

Resources-Blessed but Energy-Poor: A Critical Review of the Paradox of Energy Delivery in Nigeria

Esang Lazarus Esitikot^{1*}, Gerald Ndubuisi Okeke¹, Akaninyene Edet Ekong¹, Mary Ubong Umoh², Clement O. Obadimu², Anthony Akadi² and Utibe Amos Ofon²

¹Highstone Global University, Texas, USA

²Institute of Health, Safety, Security and Environment Studies, University of Uyo, Nigeria

*Corresponding Author

DOI : <https://doi.org/10.51583/IJLTEMAS.2025.140102>

Received: 16 January 2025; Accepted: 21 January 2025; Published: 27 January 2025

Abstract: Energy is essential for the growth and improved livelihood of any nation. Nigeria, though blessed with abundance of oil and gas, and has good land mass and natural resources for renewable energy, struggles with energy delivery. Many industries have shut down due to high energy cost or unavailability of the energy required to support their operations. Through critical review of existing studies on the Nigerian energy delivery, this study identified that the Nigerian energy challenges stem from infrastructural issues, environmental degradation, inconsistent government policies, poor regulatory framework and limited investments in renewable energy. However, the challenges can be mitigated if there is renewed policy thrust by the Nigerian government, energy incentives, stakeholders' involvement in decision-making in the sector and diversification of public power supply into renewable energy. As much as Nigeria still struggles with energy delivery from crude oil and gas, it is obvious that the future of energy delivery in Nigeria lies in resort to renewable energy sources.

Keywords: Oil and gas, energy delivery, renewable energy, environmental degradation, policy

I. Introduction

Energy is essential for the economic growth of any nation or organization [1], [3], [4]. Though energy delivery during the industrial revolution was from coal and fossil fuel [5], the current global energy delivery is mostly from crude oil and natural gas [5]. Nigeria has abundance of crude oil and natural gas and so relies mostly on energy delivery from these sources [6], [7]. She is also blessed with several renewable energy sources such as wind, solar energy, hydroelectricity and biomass [1], yet the country suffers from energy deficiency.

Though efficient energy delivery process is a catalyst for economic growth, Nigeria faces the challenge of inefficient energy delivery despite being blessed with abundant sources of oil and gas and different sources of renewable energy [1], [6]-[10]. Being that oil and gas is also the major revenue earner for the Nigerian government, oil and gas production has been subjected to internal politics and regional crisis. The uncertainty and instability associated with energy delivery from oil and gas make the need for the review of the current energy delivery plan in Nigeria inevitable.

In this article, we present a comprehensive plan for the new energy delivery mechanism in Nigeria to mitigate the existing challenges of energy delivery from oil and gas. In the plan, we consider relevant theories and existing empirical research on sustainable energy delivery. We discuss the goals and objectives of the new energy delivery process, the current challenges of the energy sector in Nigeria, the plan to ensure positive social change in the host communities, the strategies for the management of human and material resources, the logistic considerations, the decision-making process, the safety and environmental concerns, and the energy policy and regulatory framework to sustain the new energy delivery process.

II. Methodology

The study adopted critical review of literature on different studies on oil and gas energy delivery in Nigeria. The design was applied as it provided a holistic avenue to review the status and challenges impacting effective energy delivery in Nigeria despite her vast hydrocarbon reservoirs and crude oil production capacity.

Analysis of data was done by comparing and contrasting the major themes obtained through the critical review of literature. No private data was collected during the critical review of literature, hence no ethical concerns for the study

Aim of Study

Considering the challenges of sustainable energy delivery in Nigeria, the aim of this study was to develop a plan to eliminate or mitigate the challenges of energy delivery from oil and gas in Nigeria to achieve sustainable energy delivery in the country. The objectives included:

1. Review the challenges associated with energy delivery from oil and gas
2. Recommend alternative source of energy to eliminate the environmental degradation associated with energy delivery

from oil and gas [11]-[13].

3. Develop energy delivery process from non-fossil fuel source, hence reduce the existing youth restiveness in the Nigeria Niger Delta region [13]-[15].
4. Enhance energy independence, hence insulate Nigeria and organizations from the international politics associated with crude oil and gas pricing [13], [16-20].
5. Promote positive social change in communities around the new energy site through stakeholders' involvement, human capacity development and gainful employment [13], [21].

III. Review of Energy Delivery Challenges in Nigeria

Current Problems Related to Energy Delivery from Oil and Gas

Sustainable energy delivery is a necessity for economic development [7], [22]. However, Nigeria faces energy challenge both in quantity and quality of delivery. This is because energy delivery is not only unreliable and unsustainable but epileptic and far below the demand [2], [7], [14], [22]. Over 80% of Nigeria's energy delivery is from oil and gas [23], [24]. The unreliable energy delivery from the national electric power grid has resulted in many households and businesses relying on petrol-powered generators for energy delivery [25]. The subsidy on petrol is one of the efforts of government to make the product affordable though the subsidy has contributed to increased pollution [25].

Despite subsidizing petrol to make it affordable, there is no good distribution network to make petrol available in different parts of the country [26]. Distribution of petroleum product within the country is by trucking and this has resulted in many accidents, loss of lives, and environment pollution [26]. The adverse consequences of trucking has shown the lack of effective accident risk management structure in Nigeria [26]. In a study by [26], most of the fatal accidents investigated claimed one to five lives with about 0.89 cumulative frequency. The researchers noted that the challenge of petroleum distribution network shows a lack of or ineffective regulatory framework, poor accident reporting and investigating culture, corruption, and a rent seeking culture.

Thermal plants powered by oil and gas in the Niger Delta region are the main sources of energy to the national power distribution network. However, the environmental degradation in the Niger Delta as a consequence of the mismanagement of the oil and gas sector is a major concern [14], [23], [27], [28]. This concern has resulted in militancy, youth restiveness, and vandalization of power infrastructures further worsening the energy situation in Nigeria [14], [23]. Thus, most organizations and businesses in Nigeria do not rely on public power supply to avoid the challenge of frequent business shutdown.

Oil and gas exploitation and delivery in the Niger Delta is associated with gas flaring and oil spills [27], [28]. Though past governments were not effective in enforcing environmental laws, there is currently a growing concern on the potential implication of gas flaring not only in Nigeria but on global warming [29]. Thus, the continued reliance on energy delivery from thermal plants powered by oil and gas is threatened [30]. Also, considering the non-renewable nature of oil and gas, Nigeria cannot rely on these sources for sustainable energy delivery [15]. That the country does not even have adequate refining capacity for her crude oil and so relies on foreign refineries also makes sustainable energy delivery from oil and gas challenging as the country is not insulated from the volatility of international oil politics [16], [17], [31].

Part of the challenges of energy deliver from oil and gas is due to the dysfunctional regulatory authorities, poor policy framework, and the lack of legal compliance in the oil and gas industry [32], [33]. The challenges have contributed to the lack of compliance to environmental standards and other standards in the energy industry [27], [34]-[36]. The lack of compliance to international standards has resulted in conflicts and militancy that have affected energy delivery from oil and gas [34].

With the tension in the Niger Delta due to environmental degradation as a consequence of oil and gas exploration and exploitation [28], [37] and the instability in the global oil and gas market, overcoming the energy challenge in Nigeria will involve searching for a better, more reliable, and cheaper source of energy [5]. This will align with the global drive for energy efficiency and cost reduction [38].

Promoting Positive Social Change in the Host Community

Energy delivery from oil and gas in Nigeria is associated with many negative consequences such as environmental pollution and militancy [28], [39]. Since inhabitants of the Nigeria Niger Delta region are mostly farmers and fishermen, environmental degradation from energy production and delivery from oil and gas directly impacts their source of livelihood [13], [39].

Enforcement of environmental laws, effective regulatory and policy framework, or diversification of energy delivery to sources other than oil and gas will enhance the social and economic life in the Niger Delta region. [35]. A good policy thrust can serve as the means to enhance the delivery of the energy to the customers or end users [40]. The lack of legal and regulatory frameworks and policies or effective enforcement where policies already exist work against the desired social change from energy delivery process [35].

Considering the limitations of energy supply from oil and gas, there is a growing focus on renewable energy technology globally as a means of developing sustainable energy delivery for the future [20]. Considering that there is abundant sunlight,

wind, and water in Nigeria [24], diversification into renewable energy will not only enhance the economic development of Nigeria but will enhance human capital and boost investment and small scale businesses. Additionally, the diversification will enhance energy delivery to the current generation without jeopardizing the environment for the future generations [23], [24].

Diversification into renewable energy as a solution to the challenges of energy delivery from oil and gas will boost social activities in the host community through indirect employment, attraction of foreign investments, community development as part of corporate social responsibility, and development of rural infrastructures such as roads to enhance access to the energy generation site [22].

Policies and Regulatory Framework

There is inconsistency in the energy policies between successive governments in Nigeria [29], [32], [33], [41]. Apart from the inconsistencies, there is also policy limitation and a lack of effective enforcement to ensure transparency in oil and gas operations [32]. The unstable political environment and evolving democratic culture have not enhanced policy stability [41]. Thus, the government has not succeeded in ensuring sustainable public power supply from oil and gas [36;41]. This raises the uncertainty on the future of the industry and decision making [33].

Part of the challenge of the energy delivery from oil and gas is the lack of effective legal and regulatory framework [32], [33], [42]. Though there are multiple regulatory agencies in the oil and gas industry, the agencies are ineffective and this abets the lack of compliance to environmental standards and other standards in the energy industry [27], [34]-[36]. Conflicts in the Niger Delta region is partly due to the lack of compliance to international standards by the oil and gas companies in the area [34]. As noted by [40], energy managers need to drive the delivery of efficient, safe, and clean energy. Achieving this requires functional regulatory framework.

The lack of effective policy thrust in renewable energy has also impacted the development of alternative energy sources. Thus, Nigeria need to review her energy policy drive to reposition the renewable energy industry as an alternative to oil and gas [24].

Resolving the Energy Delivery Challenges in Nigeria

Management of Human and Material Resources

Energy deliver from oil and gas requires huge human and material resources. However, with the challenges of energy delivery from oil and gas, Nigeria should rather invest in technological innovations to develop renewable energy resources [37]. The innovations include energy-efficient technologies and the proper use of conventional energy resources [37]. To achieve the desired changes, Nigeria requires a policy thrust that encourages entrepreneurship, innovations, and continuous improvement [37].

A typical form of renewable energy that can replace oil and gas in Nigeria is solar energy. To develop solar energy, Nigeria needs to resolve the challenge of inadequate human capacity and the absence of local manufacturing capacity for solar components and systems [2] though the operation and maintenance cost for a solar power station is low [43]. Organizational leaders should focus on policies on human capacity enhancement to drive on-the job training and mentorship program in solar energy delivery. The initiative of the Electricity Commission of Nigeria to establish research centers for renewable energy in some Nigerian universities [44] is actually a means to fast track solar energy development.

Though solar energy may be a sustainable replacement for oil and gas, operators are likely going to face the challenge of trust based on the history of poor attitude to safety and environmental protection by oil and gas companies in the Niger Delta region [39], [45]. The solar energy companies will, therefore, require public awareness to build trust and drive favourable investment atmosphere [21], [39]. Such awareness can be through effective community relation units that enhances conflict resolution and ethical practices [21], employment of qualified personnel from the host communities, and integration of its employees in social welfare and community relations programs [21], [39].

Logistics and Strategies

Energy delivery from oil and gas in Nigeria is mainly through thermal power stations while the power generated is transmitted through national power grids. Of the renewable energy sources Nigeria is endowed with, solar energy is the most abundant and so is recommended as a suitable replacement for oil and gas [31]. As observed by [46], solar energy is one of the most reliable sources of energy. About 17,459,215.2 million MJ/day of solar energy falls on Nigeria's 923,768 km² land area, hence solar energy is readily available for organizations to harness for energy delivery [31]. The land mass for installing the solar panels will not also be a challenge as Nigeria, like China, has abundant land mass for the installation [43]. For household or small and medium business users, the solar panels can be installed on existing rooftops. The investment in solar energy will position the country to generate 27 times the energy the country currently generates from oil and gas [44].

The physical infrastructure for the solar systems will involve installation of large scale photovoltaic systems on rooftops and concentrating solar power systems [47]. Though there is 60% reduction in the cost of large-scale photovoltaic projects in recent times, there is no similar reduction in the cost of concentrating solar power systems [47]. However, the concentrating solar systems has the advantage of storing the sun's energy as heat and converting it to electric energy during sun down [47].

According to [48], solar energy is more expensive than energy produced through the traditional means unlike [47] observation of a reduction in the cost of solar panels. This is because each solar power station requires a large up-front capital investment [43]. Over a long period of time, however, there is no significant cost difference with energy delivery from oil and gas though solar energy comes with the advantage of no environmental degradation [43].

As noted by [43], government can overcome the cost of solar systems by adopting the strategy of creating an energetic hedge fund that forces the client to gather the necessary amount of money for building the solar plants. Incompatibility of solar infrastructure with the existing sources of energy is another challenge but this can be overcome by enhancing the penetration of solar technologies and developing a specific technology adoption model for the solar systems [18].

Decision-Making Process

Considering the theory of stakeholder identification, government and the energy companies should consider a holistic approach to stakeholders' involvement in decision-making to mitigate or eliminate instances of displeased stakeholders [35]. This would help improve relations and ease the tension between the energy companies and their host communities.

Considering the environmental pollution associated with energy delivery from oil and gas, it is obvious that stakeholders are aligned on the need for government to diversify the public power supply into renewable energy to achieve the desired economic and social impact [9], [23], [36]. This is to avert future energy crisis [36] as many researchers agree that the future of Nigeria's energy delivery system lies in renewable energy sources [23], [36], [49].

Safety and Environmental Protection Measures

Energy delivery from oil and gas is associated with environment pollution which requires effective legal and regulatory framework to mitigate. Diversification into solar energy will contribute to reduction in greenhouse gas emissions and waste generation while enhancing biodiversity [11], [12]. Thus, the adoption of renewable energy will enhance the reduction in global warming [12] as solar panels, for example, generate energy with no air or water pollution, solid waste, or inputs other than sunlight [47]. It is a cleaner energy source and does not contribute to global warming [47].

A source [12], however, have noted that renewable sources of energy are not totally hazard-free. Part of the issue is the relatively low level of formal education of some of the workers in the sectors which makes them prone to exploitation and abuse [12]. Also, there is the challenge of limited knowledge of the risk posed by the novel materials used in the design and construction of green technologies [12]. However, this will not be a key risk as most of the materials for the solar power stations will be imported from countries with reliable power supply and good regulatory framework for environmental protection.

Future Energy Production Policy

The lack of investments in renewable energy sources such as solar systems, as observed by [13], [37], [42] and is due to ineffective policy framework and limited government investment in energy delivery from renewable energy sources. In Nigeria, for example, there is limited government interest in the sector, no economic incentives to motivate investment, multiple taxations that discourages potential investors, and unfavorable customs and excise duty act [41], [42], [50]. In spite of the Nigerian challenges, some countries have already set target for the energy generation through renewable mean [18]. Thus, Nigeria need to emulate countries like South Africa which targets to generate 17,800 MW through renewable sources by 2030 [18]. Knowing the reduction in environmental pollution due to the development of solar energy, there is the need for incentives by government to encourage potential investments in the sector [2], [42], [50].

Developing the renewable energy sector requires the Nigeria government to put in place policies to enhance sustainable energy development for the short-, medium-, and long-term [10], [37]. Such policies should address favourable business climate for potentials investors, attraction of foreign direct investment, renewable portfolio, and energy efficiency standards [13], [37]. Nigeria will also need to revise the National Energy Policy and Master Plan [41], [42] to address specific requirements to motivate investment in solar energy. As part of effort to ensure the quality of materials for the solar power station, the Standard organization of Nigeria should collaborate with the Energy Commission of Nigeria, Manufacturers Association of Nigeria, Nigeria Society of Engineers, and the Nigeria Electricity Regulatory Commission to define the standards for the required equipment [2].

Government can also enhance investments in renewable energy such as solar plants through policies that encourage tax incentives [10], [18], [42], [47], [50]. Such tax rebate could fast tract the deployment of renewable energies [18]. Organizational leaders can, therefore, lobby and engage government agencies on tax rebate to enhance their financial capacity in developing renewable energy sources. With the right policies and legal framework, there is high prospect of sustainable renewable energy development such as solar systems in Nigeria [13] to eliminate the negative consequences of energy delivery from oil and gas.

IV. Conclusion

Though blessed with abundance of crude oil and gas, Nigeria currently struggles with energy delivery. The challenges stem from infrastructural issues, environmental degradation, inconsistent policies and regulatory framework and limited investments in renewable energy development. However, the challenges can be resolved with policy thrust that encourages entrepreneurship, innovations, and continuous improvement. Government can also deal with the challenge of the cost of solar systems by adopting

the strategy of creating energy incentives and fund that encourages organizations and individuals to invest in solar plants. Another strategic way forward is for government and the energy companies to ensure stakeholders' involvement in decision-making to mitigate or eliminate instances of displeased stakeholders thereby improving relationship and reducing the tension between the energy companies and their host communities. Dealing with the environmental pollution associated with energy delivery from oil and gas, may require stakeholders alignment on the need to diversify public power supply into solar energy. As much as Nigeria still struggles with energy delivery from crude oil and gas, it is obvious that the future of energy delivery in Nigeria lies in resort to renewable energy sources.

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