

THE LEGAL REGIME ON RENEWABLE ENERGY AS ALTERNATIVE SOURCES OF ENERGY IN NIGERIA'S POWER SECTOR: THE IMPACTS AND THE POTENTIALS

Olujobi Olusola Joshua, Covenant University
Olujobi Oluwatosin Michael, University of Lagos
Daniel E. Ufua, Covenant University

ABSTRACT

Background/Aim: *Fossil fuel has been the mainstream of energy supply and a major source of foreign exchange earnings of the Federal Government of Nigeria, despite being an un-renewable and unsustainable source of energy which has led to emission of greenhouse gases which are unsustainable in Nigeria's power sector. There is severe challenge of power irregularity over the years such that most industrial organizations and upper income family circles install exorbitant electricity generators set due to incessant power outage in the country.*

Methods/Materials: *The study adopts a doctrinal legal research with library based legal research method with comparative legal approach. The study reveals that lack of coherent legal framework with incentives for utilization of renewable energy is the key factor causing slow utilization of renewable energy as alternative source of energy in Nigeria.*

Results: *The country is yet to tap into the full benefits of renewable energies after privatization of its power sector inspite of the new global evolvement in energy sector and the growing demands for renewable energy sources, which is cheaper, environmentally friendly compared to fossil fuel and its allied products. Energy security has been a challenge to social economic development due to over dependency on fossil fuel despite the obvious indicators that fossil fuel will soon become an alternative forgone in the power sector as energy has evolved from meeting household needs and industrial demands to preserving energy sources for longevity and sustainability. This would apparently have some implications for Nigeria's oil sector due to the current global dwindling in crude oil price. This development has led to the formulation of new energy policy around the world to serve as a vehicle for translating this to reality. The study evaluated resource curse and sustainable development theories due to their impacts on renewable energy in Nigeria's power sector. The aim of the study is to end the concern for poor energy utilization to promote energy efficiency and sustainability.*

Conclusions/Recommendations: *the study recommends among other reforms, the need for coherent legal framework on renewable energy and advocates stringent enforcement of energy regulatory policies with incentives for utilization of renewable energy sources in Nigeria.*

Keywords: Renewable Energy, Fossil Fuel, Energy Sustainability, Nigeria.

JEL Classifications: Q4, Q5, K32, K12, K2, P28, K42.

INTRODUCTION

Fossil fuel has remained the mainstream of energy supply across the globe due to high level of dependency of many countries on fossil fuel as their major sources of energy and foreign exchange earnings with the corresponding oil booms. Fossil fuel usage has led to emission of greenhouse gases which are unsustainable globally (Oniemola & Sanusi, 2009). Consequently, the environment is under threat by crude oil explorations, exploitations and the usage of oil and thus, there is gradual warming up of the earth's atmosphere and depletion of the ozone layer resulting from increased in greenhouse gases emitted into the air.

Also, man, the flora and the fauna have suffered greatly due to environmental pollution and degradation resulting from the incidence of oil exploration activities in Niger Delta Areas of Nigeria (Olujobi et al., 2018). Hence, there is the need for new energy policy that will promote renewable energy in the country. Therefore, the power sector beyond privatization requires some operational and regulatory restructuring for sustainable, ecological and community friendly energy legal regime in Nigeria. There are many quantities of renewable energy sources available in Nigeria. The distribution of these renewable sources of energy is as follow: Nigeria is squarely located in the tropics, with its land mass stretching between latitudes 5 degree south and 15 degree north of the equator. The country enjoys abundant sunshine especially in the northern part of Nigeria where energy can generate about 1850×10^3 GWh/yr of solar electricity which is above the current grid of electricity consumption in Nigeria. This will give room for effective use of solar energy. Biomass is renewable low carbon fuel that is widely available in all part of Nigeria and it will ensure uninterrupted electricity supply to rural areas but there is no coherent legal framework on renewable energy yet in Nigeria.

However, the Federal Government of Nigeria has enormous reserve of natural resources for alternative energy production such as fruitful arable land, favourable climatic conditions that is rich in feedstock production such as sugarcane, cassava, palm oil, maize among others.

The energy policy is the plan of action or statement of ideals proposed or adopted by the Federal Government on the sources, nature, availability of fuel and other alternative resources used for operating machinery. The new energy policy allows the various governments to depart from the use of fossil fuel such as coal, oil and natural gas to embrace alternative sources such as renewable energy resources. Renewable energy sources include: biomass, solar, wind, hydro-power, geothermal, biofuels, among others (Figures 1 & 2). They are obtained from non-fossil and non-nuclear resources in modes that can be restocked, they are ecological friendly (Oke, 2013).

This new energy policy is a global phenomenon and it is the solution to one of the most difficult problems combating Nigeria and the world currently by generating energy or power without accelerating climate change, damaging the environment or harming food production at any rate. According to the view of Jurgen Tritten the former Germany's Federal Environmental Minister who opined that the utilization and growth of renewable energies is a situation where all stakeholders will benefit in one way or other including the advanced climes and the emerging countries. Renewable energy preserves the environment, it eradicates impecuniousness and it promotes new technologies and creates job opportunities in the energy sector (Oke, 2013).

Also, the utilization of renewable energy is in conformity with the World Summit on Sustainable Development resolutions convened in Johannesburg, South Africa in 2002 where, over 30 nations declared their obligations in boosting renewable energy sources usage and in positioning their energy agenda in accomplishing this objective (Doran, 2002).

As a result, many countries such as Israel, China, Germany, Chile, Spain and Denmark have embarked on a paradigm shift to new energy policy on renewable energy. For instance, Brazil has demonstrated an unalloyed commitment to the growth of renewable energy through the enactment of contemporary Hydropower policy, the Biodiesel Policy and the Ethanol Policy. The new energy policy envisaged by the former United States of America President, Barack Obama (2004) seeks to harness other alternative sources of energy which is believed to be cheaper and more environmentally friendly than crude oil and its allied products. Thus, the United States through her “*New energy economy*” seeks to put her citizens to conceive clean energy investments opportunities, intensifying efforts on fuel efficiency in automobiles and lessening greenhouse gas emission by ensuring that at least 25% of the nation’s energy originates from renewable resources such as wind, solar, and geothermal (Lukman, 2009).

The United Kingdom in 1990-2004 multiplied the electricity it generated from renewable energy in 12-folds. Kenya generates about 923 MW geothermal energy using solar and wind energy for electricity in 2010. The 2012 Kenyan Energy Regulations made installation of solar water heaters compulsory in all buildings especially where more than 100 liters of water are consumed per day. Successful integration of renewable energy into these countries’ energy systems was possible through stringent and coherent enforcement of their energy legal framework (Olujobi, 2017).

The International Energy Agency offered two instances in its world energy viewpoint on how policies can shape international energy market, energy precautions and other energy-interrelated concerns. Firstly, how international energy markets would improve in the dearth of innovative governmental strategies on energy sectors and secondly, international energy markets without innovative governmental policies on energy development and utilization.

Renewable energy is one of the means of decentralized energy sector in Nigeria and to optimize the benefits of renewable energy in the country, it requires proper planning with definitive legal regime on renewable energy to encourage investments in the sector.

The history and development of electricity regulation in Nigeria has been regressive in terms of effectiveness of legal, policy and institutional legal framework that will bring effective administration of power in Nigeria. The defunct National Electric Power Authority (NEPA) roles on generation, transmission and distribution of electricity in Nigeria has been abysmally poor, unstable and unreliable as plethora of law and policy enacted seem incapable of solving the challenges in the power sector. As the current legal regime under the Electric Power Sector Reform Act 2005 introduced, the Power Holding Company of Nigeria (PHCN) which was unbundled into 18 companies as part of the reform processes of the sector but this has not crystallized to stable electricity supply in Nigeria, hence the need for renewable energy to complement the existing sources of energy in Nigeria power sector.

Hence, in this paper, we shall, by way of introduction, highlight an overview of the new energy policy. This shall be followed by a cursory look into the various alternative renewable sources of energy. Next shall be the outline of the attractions held by the renewable energy. Then, we shall look at the new energy policy in Nigeria. Thereafter, we shall fathom the implications of the new energy policy for the petroleum sector in Nigeria, carry out brief comparative analysis of legal framework on renewable energy in some selected countries and from there, we shall draw our conclusion and proffer our recommendations for energy sufficiency and sustainability in Nigeria.



Source: Oyedepo et al. (2018)

FIGURE 1
MAP OF NIGERIA SHOWING GEOGRAPHIC DISTRIBUTION OF NIGERIA'S
PORTFOLIO OF ENERGY SOURCES



FIGURE 2
RENEWABLE ENERGY SOURCES

LITERATURE REVIEW

Several researchers from legal perspective have written on the need for renewable energy in Nigeria but none has considered the potentials and the impacts of renewable energy in the country and the need for strict adherence to the new energy policy. Also, Omorogbe (2008) considered legal framework on renewable energy as a necessity for national development and for the sustainability of the Nigeria's energy sector. On the comparisons between renewable energy and the conventional energy sources, (Ajomo, 2001 and Sagay, 2005) drew the attention of the Federal Government's regulatory authorities on the complex nature of petroleum resources ownership and governance in Nigeria that is solely vested in the Federal Government which has hindered active investments on electricity supply to the rural dwellers in Nigeria. There is the need for all governments at all levels to be allowed to participate in electricity generations and

distributions through the amendment of the extant energy policies and laws. We opined that the work on the role of renewable energy and its social economic and environmental impacts were not thoroughly discussed by these studies. These various scholars appreciated the importance of renewable energy but the papers fail to formulate a model legal framework suitable for combating Nigeria's distinctive energy challenges.

According to (Oke 2016) in his work on "*Essay on Nigerian Electricity Law*" observed that the major problem with the regulatory and governance framework in Nigeria is over centralization of the management, responsibilities and administrative structures of the power sector rather than being decentralized which has helped many countries to overcome electricity challenges through off-grid renewable electricity generation, transmission, distribution for rapid rural electrification for social, economic development and for sound electricity governance in Nigeria.

Also, according to Oniemola & Sanusi (2009), he argued that renewable energy benefits are more than its environmental and social impacts. The present study opined that there is the need for enactment of legal framework with incentive for utilization of renewable energy as alternative sources of energy to encourage investors in the sector. Also, identified the need for coherent policy development and implementation on renewable energy to promote energy security and efficiency. Oyedepo (2012) in his work opined that energy security is the corner stone upon which every advanced economy is structured but the present study submit that affordability is the major concern due to persistent energy insecurity and inefficiency endured by energy users in Nigeria due to high tariff handed down through estimated billings therefore, there is the need for stringent control through the instrument of laws to prevent corruption and exploitation in the sector.

METHODOLOGY

The objective of this study is to implement the new energy policy that has been embraced by several countries in the world to promote energy security and sufficiency. The Federal Government of Nigeria must depart from the use of fossil fuel and embrace alternative source such as renewable energy resources to prevent depletion of the ozone layer resulting to increase in greenhouse gases emitted into the air. Similarly, man, the flora and the fauna have suffered greatly due to environmental pollution and degradation resulting from the incidence of oil exploration activities in Niger Delta Areas, Nigeria.

To achieve this laudable objective, the researchers explore the library-based doctrinal legal research technique, substantiated by an appropriate legal analysis, comprising citation from internet sources, comprehensive assessment of systematic academic literature, evaluation of case studies and the analysis of significant judicial and statutory provisions. Comparative analysis of the legal framework for promoting renewable energy in China, Spain, Germany and India among others was considered. The study adopt secondary sources, such as journals, textbooks and primary sources, such as case laws with some unstructured interviews with some energy consumers and regulatory bodies in the sector to gain useful insights to suggest the need to use the lessons learnt to enact regulatory policy and legal framework on renewable energy to guarantee energy sufficiency and security in Nigeria. The study is also supplemented with the various policies and reports on energy in Nigeria with some unstructured interviews with some energy companies, consumers and regulatory bodies in the sector. These were used to gain useful insights to propose reform of Nigeria's electricity laws on renewable energy utilization.

Statement of Research Problems

The Federal Government of Nigeria has no coherent legal framework for renewable energy. Policies on energy are scattered and are incoherent in Nigeria legal framework. The demands for electricity outweigh supply and this has affected social and economic development in the country in the areas of poverty alleviation, industrial productivities, electricity consumer welfare, human health through smoke inhalation from indoor cooking and the use of electricity generator sets to generate power. If this problem is addressed, it will have the potential to mitigate climate change effects and to protect Nigeria's petroleum resources for sustainability (Oke, 2013).

Several countries in the world such as China, India and Germany among others are major leaders in renewable energy development and usage. The countries have enacted their legal framework on renewable energy use and development. Contrarily, the Federal Government of Nigeria which is yet to enact a coherent legal framework on renewable energy. The existing policies on renewable energy are scattered in various policy documents which are incoherent and narrow in scopes.

Also, ineffective and erratic power supply structure in Nigeria, have occasioned losses of more than 30% of the entire energy generated. In addition to these inadequacies, the consistency and availability of current installed electricity production system is very low. There is severe challenge of power irregularity over the years such that most industrial organizations and upper income family circles install exorbitant electricity generators set that cost over half of the total installed grid capacity. This constitutes colossal economic shortfalls to the Nigerian economy. The principal elements causing irregularity and inefficiency in the power sector inter alia are: consistent breakdown of generating plants and equipment due to poor and inadequate maintenances and lack of foreign exchange to procure the desired spare parts on time, archaic transmission and distribution paraphernalia which consistently breakdown, dearth of energy skilled manpower as well as shortage of basic industries to service the power sector.

The other critical concerns include inadequate or poor energy financing, dwindling technical know-how's in the power sector and inefficient regulatory framework. The power sector is a large consumer of annual national budget, demanding enormous financial resources, skillful manpower and continuous foreign exchange outflows and absence of binding, legal or regulatory framework that regulates renewable energy utilization for national growth and for socio-economic development in Nigeria.

Nigerian rural dwellers reliance on crude energy practices such as indoor cooking methods which pose serious hazard to human health through smoke inhalations which has caused many deaths which could have been prevented through a coherent legal framework on renewable energy that will ensure energy security, efficiency and sustainability.

Renewable energies such as biomass, wind, hydro, solar and nuclear energy are utilized at a very low rate in Nigeria while fossil fuels remain the major sources of energy therefore, there is the need for intensive investments in the power sector to make renewable energy a significant alternative source of commercial energy in Nigeria.

Theoretical Framework on Renewable Energy in Nigeria

Resource Curse Theory was developed in 1970-1990. The theory helps the study by emphasizing that developing countries must ensure the promotion and development of renewable sources of energy through coherent legal framework that protect and prioritize their social,

economic and environmental interests to meet the current need as well as preserving the same for future generation's needs. Developing States must ensure that their extractive resources do not promote under development and other crises associated with resources rich States such as mass poverty and poor social infrastructures. The theories help the study by highlighting the need to conserve and protect the State's extractive resources for posterity needs. It also highlights the need to enhance social and economic development of Nigeria through her abundant petroleum resources for energy sustainability and for the benefits of her citizens (Olujobi & Olujobi, 2020a & b, Olujobi et al., 2020).

The theory helps mitigating the effects of climate change through consistent enforcement of the extant legal framework on energy in all developing petroleum exporting states. It emphasizes that those resources abundant countries are largely suffering from poor economic growths. The theory further emphasizes that resources wealthy countries lack economic prosperity and developments that commensurate with their abundant petroleum resources due to prevalent violent, corruption, failure to diversify their economies and natural resources to other natural endowments such as agriculture, solid minerals among others to enhance their industrial developments to combat their various environmental challenges.

It gives reasons for resources rich countries underdevelopment due to failure to diversify timely and the prevalence of corruption in the nations. There is therefore the need for stringent enforcement of its extant laws on transparency in the extractive industries and other environmental laws to protect social, economic and other environment interests in the sector (Oyewunmi & Olujobi, 2015).

Another relevant theory adopted in this study is the Sustainable Development theory of 1980 which originated from Stockholm Conference on Human Environment in 1972 which maintains that governments should use their extractive resources in a sustainable manner for the development that satisfies the current necessities without compromising the capacity and the necessities of the future generations. The theory supports the study to understand the need for efficient utilization of extractive resources, the course of financings, thrust of technological advancement and institutional legal framework in compliance with the international best practices for the sustainability of humanities and nature. The theory emphasizes the need to use natural resources for the value and benefits of life of the present-day generations and for upcoming generations without damaging the ecosystems. Therefore, there is the need for adoption of renewable energy as alternative sources of energy in Nigeria's power sector to combat the challenge of epileptic power supply in the country. Nigerian policy makers must strive toward the greatest good for the greatest number by ensuring that their decisions and policies are balanced to guarantee energy security in the sector for the common good of Nigerians (Olujobi, 2018).

Legal Framework and Regulatory Institutions Overseeing Renewable Energy in Nigeria

The 1999 Constitution of the Federal Republic of Nigeria (as amended) positions electricity on the concurrent legislative list. This permits all levels of government to participate in major phases of electricity allocation and distribution in Nigeria as provided under Paragraph 14 of the Schedule II of the same Constitution.

Also, the Electric Power Sector Reform (EPSR) Act of 2005 underscores the significance of renewable electricity in global energy mix to guarantee access to electricity in rural and remote areas. National Energy Policy of August 2003 emphasis on the overall thrust of energy policy of ensuring optimum utilization of the country's energy resources for sustainable growth

of its energy sector. There are other energy policies such as: The 2009 Draft Renewable Electricity Policy, the 2000 Renewable Action Plan and Renewable Energy Master Plan 2012 which comprises of detailed plans for renewable energy in Nigeria's economy. Also, the National Energy Policy 2013, the Draft National Energy Master Plan (NEMP) 2014 which created the National Renewable Energy Development Agency with the statutory obligation of making renewable energy a major source of green energy in Nigeria's National Renewable and Energy Efficiency Policy (NREEP) 2015 and the reports of on vision 2020.

Another regulatory institution in the sector is the Federal Ministry of Power and steel, it has the following regulatory responsibilities among others: Power to propose policy and to make recommendations to the Federal Government of Nigeria on legislation, policy and investments on renewable energy. It is empowered to monitor, evaluate the implementation and performance of the policy within governmental agencies and in the electricity markets. To evaluate the performance of renewable electricity policy through increase in access to electricity in rural areas in Nigeria is fundamental (Danshehu & Zarma, 2013).

Pursuant to the new energy policy, the Federal Government through the Nigerian National Petroleum Corporation (NNPC) created Renewable Energy Division in NNPC to develop renewable energy initiative in August 2005 with the obligation of harnessing the bio-fuel in Nigeria for the satisfaction of energy customers but the division has not been efficient in carrying out this assignment (Olujobi, 2017). Lately, Nigeria approved a policy on bio-fuels called Nigeria Bio-Fuel Policy and Incentives 2007. The strategy was ratified by the Federal Executive Council in June 20, 2007 and gazetted as a National Bio-Fuels Policy. Under the policy, NNPC was to create an environment for the commencement of a domestic ethanol fuel industry. Subsequently, Africa's first ethanol refinery was introduced in Ekiti State and Ondo State in 2009 (Global Biofuels, 2008; Ben-Iwo et al. 2016). The aims were to reduce Nigeria's over reliance on imported gasoline and to create commercially sustainable energy industry that can provide jobs for the country's teeming youths b—but reverse is the case currently in Nigeria's energy sector's development pace due complete inefficiency in the sector.

However, over US\$4 billion has been earmarked for sugarcane-sourced ethanol project in Jigawa and Benue States while cassava-sourced ethanol projects are to be established in Anambra and Ondo States. Also, the Bio-fuels Research Agency is to coordinate biofuel research in Nigeria and to work with the Ministry of Agriculture, Ministry of Science and Technology on crop production but the ministries have not been proactive in driving this projects due to lack of funds and the requisite technical know-hows on renewable energies (Oyedepo et al., 2018).

Furthermore, the Ministry of Science and Technology is to keep records of all bio-fuel projects. Issue licenses to operators for the invention of fuel ethanol or bio-diesel in Nigeria. To enact, endorse fiscal and other incentivize rules for the sector among others. It is trite fact, that renewable energy will boost Nigeria's electric power sector since current electricity supply meets only one-third of Nigeria's energy consumption needs. It will preserve non-renewable energy sources for instance, it will preserve the Nigeria's 36.5 billion barrels of crude oil reserves by shifting Nigeria's focus from crude oil to renewable energy thereby guaranteed clean, inexhaustible energy supply, protect human and natural environment for socio-economic development that will guarantee sustainable energy security in Nigeria (Akinyetun, 2016).

The Nigerian Electricity Regulatory Commission (NERC) is instituted by virtue of Electric Power Sector Reform (EPSR) Act 2005 to create, promote, and preserve efficient energy market structures for optimal utilization of energy resources for electricity services. The commission is to boost access to energy services by encouraging and enabling consumer

connections to distribution systems in both countryside and city areas and to guarantee stable supply of electricity to consumers but commission has not been efficient in this regard as communities in Nigeria have not been enjoy constant power supply and some have not been connected to the national grids for electricity supply. See the case of *Amadi, & Ors V Essien*. (1993); 7 NWLR (Pt.354) 91 at 112 where the court affirmed electricity regulation, protection and the rights of electricity consumers in Nigeria's power sector. See also an unreported Suit No: AK/94/2019 Barr. Mike Kpemi v. Benin Electricity Distribution Company PLC delivered by Honourable Justice O.A., Adegbehingbe in Akure, Ondo State where the court ordered the electricity company to immediately install a metering device at the claimant's residence and not to cut off the electricity supply to the claimant's residence.

Another institution is the Rural Electrification Agency established by the EPSR Act 2005 to extend the main grid, to develop isolated, mini-grid systems and renewable energy for power generation. Also, the Energy Commission of Nigeria was established to conduct strategic planning and to coordinate national policies on energy. Other Agencies from which to seek advice in the execution of this rule are the Federal Government institutions, State Rural Electrification Boards and some pertinent state agencies, organized private sector and Non-Governmental organisations who are participants in the projects (Danshehu & Zarma, 2013).

Another legal framework regulating the sector is the Nigerian Oil and Gas Industry Content Development Act 2010 whose aim is to increase indigenous participation or to build local capacities in the Nigerian oil and gas sector. One of its statutory mandates is to set the standards for local content but this was not expressly defined under the Act. Sections 102 and 11(4) of the Act provide for the review of the schedule to the Act every two years and the waiver clause on every three years after the enactment of the Act but these have not been done to enhance economic growth in the sector and to combat other uncertainties associated with the industry (Olujobi, 2017).

Additionally, the proposed Petroleum Industry Governance Bill, (PIGB) 2017 emphasizes on governance issues in Nigeria's oil and gas sector by separating the roles of the Nigerian National Petroleum Corporation (NNPC) from operating as regulator as well as being petroleum operator and to unbundling the corporation to two different limited liabilities companies. The purpose is to remove the discretionary power of the Minister of Petroleum to award oil licenses or leases but such powers can only be exercised now based on the confirmation of the new commission called the Petroleum Regulatory Commission. It is the proposed regulatory body for the oil and gas industry. Expeditious passage of the bill into law by the 9th National Assembly will promote the needed reform in the sector in the areas of good governance, licensing, fiscal policy, restructuring of the corporation as a commercial legal entity to combat legal, regulatory challenges on gas utilization, market, pricing and development in Nigeria.

RESULTS AND DISCUSSION OF FINDINGS

The study underscores the importance of renewable energy to guarantee sustainable electricity in Nigeria with emphasis on legal and policy framework that needs to be enacted to promote energy sufficiency and security through renewable energy. The Nigeria's legal framework for the use and development of renewable energy is incoherent and inadequate to meet social, economic and environmental development needs of the country. The extant legal framework on renewable energy is narrow in scope and not detailed. The Federal Government must do more to overcome all the challenges associated with the formulation of coherent legal

regime on renewable energy to guarantee energy efficiency, security and sustainability in Nigeria. The countries have enacted their legal framework on renewable energy use and development. Contrarily, the Federal Government of Nigeria which is yet to enact a coherent legal framework on renewable energy. The existing policies on renewable energy are scattered in various policy documents which are incoherent and narrow in scopes. Also, ineffective and erratic power supply structure in Nigeria, have occasioned losses of more than 30% of the entire energy generated. In addition to these inadequacies, the consistency and availability of current installed electricity production system is very low. There is severe challenge of power irregularity over the years such that most industrial organizations and upper income family circles install exorbitant electricity generators set that cost over half of the total installed grid capacity. This constitutes colossal economic shortfalls to the Nigerian economy. Therefore, there is the need for stringent enforcement of energy regulatory policies with incentives for utilization of renewable energy sources in Nigeria.

The study identifies problems and fills gaps in the existing legal framework on renewable energy use and development. It justifies the need for new, coherent legal framework on renewable energy in Nigeria's power sector to conserve petroleum resources, to enhance social, economic development and to mitigate climate change in the country.

Renewable Energy as Investment Opportunities for Nigerians

There are numbers of unexplored renewable energy opportunities available in Nigeria. The study amplifies the various sources of renewable energy. Biomass is a greener energy sources, it is derived from plants. It can be used as bio-power or converted into other energy products such as bio-fuel. It has the capacity to reduce greenhouse gas emission. Bio-fuels are fuels made from biological sources. It is the cheapest and accessible source of energy because of fuel wood. It is derived from ethanol fermented and distillation of starchy cereals, grains and sugar crops such as beet, wheat, corn, sorghum and sugarcane. This is another investments opportunity that can yield good profits for Nigerians through investment in bio-fuel products.

Biodiesel is another source of energy that is derived by converting oil-bearing crops include: coconut, soya, palm, rapeseed and sunflower to methyl esters to blend with conventional diesel. New biodiesel know how manufacture diesel fuels from wood and straw to gasification point. Biomass as renewable energy source promotes uninterrupted power supply to rural areas through rural electrification programme and it will improve the livelihood of the rural dwellers. Despite its relative benefits and abundance in Nigeria, there is no legislation on biomass as a source of renewable energy therefore; there is the need for legal and policy framework on biomass in Nigeria.

Wind energy is another source of renewable energy that can promote stable electricity supply in Nigeria for meeting the needs of its electricity consumers especially in the Northern part of the country where there is abundant wind energy at 4.0 to 5.12 m/s speed. Wind energy is categorized as highly ecologically responsive resources of renewable energy. It involves the installation of wind turbines in wind farm located in an area where winds are durable and persistent for instance in offshore and high-altitude locations. The wind turbines are run by airflows and the power production depend on the cube of the wind velocity, as the wind velocity intensifies, the energy productions increases.

Also, biogas is another source of energy that is obtained from unprocessed and discarded materials such as animal feces, decomposable manufacturing and domestic unwanted solid materials (Oke, 2013).

Another source of energy that is cheaper and easily to maintain is small hydro-power. There are many forms of water energy: hydroelectric energy, micro-hydro systems, dam less hydro, oceanic energy among others. The systems harness water to generate energy through technologies such as dam, tidal power, and marine current power among others (Oke, 2013).

Solar energy is another fundamental source of renewable energy it is obtained from the sun through solar radio-activities or radiation such as photovoltaic and heats. Other sources of solar energy are: space heating and cooling through solar designs, day lighting, and solar hot water, solar steaming and high temperature practices for commercial energy usages (Oke, 2016).

Similarly, there is a geothermal energy source which is obtained by tapping the high temperature of the earth in kilometers deep into the earth's crust in some places of the earth or through some meters in geothermal temperature in all the places of the earth. This is abundantly present in Nigeria due to abundant amounts of sunshine, but the technology has not been fully accepted by all household in the country despite efforts to create awareness on it use and effectiveness. This is another source of renewable energy (Figure 3) that is cost effective and that can stimulate sustainable development in the rural areas in Nigeria.

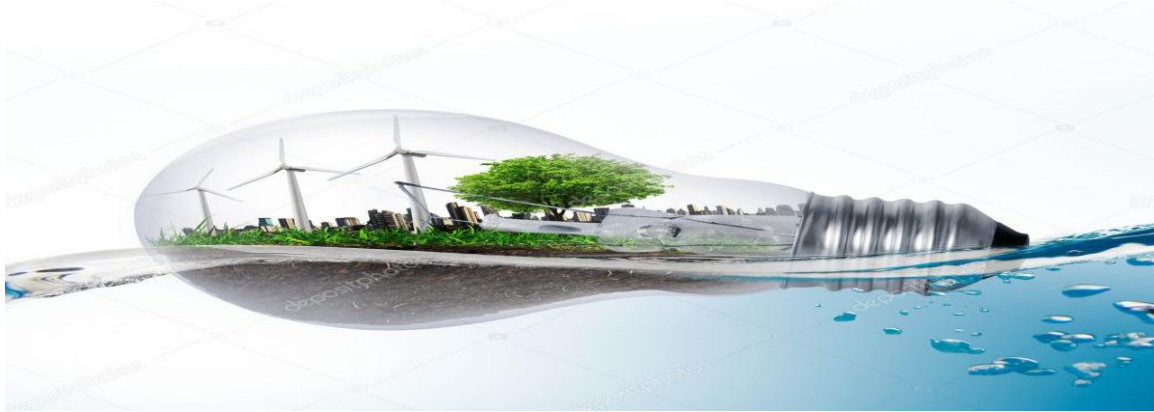


FIGURE 3
RENEWABLE ENERGY AS A SOURCE OF ENERGY

The Benefits of Renewable Energy in Nigeria

As earlier stated, there has been strong new interest in renewable energy sources. This follows from the fact that renewable energy sources hold some attractions which are not found in the fossil fuel. Thus, the factors driving the growing interest in renewable energy include the following:

Renewable energy enhances energy security due to the spiraling oil prices, crude oil theft and pipeline vandalisms, depletion of oil reserves and the increasing cost of crude oil exploration activities which are all pointers to the fact that fossil fuel may not guarantee all time availability of energy for human use. But diversified energy programme would allay the fear of energy insecurity and sustainability in Nigeria.

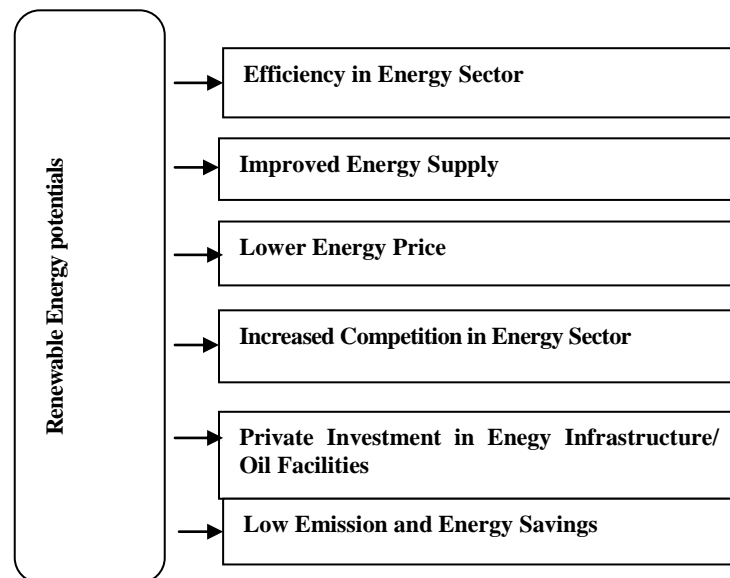
Other economic benefits of renewable energy is that the cost of extracting, tapping and harnessing energy from the renewable sources is relatively low in a long term utilization compared to that of fossil fuel consequently, the supply of alternative energy is cheaper than that of fossil fuel. Environmental pollution and degradation as well as the global warming of the atmosphere are incidental to the exploitation and usage of fossil fuel which engender untold hazards to man, the flora and the fauna. Conversely, the renewable energy is environmentally

friendly. Thus, increase use of renewable energy will improve the quality of the environment by contributing to global reduction in greenhouse gas emissions in Nigeria.

Another benefit of renewable energy is the sustainability of the energy sector. Renewable energy has the capacity of being restocked by a natural method at a value that is proportionate to the energy being utilized. Also, the collection, transformation and consumption of renewable energy usually take place in an ecological friendly manner. It forestalls damaging effects on the practicability of the energy and the inherent privileges of the inhabitant in the societies where it is utilized and natural environments contrary to fossil fuel sources of energy.

Excess reliance on crude oil revenues affected the growth of alternative energies in Nigeria. Energy diversification will promote energy security for the country. As the international request for Nigeria's crude oil is declining. The need for the enhancement of alternative energies from other domestic energy resources should be exploited. From the foregoing statement in the Policy, it could be distilled that the purposes of the policy are: to foster viable energy sources for optimum energy fusion in a sustainable and ecologically friendly manner to diversify and to cushion the consequence of diversification from petroleum products.

Among other expected benefits of renewable energy sources (Figure 4) especially, the bio-fuel programme are expansion of rural economy, education in rural urban migration and energy supply security and better environment by maximizing carbon credit opportunities. It will provide direct and indirect employment in the power sector. Free up more crude oil for exports. Boost federal and states' government tax revenues. Provide returns on investments to farmers and other stakeholders in the sector. It will create more opportunities for direct foreign investments into the Nigeria's economy.



Source: This was prepared by the Authors

FIGURE 4
BENEFITS OF RENEWABLE ENERGY IN NIGERIA

The Hurdles to Renewable Energy as Alternative Sources of Energy in Nigeria

Renewable energy has overwhelming benefits but does not devoid of side effects. Although renewable energy technologies emphasize non-existence of air-pollutant emissions during their setup but the process of energy production from some sources present pollution for instance, Bio-fuels may emit some pollution when combusted (Steenblik, 2005). Since the production of bio-fuels does not completely eliminate the release of carbon dioxide and greenhouse gases, they still pose a minimal threat to the environment and human health.

In the bid to meet the demands for bio-fuels, the environment may be degenerated through deforestation, erosion among others. This is contrary to the aims of finding alternative sources of energy. Another challenge is food security concerns; a recent United Nations report indicates that attempting to develop agricultural crops for alternative energy use may put enormous strain on dwindling water resources as well as arable land for food. The growth of crops for bio-fuels could endanger food security. It could lead to shortage of food during the periods of droughts or famines. Land could be taken away forcefully for bio-fuel production.

The expansion of agricultural land for the production of bio-fuel crops could intensify the conflicts arising concerning land rights by the people. The circumstances could force many countryside inhabitants to migrate to urban areas when they lose vital access to their natural resources such as water due to intensification in agricultural activities for bioenergy resources.

Another major hurdle to renewable energy development in Nigeria is technology. Apart from hydro-power, solar and bio-fuel technologies, no other renewable energy technology has been developed in Nigeria. Most of the technologies have to be imported at outrageous costs. Also, the level of mechanization in the agricultural sector is lower than what is required for the improvement of farming practices to enhance quality and good yields.

Similarly, there is a problem of poor Infrastructures, there is deficiency in the quantity and quality of enabling infrastructures for instance, poor power supply, impassable road networks, poor water supply these among others are required for production, processing and distribution of both agricultural produce and other materials related to the renewable energy programme success in Nigeria.

Low public awareness of renewable energy sources and technologies in Nigeria as a veritable energy sources, and its advantages, economically and environmentally is largely gloomy. Therefore, Nigerians are not well informed to pressurize the Federal Government to develop renewable energy resources and technologies for commercialization in the domestic energy market in Africa.

Generally, lack of cost-reflective charges, persistent meddling of the Federal Government in private led investments in the energy sector particularly on issue of tariff, transmission problems among others are hurdles to investments in renewable energy as alternative sources of energy in Nigeria. There is the need for incentives and full deregulation of the power sector to encourage investors in the sector.

Unpredictable weather condition can have an adverse effect on energy supply. As renewable energy often depends on variety of weather conditions, this may impact negatively on the consistency of energy supply. For instance, hydro generators require sufficient rain to satiate dams for their supply of flowing water to generate stable electricity. Also, the wind turbines will require wind to rotate their vanes. Likewise, solar panels require clear skies and sunshine to get the temperature required to produce electricity. It's hard to produce the same volumes of power as non-renewable sources. It can be demanding to produce the capacities of power that are as large as those being turn out by the conventional fossil fuel generators in Nigeria.

The Implications of the New Energy Policy on the Petroleum Sector in Nigeria

Nigeria relies seriously on the sale of crude oil for foreign exchange earnings. Thus, the oil offers over 90% of the country's foreign exchange earnings (Monday & Salihu, 2017). This has hitherto been the glory of the petroleum sector in Nigeria. Be that as it may, the new energy policy underscores the need to reduce over dependency on crude oil as energy source in Nigeria. Fortunately, the alternative sources of energy being promoted by the new energy policy have numerous benefits over fossil fuel. The policy came at the right time when the United States' Government being one of the Nigeria's biggest customers on petroleum products redirected her energy policy to embraces drastic reduction of crude oil consumption its over dependency on oil. This is a wakeup call for all stakeholders in Nigeria upstream petroleum sector to implement the new energy policy on renewable energy for the sustainability of the Nigerian oil and gas industry. The United States is one of the largest users of petroleum products in the world and the bulk of its import of crude oil comes from Nigeria. The implications of the new energy policy on the Nigeria's petroleum sector are:

First, the new energy policy will lead to reduction in the demands for Nigeria's crude oil due to the use of bio-fuel and other renewable energy sources. This will decrease the usage of fossil fuel thus reducing the demand for crude oil and its allied products which are the live wire of Nigeria's economy this is by no means a good signal to the Federal Government of Nigeria to diversify its economy to other viable sectors.

The second implication is that it will lead to an infusion of funds and modern technologies in the agricultural sector to the neglect of the petroleum sector and other revenues yielding sectors as more attention will be on the renewable energy sources, especially the bio-fuel which is at the center stage of the Nigerian new energy policy which are greatly interwoven with the agricultural sector as the benefits of renewable energy outweigh those of fossil fuel. Policy-makers are to give priority to the agricultural sector over the petroleum sector in terms of funding and to make available the required funds for effective research on renewable energy and to provide the needed technological supports for the sector.

Third, this may stimulate further decline in crude oil price and its allied products in the sector considering the economics principle of supply and demand that proffers that, the lower the price, the higher the quantity demanded may not be applicable in this instance. Thus, the decline in demand for fossil fuel would not be as result of rise in price, rather, the fall in demand would necessitate decline in the price of fossil fuel so as to stimulate demand. This entails huge slump in the petroleum sector.

Another consequence is that there shall be total remodeling of the automotive plants by the automobiles manufacturers for 100% bio-fuel usage. This would mean a complete shift from fossil fuel to renewable energy, thereby rendering the petroleum products a dispensable commodity globally.

Also, it may occasion retrenchment and down-sizing in the petroleum sector as one of the consequences of economic downturn is reduction of overheads and the number of employees in the sector by cutting costs. The implementation of the new energy policy and the consequential economic decline, it is the authors' view that retrenchment and down-sizing may be inevitable in the sector due to low demands for petroleum products which has occasioned declined in oil prices in the energy market but the current lockdown due to the Covid-19 (Corona Virus) pandemic that spread from China has occasioned decrease in demands of crude thereby occasioned low oil price globally.

It is our submission that the decline in the petroleum products price in the sector resulting from the implementation of the new energy policy could make the crude oil and its allied products less attractive, thereby promoting energy and economy diversification to non-oil sector. It will reduce the Niger Delta agitation for resource control and it may discourage pipeline vandalism among others oil related crimes in the sector. Therefore, the Nigerian petroleum sector would experience relative peace, having the lives, properties and other oil assets of the multi-national oil and gas companies in the sector safeguarded.

Comparison of Legal Framework on Renewable Energy

Several countries have enacted legal framework on the growth and development of renewable energy and some have provided incentives for utilization of renewable energy as alternative source of energy. For instance, the German's Federal Building Code requires local authorities to designate area for wind energy projects developments. Similarly, the German Renewable Source Act, 2001 made provision for the German wind market feed-in-tariff for each kilowatt of power produced and prioritized grid access for renewable energy. It was initiated in 2001 and further confirmed in 2008 all to encourage renewable energy utilization in the country (Fulton et al., 2012).

China's Renewable Energy Act, 2006 provides for the development, utilization of renewable energy to guarantee energy security and to preserve the environment. The Act decentralized renewable energy structure. The Renewable Energy Plan 2005-2010 in Spain stipulates development of renewable energy through technology to reduce dependency on import of fossil fuel, to reduce emissions and to promote sustainability of energy. In 2009, in India, the Ministry for New and Renewable Energy guarantee incentive tariff for eligible renewable energy projects for ten years. Increment on tax on every metric tons of coal produced or imported to India to encourage the usage of clean energy and to discourage fossil fuel utilization. A Green Bank and Indian Renewable Energy Development Agency was established to encourage the usage of clean energy in the country but Nigeria is yet to establish a Green Energy Bank yet, although various renewable energy centers have been established in some Federal University across the country as renewable energy research hubs but some have not been efficient due lack of sufficient funds and genuine commitment by the Federal Government to the power sector.

Denmark has generated over 40% of its energy consumption from wind energy also France uses solar energy to power most of their homes and Morocco has Ouarzazate plant to generate electricity for its citizens as crude oil may no longer be the world major source of energy due to global downturn of crude oil price and due to commercial viability of the United States' shale oil that causes reduction of the country's demands for Nigeria's crude oil (Akinrele, 2016). Presently, renewable energy has boosted the country's electricity supply to its citizens.

In Venezuela and Colombia, the reasons for their adoption of renewable energy as alternative source of energy is to curtail attacks on their oil and electricity infrastructure and to guarantee energy securities while the rationale for energy in Nigeria is not the same as the country is encountering challenges in protecting its oil and electricity infrastructure unlike Germany, China and United Kingdom that generated one quarter of its electricity from renewable energy thereby causing them to be ranked among the leading countries in renewable energy infrastructure developments in the world thereby guaranteeing stable electricity supply in their country (Smith, 2018).

In Kenya, renewable energy is made a national development priority or agenda. No similar policy in existence in Nigeria's power sector but the recent National Energy policy

suggest the use of renewable energy sources but failed to make it a national concern to reduce emission of carbon dioxide and to eliminate epileptic power supply to consumers in the country. It fails to make provisions for sanctions for non-metering of electricity consumers and estimated billings system by the electricity distribution companies in the country.

In Nigeria, efforts to diversify from fossil fuel to renewable energy have not been successful due to absence of coherent, stringent legal framework on renewable energy and lack of sincere commitment on the part of the Federal Government to overhaul the sector. There is therefore, the need to learn from the range of legal frameworks and policy measures adopted by the selected countries in developing and promoting renewable energy sources for stable electricity generation and transmission in Nigeria.

Scope and Limitations of the Study

The study focuses on combating energy insecurity which has been a challenge to social and economic development in Nigeria due to over dependency on fossil fuel and failure to consider the benefits of renewable energies sources. The fact that the study was based on the power sector out of the many other sectors in Nigeria limited generalizing the findings of the research but its findings are also suitable for adoption in other sectors of the Nigeria's economy in dealing with regulatory inefficiency. Poor record keeping culture and operational clandestineness of some power companies and regulatory authorities in the sector limit access to some required information for the study.

CONCLUSIONS

The study provides an overview of the policy framework, legislative and regulatory measures that need to be taken to promote energy efficiency in Nigeria. It identifies the challenges of renewable energy. The study underscores the importance of renewable energy to guarantee sustainable electricity in Nigeria with emphasis on legal and policy framework that needs to be enacted to promote energy sufficiency and security through renewable energy. The study underscores the needs for other energy sources such as wind turbine technology, solar, biofuel among others which have significant impacts on energy sources in the country.

The various significant gaps in the existing legal framework and policies on renewable energy have also been highlighted. The justifications for a new legal framework on renewable energy use, developments and sustainability in the country have been highlighted. From the foregoing, it is conclusive that the world has largely adopted the new energy policy which advocates radical and drastic departure from fossil fuel to renewable energy. In the light of this, by the next 20 years, greater percentage of the world energy would come from renewable energy sources so Nigeria must not be taken aback in the global energy systems.

The new energy policy would negatively impact the Nigerian petroleum sector, if Nigeria fails to diversify its economy to other extractive resources. The fundamental question that calls for answer is: What is next after Nigeria's adoption of the new energy policy like other countries in the world? There is the need for prompt passage of the Petroleum Industry Governance Bill 2017 by the 9th National Assembly to facilitate seamless implementation of the policy across board. However, there is little or no consciousness of the public on the new energy programme. These may constitute hindrances to the implementation of the new energy policy if not addressed speedily. The Federal Government must adopt how to make it work approach, harness renewable energy sources to attract foreign investors by harmonizing all existing legal framework and

energy policies to strengthen existing natural resources governance and to reform the various regulatory institutions in the sector to make enforcement of renewable energy policy a national priority for the benefits of all Nigerians.

Recommendations

In the light of the findings in this research work, author's candid recommendations are as follows: There is the need for a legal regime that is favorable to growth and sustainability. The enactment and execution of the new energy policy should be done promptly. The Federal Government of Nigeria should be committed to the new energy policy to help cushion the effects of the policy on the country petroleum sector, as Nigeria relies heavily on crude oil for her foreign exchange earnings therefore; there is the need for more sources of revenues to the Federal Government through renewable energy.

There is the need for aggressive enlightenment of Nigerians on the new energy policy and on the need for large scale marketing campaign for full acceptability of the energy policy by Nigerians. Fossil fuel energy is detrimental to the environment being the major cause of greenhouse gases (GHGs) while the renewable sources of energy is environmentally friendly, it reduces pollution. It is harmless, it enhances electricity supply and it is sustainable.

The Federal Government should integrate renewable energy into the energy system by making use of renewable energy a matter of national priority to meet electricity demands with supplies. There is the need for political will and unalloyed commitment of the government for sustainability of renewable energy systems in Nigeria. There is the need to initiate renewable energy markets. Profit oriented renewable energy in Nigeria necessitates formation of energy markets for her countryside populace energy consumption. To develop such commercial market, there is a need to intensify investments in renewable energy growth in the country. By improving services and training for the utilization of renewable energy technologies. Countryside energy consumers should be offered satisfactory repair and precautionary preservation facilities locally. There is also a need for education of consumers on rudimentary operation skills namely appropriate electrical device set-ups and battery procedure, including regular preservation techniques namely: filling batteries with water and dusting wind turbine vanes. Operators' education should also incorporate capacity regulation trainings that can aid energy consumers regulate their routine energy consumption efficiently to eliminate the necessity for copious energy storage facilities for renewable energy systems in Nigeria.

There is the need for clear guidelines or benchmarks for law makers on the best approach to adopt for enactment of legal framework and formulation of stringent policies on renewable energy utilization and developments with clear understanding of the impacts and the benefits of renewable energy use in achieving energy security, efficiency and sustainability in Nigeria. Lastly, there is the need for model legal framework on renewable energy as proposed by this study.

ACKNOWLEDGEMENTS

The financial support by Covenant University, Ota, Nigeria is gratefully acknowledged.

REFERENCES

- Ajomo, M.A., (2001). The legal framework of the petroleum industry, being a paper presented at the centre for petroleum environment and development studies workshop on essentials of oil and gas, Lagos, Nigeria.
- Akinrele, A. (2016). The current impact of global crude oil prices on Nigeria—an overview of the Nigerian petroleum and energy sector. *The Journal of World Energy Law & Business*, 9(5), 313-345.
- Akinyetun, T.S. (2016). Nigeria and oil production: Lessons for future. *International Journal of Multidisciplinary Research and Development*, 3(5), 19-24.
- Amadi, & Ors V Essien. (1993). 7 NWLR (Pt.354) 91 at 112. Retrieved June 10, 2020 from <http://www.perchstoneandgraeys.com/assets/ckfinder/userfiles/files/CaseReview008AmadivEssien.pdf>
- Ben-Iwo, J., Manovic, V., & Longhurst, P. (2016). Biomass resources and biofuels potential for the production of transportation fuels in Nigeria. *Renewable and Sustainable Energy Reviews*, 63, 172-192.
- Danshehu, B.G., & Zarma, E.I. (2013). The role of renewable energy in improving energy access to rural areas in Nigeria.
- Doran, P. (2002). World summit on sustainable development (Johannesburg)—An assessment for IISD. *International Institute for Sustainable Development, Winnipeg, Canada*.
- Fulton, M., Capalino, R., & Auer, J. (2012). The German feed-in tariff: Recent policy changes. *Deutsche Bank Group*, 1-27.
- Global Biofuels. (2008). Brief project description of global biofuels ltd, ekiti state. Retrieved from <http://globalbiofuelsnig.com/home/?p=4650>
- Lukman, R. (2009). US new energy policy a threat to Nigeria's oil and gas sector. Retrieved from https://www.opec.org/opec_web/static_files_project/media/downloads/publications/OB08_092016.pdf
- Monday, T.U., & Salihu, M. (2017). Crude oil and the politics of Nigerian foreign policy: issues and explanations. *Research on Humanities and Social Science*.
- Obama. (2004). The all-of-the-above energy strategy as a path to sustainable economic growth. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/docs/aota_report_updated_july_2014.pdf
- Oke, Y. (2013). *Nigerian Electricity Law and Regulation*. LawLords Publications.
- Oke, Y. (2016). *Essays on Nigerian electricity law*, Princeton and Associate Publishing Co. Ltd.
- Olujobi, J.O., & Oyewunmi, A.E. (2018). Oil spillage in Nigeria's upstream petroleum sector: Beyond the legal frameworks. *International Journal of Energy Economics and Policy*, 8(1), 220-226.
- Olujobi, O. J., & Olujobi, O.M, (2020a). Comparative appraisal of anti-corruption laws: Lessons Nigeria can learn from Norway, United Kingdom and United States' anti-corruption strategies. *International Journal of Management*, 11(7), 338-347.
- Olujobi, O.J. (2017). Legal framework for combating corruption in Nigeria—the upstream petroleum sector in perspective. *Journal of Advanced Research in Law and Economics (JARLE)*, 8(25), 956-970.
- Olujobi, O.J., & Olujobi, O.M. (2020b). Theories of corruption “public choice-extractive theory” as alternative for combating corruption. *International Journal of Environmental Sustainability and Green Technologies*, 11(2), 68-83.
- Olujobi, O.J., & Olusola-Olujobi, T. (2020). Comparative appraisals of legal and institutional framework governing gas flaring in Nigeria's upstream petroleum sector: How satisfactory?. *Environmental Quality Management*, 1-14.
- Olujobi, O.J., Adeniji, A.A., Oyewunmi, O.A., & Oyewunmi, A.E. (2018). Commercial Dispute Resolution: Has Arbitration Transformed Nigeria's Legal Landscape?. *Journal of Advanced Research in Law and Economics*, 9(1 (31)), 204-209.
- Olujobi, O.J., Olujobi, O.M.M., & Ufua, D.E. (2020). A critical appraisal of legal framework on deregulation of the downstream sector of the Nigerian petroleum industry. *International Journal of Management*, 11(6).
- Omorogbe, Y.O. (2008). Promoting sustainable development through the use of renewable energy: The role of the law. *Beyond The Carbon Economy: Energy Law in Transition*; Zillman, D., Redgwell, C., Omorogbe, Y., Barrera-Hernández, LK, Eds, 39-60.
- Oniemola, P.K., & Sanusi, G. (2009). The Nigerian bio-fuel policy and incentives (2007): A need to follow the Brazilian pathway. In *Energy, Economy, Environment: the Global View: Proceedings of the 32nd IAEE International Conference*.
- Oyedepo, S.O., (2012), Energy and sustainable development in Nigeria: The way forward, *Energy Sustainability and Society* 2(15), 1-17.
- Oyedepo, S.O., Babalola, O.P., Nwanya, S.C., Kilanko, O., Lerado, R.O., Aworinde, A.K., Adekeye, T., Oyebanji, J.A., Abidakun, A.O., & Agberegha, O.L. (2018). Towards a sustainable electricity supply in Nigeria: The

- role of decentralized renewable energy system. *European Journal of Sustainable Development Research*, 2(4), 40.
- Oyewunmi, O.A., & Olujobi, J.O. (2015). Transparency in Nigeria's oil and gas industry: Is policy re-engineering the way out?. *International Journal of Energy Economics and Policy*, 6(3), 630-636.
- Sagay, I. (2005). The Niger delta and the case for resource control. *Nigerian Integrative Discourse*, 2.
- Smith, R. (2018). *Three countries are leading the renewable energy revolution*.
- Steenblik, R. (2005). *Liberalisation of trade in renewable-energy products and associated goods: charcoal, solar photovoltaic systems, and wind pumps and turbines*.