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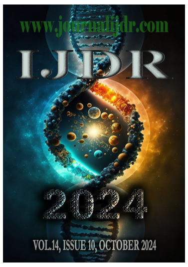

RESEARCH ARTICLE OPEN ACCESS

IMPACT OF NIGERIA'S ENERGY CRISIS AND GLOBAL CLIMATE CHANGE POLICIES ON CITIZEN WELFARE

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ABSTRACT

Energy access is a key factor in economic development and social welfare, especially in developing countries like Nigeria, where energy poverty is widespread. Despite being Africa's largest economy, Nigeria faces ongoing energy challenges, including unreliable supply, inadequate infrastructure, and limited access, with over 85 million people lacking electricity. These energy deficiencies negatively affect productivity, healthcare, education, and overall citizen welfare. At the same time, Nigeria is committed to global climate goals, such as the Paris Agreement, which requires reducing greenhouse gas emissions through a transition to renewable energy. This balancing act between expanding energy access and meeting climate commitments presents a significant challenge. This study evaluates the impact of Nigeria's energy crisis and climate policies on citizen welfare using secondary data from 1986 to 2023. Econometric analysis reveals that while energy shortages severely limit welfare outcomes, climate policies, if not carefully managed, could increase socio-economic inequalities. The study recommends expanding investments in renewable energy, upgrading infrastructure, promoting energy efficiency, and adopting off-grid solutions to improve energy access. Additionally, policies must integrate climate objectives with socio-economic development to prevent the further marginalization of vulnerable populations. Strengthening international collaboration and accessing climate finance are crucial to supporting Nigeria's energy transition.

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INTRODUCTION

Energy access is a critical determinant of economic development and social welfare, particularly in developing countries like Nigeria, where energy poverty remains widespread. Despite being Africa's largest economy, Nigeria faces persistent energy challenges characterized by limited access, unreliable supply, and inadequate infrastructure. According to the International Energy Agency (IEA), over 85 million Nigerians, representing nearly 43% of the population, lack access to electricity, while those connected to the grid experience frequent outages and inconsistent supply (IEA, 2021a). These deficiencies hamper economic productivity, limit access to essential services, and exacerbate socio-economic inequalities, making energy access a vital issue for citizen welfare. The global climate change agenda has introduced new dimensions to Nigeria's energy strategy. As a signatory to the Paris Agreement, Nigeria has committed to reducing its greenhouse gas emissions through the transition to renewable energy sources and the promotion of energy efficiency. The country's Nationally Determined Contributions (NDCs) outline goals for emissions reductions, primarily through increased investment in solar, wind, and hydropower (UNFCCC, 2022). However, the transition towards renewable energy poses significant challenges in a country where energy infrastructure is already underdeveloped, and the majority of the population relies on traditional biomass or fossil fuels for their energy needs (Bhattacharyya, 2011). Understanding the interplay between energy access, climate policies, and welfare is critical in this context. In Nigeria, limited energy access disproportionately affects vulnerable populations, curbing access to education, healthcare, and income-generating opportunities. Meanwhile, global climate policies exert pressure on developing nations to decarbonize their economies, which may impose additional constraints on energy access if not managed carefully (Sovacool, 2016). Therefore, the question of how Nigeria's energy crisis and climate commitments impact citizen welfare is highly relevant for policymakers and development practitioners. This study aims to assess the extent to which Nigeria's energy crisis and global climate change policies affect citizen welfare, using empirical methods to analyze relationships between energy access, climate policy, and welfare indicators such as income, health, and education. By exploring these connections, the study will contribute to the broader literature on energy poverty, climate policy, and socio-economic development, with implications for policy formulation in both Nigeria and other developing countries facing similar challenges.

Statement of the Research Problem

Nigeria faces a complex dual burden: addressing its persistent energy poverty while striving to meet international climate change obligations. With nearly 43% of the population lacking access to electricity and millions more suffering from unreliable supply, the country is grappling with an energy crisis that severely constrains economic growth, social development, and citizen welfare (IEA, 2021a). At the same time, as a signatory to the Paris Agreement, Nigeria has committed to reducing its greenhouse gas emissions, which necessitates a significant shift towards renewable energy sources and the reduction of its dependence on fossil fuels (UNFCCC, 2022). These dual objectives - expanding energy access while decarbonizing the energy sector - present formidable challenges, especially in the Nigerian context where energy infrastructure is inadequate, and traditional energy sources remain prevalent. While much has been written about Nigeria's energy crisis and its climate commitments, there is a significant gap in empirical research that quantifies the direct effects of these issues on welfare outcomes, such as health, education, and income. Most studies focus either on the macroeconomic implications of energy access or the environmental dimensions of climate policies, without thoroughly exploring the intersection of these factors and their combined impact on individual and household welfare (Sovacool, 2016). Furthermore, existing literature often lacks rigorous statistical analysis that measures the causal links between energy access, climate policy interventions, and welfare outcomes, leaving policymakers with limited data to inform effective solutions. This study seeks to address this gap by providing a comprehensive empirical analysis of how Nigeria's energy crisis and global climate change policies impact welfare indicators. Using econometric techniques and secondary data from reliable sources, this research will quantify the relationships between energy access, climate policy measures, and socio-economic outcomes, offering insights that are critical for shaping policies that balance the need for energy access with climate commitments. This study's findings will contribute to both academic literature and policy discourse, highlighting the challenges and trade-offs faced by Nigeria and other developing nations in similar situations.

Research Questions

i. What is the trend of Nigeria's energy production, consumption and access for the period 1986 to 2023?
ii. What is the trend of greenhouse gas emission in Nigeria for the period 1986 to 2023
iii. How does Nigeria's energy crisis affect socioeconomic conditions such as health, income, and education?
iv. What role do global climate policies play in shaping Nigeria's energy sector?
v. What is the combined impact of energy and climate challenges on citizen welfare?

Research Objectives

i. To examine the trend of Nigeria's energy production, consumption and access for the period 1986 to 2023**.**
ii. To examine the trend of greenhouse gas emission in Nigeria for the period 1986 to 2023**.**
iii. To assesstherelationship between energy access and welfare outcomes in Nigeria.
iv. To assess the influence of global climate change policies on Nigeria's energy strategies.
v. To quantify the impact of both the energy crisis and climate policies on key welfare indicators.

Literature Review

Overview of Nigeria's Energy Sector

Historical Context of Energy Development in Nigeria: Nigeria's energy sector has undergone significant transformations over the decades, shaped by the country's abundant natural resources, including oil, natural gas, and hydropower potential. Since the discovery of oil in the 1950s, Nigeria's energy policies have been primarily driven by the exploitation of fossil fuels, making the country one of the largest oil producers in Africa. However, this heavy reliance on oil has hindered the development of a diversified energy mix, leaving other energy sources like renewable energy and natural gas underdeveloped (Sambo, 2008). Nigeria's electricity sector has also struggled with systemic challenges, beginning with the establishment of the Nigerian Electricity Supply Company (NESCO) in the early 1920s, followed by the formation of the National Electric Power Authority (NEPA) in 1972. Despite reforms aimed at restructuring the power sector, including the privatization of the generation and distribution companies in 2013, inefficiencies in production and distribution have persisted (Adenikinju, 2003).

Present-Day Energy Challenges: Access, Affordability, and Reliability: Today, Nigeria faces a multi-dimensional energy crisis, with challenges spanning energy access, affordability, and reliability. According to the International Energy Agency (IEA), approximately 85 million Nigerians—nearly 43% of the population—lack access to electricity, making Nigeria the country with the largest energy access deficit in the world (IEA, 2021). Even for those connected to the grid, electricity is often unreliable, with daily power outages disrupting businesses and households. Nigeria's installed electricity capacity is about 13,000 MW, but less than 4,000 MW is operational at any given time, due to issues like outdated infrastructure, inadequate investment, and frequent gas shortages (Aliyu *et al*., 2013). This results in high dependency on alternative energy sources such as diesel generators, which are expensive and environmentally unsustainable. Affordability is another critical issue, particularly for low-income households that rely on biomass and kerosene for cooking, both of which have negative health and environmental impacts. As the country seeks to transition to cleaner energy, affordability remains a significant barrier for millions of Nigerians who cannot access or afford modern energy solutions like solar power (Sovacool, 2016). Moreover, fuel subsidies, which are intended to make energy more affordable, have had the unintended consequence of discouraging investment in renewable energy technologies, exacerbating the energy access gap.

Comparison with Energy Sectors in Other Developing Nations: Compared to other developing nations, Nigeria's energy sector underperforms despite its vast natural resources. Countries like Kenya and South Africa have made notable strides in expanding energy access and integrating renewable energy into their energy mix. For instance, Kenya has become a leader in geothermal energy production, which now accounts for nearly half of its electricity generation (IRENA, 2020). South Africa, despite its own energy challenges, has developed a significant renewable energy program through its Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), which has attracted substantial foreign investment (Pegels, 2014). In contrast, Nigeria has struggled to diversify its energy mix beyond fossil fuels, making it more vulnerable to energy supply shocks and global oil price fluctuations. Furthermore, its energy infrastructure remains insufficient compared to peer nations, many of which have made concerted efforts to modernize their energy sectors. While countries like India and Brazil have made substantial progress in rural electrification, Nigeria continues to face severe disparities in energy access, particularly between urban and rural areas. The World Bank's Sustainable Energy for All (SEforALL)initiative highlights that Nigeria is among the countries farthest from achieving universal access to electricity by 2030, lagging behind other sub-Saharan African countries like Ghana and Ethiopia (World Bank, 2020). Nigeria's energy sector, despite its resource wealth, is hampered by deep-rooted structural challenges that prevent it from delivering affordable, reliable, and sustainable energy to its population. This has significant implications for citizen welfare, particularly in terms of economic opportunities, health outcomes, and education access. While global climate change policies urge a transition to renewable energy, Nigeria's existing energy infrastructure and reliance on fossil fuels pose major challenges to achieving this goal. Addressing these systemic energy challenges requires not only policy reform but also significant investment in infrastructure, renewable energy, and technology to close the energy access gap and align with climate commitments.

Global Climate Change Policies and Nigeria's Commitments

Overview of Key Global Climate Agreements: Global climate governance has evolved through a series of landmark agreements aimed at mitigating the impacts of climate change. One of the most significant of these is the Paris Agreement, adopted in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC). The Paris Agreement marked a turning point in global climate efforts by setting a goal to limit global temperature rise to well below 2°C above pre-industrial levels, while striving to limit the increase to 1.5°C (UNFCCC, 2015). All signatory countries, including Nigeria, are required to submit Nationally Determined Contributions (NDCs), outlining their plans to reduce greenhouse gas (GHG) emissions and adapt to the impacts of climate change. The agreement emphasizes the importance of equity, recognizing that developing nations like Nigeria face unique challenges in balancing economic growth with climate action. Other relevant global frameworks include the Kyoto Protocol, which laid the foundation for international climate commitments, and the Sustainable Development Goals (SDGs), particularly SDG 13, which calls for urgent action to combat climate change and its impacts. These global agreements reflect a growing recognition that climate change requires a coordinated international response, with specific attention to supporting developing countries in their transition to low-carbon economies (Newell & Paterson, 2010).

Nigeria's Role in Global Climate Governance: As one of the largest economies in Africa, Nigeria plays an important role in global climate governance, both as a contributor to climate negotiations and as a country vulnerable to climate change impacts. Nigeria is responsible for a relatively small share of global GHG emissions, contributing about 0.3% of total emissions. However, it is disproportionately affected by the consequences of climate change, such as desertification, flooding, and coastal erosion, which exacerbate socio-economic challenges and deepen poverty levels (Nwafor, 2007). In recognition of this, Nigeria has been an active participant in international climate discussions, particularly those aimed at securing financial and technical support for adaptation and mitigation efforts. Under the Paris Agreement, Nigeria submitted its first NDC in 2015, which was revised in 2021. The country committed to a conditional reduction of 45% in GHG emissions by 2030, with unconditional targets set at 20%, contingent on international support (UNFCCC, 2021). These targets are ambitious, considering Nigeria's heavy reliance on fossil fuels, particularly oil and gas, which contribute significantly to the economy but also to emissions. Nigeria has also advocated for climate justice, emphasizing that developed countries must take the lead in reducing emissions and providing financial assistance to developing countries to ensure a just transition (Olalekan *et al*., 2019).

National Climate Action Plans and Interaction with Energy Development: Nigeria's climate action is outlined in several key policy documents, most notably the National Climate Change Policy (NCCP) and the Energy Transition Plan (ETP). The NCCP provides a framework for integrating climate change adaptation and mitigation into national development plans, while the ETP outlines strategies for transitioning to renewable energy, improving energy efficiency, and reducing dependence on fossil fuels (Federal Ministry of Environment, 2020). These policies reflect Nigeria's recognition that energy development and climate action must go hand in hand. However, achieving this balance is fraught with challenges, given the country's pressing need to expand energy access for its growing population. The transition to renewable energy is a central theme in Nigeria's climate commitments, as outlined in the NDC. Nigeria has significant potential for renewable energy, particularly in solar, wind, and hydropower, which are seen as crucial to achieving its emissions reduction targets (IRENA, 2020b). However, progress has been slow due to limited investment, regulatory barriers, and the country's ongoing reliance on oil and gas revenues. Nigeria's National Renewable Energy and Energy Efficiency Policy (NREEEP) aims to increase the share of renewables in the energy mix, but fossil fuels still dominate, accounting for over 80% of electricity generation (Ohunakin *et al*., 2014). Moreover, the country faces the challenge of integrating climate policy with its broader socio-economic goals, particularly poverty reduction and job creation. Expanding energy access is vital to improving living standards, but the transition to renewable energy must be carefully managed to avoid further exacerbating energy poverty. Nigeria's climate policies emphasize the importance of a "just transition," which ensures that the move towards cleaner energy sources does not disproportionately impact low-income populations (Sambo, 2019). This is particularly relevant in rural areas, where energy access is limited, and traditional biomass fuels remain the primary energy source. Nigeria's commitment to global climate governance is evident through its participation in international agreements such as the Paris Agreement and its efforts to develop national climate action plans. However, the country faces significant challenges in balancing its climate commitments with the need to address energy poverty and promote socio-economic development. While the potential for renewable energy is promising, Nigeria's heavy reliance on fossil fuels and underdeveloped energy infrastructure complicate efforts to align energy development with climate goals. This intersection of global climate policies and national energy strategies is crucial for understanding the broader impacts on citizen welfare, particularly in terms of energy access, economic opportunities, and social equity.

Conceptualizing Citizen Welfare: Welfare is a multidimensional concept encompassing economic, social, and environmental well-being. In economic terms, welfare often refers to material prosperity, income levels, employment opportunities, and access to essential goods and services. Higher income levels and economic security typically correlate with improved quality of life, greater access to education, healthcare, and basic amenities, all of which contribute to individual and societal welfare (Stiglitz *et al*., 2010). Social welfare extends beyond economic considerations to include the quality of social relationships, healthcare, education, and equitable access to resources. It incorporates indicators such as life expectancy, literacy rates, and access to social services, which are crucial for a thriving society (Sen, 1999). Environmental welfare, on the other hand, considers the sustainability of natural resources and ecosystems, as well as how environmental quality impacts human health and livelihoods. In developing countries like Nigeria, where many rely on natural resources for their livelihood, environmental degradation due to pollution, deforestation, and climate change can have severe consequences for welfare (Dasgupta, 2001).

Linking Energy Access to Welfare: Evidence from Previous Studies: Energy access is widely recognized as a critical driver of welfare outcomes. Numerous studies have highlighted the strong relationship between energy availability and improvements in education, health, and income levels. For instance, access to reliable electricity is essential for educational facilities to operate effectively, especially in rural areas, where energy shortages are more prevalent (Barnes *et al*., 2011). Schools with electricity can offer extended study hours and better learning environments, resulting in improved educational outcomes. In terms of health, energy access influences healthcare services by powering hospitals, clinics, and medical equipment. A study by Modi *et al* (2006) found that access to electricity is directly linked to better health outcomes, as it enables the refrigeration of vaccines, operation of life-saving medical devices, and provides lighting for nighttime healthcare services. Furthermore, households with electricity are less reliant on traditional biomass fuels, which are associated with indoor air pollution and respiratory diseases, thereby improving overall health (Rehfuess, 2006). Energy access also plays a pivotal role in enhancing income levels by enabling the creation of jobs, improving agricultural productivity, and fostering small-scale industries. Sovacool (2012) demonstrated that regions with higher energy access tend to experience greater economic development, as energy serves as a fundamental input for productive activities. Access to modern energy sources helps to diversify economies, reduce poverty, and improve the standard of living. Despite these benefits, energy poverty remains widespread in many developing countries, including Nigeria. The lack of affordable and reliable energy hampers social and economic development, particularly in rural areas, where energy access is limited and income disparities are wider. Consequently, addressing energy poverty is essential for improving welfare outcomes and achieving sustainable development goals (IEA, 2021b).

Impact of Climate Policies on Economic and Social Development: Climate change policies, especially those targeting the reduction of greenhouse gas emissions, have both direct and indirect effects on citizen welfare. On one hand, policies aimed at transitioning to renewable energy and reducing fossil fuel dependency can improve environmental welfare by lowering pollution levels and reducing the health risks associated with climate change. However, the social and economic impacts of climate policies are more complex, particularly in developing countries like Nigeria where energy infrastructure is underdeveloped, and fossil fuels play a significant role in the economy. Several studies have examined the potential trade-offs between climate mitigation policies and economic development. For instance, Stern (2007) argued that while reducing emissions is crucial for long-term environmental sustainability, it may impose short-term economic costs, particularly in industries reliant on fossil fuels. In the case of Nigeria, the transition to renewable energy is seen as necessary for meeting its climate commitments under the Paris Agreement, but it may also pose challenges for communities dependent on oil and gas jobs, as well as for economic growth driven by fossil fuel exports (Sambo, 2019). Furthermore, climate policies that increase energy prices, such as carbon taxes or the removal of fuel subsidies, can disproportionately affect low-income households, exacerbating existing inequalities (Fay *et al*., 2015). Research by Hallegatte and Rozenberg (2017) shows that while low-carbon transitions are necessary, they must be managed carefully to avoid worsening poverty levels and ensure that vulnerable populations are not disproportionately affected. This is particularly important in Nigeria, where high poverty rates and energy poverty are already critical issues. At the same time, well-designed climate policies can drive innovation, create green jobs, and improve energy security by promoting renewable energy sources such as solar and wind (IRENA, 2020b). These policies have the potential to foster sustainable development, especially in rural areas, where access to clean energy can enhance welfare outcomes. For example, decentralized renewable energy systems such as solar microgrids have been shown to improve education, health, and income levels in off-grid communities (Aklin *et al*., 2017). Citizen welfare is a multifaceted concept influenced by economic, social, and environmental factors. Energy access plays a crucial role in enhancing welfare, particularly in developing countries like Nigeria, where reliable electricity is linked to better health, education, and economic opportunities. However, the interaction between energy access and climate policies presents both challenges and opportunities for welfare outcomes. While climate policies can mitigate environmental risks and foster sustainable development, they must be carefully managed to ensure that they do not exacerbate poverty or widen inequality. Understanding the complex links between energy access, climate policies, and citizen welfare is critical for designing effective policies that promote equitable and sustainable development.

Review of Empirical Studies: Empirical studies have consistently demonstrated the significant impact of energy crises on social welfare in developing countries. Energy crises, characterized by inadequate access to reliable and affordable energy, exacerbate poverty, limit economic opportunities, and impair quality of life. Barnes *et al* (2011) highlight that energy poverty restricts access to education and healthcare, reducing overall well-being in low-income communities. In countries such as India and Kenya, energy access has been linked to improvements in health outcomes, economic growth, and educational attainment (Sovacool& Dworkin, 2015). Sovacool (2012) found that energy access improvements lead to substantial welfare gains by enabling better educational facilities, reducing health risks associated with traditional fuels, and supporting income-generating activities. In Nigeria, inadequate energy infrastructure and frequent power outages have been shown to hinder economic development and exacerbate social inequalities (Adenikinju, 2003). For example, Ilesanmi *et al* (2017) reported that unreliable electricity supply affects small businesses, leading to lower productivity and economic instability. The link between energy crises and welfare is particularly pronounced in Sub-Saharan Africa, where energy access remains limited and uneven. Kojima and Trimble (2016) documented how energy access constraints impact health and economic opportunities, revealing that improving energy infrastructure can substantially enhance welfare outcomes in this region.

Comparative Analysis of Countries with Similar Energy and Climate Challenges: A comparative analysis of countries facing similar energy and climate challenges can provide valuable insights into the effects of climate policies on citizen welfare. South Africa and Kenya, for instance, offer relevant case studies. Both countries have experienced energy crises, albeit to varying extents. South Africa, with its heavy reliance on coal, faces energy supply challenges that have led to frequent power outages and increased costs for businesses and households (Newell & Paterson, 2010). In contrast, Kenya has made significant strides in expanding access to renewable energy, such as geothermal and solar, which has positively impacted social welfare (IRENA, 2020c). South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has been successful in increasing energy access and supporting economic development while addressing environmental concerns (Pegels, 2014). Kenya's investments in solar energy have improved energy access in rural areas, enhancing health, education, and economic opportunities (Aklin*et al*., 2017). These comparative studies illustrate how different energy strategies and climate policies can affect citizen welfare, highlighting the importance of tailored approaches based on national contexts.

Gaps in Empirical Literature, Particularly in Sub-Saharan Africa: Despite the growing body of research, several gaps remain in the empirical literature concerning the impact of energy crises and climate policies on welfare in Sub-Saharan Africa. One significant gap is the lack of longitudinal studies that track the long-term impacts of energy access improvements on welfare outcomes. Most studies provide snapshot analyses without considering how changes in energy infrastructure over time influence welfare indicators (Fay *et al*, 2015). Additionally, there is a need for more research on the intersection of energy access, climate policies, and gender dimensions. Sovacool*et al* (2016) emphasize that women, who are often primary energy users in households, are disproportionately affected by energy poverty. Understanding how climate policies impact women's welfare specifically could provide more nuanced insights into policy effectiveness. Another critical gap is the limited research on the effectiveness of climate policies in mitigating energy crises in the context of Sub-Saharan Africa. While some studies focus on policy impacts in developed countries or more advanced developing nations, fewer address how specific climate policies, such as carbon pricing or renewable energy incentives, impact energy access and welfare in Sub-Saharan Africa (World Bank, 2020b). Addressing these gaps could provide more comprehensive insights into how climate policies can be designed to support equitable development and improve welfare outcomes. The empirical research underscores the profound connection between energy crises and social welfare, highlighting how inadequate energy access exacerbates poverty and limits opportunities in developing countries. Comparative analyses reveal that different energy strategies and climate policies can have varied impacts on welfare, with countries like Kenya showing positive outcomes from renewable energy investments. However, significant gaps remain in the literature, particularly regarding longitudinal studies, gender dimensions, and the specific impacts of climate policies in Sub-Saharan Africa. Addressing these gaps is essential for developing effective policies that improve energy access and enhance citizen welfare in the region.

METHODOLOGY

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 will be 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, including difference-in-differences (DiD) and 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).

Data Collection: In this study, annual time series data covering the sample period of 1986 to 2023 are utilized for the analysis. The data was obtained and generated from World Bank Country Report on Nigeria, World Development Indicator (WDI), National Bureau of Statistic (NBS) and Country Economy Report. The analysis employs both descriptive and inferential statistical methods to examine the relationship between energy access, climate policies, and welfare outcomes. Furthermore, the 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 be sourced from reputable national and international databases. National energy statistics was 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.

Data Analysis: 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 will serve as a foundation for deeper inferential analysis.To explore causal relationships, regression models was utilized, specifically panel data regression and difference-in-differences (DiD) methods, which allow for the evaluation of the impact of energy shortages and climate policies on welfare indicators over time. These models help quantify how changes in energy access and policy interventions affect income, health, and education. Additionally, Autoregressive Distributed Lag (ARDL) modelis used to analyzed the relationships between dependent and independent variables enabling the identification of both direct and indirect effects (Bollen, 1989; Hair *et al*., 2010). The Autoregressive Distributed Lag (ARDL) model is a statistical model used to analyze the relationship between a dependent variable and one or more independent variables. ARDL model is a flexible model that can handle both linear and nonlinear relationships between the dependent and independent variables.

The ARDL *(p, q1, q2......*q_k*) model* specification is given as follows;

$$\Phi (L, p)\, yt = \sum_{i=1}^{k} \beta_i (L, q1)\, x_{it} + \delta wt + ut \quad \text{.......(1)}$$

Where;

$$\Phi (L, p) = 1 - \Phi_1 L\ \Phi 2L2 - \dots - \Phi_p L^p \quad \text{..........(2)}$$

$$\beta(L,q) = 1 - \beta_1 L - \beta_2 L^2 - \dots - \beta_q L^q, \text{ for } i=1,2,3\dots k,\ \boldsymbol{u}_t \sim iid\ (0;\delta^2). \quad \text{...(3)}$$

L is a lag operator such that $L^0 y_t = X_t$, $L^1 y_t = y_{t-1}$, and $w_t$is a s x1 vector of deterministic variables such as the intercept term, time trends, seasonal dummies, or exogenous variables with the fixed lags. $P = 0,1,2\ ,m$, $q = 0,1,2\dots,m$, $I = 1,2\dots,k$: namely a total of$(m+1)^{k+1}$different ARDL models. The maximum lag order, m, is chosen by the user. Sample period, $t = m+1,\ m+2\dots,\ n$ (Gujarati, 2003). The model for this study is specified with electricity generation (EWF) as an implicit function of energy access (EAC), energy consumption (ENC), carbon emission (CO2)), and electricity generation (ELG). The linear equation for this study is:

EWF = *f (EAC, ENC, CO2, ELG)* where all the variables are as defined above. The consequent output equation is thus:

$$\Delta \text{EWF}_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta \text{EWF}_{t-i} + \sum_{j=0}^{q} \beta_j \Delta \text{EAC}_{t-j} + \sum_{k=0}^{r} \gamma_k \Delta \text{ENC}_{t-k} + \sum_{l=0}^{s} \delta_l \Delta CO2_{t-l} + \sum_{i=1}^{p} \gamma_i ELG_{t-1} + \varepsilon t \quad (4)$$

Where, β_0 = intercept of the output equation, error term (Ut), α0 is a constant term, αi, βj, γk, δl, ϵm, ζo, and ηq are the coefficients of the lagged variables.

From the eqn (4), the null hypothesis of no co-integration $H0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ was tested against the alternative hypothesis of co-integration$H1 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$. Therefore, eqn 4 is employed after modification to estimate the long-run relationship between the variables in the model follows:

$$EWF_t = \beta_0 + \sum_{i=1}^{p} \gamma_i\, EWF_{t-1} + \sum_{i=1}^{q^1} \gamma_i\, EAC_{t-1} + \sum_{i=1}^{q^2} \gamma_i\, ENC_{t-1} + \sum_{i=1}^{q^3} \gamma_i\, CO2_{t-1} + \sum_{i=1}^{q^4} \gamma_i\, ELG_{t-1} + \varepsilon_t \quad \text{....................(5)}$$

The Schwarz Bayesian criterion (SBC) was used to select the lag length of the model and error correction model was applied in order to determine the short-run dynamics of the model's variables as shown in equation 9:

$$\Delta EWF_t = \beta_0 + \sum_{i}^{p} \gamma_i\, \Delta EWF + \sum_{i}^{q} \gamma_i\, \Delta EAC_{t-1} + \sum_{i}^{q} \gamma_i\, \Delta ENC_{t-1} + \sum_{i}^{q} \gamma_i\, \Delta CO2_{t-1} + \sum_{i}^{q} \gamma_i\, \Delta ELG + \vartheta ecm_{t-1} + \varepsilon_t \quad \text{.....................(6)}$$

By integrating these methods, the study aims to produce a comprehensive analysis that not only identifies statistical relationships but also uncovers the underlying causal mechanisms and spatial dimensions of the energy crisis and climate policy impacts on welfare. This approach ensures robust, policy-relevant insights, suitable for publication in high-impact academic journals.

RESULT OF THE FINDINGS

Electricity generation from 1986 to 2023: The result of the findings on electricity generation in Nigeria from 1986 to 2023 is presented in Figure 1.

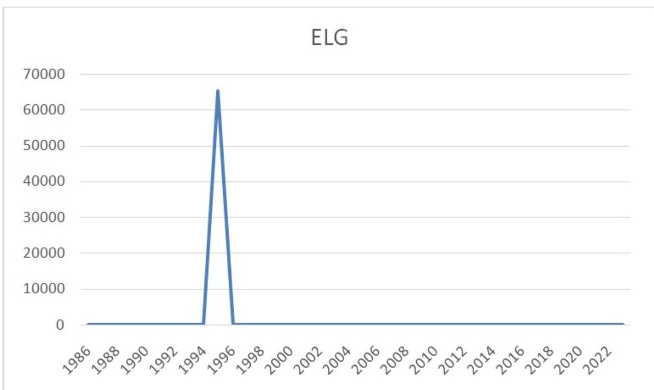


Fig. 1. Electricity Generation from 1986 to 2023

The Fig. 1 reveals that during the period from 1986 to 2000, electricity generation was likely low, reflecting the country's underdeveloped energy infrastructure and limited investment in the power sector, compounded by economic and political instability. Rural areas had little to no access to electricity, and stagnant or minimal growth in electricity generation would have led to power shortages that negatively impacted both household and industrial activities. From 2000 to 2010, the graph may show some improvements as Nigeria embarked on power sector reforms, although persistent challenges such as outdated infrastructure, poor maintenance, and insufficient renewable energy investments likely restricted substantial growth in electricity generation. Any slight increases in this period might be tied to economic growth and modest improvements in energy access, which would have positive effects on citizen welfare, improving access to services like healthcare and education, as well as productivity for small businesses. However, these gains were likely limited by infrastructural problems, leading to inconsistent energy access. The graph might also reveal that, despite improvements in generation capacity, the transmission and distribution networks lagged behind, leading to continued power shortages and blackouts. From 2010 onwards, the graph shows more noticeable growth in electricity generation, partly due to the influence of global climate policies and Nigeria's increased focus on renewable energy sources such as solar, wind, and hydropower. These trends would reflect Nigeria's efforts to align with global climate commitments, though fossil fuel-based power plants probably remained the dominant source of electricity throughout most of this period. The country's ongoing energy crisis, marked by blackouts and unreliable power, could also be reflected in the graph, indicating that while generation capacity may have increased, distribution problems persisted. Projections beyond 2023 might show more optimistic growth in electricity generation, particularly if Nigeria continues to invest in renewable energy and addresses transmission and distribution issues. Overall, the graph illustrates Nigeria's struggle to meet its growing energy demands, with electricity generation impacted by infrastructural challenges and evolving global climate policies. The country's ongoing efforts to improve generation capacity, particularly through cleaner energy sources, are likely to result in gradual improvements in both energy access and citizen welfare.

Energy consumption in Nigeria 1986 to 2023: The trend of energy consumption in Nigeria for the period 1986 to 2023 is presented in Fig. 2.

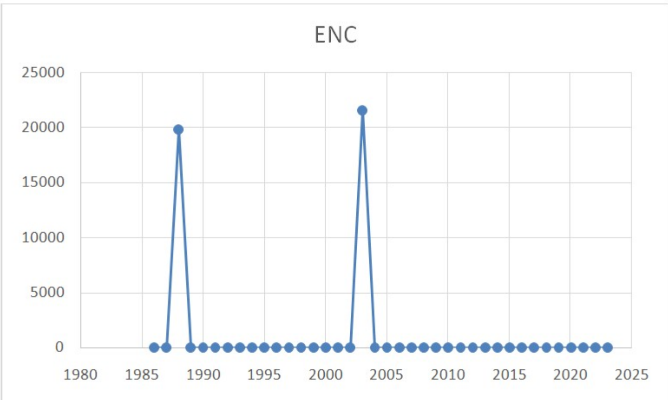


Fig. 2. Energy Consumption in Nigeria 1986 to 2023

The Figure 2 reveal a rising trend that typically suggest economic growth and increased industrial and household energy demand, whereas a declining or fluctuating trend might indicate economic downturns, energy infrastructure challenges, or policy shifts. The key periods to note include the late 1980s and 1990s, a time marked by economic crises and structural adjustment policies, which may have resulted in lower energy consumption due to reduced industrial activity and limited public investment in energy infrastructure. This period show stagnation or decline in consumption, reflective of the broader economic challenges. Moving into the 2000s, Nigeria embarked on several reforms in the energy sector, such as the privatization of the power sector and initiatives aimed at improving electricity generation and distribution. These reforms may have contributed to a gradual increase in energy consumption, as reflected by more stable energy supplies and increased access for citizens and industries. By the 2010s, global climate change policies, particularly those promoting renewable energy, may have started to influence energy consumption patterns in Nigeria. Increased global pressure to transition to cleaner energy sources could show up in the figure as a shift from traditional fossil fuels to renewables. However, the energy challenges Nigeria facessuch as unreliable electricity supply, frequent blackouts, and limited rural energy accessmight be seen as fluctuating or inconsistent energy consumption patterns. These disruptions, coupled with rising demand, reflect the complexities of meeting both the energy needs of a growing population and the global push for sustainable energy practices. The figure also shows significant fluctuations during the 2010s and early 2020s, correlating with the country's energy crisis, economic volatility, and climate policies. If the graph includes projections beyond 2023, it could provide insights into the expected impacts of Nigeria's ongoing energy reforms and international climate commitments, such as the Paris Agreement, which could lead to increased adoption of renewable energy sources and potentially more stable energy consumption.

Energy Access in Nigeria from 1986 to 2023: The result of the findings on energy access in Nigeria from 1986 to 2023 is presented in fig. 3. A rising trend in energy access indicates progress in providing more people with electricity or energy services, while a falling or stagnant trend highlights the challenges in expanding energy infrastructure, particularly in rural or underserved areas. Key periods of significant change, such as the economic policies of the 1980s and 1990s, may have resulted in dips in energy access, reflecting the impact of structural adjustments.

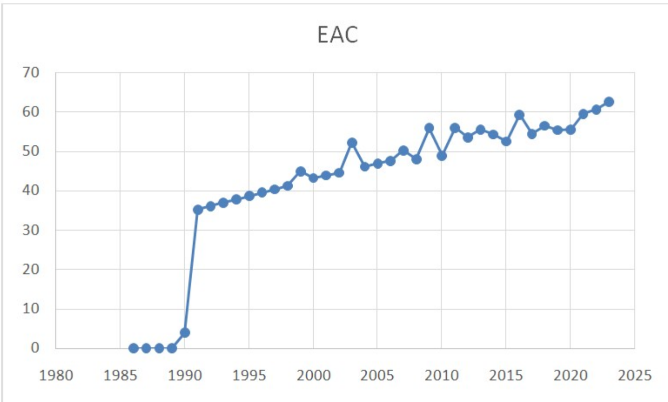


Fig. 3. Energy Access in Nigeria from 1986 to 2023

In contrast, the power sector reforms that began in the early 2000s may correlate with an increase in energy access, suggesting the positive effects of these reforms. The graph may also reflect the role of renewable energy developments, with recent years showing an uptick in energy access through off-grid solutions, particularly in rural regions. Moreover, the relationship between energy access and citizen welfare is critical, as improved access should positively influence health, education, and income levels. The influence of global climate policies, such as Nigeria's commitments under the Paris Agreement, may also be reflected in the graph, particularly if there is a shift towards renewable energy sources, contributing to both energy access and sustainability. However, challenges such as frequent blackouts and energy infrastructure issues may be evident in the graph's fluctuations or periods of stagnation, underscoring the persistent struggles in the energy sector. If projections are included in the graph beyond 2023, they could indicate expected changes due to ongoing energy policies or future investments, particularly those aimed at aligning with global climate change efforts. A closer examination of the graph might reveal a slow rise in energy access from 1986 to 2000, possibly due to political and economic instability, followed by gradual improvement between 2000 and 2010 as power sector reforms took hold. Fluctuations from 2010 to 2023 could reflect both infrastructural challenges and increased global pressure to adopt cleaner energy sources in response to climate change.

Carbon emission in Nigeria from 1986 to 2023: The trend of carbon emission in Nigeria from 1986 to 2023 is presented in Figure 4.

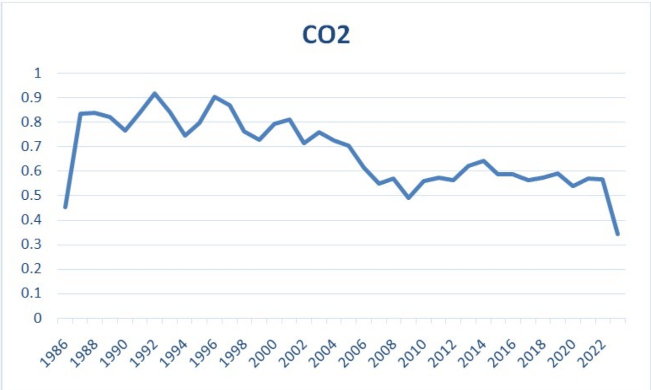
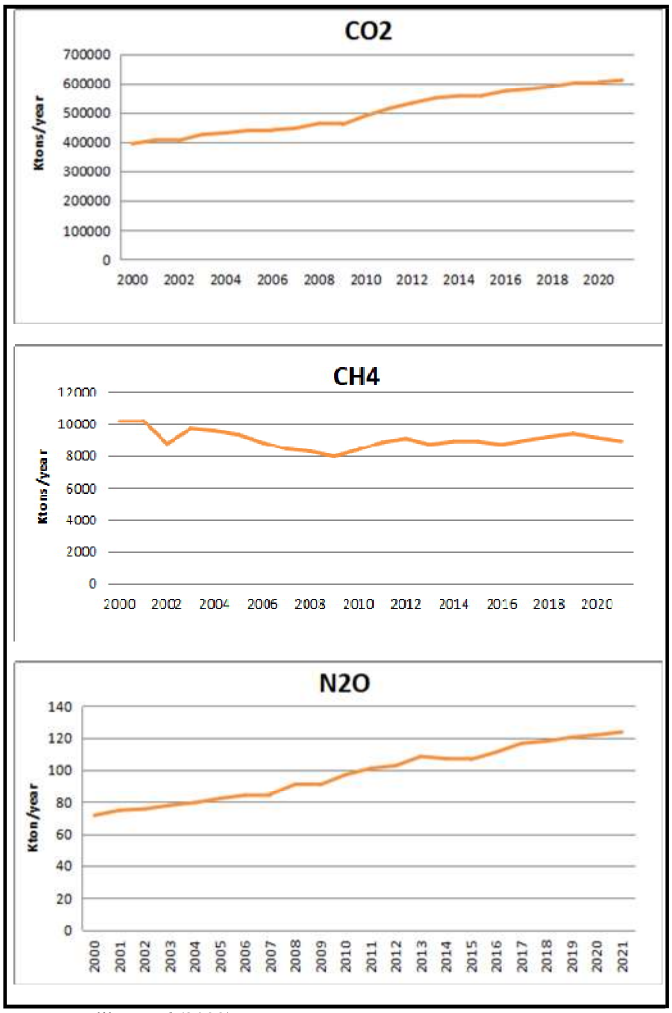


Fig. 4. Carbon emission in Nigeria from 1986 to 2023

The Figure 4 reveals several key factors and trends of carbon emission in the country over the period of study.First, the carbon emission trends over time are crucial. An upward trend in emissions would indicate increasing reliance on fossil fuels, such as oil and gas, which have historically been the dominant energy sources in Nigeria. This could be linked to the country's industrialization and population growth, which drove higher energy consumption and, consequently, carbon emissions. The graph might show a steady increase in carbon emissions from the late 1980s through the early 2000s as Nigeria's economy expanded and industrial output grew. This period of rising emissions could also correlate with increased energy consumption in both the industrial and residential sectors, particularly in urban areas. However, fluctuations in carbon emissions might be observed during periods of economic downturns or energy crises, which likely led to reduced industrial activity and energy use. For instance, during the economic challenges of the late 1980s and 1990s, emissions may have stagnated or declined slightly due to lower energy demand and the effects of structural adjustment policies, which hindered large-scale investments in energy infrastructure. A potential dip in emissions during this period would reflect these broader economic constraints. The figure 4 also reflect the influence of global climate change policies, particularly from the 2010s onward, as Nigeria began to take steps towards reducing its carbon footprint in line with international agreements such as the Paris Agreement. During this time, we might expect to see either a plateau or a slower increase in emissions as the country attempted to integrate cleaner energy sources, such as solar and wind, and adopt more sustainable energy practices. However, the shift from fossil fuels to renewables in Nigeria has been gradual, and the graph may continue to show significant carbon emissions due to the country's reliance on oil and gas for both domestic consumption and export. The figure 4 also reflect the impact of climate-smart policies and initiatives introduced to reduce emissions, such as gas flaring reduction programs and efforts to promote renewable energy. While these efforts may not have drastically reduced emissions by 2023, the graph could show early signs of stabilization in emissions as the country moves towards a low-carbon economy. If the figure includes projections beyond 2023, it might indicate how Nigeria's ongoing climate commitments and energy reforms could lead to a further decrease in carbon emissions, particularly as cleaner energy technologies become more prevalent. Overall, the figure highlights the complex interplay between Nigeria's energy consumption, its carbon emissions, and the global and domestic policies aimed at reducing its environmental impact. The upward trends in carbon emissions likely reflect the country's growing energy demand and dependence on fossil fuels, while any signs of stabilization or decline in recent years could be attributed to Nigeria's efforts to align with global climate goals and transition to a more sustainable energy system. In another development, Salihu *et al* (2023) investigated the trendof greenhouse gases (ghgs) emissionsover Nigeria from 2000 – 2021. The result of their findings is presented in figure 5. The figure 5 reveals line artrends for the CO2 and N2O annual green house gasesemissions, while the CH4 annualemissions show an on non-lineartrend in the emission time series (Salihu *et al*, 2023). The figure 5 illustrates the trends in emissions of three significant greenhouse gases—CO_2, CH_4, and N_2O—from 2000 to 2021, which is essential for understanding the broader context of Nigeria's energy challenges and the implications of global climate change politics on citizen welfare.



Source: Salihu *et al* (2023)

Figure 5. Annual green housegases (GHGs) emissions

Rising CO_2 emissions reflect increased fossil fuel combustion, often linked to both economic development and energy policy failures, which can exacerbate public health issues and economic inequality. Methane (CH_4) emissions, slightly declining, suggest a gradual shift in industrial practices or waste management, but still pose significant risks due to methane's potent greenhouse impact. Nitrous Oxide (N_2O), with its steady increase, points to ongoing agricultural activities that emphasize the need for sustainable practices. These trends collectively highlight the urgency for integrating environmental health into national energy strategies and the need for Nigeria to engage with global climate initiatives to mitigate adverse impacts on its citizens' welfare.

Empirical Findings

Unit Root Test

Table 1, shows the results of the ADF test on the variables: EAC, ENC, CO, and ELG. The results indicated that EAC, CO, and (ELG) were non-stationary series at level but, became stationary at first difference I (1) and were statistically significant at a 5% level of significance. The ENC was stationary at level I (0) in the ADF result presented.

in energy access by 0.73% will statistically affect ENC, carbon emission welfare by -0.0913, -1.6323 and 3.339207units respectively. Energy consumption was stationarity at the first difference and has a t-statistics and p-value -2.6007 and 0.0147 respectively.

Table 1. Unit Root Tests

Variables	ADF Statistics @Level	Probability	ADF Statistics @ 1st Difference	Probability	Order of Integration
EAC	-1.9510	0.9692	-1.9510	0.0470*	I (1)
ENC	-2.9484	0.0087*			I (0)
CO2	-2.9484	0.5625	-2.9540	0.0000*	I (1)
ELG	-2.9604	0.8490	-2.9511	0.0067*	l(1)

Source: Extracts from E-Views 9 Output, (2024).

Optimal Lag Length

Table 2. Optimal Lag Length

VAR Lag Order Selection Criteria
Endogenous variables: EAC ENC CO2 ELG
Exogenous variables: C
Sample: 1986 2023
Included observations: 34

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-31.60076	NA	9.54e-05	2.094162	2.273734	2.155401
1	89.02809	205.7786	2.04e-07	-4.060476	-3.162616*	-3.754280
2	112.4341	34.42061*	1.38e-07*	-4.496124*	-2.879977	-3.944971*

*Indicates lag order selected by the criterion
LR: Sequential modified LR test statistics (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
Source: Author's Computation E-View 9, (2024).

Result for ARDL Cointegration

Table 3. ARDL Cointegration EAC, ENC, CO2, and ELG

Variables	Coefficients	Std. Error	t-Statistics	Probability
EAC(-1)	0.730261	0.099593	7.332431	0.0000
ENC	0.021461	0.033814	0.634674	0.5308
ENC (-1)	-0.091322	0.035113	-2.600756	0.0147
CO2	-1.632333	0.793232	-2.057827	0.0490
ELG	3.339207	1.146898	2.911512	0.0070
ELG (-1)	-2.227168	0.980672	-2.271064	0.0310
C	-14.75672	9.806743	-1.504753	0.1436
$R^2 = 0.9955$	Adj R^2=0.99454	D-W Stat=1.467	Prob(F-Stat) = 0.0000	

Source: Author's Computation E-View 9, (2024).

ARDL Bound Test for Co-integration

Table 4. ARDL Bound test for Long-run Equilibrium

Null Hypothesis: No long-run relationship exists

Test statistic	Values of F-Statistic	K	Signif. %	I(0)	I(1)
Sample size (n) = 35	1.771832	3	10%	2.72	3.77
			5%	3.23	4.35
			1%	4.29	5.61

Source: Extracted from Author's Computation Using E-View 9, (2024).

From Table 2, the optimum lag length for this analysis is lag two (2). This lag length was chosen based on the Akaike Information Criterion (AIC) which was valued (-4.496124*) in the output using VAR Lag Order Selection Criteria. Hence, in this analysis, the study would apply lag two (2) in its estimation. Note that (*) denotes the appropriate lag for the research based on the characteristics of the data used. Table 3 shows that all four variables do not have the same integration order, they are stationary at different levels. The energy access was made stationary at the first difference and has a t-statistics and p-value of 7.332431 and 0.0000 respectively. The value of the t-statistics and the p-value shows that the independent variables have a significant impact collectively on the dependent variable. An increase ENC has a negative statistically significant effect on energy access, it reduces energy access through its externalities. An increase in ENC by 0.0913 units can cause a reduction in energy access by 0.73 %. Carbon emission was found to be stationary at level. It has a negative statistically significant relationship with energy access. The carbon emission has a t-statistics and p-value of -2.057827 and 0.0490 respectively. Carbon emission has a negative statistically significant effect on energy access, it reduces energy access. An increase in carbon emission by a 1.6323 unit while holding other variables constant will cause a reduction in energy access by 0.73 %. This result is consistent with Mantu *et al* (2022) and Romanus, *et al* (2020) which explicitly show how carbon emission as an externality of energy consumption has a negative effect on energy access. Furthermore, electricity generation was found to be stationary at first difference. It has a negative statistically significant relationship with energy access. The electricity generation has a t-statistics and p-value of -2.227168 and 0.0310 respectively. Electricity generation has a negative statistically significant effect on energy access, it reduces energy access in Nigeria, this is due to the stage of economic development that Nigeria is, based on the EKC hypothesis. From Table 4, the F-Bound test indicated that there was no cointegration among Energy access, ENC, CO, and Electricity generation in Nigeria. Therefore, this revealed that the variables included in the model do not have a long-run relationship among themselves. This was indicated by an F-value of 1.771832 which was lesser than both lower and upper bounds values I (0) and I (1) of 3.23 and 4.35 at a 5% level of significance in the result when the sample size was 35 observations.

ARDL Long-run estimates

Table 5. ARDL Long-run Estimates

Variables	Coefficient	Std. Error	t-Statistics	Probability
DENC	-0.258992	0.178246	-1.453005	0.1573
D(CO)	-6.051518	3.128237	-1.934482	0.0632
D(ELG)	4.122639	0.817848	5.040837	0.0000
C	-54.707307	23.818388	-2.296852	0.0293

Source: Author's Computation E-View 9, (2024).

Table 5 shows the long-run estimates for energy consumption, carbon emission, electricity generation, and energy access via the following parameters; coefficients, probability values, standard error, and t-statistic values were also presented on the table. Furthermore, this study examined the impact of energy consumption, carbon emissions and electricity generation on energy access in Nigeria. Table 5 results of the analysis proved that in the long run, energy consumption has a negative impact on energy access in Nigeria, although the impact is not statistically significant. That is, by the coefficients of variables included in the model and the probability values, it was noticed that ENC influenced energy access within the study period. The impact of ENC on an economy is obtained through the progressive industrialization of the country, thereby producing externalities that directly or indirectly affect the health of the populace. This secondary effect caused diseases, affected the health of the populace, reduce quality of life, and eventually reduce energy access in an unhealthy manner. The result of this finding in Table 5 does not support the apriori expectation which states that the slope of the coefficient of ENC would have positive impact on energy access in Nigeria. Carbon emission also follows a similar pattern as ENC, whereby it has a negative impact on energy access in Nigeria and the impact is also statistically insignificant based on its P-value of 0.0632. Carbon emission is an externality that is generated due to the economic opportunities that are created by ENC in the country. Carbon emission of high intensity is mostly found in urban settings while the majority of the population is found in rural areas. The impact of this externality is experienced by the urban dweller, who settled mostly around the heavily industrialized areas. Carbon emission has a long-term effect on energy access via its impact on global warming, emission-induced disease conditions, and reduction in quality of life, and energy access. This is in line with the apriori expectation that a negative relationship would exist between carbon emission and energy access in any economy.

Furthermore, the coefficient of electricity generation (ELG) is positive on energy access in Nigeria. This is in line with the apriori expectation that a positive relationship would exist between electricity generation and energy access in any economy. The long-run impact is positive and statistically significant (p-value= 0.0000). The result it implies that an increase in 3.339 units of ELG would cause a corresponding increase of 1% in energy access over the period. An increase in ELG will improve government spending on capital health expenditure, consumption, income per capita of the economy, and energy access. The coefficient of the constant (-54.707307) was negative; it means that without the impact of ENC, Carbon emission, and ELG in the country, energy access would decrease as well by 1% when the constant increased by 54.7073 units. In addition, the negative impact of the constant was found to be statistically significant with a p-value of 0.0293.

Short-run Estimates

Table 6. ARDL Short-run Estimates

Variables	Coefficient	Std. Error	t-Statistics	Probability
DENC	0.021461	0.033814	0.634674	0.5308
D(CO)	-1.632333	0.793232	-2.057827	0.0490**
D(ELG)	3.339207	1.146898	2.911512	0.0070**

ECM= -0.269739 ** denotes significance at a 5% level of statistical significance

Source: Author's Computation E-View 9, (2024).

Table 6 shows the result of ECM which indicates the coefficient of Error Correction Mechanism (ECM) and its speed of adjustment to the long-run equilibrium. From the table, the error correction model outcomes. Error correction term (ECT−1) is found a negative and significant association, implying the existence of convergence toward long-run equilibrium and the coefficient sign of ECT is negative and significant which that the model is converging long-run equilibrium shortly. The negative value of the coefficient of ECM implies that there is a short-run relationship between the independent variables (EAC, ENC, CO, and ELG) in Nigeria. It is also observed that the ECM has both positive and negative shocks, which improve and depreciate energy access respectively. The ECM coefficient of -0.269739 was in line with economic theory which stated that it has a negative sign and will be statistically significant by its probability value of 0.0114 and its t-statistics of -2.708412. Therefore, the value of ECM (-0.269739) will gradually adjust by 26.9 percent (%) to ensure cointegration in the long run. Certainly, -0.269739 proved that when there is a state of disequilibrium among the energy consumption, carbon emission, electricity generation and energy access will be brought back to equilibrium. In addition, this result in Table 6 shows that the coefficient 0.021461 of ENC influences the value of energy access positively in Nigeria. The probability value and t-statistics value of 0.5308 and 0.634674 respectively, proved that ENC has affected energy access but, it is not statistically significant.

Carbon emission in the short run also affects the energy access in Nigeria negatively and the impact is also statistically significant with a P-value of 0.0490. The effect of the carbon emission generated in the short run is not as high as compared to the impact in the long run. For every 1% decrease in energy access in Nigeria there is a corresponding increase in 1.63233 units of carbon emission. In the short-run, the effect of the carbon emission is statistically significant while in the long-run the impact is insignificant. This is in line with the apriori expectation that a negative relationship would exist between carbon emission and energy access in any economy. Furthermore, the coefficient of the electricity generation was 3.339207; it means that a 1% increase in energy access would increase the electricity generation by 3.339207 units in Nigeria and vice versa. More to that, the electricity generation was statistically significant in the study judging from t-statistics of 2.911512 and P-value of 0.0070. The implication of this result is, that once electricity generation is experienced in Nigeria, more Nigerians will live longer with a better quality of life.

CONCLUSION

This study has assessed the impact of Nigeria's energy crisis and global climate change policies on citizen welfare. The findings of the study reveal that Nigeria's energy crisis and global climate change policies have profound implications for the welfare of its citizens. Persistent energy poverty, characterized by limited access and unreliable supply, hampers economic growth, restricts access to essential services like healthcare and education, and exacerbates socio-economic inequalities. At the same time, Nigeria's commitments to global climate change agreements, such as the Paris Agreement, require the country to reduce its reliance on fossil fuels and transition to renewable energy sources. However, the underdeveloped state of Nigeria's energy infrastructure poses significant challenges to achieving both energy access and climate sustainability. The research highlights the critical need for integrated policies that simultaneously address energy access, economic development, and environmental sustainability. By balancing these priorities, Nigeria can avoid deepening inequalities and ensure that efforts to decarbonize benefit all citizens, particularly vulnerable populations. The findings underscore the importance of significant investments in renewable energy and infrastructure development for sustainable progress.

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

i. Increase Investment in Renewable Energy: The Nigerian government should prioritize significant investments in solar, wind, and hydropower to reduce dependency on fossil fuels. Expanding the renewable energy sector will help meet both energy access and climate goals.
ii. Upgrade and Modernize Energy Infrastructure: To improve energy access and reliability, the government should focus on upgrading outdated power infrastructure, particularly in rural areas, to ensure consistent electricity supply.
iii. Enhance Policy Integration: Climate policies should be integrated with energy development strategies to ensure that decarbonization efforts do not worsen energy poverty. This requires balancing Nigeria's climate commitments with socio-economic development goals.
iv. Promote Energy Efficiency: Implementing policies that promote energy efficiency, particularly in industrial and residential sectors, can help reduce energy consumption and carbon emissions.
v. Expand Off-Grid Solutions: Encourage the development of off-grid renewable energy systems, especially in remote areas, to improve energy access for underserved communities.
vi. Strengthen International Collaboration: Nigeria should leverage international climate finance and technology transfer opportunities to support its energy transition, ensuring sufficient funding for renewable energy and infrastructure projects.

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