FOSSIL-FUEL DISRUPTIONS AND LOW CARBON TRANSITION: LEGAL RESPONSES TO ENERGY SECURITY AND SUSTAINABILITY IN NIGERIA'S POWER SECTOR

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ABSTRACT

Energy is significant in any country; paucity of access to a constant energy supply fosters poverty and the decline in economic growth. Nigeria is endowed with copious low-carbon energy resources for sustainable development. However, it fails to optimize these resources. The study examines the potential of low-carbon energy that could be utilized for a constant energy supply. The study utilizes empirical, doctrinal legal research approaches with primary and secondary sources of laws such as textbooks, and peer-reviewed journals. Comparative legal analyses of low-carbon energy in China, Spain, Germany and Nigeria were done to gain valuable insights into the stable electricity supply. Theories and empirical procedures were used in the estimation of carbon emission with the instrumentality of the auto-regressive distributed lag model. The results of the short-run and long-run model estimates revealed a positive contribution of electricity consumed to significant variations in CO2 emission. Variations in hydroelectric power sources accounted for a significant decline in carbon emissions. The error correction model provided evidence of a significant high mechanism for systemic convergence in the presence of exogenous shocks. The article designs a hybrid model for adopting low-carbon energy, and advocates reform of energy laws to mitigate environmental impact and for sustainability.

Keywords: Fossil-Fuel, Low Carbon Transition, Legal Response, Sustainability, Nigeria.

INTRODUCTION

Over the years, adequate and reliable energy supply in Nigeria has been the subject of intensive concern, as the world's glamour for low carbon energy sources is a veritable instrument in attaining sustainable energy development in any nation. Fossil fuel has had an enormous influence on the growth of Nigeria's economy as the country majorly on oil export revenues thereby being vulnerable to the changing in global oil prices. However, it is worth of note how this industry is going to subsist in the period of global climate neutrality and national net zero or decarbonisation policies. The colossus role of fossil fuels in Nigeria's energy mix has occasioned an unusual increase in carbon dioxide releases into the atmosphere, dangerous heat compared to other advanced countries. The revenues from fossil fuel export are about 86% of the country's

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aggregate export revenue. Oil exploration and production have occasioned environmental degradation, energy poverty and societal disparities due to constant power failure. They undertake to decrease its greenhouse gas discharge by 20% by the year 20230 and despite being the continent's largest oil producer and exporter of refined products the country is having serious energy predicaments in its power sector thereby occasioning heavy reliance on generators during the power cut. Since the country's total electricity is relatively low for its populace. Besides, oil and gas exploration and production operations in the country are vulnerable to corruption, oil pollution, crude oil theft and other economic terrorism.

Nigeria generates 18% of its electricity from hydropower with little electricity from wind and solar energy sources. The Mambilla Dam is under construction with a capacity of 3,000Megawatts in Dongo River, Taraba State. Decentralised energy sources are key in Nigeria for energy to be utilised where it was generated rather than at the central plant. A community-centred renewable energy plan which is economical and efficient will combat power failure or electricity gap in the countryside in Nigeria (Dunne, 2020).

Low carbon energy is significant to any economy as it plays a cardinal role in energy generation which occasioned greater outputs and innovation, particularly in the industrial sector. Regular energy sources are not viable ultimately, being unpreserved and renewable.

Low carbon energy came to prominence in Nigeria due to the electricity problem in the nation which was caused basically by the poor supply of electricity to customers and due to the global trend on reduction of emission of carbon dioxide to curtail the devastating effects of the fossil energy resource which led to climate change, dangerous weather events such as famines, flooding, food shortage, ill health, economic deterioration and other environmental risks (Olujobi, 2020a).

All over the world, electricity utilization continues to upsurge. Hence, further dynamic development of Nigeria's power sector is inevitable. However, planning and the enactment of the low carbon energy transition laws and policies should take into account climate change, energy security and strengthening of the energy regulatory authorities is crucial. Since the utilisation of fossil fuels to generate electricity worsens the emission of greenhouse gases and other deleterious substances which negatively impact the climate and future generations' needs. Hence, need for the development of carbon dioxide-free energy sources (Wiśniewska & Markiewicz, 2021). In Nigeria, the majority of electricity is generated from fossil fuels, which are emissive. Consequently, the country's power sector must switch to clean energy generation with a focus on renewable energy sources and natural gas which is an environmental preferable source of energy (Kordonska & Hurnyak, 2018).

Despite that, fossil fuel has had an enormous influence on the economic growth and wealth of numerous nations particularly Nigeria. However, the sector is become less attractive due to its environmental impact and crude oil prices volatility, the global era of climate neutrality, the imperative of sustainable development, and global decarbonisation policies which are mirrored in national energy policies to under-mining the germanises of fossil fuel (Gierszewski et al., 2021).

Nigeria’s energy transition policies must promote energy security, sustainability, economy, climate protection, and the concept of sustainable development and must conform to the Paris Agreement and global economy (Zhang et al., 2021). The concept of sustainable development was initiated by Brundtland in 1987 with an emphasis on environmental protection

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and growth. The United Nations' Sustainable Development Goal 7 underlines the need for universal access to economical, reliable and green energy by developing climate resilience and diminution of discharge of greenhouse gases that occasion global warming. Promotion of clean, economical, zero-pollution, safety, energy security and sustainability in Nigeria's power sector is crucial (Rotondo et al., 2020).

In an international context, renewable energy utilisation is approximately 18.2 percent of the global energy consumption while about 79.5 percent emanated from oil, gas, and coal approximately 2.2 of nuclear energy (Peter & Mbohwa, 2019). The development of petroleum deposits to satisfy global energy demand has raised a concern about how to safeguard environmental quality while meeting global energy demands. Therefore, there is a need for a paradigm shift in energy demand to avert the exhaustion of the ozone layers triggered primarily by gas flaring and hydrocarbon combustion. Globally, approximately 19 percent of entire energy utilization emanated from renewable energy sources, with 9 percent emergence from conventional biomass such as fuel wood, and 10 percent from contemporary renewable energy sources such as biomass, geothermal, biofuel, solar, wind and hydropower (Akorede et al., 2017).

The utilization of low carbon energy sources such as renewable energy will diminish over-reliance on fossil fuels which occasioned gas flaring. The gases can be transformed into methanol and utilized as fuel for both municipal and factory use. The use of hydrocarbon for energy will be significantly diminished (Oyedepo, 2012). As low carbon energy has been acknowledged as a significant alternative energy source in respect of environmental friendliness and it can offer the panacea to the problem of ensuring a stable energy supply in most emerging economies (Olujobi et al., 2022b).

In the Nigerian context, the evolution from the fossil-fuel era towards today's low carbon transition in Nigeria above 80 percent of Nigerian essential energy utilisation is clustered petroleum. This is a major concern due to its exhaustion of resources and harmful influence on the ecosystem.

The feat of low carbon energy in the country has declined to owe to the weak regulatory framework, infrastructure, paucity of low carbon energy development strategies, absence of good management and nexus in the low carbon energy scheme, valuing misrepresentations that position low carbon energy as a drawback due to exorbitant commencement capital budgets, poor awareness and strategies, absence of experts, poor maintenance service and poor energy infrastructure (Olujobi, 2020b).

Sustainable development is the evolving development, financing, and training of technology and organisation to ensure compatibility with both present and future needs devoid of conceding the capability of upcoming generations to satisfy current necessities. The goal of sustainable development is to enhance the quality of life by boosting the standards of living in emerging countries while preserving biodegradable developments via economical and consistent energy accessibility which is sine qua non for sustainable growth (Olujobi, 2020c). Sustainable energy growth strategies comprise high-tech variations; energy conservation on the demand-driven, productivity will boost energy generation and substitution of hydrocarbons with numerous renewable energy sources which are the utmost encouraging techniques to manage the problem of energy demand, problems of many consumers globally (Oyedepo, 2014). Sustainable development demands a well-organized, restructured energy economy, focused on

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indigenous and hygienic energy founts where the bill paid by the customers exhibits the actual aggregate energy utilised devoid of corruption (Oyedepo et al., 2018).

The evolution from the fossil-fuel era towards today's low carbon transition in Nigeria. Currently, energy production and use in the country primarily hinge on several energy founts for instance petroleum, coal, biomass, solar, hydropower and thermal energy of which petroleum, hydropower, biomass and thermal have significant prepotent approximately 95 percent of energy consumption in Nigeria (Olujobi, 2023). Low-carbon power from hydropower has been the principal source of the country's grid electricity generation after the 1960s. Lately, the Kanji and Jebba Dams of 1300MW are approximately 50 percent of Nigeria's constant energy source. Gas power stations have recently taken up the stage but their functions linger due to the inhibition experienced due to the appalling state of the national grid and deficits in gas supplies.

Russia as the second-largest producer of crude oil globally, sanctioned due to the inversion of Ukraine and non-purchase of its crude oil, has disrupted global oil prices and failure of Covid 19 mitigation policies. Though this war will boost Nigeria's oil revenues, it will increase subsidy payments thereby giving room for corruption. Thus, demand for the transition to low carbon energy for sustainability and economic growth in Nigeria (Olujobi et al., 2022c).

Theoretical Framework on Low Carbon Energy Supply

Several theories have been formulated by numerous researchers and experts emphasising the necessity for low-carbon energy for Nigeria. The Sustainable Development Theory was first developed from the Brundt land Report in 1987 following the Stockholm Conference on Human Environment in 1972. The concept is pertinent to this research since it is based on the idea that governments should use their abundance of renewable energy resources sustainably by reforming their laws on renewable energy for stable electricity in Nigeria. Failure might have negative consequences for the financing energy industry and Nigeria's economy. Stable electricity will encourage socio-economic growth and compatibility of both present-day and upcoming necessities devoid of conceding the capability of upcoming generations to satisfy their necessities. The concepts highlighted the importance of the application of low-carbon energy resources for the optimum advantage of Nigerians to ensure stable electricity in the country (Olujobi et al., 2022d).

The Resource Curse Theory, (similarly acknowledged as the paradox of plenty) was developed between 1970 and 1990 and was earliest utilized by Richard Auty in 1993 to explain exactly how nations opulent in mineral resources were incapable to utilise their abundant natural resources wealth to boost their economies (Olujobi et al., 2021c). The theory emphasises the incompetence of numerous resources endowed nations to use profusely their natural resource for the well-being and infrastructural necessities of their citizens (Olujobi & Oyewunmi, 2017). The theory aids the research by emphasising the need to ensure that abundant natural resources such as low carbon energy resources are exploited for the optimal benefit of the citizens through the provision of stable electricity and other basic social amenities. Ensure that the revenues derived from these natural resources are utilised in a way that is commensurate with the amount earned from abundant natural resources.

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Empirical Evidences

The results specify that future climate change policy, electricity demand, and availability of renewable energy sources should be prioritized when formulating development strategies. All economic undertakings and developments necessitate some varieties of energy, and this practice makes energy a crucial aspect of the invention that is inevitable for a nation's economic growth.

Electricity in the country is characterised by recurrent overload dropping and power outages which has hindered sustainable growth and development in Nigeria. In Nigeria, the power supply is currently relying on the traditional power supply for instance hydrothermal, gas, hydrocarbons and wood which are speedily exhausting. Notwithstanding the copiousness of energy resources, the nation is in a deficit of electrical power supply. Availability of constant supply of electricity is a primary problem among countryside and city inhabitants in Nigeria. This energy problem has overwhelmed Nigeria for nearly two decades and has principally occasioned the prevalence of penury by incapacitating engineering and business-related operations in Nigeria. The Council for Renewable Energy approximates observed that power failure occasioned a loss of 126 billion Naira (US$ 984.38 Million) yearly (Olujobi et al., 2022e).

Approximately 40 percent of Nigerians have the right to use national grid electricity and in the countryside areas approximately 70% of the people in a country of over 200Million population. The availability of electricity drops to 15% (Olujobi et al., 2022e). Adequate low carbon energy utilization in Nigeria will mitigate climate change, meet energy security and needs as well as promote economic development.

Oniemola (2015) posited that Nigeria is also participating in ecologically detrimental undertakings, predominantly by escalating greenhouse gas discharges owing to persistent reliance on hydrocarbon for electricity generation. Oyedepo in analysing the problem of the country's power supply and potential discovered that the electricity demand in the country significantly surpasses the erratic supply. Also, Oke (2013) opined that rigorous competition as a result of privatization could discourage investment in renewable energy and to maximise the benefits of renewable energy proper planning is required to avert unnecessary loss that tends to discourage investment due to the lack of a definitive legal regime for low carbon energy with a decentralized energy structure (Okafor & Joe-Uzuegbu, 2010).

The current author avers that, currently, 60% to 70% of the populace does not have access to electricity. Undoubtedly, the current electricity quandary affecting the country will continue except the Federal Government expands the energy resources in local, business-related, and manufacturing sectors and applies innovative skills on low carbon energy to decrease energy depletion and for cost-efficiency and environmental friendliness sources of energy (Oniemola, 2015). Besides, the enormous revenue loss, it has similarly occasioned ill-health, the wellbeing of the citizens has been affected owing to frequent contact with carbon discharges triggered by continuous utilisation of Generators in numerous families and business-related firms due to unreliability of electricity from the commercial national grid which as occasioned the use of generators for electricity supply thereby polluting the environment (Oke, 2013).

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International Legal Framework on Low Carbon Energy Transition

Low-carbon energy sources have continuously been outlined at the various international ecological conferences organized by the United Nation and in other global conferences. Conversely, the formulation of international rules binding States to their use was sparingly discussed. Some soft laws will be considered. The 1992 Rio Conference on Environment and Development (UNCED) Principle 2 confers self-governing right over natural resources with the embargo on cross-border harm in member countries.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change is a global treaty that prescribes obligatory responsibilities for developed republics to diminish discharges of greenhouse gases. This is an ecological agreement to prevent hazardous anthropogenic meddling in the climate structure. As part of the Kyoto Protocol, numerous industrialized nations have agreed to decrease the discharges of greenhouse gases. The protocol was modified in 2012 to contain the second assurance period. The protocol is pertinent to renewable energy growth as the contracting parties are obliged to regulate their fonts of anthropogenic, Green House Gases discharges and to adopt climate change palliation measures (Olujobi, 2018).

Currently, Nigeria does not have a comprehensive low carbon energy efficiency policy but there was a reference to low carbon energy skills in the 2003 National Energy Policy which has not adequately addressed the need to develop a workable national low carbon energy programme. The Renewable Energy Master Plan 2006 reviewed in 2011 was submitted by the Energy Commission to develop and exploit renewable energy capacities in the country as an alternative source to the conventional energy source which is expected to contribute to 10% of the country's power supply from 23% sources of renewable energy to 36% in 2030 (Oyewunmi & Olujobi, 2016). The challenge has been weak enforcement and the absence of stringent sanctions for non-compliance.

National Legal Framework on Low Carbon Energy in Nigeria

Electricity Power Sector Reform Act 2005 is the main statute that controls the country's power industry. The Act set up the Nigeria Electricity Regulatory Commission as an institution to provide licenses and regulate the production, invention, and allocation of power in the country. The Nigeria Electricity Regulatory Commission formulated some regulations such as the Renewable Energy Feed-in Tariff Regulation 2015, a feed-in tariff for renewable energy sources for electricity production designed to encourage financing of renewable energy projects. It is projected that the country will produce a minimum of 1000MW of electricity from low-carbon energy sources if properly utilised (Olujobi & Yebisi, 2022a). However, reversed is the case currently?

The Environmental Impact Assessment Act Cap E2, Laws of the Federation of Nigeria, 2004. makes it obligatory for ecological effect appraisal to be completed for carbon projects prone to have substantial adverse effects on the atmosphere such as carbon energy projects or plants must be registered with the Federal Ministry of Environment for an ecological impact evaluation. Section 2 of the Act provides for the appraisal of public or private projects which are possible to have a significant consequence on the ecosystem for prior approval (Olujobi, 2021a).

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This has not been enforced stringent by the regulatory authority in the sector due to corruption and lack of capacity to monitor and evaluate compliance of energy firms (Mulyana, 2016).

The National Renewable Energy and Energy Efficiency Policy 2015 summarises the aim of the guidelines and procedures for the advancement of renewable energy and energy know-how. The policy brings to the consideration of legislators the fiscal and social perspective of renewable energy. It advocates suitable strategies to be formulated for exploiting these energy capabilities and adding value to the current reforms in the country's energy industry (Jegede & Idiaru, 2021).

Prospects of Low Carbon Energy in Nigeria's Power Sector

Low-carbon energy resources are perpetually being restocked from inherent resources with the reassurance of supply, distinct from hydrocarbon sources, which are often traversed on the global oil market and depend on transnational competitiveness. Consistent utilization does not alter renewable energy accessibility in the imminent since it is endless. Low-carbon energy resources are evenly distributed in Nigeria, though longitudinal and chronological variations occur. All the six geo-political zones in Nigeria have sufficient access to one or more types of low-carbon energy sources. Low-carbon energy resources are hygienic and uncontaminated and are viable energy sources that are available and affordable.

Low carbon energy sources distinct from fossil fuels plants which are owned by the Federal Government and energy firms' renewable energy can be established in miniature components appropriate for villages or rural areas' needs in Nigeria. Thereby creating opportunities for pastoral electrification projects. Decentralization of energy scheme panaceas is a valuable strategy in the country's electricity problem because of certain geographical or geological impediments in the pastoral areas which often made it too costly to cover such areas. Low carbon energy promotes energy efficiency and boosts sustainable development via affordable and availability of energy to the indigent to alleviate greenhouse gas discharges, decreasing toxic air contaminants, thus generating novel fiscal prospects, and augmenting energy safety measures via mutual aid and partnership by all stakeholders.

The Challenges of Transition to Low Carbon Energy in Nigeria

In Nigeria, one of the challenges of maximizing the potential of low carbon energy is the lack of technical capacity and innovation required to tap, utilise and manage low carbon energy sources (Olujobi et al., 2022d). There are also, institutional and governance failures that hampered production efficiency, investment in the sector and higher expenditures on undertakings or setting-up, meagre returns on investment due to the Federal Government pricing policies or regulation of electricity and petroleum products markets in Nigeria.

Also, there is a technological barrier, National Renewable Energy Master Plan made provisions for overhauling renewable electricity projects which are not much in existence in the country currently. Therefore, prospective Independent Power Projects may encounter substantial logistic problems in acquiring gadgets and safeguarding assistance for low-carbon electricity projects. There is inadequate public responsiveness on the capabilities of low carbon energy and higher risks insight for potential low carbon electricity projects (Akinbami, 2001). Low carbon

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energy growth is a challenge confronting Nigeria due to poor sensitization which has occasioned energy market distortions.

Another challenge is the anxiety regarding finance, since low carbon energy technology is costly, for pastoral societies and persons, the budget for owning a self-funded low carbon energy scheme is exorbitant in Nigeria and access to financial facilities may be difficult. Unsatisfactory resource management, corruption and absence of dedication by the Federal Government to finance low carbon energy growth are hurdles militating against the transition to low carbon energy technology and development in Nigeria (Somefun, 2015).

Epileptic Supply of Electricity in Nigeria: Low Carbon Energy Sources as Alternative

Several low carbon energy options are available in Nigeria, though largely unexplored including wind, solar and biomass. Wind energy is a clean energy resource with the potential for a consistent energy supply in the country.

Akinbami maintains that the aggregate hydroelectric energy perspective of Nigeria was approximately 8,824 Mega Watt (MW) with a yearly electricity generation perspective exceeding 36,000 Gigawatt hours (Akinbami et al., 2001). This comprises 8,000 megawatts of huge hydropower technology, while the outstanding 824 megawatts is still miniature hydropower know-how currently, 24% and 4% of both huge and miniature hydropower capabilities in Nigeria have been utilized.

Further, Solar energy is abundantly present in Nigeria, though the know-how for low carbon energy uses is yet to be completely recognized as domiciliary merchandise in Nigeria. It offers cost-effective, opportunities for developing alternative electricity sources thereby encouraging viable growth in the countryside. The Renewable Energy Policy of Nigeria 2006 reiterated this position. Nigeria is situated in the tropics with a land widening between latitudes 5 degrees south and 15 degrees north of the equator the nation possesses copious sunlight. The regular solar insulation in the country is approximated between 4.0-kilowatt- (KWh)/m2/day at the Southern shorelines to 7.0-kilowatt-hour (kWh) /m2/day in the Northern part of Nigeria. The everyday average is approximately 5.5KWh/m2/day. The technologies for solar energy applications are yet to gain acceptance in most Nigerian households (Akinbami et al., 2001). It is suitable for rural electrification due to the inability to connect to the national electric power grid.

Besides, biomass is an organic origin from active bacteria. Biomass can either be exhausted absolutely as bio-power or transformed into supplementary energy goods for instance biofuel. Sources of biomass include corn, sugarcane, wastes, dead trees, stumps, branches, yard clippings, and wood chips among others. Biomass is a renewable low carbon fuel that is a sustainable fuel that can reduce significantly carbon emissions compared with fossil fuels. However, notwithstanding its comparative advantages and copiousness, there is no law on biomass as a basis of renewable energy (Ilenikhena & Ezemonye, 2010). The use of biomass as a basis of renewable energy will promote an uninterrupted electricity supply to the countryside, boost pastoral energy proficiency, encourage high-tech revolutions and transmit low carbon energy know-how to pastoral societies to improve the lives and incomes of Nigerians. Hence, there is a necessity for a crucial definitive legal strategy or blueprint for low-carbon energy in the country.

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The Rights and Redress for Electricity Customers in Nigeria

Under the provisions of the Nigeria Electricity Regulatory Commission (NERC) Customer Service Standards of Performance for Distribution Companies, Customer Com-plaints Handling Services and Processes, Joining and Discontinuation Practices for Electricity Services and Meter Analysis, Payments and Credit Administration for electricity supply, every electricity customers have the following rights: Right to electricity supply safely and reliably, right to be correctly connected to an operational meter. Right to be properly notified on electricity service, right to clear and comprehensive electricity invoice and right to be supplied with electricity bills in compliance with the Nigeria Electricity Regulatory Commission estimated billing procedure where the such customer is not provided with the meter.

Contravention of right to the Nigeria Electricity Regulatory Commission's Consumer Forum. The commission has a Consumer Forum which is set up to respond to complaints of electricity customers who are disgruntled with the verdict regarding the treatment of the electricity customer's complaints by the Customer Complaints Unit or where the Customer Complaints Unit delays or fails to handle the electricity customer's complaints. The customer may report the decision of the Nigeria Electricity Regulatory Commission's Consumer Forum to Nigeria Electricity Regulatory Commission. Where an electricity customer is disgruntled with the decision of the Nigeria Electricity Regulatory Commission Consumer Forum, the electricity customer is entitled to submit a petition to the Nigeria Electricity Regulatory Commission. Customers in the R2 and C1 tariff categories with complaints related to estimated billing after February 2020 are expected to report the infringement directly to the Nigeria Electricity Regulatory Commission (NERC) by filling out an online Complaints Form and attaching a copy of the bill (Olujobi, 2021b).

Most Nigerians hardly report that this has occasioned abuse of their rights by the Electricity Distribution Companies in Nigeria. The culture of silence must be jettisoned to promote efficiency and energy security in Nigeria.

Comparative Legal Framework on Low Carbon Energy in China, Spain, Germany and Nigeria

Renewable energy resources are not fully exploited in Nigeria despite their abundance in the country to combat the persistent energy predicament in the nation by transiting to a clean, dependable, safe and viable energy supply. The study carries out a comparative legal framework on low carbon energy in China, Spain, Germany and Nigeria to gain useful insights to improve Nigeria's transition to low carbon energy sources. Table 1 shows the comparative legal framework on low carbon energy in China, Spain, Germany and Nigeria.

Table 1
COMPARATIVE LEGAL FRAMEWORK ON LOW CARBON ENERGY IN CHINA, SPAIN, GERMANY AND NIGERIA

S/No	Countries	Legal Framework	Population	Remarks
1.	**China**	Renewable Energy Law 2006 is to encourage progression in the utilization of renewable energy, develop energy infrastructure, expand energy provisions, and energy security, and	1,446,599,87509	The law is very simple and apt; details of the law are provided in the guidelines and strict sanctions for default. Decentralization of

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		safeguard the environment for eco-logical friendliness and growth of the country's economy. The law decentralized the implementation of renewable energy use among the numerous state and indigenous agencies. Energy Authorities of the State Council manage the growth of renewable energy.		Nigeria's energy structure will promote electricity stability.
2.	**Spain**	Spanish's Royal Decree-Law 1/2012 terminates all subsidies on renewable energy installations the aim is to combat tariff deficit. The energy plan outlines the Spanish Government's energy needs. The aim is to promote sustainable development in the countryside renewable energy technology and energy security.	46,778,444	Spain has a robust legal regime for low carbon energy which Nigeria can replicate.
3.	**Germany**	German Renewable Sources Act 1998 and German Electricity Regulation relied on a mixture of public and private law. The Renewable Energy Sources Act 2000 objective is to encourage renewable energy production and technologies in Germany. Electricity produced from renewable energy was prioritized for grid connection namely wind, solar, biomass, geothermal energy, landfill, pit and sewage gas.	84,134,677	The legal framework prioritized low-carbon energy sources in the country. The energy produced from low carbon energy sources was prioritized for grid connection which Nigeria can replicate with suitable technical know-how that will ensure energy security.
4.	**Nigeria**	The Nigerian Electricity Regulatory Commission is to promote electricity generation via conventional and renewable energy sources for sustainable electricity in the country. National Energy Policy promotes renewable energy sources but it has not translated to a matter of national priority for sustainable electricity.	212,823,072	There is a necessity for redirecting low carbon energy statutes and policies in conformity with global trends in attaining the objective of energy sufficiency and stable electricity in Nigeria.

The Legal Response to Low Carbon Transition in Nigeria's Power Sector: Are We on the Right Course of Energy Security and Sustainability?

Emission reduction and promotion of sustainable development is the principal aim of the Kyoto Protocol and Article 3(1)(a) of the Convention for the Cooperation in the Protection and Sustainable Development of the Marine and Coastal Environment of the Northeast Pacific. The Brundland Commission explained sustainable development as the development that satisfied the necessities of the current generation devoid of conceding the capability of oncoming generations to satisfy their necessities. Sustainable development encourages economic growth and social and ecological conservation. Transitioning to low carbon energy generates huge emission reductions in conformity with the United Nations Framework Convention on Climate Change whose aim is the maintenance of greenhouse gas to avert meddling with the climate system.

The transition in Nigeria's power sector to a low-carbon economy will promote environmental conservation as a proactive tool for achieving strong, desired economic growth,

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and development by reducing the degradation of the environment. It will promote the integration of the environment into economic decisions, national policies and implementation. Promotion of alternative energy investments such as green transportation systems, clean technologies, and solar-powered buildings (green buildings) to boost Gross Domestic Product and combat energy deficiency, and inadequate power supply, will enhance sustainability by reducing pollution and lower the cost of mitigating the consequences of climate change and it will diminish the need for fossil fuel in Nigeria (Adetuyi and Williams, 2020).

Furthermore, the tax incentive for investment in low carbon energy, simple procedure for obtaining technology permits and investment approvals on low carbon energy utilization projects in Nigeria will discourage unsustainable exploitation of crude oil and other natural resources to a more resilient economic model based on conservation of energy resources. The aim is to promote the common good of, good quality of life through reduction of carbon emissions, promotion of energy efficiency and combating loss of biodiversity (Olujobi & Olusola-Olujobi, 2020d).

The Roles of Technology in Renewables Intensification in Nigeria

The utilisation of renewable energy technologies to satisfy energy needs has increased; however, the flaws are the inability to guarantee renewable energy technologies' availability and affordability to increase Nigeria's power supply. If these abundant renewable energy resources in the country are utilised and supported by the relevant government agencies it will combat the energy crisis in Nigeria through commitment and evolution of new technologies, an energy cost-effective approach and a financing framework to attain this objective. These technologies often have a very insignificant operation and maintenance expenditures. The growth and implementation of these renewable energy technologies will alleviate climate change risks and promote a green society. Hence, occasion decrease in electricity bills and emission release to the ecosystem owing to fossil utilisation. Table 2 shows the roles of renewable energy technology in renewables intensification in Nigeria.

Table 2
THE ROLES OF RENEWABLE ENERGY TECHNOLOGY IN RENEWABLES INTENSIFICATION IN NIGERIA

S/No	Renewable Energy Technologies	Merits	Demerits	Remarks
1.	**Wind Energy**	Wind energy is cost-effectively, sustainable notwithstanding Wind Energy is simple and robust with the durability of over 15 years without any major new investment	The sound effect, attract and death of birds.	It guarantees clean energy and reduction of air pollutants and carbon emissions.
2.	**Biomass Energy**	Organic materials such as wood, animals and plants waste. Eco-friendly source of energy, control of pollution and guarantee a green environment.	Its incapability to guarantee consistency since it is lean on nature.	Biogas can be used to power vehicles and supply electricity to remote villages. Renewable energy sources are perpetual and are abundant in Nigeria which can be harnessed to combat energy crises in the country. Biofuel production from

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				fruits and plants with great potential is yet to gain any commercial value in Nigeria.
3.	**Fuel-Cell Technology**	This is a clean, reliable and sustainable source which can be utilised to meet electricity demand in Nigeria.	The hurdle against this technology is the production of water during operation and its management.	Renewable energy sources can meet the world's energy demand since their potential is extensive.
4.	**Hydropower**	Hydropower It is derived from the movement of water through the gravitational force of flowing water such as a dam or reservoir, penstock pipe, water turbine and generator. When the water spanks the blades of the turbine and revolves the mechanical shaft, which transforms potential energy into mechanical energy that drives a generator at the powerhouse and then generates electricity. It is the cleanest, cheapest and most reliable source of energy. The political will to promote energy security and sustainability is key	Hydro projects are capital intensive due to the large infrastructure involved and often take a longer period between 5-10 years before completion. It multiplies the propensity of earthquakes and other Acts of God.	It provides the balance of energy sources for many renewable energy sources such as solar and wind energy.
5.	**Geothermal Energy**	Geothermal Energy: It is a conversion of heat, and steam to electricity.	It has a slight negative environmental impact with high productivity.	Fossil fuels swiftly depleting renewable energy sources are promising alternatives for a greener and transitioning to low carbon and sustainable future in Nigeria.
6.	**Nuclear Energy**	Nuclear Energy is a modern technology for power generation. It is resilient to global economic circumstances. It offers long-term energy security.	The risks associated with nuclear power accident are very high. It has a harmful long-term impact on human health. The cost of construction is huge	It provides clean and sustainable energy in a long term.
7.	**Solar Energy**	Solar Energy: It is an infinite source of energy. Photovoltaic is a technology that converts sunlight into electrical energy. It is an ecologically clean source of energy that is accessible globally and it does not create any pollution.	High cost of initial acquisition of the photovoltaic system, panels and solar cells. It is based on meteorological conditions and is not financially viable for large-scale usage.	It is most appropriate for inaccessible villages. Where there is no grid power supply.

Stylized Facts

Nigeria is blessed with copious low carbon energy resources for instance hydroelectric, solar, wind, tidal, and biomass, there is a necessity to utilize these resources and design an innovative energy future for the country, hence, the government must make low carbon energy accessible and affordable to all Nigerians. The estimations of potentials of low carbon energy

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deposits for Nigeria are Practically attainable if low-carbon technologies and management opportunities are utilized to add input to domestic growth through the use of renewable energy sources for energy efficiency, fast-tracking the decline in gas flaring and utilization of commercial use of natural gas for sustainable development, improvement in agricultural yields by discouraging deforestation and promotion of fuel-efficient vehicles to make road transportation system economical or cost-effective and cleaner thereby reducing Nigeria's contributions to climate change.

The economic benefits of low carbon energy sources to Nigeria are approximately 2% of the Gross Domestic Product. Affordable electricity supply and substantial diversification of electricity sources in the country savings of 7% or 12 billion USD and climate irrepressible agriculture, efficient transportation services thereby saving fuel, promoting good air quality eliminate congestion and fuel scarcity and shortage (Olawuyi, 2013).

Globally, it combats approximately 2.3 billion tons of carbon dioxide equivalent (CO2e) emissions for approximately more than 25 years and 1.4 billion tons of emission declines are practicable with financial incentives in Nigeria. However, low-carbon energy growth requires constant human capacity development, a stringent energy legal regime and adequate finance to combat the hurdles to transitioning low-carbon energy sources in Nigeria. The Federal Government's sincere financial commitment and strong political will is sine qua non in promoting the smooth seamless transition to low carbon energy sources since carbon technologies are exorbitant (Olawuyi, 2016).

Nigeria lacks a binding legal and regulatory framework to administer and achieve low-carbon energy use for the socio-economic growth of the country.

The development of low carbon energy for rural communities through solar cannot be overemphasized though regrettably there is no specific legal regime for solar energy in Nigeria. But, the Policy Guidelines on Renewable Electricity in the country itemized solar as one of the principal sources of the government's renewable electricity policy and guidelines but weak enforcement due to the absence of the political has been the challenge (Cervigni et al., 2013).

Low level of investments in the low carbon energy industry and most foreign lenders are withdrawing their support for investments in fossil fuels to support clean sources of energy. Table 3 shows the estimations of potentials of low carbon energy deposits in Nigeria.

The estimations of potentials of low carbon energy deposits in Nigeria among others are:

Table 3
THE ESTIMATIONS OF POTENTIALS OF LOW CARBON ENERGY DEPOSITS IN NIGERIA

S/No	Renewables Sources	Estimations of Potentials	Remarks
1.	Large Hydropower	11,250MW3	The potential of hydropower sources of energy deposits in Nigeria has not been adequately utilised to combat the epileptic supply of electricity in the country to enhance energy security and efficiency.
2.	Wind data	2–4ms-1 at 10m height	The capacities of wind sources of energy accumulated in Nigeria have not been effectively used to combat the epileptic supply of electricity in the country to promote economic growth.
3.	Animal Wastes	61million tonnes/year	The capacities of animal waste sources of energy reserves in Nigeria have not been satisfactorily optimised to end the erratic supply of electricity in the country to promote industrial growth.
4.	Small	500MW	The potential of small hydropower sources of energy abundant in Nigeria has

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	Hydropower		not been sufficiently utilised to eliminate the epileptic supply of electricity in Nigeria.
5.	Crop Remainders	83 million tonnes/year	The potentials of crop residues sources of energy deposits in Nigeria have not been adequately utilised to combat the epileptic supply of electricity in the country.
6.	Solar Radiation	3.5–7.0 KWh/m2 – day	The prospects of solar radiation deposits in Nigeria have not been adequately utilised to combat the epileptic supply of electricity in the country.
7.	Fuelwood	13,071,464 hectares	The potential of fuel wood sources of energy deposits in Nigeria has not been adequately utilised to combat the epileptic supply of electricity.

Figure 1 illustrates a hybrid model designed by the study to facilitate the adoption of low-carbon energy as substitute sources of energy in Nigeria.

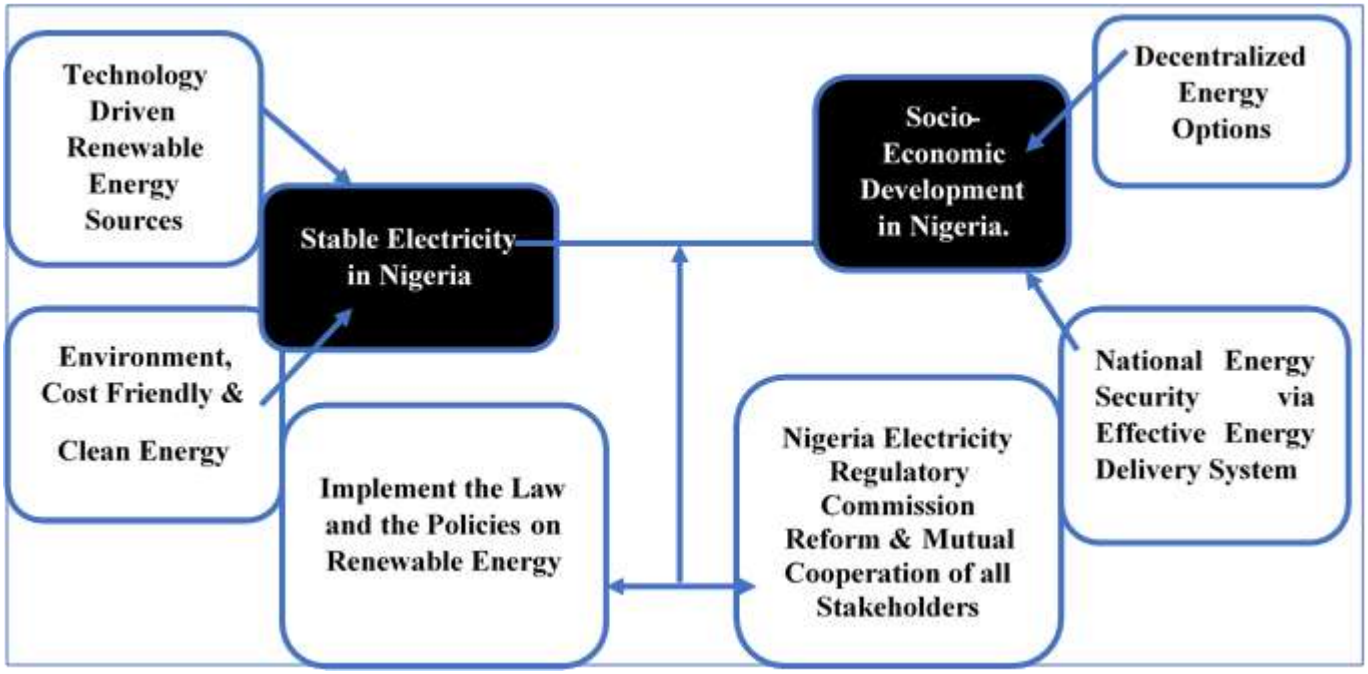

FIGURE 1
HYBRID MODEL DESIGNED TO SIMPLIFY ADOPTION OF LOW CARBON ENERGY AS SUBSTITUTE SOURCES OF ENERGY IN NIGERIA'S POWER SECTOR FOR STABLE ELECTRICITY IN THE COUNTRY

METHODOLOGY

The study utilises a conceptual legal research method and interrogates existing literature on the subject, pertinent legal instruments, the Federal Government's energy strategies in the field of fossil-fuel disruptions, low carbon transition, energy security and findings from research on the subject to recognize the value of the subject from numerous authors' perspectives.

The study utilises the doctrinal legal research approach; the study further utilises primary and secondary sources of legislation such as statutory authorities, textbooks, and peer-reviewed journals. Comparative legal analyses of low carbon energy in China, Spain, Germany and

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Nigeria were carried out to gain useful insights for stable electricity in Nigeria. The justification for using China is the main country with the biggest magnitude of thermal power plants globally with serious derive for low carbon transition. Spain and Germany have been selected as case study countries because they have reliable power systems and Nigeria can gain insight to improve the country's power sector. The justification for using the method was to establish the trustworthiness of the findings on the need for low-carbon energy to guarantee energy security and sustainability in Nigeria. Theories were also utilized as the theoretical lens to guide the study. This approach in legal research is coherent with the law, and it is readily available for verification. The related methodological papers were done by Oke (2013) who asserts Nigeria is vulnerable to the menace of an energy predicament despite Nigeria's enormous energy sources potential. Therefore, the comparative analysis is to offer a synopsis of the policies and institutional structure that are necessary to boost energy efficiency via low carbon energy utilization and to draw lessons from the related initiatives in selected countries to improve Nigeria's electricity challenges. The countries were selected because they have a range of initiatives and encouragements for low carbon energy utilisation to promote socio-economic development needs which Nigeria can adopt an insight from to enhance its laws, energy policies and strategies. The study designs a hybrid model to facilitate the successful exploitation of low-carbon energy sources for uninterrupted electricity. Besides, there has been scarce research on the legal response to low carbon transition in the country's power sector to the best of the current author's knowledge the authors filled the gap as its contribution to knowledge.

Further test was conducted for non-stationary series at levels to obtain a trend stationary series at first difference. The next stage is accompanied with the establishment of a long-run relationship among the variables in the carbon emission model. In this case the bound test estimation approach was applied through the F-bound critical values. An F-bound test below the lower Psarian critical bound indicates no co integration while the value of F-bound statistic above the upper bound implies the presence of a co integrating relationship among the model series. F-bound statistics above the lower boundary but less than upper boundary suggests an inconclusive result.

Given the PP result with order of stationary consisting of levels and first difference, the study thus proceeded to employ the autoregressive distributed lag model (ARDL) technique to analyse the nature of the relationship between carbon emission and its determinants in the model. The choice of the ARDL model is also informed by its ability to predict both the short-run and the long-run model coefficients. It also offers us opportunity to examine the systemic mechanism of adjustment from the short-run to the long-run stable state through the error correction model. All the data were secondary data sourced from World Bank data base i.e. World Development Indicator (Bazzocchi et al., 2021).

Model Specification

The economic model estimated in this study is expressed as carbon emission as a functions as electric power generation and consumption. It is econometrically represented as;

$$CO2EH = f\left(EPH,\ EPC, EPNG\right) \tag{1}$$

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Equation (1) is further explicitly specified as;

$$CO_2EH = \beta_0 + \beta_1 EPH + \beta_2 EPC + \beta_3 EPNG + \mu_t \quad (2)$$

Where: CO_2EH is carbon emission from electricity and heat production.

EPH is electricity production from hydro sources.

EPC is electricity consumption.

EPNG is electricity production from natural gas.

β_0 is the constant term.

β_1, β_2 & β_3 are the model parameters.

μ_t is the error term.

RESULT

The method of data analysis begins with the test for the ascertaining of the data properties and the extent at which they are valid for the study. In this case the Phillips (1987) test was conducted for the series at intercept and trend. The results of the stationarity test at level and first difference are presented in Table 4 which shows Phillip-Perron Stationarity Test.

TABLE 4
PHILLIP-PERRON STATIONARITY TEST

Variables	Unit-root Test (Intercept + Linear Trend)			
	@Levels	Remark	@First difference	Remark
CO_2EH	-3.9208**	Stationary	----------	Not Applicable
EPH	-13.8892***	Stationary	----------	Not Applicable
EPC	-3.1667	Non-stationary	-11.2754***	Stationary
EPNG	-3.0324	Non-stationary	-8.3649***	Stationary
Note: *** and ** denotes statistically significant at 1% and 5% levels.				

Source: Researcher's computation, (2022).

The result of the unit root test shows two of the variables (CO_2EH & EPH) were stationary at levels while two (EPC & EPNG) were non-stationary. Hence the non-stationary variables were tested at first difference to attain a stationary state. The evidence from the Phillips (PP) test shows that the data characteristics comprise of series stationary and both level and difference. This also informed the use of bound test for the co integration procedure. The Table 5 shows bound co integration test:

TABLE 5
BOUND CO INTEGRATION TEST

Test Statistic	Value	Significance	I(0)	I(1)
F-Statistic	6.4771	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
I(0) denotes lower bound co integration level				
I(1) denotes upper bound co integration level while k connotes number of parameters (4) less 1				

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Source; Researcher's computation, 2022

The F-bound test for co integration result (Table 5) indicates a test statistic (6.477; P-value<0.01) greater than the lower (3.65; P-value=0.01) and upper bound (4.66=0.01) values at 1 percent level of significance. This implies the existence of a long-run relationship among the study variables. This leads us to the rejection of the F-bounds test null hypothesis of no levels relationship. Hence, we can infer there is an indication of co integrating series involving carbon emission, electric power generation and consumption in Nigeria.

Having established the presence of a long-run relationship in the estimation of the carbon emission model. The study proceeds to examine the nature of the long run and short-run relationship among the variables of the estimated model. The nature of the convergence or divergence of the system was investigated with the use of the error correction model. Table 6 shows ARDL Dynamic Model Result:

Table 6
ARDL DYNAMIC MODEL RESULT

Variable	Coefficient	Standard error	T-statistic	P-value
(CO2EH(-1))	0.5076	0.1911	2.6568	0.0151
(CO2EH(-2))	-0.2239	0.1541	-1.4523	0.1619
EPH	-0.4572	0.1335	-3.4241	0.0027
EPH(-1)	0.3185	0.1543	2.0640	0.0522
EPH(-2)	0.1606	0.1552	1.0351	0.3130
EPH(-3)	0.0649	0.1465	0.4427	0.6628
EPH(-4)	-0.2198	0.1098	-2.0014	0.0591
EPC	0.0617	0.0287	2.1487	0.0441
EPC(-1))	-0.1038	0.0297	-3.4879	0.0023
EPC(-2)	0.0802	0.0291	2.7544	0.0122
EPC(-3)	-0.0035	0.0304	-0.1137	0.9106
EPC(-4)	0.0704	0.0282	2.4927	0.0216
EPNG	-0.0654	0.0640	-1.0218	0.3191
EPNG(-1)	0.1680	0.0811	2.0725	0.0514
EPNG(-2)	-0.0395	0.0849	-0.4656	0.6465
EPNG(-3)	-0.0220	0.0821	-0.2682	0.7913
EPNG(-4)	-0.1447	0.0794	-1.8226	0.0834
C	22.3796	5.4584	4.1001	0.0006
R-square	0.9526			
Adjusted R-squared	0.9124			
Durbin-Watson statistic	2.273			

Source: Researcher's computation, 2022

The auto-regressive distributed result (Table 6) shows a significant cumulative direct impact carbon emission ((0.5076; P-value<0.01) on the current year emission. Essentially, it is observed that electricity power generated from hydro carbon sources (-0.4572; P-value<0.01) significantly reduced carbon emission by 0.48 percent at 1 percent level. This suggests that increased utilization of hydro-electric power supply plays a significant role in the reduction of CO_2 emission, environmental pollution and degradation of the eco-system.

The analysis of the dynamic relationship between hydro-electricity generation and carbon emission shows that hydro-electric power could positively and significantly influence carbon

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emission (0.3185; P-value<0.1) though at lag1 but not significant at higher lags (2, 3). The highest lag (4) effect at 10 percent level (-0.220; P-value <0.1) further confirmed the current year effect of significant reduction in CO_2 emission as a result of increased utilization of low-carbon generated power supply.

Conversely, electricity power consumption (0.0617; P-value<0.05) had significant positive relationship with carbon-emission. It is observed that though there was a significant carbon reduction in electricity consumption at the first lag (-0.1038; P-value<0.01), it was not significant at the third lag. Also, the reduced carbon emission was not sustained in the preceded lag periods. The analysis of electricity consumption result at the second (0.0802; P-value<0.05) and forth lag (0.0704; P-value<0.05) shows a significant contemporaneous rise in carbon emission due to increases in electric power consumption.

Although electricity generation from natural gas at current period suggests a reduced contribution to the carbon emission, however it is not statistically significant. This therefore suggests the need for intensified effort the low-carbon energy generation and increase in awareness creation among the citizenry. Further evidence from the dynamic estimates shows a cumulative insignificant negative influence of electricity production from natural gas sources with the exception of the initial lag (1) indicating a positive (0.168; P-value<0.1) contribution to CO_2 emission at 5 percent significance level.

The model explanatory strength at 95.26 percent and significance (F-statistic=23.66; P-value<0.01) attest to its overall goodness of fit and validity of the empirical evidences. The Durnbn Watson (DW=2.27) indicates no incidence of serial autocorrelation. Table 7 shows ARDL Levels Equation Result:

Table 7
ARDL LEVELS EQUATION RESULT

Variable	Coefficient	Standard error	T-statistic	P-value
EPH	-0.1857	0.1379	-1.3466	0.1932
EPC	0.1467	0.0319	4.6023	0.0002
EPNG	-0.1446	0.0861	-1.6807	0.1084
C	31.2463	8.5990	3.6337	0.0017

Source: Researcher's computation 2022

The analysis of the levels equation result (Table 7) shows that electricity production from hydro carbon sources could potentially lead to low-carbon emission but has not been fully explored and hence apparently insignificant in the long-run. However, electric power consumption accounted for a significant contribution (0.1467; P-value<0.01) to the increase in Co_2 emission at 1 percent significance level. This shows that increases in electricity consumption leads to a corresponding increase in carbon emission into the environment resulting to increase incidence of air pollution. The implication of this result is that it invariably explains the inadequate utilization of low carbon energy generation sources.

Thus, accounting for the significant increase in carbon emission associated with the rise in electric power consumption. The estimated coefficient of electricity production from natural gas sources supports evidence of the potentials of low-carbon energy sources (-0.1446; P-value 0.108) in the reduction of CO_2 emission in the long-run. Table 8 shows Short-run Estimates:

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Table 8
SHORT-RUN ESTIMATES

Variable	Coefficient	Standard error	T-statistic	P-value
Δ(CO2EH(-1))	0.2239	0.1295	1.7283	0.0993
Δ(EPH)	-0.4572	0.1003	-4.5572	0.0002
Δ(EPH(-1))	-0.0057	0.1019	-0.0560	0.9559
Δ(EPH(-2))	0.1549	0.0874	1.7729	0.0915
Δ(EPH(-3))	0.2198	0.0935	2.3511	0.0291
Δ(EPC)	-0.0617	0.0191	3.2239	0.0043
Δ(EPC(-1))	-0.1472	0.0276	-5.3408	0.0000
Δ(EPC(-2))	-0.067	0.0289	-2.3126	0.0315
Δ(EPC(-3))	-0.0704	0.0229	-3.0803	0.0059
Δ(EPNG)	-0.0654	0.0529	-1.2370	0.2304
Δ(EPNG(-1))	0.2062	0.0558	3.6942	0.0014
Δ(EPNG(-2))	0.1667	0.0572	2.9161	0.0085
Δ(EPNG(-3))	0.1447	0.0578	2.5026	0.0211
CointEq(-1)*	-0.7162	0.1149	-6.2340	0.0000
R-square	0.8035			
Adjusted R-squared	0.6971			
Durbin-Watson statistic	2.273			
CointEq(-1)* is the error correction term				

Source: Researcher's computation 2022.

The previous periods CO_2 emission from hydro carbons (0.2239; P-value <0.1) contributed to the increase in current year level of carbon emitted into the atmosphere though at 10 percent significance level. The short-run model analysis (Table 8) further corresponds with the long run result which shows that electricity power generation from hydro-carbons reduced carbon-emission by -0.4572 percent at a higher level of precision with minimum allowance for error margin of 1 percent after a thousand iterations. The contemporaneous impact at lags2 (0.2198; P-value<0.05) shows that though power generation in the short run could contribute to carbo-emission, it is at a decreasing rate. Electric power consumption in the short-run supports the long-run evidence (0.06166; P-value<0.05) at a higher precision and margin error of 1 percent after 100 iterations.

The dynamic effect of electric power consumption at lags (1 & 3) shows a contemporaneously reduced CO_2 emission at 1 percent and 5 percent significance level at lag 2. This illustrates the introduction of low-carbon energy sources and short-run impact of fusile fuel substitution with alternative sources of energy consumption through hydro-carbons and natural gas. Detailed analysis of natural gas lags (1, 2 & 3) effect shows a declining positive effect on CO_2 emission.

This implies that though natural gas energy production has not been significantly explored in both the short-run and long run results, its short-run dynamic estimates indicate an instantaneous significant cumulative positive lag impact on carbon- emission at a declining marginal influence.

The error correction model (-0.7162) shows that 0.72 percent of the errors associated with the short-run adjustment process will be corrected in the long-run per annum. This reveals moderately high speed of convergence of the system and its ability to revert to an equilibrium state in the case external shocks. The R-squared (0.8035) and the Durbin Watson statistic (2.27)

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support the model high explanatory power at 80.35 percent and the absence of serial autocorrelation in the systemic relations of the model estimates.

The findings from the study shows that energy production from hydro-electric accounted for the predominant influence on reduced carbon emission in Nigeria. furher insight from the findings shows that hydro-electric sources accounted for a significant 0.467 percent decline in hydro electricty within the scope of the present study. Evidnce from the estimated score for eclectric power consumpption shows that a unit increase in power utilization significantly increases carbon emission by 0.062. The result from energy coonsumption is an indication that there exist a significant positive relationshi between electricty utilization and increased carbon emission in the country.

This implies that an increase in consumption of electric power will result to a c oresponding increase in CO_2 released into the environment though in less than proportionate measure. The finding revealed that it will involve a lag of time before elecctric power consumption could have a declining impact on carbon-emission. Hence, this result is also germane in the case of policy implementation strategy on reduction of CO_2 emission through energy consumption approach.

Power generation from natural gas in its present state appearently exhibits the potential of curbing carbon emission but not currently significant. However, its dynamic estimate provides evidence of a positive significant contributory impact on increased carbon emission in the immediate past period. This shows there is prospects for significant reduction in carbon emission with increase in exploration of alternate sources of low-carbon energy such as increased usage of natural gas against fosile fuel consumption. Table 9 shows diagnostic checks:

Table 9
DIAGNOSTIC CHECKS

Checks	Results
Serial Correlation LM test [P-value]	0.856[0.4415]
Heteroscedasticity [P-value]	0.574769[0.8734]
Ramsey RESET test [P-value]	1.423[0.2475]
Normality-JB test [P-value]	4.5808[0.1012]
CUSUM Stability test (5%)	Stable
P-values are in square brackets	

Source: Researcher's computation 2022.

The ARDL model diagnostic tests (Table 9) were conducted with Jarque-Bera (4.581; P-value=0.1012) which supports the normality of the residual series. The Breusch-Godfrey serial correlation LM test (F-statistic 0.8560; P-value=0.4415) indicates no serially correlated estimates with the error terms. Breusch-Pagan Godfrey heteroskedasticity test (F-statistic (0.5748; P-value=0.8734) indicates a homoscedastic residual series confirming that the constant error variance assumption is met in this study. The Ramsey RESET test of shows the ARDL carbon-emission model was adequately specified while cumulative sum of residual and the cumulative sum of square residuals a (Figure 2) provides evidence of the structural stability of the estimated CO_2 emission model at 5 percent level of significance. This result lends credence to the reliability of the model result for sustainable policy implications from the findings.

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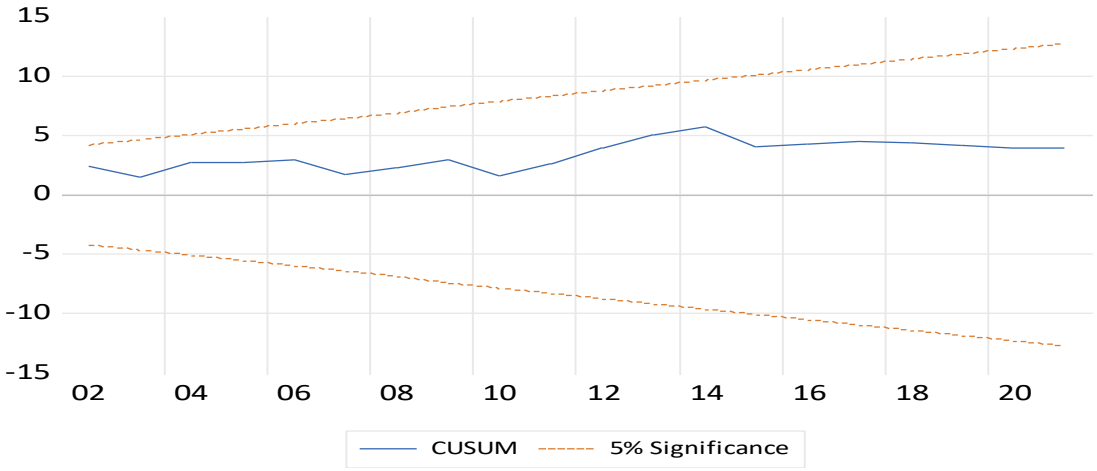

FIGURE 2
CUMULATIVE SUM OF RESIDUALS

Figure 3 shows the rates of the cumulative sum of residual squared in the study.

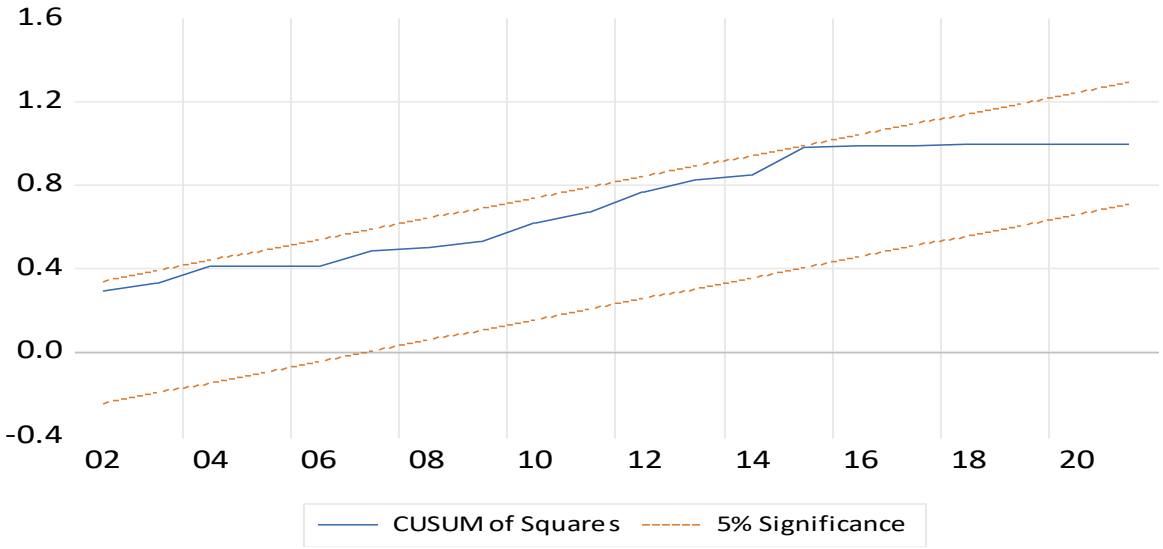

FIGURE 3
CUMULATIVE SUM OF RESIDUAL SQUARED

DISCUSSION

This study empirically investigated the effect of energy generation sources and utilization on carbo emission to the environment employing a dynamic estimation procedure involving autoregressive distributed lag model. The analysis of the model result shows that low-carbon energy generating sources exerted a significant negative impact on the reduction of carbon emission into the ecosystem in both the short-run and long-run model estimated parameters. In-depth analysis of the study result indicates that electricity generated from hydro-powered sources

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accounted for the higher contribution to the reduction in carbon emission. The study findings lend more credence to whose study stressed that low-carbon energy enhances energy efficiency and promotes sustainable economic development through the affordability and availability of cleaner energy to the masses in order to mitigate greenhouse gas emission, reduce dangerous air pollution while supplementing safe energy measure and stakeholders' engagement (Joshua et al., 2020).

This implies that legal policy frame work that advocates and promotes effective renewable sources of power generation is highly emphasized in this study. More evidence emanating from this study points to the fact that electricity power production from natural gas is negative but insignificant in explaining the variations in CO_2 emission. The study result stresses the need for the establishment and promulgation of effective policy framework that will exploration renewable low-carbon energy generating as alternative sources of electric power in Nigeria.

Thus, the position Akinbami (2001) is reaffirmed by the findings of the current study that there abounds poor public responsiveness on the potentials of low-carbon energy and higher risks orientations for projects associated with low-carbon emission prospects. The findings hitherto portray gaps in the drive, commitment and dedication by the government in exploring strategies for the transition to low carbon energy technological advancement in the country (Somefun, 2015). It is pertinent that a renewed concerted effort should be given toward exploring laudable means of energy generation that do not compromise environmental sustainability leading to distortions of the functioning of the ecosystem.

In the context of existing research, the study finding reflects the lack of adherence to constitutional provision on the execution of ecological effect appraisal for carbon energy projects or plant that are liable to exhibit a substantial negative effect on the environment before the issuance of approval (Mulyana, 2016). These reasons for these lapses could be attributed to the inability of the concerned authority and agencies to monitor and assess the level of compliance of energy firms to this constitutional provision which is also aided by corruption.

The study does not provide all answers to the challenges to legal response to low carbon transition in Nigeria's power sector. However, it has provided insight into a seamless transition to low-carbon energy in Nigeria's power sector. Future research can also improve on this study by focusing on the panel data approach from the empirical view of the topic, to further improve the transition to low carbon energy in the country's power industry to combat the epileptic supply of electricity in Nigeria. The significant low-carbon energy prospects for future research have been categorically indicated.

Some secondary data sources create huge hurdles in condensing precise data due to inaccurate statistics or paucity of data on the fossil-fuel disruptions and low carbon transition: Legal responses to energy security and sustainability in Nigeria's Power Sector: Conversely, this study judiciously utilizes pertinent available data, literature and other dependable information sources.

CONCLUSION

In Nigeria electricity consumption and demand continue to upsurge. Consequently, further vigorous growth of the country's power sector is inevitable. As low carbon energy use is significant for the accomplishment of sustainable growth and climate stabilisation. Nigeria will

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benefit from the low carbon energy interventions it will decrease the local air contamination, and combat greenhouse gas discharges in the country. Many fundamentals that are indispensable and appropriately to address the transition to a sustainable energy future have been evaluated such as full exploitation and support for low carbon energy resources, energy security systems, in addition to the usage of energy preservation procedures in the industry. The current energy policy is not appropriate for ecological friendly low carbon energy development in the country. Substantially, low carbon energy growths are not backed by any lawfully enforceable instrument, spelling out the sanctions for non-compliance with low carbon energy generation and utilization for electricity supply.

Internationally, numerous nations are transitioning to cleaner sources of energy. Equally, multinational oil firms are changing their attention to low carbon energy sources which are environmentally friendly energy sources Nigeria cannot afford to lag to end the epileptic supply of electricity in Nigeria. The Federal Government must enact a comprehensive law on low carbon energy sources and utilization in compliance with its international obligation of Decarbonisation called Net Zero in the year 2030. Future research should focus on the potential of investments in low-carbon energy sources in Africa.

The future direction for the energy transition in Nigeria's power sector is to guarantee energy security and sustainability in Nigeria's power sector. It is recommended that Nigeria should do the following: Introduction of an inclusive energy transition, investment in renewable energy sources, decentralization of the energy sector, and licensing more new energy industries related to renewable energy and nuclear energy to contribute to the transformation of the energy sector. Reduction of the citizen's perception of energy poverty in Nigeria by strengthening the energy regulatory authorities to increase public awareness on low carbon transition, zero-emission public transport and houses to promote energy security and sustainability. Reduction of CO2 emissions via the transformation of energy generation capacity and diversification of the energy generation structure.

To improve the supply of contemporary reasonable energy services to Nigerians while, concurrently, preserving ecological integrity and social harmony. Furthermore, an advantageous fusion of energy sources such as hydrocarbon and low carbon energy sources for efficiency should be obligatory to sustain the rising request for alternative energy in Nigeria. Low carbon energy high-tech growth, devolved non-grid networks, diverse energy-supply systems, and provision of reasonably priced and accessible energy services that are environmentally friendly are crucial to meeting Nigeria's energy demands.

The Nigerian Electricity Regulatory Commission must regulate the operations of all licensees in the energy market and guarantee that all procedures and policies are implemented in an impartial, translucent and fair manner. It is also vital to regulate and overhaul the pertinent legal and administrative policies regulating the use of low carbon energy sources, as well as creating a serious dedication to developing and implementing codes and laws for low carbon energy know-how utilization. The provision of fiscal incentives can curb financial hurdles to the use of low carbon energy sources, tax waiver on exported low carbon energy equipment, incomes generated, and import duty/excise duty concession, to enhance energy security and stability in Nigeria.

To achieve sustainable energy in the power sector, it is recommended that Nigeria should do the following: To improve the supply of contemporary reasonable energy services to

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Nigerians while, concurrently, preserving ecological integrity and social harmony. Furthermore, an advantageous fusion of energy sources such as hydrocarbon and low carbon energy sources for efficiency should be obligatory to sustain the rising request for alternative energy in Nigeria. Low carbon energy high-tech growth, devolved non-grid networks, diverse energy-supply systems, and provision of reasonably priced and accessible energy services that are environmentally friendly are crucial to meeting Nigeria's energy demands.

There is a need for a holistic approach toward decentralization of the energy structure governance with the multiplication of the means of energy production to secure sustainable energy utilization, energy availability and affordability of energy in the country. Grid-based low carbon electricity is vital in boosting the growth and utilization of electricity, through the broadening of sources of electricity supplies to strengthen energy security, expand electricity access and improve the environment by formulating policies on clean energy and harmonies them into the existing energy strategies.

An inclusive energy strategy is indispensable in regulating Nigerians' cost-effective utilization of low-carbon energy resources. Create consciousness on low carbon energy utilization and energy proficiency through the utilization of biofuels as a transport fuel in the country and the development of the liquid fuels and natural gas markets in Nigeria.

The primary responsibility of the Federal Government in promoting fossil-fuel disruptions and low carbon transition, legal responses to energy security and sustainability in Nigeria's power sector is the development of human resources in the energy sector through continuous training of regulatory staff, energy infrastructure development by replacing the archaic ones with sophisticated equipment, incentives and legal supports for the local energy industry, strengthening the power sector regulatory authorities and continuous public sensitization and awareness on the merits of low carbon energy transition and on the consequences of climate change to promote energy security, sustainability, economic competitiveness and energy efficiency. Development and promotion of renewable energy sources, the development of competitive fuel and energy markets and diversification of electricity generation arrangements have a limited environmental impact on future directions for the transformation of Nigeria's power sector.

The Nigerian Electricity Regulatory Commission must regulate the operations of all licensees in the energy market and guarantee that all procedures and policies are implemented in an impartial, translucent and fair manner. It is also vital to regulate and overhaul the pertinent legal and administrative policies regulating the use of low carbon energy sources, as well as creating a serious dedication to developing and implementing codes and laws for low carbon energy know-how utilization. The provision of fiscal incentives can curb financial hurdles to the use of low carbon energy sources, tax waiver on exported low carbon energy equipment, incomes generated, and import duty/excise duty concession, to enhance energy security and stability in Nigeria.

Promotion of quality energy research and development via investments in energy storage technologies, smart metering devices and energy conservation and management systems, electro mobility and substitute for fossil fuels and hydrogen technologies usage in Nigeria.

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LIMITATIONS

The exclusive dependence on existing literature to investigate the study due to insecurity in Nigeria. However, this study judiciously utilizes pertinent literature and other dependable information sources. An additional hurdle impedes obtaining access to information, which influences the effectiveness of individual meetings of many energy firms due to the prevalence of COVID-19 and its protocol that mandated social distancing and avoidance of public gatherings in the absence of a face shield or mask and due to the prevalence of insecurity in the country.

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