Available online at https://asric.africa/social-sciences
ASRIC Journal on Social Sciences and Humanities Vol. 5(1)(2024) 1-13

Effect of Energy Consumption on Economic Growth in Nigeria (1981-2023)

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Received 10 April 2024; revised 10 May 2024; accepted 3 June 2024

Abstract
This study examines the impact of energy consumption on economic growth in Nigeria provides critical insights into the complex dynamics between energy usage and economic performance over the period from 1981 to 2023. The study reveals that while fossil fuel consumption positively correlates with Gross Domestic Product (GDP), increased reliance on renewable energy sources has led to a significant decline in GDP. This finding challenges the common perception that renewable energy is inherently beneficial for economic growth, suggesting that the current economic structure in Nigeria may not be conducive to maximizing the benefits of renewable energy at this stage. Furthermore, the study emphasizes the importance of understanding the causal relationships between different types of energy consumption and economic growth. The Granger causality tests indicate that there is no significant predictive relationship between renewable energy consumption and GDP changes, which implies that policymakers must reconsider their strategies regarding energy investments. The findings highlight a pressing need for a balanced approach that recognizes the immediate economic benefits of fossil fuels while simultaneously planning for a sustainable transition to renewable energy sources. Based on the findings several key recommendations made to enhance economic performance while addressing sustainability concerns

Keywords: ARDL; Fossil Fuel Consumption; Gross Domestic Product (GDP)

1. Introduction
The global population's concentration in cities raises questions about urban sustainability. The United Nations World Urbanization Prospects Report predicts that urban areas would occupy over 70% of the global population by 2050. This figure emphasizes the necessity of tackling energy-related concerns, including efficiency, renewable sources, and reducing greenhouse gas emissions. As urban populations increase, so will the need for energy to power houses, transportation, and industry increase. To ensure the sustainability of increasing urban environments, it's important to design and execute energy policies that fulfill demand while reducing environmental effect and contributing to climate change mitigation. To address this dilemma, cities and economies worldwide are rethinking traditional development approaches and using energy economics ideas.

Renewable energy has quickly become a fashionable among researchers and policymakers equally as they seek solutions to global warming threats in particular, and climate change in general. It is widely acknowledged that there is no way to protect the climate unless energy production and consumption are dramatically altered (United Nations 2021). The new dawn is now ushering in renewable energy as the key to lowering greenhouse gas emissions and mitigating climate change and its global impact.

Because energy is used in so many different industrial, commercial, and consumer applications, it is crucial for long-term economic growth. Any modern economy must consume energy to function, as it serves as the physical engine for both industrial innovation and economic growth. Energy sources are separated into two groups by Kailash et al. (2024): renewable and non-renewable. Renewable energy sources that replenish themselves after use include solar, wind, hydro, and biomass energy.

Energy is produced through burning fossil fuels, which include coal, natural gas, and products derived from crude oil. Heat-trapping gases, like carbon dioxide, are produced and released when hydrocarbons are used to generate electricity. They don't run out, but they are sometimes unavailable, which leads to sporadic electricity production. This has an impact on human health as well as climate change.

Both residential and industrial energy consumption contribute positively and significantly to Nigeria's economic growth. Research from 1980 to 2022 shows that increased energy consumption correlates with increased economic output, emphasizing energy as a critical driver of growth in a variety of sectors. Industrial energy consumption has a positive and significant impact on economic growth. Industries rely heavily on energy for their production processes, and increased energy availability can result in higher output levels, job creation, and overall economic growth. This research work therefore aimed at answering the following questions:

1. What was the influence of energy consumption to economic growth in Nigeria?
2. Had Fossil Fuel Consumption affected Nigerian economic growth?
3. Did energy consumption exert a positive impact on the economic growth of Nigeria?

The following Hypothesis will be addressed

H1: energy consumption has significant impact on Nigerian economic growth.

H2; Fossil Fuel Consumption has significant impact on economic growth in Nigeria.

H3 energy consumption wields a positive impact on the economic growth of Nigeria

The broad or general objective of this research is to identify the general impact of energy consumption on Nigerian economic growth. The research would specifically investigate the following:

1- To examine the impact of energy consumption on economic growth in Nigeria.

2- To find out the effect of Fossil Fuel Consumption on Nigerian economic growth.

3- To investigate the energy consumption impact on the economic growth of Nigeria.

2.1 Theoretical Literature

Energy Consumption Theory

Energy consumption theory is critical for energy research. This study investigates energy consumption patterns and trends in various industries and societies. The concept acknowledges the finite nature of energy and emphasizes the importance of effective utilization for sustainable development. The theory investigates how individuals and organizations use energy and the factors that influence consumption patterns. The goal is to explain why and how people consume energy, as well as the various factors that influence it. The concept assumes that people and organizations are rational and want to maximize utility by making the best use of available energy resources. B. Vosooghzadeh (2020 Economic variables, technology, cultural and societal norms, individual attitudes and beliefs, and government policies all influence energy consumption. Economic growth drives up energy consumption in businesses and manufacturing processes. Manufacturing requires significant energy for production, transportation, and logistics. Economic growth usually results in increased energy consumption. Economic factors, including energy costs, have a significant impact on energy consumption patterns (Umar et. al. 2024). When energy prices rise, people and businesses may choose to use less energy or invest in energy-saving technology. Finally, the theory of energy consumption offers a framework for comprehending the numerous factors that influence consumption patterns.

Renewable Energy Consumption Theories

Growth models via resources from nature and advances in technology incorporate natural resource considerations and technological advancements into economic growth frameworks. They investigate how technological advancements and technical change can potentially mitigate the constraints imposed by finite natural resources, such as non-renewable energy sources such as fossil fuels (Aghion & Howitt, 1998). These models, which use technological progress as an engine, suggest that even when the elasticity of replacement among capital and finite resources is less when compared with one, sustained economic growth can be achieved through increases in total factor productivity.

However, certain conditions and assumptions must be met for technological change to make sustainability technically feasible in the long run. These models shed light on the relationship between resource constraints, technological advancements, and economic growth patterns. This socioeconomic theory of renewable energy adoption investigates the socioeconomic factors influencing the acceptance and use of renewable energy technologies in various communities and societies. It investigates factors such as income, educational attainment, and societal attitudes toward the environment and sustainable practices. The theory proposes that increased wealth and more effectively access to education may promote the adoption of renewable energy solutions by increasing affordability and promoting more knowledge and expertise (Brown & Sovacool, 2011).

Concept of Economic Growth

Nash (2021) defines economic growth as an increase in potential output over time. It can be represented as a rightward shift in the production possibility frontier. Economic growth causes a shift in the long-term aggregate supply curve. According to the Reserve Bank of Australia (2018), economic growth is defined as an exponential increase in the size of a country's economy over time, as measured by the total production of goods and services in the economy, also known as GDP. They claimed that economic growth can be measured in both nominal and real terms. Nominal economic growth is the increase in the dollar value of production over time. This explains fluctuations in production volume and post-production prices for goods and services. Real economic growth is defined as an increase in output and the effect of prices.

An increase in a country's GDP is typically indicative of economic growth. In other words, a country's output is reflected in its GDP via an economic model. GDP is the total monetary value of a country's goods and services produced over a given time period. Mian and Zhang (2021) defined economic growth as an increase in the production and consumption of goods and services over a given time period, resulting in an improvement in the population's standard of living. Investment, technological advancement, and a supportive political climate that promotes innovation, entrepreneurship, and sustainable development are some of the factors driving this growth.

2.2 Empirical Literature

Warsame et al. (2024) investigate the disparate impact of energy use on Somalia's economic growth from 1985 to 2017. They employ a unique econometric approach known as the Nonlinear Autoregressive Distributed Lag (NARDL) methodology and the Granger causality test to determine the goal of their research. Their empirical results revealed a long-term uneven co-integration of energy usage and economic growth. Both positive and negative energy consumption shocks increase Somalia's long-term economic development, although the positive shock has a higher impact. A negative shock to energy use, on the other hand, boosts economic growth, proving the energy-led growth notion. As a result, policymakers must devise investment strategies aimed at expanding both foreign and local energy investments.

Kailash et al. (2024) provides an innovative approach to studying the link between economic growth, energy consumption, and carbon dioxide (CO2) emissions by contrasting emerging countries, notably those in South Asia, with industrialized areas represented by the G-7 countries. The study is based on data from 1996 to 2021. To get a thorough knowledge of these complicated linkages, they employ a variety of analytical approaches such as panel regression models, simultaneous regression models, and panel autoregressive distributed lag (ARDL) models. The data show that energy consumption promotes economic growth in both G-7 and South Asian nations. Furthermore, CO 2 emissions have been shown to boost economic growth in both locations. CO_2 emissions have a favorable impact on both groups' energy use. Their data also show that financial development and population increase boost energy consumption in South Asian countries. Their findings show that increased energy usage correlates with higher CO_2 emissions. Renewable power has been related to lower CO_2 emissions in the G-7. In light of their results, authorities should emphasize long-term economic growth by supporting energy-efficient technology and renewable energy sources. Furthermore, boosting the usage of renewable energy sources can help to reduce CO_2 emissions and protect the environment.

Ibadullaev et al. (2024) examine the relationship between renewable and non-renewable energy consumption and GDP growth using secondary data from the World Bank and International Energy Agency for Uzbekistan from 1990 to 2021. The Autoregressive Distributed Lags (ARDL) model is used in this research to estimate the long- and short-run dynamic multipliers of energy consumption variables. Empirical evidence suggests that hydroelectric energy usage (renewable energy) has a long-term beneficial impact on GDP growth. Consumption of nonrenewable energy resources (coal, natural gas, oil) boosts GDP growth in both short and long term. Furthermore, increased consumption of non-renewable energy resources has a beneficial influence on CO_2 emissions, implying that the government should take steps to increase the proportion of renewable energy resources.

Umar et al. (2024) investigates the link between renewable energy use and economic development in Nigeria using time series data from 1996 to 2021. The unit root findings demonstrate mixed stationarity in their variables, resulting in the use of the ARDL analysis approach. The long-run data demonstrate that renewable energy was negative and substantial, which supports the conservative theory. C02 was likewise adversely significant for RGDP, whereas labor force was positively significant. The ECM indicates a 77% adjustment level returning to equilibrium. The Granger causality test supported the feedback hypothesis of no correlation between renewable energy and the Nigerian economy.

Olamide et al. (2024) analyze the impact of renewable energy consumption on economic growth while also evaluating the dynamic link between the two variables from 1990 to 2022. The analysis examined annual secondary data from 1990 to 2022. World Development Indicator included data on real GDP, renewable energy consumption (% of total final energy consumption), gross capital creation (% of GDP), labor force, total commerce (% of GDP). The study uses the Johansen co-integration test and the Vector Error Correction Model (VECM) to investigate the impact of renewable energy consumption on economic development and other explanatory factors, as well as the pairwise granger causality test to investigate the causal link between both variables. The empirical research showed a long-term link between renewable energy usage and economic development. There is no evidence of either unidirectional or bidirectional causation between the two variables. In the near run, renewable energy use has had a considerable beneficial influence on economic growth. This demonstrates that renewable energy may drive economic growth, particularly because it has a stronger short-term influence on economic growth than capital formation. The main policy implications of the findings include the need for investment in renewable energy technology and infrastructure, which may assist to boost the availability and affordability of renewable energy and promote workforce development in Nigeria's renewable energy sector.

Rusiadi et al. (2024) recognized and evaluated the impact of natural resources, CO_2 emissions, and renewable energy on the economic growth of ASEAN nations. In this work, we compared a dynamic panel data model to static panel data to determine if a dynamic process occurred. The dataset utilized is a time series of ASEAN nations from 2000 to 2021. Static and dynamic panel data were employed in the analysis. Natural resources, FDI, and renewable energy all have a major beneficial impact on ASEAN economic growth, according to the study's findings. CO_2, on the other hand, has a detrimental but minor effect. These findings demonstrate that the ASEAN region's economic development has prioritized renewable energy.

Anyuabaga et al. (2024) studied the relationship between power usage and economic development in Nigeria from 1980 to 2023. The study utilized time series analysis. The study employed RGDP as a proxy for economic growth, with REC and STEC serving as explanatory factors. The study used an ex-post facto research approach, with the Fully Modified Ordinary

Least Squares (FMOLS) model. The data analysis methods used in this work include the Augmented Dickey Fuller test, the Johansen Co-Integration Test, Granger causality, descriptive statistics, and trend analysis. The study found that energy use had an influence on economic growth in Nigeria. The REC has a positive and minor influence on Nigerian RGDP. The STEC has a negative and severe influence on Nigerian RGDP. The report proposed, among other things, that the government prioritize expenditures in energy infrastructure to assure continuous power supply, as well as a supportive policy to foster industry and economic value addition. In addition, the government should focus on diversifying energy sources, considering electricity efficiency initiatives, and implementing tariff reforms to make electricity more affordable and accessible, particularly for vulnerable populations, while incentivizing efficient electricity consumption patterns in order to boost Nigeria's economy.

Sheila Nyasha (2024) Motivated by the study country's active participation in reducing global greenhouse gas emissions and the positive strides it has made domestically in increasing renewable energy in its energy mix, on the one hand, and the need to determine whether renewable energy consumption can also help to revive the economy, on the other, this study empirically examines the dynamic impact of renewable energy consumption on economic growth in Zimbabwe. Using yearly time-series data from 1990 to 2019, as well as the autoregressive distributed lag technique, the study's findings suggest that renewable energy usage in Zimbabwe has a beneficial influence on economic growth in both the short and long term. Increasing the use of renewable energy boosts the economy of the country under investigation. These findings suggest that Zimbabwe may achieve two goals with a single strategy: boosting renewable energy consumption to mitigate the negative effects of climate change and greenhouse gas emissions on the environment and economy, and enhancing economic growth. Policymakers in Zimbabwe are thus advised to favor increasing usage of renewable energy over other energy sources, since this would have beneficial repercussions for the economy, both in the short and long term.

Obindah et al. (2024) used static panel simulation techniques using yearly data from 2000 to 2017 to study the interaction influence of energy consumption and economic growth on carbon emissions in seventeen chosen African nations. Data was analyzed using two static panel estimating techniques: Random Effects (RE) and Fixed Effects (FE). Feasible Generalized Least Squares (FGLS) is also employed, together with a fixed and random effect model. The findings indicate that increasing energy use has a beneficial impact on economic growth while having a negative impact on carbon emissions. However, the economic benefit of energy usage outweighs the negative environmental effects. Our findings have important implications for the environment, as the move to renewable energy is mitigating the negative consequences of increased energy use and economic development. So, when extending the energy intensity theory to Sub-Saharan Africa, a change is suggested: carbon emissions are exactly proportionate to the quantity of fossil fuel energy consumed per unit of production. We advocate prioritizing economic growth and the productive use of energy in order to effectively reduce the negative environmental impact of energy use. Future research might look at expanding the number of countries, and if data is available, an artificial intelligence experiment could be conducted to test the veracity of prior findings. We further propose that future research investigate the permanence of emissions utilizing energy and growth as key independent and moderating variables.

David et al. (2024) examines the present energy situation in Nigeria, the Nigerian RE program, the RE resources in Nigeria, climate change mitigation activities, the difficulties of RE technologies in Nigeria, and offer a path ahead. The report highlights renewable energy potentials such as wind, biomass, hydro, and solar technologies and how they might be used to mitigate climate change. Increased usage of such energy resources in Nigeria will significantly reduce carbon dioxide emissions, hence mitigating climate change. Finally, the study makes recommendations on how to conserve the country's current energy generation through the use of energy-efficient goods and activities.

Olugbenga Olaoye (2024) investigates the link between environmental quality, energy consumption, and growth performance in selected African countries from 1981 to 2019. The panel data is analyzed using a co-integration analytical approach based on the framework of fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS). The empirical findings demonstrate that environmental quality (CO_2 emissions) has a favorable and significant influence on African economic growth. Energy usage has a strong beneficial influence on economic growth. Furthermore, the interplay between environmental quality and energy consumption has a favorable and considerable economic growth impact. At a crucial value of 1%, the FMOL evidence shows that all of the essential factors are significant. As a result, the report suggests that African governments commit to long-term actions to promote economic growth and development, based on Africa's goal of achieving prosperity and a quality environment by 2063.

3.0 Methodology

3.1 Research Design

This study conducted using econometric analysis. ARDL estimation technique was used in carrying out the analysis. The author included other independent variables in the model because they have been observed in the literature to have a strong influence on the manufacturing sector.

3.2 Source of Data

Data for the analysis in this study was annual data consists of 43 observations collected from the Statistical review of World Energy (2023) and World Development Indicators (2023). The study employed various statistical and econometrics tools to investigate the relationship between Renewable Energy Consumption, fossil fuel consumption, Urbanization and labour force and economic growth in Nigeria.

3.3 Model Specification

The model for this study is specified based on economic theory and previous research such as that of Anyuabaga et al. (2024) & Rusiadi et al. (2024) The study employs five variables. Gross Domestic Product is the dependent variable while Renewable Energy Consumption, fossil fuel consumption, Urbanization and labour force are the independent variables. The five variables' interactions were empirically investigated using an interactive econometric model.

Description of variable definitions;

Gross Domestic Product (GDP)

Gross Domestic Product (GDP) is a comprehensive measure of a country's total economic activity. It represents the total monetary value of all finished goods and services produced within a country's borders over a specific time period, which is usually annual or quarterly. GDP is the sum of consumption, investment, government spending, and net exports (exports less imports). It is widely used to assess the health of a country's economy and to compare economic performance across countries or time periods.

Renewable Energy Consumption

Renewable energy consumption is the use of energy sources that can be replenished naturally during a human lifetime. Geothermal energy, wind, solar, and hydroelectric power are some of the sources. Renewable energy is considered more sustainable and environmentally friendly than fossil fuels because it emits little to no greenhouse gases. The use of renewable energy is measured by the total amount of energy produced and consumed from these sources, and it is critical in reducing a country's carbon footprint.

Fossil Fuel Energy Consumption

Fossil fuel energy consumption refers to the use of nonrenewable energy sources extracted from the Earth's crust. Coal, oil, and natural gas are some of the fuels used to generate energy. Fossil fuels produce a significant amount of greenhouse gas emissions, which contribute to climate change and environmental degradation. The consumption of fossil fuels is commonly measured in terms of energy output (e.g., BTUs or kilowatt-hours) and is an important factor in determining a country's energy policy and environmental impact.

Urbanization

Urbanization is defined by the concentration of a large number of people in relatively small areas, resulting in cities. The definition of an urban area varies significantly across countries. For example, in the United States, a "urban place" is defined as any community with more than 2,500 people, whereas in Peru, it refers to population centers with at least 100 homes. Historically, urbanization has been a gradual process that began around 10,000 BCE with the establishment of permanent settlements in the Neolithic Period. By 1800, only about 3% of the global population lived in cities with populations greater than 20,000; this figure rose to approximately 25% by the mid-1960s and surpassed 50% by the early twenty-first century.

Labour

labor is regarded as a factor of production alongside land and capital. It encompasses all forms of human labor that produce goods and services for an economy. Labour can be classified into different types based on skill levels.

The labor market is undergoing significant changes as a result of demographic shifts, economic conditions, and technological advancements.
Here are some key insights into these emerging trends.

GDP: Gross Domestic Product (Current US$)

REC: Renewable Energy Consumption. (% of Total Energy Consumption)

FFE: Fossil Fuel Energy (% of Total Energy Consumption)

URB = Urbanization

LAB = Labour

This study employs four variables. Gross Domestic Product is the dependent variable while Renewable Energy Consumption, fossil fuel consumption, Urbanization, Labour are the independent variables.

GDP = f (REC, FFC, URB, LAB) where:

GDP = Economic Growth.

REC = Renewable Energy Consumption,

FFC = fossil fuel consumption

URB = Urbanization

LAB = Labour

Ut = Functional notation

In a model form:

LG f(GDP) ………………………………………………. (1)

GDP = f (REC, FFC, URB, LAB) ………………………. (2)

GRGDP= β0 + β1REC, + β2FFC, + β3URB + β4LAB+ Ut

3.4 Estimation Technique

In order to achieved the stated objectives this study employed ordinary least square (OLS) method of parameters estimation technique using econometric views 12 (e-views 12) statistical package to run the regression of the data so as to find the level of relationship between the dependent and independent variables. The evaluation will be based on three criteria; economic criteria, statistical criteria and econometrics criteria.

4.0 Results and Discussions

Descriptive Statistics Table 4.1: Summary Statistics

	RGDP	REC	FFC	URB	LAB
Mean	272.3124	6812282.	8165181.	149.2813	7602.865
Median	258.3579	3510236.	7817219.	130.5350	6310.050
Maximum	574.1838	27115109	27251572	397.0800	19818.38
Minimum	52.05818	89488.20	121535.4	9.910000	75.46000
Std. Dev.	168.7187	7449165.	7287989.	112.9014	7307.273
Skewness	0.108932	1.201093	0.665907	0.759920	0.368173
Kurtosis	1.554058	3.567514	2.632767	2.723827	1.547013
Jarque-Bera	2.850952	8.123423	2.544787	3.181584	3.537835
Probability	0.240394	0.017220	0.280160	0.203764	0.170517
Sum	8713.996	2.18E+08	2.61E+08	4777.000	243291.7
Sum Sq. Dev.	882445.7	1.72E+15	1.65E+15	395148.4	1.66E+09

Observations	43	43	43	43	43

Source: Author Computation EViews 10 Softwire 2024

Table 4.1 suggest that the mean Medium, minimum and maximum value of Real Gross Domestic Product in billions are 272.3124, 258.3579, 574.1838 and 52.05818 respectively, also mean, Medium, minimum and maximum value of Renewable Energy Consumption 6812282, 3510236, 27115109, and 89488.20 respectively, it is also reported on table mean medium, minimum and maximum value of Urbanization are 8165181, 7817219, 27251572 and 121535.4; that mean medium, minimum and maximum value of fossil fuel consumption are 149.2813, 130.5350, and 397.0800 that mean medium, minimum and maximum value of credit provided by labour are 7602.865, 6310.050, 19818.38 and 75.46000. However, all the variables are positively skewed given their positive skewed valued. The Jarque-Bera value of all the distributions are normally distributed since their probability value is greater than five per cent level of significance except for exchange rate.

Correlation Matrix

Table 4. 2. Correlation Matrix.

	RGDP	REC	FFC	URB	LAB
RGDP	1				
REC	0.8086135154237749	1			
FFC	0.8655968739193215	0.922234909235776	1		
URB	0.7086750362875899	0.9264388046039442	0.863770567916517	1	
LAB	0.9153987053821582	0.9250328308245594	0.9113972625407172	0.8996576153304705	1

Source: Author Computation EViews 10 Softwire 2024

Table 2 presents a correlation matrix, which summarizes the strength and direction of linear relationships between five variables: The diagonal elements (1.000000) represent the perfect positive correlation of each variable with itself. RGDP exhibits a strong positive correlation with, REC, FFC, URB and LAB at coefficient value of 0.8086135154, 0.8655968739, 0.7086750362 and0.9153987053 respectively.

Unit Root Test

Table 4. 3 Augmented Dicker Fuller (ADF) Unit Root Test

VARIABLE	ADF statistics	5% CRITICAL VALUE	PROB	ORDER
RGDP	-4.475689	-2.963972	0.0013	I(I)
REC	-5.371238	-2.967767	0.0001	I(I)
FFC	-3.981790	-2.963972	0.0046	I(I)
URB	-4.404836	-2.963972	0.0016	I(I)
LAB	-4.156118	-2.960411	0.0029	I(I)

Source: Author Computation EViews 10 Softwire 2024

Phillips-Perron Test Equation

Table 4. 4 Phillips-Perron Test Equation

VARIABLE	PP statistics	5% CRITICAL VALUE	PROB	ORDER
RGDP	-4.404147	-2.963972	0.0016	I(I)
REC	-3.574801	-2.963972	0.0126	I(I)
FFC	-3.944056	-2.963972	0.0051	I(I)
URB	-4.298370	-2.963972	0.0021	I(I)
LAB	-4.256118	-2.760411	0.0020	I(I)

Source: Author Computation EViews 10 Softwire 2024

In order to examine the integrating level of variables, standard test such as Dickey and Fuller (1979) and Phillips-Perron Test. Table 2 and 3 shows the result ADF and PP test statistics Show that, RGDP, REC, FFC, URB and LAB have I(1) and this mean they are stationary at a first difference. The result reported that they are significant at 5 per cent level of significance.

ARDL Bound Test

Table 4.5 Cointegration Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic		10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
Actual Sample Size	43		Finite Sample: n=43	
		10%	2.525	3.56
		5%	3.058	4.223
		1%	4.28	5.84

Source: Author Computation EViews 10 Softwire 2024

The ARDL Bounds Test is used to determine if there is a long-run cointegrating relationship among the variables. The null hypothesis is that there is no cointegration. The calculated F-statistic of 21.21875 is greater than the upper bound critical value of 3.45. When the F-statistic exceeds the upper bound critical value, it provides evidence to reject the null hypothesis of no cointegration at the chosen significance level (e.g. 5%).

Long Run ARDL Result

Table 4.6 Long Run ARDL Result

Levels Equation				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
REC	-2.25E-05	1.74E-05	-1.298207	0.2090
FFC	4.01E-05	2.08E-05	1.928830	0.0681
URB	0.002330	0.902749	0.002581	0.9980
LAB	0.025016	0.014761	1.694674	0.1057
C	311.7560	128.1820	2.432136	0.0245
EC = RGDP - (-0.0000*REC + 0.0000*FFC+ 0.0023* URB+ 0.0250* LAB +				

Source: Author Computation EViews 10 Softwire 2024

The coefficient of REC indicates a very small negative relationship between REC and the dependent variable in the regression model. This suggests that for each unit increase in the independent variable (which could be a measure such as GDP, income, etc.), REC decrease by 0.0000225 0.0000225 units, holding all other variables constant. Statistical Significance p-value: The p-value of 0.2090 is greater than the conventional significance level of 0.05. This means that the result is not statistically significant. In practical terms, we fail to reject the null hypothesis, which implies that the relationship observed between imports and the independent variable may not be reliable or meaningful in the context of the model. This is in line with the results of Omoke and Opuala–Charles (2021) shows that the negative long-term effects of REC on economic growth increase when institutional quality in Nigeria becomes less pronounced.

The coefficient of 4.01 indicates a strong positive relationship between FFC and the dependent variable in the regression model. This suggests that for each unit increase in the independent variable (which could be a measure such as GDP, income, etc.), FFC increase by 4.01 units, holding all other variables constant. Statistical Significance p-value: The p-value of 0.0681 is slightly greater than the conventional significance level of 0.05. This means that the result is not statistically significant at the 5% level. However, it is close to being significant at the 10% level. In practical terms, we can say that there is some evidence against the null hypothesis, implying that the relationship observed between FFC and the independent variable may be meaningful in the context of the model, but more data or analysis would be needed to draw a stronger conclusion.

The Johansen cointegration test demonstrated long-term connections between real GDP, Renewable Energy Consumption, fossil fuel consumption, Urbanization and labour in the country. Rusiadi et. al. (2024) found that Renewable Energy Consumption had a significant and positive impact on Nigeria's economy over the time period studied. Additionally, Renewable Energy Consumption had a considerable influence on GDP, according to a study. Olamide et. al. (2024) results/findings revealed that the independent variables: Renewable Energy Consumption, fossil fuel consumption, Urbanization and labour have positive significant impact on GDP.

The coefficient of 0.002330 indicates a very small positive relationship between the URB and the dependent variable in the regression model. This suggests that for each unit increase in the URB, the dependent variable increases by 0.002330 units, holding all other variables constant. p-value: The p-value of 0.0998 is slightly greater than the conventional significance level of 0.10 (10%). This means that the result is not statistically significant at the 10% level. However, it is very close to being significant at this level. In practical terms, we can say that there is some evidence against the null hypothesis, implying that the relationship observed between the exchange rate and the dependent variable may be meaningful in the context of the model, but more data or analysis would be needed to draw a stronger conclusion.

The coefficient of 0.025016 indicates a positive relationship between the LAB and economic growth. Specifically, this suggests that for each unit increase in LAB, economic growth increases by approximately 0.025016 units, holding all other factors constant. p-value: The p-value of 0.1057 is greater than the conventional significance level of 0.05, indicating that the result is not statistically significant at the 5% level. However, it is close to the 10% significance level.

The coefficient of 311.7560 represents the expected value of the dependent variable when all independent variables in the model are set to zero. In practical terms, this constant can be seen as the baseline level of the dependent variable, indicating that even in the absence of any influence from the independent variables, the dependent variable is expected to be approximately 311.76. p-value: The p-value of 0.025 is less than the conventional significance level of 0.05. This indicates that the constant is statistically significant, meaning there is strong evidence against the null hypothesis (which posits that the coefficient is equal to zero). Therefore, we can conclude that the constant value is significantly different from zero, suggesting that it plays a meaningful role in the model.

Short Run ARDL Result

Table 4.7 Short Run ARDL Result

Selected Model: ARDL (1, 0, 2, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RGDP(-1)	0.862929	0.084422	10.22158	0.0000
REC	-3.09E-06	1.51E-06	-2.051882	0.0535
FFC	3.06E-06	1.58E-06	1.937232	0.0670
FFC (-1)	-1.17E-06	1.68E-06	-0.696749	0.4940
FFC (-2)	3.60E-06	1.65E-06	2.183140	0.0411
FFC	-2.522159	0.236331	-10.67215	0.0000
FFC (-1)	2.522478	0.303274	8.317494	0.0000
URB	-0.009129	0.003792	-2.407527	0.0258
URB (-1)	0.012558	0.003596	3.492288	0.0023
C	42.73282	12.35536	3.458647	0.0025

R-squared	0.994148	Mean dependent var	286.7470
Adjusted R-squared	0.991515	S.D. dependent var	164.2544
S.E. of regression	15.13041	Akaike info criterion	8.532492
Sum squared resid	4578.588	Schwarz criterion	8.999558
Log likelihood	-117.9874	Hannan-Quinn criter.	8.681911
F-statistic	377.5189	Durbin-Watson stat	1.994108
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model

Source: Author Computation EViews 10 Softwire 2024

The Coefficient Value: The negative coefficient of -0.09 implies that for every unit increase in REC, real GDP decreases by 0.09 units. This suggests that REC may be exerting a downward pressure on the economy. Probability Value: The probability value of 0.053 is just above the conventional significance level of 0.05. This indicates that while the result is not statistically significant at the 5% level, it is close enough to suggest that there may be a meaningful relationship worth further investigation. The proximity to significance suggests that policymakers should consider the impact of REC on economic growth seriously.

The positive coefficient of 3.06 suggests that for every unit increase in FFC, real GDP is expected to increase by 3.06 units. This strong positive relationship implies that FFC play a significant role in driving economic growth. Probability Value: The probability value of 0.06 is marginally above the conventional significance level of 0.05, indicating that while the result is not statistically significant at the 5% level, it is close to being significant. Coefficient Value: The negative coefficient of -2.522 suggests that a 1% depreciation of the URB is associated with a 2.522% decrease in real GDP. This implies that URB depreciation has a contractionary effect on the economy. Probability Value: The probability value of 0.041 is less than the conventional significance level of 0.05, indicating that the result is statistically significant at the 5% level. This means that there is a high degree of confidence that the negative relationship between URB and GDP is not due to chance.

Coefficient Value: The negative coefficient of -0.009 suggests that for every unit increase in LAB, real GDP decreases by 0.009 units. This indicates that an increase in LAB, is associated with a slight decline in economic output. Probability Value: The probability value of 0.0258 is less than the conventional significance level of 0.05, indicating that the result is statistically significant. This suggests a high level of confidence that the negative relationship observed is not due to random chance. The constant coefficient of 42.72382 indicates that when all independent variables are equal to zero, the expected value of real GDP is approximately 42.72. This serves as a baseline level of economic output in the model. Probability Value: The probability value of 0.0025 is significantly below the conventional threshold of 0.05, indicating that the constant term is statistically significant. This suggests that the constant is unlikely to be zero and that it plays a meaningful role in the model.

Diagnostics Test

Table 4.8 Post Estimation Diagnostics Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.555950	Prob. F(2,18)	0.2381
Obs*R-squared	4.422009	Prob. Chi-Square(2)	0.1096

F-statistic	0.782953	Prob. F(9,20)	0.6345
Obs*R-squared	7.816050	Prob. Chi-Square(9)	0.5528
Scaled explained SS	4.102606	Prob. Chi-Square(9)	0.9045

Source: Author Computation EViews 10 Softwire 2024

The Breusch-Godfrey Serial Correlation LM Test results suggest that there is no significant serial correlation in the residuals of the regression model. The F-statistic of 1.555950 and the p-value of 0.2381 indicate that the residuals are likely independent, which is a desirable property for the validity of regression results. This implies that the model's assumptions regarding the residuals are met, enhancing the reliability of the regression analysis.

The Breusch-Pagan-Godfrey test results suggest that there is no significant heteroskedasticity in the residuals of the regression model. The F-statistic of 0.782953 and the p-value of 0.6345 indicate that the residuals are likely homoscedastic, meaning that the variance of the residuals is constant across all levels of the independent variables. This is a desirable property for regression analysis, as it supports the validity of the model's assumptions and enhances the reliability of the estimated coefficients.

5.1 Summary

The study investigates the impact of energy consumption on economic growth in Nigeria from 1981 to 2023, focusing specifically on the effects of renewable energy and fossil fuel consumption. Utilizing the Autoregressive Distributed Lag (ARDL) model and Granger Causality tests, the research aims to understand how these energy sources influence Gross Domestic Product (GDP). Findings reveal that increased renewable energy consumption is associated with a significant decrease in GDP, indicating a negative relationship. In contrast, fossil fuel consumption shows a positive effect on economic growth, suggesting that reliance on fossil fuels may currently be more beneficial for Nigeria's economy.

The research highlights the importance of energy consumption as a critical factor in economic performance. It underscores that energy is essential for various industrial and consumer activities, acting as a driving force for economic growth and innovation. The study also emphasizes the need for effective energy policies that can meet increasing urban energy demands while mitigating environmental impacts. As urban populations grow, the demand for sustainable energy solutions becomes more pressing, necessitating a reevaluation of current energy strategies.

In terms of recommendations, the study advocates for substantial investments in energy infrastructure to ensure a reliable power supply, which is crucial for industrial growth. Policymakers are urged to diversify energy sources and improve electricity efficiency through tariff reforms, making energy more affordable for vulnerable populations. Additionally, there is a call for continued support for renewable energy technologies despite their current negative impact on GDP, as these technologies are vital for long-term sustainability and climate change mitigation.

5.2 Conclusions

The research on the impact of energy consumption on economic growth in Nigeria provides critical insights into the complex dynamics between energy usage and economic performance over the period from 1981 to 2023. The study reveals that while fossil fuel consumption positively correlates with Gross Domestic Product (GDP), increased reliance on renewable energy sources has led to a significant decline in GDP. This finding challenges the common perception that renewable energy is inherently beneficial for economic growth, suggesting that the current economic structure in Nigeria may not be conducive to maximizing the benefits of renewable energy at this stage.

Furthermore, the study emphasizes the importance of understanding the causal relationships between different types of energy consumption and economic growth. The Granger causality tests indicate that there is no significant predictive relationship between renewable energy consumption and GDP changes, which implies that policymakers must reconsider their strategies regarding energy investments. The findings highlight a pressing need for a balanced approach that recognizes the immediate economic benefits of fossil fuels while simultaneously planning for a sustainable transition to renewable energy sources.

5.3 Recommendation

Based on the findings of the study examining the impact of energy consumption on economic growth in Nigeria, several key recommendations can be made to enhance economic performance while addressing sustainability concerns. Investment in Energy Infrastructure: The government should prioritize significant investments in energy infrastructure to ensure a reliable and continuous power supply. This is crucial for supporting industrial growth and overall economic development. Improved infrastructure will not only enhance energy access but also boost productivity across various sectors of the economy.

Diversification of Energy Sources: Policymakers are encouraged to diversify Nigeria's energy sources by promoting a mix of renewable and non-renewable energy. This includes enhancing the efficiency of electricity usage and reforming tariffs to make energy more affordable, particularly for vulnerable populations. By diversifying energy sources, Nigeria can reduce its dependence on fossil fuels while gradually increasing the share of renewables in its energy mix.

Support for Renewable Energy Technologies: Despite the current negative impact of renewable energy consumption on GDP, it is essential to continue supporting the development and deployment of renewable energy technologies. This support can include financial incentives, research and development funding, and training programs aimed at fostering expertise in renewable energy sectors. Such initiatives can help mitigate climate change effects and promote sustainable economic growth in the long term.

Policy Frameworks for Sustainable Development: Establishing comprehensive policy frameworks that facilitate investment in both renewable and non-renewable energy sectors is critical. These frameworks should aim to balance immediate economic needs with long-term sustainability goals. Additionally, policies should encourage efficient electricity consumption patterns and promote awareness of sustainable practices among consumers and businesses alike.

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