Electrification in Nigeria: Challenges and Way Forward

(Second Draft)

Authors:

Chukwuka Onyekwena

Joseph Ishaku

Precious C. Akanonu

Centre for the Study of the Economies of Africa (CSEA)
Abuja, Nigeria

October, 2017

Executive Summary

Although electricity has been generated in commercial quantities in Nigeria for over a century, the rate of electricity infrastructure development in the county is low and power supply remains inadequate. Prior to reforms, the central challenges of the Nigerian power sector was the vertically integrated monopoly of government in power generation, transmission and distribution. While the reforms was successful in privatizing the generation and distribution segments of the Nigerian Electricity Supply Industry (NESI), the overbearing problems in the sector persists –with privatization only changing the dimensions of the challenges.

Financing remain a major problem across all the segments of the NESI ***partly due to non-cost reflective tariff***. Yet each segment of the NESI also faces its unique challenges. The **generation** segment is riffed with the problems of energy security and inefficiencies in other segments. The challenges in the **transmission** segment lies in the *lack of modern transmission lines and equipment, gross mismanagement, poor maintenance of available infrastructure* and inefficient grid design. **Distribution** companies face the problem of huge Aggregate Technical, Commercial, and Collection (ATC&C) losses.

In terms of electricity access, **46.09 percent of the Nigerian population remains unconnected to the national grid,** representing 83.98 million people. Further, electricity demand is estimated at 24,380 MW as at 2015 compared to NESI's available generation capacity of 7,139.6 MW. In terms of energy use, Nigeria has the lowest in the world – **80 percent below its energy use based on income levels.**

In a bid to tackle aforementioned challenges, the Federal Government of Nigeria (FGN) set ambitious targets for the country's energy mix. This should allow Nigeria exploit its potential for coal, solar, wind, biomass, as well as small and large hydroelectric power electric generation, while reducing the prevalence of self-generation, which constitute two-thirds of present energy mix. By 2020, the FGN targets to achieve up to 75 percent access to electricity by connecting 1.5 million households annually. While Nigeria's energy mix targets are desirable, the prospect of success remain bleak on account of financial constraints, pricing policy and lack of policy coordination.

Improving electricity supply in Nigeria and addressing barriers to achieving the energy mix targets will entail: addressing payment risk, financing power sector investment, as well as improving the pricing and tariff structure, **gas pricing and allocation**, and **market regulation.**

Table of Contents

INTRODUCTION

Electricity has become a crucial component of modern living, lending itself to diverse use for work, travel, communication, healthcare, learning and living (lighting, cooking, and heating/cooling). Therefore, the lack of electricity, or its inadequate supply, has consequences for households, firms and the economy at large. The importance of electricity prompted the UN and its member states to make it a goal to ensure universal access to affordable and clean energy by 2030.

In Nigeria, reliable electricity provision remains a challenge, despite heavy public investment over the years. Lack of access to electric power has stalled development by negatively affecting the real sector as well as learning and labor force participation – especially for women and girls (Moyo, 2012; Oseni and Pollitt's, 2012). A legacy of underperformance of the state utility companies (NEPA later PHCN) prompted a reform of the power sector that led to the privatization of the generation and distribution segments of the electricity value chain in 2014.

Failure of the Nigeria electric power sector to improve since the reform has posed a challenge for the government, private investors, electricity experts, development partners and scholars to find innovative solutions to the seemingly unending problem impeding the realization of electricity targets. Wholesale solutions that focus not only on access but also on other factors relating to quality of supply such as technical availability, adequacy, reliability, convenience, safety, and affordability are necessary for access to electricity to meaningfully contribute to economic and social development.

However, there is need for a thorough analysis of the sector in order to understand the mechanics of the market and reasons for the current inefficient outcomes, in order to enable stakeholders to identify a scope for intervention. This report is a response to this imperative: it unbundles the issues around the electricity sector in Nigeria and provides a thorough assessment of its current state, government plans and efforts, and pathways to realizing targets.

The rest of this report is organized as follows: Section 1 provides a historical overview of Nigeria's power sector, detailing its evolution over time that culminated in privatization. Section 2 assesses the current state of the Nigeria electricity market, highlighting the operational framework and evaluating the interaction between supply and demand that yield the current inefficient outcome. An analysis of the government's plan is detailed in Section 3, while Section 4 highlights new trends and future outlook for the power sector. The report is concluded in Section 5 with a summary and a documentation of our views on the pathways to attaining electricity targets.

1. Historical Overview of Nigeria's Power Sector

Despite the fact that Nigeria has been electrified for over a century, the rate of development of electricity infrastructure in the country is low and supply of power to Nigerians remain inadequate. This section provides a historical overview of the Nigerian power sector with the aim of highlighting challenges in the operations that necessitated power sector reforms and privatization. It also sheds light on some of the inherent challenges in the privatization of Nigeria's power sector which would need to be addressed to allow progress in the sector.

1.1 The Antecedents of Power Sector Reforms

The central challenge of the Nigerian power sector prior to the reforms was the vertically integrated monopoly of government in power generation, transmission, and distribution – including billing, metering, and customer services.

In the colonial era, electricity demand and supply in Nigeria were solely a government affair, with the first generating power plants of 0.06MW installed to serve mostly government offices/quarters in Lagos in 1896 (Olaoye, et al., 2016). But over time, the government saw the need to broaden access to all Nigerians willing and able to pay for it (Obadote, 2009). This led to the establishment of the Nigeria Dams Authority (NDA) and the Electricity Corporation of Nigeria (ECN) as separate entities in 1950 to generate and distribute electricity respectively. However, in effort to consolidate operations and promote efficiency, NDA and ECN were merged to form the National Electric Power Authority (NEPA) in 1972.

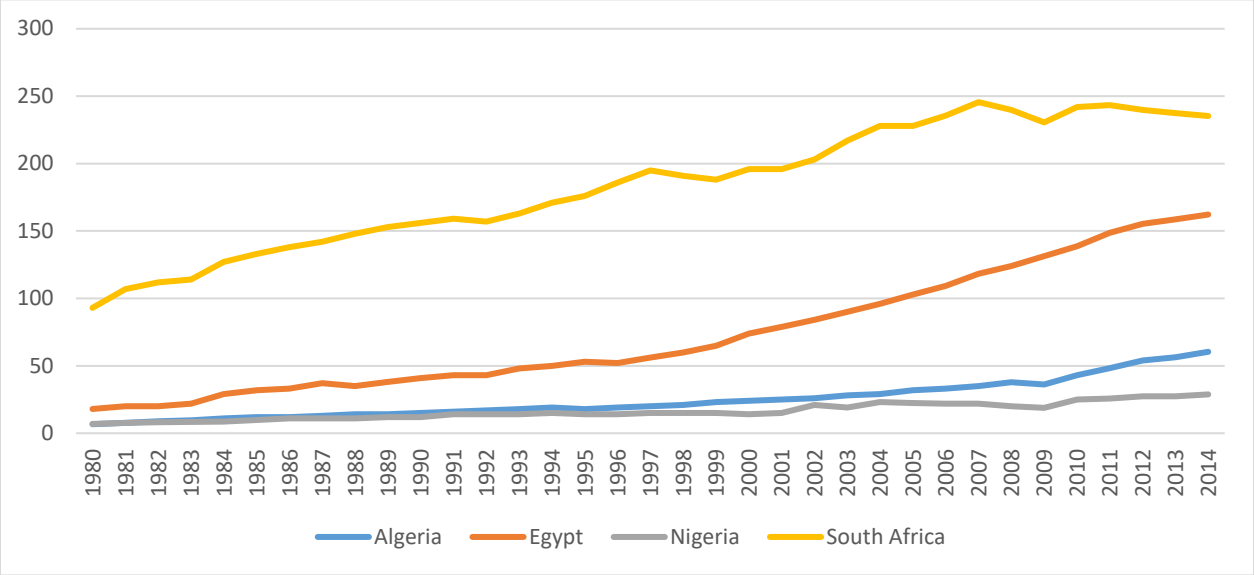
NEPA became the sole player in supply of electricity in Nigeria for over three decades, and was plagued with numerous challenges. As in the case of most government owned and operated institutions in Nigeria and beyond, the electricity service delivery by NEPA was marred with bureaucracy, corruption, and gross inefficiencies. As a result, the power sector at the time was impaired by inadequate investment in the sector, aging infrastructure, and huge gap between power demand and supply in the country. With significant increases in population and economic growth, NEPA could not keep up with the pace of electricity demand. Thus in the nineties, about 50 percent of 140 million people were without electricity from the national grid (Lindeman, 2015). The dismal supply of electric from grid soon resulted in the stunted growth of the overall economy.

The turn to democratic rule in 1999 provided more room for citizens, civil societies, and the private sector to push for power sector reforms. The drive for a more efficient power supply motivated the amendment of Nigeria's Electricity Act in order to eliminate the monopoly of NEPA and accommodate private sector participation in the sector (Onagoruwa, 2011). The central notion of the reform was that promoting private sector investment in the power sector would eliminate the longstanding challenges – a rather strong assumption.

While the amendment of the Act was a necessary condition to kick off the privatization process, it was not sufficient to attract investors at the time. The state of the infrastructure of the entire value chain of generation, transmission, and distribution was highly deficient. Based on a 2009 study by

the World Bank, the Nigerian power industry was ranked as the most inefficient, globally. As at 2011, only about 19 units out of the 79 units of generation turbines in the country were operational; generating about 3,718 MW on average out of an estimated installed capacity of 8,644 MW (Onagoruwa, 2011; Banwo & Ighodalo, 2015). Despite having a larger population, Nigeria generated less power relative to other major African economies and failed to expand its power generation along with its growing population (*Figure 1*). For instance, Nigeria with a population of 140 million generated electricity worth 43 percent of its installed capacity, whereas South Africa with a population of 48 million generated 35,000 MW out of an installed capacity of 52,000 MW – 67 percent of installed capacity. Furthermore, technical losses in the transmission and distribution reduced the proportion of the generated electricity effectively consumed. Huge commercial and collection losses accrued in the power sector as only about 50 percent of consumed electricity was paid for (World Bank, 2009).

Figure 1: Electricity Generation in Africa's Largest Economies (Million, Mwh)



Source: U.S. Energy Information Administration

Overall, at the commencement of the privatization process, the power sector was plagued with multi-dimensional challenges, consisting of lack of adequate investment, aging infrastructure, systemic corruption, bureaucracy and inefficiency, huge supply/demand gap, and inefficient billing/collection systems, among others.

1.2 Privatization

In a bid to address Nigeria's deficient power sector supply, the National Assembly passed the Electric Power Sector Reform Act (EPSRA) in March 2005. The main imperative for the reform, among others, was to transfer the control and operations of the industry from public sector to private sector in order to ensure the private sector participation necessary to improve efficiency and investment in infrastructure, promote market determined pricing and structure, as well as bridge the gap between power supply and demand in the country. However, the present state of

the power sector shows that the imperious problems in the sector persists, and the privatization has only changed the dimensions of the challenges

The reform process was divided into two main stages: the unbundling of NEPA into segments and transfer of assets to Power Holding Company of Nigeria (PHCN); and the sale of assets to private companies. In the first stage, NEPA was unbundled into generation, transmission and distribution segments, comprising of eighteen new successor companies under PHCN in November 2005. Specifically, six companies handled power generation, a single subsidiary (Transmission Company of Nigeria) controlled the transmission segment, while eleven companies managed the distribution of electricity within designated geographical areas. Nigerian Electricity Liability Management Company (NELMCO) was established to oversee the transition and liability management in the transfer of the assets, liabilities and staff of PHCN to the successor companies. In 2006, the Nigeria Bulk Electricity Trading Co Plc (NBET) was established and charged with the role of bulk trading [1], while NERC was established to act as independent regulator of the power sector.

Following a two-year delay due to elections and transition in government, the second stage kicked off in December 2010 with the request for the submission of bids from prospective private investors. In 2013, the Bureau of Public Enterprises (BPE) held a bid round to auction at least 51 percent ownership of four thermal generation plants, two hydropower generation plants, and eleven distribution companies held by the defunct PHCN. Out of 330 Expressions of Interest, 220 bidders were selected and, ultimately, 15 enterprises won the bids (FGN, 2016). The bids amounted to over US$2.53 billion: $1.27 billion for five Generation Companies (GenCos) *(Table 1A & 1B)* and $1.26 billion for ten Distribution Companies (DisCos) *(Table 2).* By the end of 2014, the government was able to completely handover the power generation and distributions assets into private hands, but transmission remained under government ownership while being managed by Canada's Manitoba Hydro International.

Tale 1A: A Breakdown of Successor Generation Companies (Thermal)

S/N	Generation Station/Asset	Successor Company	Acquisition Fee	Shares Acquired
1	Egbin Generation Company	New Electricity Distribution Company (NEDC)/KEPCO Consortium & Sahara Energy Resource Nigeria	$407 million	70%
2	Geregu Power Plc.	Amperion Power Distribution Ltd	$132 million	51%
3	Ughelli Power Plc	Transcorp/Woodrock	N47.1 billion ($362 million)	100%

Source: Nigeria Power Guide (2013)

[1] It is the buying of power/electricity from IPPs and reselling the power to the distribution companies (DisCos) and Eligible Customers. This is undertaken by NBET.

Table 1B: A Breakdown of Successor Generation Companies (Hydro)[2]

S/N	Generation Station/Asset	Successor Company	Commencement Fee
4	Kanji Hydro Power Plc.	Mainstream Energy Solutions Ltd	$257 million
5	Shiroro Hydro Power Plc.	North-South Power Company	$111.7 million

Source: Nigeria Power Guide (2013)

Table 2: A Breakdown of Successor Distribution Companies – Preferred Bidders[3]

S/N	Distribution Asset	Successor Distribution Company	Acquisition *(in million)*	Proposed Investment 2014-2019 *(in million)*	Shares Acquired (%)
1	Abuja Distribution Company	Kann Consortium Utility Company Ltd	$164	$183.03	60
2	Benin Distribution Company	Vigeo Power Consortium	$129	$121	60
3	Eko Distribution Company	West Power & Gas Limited	$135	$225	60
4	Enugu Distribution Company	Interstate Electrics Limited	$106.4	$136	60
5	Ibadan Distribution Company	Integrated Energy Distribution & Marketing Ltd	$160	$219	60
6	Ikeja Distribution Company	NEDC/KEPCO Consortium	$134.75	$219	60
7	Jos Distribution Company	Aura Energy Limited	$82	$113	60
8	Kano Distribution Company	Sahelian Power SPV Limited	$102	$151	60
9	Port Harcourt Distribution Company	4Power Consortium	$124	$127	60

[2] The privatization/sale of hydro generation stations was carried out by concession
[3] Companies with the highest financial bid and the bidder with the best service efficiency program

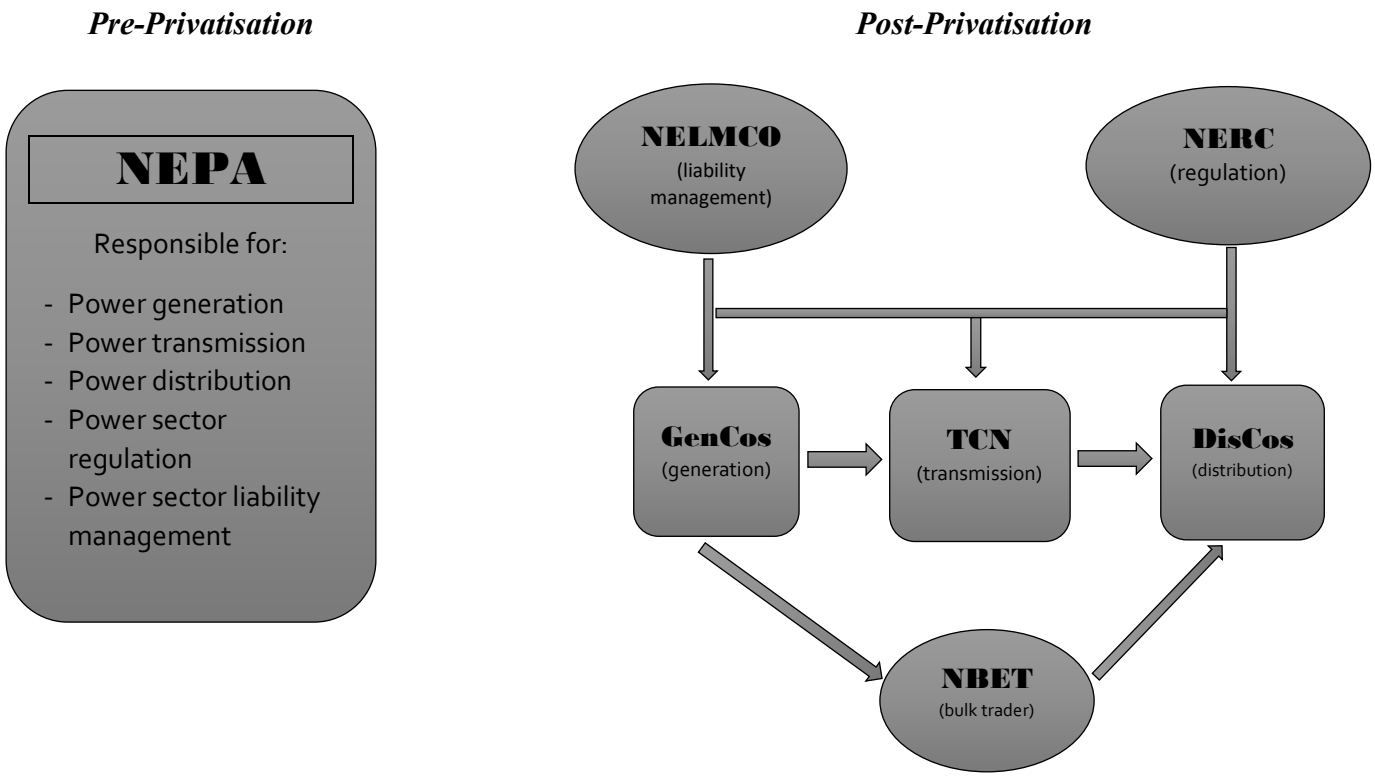
10	Yola Distribution Company	Integrated Energy Distribution & Marketing	$160	$65	60

Source: Nigeria Power Guide (2013)

However, due to widespread skepticism, most of the funds for the purchase came from domestic investors through short-term costly loans from Nigerian Banks. Specifically, international investors were skeptical about participating in the power sector privatisation because of the country's history of inefficiency and endemic corruption. This led to concerns that the financing model has increased the risks in the Nigerian financial sector. Although NBET was set up at the onset of the reform in 2006 to address this potential risk – by ensuring settlement of financial transactions between electricity generation companies and feedstock suppliers -as of 2016, NBET remain under implementation.

In sum, a major milestone achieved in the power sector was the commencement of the privatization process at the turn of the millennium. The unbundling of NEPA to eighteen companies, the transfer of assets to PHCN, and the eventual sale of the assets to private companies were monumental strides achieved in the power sector reform, and in Nigeria's pursuit for efficiency in public service delivery through private sector participation. *Figure 2* shows an overview of the structure of the Nigerian power sector pre-privatization and post-privatization. However, the current state of the power sector shows that the overbearing problems in the sector persists, and the privatization has only changed the dimensions of the challenges. Section 2 provides a detailed breakdown of the current challenges in the NESI.

Figure 2: Structure of the Nigerian Power Sector (before and after privatisation)



Source: Authors' schema

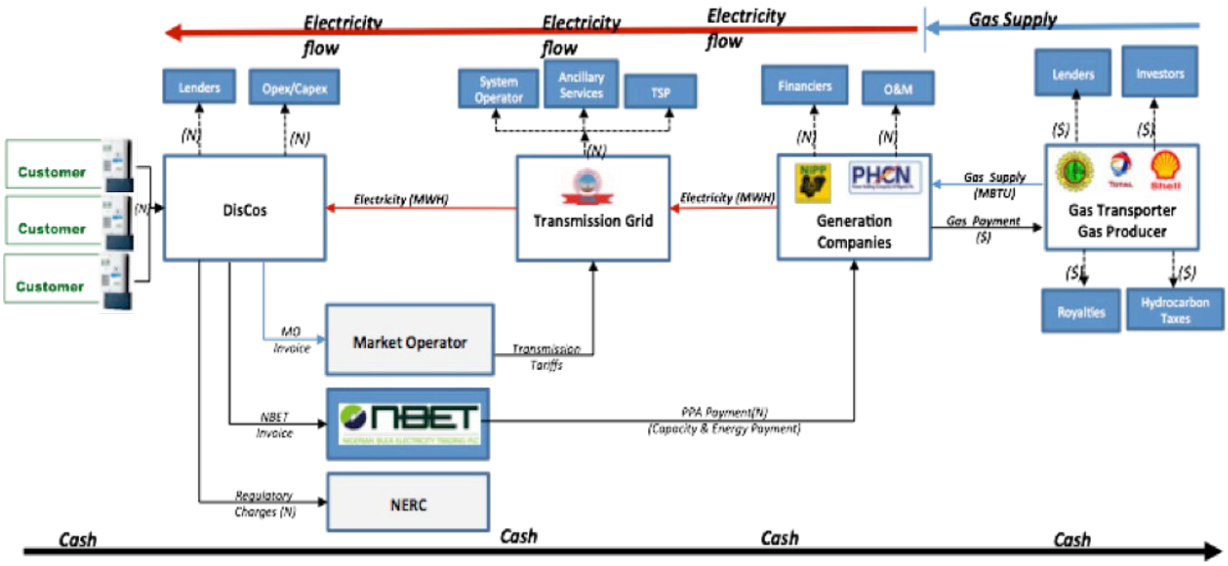
2. The Nigeria Electricity Market: Current Status

The Nigeria electricity market is yet to efficiently allocate resources and yield favorable outcomes for market participants. The supply side of the market is struggling to find its footing after a promising reform that saw the government-owned utility that failed to deliver reliable power unbundled and mostly sold to private investors. The promise of the reform is yet to materialize as new market entrants battle to optimize their operations amid daunting challenges. High electricity demand occasioned by a huge and growing population and economy creates large demand-supply gap in the electricity market. Challenges hindering the realization of an efficient market equilibrium require the most innovative of solutions.

2.1 Electricity Supply in Nigeria: Operational Framework and Challenges

The Nigerian Electricity Supply Industry (NESI) operates in such a way that any distortion or default at any point in the supply chain would create a ripple effect, thus adversely affecting the entire value chain. The NESI adopts a modern approach of deregulating government utilities, aimed at addressing market failures, management, and investment challenges. Particularly, the deregulation allows for multiple firms to operate and contribute to the electricity value chain in order for the supply of electricity to be efficient. *Figure 4* illustrates the linkages that exist in the NESI.

Figure 4: The Nigeria Electricity Supply Industry (NESI) Value Chain



Source: (Olaoye, et al., 2016)

The electricity supply industry of Nigeria consists of an interconnected flow of gas, financial resources, and electricity, across various companies in different sectors and locations. It is a highly dynamic system with a complex interplay of various factors. At the start of the value chain is the energy source, which consist of 80 percent gas. Gas producers supply gas to Generation companies at a fixed/subsidized price, which they use to generate electricity and supply to the Transmission grid which has a limited capacity. Electricity is then transmitted to the Distribution companies for

onward passage to electricity consumers. The cost incurred in the value chain is passed on to the consumers in form of electricity tariff, which in reverse motion makes its way back through the system with participating firms taking their share of the proceeds. This makes tariff pricing critical to sustaining operations and ensuring returns on investment, but presently current tariff regime in Nigeria is non-cost reflective and poses serious regulatory and operational challenges. There are other participants in the system that provide auxiliary services to ensure that the system runs effectively. NBET facilitates electricity trading in the system to ensure that generation companies get paid for the power they deliver. The Market Operator administers the wholesale electricity market and is responsible for settlement arrangements, while NERC regulates all these activities.

The NESI operates in such a way that distortions or defaults at any point in the supply chain would create a ripple effect that adversely affects the entire value chain. Typically, free-market incentives ought to sustain the smooth running of such competitive market, however, the complexity of challenges in the system requires a governance structure or regulatory framework to address market failures. Particularly, NBET was set up to provide risk-sharing incentives to ensure that investors in the power generation segment of the value chain are guaranteed some returns. Also, given the apathy of gas producers to supply gas domestically, the government had to put in place regulation to ensure that GenCos have a subsidized access to gas.

A breakdown of the key factors and challenges affecting the operation of individual segments of the NESI (generation, transmission, and distribution) is presented subsequently.

2.1.1 Generation

Three main factors typically play a role in determining the productivity and performance of GenCos in the NESI. These include: energy source, finance, and the activities of the other segments of NESI value chain.

Particularly, ensuring the availability, reliability, sustainability, and affordability of energy sources is critical to higher and sustained power generation in the country. Currently, the NESI has undiversified energy sources, with GenCos heavily dependent on thermal energy (which constitute 80% of energy sources) and hydro (20%). The government has been reluctant to diversify energy sources due to the relative affordability of large hydro and gas-powered plants over alternative sources (Henrich Boll Stiftung, 2017). Unfortunately, gas supply in Nigeria is presently constrained by: vandalism[4], poor gas infrastructure, pricing regulation[5], failure of GenCos to meet gas payments, as well as delayed reforms in the oil and gas sector[6]. As such, there are only 25 grid-connected generating plants in operation in the NESI with a total installed capacity of 11,165.4 MW but available capacity of 7,139.6 MW (*Table 3*). However, the government and private sector are looking to diversify the energy sources and improve generation capacity by

[4] There were over 400 attacks on pipelines between January and March 2016 (Adewumi, 2016)
[5] Price of gas sold to thermal plants is regulated by NERC at $2.50 per thousand standard cubic feet, which is lower than the average price in the international market. http://www.nasdaq.com/markets/natural-gas.aspx
[6] Particularly, the non-passage of the Petroleum Industry Bill (PIB) aimed at addressing inefficiencies in the oil and gas sector, which is discouraging investors.

pursuing alternative energy projects, with a focus on solar, and further exploiting the thermal and hydro sources (*See Appendix*).

Table 3: Grid-connected Generating Plant with Capacities

	Name	**Arrangement**	**Type**	**Capacity (MW)**
1- 5	Afam Power Plc (I-V)	Successor Generation Companies	Thermal	987.2
6	Egbin Power Plc		Thermal	1,320
7	Kainji Hydro Electric Plc		Hydro	760
8	Jebba Hydro Power Plant		Hydro	578
9	Sapele Power Plc		Thermal	1,020
10	Shiroro Hydro Electric Plc		Hydro	600
11	Ugheli Power Plc		Thermal	942
12	Shell – Afam VI	Independent Power Producers (IPPs)	Thermal	642
13	Agip – Okpai		Thermal	480
14	AES Barges		Thermal	270
15-16	Alaoji Phase I&II*	National Integrated Power Projects	Thermal	1,131
17	Benin		Thermal	508
18	Calabar		Thermal	634
19	Egbema		Thermal	381
20	Gbarain*		Thermal	254
21	Geregu		Thermal	506
22	Ogorode		Thermal	508
23	Olorunsogo		Thermal	754
24	Omoku*		Thermal	265
25	Omotosho		Thermal	513

* Ongoing Projects

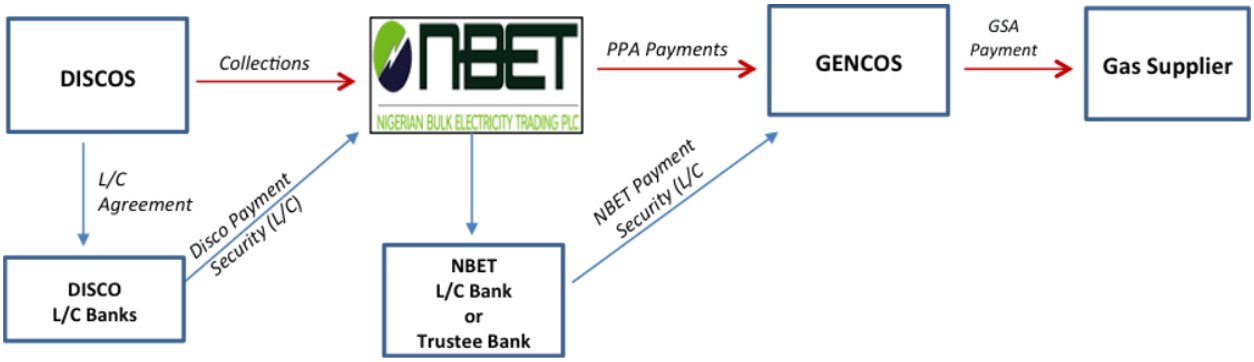
Source: Nigerian Electricity Regulatory Commission

In addition, having reliable access to investment funds either via loans (from money market) or dependable cash flow (from consumers) backed by an efficient electricity tariffs is also vital to the operations of GenCos. Presently, the flow of cash from electricity consumers to the supply chain

is grossly inefficient, contributing to a huge liquidity shortfall in the NESI. For instance, only 25.2 percent of GenCos invoice was paid in 2016. More so, according to Nigerian Electricity Hub (2016), only 48 percent of revenue is collected monthly by DISCOs– largely on account of non-payment of electricity bills by the Ministries, Agencies and Departments (MDAs). Furthermore, the existing legacy debt owed to gas producers have made these companies reluctant to provide more gas to the GenCos, until all or some of these debts are settled. Unfortunately, NBET has been unsuccessful in ensuring that investors in power generation activities are paid in full (*Figure 5*).

At the same time, the GenCos are facing difficulties in repaying their short-term debts due to higher interest rate, depreciating naira-dollar exchange rate, and revenue collection losses. This is worsening by the fact that the assumptions that fed into the pricing mechanism have dismantled and left GenCos struggling to remain in business. Presently, assumptions governing market operations such as inflation, exchange rate, and the timeline of tariff review do not mirror current realities. For instance, while Gas Purchase Agreements (GPAs) are denominated in US dollars, GenCos receive payments in naira. This has exposed them to exchange rate risks that has led to their inability to meet GPA obligations and import equipment necessary to upgrade their plants. Such performance limits their ability to finance investments in upgrading their plants, meet gas payments, and cover costs of operation and maintenance. These financial challenges have prompted the government to extend a ₦213 billion market stabilization facility in 2016 and another ₦702 billion facility to NBET in 2017 to meet its contractual obligations to GenCos. Further, the Power Minister has declared "Eligible Customers", to allow GenCos address some of their financial problems. The World Bank is currently working with the government to restructure the market governance structure to encourage investment.

Figure 5: NESI Payment Security Structure



Source: (Anyanechi, 2016)

But even in the presence of efficient energy source and adequate finance, technical losses in the transmission and distribution segments can disrupt the service delivery of GenCos. Particularly, if GenCos were to improve their operational capacity, these improvements cannot be accommodated

by the transmission grid given inefficiencies in the transmission segment[7]. *Section 2.1.2* provides more details

Hence, the need to get the gas-to-power value chain working efficiently cannot be overemphasized given the importance of gas to the NESI energy mix. Addressing the gas constraints can increase power generation by about 30 percent, according to industry experts (PWC, 2016). In response to the need to improve power generation, the FGN through the NERC increased the price of gas supplied to gas companies from US$1.50 to US$2.50 which is closer to the industry price of US$3.50 in order to incentivize gas producers to continue to supply gas feedstock to the generation companies (FGN, 2016). However, gas price is still very low especially given the depreciating exchange.

2.1.2 Transmission

The challenges in the transmission segment of the electricity value chain lies in: financial constraints, lack of modern transmission lines and equipment, gross mismanagement, poor maintenance of available infrastructure as well as inefficient grid design and operation (Sambo, et al., 2012). The operations of the Transmission Company of Nigeria (TCN) has been largely constrained by financial deficits. The TCN, on average, receives only about 21 percent of its transmission invoice from distribution companies (Gumel, 2016). Not are TCNs owed over N107 billion due to non-remittance by distribution companies, the ₦17 billion Electricity Facility Fund is yet to be released for the operations of the TCN (Nigeria Electricity Power Hub, 2017).

Besides financial constraint, the TCN has limited transmission capacity due to infrastructure deficits and poor maintenance. Presently, the TCN has the capacity to transmit just about 7,200MW of electricity[8], and at present capacity, the national grid cannot evacuate all available electricity from GenCos. These problems have contributed to the high electric power transmission and distribution losses recorded over the years, thereby significantly increasing the unit cost of electricity. The liquidity crisis further dampens the ability of the TCN to improve operations and capacity.

In addition, the TCN was under the management of an international private company – and Manitoba is seen as poorly-managed. In 2016, the House of Representatives intended to probe the firm over reports of poor performance and claims that the firm's expatriate management was taking huge sums of money as salaries by inflating the exchange rate (Independent, 2016). In light of these underperformances of the TCN, the Federal Government failed to renew Manitoba's contract on the account of mismanagement.

Going forward, major and wide-ranging improvements are needed in the national grid to enable it accommodate any increase in power generation. An estimated $1.5 billion annually for the next

[7] Though Generation Companies can enter into bilateral agreement with Distribution Companies to supply excess electricity directly to their distribution networks, bypassing the national grid.

[8] Minister of Power, Babatunde Fashola's remarks at the January Nextier Power Dialogue. Communique available at: http://www.nigeriaelectricityhub.com/download/communique-january-2017-nextier-power-dialogue-with-h-m-babatunde-fashola/

five years is required to be able to transmit available power from GenCos which is presently out of reach (PWC, 2016). Although the government has solicited for some financial support to fund the reinforcement amounting to $3.4 billion - $3.7 billion USD from proceeds of the NIPP sales, China Exim Bank, IBRD (under consideration) and other Development Finance Institutions such as the Islamic Development Bank and AFDB, this is yet to be implemented. In addition, the government is targeting additional N700 million from power wheeling charges which would be used for some of its quick-win projects contained in its 10,000MW transmission capacity plans. The Federal Government is also considering the privatization of the TCN due to financial and management issues, but members of the private sector have advised the government not to sell some of the defunct assets of TCN because privatization of power generation and distribution has not yielded any gains (Nigerian Electricity Hub, 2016).

At the same time, the private sector is exploring ways to reduce dependence on national grid and capitalize of transmission market. For instance, Petrocam Nigeria Limited introduced solar-powered filling stations to reduce dependence on national grid electricity. A Ghanaian firm is set to establish wiring and transmission equipment factory in Nigeria (Nigerian Electricty Hub, 2016).

2.1.3 Distribution

DisCos are faced with the challenges of huge Aggregate Technical, Commercial, and Collection (ATC&C) losses and lack of access to finance. First, DisCos are experiencing substantial ATC&C losses on a daily basis due to poor distribution infrastructure, poor billing system, electricity theft, and non-payment of electricity bill. The average ATC&C losses is estimated at 58.91 percent (NERC, 2017)

Particularly, weak distribution networks coupled with heavy demands loads have increased the technical losses in power distribution (Emodi & Yusuf, 2015). This is further exacerbated by network glitches caused by vandalism, accidents, and infrastructural decay that make DisCos unable to relay power even when it is available on the national grid leading to long-term power outages and load shedding. According to the World Bank 2014 Enterprise Survey, the number of power outages in firms in a typical month in Nigeria is recorded at 33 –this is well-above the average for sub-Saharan Africa estimated at 8.3.To reduce these losses and enhance service delivery, DisCos have implemented maintenance and upgrades on their network by installing new transformers and building dedicated lines to commercial and industrial customers over the past year. Also, some DisCos have introduced a unit to curb power thefts and incidents of vandalism.

In addition, a lot of electricity consumers are either not metered or use obsolete meters leading to inaccurate billing; thus culminates in commercial losses for DisCos. In this regard, NERC mandated all DisCos to meter their customers and avoid estimated billing. Many DisCos have embarked upon mass metering of customers but current efforts fall short of an estimated metering gap of over two million units (Ike, 2012).

Furthermore, the widespread electricity theft among consumers, both metered and unmetered, have led to collection losses for DisCos. For instance, metered consumers hire the services of roadside electricians to wire their homes and businesses in a way that high energy consuming appliances

'bypass' the meter, thereby paying for less power than they actually consume.[9] Collection losses are aggravated by the non-payment of electricity bills by government ministries, agencies and departments (MDAs), as well as certain non-governmental organizations like the Manufacturers Association of Nigeria (MAN) which has refused to pay the revised power tariffs.[10] These collection problems arise mostly because private consumers and government bodies share the notion that electricity is a social good, thus there is a sense of entitlement to the utility in Nigeria that fails to recognize the commerciality of power. Therefore, revenues accruing to DisCos are barely enough to cover their fixed operation costs, let alone recover any potential cost of upgrading or improving electricity infrastructure. In 2016, DisCos were only able to pay 25.8 percent of their bill to NBET. On its part, the federal government promised to pay DisCos electricity bills owed by MDAs by deducting from source, after an audit report put MDAs' debt to DisCos at ₦59 billion. DisCos had disconnected some MDAs and threatened to disconnect others. Also, DisCos have instituted a whistleblowing policy in order to mitigate the rate of power theft.

At the same time, DisCos are facing difficulties in sourcing loans due to their inability to repay current debts occasioned by the higher interest rate, depreciating naira-dollar exchange rate, and consumers' unwillingness to fully pay for electricity. This starves the distribution segment of crucial investment, particularly in properly metering of customers, upgrading distribution infrastructure and expanding distribution networks to serve more consumers. Thus, due to the massive financial shortages coupled with low expectation of a reasonable and timely return on investment (since current electricity tariffs favor affordability over cost recovery), there are currently no incentives for investment in electricity distribution.

In response to these challenges, the government through the Central Bank of Nigeria (CBN) extended a NGN 213 billion (approximately $1 billion) loan facility to both GenCos and DiCos in August 2014 which is to be repaid with a first-line charge on their revenues over a 10-year period (FGN, 2016). However, this remains insufficient to cover the revenue shortfalls in the power sector due to daily accumulation of losses. Also, the NERC has approved for the Discos to validate their baseline losses which will be considered as part of a possible electricity tariff review in the future. However, there is uncertainty in the timeline of promised review. Despite the challenges, some DisCos have been able to attract investment. For instance, Ibadan DisCo secured a $400 million investment from Trans Sahara Consortium for network upgrade and customer metering.

2.1.4 Regulation

An overarching challenge in the regulation of the NESI is the non-cost reflective tariff regime arising from failed assumptions in formulating the pricing mechanism, as well as political pressure to maintain electricity affordability. Specifically, the failure of certain assumptions in the formulation of the present electricity tariff regime have led to electricity usage prices in Nigeria being below electricity production cost (Joseph, 2014; Olaoye, et al., 2016). For instance, in 2013, only 35%-45% ATC&C loses were factored into the tariff charges in the MYTO II, however by

[9] This electricity leak is called 'rocking' in Nigeria's context (Emodi & Yusuf, 2015)
[10] Ibid (no. 9)

2015, it was ascertained that the ATC&C losses in the sector stand at 60%; thus resulting in the underpricing of electricity.

Furthermore, NERC's decision to keep electricity tariff low/affordable at the expense of cost-recovery has put the GenCos, TCN, and DisCos in a trap of low revenues, high debts, inadequate maintenance, under-investment, and poor quality of service. While the importance of recovering the costs of electricity supply is necessary towards earning a return on investment and funding future capital spending, NERC has rather opted for the political and social imperatives for keeping prices at levels that allow consumers to benefit from affordable electricity service. Ironically, given that low-earning individuals whom tariffs should benefit do not have access to electricity, subsidies typically end up benefiting a small group of more affluent individuals who consume a higher percentage of electricity. Better yet, available funds ought to be channeled towards improving access and reliability of electricity while the market is allowed to allocate resources efficiently at a cost-reflective tariff.

In response to the need to address the low tariff regime, the government introduced a new electricity tariff – a reset tariff order (Multi Year Tariff Order, MYTO 2.2) in February 2016 – which takes into consideration the facility provided by the CBN, current levels of energy output in the country, new baseline gas price, and other variables that more closely reflect the true cost of running electricity businesses (FGN, 2016). The new tariff order pushed electricity prices upwards, for instance from N11 per kWh to N23.60 per kWh in Abuja. However, the new prices still fail to fully reflect the cost of providing power.

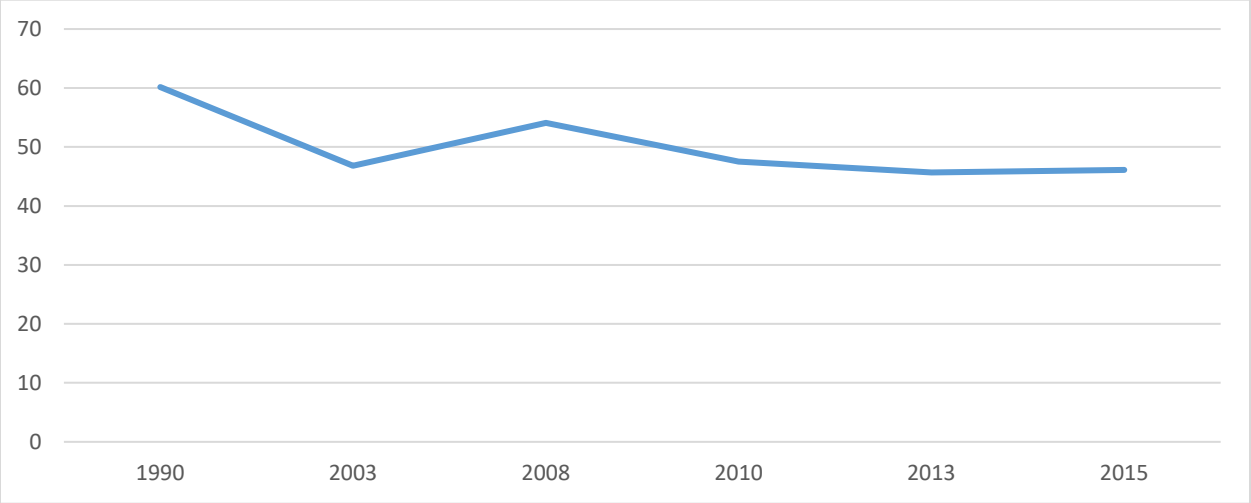
2.2 Electricity Demand in Nigeria

2.2.1 Electricity Access and Demand

While electricity access in Nigeria has improved over the years, in terms of the proportion of the population, a huge percentage of the Nigerian population remains unconnected to the national electricity grid and thus have no access to electricity. According to the National Bureau of Statistics, the percentage of the people that have no access to electricity have fallen from 60.16 percent in 1990 to 46.09 percent in 2015 *(Figure 6).* However, the absolute number of the Nigerian population without access to electricity have increased from 57.3 million in 1990 to 83.98 million in 2015. This reflects the fact that the improvements in the Nigerian power sector has not been proportional to population growth.

Even worse, connection to the national grid does not guarantee availability or reliability of power supply. Among households connected to the national grid (under-served population), some do not receive power supply for consecutive months, while others only experience occasional interruptions in power supply. It is common for under-served consumers to use backup generating sets in case of low voltage, load shedding or black outs.

Figure 6: Percent of Population without Access to Electricity (Not Connected to National Grid)



Source: NBS, 2015

Furthermore, electricity demand in Nigeria is estimated at 24,380 MW, as at 2015 (Ley, et al., 2015). This is projected to grow to 45,490 MW (2020); 115,674 MW (2030), 213,122 (2040). In contrast, the NESI has a total available generating capacity of 7,139.6 MW. The huge gap between electricity demand and supply buttresses the tremendous need to improve power generation, transmission, and distribution in the country in order to meet growing demand.

Critically, the poor state of electricity access in Nigeria is a reflection of challenging realities in the country, including poor current state of electricity infrastructure, nature and extent of expected flows of investment into different parts of the power sector, and demographic factors such as population size and population growth, especially in rural areas where providing access is much more difficult (IEA, 2014, p. 122). Failure of electricity supply to increase over the years has made a daunting challenge of meeting demand even more difficult. New demand as a result of population growth and new industrial and commercial demand due to economic growth constitute a huge problem for closing the deficit. Further considering historical trends in the rate of growth of population and economic activity vis-à-vis electricity production and supply, forecasted future demand can only be met with the most innovative of solutions.

2.2.2 Composition of Electricity Consumption

Studies have identified power shortages as one of the major reasons for the dwindling growth of most underdeveloped countries (Ferguson et. al, 2000; Morimoto and Hope, 2001). In terms of Rostow's five stages of economic development, a reliable electricity supply is the main catalyst for the long-desired transformation of Nigeria from a "traditional society preparing for take-off" to the "Take-off" stage. Given that the manufacturing sector plays a prominent role in raising and sustaining productivity growth required for the Take-off stage, Nigeria would not be able to leapfrog into the next phase of economic growth if power supply remains deficient. One of the consequences of the low electricity supply, particularly for industrial use, is the high cost of doing business for manufacturers in Nigeria, who have to pay in excess of N100 per kWh on diesel for self-generation (Straplan Research, 2012). According to Moss and Portelance (2017),Nigeria is 80

percent below its energy use, based solely on income levels –this is the lowest in the world. *Table 4* better represents the appalling state of energy consumption in Nigeria relative to selected developed and developing countries.

Table 4: Nigeria's Energy Situation compared with Selected Countries

Country	Population (Million)	Generation Capacity (GW)	Energy Consumption (billion kwh)	Energy Consumption per Capita (kwh)
USA	321,368,864	1,053	3,883	12,083
Germany	80,854,408	178	583	7,204
UK	64,088,222	76	304	4,740
South. Africa	53,675,563	44	234	4,363
China	1,367,485,388	1,505	5,523	4,039
Brazil	204,259,812	119	479	2,344
Egypt	88,487,396	27	129	1,462
Indonesia	255,993,674	41	156	609
India	1,251,695,584	223	758	605
Ghana	26,327,649	3.0	11	403
Nigeria	**178,562,056**	**7.6**	**23**	**129**

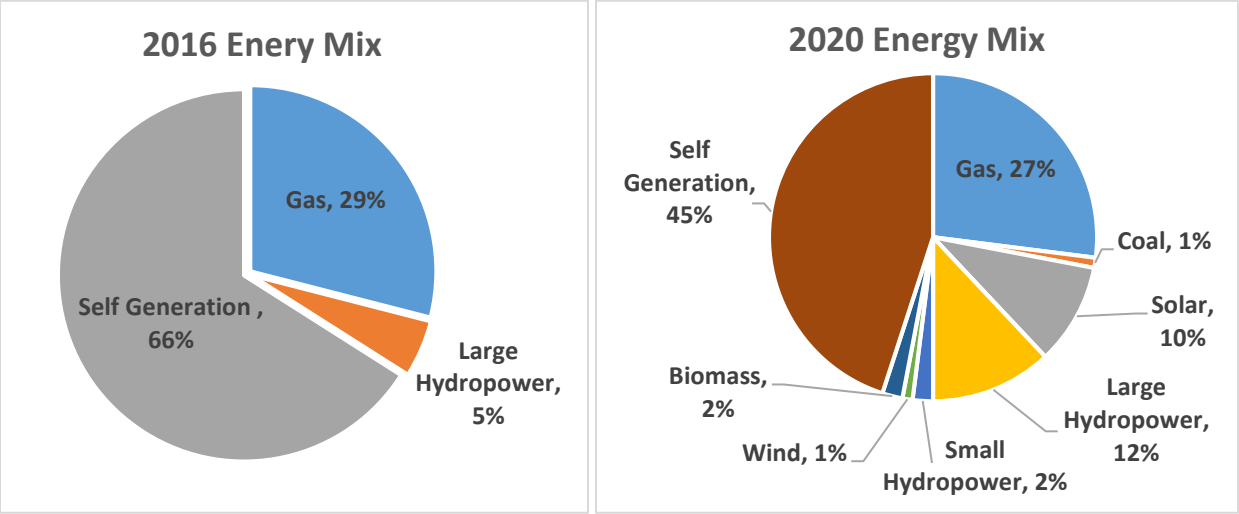
NACOP, 2016

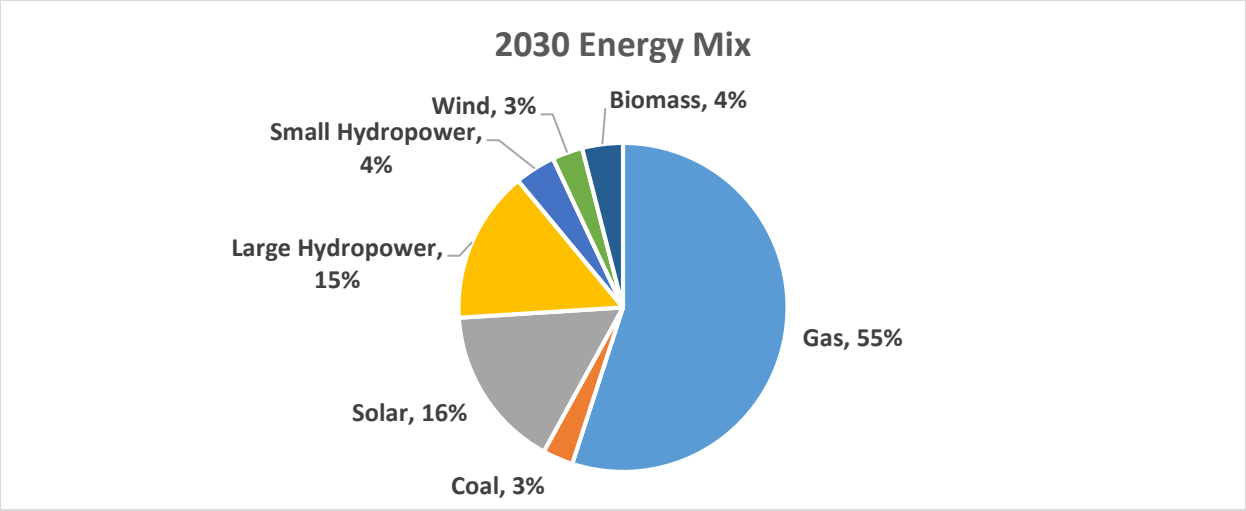
In summary, the current state of the NESI is deplorable especially when juxtaposed with electricity demand of the country's growing population. Electricity production remain significantly lower than electricity demand on account of several challenges in the industry: from a lack of diversified energy source, to financial constraints and regulatory issues present throughout the entire value chain of the NESI. Although access to electricity has fairlyimproved, a large proportion of households remain excluded from the national grid while those who are included barely receive electricity. While the government and private sector are making efforts to resolve some of the pressing challenges in the industry, the privatization of the NESI is yet to produce an efficient electricity market. Section 3 provides more details of government plans and targets for the NESI.

3. Government Plans

One of the key challenges plaguing the NESI is the lack of a diversified energy source which is deemed necessary to make electricity supply less vulnerable to disruptions as well as more available, affordable and reliable. Due to the high volatility in electricity supply, most of the households and businesses in the country use self-generating sets as a source of electricity. In a bid to tackle this problem, the Federal Government of Nigeria (FGN) has set targets for the country's energy mix. This should allow Nigeria to exploit its potential for coal, solar, wind, biomass, as well as small and large hydroelectric power generation, while reducing prevalence of self-generation – which constitute two-thirds of present energy mix. Presently, the country's estimated average generation capacity as at 2016 was 5,700MW per hour; with 86 percent of the on-grid capacity originating from gas-fired thermal power stations and the remaining 14 percent from the three large hydroelectirc power stations (FGN, 2016). By diversifying the country's energy mix, average generation capacity is projected to increase by 10,325 MW per hour by 2020, and up to 30,000 MW per hour by 2030 *(Figure 7).*

Figure 7: Present Energy Mix and Projected Energy Mix Targets

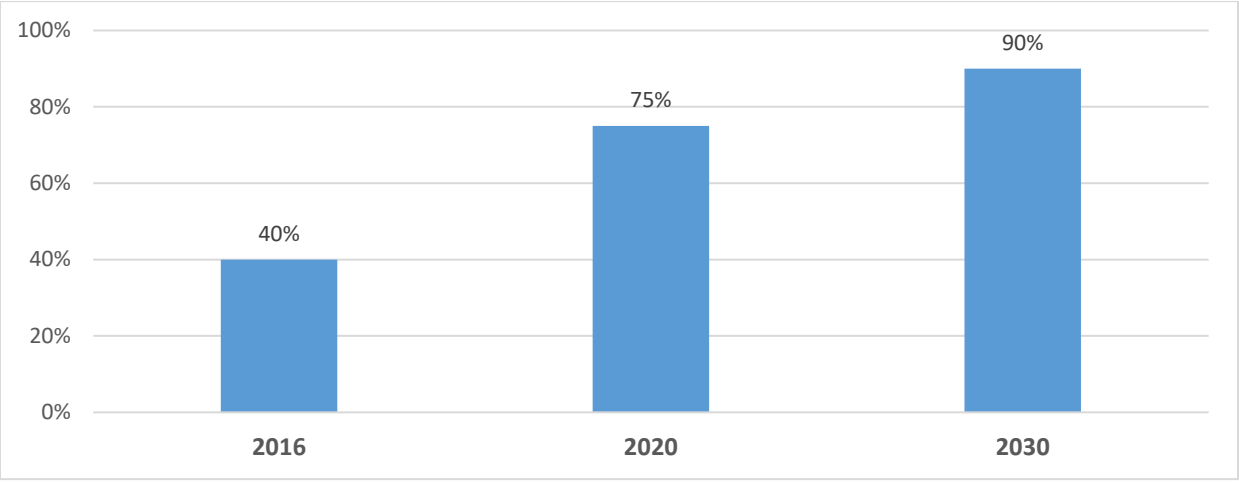




Source: FGN, 2016

Thus, government's medium-term target (by year 2020) is to achieve up to 75 percent access to electricity by 2020 by connecting 1.5 million households annually through grid extensions, non-grid extensions powered using more renewable energy sources such as solar, wind, small and medium hydropower stations. This is expected to increase electricity access to 90 percent *(Figure 8),* and significantly reduce the use of personal generators (self-generation). In the long term, by 2030, the government expects to completely eradicate the use of personal generators by further improving power supply and energy mix. As part of the short-term plan, the Transmission Company of Nigeria (TCN) has developed a 5- year transmission system expansion plan that covers the period of 2016-2022. This is meant to bring the wheeling capacity of 5,300MW to 20,000MW by 2022 at first instance as part of short term measure and to urgently address the shortfall in transmission sub-sector of electricity supply industry (ESI). The Sustainable Energy for All Action Agenda (SEA4ALL-AA) provides details of Nigeria's targets for energy documented in NACOP (2016).

Figure 8: Target for Electricity Access



Source: NACOP, 2016

In addition to the energy mix targets, the government in its SEA4ALL plans to initiate energy efficiency projects across the country such as: the Abuja Green City initiative (low-carbon housing development), the Nigerian Clean Cookstove Design and Testing Centre, the Nigerian Clean Energy Access Program, and National Building Code (to integrate energy-efficiency in building codes. Some of Grid capacity expansion plans of the government include: All State capitals to have 330/132Kv TS, and all Transmission stations to be upgraded and have at least 2 functional (not-overloaded) transformers at each time.

Albeit the aforementioned, the overarching targets set for year 2020 and 2030 as indicated in the SEA4ALL action agenda can be seen in *Table 5*:

Table 5: Overall Target for 2020 and 2030

2020	**2030**
• Efficient lighting will be used by 40% of the households	1. Efficient lighting will be used by almost 100% of the households
• For high-energy consuming sectors (transport, power and industrial sectors), efficient energy will increase by at least 20% compared to baseline	2. For high-energy consuming sectors (transport, power and industrial sectors), efficient energy will increase by at least 50% compared to baseline
• Achieve 10% biofuel blends	3. Curb the firewood demand below supply capacity
• Improve the efficiency of the bioenergy sector	
• Distribution loss reduction target to 15-20%	4. Distribution loss reduction target to less than 10%

Source: NACOP, 2016

In order to achieve these targets, it is estimated that the country will require investments in power generating capacity alone of at least US$ 3.5 billion per annum. Correspondingly, large investments are also required in the other parts of the supply chain (that is, the fuel-to-power infrastructure, power transmission and distribution networks). The growth in energy mix would depend on the completion of various hydroelectric power projects funded by the FGN and under the Private-Public – Partnership (PPP) arrangement. The large proportion of the energy mix growth would come through other generation arising from already signed number of Power Purchase Agreements (PPAs) with Bulk Trader as well as those coming through new competitive bulk procurement process by electricity producers to meet expected target.

In overall, the Nigerian government has set out ambitious overall targets for the electricity industry aimed at improving electricity supply in the country. While Nigeria's energy mix target is

desirable, the prospect of success remain bleak on account of financial constraints, pricing policy, and lack of policy coordination. However, the impressive strides of Power Africa team in Nigeria providing technical and legal support to the Nigerian government on energy matters, reduces doubts on the prospects of achieving the ambitious targets for 2030 . For instance, in July 2016, the Nigerian Bulk Trader, with the support of the Power Africa team, signed a historic power purchasing agreements (PPA) on 14 Solar independent power projects (IPP) worth $1.5 billion of combined domestic and foreign direct investment.

4. New Trends and Future Outlook

4.1 Exploring Gas Reserves: Azura-Edo Independent Power Plant (IPP)

The Azura-Edo IPP pioneers a new wave of large scale, project-financed, greenfield independent power plants (IPPs) currently being developed in Nigeria. The project was conceived in 2010 and reached financial close in December 2015. It is financed with debt and equity sourced from a consortium of local and international financiers. Construction on Phase I of the project began in January 2016 and it comprises: a 459 MW open cycle gas turbine power station; a short transmission line connecting the power plant to a local substation; and a short underground gas pipeline connecting the power plant to the country's main gas-supply. The construction is being carried out by a consortium of Julius Berger, Siemens, and some Nigerian construction firms. Phase I of the project is billed to be operational in 2018. Phases 2 and 3 of the project will then take the total capacity up to 1,500MW (Azura, 2016).

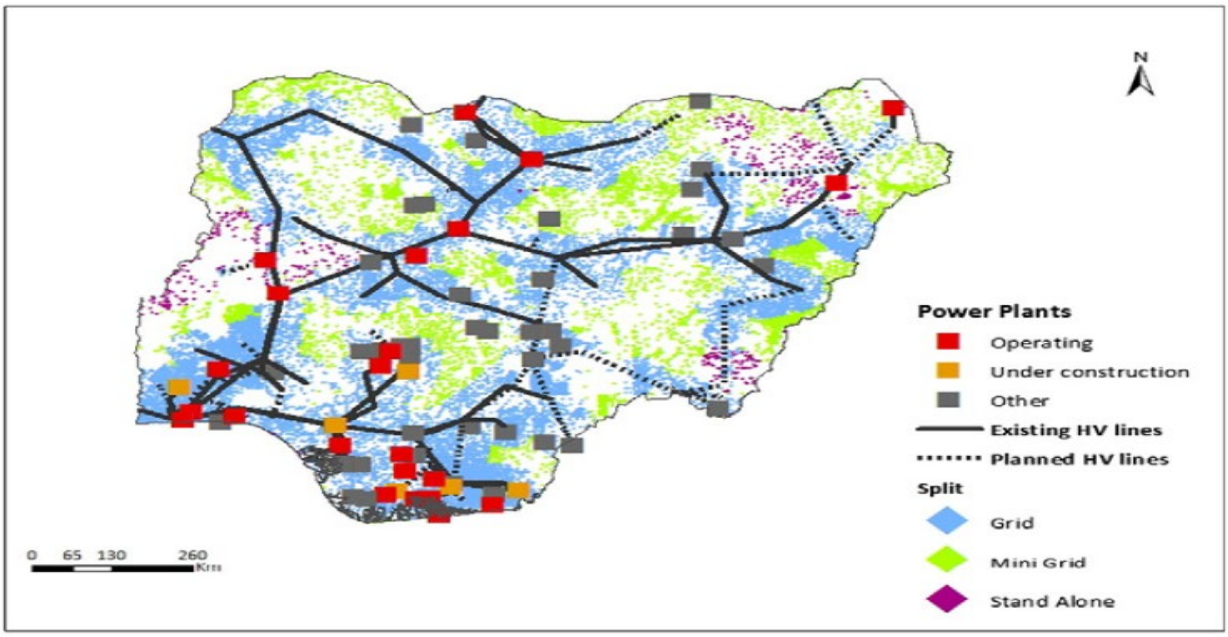
Natural gas is a major component of Nigeria's energy mix and its abundance lends it to further exploration to meet the huge demand for electricity in Nigeria. Azura provides a veritable model for other IPPs to follow in mobilizing finance, getting permits, getting projects off the ground with integrity, using a transparent set of procedures and approvals, extending to social and environmental aspects. Successful operation of Azura-Edo IPP going forward would boost investor confidence and electricity supply in the Nigerian Electricity Supply Industry.

4.2 Employing geo-spatial analysis for developing optimal electrification plan

Difficulties in accessing data in Nigeria restrict the assessment of alternative electrification options to obtain the optimal mix of such options in providing new access to electricity. Pursuing mass or nationwide electrification without an analysis-backed agenda heightens the risk of financial waste and eventual system inefficiency, aside from increasing the timeframe for delivering reliable energy for all. Mentis et al. (2015) looked to inform electrification policy by employing strategic power planning methodologies and tools despite serious data limitations. They draw on Geospatial Information Systems (GIS) tools and remote sensing techniques to fill data gaps, which they use for a comprehensive and quantitative assessment of national and regional electrification.

The study shows that grid-based connections are preferred for high consumption levels. A connection to the grid constitutes the lowest cost option for 85.6 percent of newly electrified population. Further, they found high geospatial diversity in technology and cost deployments, meaning that a mix of grid-connected and local generation capacity is needed to address electrification needs more efficiently. *Figure 9* captures the results of their analysis, showing the optimal mix of electrification options and the potential cost in terms of LCOE, of providing electricity in various regions of Nigeria. The methodology developed by Mentis et al. (2015) can inform the formulation of an integrated strategic electrification plan, which should also comprise of useful analyses such as engineering load efficiency analysis, a necessary tool in grid expansion (Powell, 2004).

Figure 9: Optimal Electrification Mix in Nigeria



Source: Mentis et al. (2015)

5. Conclusion and Recommendations

5.1 Summary

Nigeria's Electricity Supply Industry (NESI) continues to experience weak performance despite the implementation of a promising reform. Players in the NESI are plagued by a host of challenges including: an undiversified energy source base, financial constraints, infrastructural deficits which are exacerbated by vandalism, huge aggregate technical, commercial and collection (ATC&C) losses, and operating under an inefficient market governance structure. This state of Nigeria's electricity sector makes it a major underperformer in Africa.

These challenges constitute a major setback to government's plans of providing reliable and affordable access to electricity for all in Nigeria. The government has ambitious targets of: having a diversified energy source base with a significant proportion of renewables, phasing out self-generation of electricity using personal generators, increasing electricity access to 90% of the population from the current 40%, and improving energy use efficiency.

The majority of the aforementioned challenges persist despite government and private sector effort in mitigating them and pursuing set objectives. The government has inaugurated a host of projects aimed at expanding thermal and hydro sources and has a keen focus on exploiting solar energy. In addition, the government has extended two intervention facilities to GenCos and DisCos to ease their financial constraints. Ongoing peace negotiations along with efforts of law enforcement agencies are expected to curb vandalism on electricity and gas infrastructure. Furthermore, the government in collaboration with the World Bank is working to rejig the governance structure in NESI to make it more effective. On their own part, the private sector has also made efforts to expand thermal and hydro sources and rolled out several solar energy projects. GenCos and DisCos have invested in maintaining and upgrading their plants and networks, metering, and checking power theft. However, such investments are marginal compared to existing deficits and targets. Also, the private sector has enjoyed limited success in obtaining loans or attracting investments.

Some of the impediments to private sector investment in the NESI include: revenue shortages and low expectation of a reasonable and timely return on investment, uncertainty around government fiscal policies, limited government financial incentives, lack of financial window dedicated to energy in many financial institutions, and inadequate provision of long-term stability in investment climate for energy infrastructure.

In order to enhance the effectiveness of service delivery in NESI, certain steps need to be followed by relevant stakeholders, including: addressing crucial issues in the gas-to-power value chain around pricing and allocation given its prominence in current energy mix, reworking the current governance structure and enhancing system credibility, implementing an integrated and realistic plan that caters for complementarities in NESI, instituting market friendly regulations around pricing structure and mini-grid initiatives, and encouraging efficient and lawful consumption of electricity.

5.2 Way Forward

In line with the insights that follow from our analysis of the Nigeria electricity sector, we discuss the pathways through which wholesale improvements can be reached and electricity targets can be met. Improving electricity supply in Nigeria and addressing barriers to achieving the energy mix targets will entail getting the following right in a timely manner:

i. *Addressing payment risk:* NBET needs to project more reliability and have the financial backing to realistically do so. Much investment is needed in human capacity building within government institutions in the sector, to help in differentiating between legitimate demands of potential investors and unwarranted requests for government guarantees and undertakings. Furthermore, a risk sharing scheme is required to spread the risks associated with providing power equitably across the value chain.

ii. *Financing power sector investment:* Low financial inclusion is one of the major problems of sourcing finance locally. Finance from local institutions is either unavailable or extortionately expensive. Improving access to basic financial services is key in mobilizing savings and channeling them to investment. Also, documenting substantial improvements in the sector can give it access to growing pension funds and insurance resources seeking productive long term investment. A good fit given the longevity of amortization of investment in the sector.

iii. *Pricing and tariff structure:* A majority of electricity consumers have a limited ability to pay and a low expectation of the quality of service. In the interest of consumers, NERC being a government regulator responsible for reviewing and costing the electricity value chain, finds itself favoring affordability over cost-effectiveness. The outcome is an understatement of the estimate of the cost of delivering electricity, so as to maintain a low tariff –which is a recipe for low investment in the industry. Yet investment needs is arguably the most pressing challenge in the NESI. To boost investment in the NESI, contracting an independent assessment/review of the NESI value chain would be vital to ensure an accurate estimation of costs associated with electricity delivery. Then electricity tariff would need to be adjusted accordingly.

iv. *Gas pricing and allocation*: Given its prominence in the energy mix, laying down proper regulatory framework for gas transmission and distribution infrastructure as well as contracting and pricing arrangements that guarantee reliable supply and a reasonably predictable return to the gas suppliers is of upmost importance.

v. *Market regulation:* Taking post-privatization challenges into account, a creating new governance structure that guides operations in the system and boosts investor confidence is vital. It would also be necessary to implement an integrated and realistic plan for improving efficient generation capacity and a complimentary strategy for grid expansion and access. This would minimize the incidence of generation projects being held back by a lack of transmission capacity.

On the demand side, efficient use of electricity can count as a form of increased generation since unused power will be available to the next consumer. Practices such as the use of energy efficient appliances and switching off appliances when not in use constitute efficient electricity use. Furthermore, criminal activities such as power theft, sabotage of power infrastructure, and illegal connection to the distribution network need to be curtailed in order to guarantee improvement in the sector. More so, government ministries, departments, and agencies should encourage to pay electricity bills. Lastly, consumers' perception of electricity as a social good needs to be re-oriented. Going forward, related school curriculums may need to be changed so that school children can be taught that electricity is an economic good which would gradually imbibe a culture of paying electricity bills by citizens.

REFERENCES

Adewumi, A., 2016. *Pipeline Vandalism: Implications on Economy.* [Online] Available at: http://economicconfidential.com/2016/05/pipeline-vandalism-implications-economy/

Africa Progress Report, 2015. *Power, People, Planet: Seizing Africa's Energy and Climate Opportunities,* Geneva: Africa Progress Panel.

Alao, A., 2016. *Nigerian Gas Association laments N110b debt by customers.* [Online] Available at: http://www.worldstagegroup.com/worldstagenew/index.php?active=news&newscid=32444&catid=26

Alao, A. A., 2016. Residential and Industrial Electricity Consumption Dynamics and Economic Growth in Nigeria 1980-2012. *International Journal of Economy, Energy and Environment,* pp. 48-56.

Azura, 2016. *High Voltage: A Development Guide to the 459MW Azura-Edo IPP,* s.l.: Amaya Capital Limited.

Banwo & Ighodalo, 2015. *The Nigerian Power Sector Reforms: Overcoming Post-Privatization Challenges,* Lagos: Banwo & Ighodalo.

Dikki, B., 2014. *Update- Privatisation Issues ,* Abuja: Bureau of Public Enterprises.

Dikki, B. E., 2014. *Update –Privatization Issues,* s.l.: Bureau of Public Enterprises.

ECN, 2012. *Renewable Energy Master Plan,* Abuja: Energy Commission of Nigeria.

Emodi, N. V. & Yusuf, S. D., 2015. Improving Electricity Access in Nigeria: Obstacles and the Way Forward. *International Journal of Energy Economics and Policy,* pp. 335-351.

Emodi, N. V. & Yusuf, S. D., 2015. Improving Electricity Access in Nigeria: Obstacles and the Way Forward. *International Journal of Energy Economics and Policy ,* pp. 335-351.

Energy Access Targets Working Group, 2016. *More Than a Lightbulb: Five Recommendations to Make Modern Energy Access Meaningful for People and Prosperity,* Washington: Centre for Global Development.

Energy Commission of Nigeria, 2009. *60m Nigerians now own power generators —MAN.* [Online] Available at: http://www.energy.gov.ng/index.php?option=com_content&view=article&id=74 [Accessed 10 February 2017].

Ferguson, R., Wilkinson, W. & Hill, R., 2000. Electricity Use and Economic Development. *Energy Policy,* Volume 28, pp. 923-234.

FGN, 2016. *The Nigerian Power Sector Investment Opportunities and Guidelines.* [Online] Available at: http://www.power.gov.ng/Press%20Release/NIGERIAN%20POWER%20SECTOR%20INVESTMENT%20OPPORTUNITIES%20AND%20GUIDELINES.pdf [Accessed 17 February 2017].

Fick, M., 2016. *Nigeria's 'superminister' struggles to keep the lights turned on.* [Online] Available at: https://www.ft.com/content/58fdcef6-8701-11e6-a75a-0c4dce033ade

Gumel, E. M., 2016. *Evaluating the Technical Challenges in Dealing with an Insolvent Market.* Abuja, Nextier Power Dialogue.

Henrich Boll Stiftung, 2017. *Comparison of Costs of Electricity Generation in Nigeria,* Abuja: Henrich Boll Stiftung.

IEA, 2014. *Africa Energy Outlook,* Paris: OECD/International Energy Agency.

Ike, E. C., 2012. *Tracking the Metering Gap in Nigeria.* [Online]
Available at: https://www.esi-africa.com/wp-content/uploads/Chidi_Ike.pdf
Independent, 2016. *FG Terminates Manitoba Contract On TCN.* [Online]
Available at: http://independent.ng/fg-terminates-manitoba-contract-on-tcn/
[Accessed 18 May 2017].
International Energy Agency, 2016. *Energy Access Database.* [Online]
Available at:
http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/
[Accessed 17 February 2016].
Investopedia, 2016. *Demand Theory.* [Online]
Available at: http://www.investopedia.com/terms/d/demand.asp
Joseph, I., 2014. Issues and Challenges in the Privatized Power Sector in Nigeria. *Journal of Sustainable Development Studies,* 6(1), pp. 161-174.
KPMG, 2016. *A Guide to the Nigerian Power Sector,* s.l.: KPMG Nigeria.
Ley, K., Gaines, D. J. & Ghatikar, A., 2015. *The Nigerian Energy Sector: An Overview with a Special Emphasis on Renewable Energy, Energy Efficiency and Rural Electrification,* Abuja: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
Mentis, D. et al., 2015. A GIS-based approach for electrification planning—A case study on Nigeria. *Energy for Sustainable Development,* pp. 142-150.
Morimoto, R. & Hope, C., 2001. *The Impact of Electricity Supply on Economic Growth in Sri Lanka.* Cambridge: The Judge Institute of Management Studies .
Moss, T. & Portelance, G., 2017. *Do African Countries Consume Less (or More) Electricity than Thier Income Levels Suggest?.* [Online]
Available at: https://www.cgdev.org/blog/do-african-countries-consume-less-or-more-electricity-than-their-income-levels-suggest
[Accessed 11 9 2017].
Moyo, B., 2012. Do Power Cuts Affect Productivity, A Case Study of Nigerian Manufacturing Firms. *International Business & Economics Research Journal,* pp. 1163 - 1174.
NACOP, 2016. *Sustainable Energy for All Action Agenda.* [Online]
Available at:
http://www.se4all.org/sites/default/files/NIGERIA_SE4ALL_ACTION_AGENDA_FINAL.pdf [Accessed 7 February 2017].
National Bureau of Statistics, 2012. *Annual Abstract of Statistics,* s.l.: National Bureau of Statistics.
National Population Commission, 2015. *Demographic and Health Survey,* s.l.: World Bank.
NBS, 2017. *Nigerian Bulk Electricity Invoices and Payment from GENCOs to DISCOs and Offtakers.* [Online] Available at: http://www.nigerianstat.gov.ng/download/510
[Accessed 20 February 2017].
Nigeria Electricity Power Hub, 2017. *January 2017 Nextier Power Dialogue with H.M Babatunde Fashola.* [Online]
Available at: http://www.nigeriaelectricityhub.com/download/communique-january-2017-nextier-power-dialogue-with-h-m-babatunde-fashola/[Accessed 16 February 2017].
Nigeria Power Guide , 2013. *Nigeria Power Guide,* Lagos: Details.
Nigerian Electricity Hub, 2016. *News.* [Online]
Available at: http://www.nigeriaelectricityhub.com/[Accessed 7 April 2017].

Obadote, D., 2009. *Energy Crisis in Nigeria: Technical Issues and Solutions.* Abuja, Power Sector Prayer Conference.
Office of Vice President of the FGN, 2015. *Nigeria Power Baseline Report,* Abuja: Power Africa.
Ohimain, E. I., 2015. Diversification of Nigerian Electricity Generation Sources. *Energy Sources, Part B: Economics, Planning, and Policy,* pp. 298-305.
Olaoye, T. et al., 2016. Energy Crisis in Nigeria: Need for Rewable Energy Mix. *American Journal of Electrical and Electronic Engineering,* 4(1), pp. 1-8.
Onagoruwa, B., 2011. *Nigerian Power Sector Reforms and Privatisation,* Abuja: Bureau of Public Enterprises .
Oseni, M. O. & Pollitt, M. G., 2012. The Economic Costs of Unsupplied Electricity: Evidence from Backup Generation among African Firms. *Cambridge Working Paper in Economics 1351.*
PHCN, 2007. *National Load Demand Study,* Abuja: Power Holding Company of Nigeria.
Powell, L., 2004. *Power System Load Analysis.* New York: McGraw Hill Education.
PWC, 2016. *The Challenges with Transforming the Nigerian Power Landscape,* Lagos: PWC.
Sambo, A., Garba, B., Zarma, I. H. & Gaji, M., 2012. Electricity Generation and the Present Challenges in the Nigerian Power Sector. *Journal of Energy and Power Engineering,* pp. 1050-1059.
Straplan Research, 2012. *Nigerian Economics.* [Online]
Available at: https://www.slideshare.net/ajibolaalfred/nigerian-economics-vol-6-electricity-sector-update
Verolme, H., 2015. *Nigeria's Energy Future.* [Online]
Available at: https://ng.boell.org/2015/06/11/nigeria%E2%80%99s-energy-future
Vincent, E. N. & Yusuf, S. D., 2014. Integrating Renewable Energy and Smart Grid Technology into the Nigerian Electricity Grid System. *Smart Grid and Renewable Energy,* pp. 220-238.
World Bank, 2013. *World Bank to Help Nigeria Improve Gas Supply and Reliability, and Bring More Electricity to Nigerian Consumers.* [Online]
Available at: http://www.worldbank.org/en/news/press-release/2013/04/22/world-bank-to-help-nigeria-improve-gas-supply-and-reliability-and-bring-more-electricity-to-nigerian-consumers