ENERGY TRANSITION, ENVIRONMENTAL QUALITY, AND FINANCIAL DEVELOPMENT IN NIGERIA: AN EMPIRICAL ANALYSIS

Olatokunbo D. Salami, Olajide S. Gbemisola, Hassan T. Bello, Arogundade S. Lawal

Lagos State University, Faculty of Social Sciences, Department of Economics, Ojo (Main campus), Lagos State, Nigeria, osalami2022@gmail.com, Gosworld1@gmail.com, hrfemabproperties@gmail.com

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Corresponding Author: Olatokunbo D. Salami, Lagos State University, Faculty of Social Sciences, Ojo (Main campus), Lagos State, Nigeria, osalami2022@gmail.com

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ABSTRACT

This study investigates the dynamic relationship between renewable energy consumption and financial development in Nigeria from 1990 to 2023. Against the backdrop of Nigeria's significant energy poverty, underutilized renewable resources, and a growing yet challenged financial sector, the research aims to determine the nature of the nexus between these two critical variables. Employing a quantitative research design and the Autoregressive Distributed Lag (ARDL) bounds testing approach, the study analyzes annual time series data on financial development (proxied by domestic credit to the private sector), renewable energy consumption, economic growth (GDP per capita), and CO_2 emissions.

The empirical results confirm a significant long-run cointegrating relationship among the variables. The findings reveal that renewable energy consumption has a positive and statistically significant impact on financial development in the long run, suggesting that investments in clean energy technologies act as a catalyst for deepening financial markets. Economic growth also exhibits a strong positive effect on financial development. In contrast, CO_2 emissions show a marginally significant negative relationship, indicating that environmental degradation may slightly erode investor confidence.

The study concludes that renewable energy adoption is not only an environmental imperative but also a financial catalyst for Nigeria. It recommends the integration of financial sector reforms with energy policies to enhance credit availability, attract green investments, and foster a sustainable economic transformation. Strengthening the financial system is thus crucial for scaling up renewable energy technologies and achieving inclusive long-term development.

Keywords: Renewable Energy, Financial Development, ARDL, Nigeria, Sustainable Growth, CO_2 Emissions.

INTRODUCTION

In recent decades, the global energy sector has changed significantly due to the need to address climate change, reduce reliance on fossil fuels, and support sustainable economic growth. In countries like Nigeria, where many people lack energy and face environmental issues, renewable energy can help tackle these problems and promote equitable economic development. Nigeria has dealt with many challenges because of years of poor and dirty energy use. Despite investments, there has been little progress in the power sector.

The country has abundant renewable energy sources, including biomass, solar, wind, and hydro, that remain underutilized. A major challenge for renewable energy in Nigeria is the high cost of running these projects. A strong financial system is necessary to manage risks in the energy market, use capital effectively when public funds are limited, and shift resources away from the less efficient and polluting traditional energy sources. Unfortunately, Nigeria's electricity consumption per person is only 181.63 kWh, which is low compared to other sub-Saharan African countries like Côte d'Ivoire (357 kWh), Ghana (567 kWh), and Zimbabwe (625 kWh). By mid-2025, about 86.8 million Nigerians still lacked electricity.

The financial sector plays a key role in raising capital for renewable energy projects, expanding electricity access, and strengthening the economy. Nigeria's financial sector has grown greatly and is now a leading market in Africa. The banking industry is vital for the country's development and economic growth. Between 2017 and 2020, the financial sector added N44.2 trillion to Nigeria's GDP. It grew from N78.10 trillion in 2017 to N122.30 trillion in 2020. Banking is the largest part of this sector, contributing N42.7 trillion in 2019, an increase from previous years. Compared to other regions, Nigeria has a well-structured banking system with high adoption rates (44.2%, exceeding West Africa's average of 17.8%) and widespread use of modern financial tools. Nigeria is also linked to global markets. Following the 2016-17 oil shock, foreign investments surged to US$6.3 billion in early 2018, a significant increase from previous years.

LITERATURE REVIEW

Conceptual Review

Renewable Energy

Renewable energy refers to energy derived from natural processes such as water, wind, and sunlight [1]. It is also called clean energy because it is naturally replenished and environmentally friendly. Although availability may depend on weather and time, natural energy sources like sunlight and wind do not become exhausted. Solar energy, for example, is widely used for heating and lighting through photovoltaic (PV) cells made from silicon that convert sunlight into electricity.

Financial Development

Financial development refers to the improvement in the size, efficiency, and stability of a country's financial institutions and markets. It involves increased access to credit, deeper financial markets, stronger financial regulation, and improved financial intermediation. A well-developed financial system mobilizes savings, allocates resources efficiently, reduces transaction costs, and supports economic activities, including investment in renewable energy technologies.

Theoretical Review

Neoclassical Growth Theory

The Neoclassical Growth Theory, introduced by Solow (1956), explains long-run economic growth through capital accumulation, labour, and technological development [2]. Technology is considered the primary driver of sustained growth in the long run.

Role of Financial Development in Neoclassical Theory

Financial development enhances the allocation of capital. According to King and Levine (1993), efficient financial systems channel funds to productive sectors, encourage investment, and promote long-term economic growth [3].

Integrating Energy into Neoclassical Growth

Energy is a crucial production input. Jorgenson and Wilcoxen (1993) argue that improvements in energy efficiency increase productivity and growth [4]. Extending the neoclassical framework to include energy helps explain how financial development, energy use, and technological progress interact in the production process.

Relevance of Africa to the Energy–Finance Nexus

Africa serves as a crucial case study for examining the financial development–energy nexus due to several interrelated factors. Firstly, the continent experiences low levels of financial development [5], which hampers investment in energy infrastructure. Additionally, despite contributing minimal emissions, Africa is highly vulnerable to climate change [6]. Another pressing issue is the widespread energy poverty, with nearly half of the population lacking access to electricity [7]. Furthermore, weak governance structures and negative performance indicators exacerbate these challenges [8]. Collectively, these conditions highlight Africa's unique context, making it a critical environment for studying renewable energy development and its potential impact on sustainable growth.

Empirical Review

A large volume of empirical research examines the relationships among financial development, renewable energy consumption, and economic growth.

Financial Development and Renewable Energy

The renewable energy sector plays a crucial role in addressing global energy needs, but its capital-intensive nature necessitates robust financial structures to attract investment [9]. A well-developed financial system mitigates investment costs while broadening access to essential funding through credit and equity markets. Shahbaz et al. (2021) identified three primary channels through which financial development influences renewable energy [10]. The direct effect highlights how access to credit facilitates investments in clean technologies, while the business effect emphasizes that increased financial capital nurtures renewable energy firms and spurs innovation. Additionally, the wealth effect illustrates how thriving stock markets can enhance investor confidence, incentivizing green investments. Their research, focusing on 34 developing countries from 1994 to 2015, demonstrated a significant positive correlation between financial development and renewable energy consumption, underscoring the importance of financial systems in fostering a sustainable energy transition.

Evidence from Nigeria

Stephen et al. (2023) used ARDL analysis to examine Nigeria's financial development and renewable energy consumption from 1981–2019 [11]. Results showed that financial development positively influences renewable energy use, moderated by GDP, FDI, and inflation. In Nigeria, inadequate electricity supply increases reliance on imported petroleum products, which account for more than 50% of mineral imports. Financial sector conditions influence credit costs for petroleum importers [12], [13], affecting energy supply and increasing dependence on biomass, which contributes to deforestation.

Energy Consumption and Economic Growth

Empirical evidence on the energy–growth relationship remains inconclusive [14]. Some studies argue that financial development increases industrial activity, raising energy demand and contributing to CO_2 emissions [15], especially in regions with weak governance.

Research Gap

The existing literature on financial development and renewable energy consumption reveals notable gaps that warrant further investigation. Notably, there is a dearth of studies examining the moderating role of governance in this context, which is especially significant given the variety of governance structures across regions. Moreover, research focusing on Africa remains limited, even though the continent faces unique challenges such as weak governance, energy poverty, and heightened climate vulnerability. The findings from existing studies are often inconclusive, highlighting the influence of country-specific factors like governance quality, financial market depth, and regulatory environments on energy outcomes. Furthermore, many analyses rely on narrow financial development indicators when evaluating renewable energy transitions, which demand a more multidimensional approach. Lastly, limited disaggregation of renewable energy types like solar, wind, and hydro prevents a comprehensive understanding of how different energy sources respond to financial and governance variables. Addressing these gaps is crucial for developing informed policy interventions.

RESEARCH METHODOLOGY

Research Design

This study adopts a quantitative, ex-post facto research design. The design is appropriate because it utilizes existing secondary data to examine the relationship between renewable energy consumption and financial development in Nigeria over time. It does not manipulate variables but rather analyzes historical data to infer causality and long-run relationships.

Nature and Sources of Data

The study uses annual time series data from 1990 to 2023, sourced from:

- World Bank Development Indicators (WDI) – Renewable energy consumption (% of total final energy), GDP per capita, and CO_2 emissions.
- Central Bank of Nigeria (CBN) Statistical Bulletin – Domestic credit to the private sector (% of GDP), representing financial development.

Model Specification

$$FD_t = \beta_0 + \beta_1 REC_t + \beta_2 GDP_t + \beta_3 CO_{2t} + \mu_t$$

Where:

FD = Financial Development (domestic credit to private sector % of GDP)
REC = Renewable Energy Consumption (% of total final energy use)
GDP = Economic Growth (GDP per capita growth rate)
CO_2 = Carbon dioxide emissions (metric tons per capita)
μ_t = Error term
β_0 to β_3 = Coefficients to be estimated

Estimation Technique

The Autoregressive Distributed Lag (ARDL) Bounds Testing Approach is used to test for long-run cointegration among variables and estimate both short-run and long-run dynamics. This method is suitable for variables integrated at I(0) and I(1).

A Priori Expectation

Variable	Expected Sign	Economic Justification
REC	+	Renewable energy drives sustainable investment and credit growth.
GDP	+	Economic growth supports financial system expansion.
CO_2	–	Environmental degradation may discourage investment confidence.

DATA ANALYSIS AND INTERPRETATION

Table 1 Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	Obs
FD	16.82	4.92	8.74	25.36	34
REC	31.54	5.80	22.10	41.60	34
GDP	2.45	4.31	-1.79	8.35	34
CO_2	0.65	0.19	0.38	0.95	34

Financial development averaged 16.82% of GDP, indicating moderate credit depth in Nigeria's economy. Renewable energy consumption averaged about 31%, reflecting dependence on renewable sources (mainly biomass and hydro).

Table 2 Correlation Matrix

Variables	FD	REC	GDP	CO_2
FD	1	0.63	0.41	-0.32
REC	0.63	1	0.27	-0.45
GDP	0.41	0.27	1	-0.11
CO_2	-0.32	-0.45	-0.11	1

There is a moderate positive correlation (0.63) between renewable energy consumption and financial development.

Table 3 Unit Root Test (ADF)

Variable	Level	1st Difference	Order of Integration
FD	Non-stationary	Stationary	I(1)
REC	Stationary	—	I(0)
GDP	Stationary	—	I(0)
CO_2	Non-stationary	Stationary	I(1)

Table 4 ARDL Bounds Test for Cointegration

Test Statistic	Value	Lower Bound	Upper Bound	Decision
F-statistic	5.31	3.79	4.85	Cointegration Exists

Table 5 Long-Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Inference
REC	0.217	0.081	2.68	0.013	Significant
GDP	0.498	0.122	4.08	0.000	Significant
CO_2	-0.091	0.047	-1.93	0.061	Marginally significant

Table 6 Short-Run Dynamics (Error Correction Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REC)	0.145	0.056	2.59	0.016
D(GDP)	0.213	0.092	2.31	0.027
D(CO_2)	-0.048	0.034	-1.41	0.167
ECT(-1)	-0.562	0.098	-5.73	0.000

Table 7 Diagnostic Tests

Test	Statistic	Prob.	Decision
Breusch-Godfrey (Serial Corr.)	0.62	0.43	No autocorrelation
Breusch-Pagan (Heteroskedasticity)	1.10	0.31	Homoscedastic
Jarque-Bera (Normality)	1.54	0.46	Normal distribution
Ramsey RESET	0.78	0.37	Correct model specification

Diagnostic results confirm the model is statistically valid, well-specified, and free from major econometric problems.

CONCLUSION

This study examined the relationship between renewable energy consumption and financial development in Nigeria using annual data from 1990 to 2023. The findings show that renewable energy consumption, economic growth, and environmental quality all play significant roles in shaping the country's financial system. The empirical results from the ARDL model indicate a long-run cointegrating relationship among financial development, renewable energy consumption, GDP per capita, and CO_2 emissions. This confirms that Nigeria's financial and energy sectors are structurally linked.

In the long run, renewable energy consumption has a positive and statistically significant impact on financial development. This suggests that increasing the use of renewable energy technologies such as solar, wind, hydro, and biomass supports investment expansion, strengthens credit markets, and encourages financial intermediation. The finding aligns with studies by Shahbaz et al. (2021) and Wang et al. (2021), who emphasized that renewable energy projects depend heavily on strong financial systems to mobilize capital and reduce investment risks [10], [9].

Economic growth also exhibits a strong positive effect on financial development, reinforcing the principle that a growing economy increases savings, investment demand, and overall financial market depth. This is consistent with King and Levine (1993), who argue that financial development and economic growth reinforce each other over time [3].

CO_2 emissions, on the other hand, show a mild negative relationship with financial development. Although marginally significant, this relationship suggests that environmental degradation may weaken investor confidence and discourage long-term financing—especially in economies seeking to transition toward greener and more sustainable energy systems.

The study concludes that renewable energy adoption is not just an environmental necessity but a financial catalyst capable of improving credit availability, attracting investment, and supporting sustainable economic transformation in Nigeria. Strengthening Nigeria's financial system through deeper capital markets, improved regulation, and affordable lending will be crucial for scaling renewable energy technologies. Policymakers should therefore integrate financial reforms with energy policies to ensure that renewable energy becomes a backbone for inclusive growth and long-term development.

Data Availability Statement

The datasets generated and used during the current study are available in the study.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

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