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Evaluating Climate Change Mitigation and Adaptation Strategies in Nigeria's Energy Sector

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Abstract

Nigeria's energy sector occupies a dual position in the climate change discourse: it is both a major driver of greenhouse gas (GHG) emissions and one of the most vulnerable sectors to climate-related impacts. This study critically examines federal-level mitigation and adaptation strategies within the sector, with particular attention to the Energy Transition Plan (ETP), Renewable Energy Master Plan (REMP), National Adaptation Strategy and Plan of Action on Climate Change (NASPA-CCN), and the National Adaptation Plan (NAP). Employing a qualitative narrative review of policy documents, government reports, and peer-reviewed literature, the study evaluates the effectiveness, limitations, and opportunities embedded in these frameworks.

Findings indicate that while the ETP and REMF articulate ambitious goals for renewable energy deployment and a gradual transition toward a low-carbon economy, their implementation is undermined by insufficient funding, weak infrastructure, policy inconsistencies, and limited public awareness. Similarly, adaptation frameworks such as NASPA-CCN and NAP underscore the importance of resilience-building and community-based adaptation but remain largely constrained by inadequate monitoring mechanisms, poor institutional coordination, and weak integration at the grassroots level. Despite these shortcomings, Nigeria's climate policies are broadly aligned with global frameworks, including the Paris Agreement and the Sustainable Development Goals (SDGs). However, persistent barriers—technical, financial, and institutional—continue to limit their effectiveness and scalability. The study concludes that advancing Nigeria's energy sector resilience requires stronger governance structures, sustainable and diversified financing mechanisms, robust monitoring and evaluation systems, and inclusive stakeholder engagement that meaningfully incorporates communities, private actors, and civil society. By addressing these gaps, Nigeria can accelerate its energy transition, strengthen climate resilience, and contribute more effectively to global climate action.

Keywords

Climate change,
Energy sector,
Mitigation, adaptation,
Nigeria,
Policy assessment

1. Introduction

Climate change is one of the most pressing challenges of the 21st century, with profound implications for ecosystems, economies, and societies worldwide. The intergovernmental panel on climate change (ipcc) has consistently highlighted the urgent need to address both mitigation—reducing greenhouse gas (ghg) emissions—and adaptation—enhancing resilience to climate impacts (ipcc, 2021). The energy sector is central to these efforts because it is both the primary contributor to global emissions and a critical enabler of socio-economic development. Globally, energy-related activities account for nearly three-quarters of ghg emissions, underscoring the sector's pivotal role in climate action (iea, 2022).

Nigeria, Africa's most populous country and largest economy, faces a unique dilemma. On one hand, the country is endowed with abundant fossil fuel resources, which form the backbone of its economy, contributing over 80% of export earnings and about 50% of government revenue (world bank, 2022). On the other hand, this dependence on oil and natural gas has entrenched high emissions, environmental degradation, and economic vulnerability to global energy transitions (onigbinde, 2021). Moreover, Nigeria's energy infrastructure is underdeveloped, with an estimated 85 million people lacking access to electricity and many households still reliant on biomass for cooking (iea, 2021). This dual reality highlights the need for policies that balance economic growth with climate resilience.

The impacts of climate change are already evident across Nigeria. Rising temperatures, erratic rainfall, and extreme weather events such as droughts and flooding threaten energy production and distribution systems (Nwoko et al., 2020). Hydropower plants, which contribute a significant share of electricity, are increasingly affected by reduced water levels due to prolonged dry spells. Oil and gas infrastructure in the Niger Delta faces growing risks from sea-level rise, coastal erosion, and flooding (Adenle, 2020). These vulnerabilities underscore the urgent need for adaptation strategies in the sector, particularly given Nigeria's high exposure and low adaptive capacity.

To address these challenges, Nigeria has developed several policy instruments at the federal level. The energy transition plan (etp) outlines the pathway to achieving net-zero emissions by 2060, with renewable energy and natural gas as central components. The renewable energy master plan (remp) sets targets for increasing the share of renewables in the energy mix, particularly solar, hydro, and biomass. The national adaptation strategy and plan of action on climate change for Nigeria (naspa-ccn) and the national adaptation plan (nap) emphasize resilience-building measures, community-based adaptation, and ecosystem protection (federal ministry of environment, 2011; 2021). Collectively, these policies reflect Nigeria's efforts to align with global frameworks such as the Paris agreement and the sustainable development goals (sdgs).

However, the effectiveness of these strategies has been uneven. Studies have noted significant barriers, including

inadequate financing, weak governance, limited technical expertise, and low public awareness (Abubakar & Aina, 2019; Effiong et al., 2024). For instance, despite abundant solar potential, renewable energy deployment remains below 5% of the national energy mix, largely due to high costs and lack of enabling infrastructure (Ajayi et al., 2022). Similarly, adaptation strategies often remain at the policy level with limited implementation at the community scale (Butu et al., 2022).

Given these challenges, assessing Nigeria's mitigation and adaptation strategies at the federal level is critical for identifying gaps, highlighting opportunities, and ensuring that the energy sector contributes effectively to national and global climate goals. This paper focuses on evaluating the strengths and weaknesses of these strategies, providing evidence-based insights to inform future energy and climate policy.

2. Literature review

2.1 Climate change and the energy sector

The energy sector is central to global climate change debates, as it accounts for nearly 75% of greenhouse gas (ghg) emissions worldwide (iea, 2022). In developing countries like Nigeria, the sector poses a dual challenge: it is both a major source of emissions and highly vulnerable to climate impacts such as temperature extremes, flooding, and drought (Nwoko et al., 2020). Hydropower facilities, for example, are increasingly affected by reduced water inflows, while oil and gas installations in the Niger delta face heightened risks from sea-level rise and coastal erosion (Adenle, 2020). These

vulnerabilities highlight the need for strong mitigation and adaptation strategies in the sector.

2.2 Mitigation strategies in Nigeria's energy sector Mitigation involves reducing emissions through cleaner energy systems, improved efficiency, and sustainable land management (ipcc, 2021). Nigeria's energy transition plan (etp), launched in 2022, provides a roadmap for achieving net-zero emissions by 2060. The plan emphasizes renewable energy, particularly solar, and natural gas as a "transition fuel" (federal government of Nigeria, 2022). Similarly, the renewable energy master plan (remp) sets targets for scaling up renewables in electricity generation, expanding rural access, and reducing environmental degradation (energy commission of Nigeria, 2005; updated 2022).

Scholars argue, however, that these plans face barriers such as high investment costs, policy inconsistency, and low public awareness (Ajayi et al., 2022; Abubakar & Aina, 2019). Despite Nigeria's vast solar potential, renewable penetration remains below 5% of the energy mix, with diesel and petrol generators still widely used (iea, 2021). Furthermore, inadequate financing facilities and weak institutional capacity limit progress (Effiong et al., 2024).

2.3 Adaptation strategies in Nigeria's energy sector

Adaptation strategies focus on enhancing resilience to climate impacts already occurring or anticipated. Nigeria has introduced several adaptation frameworks, including the national adaptation strategy and plan of action on

climate change (naspa-ccn) (2011) and the national adaptation plan (nap) (2021). These documents emphasize community-based adaptation, ecosystem resilience, and gender-responsive approaches (Federal Ministry of Environment, 2011; 2021).

However, studies show that adaptation in Nigeria's energy sector is often poorly implemented. Butu et al. (2022) argue that adaptation policies remain largely at the national level with limited translation into local action. Similarly, community-level awareness and engagement remain weak, limiting the success of adaptation initiatives (Ayanlade et al., 2022). In practice, most adaptation measures are fragmented and driven by donor-funded projects rather than coherent national strategies (Edeh et al., 2023).

2. 4 challenges in implementing mitigation and adaptation

Several barriers affect the effectiveness of climate strategies in Nigeria's energy sector. Financial constraints remain the most significant, as renewable energy projects often require high upfront costs and face difficulties in accessing credit (Ngumah et al., 2013). Institutional inefficiencies, weak governance, and policy inconsistency further undermine implementation (Abubakar & Aina, 2019). Technical limitations, such as a shortage of skilled manpower for renewable energy maintenance, also hinder progress (Abdelrazik et al., 2022).

Social challenges include low awareness of renewable options among rural communities and resistance to change due to reliance on cheap but polluting energy sources like

kerosene and biomass (Usman et al., 2015). Collectively, these barriers explain why Nigeria continues to struggle with low renewable penetration despite ambitious policies.

2. 5 research gaps

While Nigeria has developed multiple mitigation and adaptation frameworks, there is limited empirical research on their effectiveness in the energy sector. Much of the literature highlights policy intentions rather than actual outcomes. There is also a lack of integrated studies that examine how mitigation and adaptation strategies can be harmonized for greater impact. This gap underscores the importance of critically assessing existing strategies at the federal level, which is the focus of this study.

3. Methodology

3.1 Research Design

This study adopted a qualitative narrative review design to assess climate change mitigation and adaptation strategies in Nigeria's energy sector at the federal level. A narrative review is appropriate because it enables the synthesis of diverse policy documents, academic literature, and institutional reports to generate a holistic understanding of complex policy frameworks (Snyder, 2019).

3.2 Data Sources

The analysis relied on secondary data collected from multiple reputable sources:

- **Government Policy Documents:** Nigeria's Energy Transition Plan

(2022), *Renewable Energy Master Plan* (2005, updated 2022), *National Adaptation Strategy and Plan of Action on Climate Change* (NASPA-CCN, 2011), and *National Adaptation Plan* (2021).

- **International Reports:** Publications by the Intergovernmental Panel on Climate Change (IPCC), International Energy Agency (IEA), and United Nations Development Programme (UNDP) related to climate change and energy transition.
- **Peer-reviewed Literature:** Academic studies on mitigation and adaptation in Nigeria's energy sector retrieved from databases such as Scopus, Web of Science, and Google Scholar.

3.3 Inclusion and Exclusion Criteria

Documents and literature were included if they:

1. Focused on climate change mitigation or adaptation strategies in Nigeria's energy sector.
2. Were published between 2010 and 2024.
3. Provided empirical or policy-relevant insights at the federal/national level.

Exclusion criteria included:

- Non-peer-reviewed opinion pieces, blogs, or commentaries.
- Studies not directly addressing Nigeria's energy sector or climate policies.
- Outdated publications before 2010, except when historically significant.

3.4 Data Collection Procedure

Policy documents were accessed from official government websites (e.g., Federal Ministry of Environment, Energy Commission of Nigeria), while academic literature was retrieved using search terms such as "*climate change mitigation Nigeria energy*", "*adaptation strategies Nigeria energy sector*", and "*renewable energy policy Nigeria*." Reference chaining was also used to identify additional relevant works cited in reviewed literature.

3.5 Data Analysis

A thematic content analysis was conducted. The data were coded into categories reflecting:

1. Mitigation strategies (e.g., renewable energy expansion, energy efficiency policies, gas transition).
2. Adaptation strategies (e.g., community-based resilience, infrastructure protection, policy integration).
3. Strengths and weaknesses of existing frameworks.
4. Alignment with international commitments (e.g., Paris Agreement, SDGs, Nigeria's NDCs).

This process enabled the identification of common patterns, policy gaps, and emerging opportunities.

3.6 Ethical Considerations

All sources were properly cited to maintain academic integrity. Only publicly available documents and peer-reviewed studies were used, ensuring compliance with ethical standards for secondary data research.

3. Results and Discussion

3.1 Overview of Federal Mitigation and Adaptation Strategies

Nigeria has developed several policy instruments to address climate change in the energy sector. These include the Energy Transition Plan (ETP, 2022), the Renewable Energy Master Plan (REMP, 2005; updated 2022), the National Adaptation Strategy and Plan of Action on Climate Change (NASPA-CCN, 2011), and the National Adaptation Plan (NAP, 2021). Each framework contributes to Nigeria's commitments under the Paris Agreement and the Sustainable Development Goals (SDGs).

Table 1 presents a summary of the objectives, strengths, and challenges of these policies.

3.2 Mitigation Strategies

Nigeria's Energy Transition Plan (ETP) and Renewable Energy Master Plan (REMP) provide the central frameworks for decarbonizing the national energy sector. The ETP outlines an ambitious pathway toward achieving net-zero emissions by 2060, setting targets for scaling renewable energy capacity, reducing reliance on fossil fuels, and promoting energy efficiency. Key objectives include the rapid expansion of solar and wind installations, electrification of transport, and modernization of the national grid to accommodate decentralized renewable systems.

The REMP complements this vision by specifying sectoral strategies for diversifying

the energy mix, integrating renewable technologies, and gradually reducing the dominance of oil and gas in electricity generation.

However, implementation remains problematic. Renewable energy penetration is still below 5% of Nigeria's national electricity supply, a stark contrast to the projected figures envisioned in both the ETP and REMP (Ajayi et al., 2022; IEA, 2021). Several barriers explain this underperformance:

- **Financial Barriers:** High initial investment costs deter local entrepreneurs and discourage large-scale private sector participation. The absence of innovative financing mechanisms further limits access to capital.
- **Market Distortions:** Subsidies for fossil fuels artificially depress energy prices, undermining the competitiveness of renewable alternatives.
- **Institutional Weaknesses:** Weak regulatory enforcement and poor coordination among agencies delay project approvals and reduce investor confidence.
- **Technical Constraints:** The national grid is weak and prone to instability, making integration of intermittent renewables such as solar and wind more challenging.

These constraints reveal that while the frameworks are visionary, they are insufficiently supported by practical enabling environments, thereby limiting their transformative potential.

Table 1. Federal Mitigation and Adaptation Strategies in Nigeria's Energy Sector

Policy/Framework	Objectives	Strengths	Challenges/Weaknesses
Energy Transition Plan (ETP, 2022)	Achieve net-zero emissions by 2060; expand renewable energy; use natural gas as transition fuel	Aligns with Paris Agreement; ambitious targets; focus on just transition	Limited financing; weak data availability; low institutional capacity
Renewable Energy Master Plan (REMP, 2005; updated 2022)	Scale up renewables (solar, hydro, biomass); improve rural electrification; reduce environmental degradation	Provides clear roadmaps and targets; potential to enhance rural access and jobs	Policy inconsistency; inadequate funding; low awareness; shortage of skilled manpower
National Adaptation Strategy and Plan of Action on Climate Change (NASPA-CCN, 2011)	Promote community-based and ecosystem-based adaptation; integrate climate resilience into national planning	Early recognition of adaptation needs; inclusion of vulnerable groups	Poor implementation; weak monitoring and evaluation; fragmented institutional coordination
National Adaptation Plan (NAP, 2021)	Mainstream adaptation into development planning; enhance risk reduction and resilience; gender-responsive approach	Coherent with Cancun Adaptation Framework; emphasis on cross-sectoral planning	Limited local-level translation; weak stakeholder engagement; dependence on donor funding

3.3 Adaptation Strategies

On the adaptation front, Nigeria has articulated strategies through the National Adaptation Strategy and Plan of Action on

Climate Change (NASPA-CCN) and the National Adaptation Plan (NAP). Both frameworks recognize Nigeria's acute exposure to climate risks, including sea-level rise in the Niger Delta, desertification in the northern states, and recurrent floods across

river basins. They propose resilience-building measures such as:

- **Ecosystem Restoration:** Rehabilitation of degraded wetlands, forests, and watersheds to act as buffers against climate shocks.
- **Community-Based Adaptation:** Promoting indigenous knowledge and locally tailored adaptation practices in farming, water management, and resource conservation.
- **Gender-Responsive Policies:** Ensuring that women, who often bear disproportionate climate burdens, are central to adaptation planning and project implementation.
- **Climate-Smart Agriculture:** Supporting drought-resistant crops, irrigation efficiency, and sustainable land management.

Despite the breadth of these proposals, translation into practice is limited. Many adaptation strategies remain confined to policy documents without concrete implementation on the ground. Butu et al. (2022) emphasize that adaptation projects are fragmented, poorly monitored, and overly dependent on donor-driven funding cycles, raising concerns about sustainability. Moreover, the absence of strong domestic financing mechanisms and insufficient integration into local government development plans weaken ownership and long-term viability. Without embedding adaptation into Nigeria's core economic planning, climate resilience will remain elusive.

3.4 Comparative Insights

Comparative evidence from other African countries demonstrates the potential benefits of well-structured implementation. South Africa, for instance, has pioneered renewable energy auctions that competitively allocate generation licenses to private investors, attracting billions in foreign and domestic capital. This approach has not only expanded renewable capacity but also reduced costs through competition. Kenya, meanwhile, has institutionalized community-based adaptation programs, emphasizing decentralized governance and grassroots ownership. These initiatives have empowered local farmers to adopt climate-smart techniques and build resilience to droughts and floods, creating sustainable models of adaptation (AfDB, 2022).

Nigeria's experience contrasts with these examples. Despite strong policies, weak governance and inadequate enabling frameworks have prevented similar outcomes. Lessons from South Africa and Kenya point to three critical gaps Nigeria must address:

1. **Governance and Accountability:** Transparent and consistent policy execution can attract investment and build trust among stakeholders.
2. **Private Sector Incentives:** Without mechanisms to reduce investment risk, Nigeria will struggle to mobilize large-scale financing.
3. **Community Ownership:** Adaptation strategies designed without community participation risk being irrelevant, unsustainable, or underutilized.

By internalizing these lessons, Nigeria could transform ambition into concrete results.

3.5 Synthesis of Findings

The overall synthesis reveals a policy environment characterized by ambition but constrained by execution failures. Nigeria's mitigation strategies are comprehensive on paper but are undermined by systemic obstacles: inadequate financing, persistent fossil fuel subsidies, weak institutions, and infrastructural bottlenecks. Adaptation frameworks, while progressive in their rhetoric, are hindered by limited localization, poor coordination, and overdependence on donor financing.

The gap between policy ambition and actual implementation reflects broader structural issues within Nigeria's governance and development context. Without targeted reforms, the country risks perpetuating a cycle where policies exist largely as aspirational commitments without delivering measurable outcomes. Closing this gap requires deliberate action on three fronts:

- Strengthening governance and institutional capacity to enforce policies consistently.
- Mobilizing sustainable financing, especially domestic resources, to reduce dependency on international donors.
- Ensuring inclusivity and participation so that communities, women, and vulnerable groups are not passive recipients but active drivers of adaptation and mitigation initiatives.

5.0 Conclusion and Recommendations

This study critically assessed Nigeria's climate change mitigation and adaptation strategies in the energy sector. Findings show that Nigeria has developed ambitious and globally aligned frameworks, including the Energy Transition Plan (ETP), Renewable Energy Master Plan (REMP), National Adaptation Strategy and Plan of Action (NASPA-CCN), and National Adaptation Plan (NAP). Collectively, these frameworks demonstrate Nigeria's commitment to global climate regimes such as the Paris Agreement and the Sustainable Development Goals (SDGs).

However, a recurring theme across the analysis is that ambition has not translated into consistent, large-scale implementation. Mitigation policies are weakened by structural financial and institutional barriers, while adaptation efforts are poorly localized and insufficiently embedded within Nigeria's broader development agenda. The result is a country with strong policy foundations but limited operational outcomes.

To bridge this gap, the following recommendations are advanced:

1. Enhance Climate Finance:

- Mobilize both domestic and international resources for renewable energy and adaptation initiatives.
- Establish innovative financing mechanisms such as blended finance, sovereign green bonds, and climate resilience funds.

- Proactively engage with global platforms such as the Green Climate Fund.
2. Strengthen Institutional Capacity and Governance:
- Improve coordination between ministries, agencies, and sub-national governments.
 - Create clear accountability frameworks supported by robust monitoring and evaluation systems.
 - Reduce policy inconsistency by ensuring that climate strategies are insulated from political cycles.
3. Promote Community-Based and Inclusive Adaptation:
- Design adaptation measures that reflect local realities and integrate indigenous knowledge.
 - Ensure that women, youth, and marginalized groups are not only included but prioritized in project design and decision-making.
 - Support local governments with resources and technical expertise to implement adaptation at scale.
4. Incentivize Renewable Energy Investment:
- Adopt proven models such as feed-in tariffs, renewable energy auctions, and tax incentives to attract private investors.
 - Reform fossil fuel subsidies to create a level playing field for renewable technologies.
 - Encourage domestic manufacturing of renewable components to reduce costs and build local capacity.
5. Expand Public Awareness and Capacity Building:
- Implement nationwide campaigns to enhance climate literacy and promote renewable adoption.
 - Support vocational and technical training programs that build a skilled workforce for the renewable energy sector.
 - Create knowledge-sharing platforms that link government, academia, industry, and communities.
6. Integrate Mitigation and Adaptation:
- Develop synergistic policies that consider the interdependence of mitigation and adaptation.
 - For example, renewable energy projects can double as adaptation measures by improving energy access in climate-vulnerable communities.

In conclusion, Nigeria's climate and energy policies demonstrate a commendable level of ambition, reflecting strong alignment with global climate objectives and national aspirations for sustainable development. However, this ambition remains fragile in execution, as implementation has consistently fallen short of stated goals. The gap between policy formulation and tangible outcomes highlights systemic challenges, including weak institutional capacity, inadequate financing, limited private-sector engagement, and insufficient localization of adaptation measures.

The pathway to a truly climate-resilient energy sector lies not merely in designing comprehensive frameworks but in operationalizing them with measurable impact. This requires translating policy intent into actionable strategies that deliver concrete results across communities and sectors. To achieve this, Nigeria must:

Strengthen governance by building accountable institutions, fostering inter-agency coordination, and ensuring policy consistency across political cycles.

Mobilize sustainable finance through innovative domestic and international mechanisms, reducing reliance on donor-driven projects and expanding long-term investment in clean energy and resilience programs.

Incentivize private-sector participation by creating a transparent, competitive, and enabling environment that attracts capital, encourages technology transfer, and stimulates renewable energy innovation.

Embed adaptation at the community level, ensuring that local knowledge, gender considerations, and vulnerable populations are central to the design and implementation of climate strategies.

Ultimately, Nigeria's success will depend on its ability to bridge the gap between ambition and action. By reinforcing governance structures, securing sustainable financing, and fostering inclusive participation, the country can transform its climate and energy policies from aspirational frameworks into engines of resilience, equity, and sustainable development.

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