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Impact of Nigerian Energy Challenge and Global Climate Change Politics on Consumer Welfare: Nexus with ECOWAS Member Countries

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Abstract

Nigeria faces a dual challenge: addressing its domestic energy crisis while navigating global climate change policies aimed at decarbonizing the energy sector. This paper explores the impact of Nigeria's energy challenges and global climate policies on consumer welfare, focusing on the nexus within the Economic Community of West African States (ECOWAS). With approximately 71% of Nigeria's population lacking access to modern energy services, energy shortages and high costs limit economic development, exacerbating poverty and inequality. Global climate commitments, such as the Paris Agreement, add complexities, requiring Nigeria to shift toward cleaner energy sources. Additionally, the country's reliance on fossil fuels increases vulnerability to international price fluctuations and environmental challenges. As Nigeria's energy policies resonate across ECOWAS, regional energy integration initiatives, such as the West African Power Pool (WAPP), present opportunities to enhance energy security and consumer welfare. This study emphasizes the need for sustainable energy strategies that balance climate obligations with economic development to improve living standards across Nigeria and the broader ECOWAS region.

Keywords

Consumer Welfare, ECOWAS Energy Integration, Energy Crisis, Global Climate Policies & Renewable Energy

1. Introduction

The global energy landscape is undergoing a profound transformation driven by climate change policies and the transition to sustainable energy systems. Developing countries, particularly in sub-Saharan Africa, are increasingly vulnerable to energy crises and the geopolitical implications of global climate politics. Nigeria, the most populous nation in Africa and the largest economy in the Economic Community of West African States (ECOWAS), faces a dual challenge: resolving its domestic energy crisis while navigating international climate change policies aimed at decarbonizing the energy sector (Ebohon, 2019).

The interplay between Nigeria's energy challenges and global climate change politics has profound implications for consumer welfare, particularly within the Economic Community of West African States (ECOWAS). Nigeria, as the largest economy in Africa, faces significant energy deficits, with approximately 71% of its population lacking access to modern energy services (World Economic Forum, 2023). This energy inaccessibility hampers economic development, health, and education, exacerbating poverty and inequality. Concurrently, global climate change politics, driven by international agreements such as the Paris Agreement, necessitate a transition to sustainable energy sources, further complicating Nigeria's energy landscape (Olujobi, 2024).

Nigeria's energy sector is plagued by inadequate infrastructure, inconsistent energy supply, and over-reliance on fossil fuels, which contribute to chronic electricity shortages and rising costs for consumers. The World Bank estimates that only 55% of Nigeria's population has access to electricity, leaving millions reliant on expensive and polluting alternatives like diesel generators (World Bank, 2021). The energy deficit has significantly impacted consumer welfare, exacerbating economic inequalities and hindering access to essential services, such as healthcare, education, and business activities (Eleri et al., 2022).

The country's reliance on fossil fuels, particularly crude oil, has made it vulnerable to global price fluctuations and environmental concerns. Furthermore, the growing demand for energy, driven by rapid urbanization and industrialization, has strained existing infrastructure and exacerbated power shortages. These challenges are compounded by the complex dynamics of global climate change negotiations, where Nigeria, as a developing nation, must balance its economic aspirations with its environmental responsibilities.

Simultaneously, global climate change policies, particularly the Paris Agreement, require countries, including Nigeria, to transition to cleaner energy sources. The financial and technological challenges of this transition, compounded by Nigeria's status as a major oil exporter, further complicate the country's efforts to balance economic growth with climate commitments (Olawuyi, 2020). The Nigerian government has set ambitious targets to achieve universal energy access by 2030, yet the path is fraught with financial and technical challenges (World Economic Forum, 2023). The Climate Change Act of 2021 represents a significant legislative effort to address these challenges by promoting renewable energy adoption and enhancing energy efficiency (Olujobi, 2024). However, the implementation of such policies is often hindered by weak regulatory frameworks and insufficient political will (Adeyanju et al., 2020).

In this context, the country's energy policies are not only shaped by domestic imperatives but also by international climate governance frameworks. These global regulations, while essential for curbing global emissions, can impose additional economic pressures on developing nations by increasing energy prices and limiting the use of affordable but carbon-intensive energy sources (Ogbuagu et al., 2023).

Moreover, as a member of ECOWAS, Nigeria's energy policies and welfare impacts resonate throughout the West African region. Energy shortages and price volatility in Nigeria often have spillover effects on neighboring countries, complicating regional efforts to achieve sustainable development goals (SDGs) and improve living standards. ECOWAS countries are also collectively bound by climate obligations, but disparities in energy access and economic capacities make it difficult to adopt a unified regional strategy (Adom & Bekoe, 2022).

This research paper explores the intricate relationship between Nigeria's energy challenges, global climate change politics, and the impact on consumer welfare. Specifically, it examines the nexus between these factors within the context of the Economic Community of West African States (ECOWAS). ECOWAS, as a regional economic bloc, shares many of Nigeria's energy challenges and is also grappling with the implications of climate change. Understanding the interconnectedness of these issues is crucial for developing effective policies and strategies to improve consumer welfare and contribute to global climate action.

2. Statement of the Research Problem

Nigeria, the largest economy and most populous country in Africa, faces a persistent energy crisis that significantly hampers economic development and negatively impacts consumer welfare. Despite having vast natural resources, including oil, gas, and renewable energy potential, Nigeria continues to experience chronic energy shortages. These shortages are largely due to inadequate infrastructure, mismanagement of resources, and over-reliance on fossil fuels, which together undermine the nation's ability to provide reliable and affordable energy to its citizens (Ogwumike et al., 2021). As of 2021, nearly half of Nigeria's population lacks access to electricity, forcing millions of households and businesses to depend on expensive, polluting alternatives, which further strain their economic well-being (World Bank, 2021).

In parallel, global climate change policies, such as the Paris Agreement, are pushing countries, including Nigeria, to transition from carbon-intensive energy systems to more sustainable, low-carbon alternatives. While this global shift is crucial for mitigating climate change, the economic burden of meeting international climate commitments presents significant challenges for developing nations like Nigeria. The transition to renewable energy requires substantial financial and technological investments, which Nigeria, with its current economic constraints, struggles to meet (Olawuyi, 2020). Moreover, these global climate policies often result in rising energy costs, which disproportionately affect consumers, particularly the poor, exacerbating existing inequalities and undermining welfare (Ogbuagu et al., 2023).

Furthermore, Nigeria's energy and climate policies have broader implications for the Economic Community of West African States (ECOWAS) region. As a key player in ECOWAS, Nigeria's energy security, or lack thereof, directly influences the economic and social well-being of neighboring member states. Energy price volatility, frequent blackouts, and policy-induced shifts in energy markets have cross-border effects, impacting regional development efforts and consumer welfare across West Africa (Adom & Bekoe, 2022). However, ECOWAS member states face varied energy challenges, and disparities in their capacities to meet global climate targets complicate efforts to establish a cohesive regional energy transition strategy (Ebohon, 2019).

Despite the significance of these issues, there is limited empirical research on how the intersection of Nigeria's energy challenges and global climate change politics affects consumer welfare within both Nigeria and the wider ECOWAS region. A critical knowledge gap exists regarding the extent to which global climate policies exacerbate or alleviate Nigeria's energy crisis, and how this, in turn, affects the welfare of consumers who bear the brunt of energy price fluctuations and shortages. Understanding these dynamics is crucial for designing policies that mitigate adverse welfare impacts while ensuring compliance with international climate obligations and fostering sustainable energy solutions across West Africa.

2.1 Objectives of the Study

1) Evaluate the impact of Nigeria's energy crisis on consumer welfare
2) Analyze how global climate policies influence Nigeria's energy prices
3) Assess the effects of Nigeria's energy issues on ECOWAS energy trade

2.2 Research Questions

1) How does Nigeria's energy crisis affect household consumer welfare?
2) What is the impact of global climate policies on Nigeria's energy pricing?
3) How do Nigeria's energy challenges influence energy trade in ECOWAS?

3. Literature Review

3.1 Evaluation of the Impact of Nigeria's Energy Crisis on Consumer Welfare

Nigeria, Africa's largest economy, continues to face persistent energy challenges. Despite its abundant oil, gas, and renewable energy potential, the country struggles with erratic electricity supply, fuel shortages, and high energy costs. These challenges not only constrain economic growth but also significantly affect consumer welfare. The intersection of the Nigerian energy crisis and global climate change policies presents further complexities for citizens, especially as Nigeria seeks to balance development needs with international climate obligations.

3.2 Energy Crisis in Nigeria

Nigeria's energy sector is characterized by inadequate generation capacity, frequent grid failures, and high transmission losses. The sector is also characterized by frequent power outages and inadequate supply, which has significant implications for consumer welfare. Nigeria's energy sector has faced numerous challenges, including inadequate infrastructure, corruption, and policy inconsistencies. According to Aliyu et al. (2013), the country's electricity supply remains grossly insufficient, covering only about 45% of demand. This shortfall has led to over-dependence on private generators, resulting in higher costs of living for consumers (Ogujor & Otasowie, 2010). Afolayan et al. (2017) highlights the significant financial burden placed on households that have to invest in alternative energy sources such as generators and inverters to compensate for inadequate public supply. The energy crisis has had profound effects on both urban and rural households, influencing their economic activities and overall quality of life.

3.3 Consumer Welfare and Economic Impacts

The energy crisis in Nigeria has direct and indirect consequences on consumer welfare. On a microeconomic level, unreliable energy supply drives up household expenditures, reducing disposable income. One of the most significant effects is the increased cost of living. Households spend a substantial portion of their income on alternative energy sources, which reduces their disposable income and limits their ability to afford other essential goods and services (Okereke et al., 2024). In addition, electricity outages disrupt small-scale businesses, reducing productivity and income, which in turn increases poverty levels (Olaniyan & Lawal, 2010). Households also suffer health-related impacts due to reliance on generators, which release harmful pollutants into the environment, causing respiratory problems (Ibitoye & Adenikinju, 2007). The World Bank (2020) estimates that the average Nigerian household spends up to 40% of its income on energy, limiting their access to other essential services such as healthcare and education.

3.4 Socio-Economic Implications

The socio-economic implications of the energy crisis are particularly severe for lower-income households. Studies have shown that these households are disproportionately affected by energy price increases due to their limited financial resources and lack of access to alternative energy sources (Okereke et al., 2024). The removal of fossil fuel subsidies, while aimed at promoting sustainable energy use, has also led to higher energy costs, further straining household budgets (Ikweugbu, 2023).

3.5 Government Policies and Interventions

Various government policies and interventions have been implemented to mitigate the impact of the energy crisis on consumer welfare. These include subsidy reforms, targeted financial assistance, and investments in renewable energy infrastructure. However, the effectiveness of these measures has been mixed. While some policies have provided temporary relief, long-term solutions require comprehensive reforms and substantial investments in the energy sector (Ikweugbu, 2023).

3.6 Energy Crisis and Climate Change Policies

Nigeria's energy crisis is compounded by global climate change politics. The pressure to transition to cleaner energy sources as outlined by international agreements, such as the Paris Agreement, presents additional challenges for the country. According to Adenikinju et al. (2020), while the shift to renewable energy is crucial for mitigating climate change, the lack of infrastructural development and investments in green energy means that Nigeria is still far from achieving a sustainable energy mix. This imbalance creates a dilemma for policymakers: reducing carbon emissions while ensuring affordable energy access for consumers (Olaniyan & Lawal, 2010).

3.7 Nexus with ECOWAS Member Countries

The energy crisis in Nigeria also resonates with broader issues in the Economic Community of West African States (ECOWAS) region, where many member states face similar challenges of inadequate energy infrastructure and dependency on fossil fuels. As the largest economy in the region, Nigeria's energy policies and challenges can influence regional energy security and economic stability. However, according to Abidemi & Ayodeji (2018), regional cooperation within ECOWAS has opened doors for energy integration projects aimed at enhancing energy security and consumer welfare. Projects such as the West African Power Pool (WAPP) could reduce the energy supply gap by enabling cross-border electricity trade, alleviating some of the consumer welfare concerns tied to energy availability and costs. The Nigerian energy crisis has profound implications for consumer welfare, impacting household incomes, health, and quality of life. While global climate change politics further complicates Nigeria's energy challenges, regional collaboration through ECOWAS may offer pathways for addressing both energy security and climate goals. More research is needed on sustainable energy strategies that can mitigate the adverse effects of energy poverty on consumers while aligning with global climate policies.

4. Methodology

4.1 Research Design

The study adopts a quantitative research design using secondary data analysis to assess the impact of Nigeria's energy crisis and global climate change policies on citizen welfare. Secondary data was sourced from reputable databases such as the World Bank, National Bureau of Statistics, and International Energy Agency, focusing on key indicators like energy access, poverty rates, and health outcomes. Econometric techniques such panel data regression was used to explore the relationships between energy shortages, climate policy interventions, and welfare outcomes such as income, health, and education. The research design is justified by its ability to analyze macro-level data, providing robust insights into broad trends and relationships over time. This design effectively addresses the research questions by capturing how energy crises and climate policies impact welfare, ensuring relevance to policy discussions on Nigeria's energy challenges and climate obligations (Bhattacharyya, 2011; Sovacool, 2016).

4.2 Data Collection

This study relies exclusively on secondary data to assess the impact of Nigeria's energy crisis and global climate change policies on citizen welfare. Key datasets were sourced from reputable national and international databases. National energy statistics will be obtained from the National Bureau of Statistics (NBS) and the International Energy Agency (IEA), including data on energy production, consumption, access, and energy sector performance over time. Climate policy information, including the progress and implementation of international commitments such as the Paris Agreement and Nigeria's National

Climate Change Policy, was sourced from the United Nations Framework Convention on Climate Change (UNFCCC) and the Nigerian Ministry of Environment.

Welfare indicators, such as income, health outcomes, and education levels, was drawn from sources like the World Bank Development Indicators and Nigeria Demographic and Health Survey (NDHS). These datasets provide time-series and cross-sectional data for detailed analysis of how energy access, policy interventions, and economic conditions influence welfare (Bhattacharyya, 2011; Sovacool, 2016). By leveraging these diverse data sources, the study ensures comprehensive coverage of both energy and welfare metrics.

4.3 Data Analysis

The analysis employs both descriptive and inferential statistical methods to examine the relationship between energy access, climate policies, and welfare outcomes. Descriptive statistics provided an overview of key variables, including energy consumption patterns, poverty rates, health, and education outcomes, across different time periods and regions. These insights served as a foundation for deeper inferential analysis.

To explore causal relationships, regression models was utilized, specifically panel data regression methods which allow for the evaluation of the impact of energy shortages and climate policies on welfare indicators over time. This model helped quantify how changes in energy access and policy interventions affect income, health, and education. Additionally, panel autoregressive distributed lag model (Panel ARDL) was used to analyze the relationship between multiple latent variables such as energy infrastructure, policy impacts, and welfare, enabling the identification of both direct and indirect effects (Bollen, 1989; Hair et al., 2010).

4.4 Panel Autoregressive distributed lag Bound Test (ARDL)

The ARDL model is a regression model that combines the Autoregressive (AR) and Distributed Lag (DL) models. AR model is a model where the dependent variable y_t is influenced by the variable itself in the past (y_{t-j}). The AR model explains the relationship between observations at a time with observations on the variable itself at previous times. The DL model is a model in which the dependent variable y_t is influenced by the explanatory variable at the present time $\boldsymbol{x}_t$ and the previous time $\boldsymbol{x}_{t-1}$. If V_{it} is representative for all countries i=1, N,K (individual-level observations) across all time period t=1,n,T, T =1, , K (time series observations) with cross-section dimension subscript i and time as subscript t. The reparametrized error correction equation is prearranged as (Anderson & Hsiao, 1981, 1982; Leuthold, 1991; Baltagi et al., 2003; Gujarati, 2003; Pedroni, 1999, 2004; Hakim & Bujang, 2012):

$$\Delta yij \quad = \delta Dij + \sum_{k=0}^{P-1} \lambda ij \Delta Vi, t-1$$

$$+ \sum_{k=0}^{Q-1} \Delta Sij\ \beta i, j + \in ii, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \quad (1)$$

The adjustment coefficients δij = $1-(\sum_{n=1}^{\infty}\lambda y)$ are expected to be negative to reach the steady state. D_{ij} = $V_{i\,t-1}$ - $\mu_i S_{it}$ is the error-correcting speed of adjustment term and μ_I = $\sum_{i=1}^{n}\beta ij$ are long-run coefficients. If S_{ij} has a finite autoregressive representation; then, the dependence of instructive variables on the disturbances is allowed when estimating D_{ij}. λ_{ij} = $-\sum_{n=1}^{\infty}\lambda ij$ for j = 1,2 ,K, ρ - 1 are (kx1) vector of parameters constant across groups to be estimated on the dependent variable; β_{ij} = $-\sum_{n=1}^{\infty}\beta ij$ for j=1,2, K, q-1 are (kx1) vector of parameters constant across groups to be estimated on the explanatory variable; S_{ij} (s_{ij} , K, s_{it}) are (T xk) possibly time-varying vector of covariate on k instructive variables that can vary across groups and time periods; while, Δ Si = $S_i - S_{i-1}$ = (ΔSi1, ΔSi2, ΔSit) are j lagged values of Δ Si; V_{it} (v_{it}, K, v_{iT}) are (Tx1) vectors of observation on the control variable of the i^{th} group while; $\Delta V_i = V_{i-1}$ = (Δv_{i-1}, Δv_{i-2}, K, Δv_{iT} are j lagged values of ΔV_i and $\in_{it}$ =($\in_{it}$, K, $\in_{iT}$) are e time-invariant and accounts for any unobservable individual-specific error term. In order to estimate consistence short-run measurements, it is obligatory that the disturbances are not interrelated with the regressors.

The same number of lags is expected in each cross-section for the dependent variable and the regressors; hereafter, the concentrated log-likelihood function is a product of each cross-section's likelihood given as (Pesaran, 2015; Hakim & Bujang, 2012; Wooldridge, 2010; Gujarati, 2003):

$$L,(\delta) = -\ \frac{T}{2}\ \sum_{k=0}^{n}\log\quad(2\pi\delta^2)\ -\ \frac{1}{2}\ f(x) = a_0 + \sum_{n=1}^{\infty}\frac{1}{\delta 2}\ (\Delta V_i - \delta i\ Di\quad)$$

$$M_i\,(\Delta V_i\ -\delta i\ Di\ )\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2)$$

Where; D_i (D_{i1}, D_{i2}, K, D_{iT})^1 , $M_i = \{I_T - R_i\,(R_i^1, R_i^1)^{-1}R_i^1\}^{-1}$ and R = (ΔV_{i-1}, K, ΔV_{i-p+1} , ΔS_{i-1}, K, ΔS_{i-q+1}). Pesaran, Shin and Smith (1995) showed that, the mean group (MG) intermediate estimator accepts that the intercept, short-run coefficients, and error variances can swerve across the clusters; while, unweighted averages of different coefficients are calculated for the whole panel. The fixed effect (FE) transitional estimator constrains long-run coefficients to be equal across groups; that is, homogeneity over a single subset of regressors or else countries (Mundlak, 1978; Pesaran et al., 1995, 1997, 1999; Baitagi et al., 2000; Hsiao, 2003).

5. Result

5.1 Descriptive Statistics

The descriptive statistical properties of the data used for the study are presented in Table 1.

Table 1. Summary of Descriptive Statistics of the Data

Statistic	ECN	GHG	EAC	INC
Mean	1.3509	2.9615	-0.5715	-0.6158
Maximum	1.5900	4.0000	1.0200	0.2700
Minimum	-4.9509	2.0000	-1.6000	-1.3200
Skewness	3.2540	0.2313	1.0347	0.1893
Kurtosis	14.9240	2.3433	4.4059	2.2831
Jarque-Bera	1499.3720	5.2432	50.8577	5.3402
Probability	0.0000	0.0727	0.0000	0.0692
Observations	195	195	195	195

Source: Authors' computation using E-Views 9.0 Version (2024)

Table 1 shows that the average energy consumption (ECN) for the ECOWAS member countries which is 1.35 billion dollars. The highest ECN recorded was 1.59 billion dollars while lowest is -4. 95 billion dollars for the period of the study. Greenhouse gas averaged 2.96% within the study period. The highest Greenhouse gas recorded is 4% while the lowest was 2 % for the period of the study. The highest energy access (EAC) for the region stood at 1.02% while the lowest EAC stood at -1.6% and it averaged -0.57% for the period of the study. Income level (INC) had its average to be 0.62%. The highest INC was 0.27% while the lowest INC recorded was -1.32% for the period of the study.

The statistical distribution of the series further shows that; energy consumption, Greenhouse gas, Energy access and Income level indicated evidence of positive skewness implying that the right tail is extreme. Normally distributed datasets have a skew value of zero, with a negative skew result in a value less than zero, indicating skewness to the left and positive skew result in a value greater than zero, indicating skewness to the right.

In relation to Kurtosis which measures the peakedness of the tail for normally distributed data series. Kurtosis value for a normally distributed series is expected neither to be widely greater than 3 nor far less than 3. There is indication that, the series for energy consumption (ECN) behave relatively abnormal while the series for Greenhouse gas (GHG), Energy access (EAC) and Income level (INC) behave relatively normal.

Furthermore, the Jaque-Bera (JB) test reveals that the series for all the variables of the study except Greenhouse gas (GHG) behave abnormal. The JB statistics test with null hypothesis that the series are normally distribution. Hence, the JB null hypotheses for all the variables were rejected because the p values are less than 0.05 except for the series Greenhouse gas (GHG) whose p values is greater than 0.05. The abnormality of the data series could be associated with cross sectional time series data of the study.

5.2 Cross-Sectional Dependence (CD) Test

Panel data are subject to pervasive cross-sectional dependence, whereby all units in the same cross-section are correlated. This is usually attributed to the effect of some unobserved common factors, common to all units and affecting each of them, although possibly in different ways. Pesaran scaled LM Test was used to check for the cross dependency of the panel data used for the study and the results are presented in Table 2.

Table 2. Pesaran Scaled LM Test for Cross Dependence (CD) of Panel Data

Variables	Pesaran CD Statistic	P-Value
ECN	5.54187	0.0000
GHG	24.8653	0.0000
EAC	17.0274	0.0000
INC	28.8772	0.0000

Source: Authors' computation using E-Views 9.0 Version (2024)

The outcome of the cross-dependence (CD) analysis is presented in Table 2. To obtain unbiased estimator, it was vital to acknowledge the issues associated with CD for long panel time series data. As demonstrated in this study, the probability value is significant for all variables considered for the study, leading to the rejection of the null hypothesis of no dependency among cross-sectional units. Consequently, the alternative hypothesis is accepted, hence all the variables (Energy consumption, Greenhouse gas Protection, Energy access and Income level) have cross-dependence. The presence of cross dependence among the ECOWAS members' countries could be attributed to the regional connectivity in the form of trade, globalization and unobserved common shocks such as financial crises, oil price shocks and pandemic like COVID-19. In view of the fact that, cross-dependence exist among cross-sectional unit, it was vital to apply appropriate panel unit roots tests and estimation approach that can overcome these issues to circumvent bias inference.

5.3 Panel Unit Root Test

The variables of the study were subjected to unit root tests using the Panel Unit Root. The stationarity test follows the Levin, Lin and Chu (with the attendant assumption of homogeneity in the dynamics of the autoregression coefficients for all panel members) and the Im, Pesaran and Shin (which provides for heterogeneity in the dynamics). Essentially, the stationarity test for this study follows the Im, Pesaran and Shin unit root test, though the Levin, Lin and Chu results is reported as presented in Table 3.

Table 3. The Panel Unit Root Test

Variables	Levin, Lin and Chu Null Hypothesis: Unit root (assumes common unit root process)		Remarks	Im, Pesaran and Shin W-stat Null Hypothesis: Unit root (assumes individual unit root process)		Remarks
	Statistic	**Prob.**		**Statistic**	**Prob.**	
ΔECN	-3.3136	0.0005	I(1)	-4.3339	0.0000	I(1)
ΔGHG	-1.6903	0.0450	I(1)	-2.3118	0.0104	I(1)
ΔEAC	-4.7103	0.0000	I(1)	-3.3258	0.0004	I(1)
ΔINC	-5.1272	0.0000	I(1)	-3.9679	0.0000	I(1)

Source: Authors' computation using E-Views 9.0 Version (2024)

From the stationarity test results presented in Table 3, it was discovered that, all the series were found to be stationary, although not at levels, but at first difference I(1). This condition warrants the application of Panel Autoregressive Distributed lag model (PARDL) methods which accommodates series that are either I(1) or I(0) process or the mixture of both. The stationarity tests are necessary to guard against spurious regression and to ensure no variable is integrated of order two.

5.4 Panel ARDL Result

The Panel Autoregressive Distributed Lag (ARDL) test approach was conducted base on Pooled Mean Group (PMG) to examine the long-run and short-run coefficients between groups.

5.4.1 Panel ARDL Long-Run Coefficients

The Panel ARDL long run coefficients estimated using the Pooled Mean Group estimator are presented in Table 4.

Table 4. Panel ARDL Long-Run PMG Coefficients

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
GHG	-0.0284	0.1256	-0.2259	0.0217
EAC	-0.3138	0.1439	-2.1810	0.0312
INC	-0.1074	0.2847	-0.3773	0.0003

Source: Authors' computation using E-Views 9.0 Version (2024)

According to Table 4, using the PMG estimator, PARDL shows that in the long run, if all other things were held constant, the greenhouse gas emission (GHG) has a significant negative effect on the energy consumption inflow among ECOWAS members' countries. A unit increase in greenhouse gas (GHG) would decrease the energy consumption inflow among ECOWAS members' countries by about 3%. Given the decision criteria to reject null hypothesis (H_O) if the probability value is < 0.05, it shows that probability values for greenhouse gas (GHG) (0.0217) is statistically significant, we reject the null hypothesis that, greenhouse gas has no significant effect on energy consumption inflow among ECOWAS members' countries. Hence, we conclude that, greenhouse gas has long-run negative effect on energy consumption inflow among ECOWAS members' countries for the period of the study.

Similarly, everything been equal, Energy access (EAC) has a significant negative long-run effect on energy consumption inflow among ECOWAS members' countries for the period of the study. This means that a unit increases in the Energy access (EAC) would decrease the energy consumption inflow among ECOWAS members' countries by about 31% approximately. Given the decision criteria to reject null hypothesis (H_O) if the probability value is < 0.05, the result indicated that, the probability value for Energy access (EAC) (0.0312) is statistically significant, hence we reject the null hypothesis that, Energy access has no significant effect on energy consumption inflow among ECOWAS members' countries. Hence, we conclude that Energy access has significant negative effect on energy consumption inflow among ECOWAS members' countries for the period of the study.

In the same vein, the result indicated that, Income level (INC) has a significant long-run negative effect on energy consumption inflow among ECOWAS members' countries. A unit increase in the Income level (INC) would decrease energy consumption inflow among ECOWAS members' countries by 11% approximately. Given the decision criteria to reject null hypothesis (H_O) if the probability value is < 0.05, the result indicated that, the probability value for Income level (INC) (0.0003) is statistically significant, we reject the null hypothesis that; Income level has no significant impact on energy consumption inflow among ECOWAS members' countries. Hence, we conclude that, Income level has a significant negative impact on energy consumption inflow among ECOWAS members' countries for the period of the study.

5.5 ARDL Short-Run Coefficients

Panel ARDL short-run coefficients estimated using the Pooled Mean Group estimator were further examined to establish the short-run dynamics and to ascertain the speed of converges to the long-run equilibrium. The result of PARDL short-run dynamics is presented in Table 5.

Table 5. Panel ARDL Short-Run PMG Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.7432	0.1356	-5.4801	0.0000
D(EAC)	0.0033	0.2761	0.0118	0.9906
D(GHG)	0.3755	0.3441	1.0913	0.2774
D(INC)	0.4560	0.6682	0.6824	0.4964
C	15.334	2.7886	5.4989	0.0000

Source: Authors' computation using E-Views 9.0 Version (2024)

The short-run coefficients of the PARDL estimated model presented in Table 5 revealed that, EAC exhibit positive short-run effect on energy consumption inflow among ECOWAS members' countries for the period of the study. The probability value for EAC (0.9906) was found to be statistically insignificant to conclude that, EAC has significant short-run positive effect on energy consumption inflow among ECOWAS members' countries.

Similarly, the short-run coefficient for current GHG was found to be positive and statistically insignificant. Hence, we conclude that; GHG has no positive short-run significant effect on energy consumption inflow among ECOWAS members' countries for the period of the study.

Also, INC has exhibited short-run positive effect on energy consumption inflow among ECOWAS members' countries. The probability value of (0.4964) has shown that, INC is statistically insignificant, hence INC has positive insignificant short-run effect on energy consumption inflow among ECOWAS members' countries for the period.

The estimated co-integrating error correction term (ECT_{-1}) is negative and statistically significant indicating that, the speed of adjustment at which the previous year's shock of the explanatory variables converging back to the long-run equilibrium in the current year is approximately 74% approximately.

5.6 Panel ARDL Fixed Effect Estimator

The Fixed effect estimated model which assumes that differences across units of observation can be captured in the constant term. It also assumes that there is unit-specific heterogeneity in the model which might be correlated with the regressors and needs to be removed from the regression before estimation. In this model, we estimated short-run parameters for the fixed effects between countries. Hence, the fixed effects estimator eliminates the time invariant unobserved effect. The estimated short-run individual-specific coefficients for the cross-sectional unit is shown in Table 6.

Table 6. Panel ARDL Fixed Effect Short-Run Estimates for Specific Countries

	Country	ECT	CPC	GHG	INC	Constant
1	Nigeria	-0.3729	-0.0067	-0.1506	1.8632	8.4503
		0.0135*	0.9983	0.9846	0.8227	0.9393
2	Ghana	-0.6514	0.1087	0.2407	-0.8836	14.561
		0.0243*	0.0889	0.0396*	0.4237	0.8643
3	Gambia	-0.2323	-0.4549	0.3730	-1.1802	4.5023
		0.0138*	0.2975	0.0641	0.3887	0.7905
4	Benin	-0.2892	-1.9809	0.9461	0.3313	5.7482
		0.0036*	0.0092*	0.0138*	0.7018	0.6901
5	Burkina Faso	-1.3267	0.0001	-2.0173	5.6619	25.9007
		0.0002*	0.9998	0.6028	0.8173	0.3513
6	Cape Verde	-1.6566	0.1630	-0.1530	0.8441	32.7870
		0.0002*	0.1010	0.0286*	0.0395*	0.3456
7	Cote d'Ivoire	-1.4118	-0.6668	-0.0392	3.5852	30.0911

		0.0002*	0.0042*	0.0352*	0.0334*	0.4028
8	Mali	-0.4394	0.2061	1.1188	2.0548	9.3311
		0.0014*	0.4989	0.2638	0.1804	0.6252
9	Niger	-0.5453	0.8472	1.2404	-0.6097	11.481
		0.0014*	0.0426*	0.0634	0.6407	0.6317
10	Senegal	-0.0277	-0.1804	-0.0294	1.8838	0.6913
		0.0012*	0.0002*	0.3874	0.0044*	0.5309
11	Sierra Leone	-0.8388	-0.2567	-0.4955	0.6136	17.3039
		0.0005*	0.7985	0.0927	0.0071*	0.5018
12	Togo	-1.1998	1.0866	-0.0593	-1.4803	28.6315
		0.0005*	0.0561	0.8462	0.7289	0.5450
13	Liberia	-0.1056	1.6946	-0.3276	-0.8149	1.9862
		0.0019*	0.1651	0.2344	0.4248	0.6890
14	Guinea-Bissau	-0.9755	0.9305	1.5297	1.8684	18.2262
		0.0037*	0.1385	0.4295	0.1946	0.6914
15	Guinea	-0.8674	-1.6270	1.7835	-8.7967	16.9888
		0.0011*	0.6316	0.8703	0.8289	0.6001

Source: Authors' computation using E-Views 9.0 Version (2024)

Table 6 presented Panel ARDL fixed effect short-run estimates for specific countries. The first figure in each cell is the estimated coefficient while the second is its probability value. This study uses 5% level of significance upon which the statistical significance of the estimated variables can be examined. The (∗) denotes rejection of no statistical significance at 5% critical level. This implies that the institutional quality spurs ECN in the country.

It was revealed that in Nigeria, Gambia, Benin, Cote d'Ivoire, Senegal, Sierra Leone and Guinea energy access (EAC) impacted negatively on energy consumption inflow in the short-run. The short-run negative impact of the energy access (EAC) in Nigeria, Gambia, Sierra Leone and Guinea were found to be statistically insignificantly at 5% level of significance while in Benin, Cote d'Ivoire and Senegal, the negative impact is significant at 5% level of significance. This shows that, foreign investors have little confidence in the Nigeria, Gambia, Benin, Cote d'Ivoire, Senegal, Sierra Leone and Guinea economies due to pervasive incidence of corruption in these countries. However, in Ghana, Burkina Faso, Cape Verde, Mali, Niger, Togo, Liberia and Guinea-Bissau energy access (EAC) impacted positively on energy consumption inflow in the short-run. The short-run positive effect of the energy access (EAC) on ECN inflow in Ghana, Burkina Faso, Cape Verde, Mali, Togo, Liberia, Guinea-Bissau were found to be statistically insignificantly at 5% level of significance while in Niger it shows statistically significant at 5% level of significance. This shows that, investors have some confidence in these economies in term of energy access and willing to invest in the economies.

The Panel ARDL fixed effect short-run estimates for specific countries further revealed that, in Nigeria, Burkina Faso, Cape Verde, Cote d'Ivoire, Senegal, Sierra Leone, Togo and Liberia, greenhouse gas (GHG) impacted negatively on energy consumption inflow in the short-run. The short-run negative effect of the greenhouse gas (GHG) on energy consumption inflow for the economies of Nigeria, Burkina Faso, Senegal, Sierra Leone, Togo, Liberia were found to be statistically insignificant at 5% level of significance while the short-run negative effect of the greenhouse gas (GHG) on energy consumption inflow for the economies of Cape Verde and Cote d'Ivoire were observed to be statistically significant at 5% confidence level. This shows that, there are ineffective institutional frameworks to protect investors for their inventions, brands, and creative works, which will attract investment and enhancing competitiveness in these economies. However, greenhouse gas (GHG) impacted positively on ECN inflows for the economies of Ghana, Gambia, Benin, Mali, Niger, Guinea-Bissau and Guinea. For the economies of Ghana and Benin, the positive effect of greenhouse gas (GHG) on ECN inflows was found to be statistically significant while the positive effect was insignificant for the Gambia, Mali, Niger, Guinea-Bissau and Guinea economies. This shows that, investors have some confidence in Ghana, Niger, Gambia, Benin, Mali, Guinea-Bissau and Guinea economies in term of protection of greenhouse gas and are willing to invest in these economies.

Also, income level (INC) indicated negative and statistically insignificant effect on ECN inflows in Ghana, Gambia, Niger, Togo, Liberia and Guinea at 5% confidence level, an indication that, regulatory institutions are ineffective in these countries to attract more energy consumption inflow for the economies. However, income level (INC) indicated positive but statistically insignificant effect on ECN inflows in Nigeria, Benin, Burkina Faso, Mali and Guinea-Bissau. This shows that, quality regulations have potentials to contribute to ECN inflow in these countries but regulatory institutional challenges limit the potentials thereby contributing insignificantly to the economy. Income level (INC) has shown positive and statistically significant effect on ECN inflows in Cape Verde, Cote d'Ivoire, Senegal and Sierra Leone at 5% confidence level an indication that, regulatory institutions are effective in these countries to attract more energy consumption inflow for the economies.

The cointegrating terms (ECT_{-1}) indicating the speeds of adjustment for all the countries are negative and statistically significant at 5% significance level. This implies that, disequilibrium in ECN inflows due to shocks in the past period will be converging back to the long-run equilibrium at 37% for Nigeria, 65% for Ghana, 23% for Gambia, 29% for Benin, 133% for Burkina Faso, 166% for Cape Verde, 141% for Cote d'Ivoire, 44% for Mali, 55% for Niger, 3% for Senegal, 84% for Sierra Leone, 120% for Togo, 11% for Liberia, 98% for Guinea-Bissau and 87% for Guinea respectively.

5.7 Diagnostic Test Results

The study employed econometrics tests to diagnose the residuals of the estimated model for valid and reliable outcomes. The test of serial correlation, Heteroskedasticity and normality tests were conducted and the result presented in Table 6.

Table 6. Diagnostic Test Results

Test	Null Hypothesis	F-statistics	Prob. Value
Beusch Godfrey Serial Correlation LM Test	No Serial Autocorrelation	1.3742	0.3345
Breusch-Pagan Godfrey	No Hetroscedasticity	2.5853	0.1290
Jarque-Bera	Series residuals are normally distributed	1.0575	0.5894

Source: Authors' computation using E-Views 9.0 Version, (2024)

The result in Table 6 confirms the validity of the estimated model. The model was subjected to serial correlation test. The null hypothesis is that there is no serial correlation in the residuals up to a specified lag order. The above results show that the null hypothesis cannot be rejected because the probability value F-statistics is greater than the 5% significance level. Thus, the model does not suffer from serial correlation.

To test whether the variance of the disturbance term is not the same for all the observations, the heteroscedasticity test has been conducted. The null hypothesis of this test is that the there is no heteroskedasticity. Therefore, the null hypothesis cannot be rejected since the p-value of the F-statistics is greater than 5% significance value. Hence, the model is homoscedastic.

Table 6 also indicated the results of JB statistic which reveals that, the null hypothesis that the model residuals are normally distribution is accepted because the p-values of the JB statistic is greater than 5% significant level.

6. Discussion of Major Findings

The discussion of the findings of the study is based on the objectives and tested hypotheses of the study using the Panel Autoregressive Distributed Lag (ARDL) Pooled Mean Group (PMG) for long-run effect and fixed effect estimator short-run and country specific effect. The first objective of the study was to examine the effect of greenhouse gas protection on ECN inflow in ECOWAS member countries. The estimated Panel ARDL model revealed that if all other things were held constant, the greenhouse gas (GHG) has a significant negative effect on the energy consumption inflow among ECOWAS members' countries as a unit increase in greenhouse gas (GHG) would decrease energy consumption inflow among ECOWAS members' countries by about 3%. The probability value for the estimated coefficient of the greenhouse gas protection (GHG) was found to be statistically significant to reject the null hypothesis that; greenhouse gas protection has no significant effect on energy consumption inflow among ECOWAS members' countries. In the Short-run, the greenhouse gas (GHG) has strong positive and significant influence on ECN inflows in Ghana and Bennie Republic while indicating strong negative and significant effect on ECN inflows in Cape Verde and Cote d'Ivoire.

The implication of this finding is that; greenhouse gas protection will be facilitating trade and market access, as they provide a framework for investors to protect their inventions, brands, and creative works, thereby attracting investment and enhancing competitiveness. However, investors tend to be scared of countries that do not have efficient institutional framework that protect creativity right of inventors. The long-run result for ECOWAS member countries and short-run findings for Cape Verde and Cote d'Ivoire are at variance with some of the empirical studies reviewed as it contravened findings by Li (2019), Iamsiraroj and Ulubaşoğlu (2015), Rahman, Rana, and Barua (2019), Ibrahima and Henri (2023) as well as Brou, Koffi and Yapo (2021) who found that greenhouse gas are positively associated with ECN as improved greenhouse gas protection encourages ECN inflows among nations. Good institutional framework may help to increase competitiveness and will attract more ECN flow in ECOWAS members' countries. However, the short-run findings for Ghana and Bennie Republic strongly support this empirical result obtained by Li (2019), Iamsiraroj and Ulubaşoğlu (2015), Rahman, Rana, and Barua (2019), Ibrahima and Henri (2023) as well as Brou, Koffi and Yapo (2021). The long-run result for the ECOWAS member countries and short-run result for finding for Cape Verde and Cote d'Ivoire are however in line with empirical evidence provided by Ajide and Eregha (2016), Sooreea, Rasool and Sooreea (2020) as well as Sunde (2017) who discovered that, greenhouse gas freedoms constituted drags to ECN attraction among those countries, as there is no consistent evidence that stronger rule of law and greenhouse gas really matter for inward ECN especially in SSA and hence institution do not have significant impact on ECN inflow among nations.

The second objective of the study was to examine the effect of energy access on ECN inflow in ECOWAS member countries. The long-run coefficient of the estimated PARDL model revealed that; energy access (EAC) has a negative long-run effect on energy consumption inflow among ECOWAS members' countries for the period of the study as a unit increases in the Energy access (EAC) would decrease the energy consumption inflow among ECOWAS members' countries by about 31% approximately. The probability value for the estimated long-run coefficient of the EAC was found to be statistically significant to reject the null hypothesis that; energy access institutional quality has no significant effect on energy consumption inflow among ECOWAS members' countries. It was further confirmed by the fixed effect estimator that, (EAC) exhibited negative and significant short-run effect on energy consumption inflow in Benin, Cote d'Ivoire and Senegal while it exhibits positive and significant short-run effect on energy consumption inflow in Niger.

The implication of this finding is that, foreign investors have no confidence in countries characterized by pervasive incidence of corruption as pocketing of bribes drives up the cost of doing business, the cost to consumers and adds to market impenetrability, thereby making the host country less attractive to more ECN. The long-run result and short-run result for Benin, Cote d'Ivoire and Senegal are in consonance with Asiedu (2022), Brou, Koffi and Yapo. (2021) as well as Bekoe, Jalloh and Rahaman (2021) who suggest that corruption create operational inefficiencies and is unattractive to foreign investment, has negative and significant effect on ECN inflow hence adversely affects the inflow of ECN to West Africa.

The result however does support the finding by Omodero (2019) as well as Emediegwu and Edo (2017) who found that, corruption has a significant positive influence on ECN, corruption is an insignificant determinant of ECN and hence Corruption in West Africa does not necessarily hinder foreign investments. However, the short-run result for Niger Republic supports the findings established by Omodero (2019) as well as Emediegwu and Edo (2017).

The third objective of the study was to examine the effect of income level on ECN inflow in ECOWAS member countries. The long-run estimated coefficients of the PARDL model indicated that, income level has negative effect as a unit increase in the Income level (INC) would decrease energy consumption inflow among ECOWAS members' countries by 11% approximately. The test statistical probability for the estimate coefficient of income level is significant to reject the null hypothesis correspondence to the objective three hence rejecting the null hypothesis that, income level has no significant effect on ECN inflow in ECOWAS member countries. The estimated fixed effect estimator has shown that, in Cape Verde, Cote d'Ivoire, Senegal and Sierra Leone, income level indicated positive and significant effect on ECN inflow in the short-run.

The implication of the finding is that, beyond the absolute degree of restrictiveness of policy barriers, substantial differences in the income level across countries can also act as a deterring factor to ECN by imposing additional compliance costs for investors present in multiple foreign markets. However, countries that have strong efficient regulatory institutions encourage foreign investors to bring in more ECN. The long-run estimated result supports similar findings by Belloumi (2017), Ibrahima and Henri (2023), Rahman, Saidi and Mbarek (2017), Hall and Norman (2017), Mahembe and Odhiambo (2016) who also discovered regulatory environment as the most decisive barriers in their decision to undertake ECN project as it has negative impact on ECN inflow among nations. The short-run results for Cape Verde, Cote d'Ivoire, Senegal and Sierra Leone. However, the finding does not align with the empirical findings by Belloumi (2017), Ibrahima and Henri (2023), Rahman, Saidi and Mbarek (2017), Hall and Norman (2017), Mahembe and Odhiambo (2016). Income level and rule of law appeared to be the most important and as such, economic performance of the region could be enhanced by improving these global energy performance gauges.

7. Conclusion

Nigeria's energy crisis severely impacts consumer welfare through unreliable supply, high costs, and dependence on alternative power sources. Global climate policies, like the Paris Agreement, add financial pressures, complicating Nigeria's efforts to meet both domestic energy needs and emissions reduction goals. In the ECOWAS region, Nigeria's energy struggles have regional ripple effects, hindering sustainable development. While initiatives like the West African Power Pool offer solutions, disparities in energy access and investment persist. To improve welfare, Nigeria and ECOWAS must invest in renewable energy, strengthen regulatory frameworks, and balance energy security with climate obligations for sustainable growth.

8. Recommendations

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

i. Investment in Renewable Energy: The Nigerian government and ECOWAS member states should prioritize investments in renewable energy infrastructure to reduce over-reliance on fossil fuels. This will address the energy access gap and mitigate the negative impact of global climate policies on consumer welfare.

ii. Strengthen Regional Energy Cooperation: ECOWAS countries should enhance regional energy integration efforts through projects like the West African Power Pool (WAPP). This would improve energy security by facilitating cross-border electricity trade, thereby reducing energy shortages and stabilizing prices.

iii. Enhance Regulatory Frameworks: Governments within the region must implement stronger regulatory frameworks to attract investment in the energy sector. This includes ensuring transparent policies that reduce corruption, promote efficiency, and encourage private sector participation in both traditional and renewable energy projects.

iv. Balanced Approach to Climate Commitments: Nigeria should adopt a balanced strategy that aligns with global climate obligations while addressing domestic energy needs. This includes gradual transitions to renewable energy and carefully planned subsidy reforms that protect vulnerable consumers from rising energy costs.

v. Diversification of Energy Sources: To reduce vulnerability to global oil price fluctuations, Nigeria should diversify its energy mix by incorporating more sustainable energy sources, thereby improving resilience and economic stability across ECOWAS member states.

References

Abidemi, T., & Ayodeji, A. (2018). Energy crisis and regional integration in West Africa: The role of ECOWAS energy initiatives. *African Journal of Energy*, *5*(2), 21-35.

Adenikinju, A. (2005). Analysis of the cost of infrastructure failures in a developing economy: The case of electricity sector in Nigeria. *African Economic Research Consortium*.

Adenikinju, A., Iwayemi, A., & Akinbami, J. (2020). Energy security and climate policy nexus in Nigeria: Challenges and opportunities. *Energy Policy*, *44*(3), 342-354.

Adeyanju, A., Ojo, A., & Olaniyan, O. (2020). Energy policy and regulatory frameworks in Nigeria: Challenges and prospects. *Journal of Energy Policy*, *45*(3), 123-135.

Adom, P. K., & Bekoe, W. (2022). Energy security and sustainable development in West Africa: A focus on ECOWAS member states. *Energy Policy Journal*, *156*(1), 45-59.

Afolayan, A., Adeyemi, K., & Olufunmilayo, T. (2017). The cost of power generation in Nigeria: Implications for consumer welfare. *Journal of Energy Economics*, *13*(2), 115-129.

Ajide, K. B., & Eregha, P. B. (2016). Foreign direct investment, economic freedom and growth in Sub-Saharan Africa. *Journal of Economic Development*, *41*(1), 1-2.

Aliyu, A., Ramli, A., & Saleh, M. (2013). Nigeria electricity crisis: Power generation capacity expansion and environmental ramifications. *Energy*, *61*(8), 354-367. https://doi.org/10.1016/j.energy.2013.09.011

Anderson, T. W., & Hsiao, C. (1981). Estimation of dynamic models with error components. *Journal of the American Statistical Association*, *76*(375), 598-606.

Anderson, T. W., & Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. *Journal of Econometrics*, *18*(1), 47-82.

Asiedu, E. (2022). The impact of energy consumption on economic growth in ECOWAS countries. *Energy Economics*, *105*, 105-111.

Baitagi, B. H., Egger, P., & Pfaffermayr, M. (2000). A generalized design for bilateral trade flow models. *Economics Letters*, *80*(3), 391-339.

Baltagi, B. H., Egger, P., & Pfaffermayr, M. (2003). A generalized design for bilateral trade flow models. *Economics Letters*, *80*(3), 391-397.

Bekoe, W., Jalloh, M., & Rahaman, M. M. (2021). Renewable energy consumption and economic growth in ECOWAS countries: Evidence from panel data. *Renewable Energy*, *170*, 1-1.

Belloumi, M. (2017). Energy consumption and economic growth in Algeria: Cointegration and causality analysis. *International Journal of Energy Economics and Policy*, *7*(1), 1-1.

Bollen, K. A. (1989). *Structural equations with latent variables*. Wiley.

Brou, K. D., Koffi, Y. B., & Yapo, A. P. (2021). Energy consumption and economic growth in ECOWAS countries: A panel data analysis. *Energy Policy*, *149*, 112-111.

Ebohon, O. J. (2019). The Nigerian energy challenge and its policy implications in the context of global climate change. *Renewable Energy Review*, *18*(3), 34-50.

Eleri, E. O., Ugwu, O., & Onuoha, C. (2022). Consumer welfare and the Nigerian energy crisis: Impacts on livelihoods and economic productivity. *Energy and Society*, *44*(2), 87-106.

Emediegwu, L. E., & Edo, S. E. (2017). Energy consumption and economic growth in Nigeria: A causality analysis. *Journal of Economics and Sustainable Development*, *8*(6), 1-1.

Gujarati, D. N. (2003). *Basic econometrics* (4th ed.). McGraw-Hill.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.

Hall, D., & Norman, G. (2017). Energy policy and economic growth in ECOWAS countries. *Energy Policy*, *101*, 1-1.

Hsiao, C. (2003). *Analysis of panel data* (2nd ed.). Cambridge University Press.

Iamsiraroj, S., & Ulubaşoğlu, M. A. (2015). Foreign direct investment and economic growth: A real relationship or wishful thinking? *Economic Modelling*, *51*, 200-221.

Ibitoye, F. I., & Adenikinju, A. (2007). Future demand for electricity in Nigeria. *Applied Energy*, *84*(5), 492-504. https://doi.org/10.1016/j.apenergy.2006.09.011

Ibrahima, D., & Henri, K. (2023). The impact of energy consumption on economic growth in ECOWAS countries: Evidence from panel data. *Energy Economics*, *115*, 105-111.

Ikweugbu, E. (2023). *Nigeria's fossil fuel subsidy reforms: The welfare effects on households*. ODI Report. Retrieved from ODI.

Leuthold, F. U. (1991). *A dynamic model of electricity demand and supply in Germany*. *Energy Economics*, *13*(1), 31-38.

Li, X. (2019). Energy consumption and economic growth in Sub-Saharan Africa: Evidence from panel data. *Energy Economics*, 81, 1-1.

Mahembe, E., & Odhiambo, N. M. (2016). Foreign direct investment and economic growth: A theoretical framework. *Journal of Economics and Behavioral Studies*, *8*(3), 1-1.

Mundlak, Y. (1978). On the pooling of time series and cross section data. *Econometrica*, *46*(1), 69-85.

Ogbuagu, P. C., Hassan, A., & Nnaji, C. (2023). The global climate regime and Nigeria's energy transition: Economic impacts and policy responses. *International Energy Policy Research*, *20*(1), 15-29.

Ogujor, E., & Otasowie, P. (2010). Electricity industry reform in Nigeria: The electric power sector reform act 2005. *Energy Policy*, *38*(7), 4067-4075.

Ogwumike, F. O., Akpan, U. F., & Adeniyi, O. A. (2021). Energy poverty and its implications for consumer welfare in Nigeria. *Energy and Economic Development Journal*, *12*(4), 112-129.

Okereke, C., Emenekwe, C., Nnamani, U., Onyeneke, R., & Amadi, M. (2024). *Nigeria's fossil fuel subsidy reforms: The welfare effects on households*. ODI Research Report. London: ODI.

Olaniyan, O., & Lawal, H. (2010). Electricity supply, employment, and poverty in Nigeria. *Journal of Development Studies*, *47*(3), 353-370.

Olawuyi, D. S. (2020). Climate change law and policy in the Nigerian energy sector: Balancing energy security, sustainability, and international obligations. *Journal of Environmental Law and Policy*, *15*(2), 201-230.

Olujobi, O. J. (2024). The Climate Change Act of 2021 and its implications for Nigeria's energy sector. *Environmental Law Review*, *26*(1), 45-67.

Omodero, C. O. (2019). *Energy consumption and economic growth in Nigeria: A causality analysis*. *International Journal of Energy Economics and Policy*, *9*(1), 1-1.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, *61*(S1), 653-670.

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, *20*(3), 597-625.

Pesaran, M. H. (2015). *Time series and panel data econometrics*. Oxford University Press.

Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics*, *68*(1), 79-113.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, *94*(446), 621-634.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

World Bank. (2020). *Energy poverty in Nigeria: Implications for economic development and consumer welfare*. Washington, DC: World Bank Publications.

World Bank. (2021). *Access to electricity (% of population) – Nigeria*. World Bank Group. Retrieved from [worldbank.org] (https://www.worldbank.org).

World Economic Forum. (2023). *The state of energy access in Nigeria*. Retrieved from https://www.weforum.org/reports/the-state-of-energy-access-in-nigeria