



Energy and society

Transforming the Nigerian power sector for sustainable development

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HIGHLIGHTS

- Available resources for power generation in Nigeria.
- Power sector challenges, policies and reforms.
- Implications of the reforms implemented.
- Recommendations for improving the sector's performance.

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ABSTRACT

Nigeria has been plagued with acute power shortages due to poor performance of its power sector. Several policies and reforms have been implemented by the government to address the poor performance of the power generation, transmission and distribution sectors of the electricity industry. Also various strategies were employed by the government which includes encouraging private sector participation, diversification of the energy generation sources and promoting energy efficiency for sustainable development. In addition the government has spent billions of dollars since 2001 in the construction of new power generation facilities, transmission lines and distribution centers to boost the power supply. It has deregulated the generation and distribution sectors to encourage private sector participation and empowers the Energy Commission of Nigeria to embark on programs and strategies that can boost energy generation from renewable sources. This paper examined the country's energy sources and the power sector reforms adopted by the government. The paper also outlined some recommendations based on reforms implemented by other countries with similar resources to Nigeria which yielded positive results.

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1. Introduction

Nigeria has a total area of 923,768 km² with a population of 177 million in 2014 according to the World Bank development indicators. The country is endowed with abundant renewable and non-renewable energy resources like solar, wind, biomass, crude oil, coal, natural gas and bitumen. The Nigeria National Petroleum Corporation (NNPC) indicates that Nigeria's oil production in 2014 stood at 2.5 million barrels per day (bbl/day) making it the 13th largest producer of crude oil in the world. It also holds the 9th largest natural gas reserves in the world. However, its gas-dominated electricity grid still experiences frequent collapses due to

inadequate gas supply and obsolete infrastructures. According to Oji et al. (2012), Nigeria's annual average daily solar radiation is about 5.535 kWh/m²/day, varying between 3.5 kWh/m²/day and 7.0 kWh/m²/day at the coastal areas in the south and at the northern boundary respectively. Also wind energy is available at an annual average speed of 2.0 m/s near the coast to 5.0 m/s at the height of 10 m in northern parts of the country (Adaramola and Oyewola, 2011; Agbetuyi et al., 2012). Ladan (2009) indicates that the country has high potential for bioenergy development because roughly 74 million ha of Nigeria's total land (98 million ha) is arable and about 60% of the arable land is lying idle.

Despite the availability of these resources, majority of Nigerians continue to experience epileptic power supply. Majority of Nigerians rely on wood fuel for their entire energy needs resulting in massive deforestation (Babanyara and Saleh, 2010).

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2. Methods

This paper provides a comprehensive analysis of the Nigerian power sector. The sector's performance over the last three decades was analyzed based on:

- Sources of power generation in the country which include; Fossil fuels, hydro and other renewable energy sources like wind, solar and biomass.
- Power sector challenges in Nigeria and its implications on the country's economic growth.
- Power sector reforms introduced to overcome the challenges.
- Weaknesses of the policies and reforms implemented.

Finally recommendations on how to improve the overall performance of the power sector were made. These recommendations are based on successful policies and reforms implemented in other developing countries with similar resources and challenges to Nigeria. The recommendations are also based on.

- The world energy issues monitor for 2014 prepared by the World Energy Council (WEC).
- Energy efficiency and renewable energy policies and laws.
- Perceived weaknesses of the sector and the best ways to improve its overall performance.

3. Discussion

3.1. Sources of power generation in Nigeria

Nigeria's proven crude oil, natural gas and coal reserves are presented in [Table 1](#) below.

[Table 1](#) illustrates that Nigeria has considerable reserves of fossil fuels more especially crude oil and natural gas. Niger Delta region located in the Southern part of the country holds majority of the crude oil reserves. According to the US Energy Information Administration ([EIA, 2013](#)), Nigeria is the largest oil and natural gas producer in Africa. It is the ninth largest reserves holder of natural gas in the world and holds the largest natural gas reserves in Africa ([WEC, 2013](#)). Nigerian National Petroleum Corporation ([NNPC, 2014](#)) indicates that the country's oil production is currently 2.5 million barrels/day which is mostly produced from the Niger Delta region of the country. The country also has abundant renewable energy sources like hydro, wind, solar and biomass.

Nigeria has extensive network of rivers with Rivers Niger and Benue being the two largest rivers in the country which cut across many countries in the West Africa as shown in [Fig. 1](#) ([Tunde, 2005](#)). The country has enormous bioenergy potentials in the Guinea and Savannah grasslands in the north and equatorial rain forest in the south ([Ladan, 2009](#)).

The renewable energy sources and potentials listed in [Table 2](#) are mostly located in the northern part of the country. Sokoto,

Kano and Katsina have the highest solar irradiation and wind speed in the country ([Akpu, 2012](#)).

3.2. Power sector challenges

Despite the availability of abundant energy resources, majority of Nigerians continue to experience epileptic power supply. In 1980, Nigeria's total population was 73.7 million and its total average power generated in the same year was 783 MW ([Oyedepo, 2014](#)). In 2014 the country's population increased to 177 million but the total power generated stood at 3795 MW as shown in [Table 3](#) below.

[Table 3](#) indicates that the country's population more than doubled within the last three decades but its power generation capacity barely increased which inevitably led to chronic power shortages.

Nigeria's power sector has been experiencing enormous challenges due to obsolete equipment, inadequate generation and transmission capacities, and, high aggregate technical and commercial losses. These challenges stem from decades of neglect, mismanagement and inadequate funding. The problems worsened as a result of massive increase in demand of electricity due to economic and population growth. Lack of electricity has forced about 62% of Nigerians to rely on wood fuel for their entire energy needs resulting in massive deforestation in the country ([Babanyara and Saleh, 2010](#)).

Long period of neglect left majority of Nigeria's power plants in poor state and the power sector employees with little or no motivation. Power rationing is adopted due to inadequate supply since majority of the country's power plants operate far below their installed capacities ([Usman and Abbasoglu, 2014](#)).

[Table 4](#) Performance of Nigeria's power plants in 2011, summarized from ([Usman and Abbasoglu, 2014](#)).

Thermal plants in Nigeria suffer from the decay more than the hydro stations as shown in [Table 4](#) due to lack of maintenance and inadequate gas supply. Pipelines supplying gas to the thermal plants are frequently vandalized costing the government millions of dollars annually ([NNPC, 2015](#)).

Most of the critical infrastructures in the transmission and distribution sectors are so obsolete and inadequate they cannot sustain the massive increase in demand ([Onakoya et al., 2013](#)). Majority of the customers connected to the electricity grid are not metered and even those that are metered including many government agencies do not pay their bills appropriately. Operational inefficiencies due to low staff morale coupled with huge debts and obsolete infrastructure contributes immensely to the persistent power outages in Nigeria.

Nigeria's Ministry of power indicates that the total power generated as of 5th May 2015 was 3114 MW. The ministry attributed the drop in generation to inadequate gas supply to the country's thermal power plants due to gas pipeline vandalism.

Gas fired power plants supply more than 70% of Nigeria's total power generation as shown in [Fig. 2](#). Majority of the thermal power stations in the country are operating below 50% of their installed capacities as shown in [Table 4](#) below. This is caused by insufficient funding, lack of spare parts and corruption which inevitably caused low morale among the plants' employees.

Due to rapid increase in demand as a result of economic and population growth, the output from the power stations in [Table 4](#) can only be rationed as it cannot meet up the demand. Nigeria's power sector is faced with multiple challenges ranging from inadequate funding, lack of maintenance to low generation, transmission and distribution capacities. The country's T&D losses are rated as one of the highest in Africa with losses up to 35% in 2013 due to the poor state of the power sector ([Shaaban and Petirin, 2014](#)). These losses are too high compared to 6% T&D losses in the

Table 1
Nigeria's fossil fuels reserves 2011 ([WEC, 2013](#)).

Resources Type	Reserves	Percentage of world total
Crude oil	37.2 billion barrels	2.8%
Natural gas	5.1 trillion cubic meters	2.4%
Coal	0.19 billion tons	0.02%

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