building stronger transmission towers. It demands smart grid integration, a concept Ohiri et al. (2025) identify as an urgent necessity for sustainable power distribution in Nigeria. Technical standards must also evolve to address the entire lifecycle of renewable hardware. Unegbu and Yawas (2025) expose a glaring omission in current policy: the lack of circular economy (CE) integration. While solar adoption is increasing, advanced practices like waste-to-energy and material recycling for dead solar panels and batteries are nearly nonexistent. Integrating renewable energy without CE principles guarantees a future environmental crisis driven by toxic electronic waste.

5.4 Market and Tariff Design

Capital flows where it is protected. Clean energy developers need predictable revenue streams, which are completely dependent on market and tariff design. Adebowale and Makinde (2023) highlight that the Electricity Act 2023 opens massive opportunities for independent power producers and embedded generation. However, the commercial reality is brutal. Investors face severe liquidity crises and a history of unbankable tariffs. Tariffs in Nigeria are highly political. The reluctance to enforce truly cost-reflective pricing means developers often fear they will generate power and never get paid for it. This issue is not unique to renewables as regarding the parallel gas transition agenda. As such, attracting private capital to energy infrastructure relies entirely on transparent fiscal policies and the reliable implementation of tax and tariff reforms.

5.5 Finance and Investment Support

Decentralizing the grid will cost billions. Onuh et al. (2024) confirm that financing constraints are the absolute heaviest anchor dragging down Nigeria’s renewable energy ambitions. Public funding is severely limited, meaning the transition depends on private and foreign capital. Macro-economic

factors specifically currency devaluation and high inflation make large-scale green infrastructure incredibly risky. While the Electricity Act 2023 encourages public-private partnerships, the government must go further by establishing aggressive de-risking tools. Mechanisms like local-currency green bonds, blended finance facilities, and sovereign guarantees are no longer optional. They are mandatory if the state hopes to convert policy ambition into steel and silicon.

5.6 Digital Governance and Smart Grid Readiness

The modern grid is driven by data. Smart meters, automated distribution controls, and predictive software are required to balance a decentralized electricity market. Currently, Nigeria treats digitalization as an operational luxury rather than a regulatory requirement. Ohiri et al. (2025) note that smart grid adoption is critical for bypassing legacy infrastructure limits. Deploying these digital tools introduces severe cybersecurity and data privacy risks. The regulatory framework must establish minimum digital standards for mini-grid platforms and remote monitoring systems. If a local energy community is hacked, or if smart meter data is compromised, public trust in the decentralized grid will collapse.

5.7 Decentralized Renewable Energy

Decentralization is the most promising aspect of Nigeria's current policy shift. Instead of waiting decades for the national transmission company to run wires to remote villages, the law now aggressively supports mini grids and embedded generation. The establishment of the Nigeria Independent System Operator (NISO) and the new state-level licensing frameworks provide the legal backbone for localized power generation. The success seen in states like Ekiti proves that community-scale energy markets work. The focus must now shift to streamlining the licensing process so that rural developers and industrial clusters can build and operate local grids without drowning in red tape.

5.8 Energy Justice and Social Inclusion

An energy transition cannot be built on the backs of the poor. As the market privatizes and tariffs slowly adjust to reflect actual costs, low-income households are placed at extreme risk of energy poverty. The Electricity Act 2023 explicitly attempts to address this. Coomassie (2025) provides a critical analysis of the Act, noting its strong provisions for consumer rights, billing transparency, and complaint resolution. The Act also mandates the creation of the Power Consumer Assistance Fund (KPMG, 2023). This is a vital piece of energy justice legislation designed to shield vulnerable populations from price shocks. Coomassie (2025) warns that statutory rights mean nothing without enforcement. Regulators must ensure that rural communities not only receive electricity but also benefit economically from the mini-grids operating on their land.

5.9 Preliminary Policy Readiness Assessment

To quantify the current environment, this study applies the Policy Readiness Index as summarized in Table 5. The author assigned the scores below based on a qualitative synthesis of the legal,

technical, and commercial gaps identified throughout this section. While the Electricity Act 2023 dramatically improves the legal baseline, the severe friction in financing and federal-state coordination keeps the overall readiness score low.

Table 5: Preliminary Renewable Energy Integration Policy Readiness Scorecard for Nigeria

Pillar	Score	Basis for Score	Main Weakness
Legal and regulatory clarity	3	Solid legal foundation established via Electricity Act 2023.	Severe federal-state coordination and enforcement gaps remain.
Grid readiness	2	Technical rules exist on paper, but physical limits persist.	Lack of grid flexibility, storage mandates, and circular economy integration.
Market and tariff design	2	Mini-grid and IPP licensing frameworks are improving.	Tariffs are rarely cost-reflective; payment and liquidity risks terrify investors.
Finance and investment support	2	Transition finance needs are legally recognized.	Massive macro-economic risks; large-scale de-risking tools are absent.
Digital governance	2	Smart grid necessity is acknowledged by operators.	Cybersecurity and interoperability standards are severely underdeveloped.
Energy justice	3	Electricity Act 2023 establishes consumer rights and assistance funds.	Enforcement is weak; affordability remains highly vulnerable to tariff hikes.

Using the formula:

$$\text{REIPRI} = (LC + GR + MD + FI + DG + EJ) / 6$$

$$= (3 + 2 + 2 + 2 + 2 + 3) / 6$$

$$= 14 / 6 = 2.33$$

A score of 2.33 out of 6 paints a clear picture. Nigeria possesses a moderate, well-intentioned policy foundation but a weak environment for actual market execution. The laws exist, but the infrastructure and financial realities are not yet ready to support them.

6. DISCUSSION

Nigeria's renewable energy problem is no longer a lack of natural resources or legislative ambition. The Electricity Act 2023 fundamentally solved the legal deficit. The problem now is sheer implementation friction. The preliminary Policy Readiness Index score of 2.33 out of 6 is a stark

reality check. It reveals a country possessing excellent statutory frameworks but trapped in a dysfunctional commercial environment.

Decentralizing the power sector was a necessary gamble. Allowing state governments to design energy markets tailored to their specific industrial and rural needs is the right move (Practice, 2023). This shift has created a regulatory minefield. Abubakar and Agbafo (2025) accurately highlight that overlapping jurisdictions between NERC and newly minted state electricity boards breed massive uncertainty. Investors hate uncertainty. If a developer does not know exactly which agency approves a license or sets a tariff across state lines, the project will die in the boardroom. A unified federal-state coordination protocol is not just a bureaucratic wish; it is a commercial necessity.

Then there is the physical reality of the grid. You cannot pour highly variable solar and wind power into an aging, rigid network. Energy storage is the obvious requirement, but the technical discussion must go much deeper. Ohiri et al. (2025) rightly point out that smart grid integration complete with digital monitoring and automated distribution is mandatory for managing this new decentralized market. The complete absence of circular economy regulations is also alarming. Unegbu and Yawas (2025) expose how Nigeria is blindly importing and installing millions of solar panels and batteries without any plan for end-of-life material recovery or recycling. By ignoring these practices, the country is solving an energy crisis while quietly engineering a future electronic waste crisis.

Finance remains the ultimate choke point. While the new law opens the door for independent power producers, the market itself must offer bankable returns. This requires confronting Nigeria's broader energy landscape, particularly its heavy reliance on natural gas. Gas is not the enemy of renewables in Nigeria; it is the transition bridge. This transition provides the baseload stability required to eventually scale up variable renewables means fixing tax and tariff policies across the entire energy spectrum. Without cost-reflective tariffs and aggressive financial de-risking tools, private capital will simply look elsewhere (Adebowale & Makinde, 2023).

The fastest route to rural electrification is through decentralized mini grids, a reality already generating early wins in states like Ekiti (Emmanuel, 2025). Yet, this specific transition will fail socially if it prices ordinary citizens out of the market. Energy justice must be actively enforced. Coomassie (2025) reminds us that while the new law grants consumers robust rights and establishes the power consumer assistance fund, these statutory protections are meaningless without aggressive regulatory teeth. A clean energy transition that successfully attracts private capital but leaves the rural poor in the dark will inevitably face severe political and social backlash.

6. Recommendations

To attract and retain investment in Nigeria’s electricity sector, the government must establish a binding Federal-State Regulatory Coordination Protocol that clearly demarcates the roles of NERC and state electricity boards on licensing, tariffs, and dispute resolution, while providing model

regulations that states can readily adopt. Concurrently, a National Renewable Energy Grid-Integration Plan should be published to address transmission bottlenecks and storage needs, and circular-economy hardware guidelines must require developers of solar and battery projects to submit end-of-life recycling plans. Tariff reform is essential: regulators should implement transparent, cost-reflective tariffs, standardize power purchase agreements with robust termination, currency, and payment clauses, and create a centralized de-risking facility offering partial risk guarantees. Digital governance must be institutionalized through a Smart Grid Governance Framework that enforces cybersecurity standards, protects consumer data, and mandates real-time operational data sharing. Licensing processes for embedded generation and mini-grids should be radically streamlined, with states piloting community energy projects and peer-to-peer trading in controlled settings. Finally, energy justice must be enforced by deploying the power consumer assistance fund for lifeline tariffs, establishing rapid-response complaint mechanisms, and conditioning project approvals on meaningful community engagement and local benefit-sharing.

Table 6: Integrated Policy Reform Matrix

Reform Area	Recommended Regulatory Action	Expected Market Outcome
Legal clarity	Execute a binding NERC-State coordination protocol.	Kills jurisdictional uncertainty and lowers investor risk.
Grid & circular economy	Mandate storage integration and end-of-life solar/battery recycling.	Prevents grid collapse and avoids an electronic waste crisis.
Market design	Standardize PPAs and enforce cost-reflective tariff modeling.	Secures predictable revenue streams for project bankability.
Finance	Launch a centralized partial risk guarantee facility.	Mobilizes private and foreign capital.
Digital governance	Legislate cybersecurity and data privacy baselines for smart grids.	Secures the digital grid against cyber threats and manipulation.
Decentralization	Slash red tape for mini-grid licensing across state markets.	Accelerates rural access and industrial power reliability.
Energy justice	Capitalize the Power Consumer Assistance Fund and enforce billing rights.	Protects the poor from price shocks and guarantees social inclusion.

Figure 2 presents a phased roadmap for integrating renewable energy into Nigeria's national power systems. The framework is divided into seven strategic pillars across three sequential phases: Foundational Enablers (establishing policy and governance clarity), Systemic Integration (developing grid infrastructure, market mechanisms, and financing), and Governance & Equity (focusing on digital modernization and social inclusivity). The goal of this pathway is to achieve

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a reliable, bankable, and equitable clean power system, supported by an ongoing adaptive learning loop to refine policies over time.

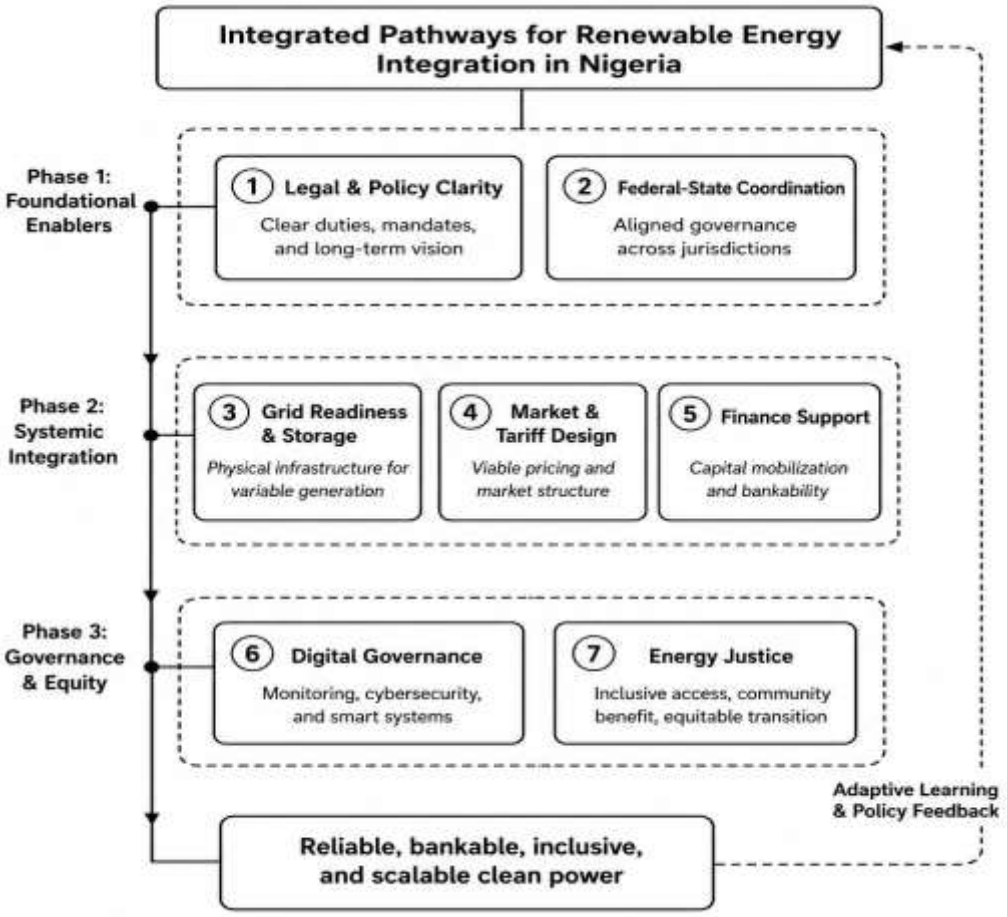

Figure 2: Integrated Reform Logic for Renewable Energy Integration

8. CONCLUSION

Nigeria's renewable energy challenge is less about resource availability than about translating recent legal and policy reforms into effective implementation. The Electricity Act 2023 introduced a more decentralized electricity framework, while the Nigeria Energy Transition Plan establishes broader national objectives for the energy transition. However, the effectiveness of these reforms depends on addressing persistent constraints, including inadequate grid infrastructure, uncertainty over federal–state regulatory responsibilities, limited financial de-risking mechanisms, and weaknesses in digital governance. The Renewable Energy Integration Policy Readiness Framework score of 2.33 out of 6 therefore indicates that, although significant legal and policy foundations are now in place, substantial institutional, infrastructural, and commercial gaps continue to constrain renewable energy integration.

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