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RENEWABLE ENERGY AND IT'S ROLE IN EXPENDING ACCESS TO ELECTRICITY AND ECONOMIC GROWTH IN NIGERIA

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ABSTRACT

The study investigated, amongst other variables, the relationship between renewable energy, its role in expanding access to electricity, and economic growth in Nigeria over the period 1960–2023. The ordinary least squares (OLS) and autoregressive distributed lag (ARDL) models were used to estimate the short- and long run dynamics of the relationship.

The study shows that the overall model is statistically significant, meaning that the independent variables, taken together, significantly predict the dependent variable (GDP growth rates). The findings underline the intricate dynamics between renewable energy, electricity access, and economic growth in Nigeria. While the positive coefficient for renewable energy suggests that increasing renewable electricity generation could theoretically enhance GDP growth, the lack of statistical significance implies that this impact is not immediate.

Finally, based on these findings, the study recommends that policymakers should continue to prioritize investments in renewable energy infrastructure. Efforts should be made to enhance the reliability and quality of the electricity supply. A more robust and cohesive policy framework is needed to support renewable energy and electricity development and integration.

Keywords: Renewable Energy, Electricity, Economic Growth, Ordinary Least Square, Autoregressive Distributed Lag.

INTRODUCTION

Nigeria, despite being Africa's largest oil producer, struggles with inadequate electricity access. The power sector is plagued by unreliable supply, hampering industrial development, stifling economic growth, and limiting social progress. As of 2020, over half of Nigerians lacked access to reliable electricity, with rural areas disproportionately affected. The existing energy infrastructure in Nigeria heavily relies on fossil fuels, mainly gas and oil, which are vulnerable to price volatility and geopolitical tensions. This dependency has hindered sustainable development and energy security, exacerbating environmental degradation and contributing to climate change.

Renewable energy sources such as solar, wind, hydroelectric, and biomass offer a sustainable alternative to fossil fuels. Solar power, in particular, holds immense potential in Nigeria, given its abundant sunlight. Initiatives like the Solar Power Naija project aim to install solar home systems across rural communities, providing reliable electricity where the grid does not reach. Expanding access to electricity through renewable sources can catalyze economic growth by enabling industries to operate more efficiently, attracting investments, and creating job opportunities. For instance, the development of solar farms and mini-grids not only boosts local economies through construction and maintenance jobs but also supports small businesses and agricultural and manufacturing sector productivity (Steve, Murad, Gyamfi, Bekun, & Uzuner, 2022).

The Nigerian government has recognized the importance of renewable energy in its National Renewable Energy and Energy Efficiency Policy (NREEEP) Nebo, & Wakil, 2015). This policy framework aims to diversify the energy mix, promote private sector participation, and enhance energy efficiency across sectors. Additionally, initiatives like the Rural Electrification Fund (REF) support renewable energy projects in underserved areas (Akinyemi, et al., 2020). International partnerships and investments play a crucial role in scaling up renewable energy projects in Nigeria. Organizations like the World Bank, African Development Bank, and bilateral donors provide financial and technical support for infrastructure development and capacity building in renewable energy.

Technological advancements in renewable energy, such as improved battery storage systems and more efficient solar panels, are making off-grid solutions increasingly viable and cost-effective (Mohsin, Taghizadeh-Hesary, Iqbal, & Saydaliev, 2022). These innovations reduce reliance on centralized power generation and facilitate decentralized energy systems that are resilient to disruptions. Community involvement is integral to the success of renewable energy projects. Engaging local communities in project planning, implementation, and ownership fosters a sense of ownership and ensures sustainable long-term benefits. Capacity-building programs also empower local stakeholders with skills in installation, maintenance, and management of renewable energy systems. Beyond economic advantages, transitioning to renewable energy mitigates environmental impacts associated with fossil fuel combustion, reducing carbon emissions, combating climate change, and improving air quality, thereby safeguarding public health and ecosystem integrity.

Despite its potential, the adoption of renewable energy in Nigeria faces several challenges, including policy inconsistencies, inadequate infrastructure, financing constraints, and a lack of technical expertise. Overcoming these barriers requires coordinated efforts from government, private sector, and civil society stakeholders. Looking ahead, Nigeria can unlock its renewable energy potential through sustained political will, robust regulatory frameworks, and targeted investments in infrastructure and human capital. Embracing a diversified energy mix with renewables at its core can accelerate progress towards universal electricity access and inclusive economic growth. This study is structured into five sections: an introduction, a literature review, methodology and trend analysis, results and discussion, and policy recommendations to strengthen the role of renewable energy in expanding electricity access and driving economic growth in Nigeria.

SELECTED LITERATURE REVIEW

Literature is replete with studies on electricity performance and its contribution to development and growth, including topics like renewables and electricity, crude oil and agricultural output, electricity prices and economic growth, and investment in energy.

However, studies focusing specifically on renewable energy, its role in expanding access to electricity, and economic growth in Nigeria are sparse, highlighting the need for this research.

Evans (2024) explores the investment dynamics in renewable energy in Africa, using a nonlinear autoregressive distributed lag model. The study finds that rising oil prices increase renewable energy technology (RET) investments through a substitution effect, while falling oil prices decrease them. Additionally, rising GDP boosts RET investment, and declining ICT negatively impacts RET investment.

Idoko et al. (2024) compare renewable energy policies in Nigeria and the USA, examining the political and socioeconomic factors influencing policy formulation and the challenges in implementing renewable energy programs in both countries. Xu, et al. (2024) link energy efficiency, renewable electricity, human capital, and inclusive growth, suggesting government investment in technological development and innovation to enhance access to information and services, boost efficiency, create job opportunities, and support equitable growth.

Amadi, Madu, Ojuka, & Igbogidi, (2024) discuss the prospects and challenges of renewable energy in Nigeria, recommending the development of necessary structures, laws, infrastructure, and technology to harness renewable resources through public-private partnerships. Chanchangi, Adu, Ghosh, Sundaram, & Mallick (2023) highlight factors influencing solar energy adoption in Nigeria, while Muazu, Yu, & Liu (2023) analyze renewable energy consumption's impact on economic growth across 54 African countries, finding a non-linear and negative relationship.

Umeji, et al. (2023) find that renewable energy consumption significantly boosts economic growth in Nigeria using the Toda-Yamamoto augmented Granger causality test and ARDL. Noumba, & Nguea (2023) assess the role of globalization in universal electricity access, concluding that economic, social, and political globalization affect electricity availability, with economic globalization reducing access disparities. This study uniquely focuses on linking access to electricity, renewable energy, and economic growth in Nigeria, aiming to bridge the literature gap and capture energy improvement actions.

METHODOLOGY

The study used for analyzing the renewable energy and its role in expanding access to electricity and economic growth in Nigeria is based on regression analysis. Regression equations of gross domestic product growth rates to control other development indicators such as the electricity to renewable and access to electricity from 1960 to 2023. The data sourced from Central Bank of Nigeria (CBN) Statistical Bulletin and National Bureau of Statistics (NBS), and World Bank Development Indicator. Data set sourced were tested using the Augmented Dickey-Fuller (ADF) Unit root test, Johansen's co-integration test and Autoregressive Distributed Lag Models (ARDL). The stylized form of the regression equation is as follows:

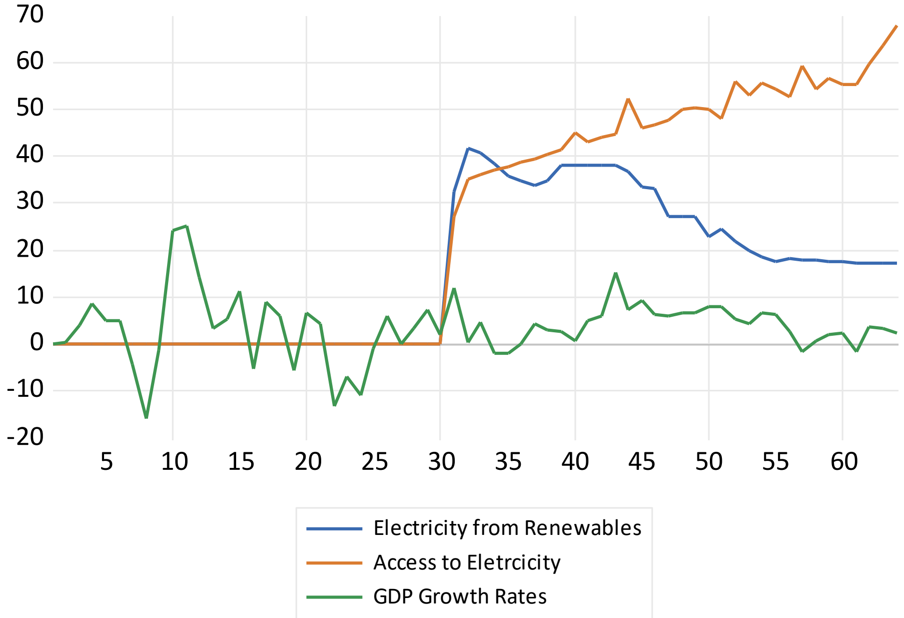

Figure 1. Trend in Electricity from Renewables, Access to Electricity and GDP Growth Rates

Model Specification

$$GDPGRt = \beta 0 + \beta 1ELECTRENt + \beta 2ACCESSELECTAt + \mu t$$

where:
GDPGR = Gross domestic product growth rate
ELECTREN = Electricity from renewable on GDPGR
ACCESSELECT = Access to electricity on GDPGR
μt = Random error term
β0 = Constant term
β1, and β2, = Coefficients for Electricity from renewable and Access to Electricity respectively.

As stated above in the study, the coefficient β1 captures the direct effect of electricity from renewable on GDPGR, while the coefficient β2 captures the direct effect of access to electricity on GDPGR. The gross domestic product growth rates are one of the economic growth indicators of Nigeria indirectly through its impact on the other controlled independent variables. Such indirect effects could be measured by including interaction terms between electricity from renewable and access to electricity as independent variables.

RESULTS AND DISCUSSION

Table 1 below shows the results of a linear regression analysis, where the dependent variable is GDPGR (gross domestic product growth rates) and the independent variables are ELECTREN (Electricity from renewable), and ACCESSELECT (Access to electricity by population).

The coefficient for the constant term (C) is 2.878271, indicating a positive intercept for the regression line. The coefficients for electricity from renewables are positive, while those for access to electricity are negative, suggesting that increases in renewable electricity are associated with higher GDP growth, while increases in electricity access are associated with lower GDP growth. The t-statistics for electricity from renewables are positive, and those for access to electricity are negative. The p-values for all independent variables, except for electricity from renewables and access to electricity, are greater than 0.05, indicating that they are not statistically significant predictors of GDP growth rate (GDPGR).

The R-squared value of 0.012833 indicates that the model explains only 1.28% of the variation in GDPGR, with an adjusted R-squared of -0.019533. The standard error of the regression is 6.914594, and the sum of squared residuals is 2916.508. The F-statistic of 0.396488 with a p-value of 0.674399 suggests that the overall model is not statistically significant. The Durbin-Watson statistic of 1.149987 suggests no significant autocorrelation in the residuals. Table 2 below presents the results of an Augmented Dickey-Fuller test, with GDPGR as the dependent variable and electricity from renewables (ELECTREN) and access to electricity (ACCESSELECT) as independent variables.

The table presents the results of an Autoregressive Distributed Lag (ARDL) model analyzing the impact of renewable electricity and access to electricity on GDP growth rates (Somoye, Ozdeser, & Seraj, 2022). With a sample of 63 observations and up to four lags for the dependent variable, the optimal model was selected using the Akaike Information Criterion (AIC). The lagged GDP growth rate has a significant positive coefficient (0.420447, p-value 0.0007), suggesting a momentum effect where past economic growth positively influences current growth. However, the variables for electricity from renewables and access to electricity show coefficients of 0.036736 (p-value 0.6640) and -0.008160 (p-value 0.8754), respectively, indicating no statistically significant impact on GDP growth. This suggests that while renewable energy might boost growth, its effect is not robust, and increased electricity access does not necessarily translate into higher GDP growth.

Table 1. Results of a linear regression analysis

Dependent Variable: D (GDP Growth Rates)
Method: ARDL
Date: 06/18/24 Time: 20:13
Sample (adjusted): 2 64
Included observations: 63 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic):Electricity from Renewab
Fixed regressors:C
Number of models evaluated: 100
Selected Model: ARDL (1,0,0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP Growth Rates (-1)	0.420447	0.117927	3.565327	0.0007
Electricity from Renewables	0.036736	0.084152	0.436542	0.6640
Access to Electricity	-0.008160	0.051813	-0.157500	0.8754
C	1.792468	1.225348	1.462824	0.1488
R-squared	0.186584	Mean dependent var		3.654395
Adjusted R-squared	0.145224	S.D. dependent var		6.887665
S.E. of regression	6.367928	Akaike info criterion		6.601812
Sum squared resid	2392.480	Hannan-Quinn criter.		6.737884
Log likelihood	-203.9571	Durbin-Watson stat		6.655330
F-statistic	4.511217			1.852294
Prob (F-statistic)	0.006468			

Source: Author's computation from Eviews 12.

Table 2. Results of a Augmented Dickey Fuller Test

Null Hypothesis: GDP Growth Rates has unit root
Exogenous: Constant
Lag Length: 0 (Automatic -based on SIC, maxlag=10)
Augmented Dickey-Fuller Test Equation
Dependent Variable: D (GDP Growth Rates)
Method: Least Squares
Date: 06/18/24 Time: 19:22
Sample (adjusted): 2 64
Included observations: 63 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP Growth Rates (-1) C	-0.573345 2.111549	0.115517 0.894415	-4.963281 2.360816	0.0000 0.0214
R-squared	0.287667	Mean dependent var		0.038254
Adjusted R-squared	0.275990	S.D. dependent var		7.377437
S.E. of regression	6.277372	Akaike info criterion		6.543011
Sum squared resid	2403.729	Schwarz criterion		6.611047
Log likelihood	-204.1048	Hannan-Quinn criter.		6.569770
F-statistic	24.63416	Durbin-Watson stat		1.860355
Prob (F-statistic)	0.000006			

Source: Author's computation from Eviews 12**.**

Table 3. Results of a Autoregressive Distributed Lag, (ARDL)

Dependent Variable: D (GDP Growth Rates)
Method: Least Squares
Date: 06/18/24 Time: 18:33
Sample (adjusted): 1 64
Included observations: 64

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C Electricity from	2.878271	1.259280	2.285647	0.0258
Renewables Access to	0.054319	0.091193	0.595654	0.5536
Electricity	-0.003428	0.056165	-0.061028	0.9515
R-squared	0.012833	Mean dependent var		3.597296
Adjusted R-squared	-0.019533	S.D. dependent var		6.848035
S.E. of regression	6.914594	Akaike info criterion		6.750886
Sum squared resid	2916.508	Schwarz criterion		6.852084
Log likelihood	-213.0284	Hannan-Quinn criter.		6.790753
F-statistic	0.396488	Durbin-Watson stat		1.149987
Prob (F-statistic)	0.674399			

Source: Author's computation from Eviews 12**.**

The model's constant term, with a coefficient of 1.792468 (p-value 0.1488), is not statistically significant, indicating that baseline GDP growth rates are not well-determined without considering the independent variables. The R-squared value of 0.186584 indicates that only 18.7% of the variation in GDP growth rates is explained by the model, with an adjusted R-squared of 0.145224, pointing to modest explanatory power. The standard error of the regression is 6.367928, and the Durbin-Watson statistic of 1.852294 suggests no significant autocorrelation in the residuals, enhancing the reliability of the estimates. The F-statistic of 4.511217 (p-value 0.006468) indicates that the model overall is statistically significant, meaning that the combined effect of all predictors significantly predicts GDP growth rates.

Despite the overall significance of the model, the low explanatory power and non-significance of individual variables highlight the need for more comprehensive models that incorporate additional factors. Policymakers should focus on creating an enabling environment that supports economic growth while addressing the complexities of integrating renewable energy and expanding electricity access. This approach can help achieve sustainable economic development and improve the livelihoods of citizens, emphasizing the importance of quality and reliability in electricity supply alongside renewable energy investments.

CONCLUSIONS

This study uses regression analysis to explore the role of renewable energy in expanding electricity access and driving economic growth in Nigeria from 1960 to 2023. Data from the Central Bank of Nigeria, National Bureau of Statistics, and World Bank Development Indicators underwent rigorous testing with the Augmented Dickey-Fuller Unit root test, Johansen's co-integration test, and Auto Regressive Distributed Lag Models. The primary regression model examines how electricity from renewables (ELECTREN) and access to electricity (ACCESSELECT) impact Nigeria's GDP growth rate (GDPGR). Results indicate that while renewable electricity has a positive coefficient suggesting a potential boost to GDP growth, this relationship is not statistically significant. Conversely, access to electricity shows a negative coefficient, though also statistically insignificant, suggesting a more complex relationship. The model's R-squared value of 0.012833 indicates that only 1.28% of the variation in GDP growth is explained by these variables, highlighting the need for more comprehensive factors in the analysis.

The findings underline the intricate dynamics between renewable energy, electricity access, and economic growth in Nigeria. The positive coefficient for renewable energy suggests that increasing renewable electricity generation could theoretically enhance GDP growth, but the lack of statistical significance implies this impact is not straightforward or immediate. The negative coefficient for access to electricity, although not significant, points to potential issues such as the quality and reliability of electricity supply affecting economic outcomes. The relatively low explanatory power of the model suggests that other critical determinants of economic growth, possibly including infrastructure quality, investment levels, and policy effectiveness, were not captured in this analysis.

RECOMMENDATIONS

Policymakers should prioritize investments in renewable energy infrastructure, including both large-scale projects and decentralized solutions like solar home systems and mini-grids, to provide reliable electricity to remote and underserved areas. Enhancing the reliability and quality of electricity supply is crucial, which could involve upgrading grid infrastructure, improving maintenance, and adopting advanced technologies to reduce power outages and technical losses. A robust policy framework supporting renewable energy development and integration is needed, featuring clear regulations, incentives for private sector participation, and mechanisms for policy consistency and stability. Financial constraints can be addressed through innovative financing solutions such as public-private partnerships, concessional loans, and grants, making renewable energy projects financially viable and attractive to investors. Continued collaboration with international organizations like the World Bank and African Development Bank can offer necessary financial and technical support, scaling up successful initiatives and introducing best practices.

Building technical expertise within the renewable energy sector through targeted training programs, capacity-building initiatives, and international partnerships is essential. Engaging local communities in planning and implementing renewable energy projects can enhance their success and sustainability, ensuring they meet specific local needs. Establishing robust monitoring and evaluation frameworks will help assess the effectiveness of renewable energy projects and policies, enabling continuous improvement based on empirical evidence and feedback. By addressing these recommendations, Nigeria can better harness its renewable energy potential to expand electricity access, drive sustainable economic growth, improve the livelihoods of its citizens, and contribute to global environmental goals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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