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The Rise of Green Energy: How Renewable Resources are Shaping a Sustainable Future in Nigeria.

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Abstract
This study evaluates the transformative impact of green energy adoption on Nigeria's economic and environmental landscape. The main objective of the study is to evaluate the rise of green energy and how renewable resources are shaping a sustainable future in Nigeria. The research objectives and questions were formulated to guide the study. The study utilized primary data collected through questionnaires distributed to 150 respondents. The study employed mean and standard deviation as a statistical tool to analyze the data. By analyzing data from questionnaire responses, it assesses the extent to which renewable energy resources contribute to job creation, skills development, local business growth, and cost savings in energy use. Findings show that green energy adoption is widely perceived to benefit local economies, increase employment opportunities, and reduce dependence on traditional energy sources. However, challenges persist, particularly regarding unpredictable financing options and regulatory support, which hamper more widespread adoption and equitable benefits across regions. In other words, high variability in these areas suggests a need for targeted financial programs and streamlined policies to address obstacles and facilitate growth. The study recommends that there should be increase in financial accessibility for SMEs in Green Energy and the regulatory support and streamline policies should be strengthened.

Keywords: Green energy, Nigeria, renewable resources, sustainable development, economic growth

Background of the Study

Climate change the most urgent challenge of our time is happening now. The single wicked problem that policymakers face, to which there is no global consensus on the solution, is the reduction in carbon emissions from the energy sector, mostly for electricity generation. In the entire contribution to global greenhouse gases and employing renewable sources of energy as substitutes for fossil fuel energy, decoupling economic growth from carbon emissions can be achieved (International Renewable Energy Agency, 2020). This is precisely the rationale for the shift to green energy, with hydro, wind, solar, geothermal, and biomass having virtually non-existent effects on climate by reducing greenhouse gas generation. Frequent interruptions of supply, frequent high system costs, and system instability, however, off-balance the needs for rapid green energy adoption. Utility-scale green energy systems at present require lower-cost and higher-performance storage materials, the applications of which reach far beyond enhancing energy sustainability and security.

A commitment to combating climate change and enhancing sustainable energy security has been reflected towards the global shift renewable energy. Significant advantages over fossil fuels, including a reduction in greenhouse gas emissions and decreased environmental

degradation have been offered by renewable energy sources, such as solar, wind, and biomass (International Renewable Energy Agency, 2020). Many African countries, including Nigeria, are exploring green energy option to reduce dependence on traditional energy sources, as part of this global movement. Nigeria as a country faces critical energy shortages especially in the rural areas, which affects both the economy and the quality of life of its citizens yet, Nigeria's energy needs (World Bank, 2019).

Nigeria, which is located in west African region, has considerable solar and biomass resources, making it well-positioned for green energy development (Energy Commission of Nigeria, 2021). However, notwithstanding its potential, Nigeria continues to depend on non-renewable sources, such as coal and diesel generators, this leads to periodic power shortages, high energy costs, and adverse environmental effects. Thus, there is need to explore how Nigeria can control its natural renewable resources to transition to a more sustainable energy future, to support not only environmental sustainability but also economic and social development (NERC, 2021). This study however, seeks to investigate the current state of green energy in Nigeria, focusing on the effects and challenges of renewable resource adoption in this context.

Decoupling economic growth from carbon emissions can be achieved by reducing greenhouse gas contributions from fossil fuel energy sources. Not only this, but the replacement of equal capacity conventional power units and the resulting reduction in emissions, making for large-scale local employment, were direct economic development outcomes (Nwafor & Igwe, 2022). On the political front, renewable energy sources have a considerable advantage over fossil fuel and nuclear sources in that they provide the possibility of reducing energy dependency and diversifying energy strategy in almost all countries. For today, however, electricity comes mainly from burnt fossil fuels. The greenhouse gas emissions, which efficiently trap infrared radiation and consequently warm the earth's surface via the greenhouse effect, create long-lasting climate change and consequential serious effects on human health, the environment, and the economy. Since such effects resist compensation, wastes producing them should be avoided and abatement costs properly internalized by the polluting sources.

Statement of the Problem

Nigeria's energy sector deeply relies on non-renewable energy sources despite its abundant solar and biomass resources, this contributes to environmental degradation, high carbon emissions, and energy insecurity. However, the limited adoption of green energy technologies in Nigeria is primarily due to financial, technical, and regulatory obstacles that constrain the growth of renewable energy infrastructure (Nwafor & Igwe, 2022). As a result of this, rural areas remain underserved, and the economic and environmental benefits of green energy remain untapped.

Although policies have been introduced by Nigeria's government to promote renewable energy, thus implementation remains inconsistent, particularly at the state level, hampering sustainable development efforts (UNDP, 2022). This study addresses these challenges by discovering the potential for green energy in Nigeria and assessing the impact of renewable energy adoption on economic, social, and environmental aspects. Finding solutions to these barriers is vital for advancing green energy and enabling a sustainable future for Nigeria.

The main objective of the study is to evaluate the rise of green energy: how renewable resources are shaping a sustainable future in Nigeria. The specific objectives include; To

evaluate the economic implications of green energy adoption on job creation and local business growth in Nigeria; To identify the primary challenges and opportunities associated with green energy development in Nigeria. However, the study tends to provide answers to the following questions; what are the primary challenges and opportunities associated with green energy development in Nigeria?, and what are the economic implications of green energy adoption on job creation and local business growth in Nigeria?

This research is divided into five sections. The first is the introductory part, which is followed by the literature review section. The third part of the study is the methodology, while the fourth section is the data analysis and discussion of findings. The final part is the conclusion and policy recommendations.

Review of Related Literature

The conceptual framework for this study is aimed to outline the nexus between green energy adoption and its impact on environmental sustainability, economic growth, and energy accessibility in Nigeria. Green energy adoption includes the use of renewable energy sources, such as solar, biomass, and wind, as well as the application of technologies and policies that support sustainable energy. This framework asserts that the adoption of green energy can positively impact Nigeria by reducing environmental degradation, lowering carbon emissions, and promoting job creation and economic growth (IRENA, 2020; World Bank, 2019).

Benefits of Green Energy Adoption

Green Energy Adoption is the amount to which renewable resources (solar, biomass, wind) and green technologies are employed within Nigeria. Green energy adoption offers several benefits, from environmental protection to economic growth. Renewable sources like solar and wind reduce greenhouse gas emissions, helping climate mitigation efforts (IRENA, 2020). In addition, green energy promotes energy independence, reduces reliance on imported fuels, and improves energy security (UNDP, 2022). Economically, it initiates job creation in new energy sectors and also promotes sustainable industries (World Bank, 2019). Socially, renewable energy improves access to inexpensive, consistent power, especially in underserved communities (NERC, 2021). Thus, green energy adoption is a perilous pathway to a sustainable and equitable future for all.

Challenges of Green Energy Adoption

Significant challenges have been faced for the adoption of green energy in Nigeria, which include high initial costs and limited access to financing, making projects unaffordable for many (World Bank, 2019). However, inadequate infrastructure, like poor grid connectivity and outdated technology, curbs renewable energy expansion (NERC, 2021). Regulatory and policy uncertainties further discourage investment, with inconsistent support for green energy initiatives (UNDP, 2022). Thus, technical expertise and public awareness is lacking in the sector, particularly in rural areas, where renewable energy adoption could have significant impact (IRENA, 2020). To address these issues requires comprehensive policies, investments, and local capacity-building.

Environmental Sustainability in Nigeria

Environmental sustainability in Nigeria faces substantial challenges due to rapid population growth, urbanization, and industrial activities. However, deforestation, driven by agricultural

expansion and fuel wood collection, threatens biodiversity and contributes to soil erosion (World Bank, 2019). Moreover, the pollution from oil exploration and industrial activities contaminates water and air, affecting both human health and ecosystems, particularly in the Niger Delta (UNEP, 2011). Waste management is inadequate, leading to environmental hazards in urban areas (Nigerian Environmental Society, 2020). However, to promote sustainability, Nigeria must reinforce environmental policies, invest in renewable energy, and promote conservation practices that balance economic growth with ecological preservation.

Economic Development in Nigeria

Economic development in Nigeria is shaped by its enormous natural resources, growing population, and diverse economy. Oil is the primary revenue source, but dependence on it makes the economy susceptible to global price shifts (World Bank, 2019). However, efforts to diversify into other sectors like agriculture, manufacturing, and technology are expanding, aiming to lessen unemployment and increase resilience. Moreover, challenges such as poor infrastructure, corruption, and policy inconsistencies hinder development (IMF, 2021). Investments in infrastructure, education, and entrepreneurship are vital to promoting inclusive growth. By addressing these barriers, Nigeria can enhance job creation, reduce poverty, and promote sustainable economic development (Chukwu, 2023).

Theoretical Frameworks

The Theory of Diffusion of Innovation

The Diffusion of Innovation Theory by Everett Rogers (2003) explains how new ideas, practices, or technologies spread within a society or a specific group. In the situation of green energy, this theory is helps to understand how renewable energy technologies, such as solar panels, biomass, and wind turbines, are adopted and accepted in Nigeria. According to this theory, the adoption of green energy depends on five key factors which include; relative advantage, compatibility, complexity, trialability, and observability.

Application to Study:

Relative Advantage: Renewable energy sources offer benefits over outmoded fossil fuels by providing a cleaner, more sustainable power source (Rogers, 2003).

Compatibility: The compatibility of renewable energy with Nigeria's natural resources (like abundant solar radiation and biomass availability) increases its adoption potential.

Complexity: If the necessary technical expertise is not available, the technical complexity of green energy solutions could hinder adoption.

Trialability and Observability: As more communities adopt renewable energy, the observable benefits, such as reduced energy costs and improved reliability, may encourage wider acceptance across Nigeria.

This theory helps frame the challenges and facilitators of renewable energy adoption in Enugu and provides insight into how renewable energy projects can achieve broader acceptance within the region.

Sustainable Development Theory

The Sustainable Development Theory, introduced by the Brundtland Commission in 1987, emphasizes meeting current energy needs without conceding the ability of future generations

to meet theirs. This theory supports the evolution of renewable energy by promoting sustainable practices that minimize environmental harm, foster economic growth, and enhance social welfare (WCED, 1987).

The Sustainable Development Theory provides an initial lens for scrutinizing how green energy projects can concurrently achieve economic, environmental, and social benefits for Nigeria. It emphasizes the necessity of aligning green energy adoption with broader sustainability goals, ensuring that current energy practices are environmentally responsible, economically viable, and socially inclusive.

Empirical Review

Ajayi et al (2022) examined the problems surrounding renewable energy in order to pinpoint Nigeria's prospects and evaluate the country's renewable energy policy critically in light of the initiatives and successes of both governments and local practitioners. In addition to surveying international statistics on the relationships between energy and renewable energy adoption, national development, population explosion, job creation, and rural-urban integration, it identified the inherent opportunities of renewable energy resources at mitigating the incidents of climate change and global warming. It concluded that Nigeria's rural development strategy must incorporate renewable energy for power generation in order to maintain economic growth, particularly with regard to agriculture and food security. Additionally, it showed that using renewable energy might help reduce the country's anthropogenic climate change contributions.

Kalogiannidis et al (2024) assert that climate change is a significant challenge to regional development, impacting economies, environments, and societies globally. Europe, particularly Greece, serves as a unique case study for integrating climate change strategies into regional policy and planning. A study of 270 environmental experts in Greece found that regional economic growth, infrastructure quality, educational attainment, and a conducive business environment are key measures of regional development. The study also explored opportunities from climate change strategy integration, such as economic benefits, environmental opportunities, social enhancements, and technological advancements. Successful integration can position regions as global leaders in sustainability and innovation. However, barriers such as institutional fragmentation, resource constraints, conflicting priorities, and insufficient stakeholder engagement hinder integration efforts.

Galperina and Kyian (2021) explore the essence of global coordination of economic development strategies, estimating trends and possible scenarios. It classifies the conceptual apparatus and offers a typology of global coordination strategies. The authors periodize the development of the theory of coordination and study the evolution of coordination. They found that official development assistance does not correlate with GDP per capita, the share of the poorest population, and global carbon emissions. The paper highlights the need for improved coordination instruments to address environmental and social issues in sustainable development. It also highlights the non-balanced effectiveness of global coordination strategies in countries with different levels of development. The article also addresses geopolitical, organizational, economic, procedural, and technological problems in traditional global coordination institutions.

Eitan (2024) evaluates the Climate Change Adaptation through Renewable Energy: The Cases of Australia, Canada, and the United Kingdom. Climate change is escalating rapidly, and renewable energy systems are crucial for global mitigation efforts due to their minimal

greenhouse gas emissions. However, existing literature often overlooks their significant adaptation capacity, particularly in national policies. This study examines how renewable energy is integrated into climate change adaptation policies in Australia, Canada, and the UK. While there is growing awareness of renewable energy's role in these countries' policies, the actual deployment of renewable energy mainly focuses on mitigation efforts, neglecting crucial adaptation needs in the energy sector, such as geographical and technological diversification.

Gyimah et al (2023) investigates the impact of renewable energy on economic growth and carbon emissions from 1990 to 2021. Results show that renewable energy consumption leads to carbon emissions and does not impact economic growth. Financial inclusion and foreign direct investment positively affect carbon emissions. However, renewable energy indirectly negatively impacts carbon emissions through economic growth. The Granger causality test shows a unidirectional causality relationship between renewable energy and financial inclusion, and a feedback causality relationship with economic growth. The study suggests policy recommendations for policymakers based on these findings.

Teklie & Ya ˘gmur (2024) examined the Role of Green Innovation, Renewable Energy, and Institutional Quality in Promoting Green Growth: Evidence from African Countries. Green growth has the potential to transform economies and protect the planet by creating a symbiotic relationship between economic progress and environmental protection. This study investigates the impact of green innovation, renewable energy consumption, and institutional quality on green growth in African countries, controlling for GDP per capita, trade openness, FDI, population, and natural resource rent. Results show that green innovation, renewable energy consumption, institutional quality, GDP per capita, trade openness, and population growth have positive long-term effects on green growth. However, FDI and natural resource depletion have adverse effects. In the short run, only institutional quality and GDP per capita positively affect green growth, while natural resource rent has a negative impact.

van Niekerk (2024) examined Economic Inclusion: Green Finance and the SDGs. The Sustainable Development Goals (SDGs) aim to address economic exclusion and natural resource depletion, but achieving these goals is challenging due to a lack of economic incentives. Green finance has emerged as a valuable mechanism to address this challenge. This study aims to bridge the gap between green finance and economic inclusion, focusing on the potential of green finance as a bridge. Key findings include a strong synergy between green finance and economic inclusion, different forms of green finance facilitating economic inclusion, and green finance being instrumental in attracting investors to fast-track SDG attainment. Green finance can play a vital role in activating and prolonging broad-based benefit sharing in an eco-conscious way, ultimately promoting economic inclusion and resource depletion.

Getachew et al (2024) investigates the impact of international financial flows, including investments and development assistance, on the expansion of renewable energy technologies in Ethiopia. It also explores the sectoral economy's impact on renewable energy consumption. The research uses an explanatory research design and a quantitative approach, using an autoregressive distributed lag model to explore the long and short-term relationship among variables. The findings suggest that sustainable finance programs are crucial for advancing renewable energy projects in Ethiopia. The main economic sectors determining Ethiopia's renewable energy consumption include manufacturing, mining, and service industries. The study suggests that policies focusing on continuous financial support and international

cooperation are needed to promote the development of the manufacturing sector, including incentives for adopting renewable energy technologies and investing in renewable energy infrastructure. Diversifying renewable energy sources beyond these sectors, such as manufacturing, agriculture, construction, and trade, is also necessary. The study presents empirical evidence linking renewable energy use to long- and short-term economic growth.

Kumba & Olanrewaju (2024) studied "Towards Sustainable Development: Analyzing the Viability and Integration of Renewable Energy Solutions in South Africa"—A Review. The global economy is facing environmental challenges and economic instability, prompting the adoption of innovative energy technologies. This study aims to evaluate renewable energy solutions for sustainable development in South Africa. It uses literature analysis to examine renewable energy infrastructure, policy frameworks, technological advancements, and economic viability. The study aims to provide a refined understanding of renewable energy solutions' feasibility and integration potential, identifying key opportunities, challenges, and implications for sustainable development. The findings offer guidance for policymakers, researchers, and stakeholders in advancing a country's transition towards a sustainable energy future.

Nwankwo et al (2024) studied the review of Nigeria's renewable energy policies with focus on biogas technology penetration and adoption. The Nigerian Government has been promoting biomass as a renewable energy source, but has not given much attention to biogas technology. This study aims to investigate how biogas technology can be legislated in the Nigerian energy policy. Over 70 scientific articles revealed that policy, social acceptance, awareness, and availability of feedstock are key challenges in adopting biogas technology as an alternative clean energy source. The study presents a strategic policy framework for biogas policy adoption, highlighting the importance of identification and stakeholder consultation for a holistic policy that fully supports biogas technology in Nigeria. The study provides robust policy recommendations for deploying biogas technology in the Nigerian energy policy. The research aims to encourage the adoption of alternative energy sources and reduce the environmental impact of traditional forms of energy like firewood.

Ioan et al (2024) analyzes the economic factors influencing economic growth and well-being in Romania and Moldova, two Eastern European countries. It examines the relationship between economic growth and development, revealing patterns and dynamics within these economies. The study emphasizes the importance of economic management policies and structural reforms in fostering growth and improving quality of life. It provides insights into the challenges and opportunities faced by transitioning economies in Eastern Europe, offering strategies for sustainable development and improved well-being. The study underscores the significance of economic management policies and structural reforms in enhancing citizens' quality of life.

Semenova, & Martínez Santoyo (2024) examine the Economic Strategy for Developing the Oil Industry in Mexico by Incorporating Environmental Factors. This article presents a methodological approach to address environmental problems related to oil companies' activities. Traditionally, environmental factors have been seen as an additional cost that hinders economic development. The authors propose a methodology that considers environmental factors scientifically and aims to increase the potential for Mexico's oil industry's development. The methodology includes the concept of sub-potentials, including reproduction, protection, management and development, and reserve. Neglecting environmental factors leads to increased threats and deterrence. The methodology integrates

environmental components into the country's socio-economic strategy, addressing environmental problems and achieving socio-economic development goals. This approach allows for the effective utilization of society's limited resources and yields additional synergies, encompassing all levels of sustainable strategic development, including the oil company, industry, and country.

Methodology

This study uses a qualitative approach to analyze the impact and growth of renewable energy in Nigeria. Data was gathered through the administration of questionnaires to 150 respondents. Statistical data on energy production, carbon emissions, and economic benefits are analyzed to assess the viability and impact of renewable resources. The statistical technique adopted for this study to analyze the data is mean and standard deviation.

Model

This research employs the Sustainable Development Theory (SDT) to examine renewable energy's role in Nigeria's socioeconomic and environmental sustainability. The model ruminates three main points: economic viability, environmental impact, and social acceptance. By assessing renewable energy initiatives under these measures, the model evaluates the contributions of solar, wind, and hydropower in achieving Nigeria's green energy goals. The SDT model aids illustrate how renewable energy sources can shape a sustainable and inclusive energy future in Nigeria.

Data Presentation and Analysis

To evaluate the economic implications of green energy adoption on job creation and local business growth in Nigeria:

S/N	Item	Very High Extent	High Extent	Very Low Extent	Low Extent	Mean $(\bar{x})$	StD (s)
1.	Job availability impact	60	50	30	10	2.93	7.10
2.	Job training programs	55	65	12	18	3.09	4.87
3.	Growth of local businesses	35	48	30	37	2.54	6.12
4.	Increase in financing options for SMEs	30	40	35	45	2.43	6.12
5.	Impact on household income or opportunities	66	60	10	12	3.23	4.86
6.	Reduction in energy costs and economic impact	55	75	5	15	3.20	4.17

Source: Author's computation using SPSS

To explore the primary challenges and opportunities associated with green energy development in Nigeria:

S/N	Item	Very High Extent	High Extent	Very Low Extent	Low Extent	Mean $(\bar{x})$	StD (s)
1.	Infrastructure challenges	40	62	18	30	2.83	5.17
2.	Regulatory or policy obstacles	30	15	70	45	2.03	7.46
3.	Accessibility of financing	35	20	45	50	2.30	7.02
4.	Opportunities for private sector investment	58	72	12	8	3.17	4.64
5.	Impact on job creation and local business growth	66	59	10	15	3.21	4.97
6.	Access to affordable and stable electricity	50	78	6	16	3.15	4.04

Source: Author's computation using SPSS

Findings

"Job training programs" (3.09), "Impact on household income" (3.23), and "Reduction in energy costs" (3.20) indicate a generally positive perception of green energy's impact on these areas. These high mean values, along with relatively lower standard deviations (around 4-5), suggest a level of consensus among respondents on the benefits in these areas.

"Increase in financing options for SMEs" (2.43) and "Regulatory or policy obstacles" (2.03) indicate lower perceived benefits. Notably, "Regulatory or policy obstacles" has the highest standard deviation (7.46), suggesting significant variation in experiences, likely due to diverse regional regulatory environments.

"Job availability impact" (7.10), "Regulatory or policy obstacles" (7.46), and "Accessibility of financing" (7.02) reflect greater variability in responses, hinting at mixed experiences or uneven development in green energy impacts across regions.

Items with standard deviations near 4, such as "Access to affordable and stable electricity" (4.04), imply more consistent responses across regions, suggesting uniformity in perceived benefits or challenges.

Discussion of the Findings

The findings of this study indicate positive economic impacts in relation to job training, impact on household income and reduction in energy costs which have relatively high mean value. This implies that perception of green energy's impact on these areas will contribute positively to sustainable economic development. The finding connotes with the findings of Nwankwo et al (2024), who found that there should be adoption of alternative energy sources and reduce the environmental impact of traditional forms of energy. The study also presents a strategic policy framework for biogas policy adoption, highlighting the importance of identification and stakeholder consultation for a holistic policy that fully supports biogas technology in Nigeria. Also, Kumba & Olanrewaju (2024) in their findings indicate that there should be advancing country's transition towards a sustainable energy future.

The findings of this study also show that there are challenges in financing and regulatory support. This implies that there is perceived difficulties in the areas of SME's financing and regulatory policy. However, this suggests that financing will aid the sectors to grow. The

findings is in line with the findings of Getachew et al (2024) which suggest that sustainable finance programs are crucial for advancing renewable energy projects in Ethiopia. Also, Gyimah et al (2023), in their results show that renewable energy consumption leads to carbon emissions and does not impact economic growth.

Summary

The findings highlight the positive impact of green energy on skills development, income, and energy costs but reveal challenges related to financing accessibility and regulatory barriers. Addressing these inconsistencies can further strengthen green energy's economic impact across Nigeria, promoting more balanced regional benefits.

Conclusion

Conclusively, adopting green energy in Nigeria shows hopeful benefits in creation of job, development of skills, and economic savings. In other words, challenges in financing accessibility and regulatory support hinder constant growth. Tackling these problems through targeted funding and restructured policies can enhance green energy's positive impact, fostering sustainable economic development and more equitable regional opportunities.

Recommendations

Based on the findings, here are two recommendations to enhance the positive impacts of green energy adoption in Nigeria:

1. There should be increase in Financial Accessibility for SMEs in Green Energy.

2. The Regulatory Support and Streamline Policies should be Strengthened.

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