



HAL
open science

Market Reform in the Nigeria power sector: A review of the issues and potential solutions

Wale Arowolo, Yannick Perez

► To cite this version:

Wale Arowolo, Yannick Perez. Market Reform in the Nigeria power sector: A review of the issues and potential solutions. *Energy Policy*, 2020, 144, pp.111580. 10.1016/j.enpol.2020.111580. hal-03903660

HAL Id: hal-03903660

<https://hal.science/hal-03903660>

Submitted on 7 Sep 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Market Reform in the Nigeria Power sector: A review of the issues and potential solutions

Wale Arowolo¹ and Yannick Perez²

Abstract

The Nigeria Power sector reform was performed between the year 2010 and 2013 but has undoubtedly been adjudged unsuccessful by most stakeholders. The failure of the reform is evidenced by a myriad of seemingly insurmountable economic, institutional, technical, financial and socio-political challenges exacerbated by the recent macroeconomic crisis. This paper performs a comparative analysis of the Nigeria reform with the “Standard model” of electricity reform to understand the root cause of the reform failures while taking cognizance of the starting conditions of Nigeria. Our result reveals that incomplete privatization coupled with the horizontal integration of the transmission and network operations, the underdeveloped gas supply infrastructure network and the ineffective/weak regulatory framework as the root problems. Thereafter, we recommended strengthening the regulatory framework as a good starting point to resolve sectoral problems. We argued that, considering the depth of the regulatory concerns, strengthening the framework will resolve the problems of investment, access and pricing and improve the overall sectoral performance (ex-post). Furthermore, we recommended the need for a workable market design and regulatory framework for decentralized solar PV generation and integration that is adaptable and nicely fits with a strengthened centralized generation framework.

Keywords: Nigeria Power Sector, Market Reform, Market Design, Institutional design, Energy Policy.

¹ **Corresponding author:** Paris Sud University, RITM, Faculty of Economics, Law and Management, 54 Boulevard Desgranges, 92330, Sceaux, Paris Region, France. adewale.arowolo@u-psud.fr

² Paris Sud University, RITM, Faculty of Economics, Law and Management, and LGI CentraleSupélec, 3 rue Joliot Curie, 91192 Gif Sur Yvette, France

1. Introduction

Sub-Saharan Africa faces chronic power problems, including insufficient generation capacity, low connectivity, poor reliability, and high costs, all of which constrain development (Eberhard and Shkarata, 2012). In Nigeria, the acute shortage of power supply stems from an interconnected web of factors creating a complex challenge that needs to be urgently addressed for Nigeria to be on the path of sustainable development.

Nigeria has 87 million people without access to electricity - the second highest globally after India's 99 million (IEA et al., 2019). For many Nigerians, tackling the electricity supply deficit means the procurement and installation of private gasoline or diesel-powered generators (Oseni, 2016). Relative to the grid supply, back-up power generation is expensive, and the levels of use are generally not recorded in energy statistics (IEA, 2014). This costs households and businesses almost US\$ 22 billion annually in fuel costs alone (IFC, 2018). Even after the back-up generation is included, there is still electricity demand that remains unmet (IEA, 2014). This acute shortage of power supply and its crippling effects on economic growth and development constitute a complex problem in need of urgent solutions. The Nigeria government embraced 'market reform' as a solution.

The fundamental objective of the electricity market reform is to "ensure that Nigeria has an electricity supply industry that can meet the needs of the citizens in the twenty-first century". Others are to modernize and expand electricity coverage and to support national, economic and social development (ECN, 2014). After some years of delay, the reform process commenced in 2010 after the launch of the Roadmap (2010). The transfer of the assets and liabilities of the vertically integrated monopoly Power Holding Company of Nigeria (PHCN) to most of the new investors was concluded in October 2013.

It is noteworthy that since then and until date, there appears not to be any significant improvement in the sector and the core issue of lack of power supply remains stubbornly unresolved with little

hope in sight while tariffs keep increasing. The key performance indicators on average worsened between 2014 and 2016. The year 2016 actual generation was 39% lower than forecast generation while the billing and collection efficiencies averaged 80% and 51% respectively. In addition, the Aggregate Technical, Commercial and Collection (ATC&C) losses increased from an average of 52.1% in 2015 to 54.3% in 2016 (PSRP, 2017).

In the first nine months of 2018, only about half (hovering between 3,700MW and 4,100MW) of the available power capacity (between 7,400MW and 8,200MW) was generated (Figure 1). The remaining total available capacity was redundant due to a combination of factors including inadequate gas supply, limited distribution networks, water management issues at the hydro power stations and limited transmission line capacity and associated infrastructure (NERC, 2019). It is also noteworthy that the peak power generation of 3,804 MW (Roadmap, 2010) at the commencement of the reform is higher than the 3,571MW generated in September 2018 (NERC, 2019).

Figure 1: Average generation (MW) versus average available capacity (MW)

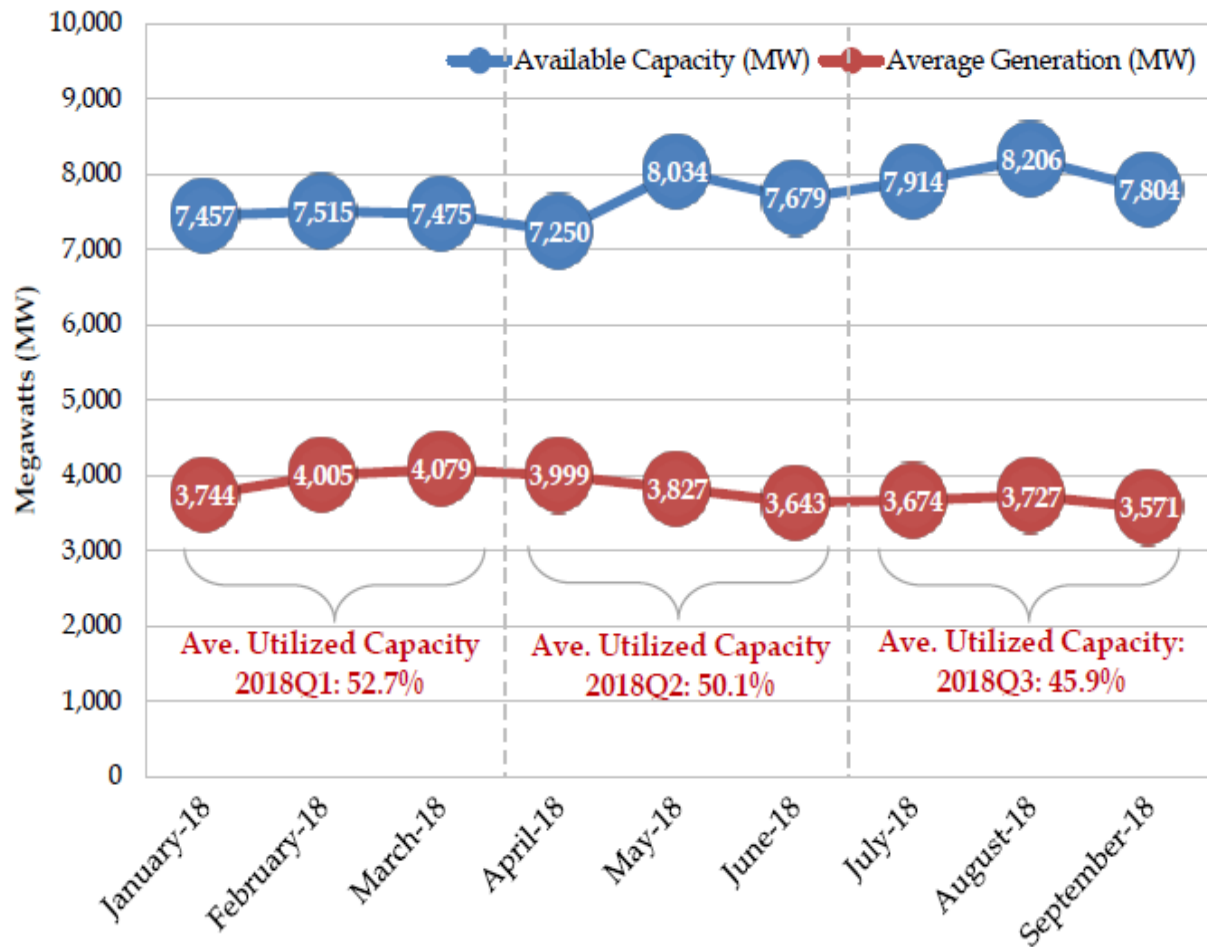


Fig 1: NERC Quarterly Report (available capacity vs generation chart Jan.- Sep. 2018)

Several challenges are persistently present, and the investment climate is complexly enmeshed in uncertainties for investors to make meaningful informed decision(s). Besides, the existing assets are improperly managed and the new asset acquisition projects by stakeholders remain stubbornly uncompleted or abandoned in the value chain. Indeed, the reform is plagued with many seemingly insurmountable challenges leading to market failure while the core issue of inadequate power supply persists. This paper answers two central research questions as follows: *What is the root cause of the Nigeria market reform failure? and What are the potential solutions to improve sectoral performance (ex-post reform)?*

To answer these questions, we reviewed the history of the Nigeria Power sector and went on to assess the reform process that was undertaken to improve sectoral efficiency, performance and to support economic and social development. Thereafter, we reviewed the existing literature on the sector reform and found the lack of scientific insight on the root cause(s) of the problem based on knowledge in the field of electricity market design and regulation. To bridge this gap, we performed a comparative analysis of the Nigeria reform with the reference market design “Standard model” of electricity reform while taking cognizance of the peculiar starting conditions of Nigeria. Our result reveals that ineffective/weak regulatory framework, incomplete privatization coupled with the horizontal integration of transmission and network operations and the underdeveloped gas supply infrastructure network were the root cause problems of the reform failure.

We then made the following key policy recommendations 1. Strengthening the regulatory framework 2. The need for effective stakeholders’ engagement 3. The need to increase investment in transmission, distribution and gas supply infrastructure and 4. The need for a workable market design and regulatory framework for solar PV generation and integration with the existing centralized generation framework.

This paper is structured as follows: Section 2 is the brief history of the Nigeria power sector. Section 3 is the overview of the power sector reform. Section 4 is the reviews of the existing literature. Section 5 is the overview of the ‘Standard Model’. Section 6 is the Methodology. Section 7 is the results and discussions and Section 8 is the conclusion and policy implications.

2. BRIEF HISTORY OF THE NIGERIA POWER SECTOR

The Electricity supply industry in Nigeria dates back to 1866 when two small generating sets were installed to serve the colony of Lagos. In 1951, the Electricity Corporation of Nigeria (ECN) was established through an Act of parliament to cater for all the power supply system in the country. The Niger Dam authority was subsequently established for the development of the electric power project

at Kainji on the River Niger. The two establishments were merged to form the National Electric Power Authority (NEPA) in 1972 (ECN, 2014). NEPA became the vertically integrated government utility in the value chain.

There is worldwide consensus that the vertically integrated public sector electricity market Nigeria was operating cannot deliver the quantum of electricity at a pace capable of bridging the growing gap between the demand and supply (RoadMap, 2013). This thinking motivated the National Electric Power Policy (2001) and led to the Electric Power Sector Reform Act EPSRA, 2005 (RoadMap, 2013). The Act gave legal backing to the formation of the initial and successor companies and the transfer of the assets of NEPA (EPSRA, 2005), the development of a competitive electricity market and the establishment of the Nigeria Electricity Regulatory Commission (Regulator). The Bureau of Public Enterprises (BPE) i.e the government agency responsible for the privatization renamed NEPA to Power Holding Company of Nigeria (PHCN).

The reform roadmap (Roadmap, 2010) contained the detailed implementation strategies of the process. PHCN was unbundled into six successor generation companies³ (GENCOs), eleven successor distribution companies⁴ (DISCOs) and the transmission company⁵ (TCN) that remained a government monopoly. Figure 2 below shows the industrial organization of the Nigeria Power sector ex-ante and ex-post reform.

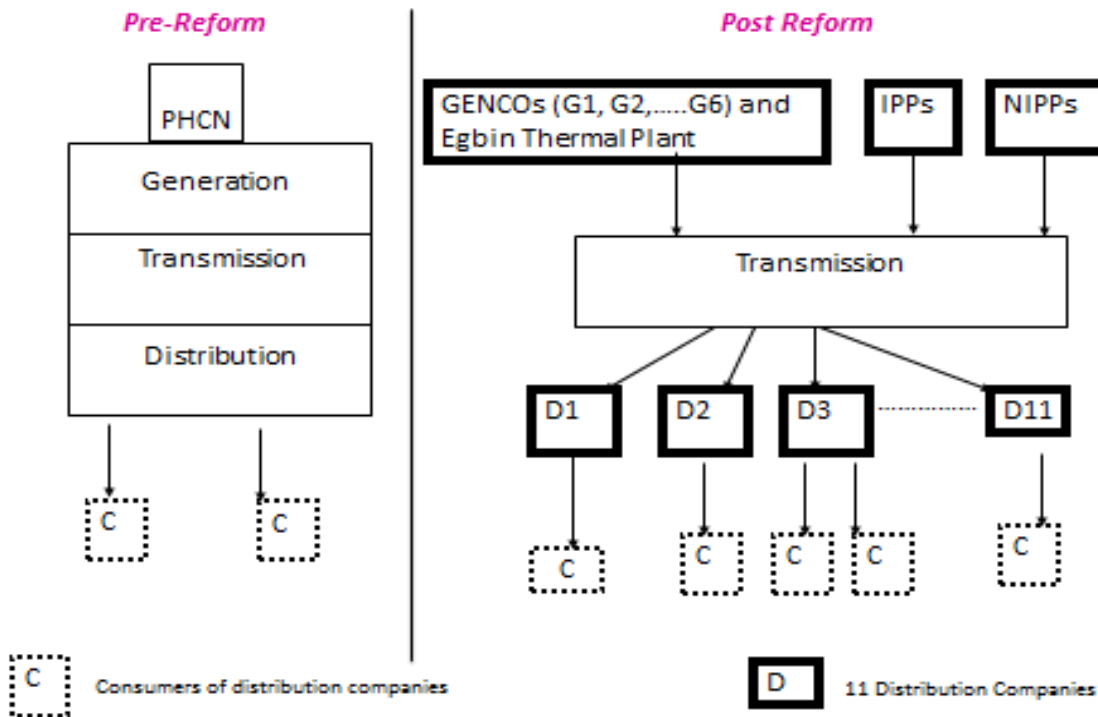
Figure 2: Industrial Organization of the Nigeria Power Sector

³ The Gencos are Geregu Power Plc (414MW), Ughelli Power Plc (900MW), Afam Power Plc (726MW), Sapele Power Plc (1020MW), Kainji (Jebba) Hydro Power Plc (1300MW) and Shiroro Hydropower Plc (600MW). Please note that Egbin Power Plant (1320MW) in Lagos was not part of the privatized Power Plants during the reform. Egbin Power Plant's privatization started before the reform in 2007, was halted and later completed in 2013. The 70% stake was sold to KEPCO Energy Resources Limited (KERL). KERL is a joint venture between Sahara Power Group (SPG) and KEPCO (Korea Electric Power Company). The Government owns the remaining 30% stake and is represented by the Bureau of Public Enterprises (24%) and the Ministry of Finance Incorporated (6%). Please also note that Afam Power Plant's privatization was not concluded. It was put up for resale by the Government in August, 2018.

⁴ The Discos are Abuja Electricity Distribution Company (AEDC), Benin Electricity Distribution Company (BEDC), Enugu Electricity Distribution Company (EEDC), Eko Electricity Distribution Company (EKEDC), Ibadan Electricity Distribution Company (IBEDC), Ikeja Electricity Distribution Company (IKEDC) later renamed Ikeja Electric, Jos Electricity Distribution Company (JEDC), Kaduna Electricity Distribution Company (KAEDC), Kano Electricity Distribution Company (KEDC), Port Harcourt Electricity Distribution Company (PHEDC) and Yola Electricity Distribution Company (YEDC). Please note that YEDC declared force majeure in 2015 and was repossessed by the Government. It was put up for resale in August 2018

⁵ Transmission Company of Nigeria (TCN)

Industrial Organisation of the Nigeria Power Sector



In addition, there are ten (10) National Integrated Power Plants (NIPPs)⁶ jointly owned by the three tiers of government (Federal, State and Local) that were under construction during the reform (yet to be privatized till date) and the Independent Power Plants⁷ (IPPs) owned by some state governments and private investors.

3. OVERVIEW OF THE CHALLENGES IN THE NIGERIA POWER SECTOR

Amadi (2014) gave an overview of the challenges necessitating the reform process as follows i. Poor sectoral capacity ii. The government’s inability to run a world class sector iii. Endless capital injection without corresponding output iv. National power dilemma entangled in politics v. Ever expanding

⁶ Geregu II (434MW), Sapele (450MW), Alaoji (107MW), Olorunsogo II (750MW), Omotosho II (500MW), Omoku (250MW), Ihovbor (450MW), Calabar (561MW), Egbera (338MW) and Gbarain (225MW) Power Stations. Note that this NIPP plants were all under construction during the reform. There are plans to privatize them after commissioning of the plants but still not privatized. As at October 2018 (8 out of the 10 plants) are connected to the grid.

⁷ Major IPP Plants on national grid are: Afam VI (650MW), Akwa Ibom State Government - Ibom (155MW), AES (224MW), River State Government Omoku (150MW) and Trans Amadi (100MW) and recently Azura Edo (450MW) etc.

workforce of the vertically integrated monopoly and sundry liabilities far outstripping an ageing asset base vi. Government's funding always outstripped by the sector's colossal financial appetite.

In general, any reform process attempts to introduce changes in the ownership, industry structure, governance mechanisms and the nature of transactions (Bhattacharyya, 2011). When reform processes are undertaken, the overriding reform goal has been to create new institutional arrangements for the electricity sector that provide long term benefits to society and to ensure that an appropriate share of these benefits are conveyed to consumers through prices that reflect the efficient economic cost of supplying electricity and service quality attributes that reflect consumer valuations (Joskow, 2008). Indeed, a major benefit expected from the market reform is the availability of power supply (the yearning of Nigerians for decades) and at reasonable cost.

The negotiation and contracting of the liberalized assets with the successful private investors was completed in February 2013 and the assets were formally handed to the fifteen private generation and distribution firms in October 2013 (thirty months later than the initially planned handover date of April 2011), Kaduna Electric was handed over in 2014 while Afam plant's privatization was not concluded. Perhaps, this is a first major warning sign of other serious challenges to come.

The Regulator was set up to coordinate the sectoral activities. Unfortunately, the paperwork efforts of the Regulator almost always fail during implementation. For instance, in 2012, the Regulator set up a public review committee to assess the metering situation in the country. The committee found that the total number of consumers captured in the records of the DISCOs represented 18.65% of the total households. It also found that 54.83% of all the customers registered were not metered at all or have no functional meters excluding those enjoying electricity illegally that are unregistered by the DISCOs, known as the 'illegal consumers' (NERC, 2012).

Based on this finding, the Regulator in 2013 introduced the Credit Advance Payment for Metering Implementation (CAPMI) framework to provide funds to the DISCOs to close the metering gap. Consumers were to pre-pay for their own meters and the DISCOs were expected to provide the meters to them within 45 days. However, consumers waited several months with some eventually lucky enough to receive their meters. In the Regulator's own words (three years after introducing CAPMI) - "*The situation has not improved as there is still an abysmally low level of metering in the Nigeria Electricity Supply Industry. As at today, over 50% of all the registered customers are either unmetered or have non-functional meters*"...Initiatives did not yield the desired result as the implementation were poorly executed with minimal roll-out of meters recorded in all the DISCOs despite provisions for full cost recovery" (NERC, 2015).

After the failure of CAPMI, the Regulator allowed the DISCOs to continue estimated billing but introduced a framework to cap estimations based on the tariff classes and energy consumption patterns. Nevertheless, there is widespread claim of abuse by the DISCOs through inflated electricity bills to consumers without commensurate power supply. In a press release in 2016, the Regulator affirmed 47,127 complaints were lodged by consumers against the eleven DISCOs during the last quarter of 2015, an indication of a high-level customer dissatisfaction in the industry (NERC, 2016). Unfortunately, this situation has worsened over the year as 131,661 complaints were lodged by consumers in the last quarter of 2017 and 108,872 in the first quarter of 2018 (NERC, 2018).

Moreover, many consumers are unwilling to pay for their electricity consumption and therefore connect illegally to the grid. Many of the non-paying consumers are largely undetected because power meters are not widespread. This market failure makes it difficult for many DISCOs to realize post-privatization returns on investment and therefore need to make further investment in metering systems, which racks up costs for investors. The (World Bank, 2016) estimated a Quasi-Fiscal Deficit (QFD) of US\$ 2.9 billion for the Nigeria Power sector. This shows the sector is presently not

financially viable, this situation seems to create a further disincentive and discouragement to investors to invest more funds in order to realize return on their large, specific and sunk assets. It therefore appears to contribute to the poor quality of service experienced in the sector.

In addition, the tariff structure - Multi-Year Tariff Order (MYTO) with different structures for residential, industrial, commercial and special consumers (government, religious bodies, educational establishments etc.) appears unattractive to investors to make decisions on the large sunk cost investments required in the sector. If the investors are to be induced to invest, they need the reassurance that future prices will be set at a remunerative level to justify the investment (Newbery, 2000). Therefore, meaningful progress has not been achieved in increasing infrastructure investment in the value chain and the investors appear not to have enough incentives to invest in the gas supply infrastructure to the thermal power plant and the power generation and distribution infrastructure. In a nutshell, the current tariff structure does not seem to send the right economic signals that promote investment and efficient operations.

Attempts by the Regulator to increase tariffs and attract investment are usually met with strict opposition from consumers with the general argument that price cannot increase for unavailable electricity and for a population with low purchasing power. This is often a serious socio-political issue. While the investors generally argue that the present price regime is not cost reflective neither to sufficiently and completely recover the network infrastructure investment, operations and maintenance costs nor to address the huge backlog of under-investment in the sector. The Regulator is the driver of the entire power industry; its actions and inactions have direct influence on the activities of other stakeholders and encapsulate all sectoral decisions (Battle and Ocana, 2013). Regulatory concerns typically include a wide diversity of topics, such as: consumer prices and tariffs, quality of service, economic viability of the companies involved, environmental impact of industry activities, policies for supplying the less advantaged or others without access, market structure and

market power, proportionality between investment volumes and operational efficiency and demand, and asymmetries between information available to the regulator and to market agents (Battle and Ocana, 2013). As noted by Newberry (2000), if public utilities are to be successfully privately financed, then regulation must credibly satisfy the demands of both consumers and investors.

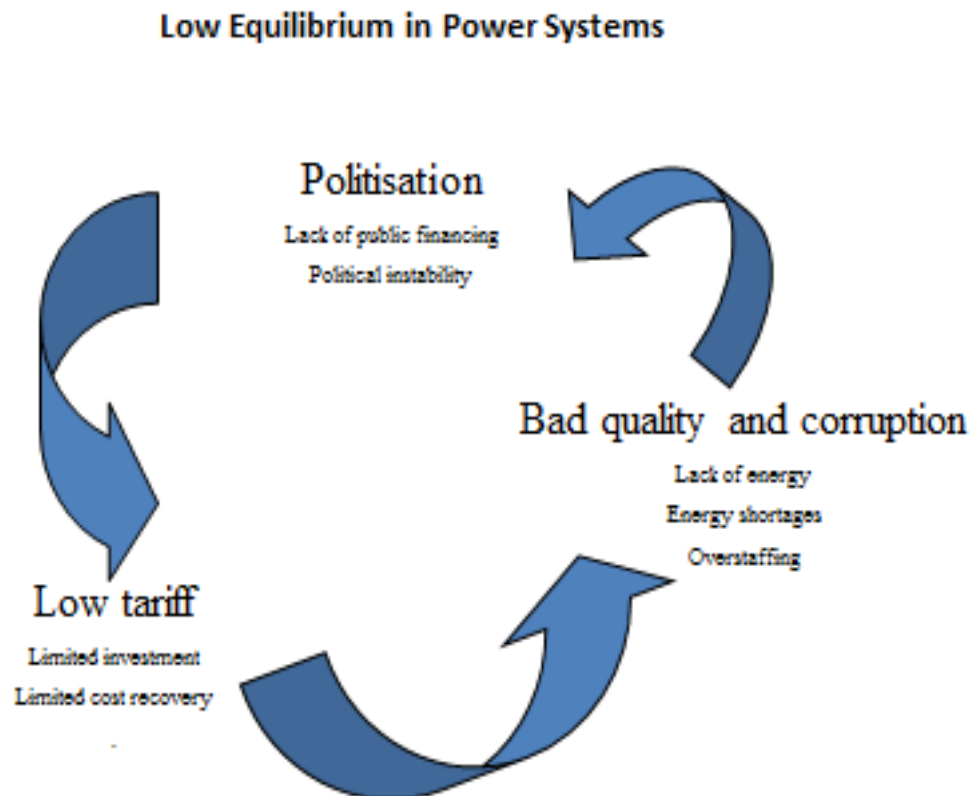
After two major reviews of the MYTO 1 (i.e. MYTO 2 and MYTO 2.1) within five years with semi-annual minor reviews (to account for inflation, exchange rate, gas prices and generation capacity) leading to price increments, the Regulator further instructed the DISCOs to prepare and submit what they believed could be cost reflective tariffs in 2015. Afterwards, the Regulator analysed the submissions and informed the consumers of another tariff increase of about 45% effective February 2016. This caused widespread outrage, lawsuits and protest by consumers. Nevertheless, the new tariffs came into effect in February 2016 and is called the 'MYTO 2015'.

Another major challenge is the gas supply constraints to the gas-fired power stations. These plants currently account for about 70-80% of the total power generation in Nigeria. Natural resources generally offer multiple export-oriented monetization opportunities in addition to raw exports. For example, natural gas can be exported in a raw form using transnational pipelines or Liquefied Natural Gas (LNG) vessels but it can also be used as a source of power in electricity-intensive activities (Massol and Banal-Estañol, 2014). Nigeria has a proven gas reserves of 188 trillion cubic feet (tcf) and has the 9th largest gas reserves in the world (NGP, 2017). Moreover, the Nigeria Gas Master Plan (NGMP) contains the infrastructure blueprint for the development of the domestic gas market. The NGMP aims to achieve gas-driven economic growth with a strong focus on gas to power projects (Nwaoha and Wood, 2014). However, the potential for diversification is affected by many factors, including the resource base, the capacities of the population and the quality of governance (Gelb and Grasmann, 2010). In this regard, the Gas Aggregation Company of Nigeria (GACN) was established as the 'strategic aggregator' responsible for the demand management, gas price

management, network access and administration for the domestic gas supply. However, the NGMP did not deliver on all its set targets (NGP, 2017). Consequently, it was replaced by the National Gas Policy (NGP) in 2017.

This complex situation in the Nigeria Power sector is called a “stable-low equilibrium” in the literature since the pioneering work of Spiller and Savedorff (1999) as illustrated in Figure 3. A stable low-level equilibrium is achieved when prices are kept low, government transfers are limited, service quality and coverage are low, and no one - whether the service operator, the government or consumers has an interest in changing their position. Although attempts at reforms may occur, they commonly fail (Spiller and Savedorff,1999).

Figure 3 - Stable low-level equilibrium in the Nigeria Power Sector



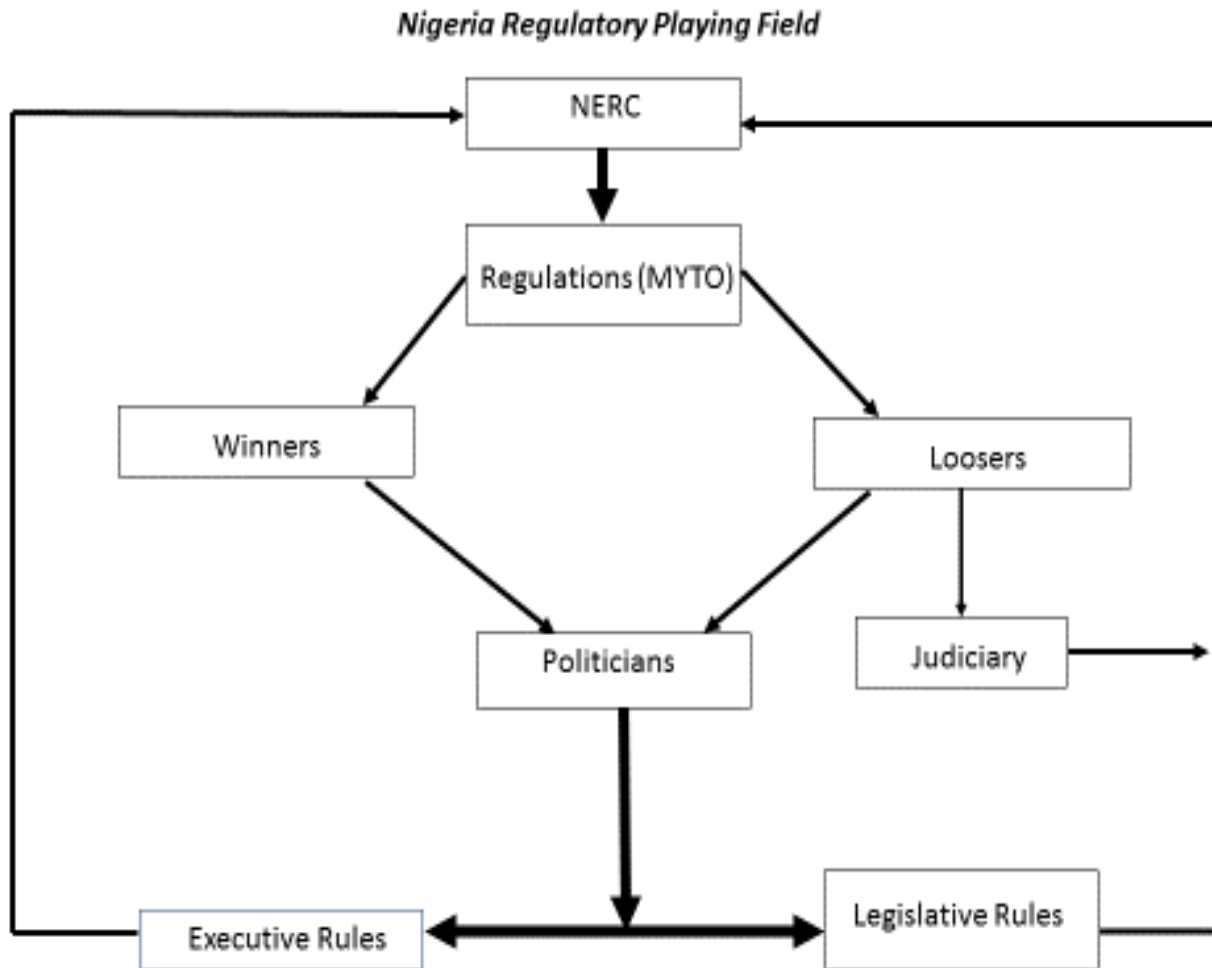
Sources: Spiller & Savedoff : Government opportunism and the Provision of Water, chap 1 in “Spilled Water”, institutional Commitment in the Provision of Water Services, inter-american development bank 1999

In Figure 3, all the elements prevent an evolution towards a sustainable and self-financing organization of the power sector. Electricity sector reforms have significant potential benefits but also carry the risk of significant potential costs if the reforms are implemented incompletely or incorrectly and implementing good electricity sector liberalization is a technical, institutional and political challenge (Joskow, 2008). According to Ostrom (2012), without understanding both the social systems and the technical aspect of the management of a resource, we cannot conduct work that enables us to understand the conditions that help produce sustainable development.

Jamasb et al (2005) gave some good description that can be likened to the status quo in the Nigeria's power sector reform as follows - it is clear that Reformers underestimated the political difficulty in moving tariffs to cost-recovering levels, the problems of corruption, patronage, labour opposition to reducing waste, poor collection and other fiscal leakages. Simpler reforms, such as encouraging independent power producers to enter long-term power purchase agreements with financially fragile counterparts, stored up difficulties that were revealed by devaluation and other macro-shocks. Serious reform of the price setting mechanism for residential tariffs, combined with economically rational regulation, both central for revenue adequacy, were delayed or not recognized as important, or were derailed by intransigent price regulation.

Figure 4 below illustrates the regulatory playing field in the Nigeria power sector. It shows the dynamics of winners and losers and the possible ways to modify the impact of new regulation.

Figure 4. The regulatory playing field of the Nigerian power sector



The Regulator makes regulations for example the MYTO, the losers (for example, consumers) seek legal redress or complains to the politicians, the judiciary gives injunctions to influence the Regulator while the politicians influence through executive or legislative rules. Likewise, the winners e.g. investors also influence the Regulator through the politicians.

While market reforms have been performed in many countries, it is noteworthy that the electrical industry has proven itself unable to present a standard complete market design that garners universal acceptance (Glachant and Perez, 2008). Therefore, transfers of design solutions that worked in a country are unlikely to produce the desired outcome in another regulatory environment.

Local adaptations and tailor-made designs should be defined based on lessons and best practices learnt from other country reforms.

4. LITERATURE REVIEW ON THE NIGERIA POWER SECTOR REFORM

Some studies have reviewed the reform vis-a-vis the current state and challenges. Titus et al (2013) discussed the challenges facing the electricity market in Nigeria as the slow growth in generation capacity, market deregulation process delay, interference by the government, transmission lines and distribution equipment vandalism and poor maintenance of existing power system. Erukilede (2012) mentioned the challenges as over-centralization of the power sector regulation, labour issues, corruption, weak justice system and poor existing legal framework. In their paper, Edet and Akpan (2016) opined the reform does not have significant impact on electricity supply growth although it possesses positive coefficient. Okolobah and Zuhaimy (2013) mentioned the key reform challenges as policy somersault, project execution issues, inadequate infrastructure and gas supply, financial challenges, data inadequacy and single grid system.

Ochugudu and Onodugo (2013) assessed the challenges of the reform as economic and social, technical, political and environmental factors. The authors also noted that the reform does not have significant impact on the quality of service delivery (ex-post) reform based on their findings in one of the major business units in the North Central region of Nigeria. Makwe et al (2012) identified the key challenges as the appalling state of power infrastructures, double-digit transmission losses and low tariffs and recommended an upward review of prices and reduction in transmission losses to incentivize investors. Aliyu et al (2013) identified the key challenges as conflicting stakeholder interests, tariff increase in environment of poverty, unemployment and high inequality; problem with transparency and credibility of government's officials leading to investors and consumers lack of trust. Folorunso and Olowu (2014) identified power outages, inefficient and unreliable energy supply system as the key issues. Ogunleye (2016) in his political economy viewpoint mentioned the challenges as raising long term finance, sourcing skilled manpower, creating effective gas pricing

and tackling insufficient supply, challenging political (regulatory and institutional issues) and macroeconomic environment.

Table 1 summarizes the Nigeria Power Reform/challenges from the literature review

Literature	Challenges
Koledoye et al (2013)	Slow growth in generation capacity. Market deregulation process delay. Interference by Government. Transmission lines and distribution equipment vandalism. Poor maintenance of existing power system.
Erukilede (2012)	Over-centralization of the power sector regulation, labour issues, corruption, weak justice system and Poor existing legal framework.
Edet and Akpan (2016)	Lack of significant impact of reform on electricity supply in Nigeria.
Okolobah and Zuhaimy (2013)	Policy somersault, Project execution issues, Inadequate infrastructure, Inadequate gas supply, Financial challenges, Data inadequacy and Single grid system.
Ochugudu & Onodugo (2013)	social, technical, political and environmental factors, Poor quality of service delivery
Makwe et al (2012)	Appalling state of power infrastructures, double digit transmission losses and low tariffs
Aliyu et al (2013)	Conflicting stakeholder interests, tariff increase in environment of poverty, unemployment and high inequality; problem with transparency and credibility of Government

	officials leading to investor's and consumers lack of trust, Utter inadequacy of modern regulatory structures
Folorunso and Olowu (2014)	Power outages, inefficient and unreliable energy supply system
Ogunleye (2016)	Raising long term finance, sourcing skilled manpower, creating effective gas pricing and tackling insufficient supply, challenging political (regulatory and institutional issues) and macroeconomic environment

The papers in the literature mostly gave an overview of the power reform, the diverse issues and the observed consequences of the challenges and offered general opinions and suggestions of what the authors think are the consequences and solutions to the reform problems.

Our Present Work

This paper adds to the Nigeria Power reform debate in two significant ways. First, we provide the first in-depth contribution (to the best of our knowledge) from the field of electricity market design and regulation. Second, we applied scientific insight to provide an understanding of the root cause problems of the reform failure. To understand the path forward in a failed reform, the root cause of the failure has to be clearly understood. Thereafter, we made policy recommendations to address the issues (ex-post) for academics, policy makers/analysts and other stakeholders in the Nigeria power sector.

5. OVERVIEW OF THE 'STANDARD' ELECTRICITY' REFORM MODEL

Power sector reforms introduce more radical changes to the power sector, as the public ownership of the key segments of the sector is relinquished (Urpelainen and Yang, 2019). Among the key aims (and assumptions) of these reforms is the realization of improvements in power sector efficiency (Erdogdu, 2011). Chile was the first country in the world to implement a comprehensive reform of its electricity sector in the recent period. Chile's 1982 Electricity Act led to the vertical and horizontal

break up (beginning in 1981), commercialisation and part privatisation of the existing state-owned electricity system (Pollitt, 2004). Large scale privatisation began in 1986, four years before the re-organisation of the electricity sector in England and Wales, arguably the world's most comprehensive electricity reform. Chile's electricity reform has been hailed as a highly successful example of electricity reform in a developing country and a model for other privatisations in Latin America and around the world. The Chilean electricity system illustrates that it is possible to have effective competition and privatisation in a relatively small power market with significant hydro generation (Pollitt, 2004).

By the 1990s, market-oriented reforms in the power sector had crystallized into a global norm, albeit with alternative formulations. Early reformers' market-oriented experiences involved a loose set of different ideas. The reform literature brought these together into what was subsequently called a "standard model", "blueprint for action", "standard prescription", "textbook architecture" or 'third phase' of sector norms (Lee and Usman, 2018). This standard package of reforms prescribed by international donors in the 1990s included four principal components: restructuring (vertical and horizontal unbundling of power utilities); private sector participation; creation of an independent regulator; and competition in power generation (Godinho and Eberhard, 2019). It was believed that reforms would reduce the dominance of the state in the sector through the creation of Independent Regulatory Agencies and private sector participation in the electricity markets (Imam et al., 2019). Driven by ideology, economic reasoning and early success stories, vast amounts of financial resources and effort have been spent on reforming infrastructure industries in developing countries (Jamasp et al., 2005).

6. METHODOLOGY

Comprehensive electricity reform can work in a developing country (Pollitt, 2008). Nevertheless, to be successful, electricity reform must reflect a good understanding of what makes markets work well

and what prevents this happening (Littlechild, 2006). While it is generally agreed by market reform experts worldwide that no electricity reform program was perfect at the outset, but always followed by additional reforms, research and analyses of successful reforms worldwide tend to follow a logical pattern/benchmark as provided by Joskow (2006) – the “Standard model” of electricity reform. Where the model has been largely followed, it has been broadly successful, for example in the UK, Argentina, Nordic countries, Victoria and Texas; where it has not been followed, there have been problems (Littlechild, 2006). In many of these cases, competition has been less effective, and prices to consumers have been correspondingly higher than would have been had the “Standard model” for electricity reform been followed (Littlechild, 2006).

A successful electricity reform is expected to enhance the efficiency of the sector, improve energy service reliability and service quality, reduce the price-cost gap through cost reflective pricing and increase investments (Jamash et al, 2015). Since the Nigeria Power Reform is generally acknowledged as unsuccessful by stakeholders, and the “Standard model” of electricity reform has worked in both developed and developing countries alike, we considered it a good benchmark for comparative analysis while we are cautious of the differences in the starting conditions of Nigeria. These conditions include the size of the country and its power system and market, the country’s location relative to other power markets, its income level and macroeconomic condition, its political situation, and the capacity of its domestic financial markets and institutions. They reflect the many dimensions of the power market reform and critically influence the feasibility of reform programs and hence the outcomes that can be achieved from them in the short to medium term (Besant Jones, 2006).

Pre-Reform, Nigeria fits into the lower-income group country description with the following characteristics: Electricity prices was well below costs, low access rates to electricity by the population; poor quality and shortage of public power supply causing numerous consumers to install

private power generators; poor governance of state-owned power utilities leading to poor technical and financial performance, lack of substantial credit support; very low operating efficiency that drives up unit supply costs under lack of maintenance; theft of electricity and utility property including cash; inefficiency in collecting revenues owed to utilities; lack of investment caused by the inability of utilities (and governments) to mobilize financing and very low country ratings for corruption and creditworthiness (Besant-Jones, 2006). With a good knowledge and understanding of the starting conditions of the Nigeria power reform, we then applied the “Standard Model” of electricity reform as our methodology to analyse the Nigeria market reform failures to gain further insight into the underlying issues as follows:

Privatization of state-owned utilities

Privatization creates higher performance incentives for performance improvement and makes it more difficult for the state to use the enterprises to pursue costly political agenda. The components of the political agendas have included the use of state-owned monopolies for patronage employment, macroeconomic and redistributive policies and to funnel revenue to government budgets outside of the tax system (Joskow, 2006).

In the Nigeria reform, the state-owned thermal plants - Ughelli and Sapele were fully privatized. Geregu (51%) (was not fully privatized), Afam plant’s privatization eventually failed while the hydro plants (Kainji/Jebba and Shiroro) were concessioned to the private investors. The Discos were partly privatized (60%) while the transmission utility remained a government monopoly.

Vertical separation of competitive segment from regulated segments

The vertical separation is thought to be necessary to guard against cross-subsidization of competitive businesses from regulated businesses and discriminatory policies affecting access to distribution and transmission networks upon which all competitive suppliers depend (Joskow, 2006).

In the Nigeria reform, the generation segment was structurally separated from the transmission segment. However, the distribution segment was not separated from the retail (the same DISCOs performed the distribution and retail functions in their specified geographical coverage area). Within the DISCO's corporation, there was no separation of the distribution and retail affiliates.

Horizontal restructuring of the generation segment

This is to create an adequate number of competing generators to mitigate market power and to ensure wholesale markets yield reasonably competitive performance results (Joskow, 2006).

In the Nigeria generation segment, there was an attempt at horizontal restructuring but a major constraint was the underdeveloped gas supply infrastructure to transport the gas to the power plants leading to frequent supply disruption to the Suppliers⁸. About 600mmscf/day of gas was available to the power station while the gas requirement was 2,699mmscf/day (FGN, 2016). This is about 22% of the needed capacity to run the gas-fired thermal plants and attracting sufficient investment into this segment was a challenge. As noted by Laffont (2005), the liberalization and deregulation of public infrastructure in developing countries often fail to attract the level of foreign capital that is necessary.

Furthermore, bilateral trading arrangements with the bulk trader and single buyer purchasing agency – Nigeria Bulk Electricity Trading Company (NBET) was put in place to manage the market power influences and competition among suppliers in the transitional stage of the market⁹. This stage is characterized by contract-based arrangements for electricity trading and the introduction of competition for market entry (ONEM, 2014). Furthermore, there is no centrally administered

⁸ The Suppliers are the GENCOs, NIPPs and IPPs

⁹ The transitional electricity market stated in February 2015 and it is still at this stage till date.

balancing mechanism for the transitional stage market. It is anticipated that the Discos will procure power directly from the suppliers in the wholesale market when they become commercially viable in the medium-term market (NBET will cease to exist). The medium-term market will be a balancing/spot market, allowing efficient opportunity trading and efficient contracts to cover and/or hedge price risk while maintaining a security constrained economic merit order dispatch using the determined system marginal price (ONEM, 2014). Thus, the intention was not to create a permanent single buyer agent but as a transitional process. The suppliers send their invoices to NBET that in turn collects the payment from the Discos through vesting contracts while the consumers pay directly to their respective Discos.

Horizontal integration of transmission and network operations

This is to encompass the geographic expanse of “natural “wholesale market and designation of a single independent system operator to manage the operation of the network, to schedule generation to meet demand and to maintain the physical parameters of the network - frequency, voltage, stability (Joskow, 2006).

In the Nigeria reform, there was horizontal integration of transmission and network operation but a single Independent System Operator (ISO) was not set up to manage the network operations. The state-owned monopoly TCN owned and operated the network. The system operator (SO) remained a department under the TCN including the Market Operator (ONEM) and the Transmission Service Provider (TSP). The SO and ONEM were expected to provide non-discriminatory and efficient system operation and market administration services to all participants (ONEM, 2014). Since the TCN is fully government owned, discrimination against some investor owned IPPs is a possibility since some GENCOs are still fully/partly government owned while the NIPPs are fully government owned.

The creation of voluntary public wholesale spot energy and operating reserve market institutions

This is to support the requirements for real time balancing of supply and demand for electric energy, to allocate scarce network transmission capacity, to respond quickly and effectively to unplanned outages of transmission or generation facilities consistent with the need to maintain network voltage, frequency and stability parameters within narrow limits, and to facilitate economic opportunities among suppliers and between buyers and sellers (Joskow, 2006).

In the Nigeria reform, spot energy and operating reserve market institutions were not set up to respond quickly and effectively to unplanned outages of transmission or generation facilities. As part of its market administration services, the market operator is to develop a procedure for the management of inadequate supply and shortage conditions during the transitional stage. This market procedure is used to allocate the generation shortages proportionally among load participants and is to be tested and improved during the transitional stages and become part of the Grid Code at the start of the Medium-term Market (ONEM, 2014).

The application of regulatory rules and supporting network institutions

This is to promote efficient access to the transmission network by wholesale buyers and sellers in order to facilitate efficient competitive production and exchange, including mechanisms to efficiently allocate scarce transmission capacity among competing network users and to provide efficient siting and interconnection of new generation facilities (Joskow, 2006).

In the Nigeria reform, the Regulator has the Grid Code and Market Rules. The Grid Code contains the day-to-day operating procedures and principles governing the development, maintenance and operation of an effective, well-coordinated and economic transmission system (GridCode, 2017). Furthermore, the market rules was in place to guarantee an efficient, transparent and non-discriminatory market administration service to all participants, to facilitate the development of a

sustainable competitive wholesale electricity market and to adapt to the regional wholesale electricity markets or regional electricity trading agreements. The Grid Code and the Market Rules were expected to work together to secure efficient co-ordination and adequate participation (ONEM, 2014). Although, there were no wholesale buyers and sellers in the market in the transition stage, this is expected to be achieved in the medium-term market.

Notwithstanding the market rules and grid code, it is common occurrence for many DISCOs to (counter-intuitively) reject/shed their load allocation (i.e. deny consumers power supply) from the TCN to avoid paying their invoices for the power supplied to them. The often-cited reason is that the price paid by consumers is insufficient to pay up the invoices received from NBET, and the transmission use of system charges, ancillary service costs, system operation and market administration charge from the market operator. The load rejection creates systemic problems as some generation plants' units are forced to shut down due to high frequency among other reasons.

The unbundling of retail tariffs

This is to separate prices for retail power supplies and associated customer services to be supplied competitively from the "regulated" delivery charges for using transmission and distribution networks that would continue (primarily) to be provided by regulated monopolies. This makes it possible for retail consumers eligible to choose their power suppliers competitively to purchase their power supplies from competing retail suppliers (Joskow, 2006).

In the Nigeria reform, competitive retail market did not exist. Retail tariffs were not unbundled from the transmission and distribution network charges. End user consumers pay a single tariff specified by the Regulator in line with the MYTO for the DISCO in their respective geographical region depending on the consumer classification as residential, industrial, commercial etc. Furthermore, the

tariff designs and metering solutions were not efficiently developed, and remained a challenge to the development of an efficient market that allows investment recovery.

Retail competition

Where policy makers have determined that retail competition will not be available (e.g for domestic and small commercial consumers), distribution companies or alternative designated supplier would have the responsibility to supply customers by purchasing power from competitive wholesale markets (Joskow, 2006).

In the Nigeria reform, DISCOs purchase power from the only wholesale market bulk trader (NBET) through vesting contracts. It was anticipated that the DISCOs will procure power directly from Suppliers in the wholesale market when they become commercially viable.

The creation of independent regulatory agencies with good information about costs, service quality and comparative performance of the firms supplying regulated network services and authority to enforce regulatory requirements.

The Regulator should rely on well balanced performance-based regulation mechanisms that meet budget balance, rent extraction, and efficiency criteria, given the information available to them, and must create a stable and credible regulatory environment that will support the attraction of the capital needed to improve the performance and expand the regulated network platforms upon which competition depends (Joskow, 2006).

In the Nigeria reform, the Regulator was created by law in 2005. In 2017, the Regulator had 171 staff and a net revenue¹⁰ of NGN 6.29 billion¹¹ (~US\$ 20.6 million) (Deloitte, 2018). However, the Regulator is ineffective (see section 3) at enforcing regulatory requirements. In Glachant et al (2013), the authors explained that it is the bounded endowment of the Regulator set by the government and legislators that determine their abilities (staff, budget, administrative power) to implement any of the regulatory tools (cost plus, price/revenue cap output or performance-based regulation, menu of contracts and yardstick competition).

Transition mechanisms

Transition mechanisms that are compatible with the development of well-functioning competitive markets needs to be built into the reform program. As there will be problem that needs to be addressed as the reforms proceed, it makes sense to anticipate them and to build effective transition mechanisms into the reform process (Joskow, 2006).

In the Nigeria reform, transition mechanisms were built into the reform programs but were ineffective. For example, the setup of NBET was a transition mechanism. Furthermore, there was a subsidized retail default service arrangement available to retail customers but failed as the government could no longer meet up with the subsidy payments due to funding constraints. The government parastatals that were also DISCO customers became heavily indebted for their power consumption. Moreover, market monitoring and mitigation mechanisms were also grossly ineffective. Table 2 summarises our findings

Table 2: Summary of our analysis of the Nigeria Power Sector Reform versus the “Standard” Model

¹⁰ The Regulator earns its revenue from 1.5% of tariff charge/kWh from the generation companies and 1.5% of licensee’s charges/kWh net of the cost of generation and transmission of energy wheeled on a monthly basis. Since the income is not fully realizable, a sum of NGN 3.86 billion was recognized as receivables impairment charge for 2017 in the audited account to arrive at a net income of NGN 6.29 billion (Deloitte, 2018).

¹¹ The Regulator also earns revenue from government subventions and international grants.

Standard Model	Nigeria Power Sector Reform
Privatization of state owned utilities	Yes – Sapele, Ughelli, Geregu (51%), ¹² Egbin thermal plant (70%), Afam Plants (transaction failed), Shiroro and Kainji hydro plants concessioned for 30 years. No – Transmission (0%) Yes partly - Distribution (60%)
Vertical separation of competitive segment from regulated segments	Yes - Separation of Generation from Transmission. No - Separation of Distribution from Retail
Horizontal restructuring of the generation segment.	Yes but ineffective.
Horizontal integration of transmission and network operation. Designation of ISO.	Yes - Horizontal Integration. No ISO. SO department under TCN responsible for planning and system operation.
The creation of voluntary public wholesale spot energy and operating reserve market institution.	No.
The application of regulatory rules and supporting network institutions.	Yes but ineffective.
The unbundling of retail tariffs	No
Retail competition	Yes. DISCOs purchase power from the single buyer wholesale agent - NBET

¹² Egbin Power Plant privatization was started before the reform in 2007, was halted and later completed in 2013. 70% stake sold to KEPCO Energy Resources Limited (KERL). KERL is a joint venture Sahara Power Group (SPG) and KEPCO (Korea Electric Power Company). The Government owns the remaining 30% stake represented by Bureau of Public Enterprises (24%) and Ministry of Finance Incorporated (6%).

The creation of Independent Regulatory Agencies.	Yes but ineffective.
Transition mechanisms	Yes but ineffective.

7. RESULTS AND DISCUSSIONS

Analysis of our results is captured under four key categories of Privatization and horizontal integration of transmission and network operations, Distribution/Retail unbundling, Horizontal Restructuring of Generation and Regulatory Framework.

- *Privatization and Horizontal integration of transmission and network operations*

The government's involvement, control and decision making is still heavy in the value chain (ex-post). First, the generation segment still has ten (10) fully government owned NIPP plants, one thermal plant (Afam - put up for resale in 2018) and part ownership of two thermal plants (Geregu and Egbin). Although the NIPP plants were still under construction as at the commencement of the reform, eight have been completed between 2012 to date and presently connected to the grid but yet to be privatized. Furthermore, the DISCOs were partly privatized and are still 'private' monopolies in their specified geographical zones (except Yola Disco that declared force majeure and was repossessed by the government). Since government's inefficiency was a key reason for the reform, the full privatization of the GENCOs and DISCOs to the qualified private sector investors/operator could have delivered better performance and remove bureaucratic bottlenecks in decision-making for the new private investors in the value chain. Under these circumstances, it cannot be argued that they are not used to pursue political agenda. This can be argued as a reason for the lack of improvement in the quality of service delivery (post-reform) as noted by Ochugudu and Onodugo (2013).

Furthermore, a case whereby some Suppliers (GENCOs, NIPPs and IPPs) are still fully and partly owned by the government ex-post and the TCN (that is simultaneously responsible for the network and market operations) is still fully owned by the government (initially placed under management contract with an external consultant - MHI¹³) poses a major challenge to the entire value chain and creates possible discriminatory tendencies against the investor owned IPPs and privatized GENCOs. The national grid still experienced six total system collapses in the first quarter of 2018 – (NERC, 2018).

- *Distribution/Retail Unbundling*

Based on our review and analysis of the electricity consumer classification in Nigeria (table 3). About 99% of the consumers were residential and small commercial (single phase and three phases low voltage) power consumers as at 2016. Therefore, the lack of unbundling of distribution from retail is arguably unnecessary during the reform. There is little evidence that residential and small commercial consumers get any significant added value from retail suppliers but there is evidence of significant costs associated with implementing a retail competition program for residential consumers (Joskow, 2008). Table 3 summarises our findings

Table 3: Summary of Residential and Low Commercial Customer

	Percentage of Residential and low load commercial customers (2016)
Abuja Electricity Distribution Company (AEDC)	99.58%
Benin Electricity Distribution Company (BEDC)	98.80%
Enugu Electricity Distribution Company (EEDC)	98.60%
Eko Electricity Distribution Company (EKEDC)	99.37%
Ibadan Electricity Distribution Company (IBEDC)	99.69%
Ikeja Electricity Distribution Company (IKEDC)	99.19%

¹³ MHI is Manitoba Hydro International

Jos Electricity Distribution Company (JEDC)	98.92%
Kano Electricity Distribution Company (KEDC)	99.64%
*Port Harcourt Electricity Distribution Company (PHEDC)	98.80%
Yola Electricity Distribution Company (YEDC)	98.55%
TOTAL	99.11%

Table 3: Author's computation from customer number data submitted to Regulator by DISCOs in 2016. KAEDC and PHEDC are 2015 data. Kaduna Disco data unavailable.

Horizontal Restructuring of Generation/vertical separation of competitive segment

The horizontal restructuring of generation/vertical separation of competitive from regulated segments were meant to facilitate competition. However, the availability of gas to the power plants was a major challenge mitigating the much-needed competition during and ex-post market reform as the gas supply infrastructure to the thermal plants were grossly underdeveloped coupled with the gas pipeline vandalization problems. Many of the gas fired plants are often with inadequate/ insufficient or no supply of gas to generate electricity.

Indeed, harnessing and transporting the gas from the fields to the thermal generation plants will not only improve the power sector's performance and reduce gas flaring (i.e combat resource waste) but also serve industrial and commercial users. A good starting point is to make the utilities commercially viable. This will attract investments to the gas gathering/gas-to-power projects and facilitate the construction of the gas pipelines and other infrastructure to harness the gas and end the domestic gas constraint challenges. However, this requires substantial investments in the gas infrastructure projects and attracting investment has remained challenging after the failed reform. Consequently, there is always constrained generation plus the transmission grid constraint that could not wheel more than 5,000MW¹⁴ at the time. In a nutshell, adequate competition has not been successfully created in the generation segment.

¹⁴ The transmission grid achieved the highest ever peak supply of 5,222 MW on December 18, 2017

Five years ex-post reform, the market is still at the transitional stage. It is unable to meet the key conditions precedent to the commencement of the medium-term market as follows: i. Attainment of a sufficient degree of privatisation of participants. ii. presence of sufficient generation to achieve an adequate balance between installed generation capacity, reserve requirements and projected load demand and sufficient numbers of generators to avoid the likelihood market power abuse iii. presence in the wholesale electricity market of sufficient number of competitive credit worthy Discos iv. satisfaction of the infrastructure preconditions, including the necessary metering and information technology required to implement the metering, balancing mechanism and settlement systems in accordance with the Market Rules (ONEM, 2014). The preconditions needed to establish a wholesale power market are relatively demanding and not met in much of the developing world (Foster and Rana, 2020). With the current state of the Nigeria power sector, it remains to be seen when the market will meet the preconditions precedent to the medium-term market. In many developing countries, reforms were only selectively adopted according to the ease of implementation, often stagnated at an intermediate stage, and were sometimes packaged and sequenced in ways unrelated to the original logic (Foster et al., 2017).

- *Regulatory Framework*

The Independent Regulator was established but appears ineffective. The current state of the sector seems to partly hinge on the weak regulatory framework. While regulations abundantly exist in paperworks, their application appear ineffective. In addition, although transition mechanisms were built into the reform program to stymie some (un)foreseen problems, they failed during macro-economic shocks.

In a nutshell, while it can be argued that the Nigeria reform has followed to some reasonable extent the “Standard model” of electricity reform. The core problem is not the lack of attempt to “get *it right*” from the outset but the ineffective practical implementations occasioned by the incomplete

privatization coupled with the horizontal integration of transmission and network operations, underdeveloped gas supply infrastructure network and the ineffective/weak regulatory framework.

8. Conclusion and Policy Implications

We applied the “Standard Model” of electricity reform as the methodology to perform a comparative analysis of the root cause of the Nigeria power reform failure while taking cognizance of the starting conditions of Nigeria. Our result reveals that the incomplete privatization coupled with the horizontal integration of the transmission and network operations without setting up an Independent System Operator did not facilitate (the expected) competition in the generation segment thereby hampering investments. Furthermore, the underdeveloped gas supply infrastructure network led to gas supply shortages to the thermal plants by limiting power supply that consequently led to consumer lack of willingness-to-pay and other market failure issues (ex-post). Moreover, the ineffective/weak regulatory framework that the reform was built upon also caused market failure issues. Therefore, to improve the status quo in the Nigeria Power sector, these key issues need to be carefully addressed. Below are our policy recommendations:

- *Strengthening the Regulatory Framework*

While it may be tempting to suggest the full privatization of the utilities because of the public sector inefficiencies, the current state of the sector coupled with the huge quasi-fiscal deficits is undoubtedly a strong deterrent to potential investors in the entire power and gas infrastructure value chain. Therefore, it is advisable to focus on restoring confidence to the sector with a strong regulatory framework before aiming to complete the privatization process. This should also rub-off and boost the investor’s confidence in the critical gas infrastructure value chain over time. Considering the depth of regulatory concerns, strengthening the regulatory framework should provide the right springboard to resolve the problems of investment, access and pricing and ultimately improve the overall market performance.

- *Increase investment in gas supply, transmission and distribution infrastructure*

Government should increase its investment in the transmission, distribution and gas supply infrastructure in its budgetary allocation. This will help to address the gas supply constraint challenges to the existing thermal power plant and to reduce the high transmission and distribution network losses thereby improving power supply to the consumers.

- *Effective stakeholders' engagement*

Prompt, continuous and effective stakeholders' engagement is critical at the states, local government and communities to resolve the socio-political and conflict of interest issues such as the tariff design, gas pipeline vandalization etc.

- *Workable Market Design and Regulatory Framework for Solar PV generation & integration*

The vast solar energy potential in Nigeria should be harnessed in decentralized offgrid/minigrid generation to complement the centralized generation encumbered with the reform failure. Solar PV has become cost competitive versus conventional technologies, Nigeria has good solar energy resource potentials, the technology is matured and available, the speed of implementation is in a shorter time versus centralized generation, it is modular for local adaptations, it provides the much-needed security of supply and green. Therefore, a workable market design for solar PV is needed to attract the needed investment and power up Nigeria in a much shorter timeframe. It is noteworthy that the design and framework should be robust, adaptable and fit with the strengthened framework for centralized generation.

Acknowledgement

Many thanks to the journal editor and three peer-reviewers for your comments and suggestions.

References

Aliyu I., Sanu M, Muhammed A., Abba Y., (2013), An assessment of the power sector reform in Nigeria. International Journal of Advancements in Research and Technology, Volume 2, Issue 2, February, 2013.

Amadi S. (2014), Successes and Challenges of the Power Sector Reform so far: Next Step. Keynote presentation at the Nigeria Bar Association, 2nd Annual Energy and Environmental Law Roundtable Yenagoa, Nigeria.

Battle C., and Ocana C. (2013), Electricity Regulation Principles and Institutions: In Regulation of the Power Sector by Ignacio Perez-Arriaga Page 125-150 Springer-Verlag London, 2013.

Bhattacharyya S. (2011), Reform of the energy industry. Energy economics. Pages 683-721

Besant-Jones J. (2006), Reforming Power Markets in Developing Countries: What have we learned ? Energy and Mining Sector Board Discussion Paper No. 19 The World Bank Group.

Deloitte (2018), Nigeria Electricity Regulatory Commission Annual Report and Financial Statements for the year ended 31 December, 2017. Abuja, Nigeria.

Eberhard and Shkaratan (2012), Powering Africa: Meeting the financing and reform challenges. Energy Policy, Volume 42, March 2012, Pages 9-18

ECN (2014), National Energy Master Plan (Revised Edition): Energy Commission of Nigeria, Federal Ministry of Science and Technology, Abuja, Nigeria.

Edet O. and Akpan B. (2016), Power Sector Reforms and Electricity Supply Growth in Nigeria. Asian Journal of Economics and Empirical Research, 3(1): 94-102

EPSRA (2005), Electric Power Sector Reform Act 2005: Federal Republic of Nigeria Official Gazette August 2005.

Erdogdu E. (2011) "What happened to efficiency in electricity industries after reforms?" Energy Policy 39(10): 6551–6560.

Erukilede, J., (2012), Power sector reform in Nigeria: A ruse or a Reality? Available at SSRN: <https://ssrn.com/abstract=220352>. (Accessed 10.10.16)

FGN (2016), The Nigeria Power sector investment opportunities and guidelines, Ministry of Power, Federal Republic of Nigeria (Draft) June 2016.

Foster V., Witte S., Banerjee S., Moreno A.(2017), Charting the diffusion of power sector reforms across the developing world. Policy Research Working Paper 8235. World Bank.

Foster V., and Rana A. (2020), Rethinking Power Sector Reform in the Developing World. Sustainable Infrastructure Series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1442-6

Gelb, A. and Grasmann, S. (2010). 'How should oil exporters spend their rents?' CGD Working Paper No. 221. Center for Global Development: Washington, DC.

GridCode (2017), The Grid Code for the Nigeria Electricity Transmission System - Version 3. Nigeria Electricity Regulatory Commission, Abuja, 2017.

Glachant J-M and Perez Y. (2008), Regulation and Deregulation in Network Industry "New Institutional Economics: A Guidebook," Page 328-362 Cambridge University Press.

Glachant J-M., Khalfallah H., Perez Y., Rioux V., Saguean M., (2013), Implementing Incentive Regulation and Regulatory alignment with resource bounded Regulators. Competition and Regulation in Network Industries, Volume 14 (2013), No. 3

Godinho C. and Eberhard A. (2019), Learning from Power Sector Reform Experiences. The Case of Uganda. Policy Research Working Paper 8820. Energy and Extractive Global Practice. World Bank Group 2019.

Folorunso and Olowu (2014), The Nigeria Power System till date: A review. International Journal of Advance Foundation and Research in Science & Engineering (IJAFRSE) Volume 1, Issue 5, October 2014.

IEA, IRENA, UNSD, WB, WHO (2019), Tracking SDG 7: The Energy Progress Report 2019, Washington DC

IEA (2014), International Energy Agency - Africa Energy Outlook: A focus on Energy Prospect in Sub-Sahara Africa, World Energy Outlook Special Report 2014.

IFC (2018), Off-Grid Solar Market Trends Report 2018. International Finance Corporation, World Bank Group, January 2018

Imam I.M, Jamasb T. Llorca M. (2019), Sector reforms and institutional corruption: Evidence from electricity industry in Sub-Saharan Africa. Energy Policy. Volume 129, 2019, Pages 532-545

Jamasb T., Mota R., Newberry D., Pollitt M. (2005), Electricity sector reform in developing countries: a survey of empirical evidence on determinants and performance. Policy, Research Working Paper ; No. WPS 3549. Washington, DC: World Bank.

Jamasb T., Nepal R., Timilsina G. (2015), A quarter century effort yet to come of age: A survey of power sector reforms in developing countries. Policy Research Working Paper 7330. World Bank.

Joskow P. (2006), Introduction to Electricity sector liberalization: Lessons learned from cross-country studies. In Sioshansi, F. and Pfaffenberger, W. (eds.): Electricity market reform: an international perspective. Page 1-32 Oxford: Elsevier 2006.

Joskow P. (2008), Lessons Learned from Electricity Market Liberalization: The Future of Electricity: Paper in Honour of David Newberry. The Energy Journal, Special Issue. 2008.

Laffont J.J (2005), Regulation and Development Cambridge University Press 2005.

Littlechild S.(2006), "Foreword: the market versus regulation." In Sioshansi, F. and Pfaffenberger, W. (eds.): Electricity market reform: an international perspective. Oxford: Elsevier, pp.xvii-xxix

Lee A.D and Usman Z (2018), Taking Stock of the Political Economy of Power Sector Reforms in Developing Countries. A literature review. Policy Research Working Paper 8518. Energy and Extractive Global Practice. World Bank Group 2018.

Makwe J.N, Akinwale Y.O, Atoyebi M.K. (2012): An Economic Assessment of the Reform of Nigerian Electricity Market. Energy and Power 2012, 2(3): 24-32.

Massol, O., Banal-Estañol, A. (2014), Export diversification through resource-based industrialization: The case of natural gas. European Journal of Operational Research, Volume 237, Issue 3, 1067-1082.

NERC (2012): Final Report for Metering Committee: Nigeria Electricity Regulatory Commission, Abuja, Nigeria.

- NERC (2015): Concept paper on capping estimation of energy consumption developed by the Nigerian Electricity Regulatory Commission, July 2015, Abuja, Nigeria.
- NERC (2016): NERC Charges DISCOs on High Customers' Complaints .Press Release available at: <http://www.nercng.org/index.php/media-and-publicity/press-releases/338-nerc-charges-discos-on-high-customer-complaints> (Accessed 20.10.16)
- NERC (2018), Nigeria Electricity Regulatory Commission, First Quarter 2018 Report, Abuja, 2018.
- NERC (2019), Nigeria Electricity Regulatory Commission, Third Quarter 2018 Report, Abuja, 2019.
- Newberry D. (2000), Privatization, Restructuring and Regulation of Network Utilities. Cambridge (MA), London.
- NGP (2017), National Gas Policy. Nigeria Government Policy and Actions. Ministry of Petroleum Resources, Federal Republic of Nigeria, 2017.
- Nwaoha, C., Wood, D.A. (2014), A review of the utilization and monetization of Nigeria's natural gas resources: Current realities, *Journal of Natural Gas Science and Engineering*, 18, 412-432.
- Ochugudu A.I and Onodugo V.A (2013), 'Power Sector Reform Deliverables: How Well and How Good to Customers? *International Journal of Management Technology*, Vol.1, No.1: pp, 1–14, 2013.
- Ogunleye E.K (2016), Political economy of Nigerian power sector reform. WIDER Working Paper 2016/9: United Nations University World Institute for Development Economics Research, 2016.
- ONEM (2014), Market Rules for transitional and medium-term stages of the Nigerian Electricity Supply Industry, Operator of the Nigeria Electricity Market (ONEM), 2014.
- Okolobah V. and Zuhaimy I. (2013): On the Issues, Challenges and Prospects of Electrical Power Sector in Nigeria. *International Journal of Economy, Management and Social Sciences*, Pages: 410-418, 2(6) June 2013
- Oseni M. (2016): Get rid of it: To what extent might improved reliability reduce self-generation in Nigeria? *Energy Policy* 93 (2016) 246-254
- Ostrom E. (2012): *The future of the Commons: Beyond market failure and Government Regulation*: The Institute of Economic Affairs, London.
- Pollitt M. (2008), Electricity Reform in Argentina, Lessons for developing countries. *Energy Economics* 30 (2008) 1536–1567
- Pollitt M. (2004), Electricity Reform in Chile. Lessons for Developing Countries. MIT Centre for Energy and Environmental Policy Research (CEEPR), 04-016 WP, 2004
- PSRP (2017), Draft Power Sector Recovery Program: 2017-2021, Federal Republic of Nigeria. 2017.
- Roadmap (2010), Roadmap for Power Sector Reform, The Presidency, Federal Republic of Nigeria. August 2010.

Roadmap (2013), Roadmap for Power Sector Reform, Revision 1 - The Presidency, Federal Republic of Nigeria. August 2013.

Spiller P.T and Savedoff W.D (1999), Government opportunism and the Provision of Water, Chapter 1 in "Spilled Water", Institutional Commitment in the Provision of Water Services, Inter-American Development Bank 1999.

Titus K.O, Abdul-Ganiyu A.J, Phillips D.A, (2013): The current and future challenges of electricity market in Nigeria in the face of deregulation African Journal of Engineering Research Vol. 1(2), pp. 33-39, March 2013.

Urpelainen J. and Yang J. (2019), Global patterns of power sector reform, 1982–2013. Energy Strategy Reviews 23 (2019) 152–162

World Bank (2016), Financial Viability of Electricity sector in Sub-Saharan Africa: Quasi-fiscal deficits and Hidden costs. Policy Research Working Paper 7788, Energy and Extractives Global Practice Group August 2016.