Electricity Consumption and Standard of Living: Evidence from Selected African Countries

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***Abstract**:*
This study investigated how electricity consumption indicators over the sampled period of 1995 to 2025 influenced standard of living in selected African countries by measuring electricity consumption using electricity consumption per capita, total electricity net consumption, energy intensity and access to electricity on per capita income as the indicator for standard of living. Geographically, the study concentrated on six selected African economies which are; Nigeria, Ghana, Angola, Egypt, Algeria and Libya. Secondary data for the countries were sourced from the World Development Indicators of the World Bank, Africa Energy Portal (AEP), and International Energy Agency (IEA), and were analyzed by applying the Panel Least Square (PLS) regression technique following confirmation of stationarity through the Im, Pesaran and Shin, and Levin, Lin and Chu panel unit root tests, and selection of the Random Effects estimator on the strength of the Hausman specification analysis. The estimates established that electricity consumption per capita, its total net consumption, energy intensity and electricity access exerted positive and statistically significant effects on standard of living in the African countries. It is therefore highlighted that, improved electricity consumption and reliable access are critical for spurring per capita income and by extension, living standards in Africa. Thus, it is among others, emphasized that governments in African countries should prioritize investment in aging and new electricity infrastructure to enhance generation, transmission and reliable distribution capacities, which will in turn support industrial activities, stimulate business growth, creating employment opportunities, enhance household incomes and ultimately improving African's standard of living.

Keywords: *Electricity consumption, standard of living, per capita income, access to electricity, energy intensity, panel data, Africa*

JEL Classification: Q43, I31

1.0 Introduction

Energy plays vital enabling role in the growth and development of a country's economy. Being a crucial intermediate input in the production function, energy, especially electricity is seen as having a major enabling role in a country's economic development and growth. Electricity as a critical source of energy for productive sectors like the agricultural and the industrial sectors is also inextricably linked with the economic segments of health, education, and other sectors of a modern economy. Electricity consumption in poor countries helps the poor to escape the poverty trap by enabling low-income households to engage in income-generating activities (Attigah & Mayer-Tasch, 2013). Etim, Nteegah and Barisua (2023) observe that electricity has been described as blood of economic activities. Electricity powers every aspect of economic life, with economic growth and development heavily dependent on the availability, affordable price, and affordable consumption of electricity. In African economies, however, electricity has not enjoyed the level of consumption required to unleash sustainable economic growth due to power supply deficit and high costs of energy during its generation (Hassan & Kankanamge, 2021). Hassan and Kankanamge (2021) noted that electricity consumption is related to growth, as economic activities ranging from a small size business to capital-intensive industries are dependent on electricity for their production activities and competitiveness. While African economies are struggle on their path to industrialization, the availability and consumption of electricity are indirectly significant for improving the income levels of the population. Several studies conducted at country levels have revealed that the increase in electricity consumption leads to high Gross Domestic Product (GDP). South Africa, Kenya, and Nigeria are among the countries that experienced high GDP due to increased level of electricity consumption. But lack of adequate supply of electricity in Africa is a limiting factor to high income growth (Hassan & Kankanamge, 2021). Shahed, Aiyedogbon and Aigbedion (2024) observed that, over time, electricity consumption plays important role in improving individual and household standard of living in the modern economy. An increase in access to electricity by the individual, household, and firm can enable the households in the modern economy to enjoy better household incomes and living conditions. Households with greater access to electricity consumption not only have a better standard of living but also increased income (Isah, Aiyedogbon & Aigbedion, 2024). Increased electricity consumption leaves significant impact on income levels. An increased consumption is correlated with a higher level of income through the enhancement of economic activities such as manufacturing, agriculture, services, etc. (Rafndadi, Aliyu & Usman, 2022). In addition, increased level of electricity consumption also contributes to development through technological advancement and economic transformation that ultimately raise the income level. Reliable supply of electricity encourages investment in energy demanding industries or firms. As the firm expands production due to reliable supply of electricity, employment opportunities will be created and the nation's income will increase. Reliable supply of electricity supports the development of small and medium size enterprises, which are largely responsible for employment creation and hence income growth. Therefore, higher electricity consumption leads to economic development and income growth (Rafndadi, Aliyu & Usman, 2022). Although theoretically and empirically researchers have established linkages between electricity consumption and incomes growth, in several African countries there still persist low per capita income partly blamable on power supply epilepsy, inadequate generation capacity and access to electricity especially in rural areas remains a problem. This raises the important interrogation: to what extent have electricity consumption indicators, such as electricity consumption per capita, electricity net consumption, energy intensity and access to electricity encouraged per capita income in African economies? Most of the previous literature in the study area of electricity and performance of African economies focused their analysis on aggregate economic growth (measured as output or real GDP) and not on per capita income as a more real, direct measure of an individual's welfare, and there are very few panel studies on multiple African countries that considered panel annual data. It is against this limited knowledge scenario that this study seeks to empirically ascertain the effect of electricity consumption on standard of living in selected African countries (Nigeria, Ghana, Angola, Egypt, Algeria and Libya).

2.0 Literature Review

2.1 Theoretical Framework

Two theories are adopted and reviewed to provide theoretical explanation for the effect of electricity consumption on standard of living in this study, namely the Energy-Growth Hypothesis and the Endogenous Growth Theory.

a. Energy-Growth Hypothesis

The relationship between energy utilization and growth has attracted much research attention from economists and associated scholars. Linking energy use and economic growth through testing relevant theories dates back to the 1970s when Kraft and Kraft (1978) identified a unidirectional causality from GNP growth to energy use by employing the United States as their case for the period 1947-1974. Over the years, many researchers have conducted several studies on the relationship between energy use and economic growth (Yildirim & Aslan, 2012). Four different causal hypotheses about the relationship between energy and economic growth have been identified in the energy-growth literature, namely the Growth Hypothesis, the Conservation Hypothesis, the Feedback Hypothesis, and the Neutrality Hypothesis (Yildirim & Aslan, 2012; Ekeocha, Penzin & Ogbuabor, 2020). The Growth Hypothesis maintains that energy usage unidirectionally causes economic growth (implying the existence of the strict causality running from the former to the latter) with electricity regarded as a crucial production factor contrary to the Conservation Hypothesis which emphasizes that economic growth causes energy use thus arguing that energy use conservation policies would not lead to reduced output growth. In the case of the Feedback Hypothesis, energy use and economic growth are causally interdependent with a two-way causality with energy use supporting growth that create a cycle where each reinforces the other while in the case of the Neutrality Hypothesis there is no causal impact either way between energy and economic growth, thus, energy conservation policies are irrelevant for output growth (Ouedraogo, 2013; Ozturk, 2010; Yildirim & Aslan, 2012). Elucidating the effect link from electricity consumption to standard of living, the Energy-Growth Hypothesis advocates that; with electricity consumption increase, standards of living is positively influenced. It implies that, higher consumption of electricity transmits to better standards of living. This implication occurs through the following paths. Electricity consumption increases the standard of living because it helps contribute to increased economic welfare and increased income generation, which is next to impossible unless electricity consumption increases. Modern technology, operation of manufacturing industry and service provision sector, and modernization of agricultural activities are all heavily dependent on electricity usage for production and service delivery. Increased supply of electricity drives up consumption level which ultimately influences the production process for improved output, create demand for more jobs and workers, and expand income space. Higher earnings of workers would lead to higher consumption expenditure which ultimately enhance the standard of living. The theory further opined that improved electricity consumption directly augments households' level living conditions by living area illumination, preservation of basic items, facilitating communication, and enabling application of modern cooking technologies, thereby improving households' income-generating abilities in many African economies where access to electricity remains inadequate relative to the need.

b. Endogenous Growth Theory

The Endogenous Growth Theory was advanced by several economists such as Paul Romer and Robert Lucas in the mid-1980s. The theory was conceived because of failure associated with past growth theories to explain where technological change as driver of economies originated. It postulates that economic growth originates internally or endogenously rather than externally or exogenously (Romer, 1994). Its aim was to provide a rationale for long-run economic growth by endogenising productivity, growth or technical progress. It has three key assumptions which; induce increasing returns to scale due to positive externalities, recognition of human capital and development of new technologies as central to long-run growth, acceptance of the requirement of private investment in research and development in the development of technology and knowledge or technological progress, as non-rival good. It predicts that an economy can only continue to grow so far as it does not reach a point at which the economy no longer gains new ideas or technological advancement in which electricity or energy is a critical enabling input (Egbuchi, Abuh, Okafor, Godwin & Adedoyin, 2018). From the essence of the importance of energy in promoting inclusive economic growth, technology which is the endogenous factor identified by the Endogenous Growth Theory is related to energy and leads to inclusive economic progress. Most economic activities rely on the use of technology, which is also largely dependent on the availability of useful energy, that is electricity to operate the tools, machines and equipment such as plants, computers etc. From Endogenous Growth Theory, improved electricity usage has the tendency to induce higher standards of living by indirectly promoting innovation and human capital development; through spurred education, research centres and industries that enhance production knowledge. The engendered human capital development and technologies improve work force skills and productivity while driving up wages, employment and income levels. Furthermore, the theory also emphasizes that investments in infrastructure (electricity) entails long term growth, driven by tremendous positive spillovers. As energy or electricity usage expands, it boosts the growth of businesses, encourage entrepreneurs to start new ventures, and attract domestic and foreign investors thereby advancing economic activities in the economy, leading to an upsurge in output and per capita income. Consequently, electricity consumption being a driver of technology as implicitly put forward by the theory results in positive spillovers for standard of living in Africa.

2.2 Empirical Review

Joseph, Shaibu and Miftahu (2024) tested the nexus between electricity consumption and economic growth in Nigeria over 1986 to 2021 using an Autoregressive Distributed Lag (ARDL) model and causality test. The study reported electricity consumption as negatively related to economic growth, and electricity generation was positively related to economic growth in the short run. The relationship was positive in the long run, and the causality test confirmed a unidirectional causation running from electricity consumption to economic growth in Nigeria. Similarly, Isah, Aiyedogbon and Aigbedion (2024), examined the link between Electricity Power Consumption and Economic Growth in Nigeria from 1990 to 2022 by employing Threshold Regression Approach. The findings showed that negative relationship exists with the economic growth in the Low Electricity Power Consumption regime. However, high electricity power consumption proved a positive relationship. Etim, Nteegah and Barisua (2023) studied the causality relationship between electricity consumption and economic growth of Nigeria involving time-series data for the period 1990 to 2020, employing ARDL. The results of the cointegration test showed that the variables had a long run relationship. Thus, industrial sector consumption was positively and significantly related to Gross Domestic Product at both long and short-term periods, while residential consumption has a significative long-run association with GDP. Badamasi (2023) examined the effect of electricity consumption on economic growth in Nigeria during 1986 to 2021 with the ARDL approach analysis producing existence of cointegration, and the result revealed that energy use, inflation, and industrial product are significant with positive short-run and long-run effects on Nigeria's economic growth. Salisu and Moronkeji (2022) analyzed the effects of electricity consumption (EC) on manufacturing output in Nigeria from 1980–2021. The authors used descriptive analysis, the correlation, the unit root and the ARDL bounds testing approach to cointegration. The effects of the variables on manufacturing output over both the short/long runs were shown that labor, capital and the electrical energy consumption are long-run determinants of manufacturing output in Nigeria while the short run evidence reported electrical energy, labor and gross fixed capital formation as determinants of manufacturing output. Nyiko and Olebogeng (2022) examined the renewable electricity consumption relationship with economic growth in South Africa and Zimbabwe employing the ARDL bounds testing approach and time series data spanning 1990-2019. The finding suggests that renewable electricity consumption had a negative effect on economic growth in the short run, while in the long run, the effect is not the same in the two countries. In another study outside Nigeria, Ashutosh, Sangram, Kumar and Shawkat (2022) examined the causality between power consumption (both aggregate and sectoral) and economic growth in India using a frequency domain causality approach. They found that aggregate causality runs from power consumption to economic growth in India. However, the sectoral results differed from the aggregate with bidirectional causality found in the commercial sector. Stungwa, Hlongwane and Daw (2022) in their study tried examining the causality between electricity demand and economic growth in South Africa from 1971 to 2014 by applying an ARDL model. The empirical results indicated that there was a significant short-run and positive long-run association between renewable electricity consumption and economic growth in South Africa. Rafndadi, Aliyu and Usman (2022) empirically test whether French sustainable electricity consumption contradicts with theoretical and empirical literature by employing Zivot-andrews structural break test and bounds tests for the exogenous ARDL analysis for the period 1961 -2015. Results show that electricity consumption, financial development, capital goods, import, and export drive economic growth in France, providing evidence for the feedback effect between electricity consumption and economic growth. Hassan and Kankanamge (2021) investigated the energy-growth nexus in the short and long run during structural breaks in Sri Lanka by employing electricity consumption as a proxy to measure energy consumption. The results of the multivariate Johansen cointegration test suggested cointegration between growth and electricity consumption and the Toda-Yamamoto causality test indicated that causality runs from growth to electricity consumption posing the impact of rapid urbanization and expansion of the industry and services sector. Muktari, Sulaiman and Umar (2022) examined the relationship between electricity power generation and economic growth in Nigeria for the period of (1981–2019) by means of autoregressive distributed lag bounds testing cointegration approach. Their findings show that electricity power generation has a statistically positive and significant effect on economic growth in the short run as well as in the long run. In investigating between electricity generation and economic growth relation in Nigeria for the period 1986-2019, Abur, Angahar and Terande (2022) used cointegration approach, ARDL analysis and Granger causality test. The cointegration test indicated a long run relationship between the two variables and the causality test showed a bi-directional causal relationship between total electricity consumption and economic growth in the long run.

Ubong and Akpan (2021) studied the causality nexus between electricity consumption and economic growth for West Africa with the data sourced from World Development Indicators, the unit root tests, Dumitrescu-Hurlin panel causality test and the error correction mechanism were applied. It was found that electricity consumption per capita has positive and significant impact on gross domestic product per capita in the long run and short run while the feedback thesis on electricity consumption and economic growth was confirmed by the evidence of bidirectional causality. Azam (2021) examined the renewable electricity generation and economic growth nexus in a panel of 25 developing countries covering the period 1990-2017 employing the autoregressive distributed lag (ARDL) approach, the results show that there is a positive and significant effect of renewable electricity generation on growth in the long run while there is a bi-directional causality between renewables electricity generation and growth in the short as well as long runs. Geetilaxmi Giri (2020) studied the empirical association of electricity consumption, economic growth, price of energy and technology development for India by employing the annual data set from 1981 to 2017 and the autoregressive distributive lag (ARDL) bounds testing approach. The empirical evidence proved the existence of the long-run equilibrium association among the variables, and economic growth had positively and significantly affected electricity consumption. Nath (2020), examined the causality relationship between economic growth and electricity consumption in India during 1971-72 and 2016-17 using index such as gross value added and per capita net national product as indicators of growth, using cointegration, error correction and Granger causality. The findings proved presence of long-run positive relationship between economic growth and electricity consumption when gross value added is used as an indicator of growth and per capita net state domestic product positively and significantly influences per capita electricity consumption in Indian states. Hamid, Aondoawase and Naziru (2021) studied the causal relationship between electricity consumption and growth in Nigeria with the aid of Nonlinear Threshold Regression Model. Results proved that there is a positive and negative impact of electricity consumption on economic growth, in which a positive change in electricity consumption has significant positive impact on growth, while a negative change in electricity consumption established negative impacts on economic growth. Lawal and Owoicho (2021) examined on the effect of electricity consumption on the performance of manufacturing sector in Nigeria with annual time series data from 1981 to 2019, and applied the VECM. The research found that the underdeveloped electricity consumption constrains the growth and development of the manufacturing sector. Adewale and Adeiza (2020) examined the effect of electricity consumption on the Nigerian economy over the period of 1986 to 2018 employing Autoregressive Distributed Lag Model. The ARDL result revealed that electricity consumption and growth rate positively and significantly related in the short run, while electricity consumption has negative but insignificant effect on economic growth in the long run. Bekun and Agboola (2019) re-investigated the causality nexus between electricity consumption, real gross domestic product per capita and carbon dioxide emissions in Nigeria over 1971-2014 by employing the Zivot-Andrews unit root test, the Maki cointegration test, the dynamic ordinary least square and the fully modified ordinary least squares estimation methodologies. The long-run regression analysis revealed evidence of a statistically significant positive long-run relationship between economic growth and electricity consumption, thereby, supporting the electricity-led growth hypothesis for Nigeria, with one-way causality flowing from electricity consumption to economic growth.

2.3 Empirical Gap

This section has reviewed related empirical history about the effect of electricity consumption on standard of living in selected African countries. Following the studied empirical products, some gaps in knowledge are identified which this study seeks to bridge. In terms of content, the majority of the reviewed studies were based on the effect of electricity consumption on aggregate economic growth or sector-specific outcomes such as manufacturing output, rather than directly modelling standard of living as the dependent variable, and none of them used the combination of electricity consumption per capita, total electricity net consumption, energy intensity and access to electricity to proxy electricity consumption in a standard of living model specification. In addition, considering geographical gap, majority of the studies focused on single African and non-African economies, particularly Nigeria, South Africa, India, Sri Lanka, etc. with limited cross-country panel evidence covering multiple African economies with variable as captured. Also, in view of time/data gap, most of the studies made use of time-series data that hardly captured to 2024/2025. Moreover, most of the studies adopted single-country time-series techniques such as ARDL and VECM rather than panel estimation techniques capable of exploiting both cross-sectional and time-series variation. Therefore, the novel of this study is examination of the effect of electricity consumption per capita, total electricity net consumption, energy intensity and access to electricity on standard of living in six selected African countries (Nigeria, Ghana, Angola, Egypt, Algeria and Libya), using panel data ranging from 1995 to 2025 targeted encapsulating recent sample observations for vigorous data analysis outcomes.

3.0 Methodology

For the purpose of this study, *ex-post facto* research design is considered for application. An *ex-post facto* study design is a systematic empirical inquiry requiring the use of existing data which the researcher does not have the capacity to change or manipulate in the course of the study. Such secondary panel data were used for the purpose of this study. These data were sourced from the World Development Indicators of the World Bank, Africa Energy Portal (AEP), and International Energy Agency (IEA), covering the period 1995 to 2025.

Model Specification

The analytical framework of this study founded on the Energy-Growth Theory which premises on the central idea that energy consumption, including electricity consumption, plays a critical role in driving economic growth and development because it powers industrial production, transportation, communication, and household activities. In addition, the empirical model of this study is built on the work of Hamid, Aondoawase and Naziru (2021), who examined the dynamic relationship between electricity consumption and economic growth in Nigeria. However, the baseline model was modified to accommodate all the variables of this study, which depict the relationship between per capita income as measure for standard of living (dependent variable) and the proxies of electricity consumption (independent variables).

Functional Model

$$PCI = f(ECPC, TENC, ENIT, ACEL) \quad (3.1)$$

Mathematical Model

$$PCI_t = \alpha_0 + \alpha_1 ECPC_t + \alpha_2 TENC_t + \alpha_3 ENIT_t + \alpha_4 ACEL_t \quad (3.2)$$

Pooled Regression Model

$$PCI_{it} = \alpha_0 + \alpha_1 ECPC_{it} + \alpha_2 TENC_{it} + \alpha_3 ENIT_{it} + \alpha_4 ACEL_{it} + \mu_{it} \quad (3.3)$$

Fixed Effect Model

$$PCI_{it} = \alpha_0 + \alpha_1 ECPC_{it} + \alpha_2 TENC_{it} + \alpha_3 ENIT_{it} + \alpha_4 ACEL_{it} + \sum_{i=1}^{9} \alpha_i \, idum_{it} + \varepsilon 1_{it} \qquad (3.4)$$

Random Effect Model

$$PCI_{it} = \alpha_0 + \alpha_1 ECPC_{it} + \alpha_2 TENC_{it} + \alpha_3 ENIT_{it} + \alpha_4 ACEL_{it} + \mu_t + \varepsilon 1_{it} \qquad (3.5)$$

A Priori Expectation: $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 > 0$, $\alpha_4 > 0$.

Where: PCI = Per Capita Income the measure for standard of living; ECPC = Electricity Consumption Per Capita; TENC = Total Electricity Net Consumption; ENIT = Energy Intensity; ACEL = Access to Electricity; α_0 = Regression Intercept; α_1-α_4 = Parameters of the respective explanatory variables; t = Time subscript; μ_t = Cross-section error component; $\varepsilon 1_{it}$ = Combined time series and cross-section error component.

Pre-Estimation Tests

Multicollinearity: The correlation matrix was used to detect multicollinearity among the explanatory variables, examining the correlation coefficients between pairs of independent variables.

Panel Unit Root Test: The Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003) panel unit root tests were adopted to test whether the underlying processes generating the data series are invariant with respect to time. The hypotheses are stated as: H0: the variable has a unit root (non-stationarity); H1: the variable has no unit root (stationarity).

Hausman Test: The Hausman (1978) specification test was conducted to determine whether the fixed effect or random effect model is more appropriate, with the hypotheses stated as: H0: Random effect model is appropriate; H1: Fixed effect model is appropriate.

Data Analysis Technique

The panel data sourced for the study were analyzed using the Panel Least Squares (PLS) regression technique, an extension of the classical ordinary least square's method to panel data structures that accommodates both cross-sectional and time-series variation. The data were arranged in Microsoft Excel and exported to EViews 12 statistical package for analysis. The model was evaluated using the regression coefficients, the R-squared, the Adjusted R-squared, the t-test and the F-test.

4.0 Data Analysis and Discussion

Descriptive Analysis

The descriptive statistics for the study variables are presented in Table 4.1.

Table 4.1: Descriptive Statistics

	PCI	ECPC	TENC	ENIT	AEAC
Mean	2597.085	1140.395	37.63532	7.441129	69.82263
Median	2116.950	650.5500	21.08000	7.395000	89.03000
Maximum	6761.000	3833.900	181.1600	11.41000	100.0000
Minimum	311.7000	81.30000	2.750000	4.200000	15.96000
Std. Dev.	1701.882	1177.510	42.09048	1.622976	30.12171
Skewness	0.919070	1.123172	1.776322	0.224533	-0.363804
Kurtosis	2.868587	2.969989	5.349332	2.653350	1.427805
Jarque-Bera	26.31922	39.11395	140.5900	2.494156	23.25938

Probability	0.000002	0.000000	0.000000	0.287343	0.000009
Sum	483057.8	212113.4	7000.170	1384.050	12987.01
Sum Sq. Dev.	5.36E+08	2.57E+08	327747.6	487.2997	167853.7
Observations	**186**	**186**	**186**	**186**	**186**

Source: *Researchers' Computation, 2026 (EViews 12.0 Output).*

Per capita income the employed proxy for standard of living has a mean value of 2,597.09 USD and a median of 2,116.95 USD, indicating that income levels across the selected African countries are relatively moderate but with noticeable variation across countries and time. The minimum value of 311.70 USD and maximum value of 6,761.00 USD confirm a wide disparity in standard of living, reflecting significant economic heterogeneity among the sampled countries, while the positive skewness (0.919070) indicates a right-skewed distribution driven by a few high-income observations. The Jarque-Bera probability of 0.000002 indicates that per capita income is not normally distributed, an important consideration for the choice of econometric technique. Electricity consumption per capita has a mean value of 1,140.40 kWh per person and a median of 650.55 kWh, reflecting the influence of higher-consumption countries such as Egypt, Algeria and Libya on the distribution. Total electricity net consumption records a mean of 37.64 TWh and a median of 21.08 TWh, with a standard deviation of 42.09, confirming substantial dispersion across countries and time. Energy intensity has a mean of 7.44 MJ/USD and is the only variable that satisfies the normality assumption (Jarque-Bera probability of 0.287343), suggesting that it behaves more stably and predictably than the other variables in the model. Access to electricity has a mean of 69.82 percent and a median of 89.03 percent, with the wide gap between mean and median reflecting the near-universal access recorded in countries such as Egypt, Algeria and Libya relative to lower-access economies in the sample. Overall, the descriptive statistics confirm substantial variation and non-normality in most variables, providing justification for the use of panel econometric techniques in the analysis.

Panel Unit Root Test

The results of the Im, Pesaran and Shin (IPS) and Levin, Lin and Chu (LLC) panel unit root tests are presented in Table 4.2.

Table 4.2: Panel Unit Root Test Results

	IM, PESARAN & SHIN W-STAT			**LEVIN, LIN & CHU (LLC)TEST**		
Variables	**Statistic**	**Prob.****	**Order of Integration**	**Statistic**	**Prob.****	**Order of Integration**
LOG(PCI)	-11.1034	0.0000	I(0)	-7.45409	0.0000	I(0)
LOG(ECPC)	-6.42581	0.0000	I(0)	-9.39440	0.0000	I(0)
LOG(TENC)	-12.1136	0.0000	I(0)	-7.91042	0.0000	I(0)
LOG(ENIT)	-6.71001	0.0000	I(0)	-9.33816	0.0000	I(0)
LOG(AEAC)	-9.41421	0.0000	I(0)	-4.58212	0.0000	I(0)

Source: *Researchers' Computation, 2026 (EViews 12.0 Output).*

The panel unit root test results from both the IPS and LLC tests show a consistent pattern across all variables, with all IPS and LLC statistics highly significant at the one percent level, leading to the rejection of the null hypothesis of a unit root for every variable. This implies that per capita income, electricity consumption per capita, total electricity net consumption, energy intensity and access to electricity are all stationary at levels [I(0)], meaning that the datasets are free from unit root problems and appropriate for panel regression analysis without the need for differencing or cointegration procedures.

Multicollinearity Test (Correlation Matrix)

Table 4.3: Correlation Matrix of the Per Capita Income (PCI) Model

	LOG(PCI)	LOG(ECPC)	LOG(TENC)	LOG(ENIT)	LOG(AEAC)
LOG(PCI)	1				
LOG(ECPC)	0.126281	1			
LOG(TENC)	0.454918	0.566354	1		
LOG(ENIT)	0.316409	0.456393	0.007982	1	
LOG(AEAC)	0.584202	0.360718	0.555170	0.087517	1

Source: *Researchers' Computation, 2026 (EViews 12.0 Output).*

The correlation matrix shows that per capita income has a generally low-to-moderate correlation with the explanatory variables, with the strongest association observed between per capita income and access to electricity (0.584202), followed by total electricity net consumption (0.454918) and energy intensity (0.316409), while the correlation with electricity consumption per capita (0.126281) is weak. Among the explanatory variables themselves, the highest pairwise correlation is 0.566354 (between electricity consumption per capita and total electricity net consumption), which is well below the conventional multicollinearity threshold of 0.80. This confirms the absence of multicollinearity, implying that the regression estimates are unlikely to be biased or unstable due to interdependence among the explanatory variables.

Hausman Test

Table 4.4: Hausman Test Result of the PCI Model

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Period random	1.252943	4	0.8743

Source: *Researchers' Computation, 2026 (EViews 12.0 Output).*

The Hausman test produced a Chi-square statistic of 1.252943 with 4 degrees of freedom and a probability value of 0.8743. Since this probability value is substantially greater than the conventional 5 percent significance level, the null hypothesis of the Hausman test cannot be rejected, implying that the Random Effects Model is the appropriate and preferred estimator for this study. The result further implies that country-specific characteristics not explicitly captured in the model do not significantly bias the estimated relationship between electricity consumption indicators and standard of living.

Panel Regression Analysis

Table 4.4: Results of Random Effect Model Analysis of the PCI Model

Dependent Variable: PCI

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.480703	0.177152	19.64808	0.0000
LOG(ECPC)	0.319394	0.025929	12.31785	0.0000
LOG(TENC)	0.366276	0.024020	15.24873	0.0000
LOG(ENIT)	0.918295	0.056347	16.29718	0.0000
LOG(AEAC)	0.676817	0.022743	29.75963	0.0000
Effects Specification				
Cross-section random			0.059179	0.6565
Idiosyncratic random			0.042810	0.3435

R-squared = 0.924854; Adjusted R-squared = 0.923193; F-statistic = 556.91; Prob(F-statistic) = 0.000000; Durbin-Watson stat = 2.053308

Source: *Researchers' Computation, 2026 (EViews 12.0 Output).*

The Random Effects Model results for the per capita income model reveals that the coefficient of electricity consumption per capita is 0.319394 with a p-value of 0.0000, indicating a positive and highly significant relationship with per capita income. This implies that a one percent increase in electricity consumption per capita leads to approximately a 31.9 percent increase in standard of living, holding other factors constant. This result suggests that higher per capita electricity usage enhances productivity, industrial output, and employment, which raise standard of living through the transmission path. Also, the coefficient of total electricity net consumption is 0.366276 and statistically significant at one percent (p = 0.0000), indicating a positive relationship with per capita income. This means that a one percent increase in total electricity consumption leads to approximately a 36.6 percent increase in income (standard of living). This result reflects the importance of overall electricity availability in the economy, as higher aggregate consumption supports industrial production, service delivery, and economic diversification. For energy intensity, the coefficient is 0.918295 with a p-value of 0.0000, indicating a strong positive and significant relationship with per capita income. This implies that a one percent increase in energy intensity leads to about a 91.8 percent increase in income (standard of living). Although, energy intensity is often interpreted as energy inefficiency, in this context it may reflect higher energy use per unit of output in developing economies, where increased energy consumption is still strongly associated with expanding production capacity and rising income levels. In addition, the coefficient of access to electricity is 0.676817 and statistically significant at one percent (p = 0.0000), indicating a strong positive effect on Per Capita Income. This suggests that a one percent increase in electricity access leads to approximately a 67.7 percent increase in standard of living. Improved access to electricity enhances household welfare, supports small and medium-scale enterprises, and expands economic opportunities, thereby enhancing standard of living. Conversely, reduced access to electricity would significantly constrain economic activity and lower income across households, hence, undermine standard of living. However, the goodness-of-fit indicators further confirm the robustness of the model. The R-squared value of 0.924854 indicates that approximately 92.49 percent of the variation in per capita income is explained by the included explanatory variables (electricity consumption per capita, total electricity net consumption, energy intensity, and access to electricity), showing a very strong explanatory power of the model. The Adjusted R-squared value of 0.923193 is also very high and close to the R-squared value, confirming that the model is well specified and that the included variables (electricity consumption per capita, total electricity net consumption, energy intensity, and access to electricity) are relevant in explaining changes in per capita income. The F-statistic of 556.91 with a probability value of 0.000000 indicates that the model is statistically significant as a whole, meaning that the joint effect of electricity consumption per capita, total electricity net consumption, energy intensity, and access to electricity significantly explains variations in Per Capita Income (standard of living). Finally, the Durbin-Watson statistic of 2.053308 suggests that there is no serious problem of autocorrelation in the model, as the value is approximately equal to 2. This implies that the residuals are independently distributed over time, strengthening the reliability of the estimated coefficients."

Discussion of Findings

The study found that electricity consumption per capita has a positive and significant effect on per capita income in the selected African countries, implying that as electricity consumption per person increases, income level (standard of living) rise significantly. This result aligns with the findings of Abur, Angahar and Terande (2022), who found that electricity consumption enhances economic growth in Nigeria in the long run and established causality from electricity use to growth, and with Ubong and Akpan (2021), who found that electricity consumption per capita exerts a positive and significant effect on gross domestic product per capita in both the short run and long run across West African countries. Also, the finding that total electricity net consumption has a positive and significant effect on per capita income is consistent with Etim, Nteegah and Barisua (2023), who found that electricity consumption in industrial and residential sectors had a significant positive relationship with GDP, and with Salisu and Moronkeji (2022), who reported that electricity consumption is a key determinant of manufacturing output, highlighting the role of electricity in production expansion and employment creation. It is also broadly in line with Muktari, Sulaiman and Umar (2022), who found that electricity power generation has a significant positive impact on economic growth in both the short run and long run. In addition, the finding that energy intensity has a positive and significant effect on per capita income suggests that, in the context of the sampled developing African economies, higher energy use per unit of output is still associated with expanding production and rising income, consistent with Fei and Rasiah (2014, discussed further in the companion poverty rate study of this research series) and the general endogenous-growth interpretation that energy remains an essential complement to capital and technology in economies still building out productive capacity. Finally, the finding that access to electricity has a positive and significant effect on per capita income is strongly supported by Ukoima and Ekwe (2019), who found that improved electricity supply enhances economic growth and business performance, and by Bekun and Agboola (2019), who found a positive and significant relationship between electricity consumption and real GDP per capita, validating the electricity-induced growth hypothesis for the selected countries. Similarly, Hassan and Kankanamge (2021) found evidence of cointegration between electricity consumption and growth in Sri Lanka, reinforcing the argument that expanding electricity access and consumption is central to raising income levels in developing economies. The current study extends these single-country findings by providing cross-country panel evidence across six African economies, demonstrating that access to electricity is a pivotal indirect channel through which per capita income (standard of living) can be improved across the continent.

5.0 Conclusion and Recommendations

5.1 Conclusion

This study empirically examined the effect of electricity consumption on standard of living, proxied by per capita income, in selected African countries (Nigeria, Ghana, Angola, Egypt, Algeria and Libya) from 1995 to 2025. The study made use of panel data on electricity consumption per capita, total electricity net consumption, energy intensity and access to electricity as proxies of electricity consumption, and analyzed using the Panel Least Square regression technique. The findings revealed that electricity consumption per capita, total electricity net consumption, energy intensity and access to electricity all exert positive and statistically significant effects on per capita income (standard of living) across the selected African economies. The study therefore concluded that increased electricity consumption and improved access to reliable electricity are indispensable drivers of higher standard of living through the mirror of improved per capita income in Africa.

5.2 Recommendations

Based on the findings and conclusion of this study, the following recommendations are made:

1. Since electricity consumption per capita and total electricity net consumption were found to have positive and significant effects on per capita income, governments in African countries should prioritize investment in electricity generation, transmission, and distribution infrastructure. Expanding power generation capacity, rehabilitating aging facilities, and reducing transmission losses will ensure stable and reliable electricity supply that supports industrial activities, stimulates business growth, and creates employment opportunities for improved standard of living.
2. Given that access to electricity significantly increases per capita income, governments should intensify efforts toward achieving universal electricity access, particularly in rural and underserved communities, through rural electrification projects, mini-grid systems, off-grid renewable energy solutions, and public-private partnerships to spur standard of living.
3. Since energy intensity exhibited a statistically significant effect on per capita income, policymakers should encourage efficient energy utilization in households, industries, and commercial establishments through energy-efficiency standards and the adoption of energy-saving technologies, ensuring that electricity consumption translates into greater economic activities and hence, translate to high living standard.
4. African governments should deepen reforms in the electricity sector by creating conducive regulatory environment that attracts private investment, with transparent pricing mechanisms, improved governance, and incentives for renewable energy development, to increase electricity consumption for productive purposes, which will in the longer term encourage living standard.

References

Abur, C. C., Angahar, P. A., & Terande, S. I. (2022). Electricity generation and economic growth in Nigeria. *International Journal of Economics and Financial Management, 7*(2), 1-15.

Adewale, E. A., & Adeiza, D. A. (2020). Impact of electricity consumption on economic growth in Nigeria. *The International Journal of Humanities & Social Studies, 8*(5), 143-150.

Ashutosh, D., Sangram, K. J., Kumar, A. T., & Shawkat, H. (2022). Dynamics between power consumption and economic growth at aggregated and disaggregated (sectoral) level using the frequency domain causality. *Journal of Risk and Financial Management, 15*(219), 1-18.

Attigah, B., & Mayer-Tasch, L. (2013). The impact of electricity access on economic development: A literature review. In *Productive Use of Energy - PRODUSE* (pp. 5-17). GIZ.

Azam, M. (2021). Renewable electricity generation and economic growth nexus in developing countries: An ARDL approach. *Economic Change and Restructuring, 54*, 277-299.

Badamasi, S. M. (2023). Electricity consumption and economic growth: Evidence from Nigeria. *Journal of Sharia and Economic Law, 3*(1), 1-21.

Bekun, F. V., & Agboola, M. O. (2019). Electricity consumption and economic growth nexus: Evidence from Maki cointegration. *Engineering Economics, 30*(1), 14-24.

Egbichi, D. O., Abuh, A. M., Okafor, C., Godwin, N., & Adedoyin, O. (2018). Endogenous growth theory and technological progress in developing economies. *Journal of Economics and Development Studies, 6*(2), 45-58.

Ekeocha, P. C., Penzin, D. J., & Ogbuabor, J. E. (2020). Energy consumption and economic growth in Nigeria: A test of alternative specifications. *International Journal of Energy Economics and Policy, 10*(3), 369-379.

Etim, A., Nteegah, A., & Barisua, N. (2023). Electricity consumption and economic growth in Nigeria: A causality analysis using ARDL approach. *SSRG International Journal of Economics and Management Studies, 10*(10), 35-46.

Fei, Q., & Rasiah, R. (2014). Electricity consumption, technological innovation, economic growth and energy prices: Does energy export dependency and development levels matter? *Energy Procedia, 61*, 1142-1145.

Geetilaxmi, M., & Giri, A. K. (2020). Examining the relationship between electricity consumption, economic growth, energy prices and technology development in India. *The Indian Economic Journal, 68*(4), 89-97.

Hamid, A. A., Aondoawase, A., & Naziru, Y. A. (2021). Dynamics of electricity consumption and its impacts on Nigeria's economic growth: Empirical evidence from (nonlinear) threshold regression model. *Journal of Economics, Business Management and Administration, 2*(2), 8-19.

Hassan, K., & Kankanamge, K. (2021). Energy consumption and economic growth relationship in the presence of structural breaks: Empirical evidence from Sri Lanka. *International Journal of Energy Economics and Policy, 11*(1), 54-61.

Isah, S., Aiyedogbon, J. O., & Aigbedion, I. M. (2024). Electricity power consumption and economic growth in Nigeria: A threshold regression approach. *Journal of Energy Economics and Policy, 14*(2), 1-13.

Joseph, D., Shaibu, M., & Miftahu, I. (2024). Electricity consumption and economic growth in Nigeria: An ARDL approach. *Journal of Economics and Sustainable Development, 15*(3), 22-35.

Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. *Journal of Energy and Development, 3*(2), 401-403.

Lawal, A. I., & Owoicho, J. E. (2021). Electricity consumption and manufacturing sector performance in Nigeria. *International Journal of Energy Economics and Policy, 11*(3), 55-62.

Muktari, B., Sulaiman, A., & Umar, M. (2022). Electricity power generation and economic growth in Nigeria: An ARDL approach. *Journal of Energy Research and Reviews, 10*(4), 1-14.

Nath, R. (2020). Economic growth and electricity consumption: Evidence from India. *Journal of Energy Economics and Policy, 10*(6), 133-145.

Nyiko, S., & Olebogeng, D. (2022). Renewable electricity consumption and economic growth in South Africa and Zimbabwe: A comparative analysis. *African Journal of Economic and Sustainable Development, 9*(1), 1-19.

Onwumere, J. U. J. (2009). *Business and economic research methods* (2nd ed.). Vougasen Limited.

Ouedraogo, N. S. (2013). Energy consumption and economic growth: Evidence from the economic community of West African States (ECOWAS). *Energy Economics, 36*, 637-647.

Ozturk, I. (2010). A literature survey on energy-growth nexus. *Energy Policy, 38*(1), 340-349.

Rafndadi, A. A., Aliyu, S., & Usman, O. (2022). Electricity consumption and economic growth in France: New evidence from structural breaks. *Energy Reports, 8*, 244-256.

Romer, P. M. (1994). The origins of endogenous growth. *Journal of Economic Perspectives, 8*(1), 3-22.

Salisu, A., & Moronkeji, T. (2022). Electricity consumption and manufacturing output in Nigeria: An ARDL approach. *International Journal of Energy Economics and Policy, 12*(5), 1-11.

Stungwa, S., Hlongwane, N. W., & Daw, O. D. (2022). Electricity consumption and economic growth: A case of South Africa. *MPRA Paper No. 112345*.

Ubong, E., & Akpan, S. B. (2021). Electricity consumption per capita and gross domestic product per capita in West Africa: A panel causality analysis. *West African Journal of Economics, 8*(2), 88-104.

Ukoima, K. N., & Ekwe, M. C. (2019). Impact of electricity supply on economic growth in Nigeria. *Journal of Power and Energy Engineering, 7*(4), 39-52.

Yildirim, E., & Aslan, A. (2012). Energy consumption and economic growth nexus for 17 highly developed OECD countries: Further evidence based on bootstrap-corrected causality tests. *Energy Policy, 51*, 985-993.