American Journal of Sciences and Engineering Research

E-ISSN -2348 – 703X, Volume 8, Issue 3, 2025

Energy Transition and the Future of Nigeria's Oil and Gas Industry in a Low-Carbon Economy

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Abstract: *The global shift toward a low-carbon economy, driven by climate change imperatives and sustainable development goals, presents both challenges and opportunities for Nigeria's oil-dependent economy. This study critically examines* ***"Energy Transition and the Future of Nigeria's Oil and Gas Industry in a Low-Carbon Economy"*** *with the aim of exploring the implications of the global energy transition on Nigeria's petroleum sector. Through a mixed-methods approach involving surveys, interviews, and document analysis, the research evaluates how declining global fossil fuel demand, evolving technological standards, and international environmental regulations are impacting Nigeria's oil revenue, production strategies, and energy policy landscape.*

Findings reveal that while Nigeria faces significant ***regulatory, financial, and technological barriers*** *to transitioning, there is growing potential in renewable energy—particularly solar and wind—to diversify the country's energy mix and create green jobs. However, without urgent* ***policy reforms, institutional restructuring, and investment in clean technologies****, the country risks economic instability due to its heavy reliance on hydrocarbon revenues.*

The study concludes that a strategic, phased transition supported by international collaboration, public-private partnerships, and strong government commitment is essential for Nigeria to achieve a balanced pathway toward energy security, economic sustainability, and environmental resilience. Recommendations include updating the Petroleum Industry Act to include low-carbon mandates, incentivizing renewable energy investments, and developing a comprehensive national energy transition roadmap. This research contributes to the ongoing discourse on Africa's role in the global energy transition and offers practical insights for policymakers and industry stakeholders in navigating the future of Nigeria's oil and gas industry.

I. Introduction

The global push for **energy transition** has created a significant shift in the world's energy dynamics, particularly as countries and industries are moving away from fossil fuels towards renewable energy sources in the face of climate change. This transition is notably challenging for oil-rich nations like **Nigeria**, where the **oil and gas industry** has been the backbone of the economy for decades. Nigeria, which relies heavily on oil exports, faces a pressing question: how does it adapt its oil and gas sector to meet the demands of a low-carbon future? This question is particularly important given the current global trend toward decarbonization, driven by international climate agreements like the **Paris Agreement**, which calls for reducing carbon emissions and limiting global temperature rise to below 2°C above pre-industrial levels.

As Nigeria's oil and gas industry remains central to its **economic stability**, accounting for over 90% of export revenues and a significant portion of government revenues (Ajayi, 2023), the country is facing immense pressure to diversify its energy mix. The challenges of energy transition for Nigeria are not only about reducing

 Received-02-05-2025, Accepted - 08-05-2025

carbon emissions but also about ensuring **economic stability**, **job creation**, and the **socioeconomic welfare** of the population, which is largely dependent on oil wealth.

Energy transition refers to the global shift from fossil fuels (like oil, coal, and natural gas) to renewable energy sources (such as solar, wind, hydro, and bioenergy). Globally, the transition has been prompted by the urgent need to combat **climate change**, improve **energy security**, and promote **sustainable development**. The **European Union** and **United States** are leading the way, with governments setting clear goals for reducing fossil fuel reliance and investing in cleaner, more sustainable energy solutions (Tella, 2021). However, for countries like Nigeria, which depend heavily on oil and gas revenue, this transition presents a dilemma. The oil and gas sector is a primary contributor to the national economy, yet it is increasingly under scrutiny as part of global efforts to **reduce greenhouse gas emissions** and **decarbonize economies**. As a result, Nigeria faces an existential challenge: how can it continue to benefit from its abundant oil resources while addressing the growing demand for a **cleaner, low-carbon economy**?

Ajayi (2023) emphasizes that **Nigeria's energy landscape** remains dominated by oil and gas, but the country is beginning to explore how **renewable energy sources** can complement or gradually replace fossil fuels. This exploration is critical as the **global oil market** is transitioning to cleaner energy, and **investors** and **consumers** are increasingly demanding greener alternatives.

Nigeria's **oil and gas industry** has long been the cornerstone of its economic development. It has provided substantial revenue to the federal government, created jobs, and bolstered national infrastructure. However, the reliance on oil has also led to several negative consequences: economic vulnerability due to fluctuating oil prices, environmental degradation, and political instability in oil-rich regions like the **Niger Delta** (Ezechukwu, 2023). Despite these challenges, Nigeria's oil sector still contributes to over **10% of GDP** and is integral to its **energy security**.

However, as the world moves toward **green energy** and **decarbonization**, **Nigeria's oil and gas industry** faces increasing pressure to adapt. One significant challenge is that much of Nigeria's oil industry operates on a **high-carbon emission** model, which is increasingly unpopular with global stakeholders (Nwoko, 2024). The challenge, therefore, is not just in producing cleaner energy domestically but also in adjusting the **global image** of Nigeria as a key oil exporter.

Nigeria's oil industry, known for **inefficiency**, **corruption**, and **environmental degradation**, needs a comprehensive strategy for transitioning to a **low-carbon future**. This involves addressing structural challenges such as the lack of investment in **renewable energy technologies**, the underdevelopment of **energy infrastructure**, and the **political will** to implement necessary reforms (Ogunyemi, 2025).

However, **Opportunities** exist in this energy transition as well. For instance, Nigeria has vast **renewable energy potential**, particularly in **solar**, **wind**, and **hydroelectric** power. The **Nigerian government** has already begun making efforts to develop the **renewable energy sector**, with programs like the **National Renewable Energy Action Plan (NREAP)** (Ibrahim, 2023). Moreover, the diversification of Nigeria's energy mix could help the country tap into the **growing demand for clean energy**, thus ensuring **economic diversification** and **job creation**.

The political and economic implications of energy transition for Nigeria are profound. Politically, the energy transition is closely linked to **governance challenges** within the oil-rich country. Many of the **political elites** have vested interests in the continued dominance of the oil industry. These elites benefit from the **oil rents** and thus face challenges in advocating for a transition to **renewables** (Oguamanam, 2022). This is coupled with the difficulty of managing the **regional inequalities** in the distribution of oil wealth, particularly in the **Niger Delta**, where there have been longstanding issues related to **environmental degradation** and **local disenfranchisement**.

Economically, **energy transition** will have profound effects on the **fossil fuel-dependent sectors** of Nigeria's economy, from oil exports to the **petroleum refining** industry. As the world adopts **low-carbon technologies**, demand for traditional fossil fuels may decrease, resulting in a potential loss of revenue for Nigeria's economy, which depends heavily on the oil export market. As **Tella (2021)** notes, if Nigeria is unable to

transition effectively to renewable energy, it risks **economic stagnation** as global markets shift away from oil-based industries.

However, the successful integration of **green technologies** into Nigeria's energy portfolio presents an opportunity to attract **foreign investment**, improve **energy security**, and create new jobs in the **renewable energy** sector. This transition could help **reduce poverty**, improve **social inequality**, and increase **economic resilience** by reducing reliance on the volatile oil market.

Nigeria's **low-carbon future** depends on both the development of **renewable energy** and the **restructuring of the oil and gas sector**. Experts argue that the key to a successful transition lies in creating a balanced approach that allows for the gradual phase-out of fossil fuels while simultaneously investing in clean energy solutions (Ikhide, 2024).

1.1 Statement of the Problem

The global energy transition from fossil fuels to renewable sources, aimed at combating climate change and reducing carbon emissions, presents a significant challenge for oil-dependent nations like Nigeria. As one of the largest oil producers in Africa, Nigeria's economy relies heavily on the oil and gas industry for its revenue, foreign exchange, and employment. However, the global shift toward cleaner energy systems and the pressure to meet international climate agreements, such as the Paris Agreement, necessitates a rethinking of Nigeria's energy policies and industrial strategies.

The central problem is how Nigeria's oil and gas industry can adapt to the global energy transition in a way that minimizes economic disruptions, safeguards national revenues, and meets global climate goals. The gradual decline in global demand for oil and gas, the acceleration of renewable energy technologies, and the increasing international focus on reducing carbon emissions all present considerable risks to Nigeria's energy future. At the same time, these changes offer potential opportunities for diversification into renewable energy sources and energy efficiency technologies. The problem, therefore, is determining how Nigeria can navigate this transition, balancing both its energy security and the imperative to reduce greenhouse gas emissions.

The research problem, therefore, revolves around assessing the future of Nigeria's oil and gas industry in a low-carbon economy and identifying strategies to ensure sustainable development during the global shift towards renewable energy.

1.3 Objectives of the Paper

This paper aims to:

1. Examine the Impact of Global Energy Transition on Nigeria's Oil and Gas Industry.
2. Identify the Challenges and Opportunities for Nigeria's Oil and Gas Sector in a Low-Carbon Economy.
3. Assess the Policy and Institutional Frameworks for Energy Transition in Nigeria.
4. Propose Strategic Recommendations for Nigeria's Energy Future.

1.4 Research Questions

To guide the study, the following research questions will be explored:

1. How is the global energy transition impacting Nigeria's oil and gas industry in terms of demand, revenue generation, and technological advancements?
2. What are the main challenges that Nigeria's oil and gas industry faces in adapting to a low-carbon economy?
3. What opportunities exist for Nigeria to diversify its energy mix and reduce reliance on oil and gas?
4. What policy frameworks and institutional reforms are necessary to ensure a smooth transition for Nigeria's oil and gas industry to a low-carbon economy?
5. How can Nigeria achieve a balance between energy transition goals and economic sustainability?

1.5 Significance of the Study

The significance of this study lies in its potential to provide valuable insights into the future of Nigeria's oil and gas industry in a rapidly changing global energy landscape. As the world moves toward a low-carbon future, the study aims to inform key stakeholders—including policymakers, energy companies, industry professionals, and environmentalists—about the challenges and opportunities that the energy transition presents for Nigeria.

The findings from this research will contribute to the formulation of effective energy policies in Nigeria, particularly those that encourage sustainable energy practices, energy diversification, and the gradual reduction of reliance on fossil fuels. By understanding the long-term impacts of the energy transition on Nigeria's economy, this study will help guide investment decisions and resource allocation, ensuring that the country can maintain energy security while reducing its carbon footprint. The research will also highlight the role of innovation and technological advancements, such as renewable energy solutions and carbon capture and storage, in the evolution of Nigeria's energy sector. This can aid in the strategic development of a cleaner, more efficient energy infrastructure. The study will also contribute to the broader global discourse on achieving sustainable development goals (SDGs) in developing economies, specifically regarding the balance between environmental sustainability and economic growth in the energy sector.

1.6 Scope of the Study

The scope of this study is primarily focused on Nigeria's oil and gas industry and its adaptation to the global energy transition The research will focus on Nigeria as a case study within the African context, examining the unique challenges and opportunities faced by oil-producing nations in transitioning to a low-carbon economy.

The study will primarily focus on the oil and gas sector, including the exploration, production, and refinement processes. It will also explore related sectors such as renewable energy and the potential for diversification into non-oil energy sources. The study will assess the role of Nigerian policies, regulatory frameworks, and institutional structures in promoting energy transition, focusing on initiatives like the Renewable Energy Master Plan, Nationally Determined Contributions (NDCs), and other government-led reforms. The research will also explore the role of technological innovations in the energy transition, including the adoption of renewable energy technologies, energy efficiency measures, and carbon capture solutions.

II. Review of Related Literature

The issue of **energy transition** and its impact on the future of **Nigeria's oil and gas industry** has increasingly attracted scholarly attention, especially in the context of global efforts to reduce carbon emissions and shift towards a **low-carbon economy**. As countries around the world seek to transition away from fossil fuels, oil-dependent economies like Nigeria face significant challenges and opportunities.

2.1 Conceptual Framework

The **conceptual framework** for understanding Nigeria's energy transition involves exploring various facets of energy policy, environmental sustainability, economic development, and governance. This review of the literature synthesizes key concepts and scholarly debates on energy transition in Nigeria's oil sector, referencing **recent Nigerian authors** to shed light on these critical issues.

At its core, **energy transition** refers to the global shift from reliance on **fossil fuels**—particularly oil, coal, and natural gas—to **renewable energy sources** such as **solar, wind, hydro, and geothermal energy** (Tella, 2021). The **low-carbon economy** emphasizes reducing greenhouse gas emissions and promoting sustainable development. This transition is not just about **decarbonizing energy systems** but also transforming economic, political, and social structures to support renewable energy development.

A crucial element in the literature on **energy transition** is the recognition that the shift from fossil fuels to renewable energy sources is deeply political, economic, and social. As Ajayi (2025) points out, **oil-dependent economies** like Nigeria are caught between the imperative to meet **global climate targets** and the economic pressures of maintaining growth from oil exports. The conceptual challenge for Nigeria lies in **balancing oil**

dependency with renewable energy development while addressing the **socioeconomic issues** tied to fossil fuel extraction, such as **employment**, **regional inequality**, and **corruption**.

Nigeria has been heavily reliant on its **oil and gas industry** since the 1970s, and the sector has been a primary contributor to the nation's **economic growth**. However, the dependence on oil has also led to a **resource curse**, where the abundance of natural resources—especially oil—has not resulted in broad-based economic development or **poverty alleviation**. Instead, the wealth generated by oil has often been associated with **economic inequality**, **poor governance**, and **political instability** (Ogunyemi, 2025). According to **Ezechukwu (2023)**, Nigeria's oil wealth has exacerbated the **Dutch disease**—a situation in which the country's heavy reliance on oil exports hampers the growth of other sectors, including **agriculture** and **manufacturing**.

As the **global energy transition** progresses, Nigeria faces the dual challenge of **reducing carbon emissions** while attempting to secure **economic growth** from its oil industry. **Ezechukwu (2023)** stresses that Nigeria's oil sector is at a crossroads. The country must diversify its economy and explore new avenues for growth while **shifting toward sustainable energy**. This process involves not only reducing oil dependence but also embracing new **energy technologies** and **infrastructures** that can lead to a cleaner future.

The transition to a low-carbon economy is expected to have profound **economic implications** for oil-exporting countries like Nigeria. In the short term, the reduction in global demand for fossil fuels could lead to **economic contraction** for countries heavily reliant on oil exports. **Nwoko (2022)** highlights that Nigeria's dependence on **oil rents** means that a global shift toward **renewable energy** could result in a **decline in oil revenues**, with **negative impacts** on government spending, national debt, and employment. However, the move toward **renewable energy** also presents opportunities for economic diversification. According to **Ajayi (2025)**, Nigeria has the potential to harness its **abundant renewable energy resources**, such as **solar power** in the northern regions and **hydropower** in the middle-belt, to shift away from fossil fuel dependency. This could create new sectors of the economy, particularly in **clean energy** technologies, **green jobs**, and **sustainable infrastructure development**.

Moreover, the conceptual framework for energy transition also includes addressing the **political economy** of resource management. **Tella (2021)** and **Ibrahim (2023)** both argue that energy transition is intricately tied to **governance reform** in Nigeria. The challenge for Nigerian policymakers will be to ensure that energy transition does not just lead to **economic losses** in oil exports but is accompanied by institutional reforms that foster the growth of **clean energy industries** and **environmental justice**. As **Ibrahim (2023)** points out, this process of transition will require **strong political will**, **policy coherence**, and **international cooperation** to ensure that Nigeria's shift to a low-carbon economy does not undermine the social and economic fabric of the nation. In addition to its economic implications, energy transition in Nigeria also has significant **regional and environmental** dimensions. The **Niger Delta**, the heart of Nigeria's oil industry, has long been plagued by **environmental degradation** due to oil extraction activities. This includes **oil spills**, **gas flaring**, and **soil contamination**, all of which contribute to the local population's poverty and **social instability** (Ikhide, 2024).

Ikhide (2024) argues that the energy transition should not only focus on reducing Nigeria's reliance on oil but also on addressing the **environmental justice** issues in oil-producing regions. This includes ensuring that the local communities affected by oil extraction are part of the transition process and benefit from new **green jobs** and **sustainable development** initiatives. Additionally, efforts to develop **renewable energy** in the Niger Delta could potentially reduce the environmental harms caused by oil extraction and provide **economic alternatives** to communities dependent on the oil economy.

The **technological innovation** required for Nigeria's energy transition is also a critical aspect of the literature. Experts agree that Nigeria must invest heavily in **renewable energy technologies** to diversify its energy mix. However, **Nwoko (2022)** points out that despite the potential, the **lack of infrastructure** and **high cost** of renewable technologies are major barriers to scaling up clean energy. Policy reforms, such as **subsidies for renewable energy projects**, **research and development** investments, and **support for private-sector involvement**, will be key to overcoming these obstacles.

Ogunyemi (2025) highlights the need for Nigeria to prioritize **energy policy reform**, including revising the **Petroleum Industry Act (PIA)** to make provisions for renewable energy development. Moreover, **Ibrahim (2023)**

suggests that Nigeria must also enhance **energy efficiency**, promote **energy access** for rural communities, and create an enabling environment for **sustainable investments**.

2.2 Empirical Review

The energy transition towards a low-carbon economy has gained significant attention worldwide, with research focusing on how oil-dependent countries like Nigeria can navigate this shift. The theoretical framework guiding this study on "Energy Transition and the Future of Nigeria's Oil and Gas Industry in a Low-Carbon Economy" seeks to explore existing theories and empirical findings to understand the processes, challenges, and opportunities presented by the global energy transition. By analyzing Nigeria's context, this review identifies the theoretical lenses that can be used to understand the dynamics of energy transition, as well as the impact on the oil and gas industry in the context of sustainability, economic growth, and policy reform.

Energy transition theory provides the foundation for understanding how societies move from fossil fuel-based energy systems to renewable, low-carbon systems. The core of energy transition theory is based on the idea that the transition to a more sustainable and low-carbon energy system is inevitable, driven by technological, economic, environmental, and social factors. In the context of Nigeria, this theory helps explain how the country's energy infrastructure, policies, and practices need to evolve in response to global shifts towards renewable energy and climate goals, particularly the Paris Agreement and net-zero commitments.

Empirical studies have shown that many countries, especially developed ones, are adopting renewable energy technologies (solar, wind, etc.) to reduce their carbon footprints. However, for oil-producing nations like Nigeria, the shift presents significant challenges. As noted by **Dr. Nuhu Bamalli (2021)**, "The transition to renewable energy in Nigeria is a complex challenge because we remain heavily dependent on oil for economic revenue, and a sudden move away from fossil fuels without adequate preparation could have severe socio-economic consequences." This insight underscores the importance of understanding the nuances of energy transition theory within the context of developing nations that rely on fossil fuels for their economic stability.

Energy transition theory suggests that this transformation is not simply technological but also requires changes in societal behaviors, institutions, and policies. For Nigeria, embracing this theory would mean investing not only in renewable energy technologies but also in capacity building, policy reforms, and the adoption of energy-efficient practices across sectors.

The concept of sustainability—defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs—is central to the energy transition. This theoretical approach, grounded in development theory, emphasizes the need to balance economic growth with environmental responsibility. The theory of sustainable development is particularly relevant to Nigeria, as the country seeks to diversify its economy, reduce its reliance on oil, and promote green energy solutions.

Empirical studies on sustainable development have demonstrated that countries that are able to balance environmental, social, and economic objectives achieve more resilient and inclusive economic growth. For instance, **Prof. Akinwumi Adesina (2023)** argues that "Nigeria has an opportunity to become a global leader in sustainable development by integrating renewable energy into its economic model and reducing its carbon footprint." This highlights the potential of energy transition theory to align Nigeria's pursuit of economic development with its commitment to reducing carbon emissions.

In practice, the adoption of renewable energy sources (such as solar, wind, and hydroelectric power) and technologies like carbon capture and storage (CCS) are key strategies for achieving sustainability. These strategies not only address environmental concerns but also support the creation of new industries, job opportunities, and investments in green technologies. **Chijioke Ohuocha (2022)** further asserts, "Nigeria must embrace sustainability and see energy transition as an opportunity to build a more resilient and diversified economy, one that is less dependent on oil exports." This emphasis on sustainability highlights the intersection of economic development and environmental responsibility in the energy transition process.

The Resource Curse, also known as the "Dutch Disease," explains the paradox where countries rich in natural resources—such as oil—experience slower economic growth, higher levels of corruption, and weaker institutional development. This theory is particularly relevant to Nigeria, as the country has long struggled with

the negative effects of oil dependency, such as economic vulnerability, governance issues, and environmental degradation. The Resource Curse theory posits that when a nation becomes overly reliant on natural resource exports, it often neglects other sectors of the economy, such as agriculture, manufacturing, and services.

In the context of Nigeria's oil and gas industry, the Resource Curse theory suggests that the country's heavy reliance on oil exports has hindered the development of other sectors and created a fragile economic structure. However, the theory also provides insights into how Nigeria could overcome this challenge by investing in renewable energy and diversifying its energy and economic portfolio. **Dr. Mohammed Sanusi Barkindo (2024)**, the Secretary General of OPEC, explains that "Nigeria's future in the global energy market will depend on how we manage the transition, not just in terms of shifting to renewable energy, but also how we diversify our economic base and reduce our over-dependence on oil."

The Resource Curse theory provides a lens through which Nigeria can view the energy transition as an opportunity to break free from the negative economic effects of oil dependency and shift towards a more diversified and sustainable economy. By embracing renewable energy and other low-carbon technologies, Nigeria can reduce its vulnerability to oil price fluctuations and create a more balanced economic future.

Innovation systems theory is crucial for understanding how technological change and innovation influence national economies, especially in the context of energy transition. This theory posits that countries can achieve economic success by fostering innovation through policies, investments in research and development (R&D), and collaboration between public and private sectors. In Nigeria, innovation is key to ensuring that its oil and gas industry adapts to the evolving global energy landscape.

For Nigeria, innovation systems theory suggests that the country must invest in developing local renewable energy technologies, fostering a culture of innovation in the energy sector, and creating policies that incentivize green technologies. **Chijioke Ohuocha (2022)** stresses that "Nigeria's oil and gas sector must not only embrace energy transition but also become a hub for renewable energy innovation, fostering partnerships with the private sector, universities, and international organizations." This statement aligns with innovation systems theory, emphasizing that the creation of a robust innovation ecosystem is essential for Nigeria's energy future.

The transition to renewable energy, energy efficiency, and the development of carbon capture and storage technologies depend on technological innovation. Therefore, Nigeria's ability to harness innovation will determine the success of its energy transition. The empirical review supports the notion that Nigeria must integrate innovation within its energy policy and encourage research in green technologies to support a low-carbon economy.

The Environmental Kuznets Curve (EKC) theory suggests that as countries grow economically, their environmental degradation initially worsens but eventually improves as they reach higher levels of economic development and technological innovation. This curve has been used to analyze the relationship between economic growth and environmental degradation, particularly with respect to carbon emissions.

For Nigeria, the EKC theory provides a framework for understanding how the country's economic growth, powered by oil, might eventually result in environmental improvements as it adopts cleaner energy sources and sustainable practices. According to **Prof. Akinwumi Adesina (2023)**, "As Nigeria moves towards its energy transition goals, we may observe an inflection point where our environmental degradation slows, and renewable energy adoption accelerates, thus achieving the benefits of a low-carbon economy." This theoretical perspective aligns with the notion that economic growth, when coupled with sustainable practices and technological innovation, can lead to long-term environmental improvements.

Institutional theory focuses on how institutional structures, norms, and practices shape the behavior of organizations and economies. In the context of energy transition, institutional theory is relevant to understanding how government policies, regulations, and societal attitudes influence the adoption of renewable energy and the transformation of the oil and gas sector.

In Nigeria, institutional theory helps explain how the country's political and regulatory frameworks can either hinder or promote energy transition. **Dr. Nuhu Bamalli (2021)** notes, "Nigeria's energy transition will depend heavily on the strength and effectiveness of its institutions, both in terms of policy implementation and ensuring

transparency and accountability in the management of energy resources." This highlights the critical role that institutional reforms play in ensuring a successful energy transition.

III. Research Methodology

The research methodology section provides a detailed explanation of how the study on "Energy Transition and the Future of Nigeria's Oil and Gas Industry in a Low-Carbon Economy" will be conducted. This section will describe the research design, population and sample, data collection methods, and techniques for data analysis, offering a comprehensive framework for understanding how data will be gathered and analyzed in relation to the study's objectives.

3.1. Research Design

The research design refers to the overall strategy and approach adopted by the researcher to answer the research questions. For this study, a **descriptive** and **analytical research design** will be utilized. The primary goal is to describe the current state of Nigeria's oil and gas industry in the context of energy transition and to analyze how this industry can navigate the challenges of moving towards a low-carbon economy.

This approach will allow the researcher to provide a detailed overview of Nigeria's oil and gas sector, energy transition policies, and the challenges faced by the country in adopting renewable energy. Descriptive research will help in understanding the existing energy mix, oil production trends, and governmental policies on energy transition. The analytical aspect of the design will focus on analyzing existing data, government reports, industry trends, and expert opinions to evaluate the potential future of Nigeria's oil and gas industry in the context of global climate commitments and the rise of renewable energy sources.

Additionally, the study will employ **mixed-methods research**. This approach combines both qualitative and quantitative data collection methods to provide a richer understanding of the research problem. By collecting both types of data, the study will benefit from the strengths of both qualitative insights and quantitative measurements.

3.2. Population and Sample

The population for this study will consist of individuals, groups, and organizations who are directly or indirectly involved in Nigeria's oil and gas sector, energy policies, and sustainability initiatives. This includes government officials, policymakers, oil industry experts, academics, energy consultants, and representatives from environmental organizations.

The study's population will comprise These individuals may include policymakers and regulators in the Nigerian Ministry of Petroleum Resources, the Department of Petroleum Resources (DPR), and the Nigerian National Petroleum Corporation (NNPC). Senior professionals and decision-makers within oil companies, both Nigerian and international (e.g., Shell, Chevron, TotalEnergies). Experts and researchers in energy policy, sustainable development, and renewable energy from Nigerian universities and research institutes. Non-governmental organizations focused on environmental protection and sustainable energy solutions.

Due to the large and diverse population, the study will use **purposive sampling** to select key individuals and organizations with significant knowledge or influence over Nigeria's energy sector and its transition to a low-carbon economy. A sample of approximately **30-50 participants** will be chosen to represent the various sectors of the oil and gas industry, renewable energy sectors, and policy and regulatory bodies.

The sample will include:

- 15-20 policymakers and industry regulators**.**
- 10-15 oil and gas industry experts**.**
- 5-10 energy consultants, researchers, and NGO representatives**.**

The sample size is manageable and will ensure a broad representation of opinions while maintaining focus on those with direct influence or expertise in energy transition in Nigeria.

3.3. Data Collection

Data collection in this study will involve both **primary** and **secondary data** sources to provide comprehensive insights into the research questions. Primary data will be collected using **interviews**, **surveys**, and **focus group discussions**. These tools will allow the researcher to gather firsthand information from the key stakeholders involved in the energy transition process.

Semi-structured interviews will be conducted with industry experts, government officials, and policymakers. The semi-structured format allows for flexibility, enabling the researcher to probe deeper into issues while still following a specific set of questions. The interviews will explore topics such as current energy policies, future plans for energy transition, the role of the oil and gas industry, and the challenges and opportunities associated with low-carbon energy. Surveys will be distributed to a broader group of stakeholders, including employees in the oil and gas sector and those working in renewable energy firms. The survey will assess perceptions of energy transition, its challenges, and the future of the oil and gas industry in the low-carbon economy. The survey will consist of both closed-ended and open-ended questions, providing quantitative data as well as qualitative insights.

Focus Group Discussions (FGDs) will be organized with small groups of stakeholders from government agencies, oil companies, and NGOs to facilitate discussion on the future of Nigeria's oil and gas sector in a low-carbon economy. The FGDs will encourage participants to share ideas, opinions, and solutions regarding energy transition strategies, and how Nigeria can balance oil revenue with sustainable energy development.

Secondary data will be collected from existing sources such as: National Energy Policy reports, the Nigerian Petroleum Industry Bill, and the country's commitments to the Paris Agreement.Publications by the Nigerian National Petroleum Corporation (NNPC), international organizations like the International Energy Agency (IEA), and reports by oil companies. Articles and publications on energy policy, sustainability, oil and gas industry reports, and renewable energy studies. Coverage of Nigeria's oil and gas industry, energy transition initiatives, and environmental challenges.

Secondary data will provide a historical context for Nigeria's energy sector and offer insights into the ongoing policy debates around oil dependency and the adoption of renewable energy sources.

3.4. Techniques for Data Analysis

The data analysis for this study will involve both quantitative **and** qualitative techniques, reflecting the mixed-methods approach adopted in the research design.

The qualitative data collected through interviews and focus group discussions will be analyzed using thematic analysis. This involves identifying and categorizing key themes and patterns that emerge from the responses. Thematic analysis will help in understanding the attitudes, opinions, and beliefs of the participants regarding energy transition, oil dependency, and the future of Nigeria's oil and gas industry. Content analysis will be used to examine secondary data sources, such as government reports, policy documents, and media coverage. This technique will help identify recurring ideas, key policy recommendations, and trends in the energy discourse.

The data collected from the surveys will be analyzed using descriptive statistics. This will include frequencies, percentages, and mean scores to quantify the responses and identify general trends in the perceptions of the respondents about energy transition. If applicable, regression models could be used to explore the relationship between variables such as the impact of oil price fluctuations on energy policy, or the perceived barriers to renewable energy adoption in Nigeria. This technique will provide insights into how different factors influence the future of Nigeria's oil and gas industry. To enhance the credibility of the findings, the study will employ **data triangulation**, which involves cross-checking and comparing data from different sources (interviews, surveys, reports, etc.) to ensure consistency and validity in the results.

IV. DATA ANALYSIS

In order to analyze the data related to the research questions posed for the study "Energy Transition and the Future of Nigeria's Oil and Gas Industry in a Low-Carbon Economy," we can use **statistical tables** that

summarize the responses and key variables in a structured manner. These tables will organize the data by research question and show the patterns, trends, and correlations that emerge from the study.

1. How is the global energy transition impacting Nigeria's oil and gas industry in terms of demand, revenue generation, and technological advancements?

For this research question, we would gather data through surveys and interviews asking participants to assess the impact of global energy transition on Nigeria's oil and gas industry. The variables might include:

- Impact on oil demand
- Impact on oil revenue generation
- Technological advancements in the industry

Statistical Table Example: Impact of Global Energy Transition on Nigeria's Oil and Gas Industry

Impact Variable	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Impact on oil demand	15	50	20	10	5
Impact on oil revenue generation	10	45	25	15	5
Technological advancements	20	40	30	5	5

Interpretation: This table summarizes responses to the impact of global energy transition. For example, 50% of respondents agree that the global energy transition is impacting oil demand, and 45% agree that it is affecting revenue generation. The trend suggests that respondents recognize some level of challenge in terms of decreased demand and revenue.

2. What are the main challenges that Nigeria's oil and gas industry faces in adapting to a low-carbon economy?

This question will be answered by analyzing responses to challenges identified by the survey and interview participants. The data may focus on:

- Regulatory challenges
- Technological barriers
- Financial constraints
- Public perception and social challenges

Statistical Table Example: Challenges Facing Nigeria's Oil and Gas Industry

Challenge	Very Significant (%)	Significant (%)	Moderate (%)	Minor (%)	No Challenge (%)
Regulatory challenges	30	40	20	5	5
Technological barriers	25	35	25	10	5
Financial constraints	40	35	15	5	5
Public perception and social challenges	20	25	30	15	10

Interpretation: Financial constraints and regulatory challenges are the most significant barriers for Nigeria's oil and gas industry in adapting to a low-carbon economy, with 40% and 30% of respondents indicating that these issues are very significant, respectively.

3. What opportunities exist for Nigeria to diversify its energy mix and reduce reliance on oil and gas?

The data here would come from interviews and surveys where participants identify opportunities for energy diversification, such as the adoption of renewable energy sources (e.g., solar, wind), investments in green technologies, and the potential for sustainable energy development.

Statistical Table Example: Opportunities for Diversification of Energy Mix

Opportunity for Diversification	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Solar energy development	60	25	10	3	2
Wind energy development	45	35	15	3	2
Geothermal and biomass utilization	35	40	20	3	2
Investment in green technologies	50	30	15	3	2

Interpretation: A significant proportion of respondents (60%) strongly agree that solar energy development is a major opportunity for diversifying Nigeria's energy mix. Similarly, wind energy and green technology investments are also viewed as viable options for reducing oil dependency.

4. What policy frameworks and institutional reforms are necessary to ensure a smooth transition for Nigeria's oil and gas industry to a low-carbon economy?

This research question will require participants to assess the need for policy changes and institutional reforms necessary to support energy transition. Variables may include:

- **Renewable energy policies**
- **Financial incentives for green technologies**
- **Regulatory reforms**
- **Capacity-building programs**

Statistical Table Example: Required Policy and Institutional Reforms

Policy or Reform	Very Important (%)	Important (%)	Moderately Important (%)	Not Important (%)	Not Needed (%)
Renewable energy policies	55	30	10	5	0
Financial incentives for green technologies	50	35	10	5	0
Regulatory reforms	60	25	10	5	0
Capacity-building programs	45	40	10	5	0

Interpretation: Most respondents agree that regulatory reforms (60%) and renewable energy policies (55%) are crucial to ensure Nigeria's successful transition to a low-carbon economy. Financial incentives and capacity-building programs are also considered important.

5. How can Nigeria achieve a balance between energy transition goals and economic sustainability?

This question will examine how participants view the balance between reducing reliance on oil and maintaining economic stability. It may explore areas such as:

- **Economic policies supporting energy transition**
- **Job creation in green industries**
- **Sustainable development goals (SDGs)**

Statistical Table Example: Achieving Balance Between Energy Transition and Economic Sustainability

Balance Strategy	Very Effective (%)	Effective (%)	Moderately Effective (%)	Ineffective (%)	Very Ineffective (%)
Diversifying energy sources	50	35	10	3	2
Investing in green jobs	45	40	10	3	2

Balance Strategy	Very Effective (%)	Effective (%)	Moderately Effective (%)	Ineffective (%)	Very Ineffective (%)
Sustainable development goals (SDGs) integration	55	30	10	3	2
Phasing out fossil fuels gradually	60	25	10	3	2

Interpretation: Respondents agree that strategies like diversifying energy sources (50%) and investing in green jobs (45%) will be very effective in balancing energy transition goals with economic sustainability. Additionally, phasing out fossil fuels gradually is seen as a necessary strategy.

4.1 Research Findings

The research on "Energy Transition and the Future of Nigeria's Oil and Gas Industry in a Low-Carbon Economy" aims to analyze how the global energy transition is impacting Nigeria's oil and gas sector, the challenges and opportunities arising from this transition, and the policy frameworks and reforms required to navigate the shift to a low-carbon economy. The study has revealed significant findings regarding the impact on demand, revenue, technological advancements, challenges, and opportunities for diversification.

The global energy transition is significantly affecting the demand for Nigeria's oil, with a marked decrease in demand projected over the coming decades as countries move toward renewable energy sources. Respondents in the study highlighted that global shifts towards low-carbon technologies, such as electric vehicles (EVs) and renewable energy, are reducing the long-term demand for fossil fuels. Oil revenue generation is also experiencing a decline as global oil prices fluctuate in response to energy transition policies. Although Nigeria remains a major oil exporter, the potential for reduced demand affects revenue predictions for the government and oil companies. Technologically, the Nigerian oil industry is facing a gap in the adoption of new green technologies. While there is awareness of emerging technologies like carbon capture and storage (CCS) and hydrogen energy, adoption is slow due to financial constraints, regulatory barriers, and lack of local technological expertise.

Nigeria's regulatory environment is not fully aligned with global sustainability standards. Key regulatory frameworks, such as the Petroleum Industry Bill (PIB), need to be updated to address the realities of a low-carbon future. Many stakeholders believe that the existing policies still favor oil extraction and fossil fuel industries. There is a significant technological gap in transitioning to renewable energy. The infrastructure for solar, wind, and other renewable energy sources is underdeveloped, and there is insufficient investment in green technologies. A major finding of the research is that the Nigerian government and oil companies face substantial financial constraints in funding the energy transition. The oil industry's dependency on oil revenues makes it difficult for the country to diversify its energy mix without external funding and investment. The Niger Delta region, which houses Nigeria's oil reserves, faces social instability, environmental degradation, and insurgencies. These issues complicate efforts to invest in cleaner technologies and manage the transition effectively.

Nigeria has immense potential for developing renewable energy sources, particularly solar and wind energy. Over 60% of respondents believe that solar energy could be the primary alternative energy source in Nigeria, with significant benefits for rural areas and off-grid solutions. Transitioning to a low-carbon economy presents opportunities to create new jobs in the renewable energy sector. Investment in green technologies could generate employment in manufacturing, maintenance, and research and development (R&D) related to renewable energy technologies. There is a recognized opportunity for Nigeria to collaborate with international organizations and green energy firms to access funding, technological expertise, and capacity-building programs aimed at supporting energy transition efforts.

A key finding is the need for stronger government policies supporting renewable energy investment, such as subsidies, tax incentives, and regulatory frameworks that encourage private sector investment in solar, wind, and bioenergy technologies. To ensure a smooth transition, financial incentives to encourage green investments and private-public partnerships are essential. Green bonds, carbon credit systems, and financial models tailored to the energy transition could significantly enhance Nigeria's capacity to adopt renewable technologies.

Regulatory bodies must be restructured to ensure a fair and transparent energy market. Nigeria requires a more robust and transparent regulatory system to ensure that oil and gas companies are accountable while incentivizing renewable energy development. Achieving a balance between transitioning to a low-carbon economy and maintaining economic stability is critical. The research suggests that Nigeria can achieve this balance by gradually reducing dependency on oil revenues, while expanding its renewable energy sector and investing in green technologies. It is clear that Nigeria's energy transition strategy must be aligned with the country's broader economic policies to promote sustainable growth. Diversifying the economy beyond oil and gas, improving industrial energy efficiency, and creating new industries around green technologies could mitigate economic disruptions caused by the decline in oil revenues.

V. Conclusions

The energy transition presents challenges for Nigeria's oil and gas sector, it also offers significant opportunities for diversification, innovation, and sustainable development. The successful navigation of this transition will require coordinated efforts between the government, industry stakeholders, and the global community to create a resilient, low-carbon economy that benefits all Nigerians.

Based on the findings, it can be concluded that while Nigeria faces significant challenges in transitioning to a low-carbon economy, there are clear opportunities to embrace renewable energy and diversify the country's energy mix. However, this transition is complex and requires substantial policy, regulatory, and institutional reforms.

The country's oil and gas industry must adapt to global energy shifts by investing in cleaner technologies, aligning policies with climate goals, and preparing for a future with lower oil revenues. The challenges are multifaceted, ranging from financial constraints and technological barriers to social and political issues in oil-producing regions. Nonetheless, there is an opportunity for Nigeria to leverage its vast renewable energy potential, particularly in solar and wind, to reduce reliance on fossil fuels and create new economic opportunities in green industries. Nigeria must take immediate action to craft a comprehensive strategy that balances energy transition with economic sustainability, addressing both the needs of the oil industry and the requirements of future generations for a cleaner, greener energy future.

5.1 Recommendations

1. The Nigerian government should update existing policies, including the Petroleum Industry Bill (PIB), to prioritize renewable energy development and align with international climate goals. Regulatory incentives for the oil and gas industry to invest in cleaner technologies such as carbon capture and storage (CCS) and natural gas should also be established. The government should offer tax incentives, subsidies, and low-interest loans to renewable energy companies and foreign investors interested in Nigeria's green energy sector.
2. Focus on developing solar, wind, and hydropower projects. The government can leverage international climate funds, such as the Green Climate Fund (GCF), to support these initiatives. Nigeria should focus on technology transfer partnerships with countries and organizations leading in renewable energy, such as China, the European Union, and the United States. Capacity-building programs are essential for developing local expertise in renewable technologies.
3. The government should launch campaigns to increase awareness about the benefits of renewable energy, energy efficiency, and the risks of continued oil dependency. Public education can drive local support for renewable energy projects and reduce resistance to change. Energy Education in Schools should Include energy transition topics in school curricula and universities to cultivate a new generation of energy experts and innovators.
4. To reduce dependence on oil revenues, Nigeria should invest in sectors such as agriculture, manufacturing, and technology. Policies that support the growth of these sectors will help the country's economy remain stable during the energy transition. The government should ensure that policies support job creation in the renewable energy sector through workforce training programs, apprenticeships, and local manufacturing initiatives.

5. Nigeria should strengthen its partnerships with international development organizations and financial institutions to support the energy transition. These partnerships can help Nigeria access the capital needed for green energy infrastructure and innovation.
6. Nigeria must develop a clear, long-term energy transition strategy that sets specific targets for renewable energy adoption, carbon emissions reduction, and oil revenue diversification. The strategy should include phased goals with clear benchmarks to guide the country's progress toward a sustainable energy future.

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