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Energy Consumption and Standard of Living in Nigeria

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Abstract- This study determined the effect of energy consumption on standard of living, measured by per capita income, in Nigeria from 1990 to 2023. Energy consumption was proxied by electricity consumption, natural gas consumption, solar energy consumption, and hydropower energy. The study made use of time series data sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin, World Development Indicators of the World Bank, National Bureau of Statistics (NBS), Africa Energy Portal (AEP), and International Energy Agency (IEA). The main data analysis techniques adopted include Augmented Dickey-Fuller (ADF) unit root test, correlation matrix, bounds cointegration test, and the Autoregressive Distributive Lag (ARDL) approach. The major findings showed that electricity consumption, natural gas consumption, and solar energy consumption have positive and significant effects on per capita income in Nigeria, while hydropower energy has a positive and non-significant effect on per capita income. Premised on the findings, the study concluded that energy consumption plays a significant vital role in enhancing the standard of living of Nigerians as measured by per capita income. It was recommended among others that the Nigerian government should invest heavily in both the national electricity grid and off-grid energy solutions (such as solar mini-grids and home systems), particularly in underserved rural and peri-urban areas, to increase economic activity and raise per capita income.

Keywords: Energy Consumption, Standard of Living, Per Capita Income, Electricity Consumption, Natural Gas Consumption, Solar Energy Consumption, Hydropower Energy, Nigeria

I. INTRODUCTION

Energy is widely recognized as a fundamental input in economic production and a critical enabler of human welfare and living standards. Nations with robust and diversified energy systems are generally associated with higher standards of living, while those constrained by energy poverty tend to face persistent developmental challenges. Per capita income, as a measure of standard of living and economic well-being, is closely linked to the ability of households and businesses to access reliable, affordable, and modern energy services (Enu & Havi, 2014; Umeh, Ochuba & Ugwo, 2019).

In developing economies such as Nigeria, the persistent deficiency in energy supply has been identified as a major structural constraint on income growth, productivity, and welfare improvement. Nigeria is endowed with abundant energy resources, including petroleum, natural gas, coal, hydropower, solar radiation, and other renewable sources. Yet, despite this endowment, the country faces a chronic energy access crisis.

Over two-thirds of Nigerians lack reliable access to electricity, and per capita power consumption remains grossly inadequate—estimated at 82 kilowatt-hours (kWh) compared to the global average of several hundred kilowatt-hours (International Energy Agency, 2015; World Bank, 2024).

The average household and enterprise in Nigeria rely heavily on expensive and polluting self-generated power, which raises production costs and suppresses income levels. This energy poverty directly undermines per capita income and widening developmental disparities.

The relationship between energy consumption and standard of living (per capita income) has received growing attention in the empirical literature. The Energy Transition Theory (Hosier & Dowd, 1987; Leach, 1992) posits that higher levels of per capita income are associated with transitions toward modern, cleaner, and more efficient energy sources.

Conversely, limited energy access constrains economic activity and keeps per capita income suppressed.

Empirical evidence from Africa and Nigeria broadly supports the notion that increased energy consumption—especially from electricity and natural gas—is positively related to income growth (Akinlo, 2008; Okeoma, Nwachukwu, Ezeonye & Osatemple, 2023; Abner, Izuchukwu, Eneoli & Udo, 2021).

However, evidence on the role of renewable sources such as solar energy and hydropower in improving per capita income remains limited, especially in the Nigerian context. Furthermore, the empirical literature has concentrated more on the link between energy consumption and aggregate economic growth (GDP), with less focus on its effect on per capita income as a direct measure of individual living standards.

Prior studies have also largely failed to disaggregate energy consumption into its constituent components (electricity, natural gas, solar energy, and hydropower) when examining their differential effects on living standards.

This study therefore bridges that gap by empirically analyzing the disaggregated effect of energy consumption on per capita income in Nigeria from 1990 to 2023. Specifically, the study sought to:

i. determine the effect of electricity consumption on per capita income in Nigeria;
ii. ascertain the effect of natural gas consumption on per capita income in Nigeria;
iii. examine the effect of solar energy consumption on per capita income in Nigeria; and
iv. investigate the effect of hydropower energy on per capita income in Nigeria.

II. LITERATURE REVIEW

Theoretical Literature Review

The following theories provide the theoretical foundation of this study:

a. Energy Transition Theory

The Energy Transition Theory, associated with Hosier and Dowd (1987) and Leach (1992), links the nature and type of energy consumed to income levels and economic development trajectories. The theory posits that as income rises, energy consumers—both households and industries—progressively transition from traditional, inferior, and less efficient energy sources to modern, cleaner, and more productive ones.

This transition is not merely a preference but a necessity for sustaining productivity and economic competitiveness. From the perspective of consumer theory, the Energy Transition Theory argues that high-income countries and households tend to consume more quality energy than low-income counterparts, reflecting the income-elastic nature of energy demand.

Poor access to modern energy, conversely, limits a nation's potential to reduce poverty and improve living standards, as energy access is central to productive activity, employment, and income generation (Pachauri & Spreng, 2004; Kaygusuz, 2011).

In the Nigerian context, the Energy Transition Theory is particularly relevant because the majority of households, especially in rural areas, still rely on traditional biomass for cooking and lighting due to inadequate electricity supply.

This constrains productivity and income growth. As the government and private sector invest in modern energy sources—including natural gas, solar energy, and improved electricity infrastructure—the theory predicts that per capita income should rise as individuals and enterprises benefit from improved energy access and reduced energy costs.

The theory thus provides both theoretical justification for expecting a positive relationship between energy consumption and per capita income and a policy framework for understanding why energy diversification is central to improving living standards in Nigeria.

b. Biophysical Theory of Economic Growth

The Biophysical Theory of economic growth, developed by Kardashev in 1964, posits that energy is the fundamental and indispensable driver of economic output, productivity, and income generation. Unlike mainstream neoclassical economics, which centers growth on capital and labour, the Biophysical Theory treats energy as the primary factor of production without which no economic activity is possible.

Every economic process—from agricultural production and manufacturing to transportation and services—requires the conversion of energy inputs into useful work. According to this theory, the level of energy availability and the efficiency of energy use determine the scale and pace of economic growth and the income generated within an economy (Kardashev, 1964; Stern, 1999).

Applied to the Nigerian context, the Biophysical Theory suggests that the persistent energy deficits in Nigeria—characterized by inadequate electricity supply, low natural gas utilization, underdeveloped solar energy capacity, and insufficient hydropower generation—are directly responsible for the country's relatively low per capita income.

Energy deficiencies suppress industrial output, increase production costs, reduce employment opportunities, and limit overall economic activity, all of which constrain income levels.

The theory thus supports the expectation that increases in electricity consumption, natural gas consumption, solar energy consumption, and hydropower energy will positively influence per capita income by enabling greater economic activity, productivity gains, and income generation.

Empirical Literature Review

Okeoma, Nwachukwu, Ezeonye and Osatemple (2023) found that electricity consumption and crude oil consumption have a positive and significant impact on economic growth in Nigeria, with electricity being particularly instrumental in driving GDP growth. Ikpe and Oyedeji (2023) highlighted the substantial impact of electric power consumption on Nigeria's Gross Domestic Product, confirming a long-run positive relationship between electricity consumption and economic performance.

These findings are consistent with the growth hypothesis, which posits that energy consumption drives economic growth and, by extension, per capita income. Haliru (2023) established a positive and statistically significant relationship between electricity consumption and green growth in Nigeria, while Iyabo and Segun (2022) found that a percentage increase in energy consumption engenders economic growth by 1.3 percent in Sub-Saharan Africa.

These results support the energy-led growth hypothesis and suggest that improved energy access is associated with rising per capita income. Similarly, Lawrence, Alexander, Johnson, Uchechukwu, Felix, Benjamin and Gideon (2021) found that electricity consumption is a positive predictor of economic growth in Nigeria from 1981 to 2018, recommending that policies to improve energy access be prioritized.

Wang, Wang and Li (2022) found that natural gas consumption follows an inverted U-shaped relationship with the Human Development Index in BRICS countries, indicating that natural gas consumption enhances development outcomes—including income—at moderate levels. Akokaike, Adenikinju, Ekpe, Eleri, Ajulo and Gini (2021) found that natural gas consumption is positively related to economic growth in selected African countries including Nigeria.

Nwabueze, Ogbonna and Nwaozuzu (2021) also found a strong positive correlation between natural gas consumption and per capita GDP in Nigeria, emphasizing that economic policies encouraging production and value addition tend to increase natural gas demand and income levels.

Ekone and Amaghionyeodiwe (2020) found that renewable energy consumption—including solar energy—has a positive contribution to economic development in Nigeria for the period 1990 to 2016. Maji, Chindo, and Abdul-Rahim (2019) found that renewable energy consumption, including solar energy, has a significant effect on economic development in West Africa.

These findings support the expectation that solar energy consumption is positively associated with per capita income in Nigeria. Qudrat-Ullah and Chinedu (2021) reported that a one percent increase in renewable energy consumption is associated with a 0.07 percent increase in short-term economic growth and a 1.9 percent increase in long-term economic growth across African nations, providing further empirical backing for the renewable energy–income nexus.

Regarding hydropower energy, Ogochukwu and Keghter (2024) found that renewable energy consumption in terms of hydropower energy has a positive but often non-significant association with industrial sector performance.

Somoye, Ozdeser and Seraj (2022) found a positive relationship between hydro energy consumption and economic development, though the effect was not always statistically significant, consistent with the limited utilization of hydropower potential in developing economies.

These findings suggest that while hydropower energy has a theoretical positive link with per capita income, its actual impact in Nigeria may be muted by limited development of hydropower infrastructure.

III. METHODOLOGY

The research design adopted in this study is the ex-post facto research design. An ex-post facto research design is a systematic empirical inquiry that requires the use of variables which the researcher does not have the capacity to change its state or direction in the course of the study. The nature of data used in this study is secondary in nature.

These data were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin, World Development Indicators of the World Bank, National Bureau of Statistics (NBS), Africa Energy Portal (AEP), and International Energy Agency (IEA). The data covered a period of thirty-four (34) years from 1990 to 2023.

Model Specification

Theoretically, the model for this study shall be based on the Energy Transition theory. However, since this study is interested in establishing empirically the relationship between the dependent (economic development) and the independent variables (energy consumption and carbon emission) as well as the possible projections, econometric model was therefore adopted.

This model wa built on the work of Ishioro (2020) in his analysis of the effect of consumption of energy on economic growth in the Nigerian economy. However, the model was subjected to slight modifications in order to incorporate and accommodate all the variables adopted with respect to the objectives of the study.

The functional forms of the models are specified as follows:

PCI = f(ELC, NGC, SEC, HYP) (3.1)

Specifically, transformation of above functional models to estimation forms with the inclusion of constant variables, parameters and error term becomes:

PCIt = β0 + β1ELCt + β2NGCt + β3SECt + β4HYPt + μt (3.2)

More explicitly, the above model is transformed into log linear forms by taking the natural log of the variables as follows:

InPCIt = β0 + β1InELCt + β2InNGCt + β3InSECt + β4InHYPt + μt (3.3)

The Autoregressive Distributed Lag (ARDL) model's specifications of the above models are given as;

$$\Delta\ln(PCI_t) = \beta_0 + \beta_{1i}\Delta\ln(PCI_{t-1}) + \beta_{2i}\Delta\ln(ELC_{t-1}) + \beta_{3i}\Delta\ln(NGC_{t-1}) + \beta_{4i}\Delta\ln(SEC_{t-1}) + \beta_{5i}\Delta\ln(HYP_{t-1}) + + \sum_{t=1}^{p}\delta_{1i}\Delta\ln(PCI_{t-1}) + \sum_{t=1}^{q}\delta_{2i}\Delta\ln(ELC_{t-1}) + \sum_{t=1}^{p}\delta_{3i}\Delta\ln(NGC_{t-1}) + \sum_{t=1}^{q}\delta_{4i}\Delta\ln(SEC_{t-1}) \sum_{t=1}^{q}\delta_{5i}\Delta\ln(HYP_{t-1})\ \lambda ECM + \varepsilon_{1t} \quad (345)$$

Where: PCI = Per Capita Income; ELC = Electricity Consumption; NGC = Natural Gas Consumption; SEC = Solar Energy Consumption; HYP = Hydropower Energy; β0 = Regression Intercept; β1 – β4 = Parameters; t = Time subscript; μt = Error component.

A Priori Expectation: β1 > 0; β2 > 0; β3 > 0; β4 > 0.

Data Analysis Techniques

The data analysis technique adopted depends on the outcome of the pre-estimation tests. The

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Autoregressive Distributed Lag (ARDL) technique was adopted for model estimation.

ARDL is a least squares method developed by Pesaran, Shin and Smith (2001) that allows the inclusion of lag values of the dependent and independent variables in a model while carrying out regression analysis.

This technique is appropriate because the variables exhibit a mixed order of integration [I(0) and I(1)], which renders the conventional Engle-Granger cointegration test invalid. The ARDL bounds test is the appropriate cointegrating technique for possible long-run relationships among series with different integration orders.

Unit root tests using the Augmented Dickey-Fuller (ADF) technique were conducted to determine the stationarity properties of the variables.

IV. RESULTS AND DISCUSSION

Descriptive Analysis

The descriptive statistics for the study variables are summarized in Table 1:

Table 1: Descriptive Statistics

	PCI	ELC	NGP	SEC	HYP
Mean	1670.476	118.1766	103993.8	91.32353	6338.824
Median	1874.100	122.2813	116814.0	86.50000	5995.000
Maximum	3201.000	178.5351	190075.0	147.0000	8349.000
Minimum	494.1000	74.49060	30326.00	76.00000	4387.000
Std. Dev.	829.5208	29.25249	60702.63	14.48661	1066.157
Skewness	-0.039870	0.076978	-0.015277	2.340719	0.452437
Kurtosis	1.804584	1.938516	1.284973	8.528872	2.290589
Jarque-Bera	2.033452	1.629805	4.168191	74.35273	1.872922
Probability	0.361777	0.442682	0.124420	0.000000	0.392013
Sum	56796.20	4018.003	3535788.	3105.000	215520.0
Sum Sq. Dev.	22707459	28238.37	1.22E+11	6925.441	37510773
Observations	34	34	34	34	34

Source: Authors' Computation, 2026.

The descriptive statistics presented in Table 1 indicate the distributional characteristics of the study variables over the period 1990 to 2023. Per capita income (PCI) recorded a mean value of N1,670.48, a maximum of N3,201.00, and a minimum of N494.10, with a standard deviation of 829.52, indicating considerable variability.

The Jarque-Bera probability of 0.362 confirms normal distribution. Electricity consumption (ELC) had a mean of 118.18, with moderate dispersion (standard deviation of 29.25) and normal distribution (Jarque-Bera probability of 0.443). Natural gas consumption (NGC) had a mean of 103,993.80, with high variability (standard deviation of 60,702.63) and normal distribution (probability of 0.124).

Solar energy consumption (SEC) displayed high positive skewness (2.341) and leptokurtosis (8.529), and its Jarque-Bera probability of 0.000 indicates non-normality, reflecting the concentration of high solar energy observations in recent years.

Hydropower energy (HYP) had a mean of 6,338.82 and is normally distributed (probability of 0.392). These distributional properties support the use of the ARDL approach, which does not impose strict normality requirements on all variables.

Unit Root Test

Table 2: Augmented Dickey-Fuller (ADF) Unit Root Test Results

Augmented Dickey-Fuller (ADF)						
Variables	Level	5% Critical Value	1st Difference	5% Critical Value	Order of Integration	Stationary @
$lnPCI_t$	2.002290	-2.954021	-5.485369	-2.957110	I(1)	1st Difference
$lnELC_t$	-0.905291	-2.954021	-6.621155	-2.957110	I(1)	1st Difference
$lnNGC_t$	-1.331578	-2.954021	-6.373521	-2.957110	I(1)	1st Difference
$lnSEC_t$	-0.394927	-2.957110	-9.066614	-2.957110	I(1)	1st Difference
$lnHYP_t$	-2.959383	-2.954021	-	-	I(0)	Level

Source: Authors' Computation, 2026.

The unit root test results in Table 2 show that hydropower energy (HYP) is stationary at level [I (0)], while per capita income (PCI), electricity consumption (ELC), natural gas consumption (NGC), and solar energy consumption (SEC) are non-stationary at level but become stationary after first differencing [I (1)].

The presence of this mixed order of integration [I(0) and I(1)] among the study variables validates the use of the ARDL bounds testing approach for estimating long-run relationships.

Multicollinearity Test

Table 3: Correlation Matrix

	$lnPCI_t$	$lnELC_t$	$lnNGC_t$	$lnSEC_t$	$lnHYP_t$
$lnPCI_t$	1				
$lnELC_t$	0.118741	1			
$lnNGC_t$	0.447441	0.141785	1		
$lnSEC_t$	0.26742	0.411302	0.412742	1	
$lnHYP_t$	0.377274	0.398903	0.495306	0.476514	1

Source: Authors' Computation, 2026.

The correlation test result reported in Table 4.3 shows that electricity consumption (ELC), natural gas consumption (NGC), solar energy consumption (SEC) and hydropower energy (HYP) all have mixed of positive and negative but weak relationships with per capita income (PCI) over the research period.

Also, electricity consumption (ELC), natural gas consumption (NGC), solar energy consumption (SEC) and hydropower energy (HYP) all have mixed of positive and negative but weak relationships with each other. The implication of this is that there is absence of multicollinearity problem among the independent variables and this therefore gives us confidence to proceed with our econometric analysis.

ARDL Bounds Cointegration Test

Table 4: ARDL Bounds Cointegration Test Results

Significant Level	I (0) Bound	I (1) Bound	Hypothesis	F-Statistics
10%	2.08	3	H0: There is long run relationship	
5%	2.39	3.38		4.665801
2.5%	2.7	3.73		
1%	3.06	4.15		
F_{PCI} (PCI/ELC, NGC, SEC, HYP)				
			K = 4	

Source: Authors' Computation, 2026.

Table 4 presents the ARDL bounds cointegration test result. The computed F-statistic of 4.665801 exceeds the upper bound critical values of 3.00, 3.38, 3.73, and 4.15 at 10%, 5%, 2.5%, and 1% significance levels respectively.

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This confirms the rejection of the null hypothesis of no cointegration, establishing the existence of a long-run equilibrium relationship among per capita income, electricity consumption, natural gas consumption, solar energy consumption, and hydropower energy in Nigeria.

Estimation of ARDL Long-Run and Short-Run Dynamics

Table 5: ARDL Long-Run and Short-Run Estimation Results (

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Dependent Variable = LOG(PCI)				
Selected Model: ARDL (3, 3, 3, 3, 3)				
ARDL Long-Run Results				
InELC	0.012678	0.005963	2.126054	0.0468
InNGP	0.053633	0.022271	2.408192	0.0264
InSEC	0.108975	0.031595	3.449101	0.0027
InHYP	0.389610	0.232839	1.673297	0.1328
C	-4.475738	3.621786	-1.235782	0.2516
EC = In (PCI) - (0.0127*In (ELC) + 0.0536*In (NGP) + 0.1090 *In (SEC) + 0.3896*In (HYP) - 4.4757)				
ARDL Short-Run Results				
D(InPCI(-1))	-0.144612	0.104141	-1.388618	0.2024
D(InPCI(-2))	0.960756	0.100970	9.515241	0.0000
D(InELC)	0.059540	0.013355	4.458373	0.0021
D (In (LC (-1))	-0.072574	0.016344	-4.440360	0.0022
D(InELC(-2))	-0.030287	0.014807	-2.045384	0.0750
D(InNGP)	0.026476	0.005490	4.822475	0.0013
D(InNGP(-1))	0.005448	0.006541	0.832949	0.4290
D(InNGP(-2))	0.042913	0.005820	7.373836	0.0001
D(InSEC)	0.115884	0.018881	6.137756	0.0003
D(InSEC(-1))	-0.071709	0.021440	-3.344591	0.0102
D(InSEC(-2))	-0.123865	0.020550	-6.027528	0.0003
D(InHYP)	0.017560	0.010849	1.618604	0.1442
D(InHYP(-1))	0.000383	0.023369	0.016377	0.9871
D(InHYP(-2))	-0.043242	0.022763	-1.899673	0.0728
CointEq(-1)*	-0.186551	0.024676	-7.560163	0.0001
Adjusted R^2 = 0.673761				
Durbin-Watson stat = 2.353688				

Source: Authors' Computation, 2026.

Electricity Consumption (ELC) and Per Capita Income (PCI)

The long-run estimates of the ARDL model revealed that electricity consumption has a positive and significant effect on per capita income in Nigeria. This is evident by the positive coefficient value (0.012678) of electricity consumption and its p-value (0.0468) which is less than 0.05.

This implies that an increase in electricity consumption by a unit will lead to a 0.012678 increase in per capita income in the long run. Also, the short-run estimates revealed that electricity consumption has a positive and significant effect on per capita income in Nigeria.

The positive coefficient value (0.059540) and p-value (0.0021), which is less than 0.05, imply that an increase in electricity consumption by a unit will lead to a 0.059540 increase in per capita income in the short run.

Natural Gas Consumption (NGC) and Per Capita Income (PCI)

The long-run estimates of the ARDL model revealed that natural gas consumption has a positive and significant long-run relationship with per capita income in Nigeria.

The positive coefficient value (0.053633) and p-value (0.0264), which is less than 0.05, imply that an increase in natural gas consumption by a unit leads to a 0.053633 increase in per capita income in the long run. Also, the short-run estimates revealed that natural gas consumption has a significant positive short-run relationship with per capita income.

The positive coefficient value (0.026476) and p-value (0.0013), which is less than 0.05, imply that an increase in natural gas consumption by a unit leads to

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a 0.026476 increase in per capita income in the short run.

Solar Energy Consumption (SEC) and Per Capita Income (PCI)

The long-run estimates revealed that solar energy consumption has a significant positive long-run relationship with per capita income in Nigeria. The positive coefficient value (0.108975) and p-value (0.0027), which is less than 0.05, imply that an increase in solar energy consumption by one unit leads to a 0.108975 increase in per capita income in the long run.

The short-run estimates similarly revealed that solar energy consumption has a significant positive short-run relationship with per capita income. The positive coefficient value (0.115884) and p-value (0.0003), which is less than 0.05, imply that an increase in solar energy consumption by one unit leads to a 0.115884 increase in per capita income in the short run.

Hydropower Energy (HYP) and Per Capita Income (PCI)

The long-run estimates revealed that hydropower energy has a non-significant positive long-run relationship with per capita income in Nigeria.

The positive coefficient value (0.389610) and p-value (0.1328), which is greater than 0.05, indicate that although an increase in hydropower energy leads to an increase in per capita income, the effect is statistically unreliable in the long run. Similarly, the short-run estimates revealed that hydropower energy has a non-significant positive short-run relationship with per capita income.

The positive coefficient value (0.017560) and p-value (0.1442), greater than 0.05, imply that the positive effect of hydropower energy on per capita income is not statistically significant in the short run.

Interpretation of CointEq(-1) Result

The estimated error correction coefficient of -0.186551 (with p-value of 0.0001) is highly significant, has the correct negative sign, and implies a fairly high speed of adjustment to long-run equilibrium after a shock. This implies that approximately 18.66% of disequilibria from the previous year's shock converge back to the long-run equilibrium in the current year.

Interpretation of Adjusted R-Squared Value

The Adjusted R-squared value of 0.673761 indicates that approximately 67 percent of the variation in per capita income is explained by the systematic changes in electricity consumption, natural gas consumption, solar energy consumption, and hydropower energy, while the remaining 33% is accounted for by other variables outside the model.

Interpretation of Durbin-Watson Statistic

The Durbin-Watson statistic of 2.353688, which is greater than 2, indicates the absence of serial autocorrelation in the model residuals.

Post-Estimation Tests

Table 6: Post-Estimation Test Results

Test	Null Hypothesis (H_0)	Test Type	F-stat.	Prob.
Normality Test	Normal distribution exists	Jarque-Bera Test	0.471919	0.7898
Serial Correlation Test	Serial correlation does not exist	Breusch-Godfrey LM Test	1.523546	0.2917
Heteroscedasticity Test	Homoscedasticity exists	Breusch-Pagan-Godfrey	1.969645	0.1624
Functional Form Test	Model is stable	Ramsey RESET	0.129547	0.9006

Source: Authors' Computation, 2026.

The Jarque-Bera normality test probability value of 0.7898 exceeds 0.05, confirming that the residuals are normally distributed. The Breusch-Godfrey Serial

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Correlation LM test probability value of 0.2917 exceeds 0.05, confirming the absence of serial correlation.

The Breusch-Pagan-Godfrey heteroscedasticity test probability value of 0.1624 exceeds 0.05, confirming homoscedasticity—that relevant variables were not omitted. The Ramsey RESET test probability value of 0.9006 exceeds 0.05, confirming that the model is correctly specified and that the functional form is appropriate.

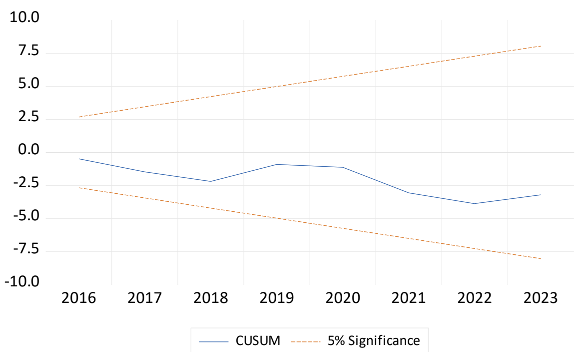

Figure 1: Stability Cusum Test

The cumulative sum (CUSUM) stability test indicates that the CUSUM line stayed within the 5 percent critical bounds and did not cross the 5 percent critical lines at any point during the study period.

This confirms the stability of the long-run coefficients of the model, indicating that the estimated relationship between energy consumption and per capita income is structurally stable throughout the sample period.

Discussion of Findings

This study empirically analyzed time series data to determine the effect of energy consumption on per capita income in Nigeria from 1990 to 2023 using the Autoregressive Distributive Lag (ARDL) estimation technique. The results of both the short-run and long-run estimates are discussed below.

First, electricity consumption has a positive and significant effect on per capita income in Nigeria in both the short run and long run. This finding implies that electricity consumption has made a positive and significant contribution to the standard of living of Nigerians as measured by per capita income.

This finding is consistent with the empirical results of Yahaya and Bakare (2018), who found that electricity consumption has a significant positive impact on economic growth in Nigeria.

It also aligns with the findings of Salisu and Moronkeji (2022), who found that electricity consumption has a positive and significant impact on manufacturing output in Nigeria, which translates into higher incomes through employment and productivity.

The finding further resonates with the energy-led growth hypothesis, which posits that energy availability drives economic activity and income generation.

Second, natural gas consumption has a positive and significant effect on per capita income in Nigeria in both the short run and long run.

This finding is consistent with Akokaike, Adenikinju, Ekpe, Eleri, Ajulo and Gini (2021), who found that natural gas consumption positively influences economic growth in selected African countries including Nigeria. It also aligns with Nwabueze, Ogbonna and Nwaozuzu (2021), who found a strong positive correlation between natural gas consumption and per capita GDP in Nigeria.

The positive and significant role of natural gas in driving per capita income reflects the energy's critical contribution to industrial production, household energy access, and the broader productive capacity of the Nigerian economy.

Third, solar energy consumption has a positive and significant effect on per capita income in Nigeria in both the short run and long run. This finding is consistent with Ekone and Amaghionyeodiwe (2020), who found that renewable energy consumption, including solar energy, positively contributes to economic development in Nigeria.

The finding also supports Maji, Chindo, and Abdul-Rahim (2019), who found that solar energy consumption has a significant positive effect on economic development in West Africa. The growing importance of solar energy—especially for off-grid

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communities—in supporting productive economic activities makes this a particularly salient finding for Nigeria's energy and development policy agenda.

Fourth, hydropower energy has a positive but non-significant effect on per capita income in Nigeria in both the short run and long run. This finding is consistent with Ogochukwu and Keghter (2024), who found that hydropower energy has a positive but statistically weak association with sectoral economic performance.

It also aligns with Somoye, Ozdeser and Seraj (2022), who found a positive relationship between hydro energy consumption and economic development that was not always statistically significant. The non-significance of hydropower energy likely reflects the underdeveloped state of Nigeria's hydropower infrastructure and the erratic availability of hydroelectric power, which limits its contribution to productive activity and per capita income in the country.

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

Conclusion

This study empirically examined the effect of energy consumption on the standard of living, measured by per capita income, in Nigeria from 1990 to 2023. The ARDL bounds cointegration test confirmed a long-run equilibrium relationship among per capita income, electricity consumption, natural gas consumption, solar energy consumption, and hydropower energy.

The estimation results showed that electricity consumption, natural gas consumption, and solar energy consumption have positive and significant effects on per capita income in both the short run and long run, while hydropower energy has a positive but statistically non-significant effect.

Premised on these findings, the study concluded that energy consumption plays a significant and vital role in enhancing the standard of living of Nigerians as proxied by per capita income. However, the full developmental impact of energy remains constrained by structural inefficiencies in energy infrastructure, supply gaps, and limited penetration of modern energy services, especially in rural areas.

RECOMMENDATIONS

The following recommendations are proffered based on the findings of this study:
First, given the significant and positive impact of electricity consumption on per capita income, government should prioritize expanding electricity infrastructure, particularly in underserved rural and peri-urban communities.

Investment in grid extension, mini-grids, and off-grid renewable energy solutions such as solar home systems will ensure more reliable and widespread access. Improved electricity availability will directly enhance economic productivity, enable businesses to expand operations, and translate into higher per capita income for the average Nigerian.

Second, since natural gas consumption has a significant positive effect on per capita income, policymakers should accelerate the development of gas infrastructure—pipelines, storage facilities, distribution networks, and liquefied natural gas terminals—to expand the domestic utilization of Nigeria's abundant natural gas reserves.

Gas-based industrialization should be prioritized through incentives such as tax credits, subsidized gas pricing for manufacturers, and special economic zones powered by natural gas, thereby deepening value addition and raising household and national income levels.

Third, the positive and significant effect of solar energy consumption on per capita income calls for aggressive government and private sector investment in solar energy capacity. Policies should promote the adoption of solar-powered enterprises, particularly for rural communities that are beyond the reach of the national grid.

Subsidized solar systems, low-interest financing for solar investments, and technology transfer programs will enable broader adoption of solar energy, support income-generating activities and improving the standard of living of Nigerians.

Fourth, to enhance the contribution of hydropower energy to per capita income, government should increase investment in the rehabilitation of existing hydroelectric power plants and the construction of new small and medium-scale hydropower facilities across Nigeria's major rivers. Incorporating hydropower into rural electrification programmes and agro-industrial development initiatives will maximize its multiplier effect on income generation and living standards.

REFERENCES

[1] Abner, I. P., Izuchukwu, O., Eneoli, O. C., & Udo, E. S. (2021). Energy consumption effect on economic growth in Nigeria: Multivariate framework. International Journal of Economics, Management and Accounting, 29(2), 519–542.

[2] Akinlo, A. E. (2008). Energy consumption and economic growth: Evidence from 11 Sub-Sahara African countries. Energy Economics, 30(5), 2391–2400.

[3] Akokaike, M. N., Adenikinju, A., Ekpe, A. N., Eleri, A. I., Ajulo, K. D., & Gini, K. B. (2021). Natural gas consumption and economic growth in Africa. Natural Gas Consumption and Economic Growth in Africa, 8(6), 104–113.

[4] Ekone, F. A., & Amaghionyeodiwe, L. (2020). Renewable energy consumption and economic growth in Nigeria: Any causal relationship? The Business and Management Review, 11(1), 59–76.

[5] Enu, P., & Havi, E. D. (2014). Influence of electricity consumption on economic growth in Ghana: An econometric approach. International Journal of Economics, Commerce, and Management, 2(9), 1–20.

[6] Haliru, B. (2023). Analysis on the impact of energy consumption and green growth in Nigeria. Energy Policy, 38(1), 656–660.

[7] Hosier, R., & Dowd, J. (1987). Household fuel choice in Zimbabwe: An empirical test of the energy ladder hypothesis. Resources and Energy, 9, 347–361.

[8] International Energy Agency. (2015). Key world energy statistics. IEA Publications.

[9] Ishioro, B. O. (2020). Energy consumption and economic growth in Nigeria: An augmented neoclassical growth model perspective. Journal of Environmental Management and Tourism, 10(7), 1637–1657.

[10] Iyabo, I., & Segun, B. (2022). Assessing the nexus among energy consumption, foreign direct investment and economic growth in Sub-Saharan Africa. Economic Modelling, 22(3), 423–438.

[11] Kaygusuz, K. (2011). Energy and environment issues relating to greenhouse gas emissions for sustainable development in Turkey. Renewable and Sustainable Energy Reviews, 253–270.

[12] Lawrence, U. O., Alexander, E. O., Johnson, I. O., Uchechukwu, E. O., Felix, N. E., Benjamin, I. E., & Gideon, K. E. (2021). Effect of energy utilization and financial development on economic growth in Nigeria. International Journal of Energy Economics and Policy, 11(2), 392–401.

[13] Leach, G. (1992). The energy transition. Energy Policy, 20(2), 116–123.

[14] Maji, I., Chindo, S., & Abdul-Rahim, A. S. (2019). Renewable energy consumption and economic growth nexus: Fresh evidence from West Africa. Energy Reports, 5, 384–392.

[15] Nwabueze, G., Ogbonna, J., & Nwaozuzu, C. (2021). Analysis Nigerian natural gas consumption (1990–2025): A VECM approach. International Journal of Engineering Technologies and Management Research, 9(1), 7–19.

[16] Ogochukwu, E., & Keghter, L. (2024). Renewable energy consumption and industrial sector performance in Nigeria. Energy Economics Research Journal, 12(1), 55–72.

[17] Okeoma, T. F., Nwachukwu, E. I., Ezeonye, C. S., & Osatemple, M. (2023). A study on the impact of energy consumption on the Nigerian economy. Journal of Energy Technology and Environment, 5(1), 40–52.

[18] Pachauri, S., & Spreng, D. (2004). Energy use and energy access in relation to poverty. Economic and Political Weekly, 39(6), 271–278.

DOI: https://doi.org/10.64388/IREV10I1-1719586

[19] Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289–326.

[20] Qudrat-Ullah, H., & Chinedu, O. (2021). Renewable energy consumption and environmental sustainability on economic growth across Africa. Energy, Sustainability and Society, 11(1), 1–14.

[21] Salisu, A. A., & Moronkeji, T. (2022). Electricity consumption and manufacturing output in Nigeria. CBN Journal of Applied Statistics, 13(1), 45–70.

[22] Somoye, O. A., Ozdeser, H., & Seraj, M. (2022). Renewable energy and economic development nexus. Frontiers in Energy Research, 10, 891839.

[23] Stern, D. I. (1999). Is energy a factor of production? Energy, 24(3), 225–232.

[24] Umeh, J. N., Ochuba, O. V., & Ugwo, I. E. (2019). Energy consumption and economic growth in Nigeria. International Journal of Multidisciplinary Research and Development, 6(1), 30–38.

[25] Wang, J., Wang, J., & Li, Q. (2022). Effects of fossil energy on human development. Energy Reports, 8, 5709–5721.

[26] World Bank. (2024). World development indicators. The World Bank Group.

[27] Yahaya, H., & Bakare, A. S. (2018). Electric power consumption and economic growth in Nigeria: A causality analysis. African Journal of Economic Review, 6(2), 112–127.