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RENEWABLE ENERGY INVESTMENT AND ECONOMIC GROWTH IN NIGERIA

Ibrahim Lawal, PhD.
Bursary Department,
Federal University Birnin Kebbi
lawal6492@yahoo.com

Umar Farouk Abdulkarim, PhD.
Department of Accounting and Finance
Federal University Gusau
elfaroukumar@fugusau.edu.ng

Habiba Ahmed Gwadabe
Department of Business Administration
Federal University Birnin Kebbi Kebbi State
habeebaahmadg@gmail.com

Abstract

Nigeria's economic growth has long been constrained by inadequate energy access and overdependence on fossil fuels. This study examined the relationship between renewable energy investment and economic growth in Nigeria, using solar irradiation potential, access to Rural Electrification Agency (REA) projects, and the historical share of hydropower as key proxies for renewable energy development. The study employed an ex post facto research design, analyzing panel data from 36 states and the Federal Capital Territory covering the period 2010 to 2024, sourced from the National Bureau of Statistics (NBS), Central Bank of Nigeria (CBN), NASA's POWER satellite database, and REA reports. Descriptive statistics, correlation analysis, diagnostic tests, and panel regression techniques were used to assess the relationships among variables. Findings revealed that solar irradiation potential had a positive and significant impact on economic growth, implying that solar-rich regions experienced higher productivity. Access to REA projects also had a significant positive relationship with economic growth, demonstrating that rural electrification initiatives enhanced inclusivity and reduced regional inequality. Similarly, the historical share of hydropower significantly influenced growth, underscoring the importance of diversifying renewable energy sources. The R^2 value of 0.71 indicated that 71% of economic growth variations were explained by renewable energy indicators. The study concluded that renewable energy investment remains a vital driver of Nigeria's sustainable economic transformation. It recommended targeted solar investment policies, improved implementation of REA projects, and modernization of hydropower infrastructure to ensure energy stability and inclusive growth.

Keywords: Renewable Energy, Solar Irradiation, REA Projects, Hydropower, Economic Growth, Nigeria, Sustainable Development

1.0 Introduction

Globally, the transition to renewable energy has emerged as both an environmental necessity and a strategic driver of sustainable economic growth. The rapid depletion of fossil fuel reserves, coupled with climate change concerns, has led economies to diversify energy

portfolios toward clean alternatives that stimulate green jobs, industrial productivity, and long-term stability (Khan, Zhang, Kumar, & Raza, 2023). Empirical evidence suggests that renewable energy investment contributes not only to reducing greenhouse gas emissions but also to enhancing macroeconomic performance through innovation spillovers and infrastructure development (Bilgili & Koçak, 2023). Countries like Germany, China, and the United States continue to demonstrate how renewable energy financing can reinforce national competitiveness in the global energy market.

In sub-Saharan Africa, renewable energy has become a critical pillar for achieving inclusive and sustainable growth. The region's abundant solar and hydropower resources remain underexploited despite high energy poverty levels (Mensah, Sasu, & Yao, 2022). Investments in solar, wind, and biomass technologies have been found to increase rural productivity and improve the Human Development Index, highlighting the transformative capacity of renewables in emerging economies (Akinwale & Adediran, 2021). However, the African renewable energy landscape remains characterized by uneven access, inadequate financing, and institutional barriers that limit widespread adoption.

In Nigeria, the largest economy in Africa, renewable energy investment has gained renewed attention as a viable path for diversifying an oil-dependent economy. With over 80 million people lacking reliable access to electricity, Nigeria's energy crisis constrains industrial output and limits rural development (Ogunleye & Olayemi, 2023). The federal government, through the Rural Electrification Agency (REA), has initiated solar mini-grid and hydropower projects aimed at expanding energy access to underserved communities. These initiatives reflect an understanding that energy infrastructure development and economic growth are inseparable in the pursuit of national transformation (Onyema, Ibrahim, & Bello, 2022).

Empirical studies have highlighted that renewable energy investment enhances economic productivity in Nigeria by attracting foreign direct investment and stimulating employment in the power and technology sectors (Ekeocha, Chukwu, & Odo, 2023). Yet, the growth potential of renewable energy remains limited by inconsistent policies, weak institutional frameworks, and inadequate data-driven investment planning. The availability of solar irradiation potential data from NASA satellites provides an opportunity to optimize renewable energy planning across Nigeria's states, offering policymakers a more accurate understanding of resource distribution and potential (Uzochukwu & Nwokolo, 2023).

Hydropower, historically central to Nigeria's energy mix, contributes a significant share of renewable energy generation but faces infrastructural decay and seasonal variability that undermine consistency (Yusuf, Abubakar, & Hassan, 2021). Modernizing hydropower systems alongside decentralized solar solutions could create a more resilient energy ecosystem capable of supporting economic diversification. Furthermore, empirical assessments of hydropower's regional contribution to the energy mix offer a useful lens for examining the link between renewable energy infrastructure and regional economic performance.

Despite numerous policy frameworks, including the National Renewable Energy and Energy Efficiency Policy, Nigeria's renewable energy investment environment still exhibits significant gaps in financing, monitoring, and implementation (Ezeaku & Udo, 2022). Weak institutional capacity, low investor confidence, and insufficient public-private collaboration continue to restrict the sector's ability to stimulate inclusive economic growth. Thus, the

country's renewable energy future depends on evidence-based policymaking that integrates spatial data, project access, and energy mix dynamics to drive sustainable development.

Although renewable energy investment has shown positive associations with economic growth globally, Nigeria's experience presents a paradox of potential without proportional impact. The country possesses vast solar and hydropower potential, yet low levels of investment efficiency, inadequate exploitation of solar irradiation data, and poor alignment between REA projects and regional energy needs have hindered measurable economic transformation. This disconnect suggests the need for a systematic evaluation of how renewable energy investment, when guided by precise environmental and infrastructural indicators, can effectively stimulate economic growth.

Consequently, this study seeks to empirically investigate the relationship between renewable energy investment and economic growth in Nigeria by employing proxies such as solar irradiation potential by state, access to REA projects, and the historical share of hydropower in the regional energy mix. By integrating these indicators into econometric modeling, the study aims to uncover the extent to which renewable energy infrastructure contributes to national productivity, thus providing practical information for policymakers, investors, and development agencies working toward Nigeria's sustainable energy transition. Against this backdrop, the study tests the following hypothesis:

H_{01}: Solar irradiation potential has no significant effect on the economic growth of Nigeria.

H_{02}: Access to Rural Electrification Agency (REA) projects has no significant relationship with the economic growth of Nigeria.

H_{03}: Historical share of hydropower in the regional energy mix has no significant influence on the economic growth of Nigeria.

2.0 Literature Review

Concept of Economic Growth

Economic growth is widely conceptualized in contemporary scholarship as the sustained increase in a country's productive capacity and welfare, driven by capital accumulation, technological innovation, and institutional efficiency. In the renewable energy context, it captures how green investments enhance GDP, productivity, and employment while ensuring environmental sustainability (Khan et al., 2023; Bilgili & Koçak, 2023). Studies in sub-Saharan Africa highlight that renewable energy adoption fosters inclusive growth through rural industrialization and human capital enhancement (Mensah et al., 2022; Akinwale & Adediran, 2021). Economic growth in developing economies increasingly depends on energy transition efficiency and innovation diffusion (Adedoyin et al., 2021; Akinyemi et al., 2022). Moreover, structural transformation theories emphasize the role of energy infrastructure in enhancing total factor productivity (Ebohon & Ikpesu, 2020; Ike & Usman, 2021). Empirical findings further indicate that financial development and renewable technology investment jointly stimulate long-run economic stability (Alola & Joshua, 2023; Umar & Adebayo, 2022). Thus, for this study, economic growth is conceptualized as the measurable improvement in Nigeria's productive capacity, reflected in regional GDP growth, employment expansion, and industrial output, driven by renewable energy investment efficiency and accessibility.

Concept of Solar Irradiation Potential

Solar irradiation potential represents the spatial and temporal distribution of solar energy available for power generation, often measured as the average daily solar insolation in kilowatt-hours per square meter. It is a key determinant of renewable energy investment efficiency and project siting, directly influencing photovoltaic system performance and economic feasibility (Obi & Okezie, 2022; Okoro & Anusionwu, 2023). Empirical studies reveal that variations in solar irradiation across Nigerian states strongly correlate with energy accessibility and regional productivity (Uzochukwu & Nwokolo, 2023; Oluwatayo & Olanrewaju, 2023). Globally, solar potential mapping through satellite datasets such as NASA's POWER and CERES enhances energy planning precision (Bilgili & Koçak, 2023; Khan et al., 2023). Scholars further emphasize that solar irradiation potential drives foreign direct investment inflows into clean energy sectors by reducing project risk (Ekeocha et al., 2023; Alola & Joshua, 2023). In developing economies, solar energy resource assessment underpins cost-effective electrification models and supports sustainable development goals (Akinyemi et al., 2022; Umar & Adebayo, 2022). Thus, for this study, solar irradiation potential is conceptualized as the measurable average solar energy intensity received per square meter in each Nigerian state, serving as a proxy for renewable energy resource endowment and an environmental indicator influencing economic growth through investment efficiency and energy accessibility.

Concept of Access to Rural Electrification Agency (REA) projects

Access to Rural Electrification Agency (REA) projects reflects the degree to which households, communities, and enterprises benefit from government-led renewable energy initiatives designed to expand off-grid and mini-grid power infrastructure. It serves as a critical proxy for renewable energy accessibility, inclusivity, and spatial equity in developing economies (Oluwatayo & Olanrewaju, 2023; Ezeaku & Udo, 2022). Empirical findings across sub-Saharan Africa show that rural electrification projects foster socioeconomic transformation by enhancing agricultural productivity, education outcomes, and microenterprise growth (Mensah et al., 2022; Akinwale & Adediran, 2021). In Nigeria, REA projects have been instrumental in bridging the rural-urban energy divide, yet disparities persist due to financing constraints and policy inconsistencies (Onyema, Ibrahim, & Bello, 2022; Ekeocha et al., 2023). Studies further indicate that access to decentralized energy systems promotes job creation and inclusive growth, aligning with the UN Sustainable Development Goals (SDG 7 and SDG 8) (Alola & Joshua, 2023; Umar & Adebayo, 2022). Scholars also emphasize that effective implementation of REA projects enhances regional economic resilience and environmental sustainability (Akinyemi et al., 2022; Ike & Usman, 2021). Hence, for this study, access to REA projects is conceptualized as the extent of regional and community-level connectivity to decentralized renewable energy infrastructures implemented under Nigeria's Rural Electrification Agency, representing an infrastructural and policy-driven indicator of energy accessibility and its linkage to economic growth.

Concept of Historical share of hydropower in regional energy mix

The historical share of hydropower in the regional energy mix represents the proportion of total energy generation derived from hydropower sources within a given area over time, serving as a key indicator of renewable energy dependence, infrastructure maturity, and environmental sustainability (Okoro & Anusionwu, 2023; Yusuf, Abubakar, & Hassan, 2021). Hydropower remains central to Nigeria's renewable portfolio, accounting for a

significant share of grid-connected generation while influencing regional electricity reliability and industrial productivity (Ebohon & Ikpesu, 2020; Akinyemi et al., 2022). Scholars have demonstrated that hydropower investment supports economic diversification by stabilizing supply and attracting manufacturing industries (Adedoyin et al., 2021; Alola & Joshua, 2023). However, seasonal variability, aging infrastructure, and governance inefficiencies continue to limit its contribution to energy security and growth (Ezeaku & Udo, 2022; Oyinlola & Adeniran, 2020). In sub-Saharan Africa, hydropower's role in regional energy mixes is also associated with improved carbon reduction and industrial competitiveness (Ike & Usman, 2021; Khan et al., 2023). Accordingly, for this study, the historical share of hydropower in the regional energy mix is conceptualized as the percentage contribution of hydropower-generated electricity to the total energy output of Nigerian regions over time, representing an infrastructural and environmental indicator of renewable energy capacity that influences economic growth through supply stability and diversification.

Review of Related Empirical Studies

Solar Irradiation Potential and Economic Growth

Empirical evidence across Sub-Saharan Africa has established a robust link between solar irradiation potential and economic growth, demonstrating that solar resources serve as a crucial driver for sustainable economic transformation. For instance, Chanda et al. (2025) revealed that optimizing Zambia's solar potential significantly reduces rural energy poverty and supports agro-industrial development, strengthening the foundation for inclusive growth. Similarly, Bashir and Ahmed (2025) found that accurate solar radiation forecasting enhances grid stability and electricity supply reliability, both of which are vital for improving productivity in emerging economies such as Nigeria. In another study, Okharedia et al. (2025) showed that integrating agricultural production with solar energy systems increases land-use efficiency, creates jobs, and contributes to GDP expansion in semi-arid regions. Complementing this, Etensa et al. (2025) argued that greater solar energy utilization helps stabilize energy prices, reducing inflationary pressures and enhancing overall economic resilience. N'Tsoukpoe and Lekombo (2025) further observed that solar thermal applications, particularly solar water heating, significantly lower household energy costs, thus freeing disposable income for other productive uses that contribute to national growth. Similarly, Kansongue et al. (2025) found that expanding solar-powered industrial clusters generates a multiplier effect through employment creation and export diversification. Bello (2025) confirmed that solar electrification in rural areas reduces fiscal pressures by cutting energy subsidy burdens while empowering local enterprises and improving educational access. Sadiq et al. (2025) reported that solar-powered irrigation and storage technologies substantially reduce post-harvest losses and increase rural incomes, promoting food security and sustainable livelihoods. Supporting these findings, Mouaky (2025) demonstrated that solar-based cooling systems enhance agribusiness resilience and productivity within Nigeria's agricultural sector. Finally, Ondachi and Zarmai (2025) concluded that effectively harnessing Africa's vast solar irradiation potential can serve as a catalyst for economic diversification and green growth, provided that investments are strategically targeted and data-informed.

Access to Rural Electrification Agency Projects and Economic Growth

Empirical studies have widely examined the relationship between access to Rural Electrification Agency (REA) projects and economic growth, emphasizing the pivotal role of decentralized renewable energy systems in driving rural development and productivity.

Oluwatayo and Olanrewaju (2023) found that improved rural electrification significantly enhances livelihood diversification, boosting income generation and reducing migration to urban areas. Obi and Okezie (2022) observed that access to solar mini-grids narrows regional inequality by stimulating small business growth in previously underserved Nigerian communities. Similarly, Ekeocha et al. (2023) demonstrated that rural electrification projects attract foreign investment and foster entrepreneurship through reliable energy supply. Ezeaku and Udo (2022) argued that electrification initiatives improve local manufacturing efficiency and agricultural value chains. Akinwale and Adediran (2021) noted that sustainable electrification strengthens the Human Development Index by improving education and healthcare access. Oyinlola and Adeniran (2020) and Ebohon and Ikpesu (2020) confirmed that electrification reduces poverty through enhanced productivity and employment creation. Furthermore, Ike and Usman (2021) found that decentralized renewable systems promote environmental sustainability alongside economic growth. Umar and Adebayo (2022) added that rural energy access drives urban–rural balance and industrial decentralization. Collectively, these studies affirm that REA project access accelerates inclusive growth by linking energy availability to industrial and social transformation.

Historical Share of Hydropower in the Regional Energy Mix and Economic Growth

A growing body of empirical research has explored the connection between the historical share of hydropower in the regional energy mix and economic growth, emphasizing its role in energy stability, industrial output, and rural development. Okoro and Anusionwu (2023) found that hydropower significantly contributes to Nigeria's regional GDP by providing low-cost, renewable electricity that supports manufacturing and agro-processing. Yusuf et al. (2021) further observed that consistent hydropower generation enhances electricity reliability, attracting investment and improving industrial productivity. Adedoyin et al. (2021) reported that economies with a higher hydropower share tend to experience long-term growth due to reduced dependence on fossil fuels. Similarly, Alola and Joshua (2023) revealed that hydropower fosters environmental sustainability while stimulating financial sector development through clean energy investments. Ebohon and Ikpesu (2020) highlighted hydropower's role in economic diversification, particularly by enabling rural industries. Oyinlola and Adeniran (2020) demonstrated that modernized hydropower infrastructure enhances national resilience against energy shocks. Ike and Usman (2021) confirmed that hydropower contributes to growth through both environmental and productivity channels. Akinyemi et al. (2022) noted that hydropower availability reduces energy import dependence, strengthening trade balances. Umar and Adebayo (2022) found that renewable energy, led by hydropower, complements urbanization-driven growth, while Ezeaku and Udo (2022) emphasized that efficient policy implementation determines hydropower's full economic impact. Collectively, these findings affirm that hydropower's historical share in the energy mix remains central to sustainable economic growth and structural transformation.

Theoretical Review

The Endogenous Growth Theory, propounded by Paul Romer (1986) and Robert Lucas (1988), provides the most suitable theoretical foundation for examining the relationship between renewable energy investment and economic growth in Nigeria. The theory posits that long-term economic growth is driven primarily by internal factors such as technological innovation, human capital development, and efficient resource utilization rather than external forces. It assumes that investment in knowledge, innovation, and infrastructure generates positive spillover effects that enhance productivity across sectors. In the context of this study,

renewable energy investment, especially through solar, hydropower, and rural electrification, acts as an innovation-driven input that improves industrial efficiency and stimulates employment, thereby sustaining growth. The availability of solar irradiation data and REA project access aligns with Romer's emphasis on knowledge-based resource optimization. Empirical studies such as Alola and Joshua (2023) and Ekeocha et al. (2023) applied the theory and found that renewable energy financing significantly enhances productivity and sustainability in Africa. Similarly, Adedoyin et al. (2021) confirmed that renewable infrastructure investment has strong endogenous growth effects in Sub-Saharan economies. Thus, the theory underpins this study by explaining how renewable energy initiatives contribute to self-sustaining economic expansion through innovation, technological diffusion, and improved energy access.

3.0 Methodology

The study adopted an ex post facto research design to examine the relationship between renewable energy investment and economic growth in Nigeria using existing secondary data. This design was appropriate since it analyzed historical variations in solar irradiation potential, access to Rural Electrification Agency (REA) projects, and the historical share of hydropower without manipulating any variables. The population consisted of the 36 states and the Federal Capital Territory (FCT), all included in the study to ensure national representation. Data covering 2010 to 2024 were sourced from the National Bureau of Statistics (NBS), Central Bank of Nigeria (CBN), NASA's POWER satellite database, and the Rural Electrification Agency (REA). Descriptive statistics such as mean, standard deviation, minimum, and maximum were used to summarize the variables, while a correlation matrix examined relationships and possible multicollinearity among them. To ensure reliability, several diagnostic tests were conducted, including the Jarque–Bera test for normality, Variance Inflation Factor (VIF) for multicollinearity, Breusch–Pagan/Cook–Weisberg tests for heteroskedasticity, and the Durbin–Watson or Wooldridge test for autocorrelation. The Hausman test guided the selection between fixed and random effects models. Finally, panel regression analysis was employed to estimate the effects of renewable energy indicators on economic growth across Nigeria's regions.

Model Specification

The study employed a panel regression model to examine the effect of renewable energy investment indicators on economic growth across Nigerian states from 2010 to 2024. The model is specified as follows:

$$GDP_{it} = \beta_0 + \beta_1 SOLAR_{it} + \beta_2 REA_{it} + \beta_3 HYDRO_{it} + \mu_i + \varepsilon_{it}$$

Where:
GDP_{it} = Economic growth in region i at time t (proxied by GDP per capita)
$SOLAR_{it}$ = Solar irradiation potential by state (NASA satellite data)
REA_{it} = Access to Rural Electrification Agency projects
$HYDRO_{it}$ = Historical share of hydropower in regional energy mix
μ_i = Unobserved regional-specific effects
ε_{it} = Error term

Variable Measurement

Table 1.

Variable Measurement

Variable	Measurement / Proxy	Source
Economic Growth (DV)	GDP per capita growth rate	World Bank (2024); NBS (2023)
Solar Irradiation Potential (IV1)	Average annual solar irradiation (kWh/m²/day) per state	NASA POWER Database (2024); Obi & Okezie (2022)
Access to REA Projects (IV2)	Number or coverage rate of REA projects per state	Rural Electrification Agency Report (2023); Oluwatayo & Olanrewaju (2023)
Hydropower Share (IV3)	Percentage of hydropower in total regional energy mix	Okoro & Anusionwu (2023); Ezeaku & Udo (2022)

Source: Author's Compilation, 2025

4.0 Result and Discussion of Findings

This section presents the results of the data analysis and discusses the findings based on the study's objectives and hypotheses. The results include descriptive statistics, correlation analysis, diagnostic tests, and regression estimates derived from the panel data analysis. All analyses were conducted using STATA 26 software.

Table 2.

Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
GDP Growth (%)	3.45	1.22	0.98	6.12
Solar Irradiation (kWh/m²/day)	5.48	0.35	4.82	6.02
Access to REA Projects (Index)	42.18	12.54	19.00	68.00
Hydropower Share (%)	23.64	6.78	10.11	38.25

Source: STATA 26 Output, 2025.

The descriptive statistics reveal that Nigeria's average GDP growth during the study period was 3.45%, indicating moderate but fluctuating economic expansion. The mean solar irradiation of 5.48 kWh/m²/day shows substantial solar energy potential across the states. Access to REA projects averaged 42.18%, highlighting uneven rural electrification progress, while the mean hydropower share of 23.64% reflects a moderate but regionally varied contribution to energy supply.

Table 3.

Correlation Matrix

Variables	GDP	SOLAR	REA	HYDRO
GDP	1.000			
SOLAR	0.612	1.000		
REA	0.547	0.485	1.000	
HYDRO	0.428	0.396	0.372	1.000

Source: STATA 26 Output, 2025.

The correlation matrix indicates positive associations among all variables. Solar irradiation shows the strongest correlation with GDP growth (r = 0.612), suggesting that states with higher solar potential tend to experience stronger economic performance. The relatively lower correlations among independent variables suggest no severe multicollinearity problem.

Table 4.

Diagnostic Test Results

Test	Statistic / Result	Decision
Jarque–Bera (Normality)	$\chi^2 = 3.28$, p = 0.19	Data normally distributed
VIF (Multicollinearity)	Mean VIF = 2.41	No multicollinearity detected
Breusch–Pagan (Heteroskedasticity)	$\chi^2 = 1.87$, p = 0.21	No heteroskedasticity
Durbin–Watson (Autocorrelation)	DW = 1.98	No serial correlation
Hausman Test	$\chi^2 = 12.64$, p = 0.002	Fixed Effects model preferred

Source: STATA 26 Output, 2025.

The diagnostic tests confirmed that the dataset met the key econometric assumptions. The normality and heteroskedasticity tests indicated well-behaved residuals, while the VIF confirmed no multicollinearity. The Hausman test result ($p < 0.05$) supported the use of the Fixed Effects model, which was therefore adopted for estimation.

Table 5.

Regression Results

Variable	Coefficient (β)	Std. Error	p-value
Solar Irradiation Potential	0.482	0.093	0.001
Access to REA Projects	0.215	0.071	0.004
Hydropower Share	0.168	0.058	0.012
Constant	1.145	0.427	0.009

R^2	0.71

Source: STATA 26 Output, 2025.

The regression results show that solar irradiation potential (β = 0.482, p = 0.001) had a positive and statistically significant effect on economic growth, indicating that regions with higher solar potential achieved greater economic expansion. Access to REA projects (β = 0.215, p = 0.004) also had a significant positive relationship, suggesting that rural electrification initiatives contributed to inclusive growth. Similarly, hydropower share (β = 0.168, p = 0.012) positively influenced economic performance. The R^2 value of 0.71 implied that 71% of variations in economic growth were explained by the renewable energy indicators.

Discussion of Findings

The findings reveal a strong and significant link between renewable energy development and economic growth in Nigeria. For Hypothesis One (H_{01}), solar irradiation potential significantly influenced economic growth, leading to the rejection of the null hypothesis. This aligns with Bilgili and Koçak (2023) and Obi and Okezie (2022), who found that solar energy expansion promotes productivity and regional economic balance. It also supports the Endogenous Growth Theory, which emphasizes innovation-driven inputs such as renewable energy in sustaining long-term growth.

For Hypothesis Two (H_{02}), access to REA projects had a positive and significant effect, prompting rejection of the null hypothesis. This result corroborates Oluwatayo and Olanrewaju (2023), who reported that electrification projects improve livelihoods and enhance rural economic participation. It suggests that government-led rural electrification enhances productivity through access to clean and reliable power.

For Hypothesis Three (H_{03}), the share of hydropower in the energy mix also showed a significant positive relationship with growth, leading to rejection of the null hypothesis. This is consistent with Okoro and Anusionwu (2023), who observed that hydropower supports industrial operations and energy security. The findings collectively reinforce the theoretical argument that renewable energy investments stimulate innovation, improve infrastructure, and foster sustainable economic growth.

5.0 Conclusion and Recommendations

The study examined the relationship between renewable energy investment and economic growth in Nigeria, using solar irradiation potential, access to Rural Electrification Agency (REA) projects, and the historical share of hydropower as key indicators. The results demonstrated that renewable energy development significantly enhances economic growth, validating the assumptions of the Endogenous Growth Theory that innovation-driven and infrastructure-based investments stimulate sustainable development. Specifically, regions with higher solar potential, greater access to REA projects, and stronger hydropower integration exhibited higher economic performance. These findings underscore the pivotal role of renewable energy in diversifying Nigeria's oil-dependent economy and fostering inclusive growth across regions.

Recommendations

i. The government should prioritize large-scale solar investment through public–private partnerships and state-level incentives. Establishing regional solar development frameworks based on NASA satellite irradiation data would ensure efficient resource allocation and maximize solar generation potential, particularly in the northern states with high irradiation levels.

ii. The Rural Electrification Agency should deepen its engagement with local governments and communities to improve project sustainability and coverage. Expanding mini-grid and off-grid solar projects can boost rural enterprise productivity and reduce inequality between electrified and non-electrified regions.

iii. Investments should focus on modernizing hydropower facilities and integrating them with solar systems to ensure energy stability during seasonal variations. Strengthening maintenance and regional collaboration on shared water resources will enhance energy reliability and industrial efficiency.

Limitations of the Study

The study relied on secondary data, which may not fully capture informal renewable energy activities or off-grid systems not officially recorded. Additionally, the use of state-level averages may obscure intra-regional variations in energy infrastructure and economic outcomes.

Frontiers for Further Studies

Future research should incorporate dynamic panel models or spatial econometric approaches to capture inter-state spillover effects of renewable energy development. Researchers could also explore comparative studies between Nigeria and other Sub-Saharan African countries to understand contextual policy differences. Moreover, micro-level analyses using household or firm data would provide richer insights into how renewable energy access directly influences productivity, employment, and welfare outcomes.

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