

Building Resilience in Nigeria's Energy Sector for Sustainable Development

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Abstract

Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. Incidentally, Nigeria's energy sector is the heart beat of the nation. This paper therefore analyses resilience building efforts in Nigeria's energy sector with a view to identifying the specific efforts of government, private or non-government organizations, assessing the level of such efforts and looking into any form of support that can enhance the efforts in question. This paper particularly noted there have been some significant efforts from certain private establishments and NGOs. The paper concluded that for Nigeria's energy sector to be resilient, the current resilience building efforts must be enhanced and sustained by government.

Keywords: Resilience, energy sector, Nigeria, sustainable development

Introduction

In the pre-colonial era of Nigeria, use of biomass as the primary source of energy was the order of the day. In those days, every individual resorted to bush/farm to fetch wood as the source of energy. However, this practice partially gave way to the use of coal in 1909 when coal was discovered in Enugu, Eastern Nigeria. These practices though still prevalent today, however became less popular towards the end of colonial era when crude oil was discovered in 1956. The initial

output of crude oil was 51,000 barrels per day (bpd) (Akinosho, 1998), by 1970s, a sporadic increase in outputs and earnings was witnessed, thus tagging the period the oil boom era, with crude oil constituting about 70% of the total commercial energy consumption and providing more than 90% of Nigeria's foreign exchange income (Okonkwo, 1998). In 1999, the crude oil output was 778,900 barrels while today in 2015; the output is over 2 million barrels per day. With present level of research on energy issues across the globe and in Nigeria hemisphere, the future postcolonial era stands to witness new dawn of renewable energy.

As earlier mentioned, resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. As amplified below, the focus is on the dynamics of the system when it is disturbed far from its modal state. The notion of speed of return to equilibrium (Pimm, 1991) leads to what has been termed "engineering resilience" (Holling, 1996) and, although related to one aspect of "ecological resilience," cannot be considered as *the* measure of resilience. As a result of the possibility of multiple stable states, when considering the extent to which a system can be changed, return time doesn't measure all of the ways in which a system may fail—permanently or temporarily—to retain essential functions. It is also important to bear in mind that "systems" consist of nested dynamics operating at particular organizational scales—"sub-systems," as it were, of households to villages to nations, trees to patches to landscapes.

There are four crucial aspects of resilience. The first three can apply both to a whole system or the sub-systems that make it up.

1. Latitude: the maximum amount in which a system can be changed before losing its ability to recover (before crossing a threshold which, if breached, makes recovery difficult or impossible).
2. Resistance: the ease or difficulty of changing the system; how "resistant" it is to being changed.
3. Precariousness: how close the current state of the system is to a limit or "threshold."
4. Panarchy: because of cross-scale interactions, the resilience of a system at a particular focal scale will depend on the influences

from states and dynamics at scales above and below. For example, external oppressive politics, invasions, market shifts, or global climate change can trigger local surprises and regime shifts.

Adaptability is the capacity of actors in a system to influence resilience. In a SES, this amounts to the capacity of humans to manage resilience. A characteristic feature of complex adaptive systems is self-organization without intent (Levin, 1998), and although the dynamics of SESs are dominated by individual human actors who do exhibit intent, the system as a whole does not (as in the case of a market). Nevertheless, because human actions dominate in SESs, adaptability of the system is mainly a function of the social component—the individuals and groups acting to manage the system. Their actions influence resilience, either intentionally or unintentionally. Their collective capacity to manage resilience, intentionally, determines whether they can successfully avoid crossing into an undesirable system regime, or succeed in crossing back into a desirable one. There are four ways to do this, corresponding to the four aspects of resilience. Actors can move thresholds away from or closer to the current state of the system (by altering (1) above), move the current state of the system away from or closer to the threshold (altering 3), or make the threshold more difficult or easier to reach (altering 2). In addition, actors can manage cross-scale interactions to avoid or generate loss of resilience at the largest and most socially catastrophic scales (altering 4).

Transformability is the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable. Sustainable development is that development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). Nigeria officially the Federal Republic of Nigeria, is a federal constitutional republic comprising 36 states and its Federal Capital Territory, Abuja. The country is located in West Africa and shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east, and Niger in the north. Its coast in the south lies on the Gulf of Guinea on the Atlantic Ocean.

Along the site of numerous kingdoms and empires, the modern state of Nigeria has its origins in the British colonization of the region during the late nineteenth to early twentieth centuries, emerging from the combination of two neighbouring British protectorates: (the Southern Nigeria Protectorate and Northern Nigeria Protectorate). The British set up administrative and legal structures while retaining traditional chiefdoms. Nigeria became independent in 1960, but was plunged into civil war several years later. It has since alternated between democratically-elected civilian governments and military dictatorships, with its 2011 presidential elections being viewed as the first to be conducted reasonably free and fair (Nossiter, 2011).

Nigeria is often referred to as the "the Giant of Africa", due to its large population and economy (Peter, 1987). With around 174 million inhabitants, Nigeria is the most populous country in Africa and the seventh most populous country in the world (LOC-FRD, 2008). The country is inhabited by over 500 ethnic groups, of which the three largest are the Hausa, Igbo and Yoruba. Nigeria is roughly divided in half between Christians, who mostly live in the Southern and central parts of the country, and Muslims, concentrated mostly in the North and South-West. A minority of the population practice traditional and native religions, such as the Igbo and Yoruba religions.

Nigeria has been identified as a regional power in Africa (Ronak, 2012; Encyclopedia Britanica, 2014). Its economy (GDP) in 2014 became the largest in Africa; worth more than \$500 billion, and overtaking South Africa while becoming the world's 26th largest economy (National Bureau of Statistics, 2014). Furthermore the debt-to-GDP ratio is only 11 percent, 8 percent below from 2012 ratio and is expected to become one of the world's top 20 economies by 2050 (National Bureau of Statistics, 2014). The country's oil reserves have played a major role in its growing wealth and influence. Nigeria is considered to be an Emerging market by the World Bank. It is also a member of the MINT group of countries, which are widely seen as the globe's next "BRIC-like" economies. It is also listed among the "Next Eleven" economies to become among the biggest in the world. Nigeria is a member of the Commonwealth of Nations, the African Union, OPEC, and the United Nations among other International organizations (National Bureau of

Statistics, 2014). Figure 1 shows the map of Nigeria indicating all the states of federation.



Figure 1: Map of Nigeria showing the States of the federation

Energy situation in Nigeria

Nigeria is fortunate to have huge energy resources, which potentially give the country ample opportunity to transform her economy and the lives of her citizens. Nigeria sits astride of over 35 billion barrels of oil, 187 trillion cubic feet of gas, 4 billion metric tons of coal and lignite, as well as huge reserves of tar sands, hydropower and solar radiation, among others. Nigeria has not devoted equal attention to her abundant energy resources. Her efforts have been concentrated on the development, exploitation and utilization of crude oil and gas for fiscal objectives and the electric power to generate electricity to power the economy. Table 1 shows the profile of the Nigerian electricity industry infrastructure, while figure 2 shows the oil producing area of the country.

Table 1: Profile of the electricity industry infrastructure

| Generation | Pre-1999 | Post-1999 |
|----------------------|-------------|--------------|
| Thermal | 4,058MW | 5,010MW |
| Hydro | 1,900MW | 1,900MW |
| Installed capacity | 5,996MW | 6,910MW |
| Available capacity | 1,500MW | 4,451MW |
| Transmission | | |
| 330Kv line | 4,800km | 4,889.2km |
| 132Kv lines | 6,100km | 6,284.06km |
| Transformer capacity | | |
| 330/132KV | 5,618MVA | 6,098MVA |
| 132/33KV | 6,230MVA | 7,805MVA |
| Distribution | | |
| 33kv lines | 37,173km | 48,409.62km |
| 11kv lines | 29,055km | 32,581.49km |
| 415v lines | 70,799km | 126,032.79km |
| Transformer capacity | 8,342.56MVA | 12,219MVA |

Source: Maigida 2008

**Figure 2: Map showing the oil producing area of Nigeria**

Energy and climate resilience

Nigeria hopes to generate about 35,000MW of electricity by 2020, raising the per capita electricity consumption to about 2000kwh. Many of the most critical economic, social, and environmental issues impacting the future development of Nigeria as a result of climate change have an energy underpinning. The hydrology of Nigeria's hydroelectric dams has suffered low water levels, even during the rainy seasons. Increased temperature and desertification in the northern parts of the country account for this. Should climate change result in even high temperatures, the future of hydroelectric power production will be in jeopardy. Approximately half of Nigeria's oil production is offshore while the rest is located along the coast of the Niger Delta. Rising sea levels and severe climatic events will pose significant danger to these investments. As wood dominates energy demand, especially among poor families, human activities accentuated by climate change will result in wood loss. Already, wood scarcity has been recorded in most parts of the country, especially along the Sahelian North. Clean cookstoves may help address increasing scarcity and cost of wood. By expanding access to clean cookstoves for poor families, the poor may become part of the climate solution.

Efforts so far

Pan Ocean gas utilization project

This project has the objective of eliminating gas flaring at the Ovade-Ogharefe oil field operated by Pan Ocean Oil Corporation in a Joint Venture Partnership with Nigerian National Petroleum Corporation (NNPC). The plant will process about 130million standard cubic feet of associated gas per day. This will save about 7,280 tonnes of CO₂ equivalent per day. In addition to the reduction of methane emissions, the project seeks to discourage the prevailing practice of domestic and industrial use of generators in Nigeria by replacing them with cleaner natural gas. In addition to replacing the more potent methane with the less potent CO₂, the gas can deliver approximately 520MW of electricity per day. The project activity will capture and process associated natural gas that is currently flared and would be flared in the future. It will reduce the GHG concentration, promote

sustainable development and contribute to environmental sustainability.

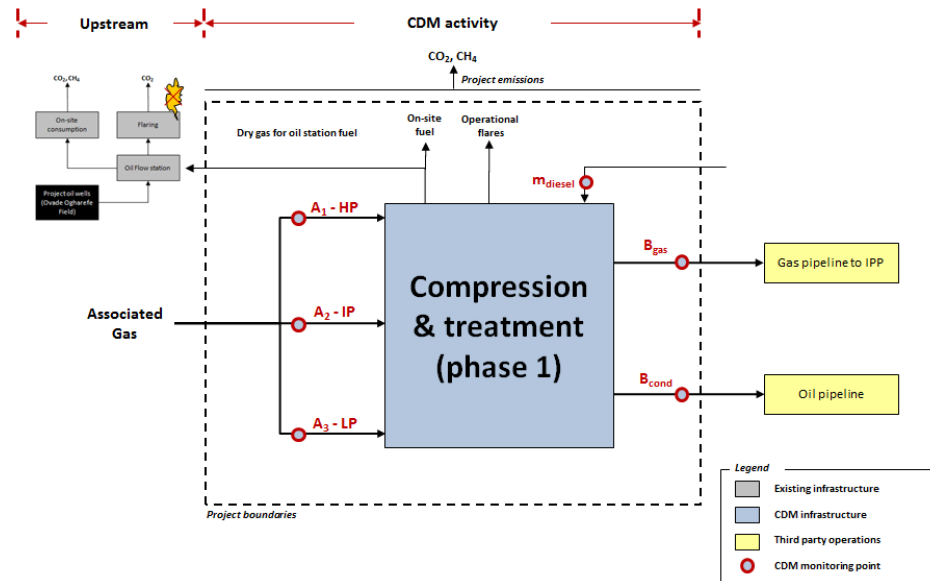


Figure 3: Schematic of project activity, project boundary and CDM monitoring parameters

The project consists of a gas processing facility designed to process approximately 130million standard cubic feet of associated gas per day. These products are dry sales residue gas with stabilized liquid hydrocarbons as crude feedstock. The design of the facility is optimized to maximize the methane, ethane and propane-plus recoveries and minimize utilities usage while ensuring trouble-free, low maintenance operations. The project was executed by the following firms: Lemna Energy Resources, a Nigerian subsidiary of Lemna International, Incorporated, Audubon-Linkso Engineering Company Limited, and others. The technologies are from different countries, notably the United Kingdom and the United States of America, among others.

Project benefits

The project has contributed to environmental sustainability in the project region through gas flare reductions. Local air pollution and

other environmental impacts and respiratory problems associated with the combustion of natural gas such as asthma and bronchitis may be reduced. According to the project design document, the installation is expected to employ 35 to 45 skilled staff and about 150 unskilled positions when fully operational. These jobs are expected to continue over a period of 20 years. This project serves as an important step in using CDM to address this crucial environment issue. It also shows the ability of local Nigerian companies and the society to participate in CDM and sustainable development. Under this project activity, the treated gas will be infused into an existing gas transmission line for sale to Independent Power Producers (IPPs). At full capacity, it would provide 135 million standard cubic feet of gas per day for electricity generation, thus supporting economic sustainability and growth of the country.

It presents an opportunity for ecofriendly habitation for both aquatic and human inhabitants. Over the ten years of crediting this project, the net GHG emissions will be reduced by approximately 26.27 million tons CO₂ equivalents. Air quality within the project area will be relatively free from pollutants and the frequency of acid rains will be significantly reduced. This may lead to increased yields in agriculture and other agro-allied businesses. Employment within the project community will be enhanced and there may be corporate social benefits to the host communities. If a survey is to be carried out, it will possibly show that supply chain jobs could be created. The project will serve as a template for replication in other gas flaring fields around the Niger Delta. As previously stated, the technologies are in the open domain, though the main barrier is finance. With adequate mobilization of funds, the technologies can be deployed in other gas flaring sites.

Additionally, this type of project comes with added infrastructure development like roads, housing for staff, provision of pipe-borne water and electricity to both members of staff and the host community, among others. The Niger Delta region is in dire need of infrastructural development, and with more than 100 gas flaring sites in the region, installing gas processing facilities with their associated infrastructure development will go a long way in providing basic amenities to the host communities.

Types of investment needed

Significant financial commitments from both the government and private companies are needed to expand gas processing facilities in the Niger Delta. Recent government initiatives aim to revitalize state-owned oil and gas processing installations, as well as establish new ones. In all, the government together with the multinational oil companies plan to spend about US\$5.3 billion in the next three to four years on the establishment of three green field refineries, a petrochemical plant, fertilizer plants, methanol plants, gas-processing facilities, as well as other gas related infrastructure. This comes in addition to the tens of billions of dollars in investment plans for gas power plants, transmission and distribution infrastructure.

Other types of support needed for the project

There is need for capacity building for the national gas regulatory body in Nigeria - the Nigeria National Gas Company (NGC) and other relevant institutions. This capacity is necessary because the issue of gas flaring need to be tackled from all fronts.

Security: It is always difficult doing business in the Niger Delta region due to the incessant disruptions on oil facilities. In fact, this project was suspended for about two years as a result of militancy and disruptions in the area. An expansion of this type of projects depends on the peaceful resolution of outstanding conflicts in the region. Market development: Efficient LPG distribution and marketing is also vital to the success of this project and prospects for expansion. Such barriers like shipping, transportation, cylinder bottling and most especially, pricing need to be addressed. It requires a robust gas pricing policy that will activate investment in this sector. The current gas regime is not favourable to project developers since returns on investment are not guaranteed, except in the long term.

The SAVE 80 efficient fuel-wood stoves

The purpose of this project activity is the dissemination of up to 12,500 efficient fuel-wood stoves (SAVE 80) and heat-retaining polypropylene boxes (called Wonder Boxes) in different states located in

the Guinea Savannah Zone of Nigeria, at subsidized prices. This stove saves over 80% of wood use, and therefore is attractive in areas where wood scarcity is particularly severe. Today, the SAVE 80 is the most efficient household wood stove available in Nigeria, despite its high cost. The project is implemented by the Nigerian Developmental Association for Renewable Energies (DARE), the German Non-Governmental Organization Lernen-Helfen-Lebene. V. and the German carbon offset organization, AtmosfairGmbH.



Figure 4: The SAVE 80 efficient fuel wood stoves

Project benefits

As specified by the manufacturer, the stove needs only about 250g of small brittle sticks of wood to boil 6litres of water: 80% less than traditional fire places. By bringing wood consumption drastically down, it will slow down deforestation in the Guinea savannah region and allow for natural recovery of forests and/or reforestation to take place. Each of the 12,500 stoves saves about 2.7 tonnes of CO₂ annually, creating about 31,000 tonnes of offset credits annually in the carbon market. This has the potential to generate US\$310,000 annually at the price of US\$10 per tonne of CO₂. For the 10 years that the project is

expected to bring in CDM earnings, expected income is about US\$3.1million. This foreign revenue will go a long way in financing and expanding other sustainable energy projects, thus creating foreign income potentials for the country. Additionally, the stoves contribute to poverty reduction and achieving the Millennium Development Goals (MDGs). The following MDGs are expected to be achieved in the project area: MDG 1 (less time spent on wood collection, more time for other productive uses) as well as co-benefits for health; and MDGs 4, 5 and 6 (less black soot, less indoor pollution and fewer respiratory diseases). It will also contribute to the preservation of wood resources so as to avoid inter-communal and/or inter-religious conflict over resources.

The main opportunity created by this project is the ability to generate awareness about clean cookstoves in Nigeria. Before the project, little was known of the modern use of wood energy. Despite the high costs, several governments, foundations and NGOs have used it as a template for disseminating information about clean cooking. Today, the launching of the Nigerian Alliance for Clean Cook stoves benefits from the awareness generated by this project, and in particular the opportunity to use the carbon market for other types of stoves that may be more affordable to the poor.

The project offers opportunity for replication in other parts of the country. Since woodstove technologies are rarely weighed down by intellectual property rights, it is possible to copy these stoves or even venture into other stove models using the principles of the SAVE 80 as a basis. This project helps create employment opportunities for people working in the Nigerian assembly plants, wholesalers and retailers of these stoves, thus promoting economic expansion in these areas.

Market expansion for efficient woodstoves depends on enabling policy, legal and regulatory frameworks. The government needs to enact the appropriate laws to support its growth. However, government policy has focused on promoting the switch from fuel-wood to kerosene, LPG and electricity. The reality on the ground is a stark contrast to the intention of the government. Until the necessary policies are implemented, the market for efficient woodstoves will not be expanded.

Types of investment needed

The SAVE 80 stove models may stimulate interest in more appropriately priced models of clean cookstoves in Nigeria. Access to investment finance for companies and NGOs seeking to establish stove producing facilities will be required. The lack of such facilities has led entrepreneurs to often produce stoves with poor technical standards and an inability to market them. This has impeded the plans to scale up markets for clean cooking. Innovative finance will also be needed in providing consumer credits so poor people can buy stoves and pay in instalments. Microfinance is therefore important in creating access to clean cooking.

Other types of support to the project

Technology: The SAVE 80 stove is a German product. Market expansion might require the domestication of the technology. This will also create jobs and may help to bring down the cost of the stoves.

Capacity Building: Capacity building for project developers, metal works SMEs and microfinance institutions needs to be carried out if the hope of expanding market access for efficient woodstoves is to be achieved.

Strong Institutional Framework: Presently there is no national institutional framework in place to support the dissemination of efficient woodstoves. No government institution is charged with the mandate of ensuring access to clean household energy. A strong institutional framework is needed if this vision is to be realized.

NESCO hydropower

The Nigeria Electricity Supply Company (NESCO) commenced operations as an electric utility company in Nigeria in 1929 with the construction of a hydroelectric power station in Kurra near Jos. As a private company, its main aim was to make profit out of the investment and also ensure increased generation and distribution of electricity efficiently in Jos to the satisfaction of its customers. The NESCO system operates as an independent network serving a number of industrial customers and communities, and also sells to the national grid. NESCO provides the main source of power for the city of Jos, with a population of about 900,000 people.

Project benefits

Electricity supply from the NESCO hydropower installation has contributed to the industrialization of Jos and its environs. Almost all the industries in Plateau State rely on NESCO for electricity supply. Some of them include Makeri Smelting Company in Jos and the Fiber Product Factory (an arm of NASCO Group factory). Employment generated in the project area is significant. In an interview with the Managing Director of the company, he revealed that the company currently employs 260 persons directly. Indirect and supply chain jobs created amount to about 2,800 and this, according to him, is a conservative estimate since the survey was conducted a long time ago. Overall, it is estimated that a total of 20,000 or 30,000 jobs might have been created from their operations in the Jos, Plateau region since they came into existence more than 80 years ago. NESCO invests over N300 million in its Nigerian operations annually and carries out development and training scheme for its Nigerian technicians and engineers who manage the plant's operations without expatriates. These have boosted local capacity as well as domesticating investments in Nigeria. The beauty of NESCO dams also attracts tourists, thereby increasing the eco-tourist potential of the area. Other benefits include reducing rural-urban migration and also reducing or replacing the use of firewood for cooking, hence reducing environmental degradation.

It is estimated that Nigeria has approximately 3,500MW of exploitable small hydropower capacity. Assuming this capacity is built and produces at about 90% capacity and that, power to the households is provided at 10 times of the current national per capita electricity consumption, this capacity will supply 21.9 million Nigerians with electricity. Job creation potentials for small hydropower can be significant. In a study by International Centre for Environment and Development on low carbon jobs in Nigeria, over 95,000 direct, indirect and supply chain jobs will be created if 734MW of this capacity is harnessed. Installation of small hydropower facilities will bring along other infrastructures like roads and bridges, especially in the rural areas where many of the rivers that have small hydropower potential are located.

Types of investment needed

As a result of the scale of financial requirements for building clean energy infrastructure in Nigeria, Nigeria's domestic financial market presents the most important potential source of finance. This investment will primarily go to clean energy generation, transmission and distribution, including the expansion of decentralized energy in community mini-grids and stand-alone clean energy systems. Investments are also required in expanding collective transportation in an efficient and sustainable manner. The carbon market will potentially be important in meeting the cost of additionality in the implementation of these projects. To date, no hydropower project has attracted carbon financing in Nigeria. Foreign direct investments will also be required, especially in large clean energy schemes.

Conclusion

As highlighted in the paper, Nigeria is prone to some natural hazards including those of atmospheric, geological and anthropogenic in origin. The country is also considered to be vulnerable to terrorist activity especially in the northern part of the country and Oil rich Niger Delta axis. As development continues in the nation energy sector, the country and its people become even more vulnerable to the effects of these hazards. It is therefore very important that Nigeria's government must formulate sound energy policies that will minimize potential hazards and directly embark on projects that will directly build resilience to the nation energy sector not only to make the sector resilient but sustainable.

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