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Improving Electricity Access in Nigeria: Obstacles and the Way Forward

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ABSTRACT: Access to electricity is vital for economic development. Developing countries around the world have made various effort to improve electrcity access. In order to improve electrcity access, the obstacles need to be properly identified. Nigeria's electrcity access have been low for a very long time with no improvement in sight. This paper examined the obstacles hindering the improvement of electricity access in Nigeria. The obstacles identified includes; low efficiency and performance, security of fuel source for power generation, data inadequacy, regulatory barriers, lack of institutional arrangement, poor grid structure, delapidated transmission and distribution network, low financial investment, lack of policy and project continuity. A way forward was presented in order to improve electricity access in Nigeria.

Keywords: Nigeria; Electricity access; Efficiency and performance; Grid structure; Energy Security.
JEL Classifications: L94; Q20; Q30

1. Introduction

Energy is an import factor for socioeconomic development and economic growth of in the world (Emodi et al, 2014). Energy availability is crucial for a sustainable development in an economy while its non availablity may present some adverse effect which are detrimental to the society at large. Energy cannot be substituted in key areas of the economy such as industries, agriculture, transportation and service sector. With the increase in the world population, standard of living and rapid industrilization, the future energy is expected to grow. Inadequated supply of energy restricts socioeconomic activities, constrains economioc development and negatively affect the quality of life (Oseni, 2011).

In our present world today, electricity is the most widely used and desirable form of energy. One important observable trend is that the increase in country's population results to the increase in electricity demand (Oyedepo, 2012). In many developing countries especially African and some Southeast Asia countries, power supply is generally known for its unreliability and high disruption costs which affects production efficiency and competiveness. Africa is indeed endowed with the widest possible range of energy resources for electricity generation such as coal, natural gas, petroleum, solar, hydro, geothermal, nuclear, etc. but the continent's power sector remains severely underdeveloped and the energy consumptionin general and electricity consumption in particluar are relatively low (Economic Commission for Africa (2004) in Mayo, 2012).

At the country level, Nigeria which is located in the West African region bordered by Nigeria to the north, Atlantic Ocean to the south, Benin Republic to the west and Cameroon to the east. Nigeria is heaviely endowed with an abundant resources but electricity generation is relatively low with the current output less than 3000 (Bello-Iman, 2009). According to the Worldbank (2013), only 48% of Nigeria's 174 million people have acess to electricity. The access to electricity is relatively low compared to other African countries.

The research question this paper presents is how can the low electricity access in Nigeria be elevated to an economic accepted level. To answer the research question, we analyze the current status of the electricity sector in Nigeria, which will include electricity production and consuption, fuel use, cost, energy security, CO_2 emissions. We then investigate the obstacles to electricity access in Nigeria and provide solution to improve electricity access in Nigeria.

The rest of this paper is organized as follows. Section 2 reviews the current status of the electrcity sector in Nigeria. The obstacles and issues to electrity access in Nigeria are investigated in Section 3. Some issues were raised in Section 4. The way forward was provided in Section 5. Section 6 concludes the paper.

2. Current Status of the Electricity Sector in Nigeria

Electricity generation in Nigeria, rose from few kilowatts that were used in Lagos by the colonial masters when the first generating plant was installed in 1898. By the Act of Parliament in 1951, the Electricity Corporation of Nigeria (ECN) was established. Niger Dams Authority was set up in 1962 to develop hydroelectricity and was merged with ECN to form the National Electric Power Authority (NEPA) in 1972. Despite various effort by NEPA (which operated a monopolized market) to manage the power sector by providing electricity to the increasing population, it became clear that NEPA was losing the battle to meet up with the electricity demand in the 1990s. Hence, in 2001, the National Electric Power Policy (NEPP) was introduced to kick-off the power sector reform and this lead to several other reforms in the past years. The NEPP in 2001 created the roadmap for Nigeria's Power Sector Privatization, but due to government bureaucracy; the policy was not signed into law until 2005. This signed document was the Electric Power Sector Reform (EPSR) Act in 2005 which was expected to level the playing ground for potential investors and improve the wellbeing of its citizens. The EPSR Act led to the incorporation of the Power Holding Company of Nigeria from NEPA, which was later defunct and divided into sub-sectors (Emodi & Yusuf, 2014).

The sub-sectors are made up of 18 companies which include: six generators (GENCOs), 11 distributors (DISCOs) and one Transmission Company (TCN). These companies are saddled with the responsibility of carrying out the functions relating to the generation, transmission, trading, distribution and bulk supply as well as resale of electricity in the country (Oseni, 2011).

Figure 1. The Nigeria Electricity Grid Network

Source: www.geni.org

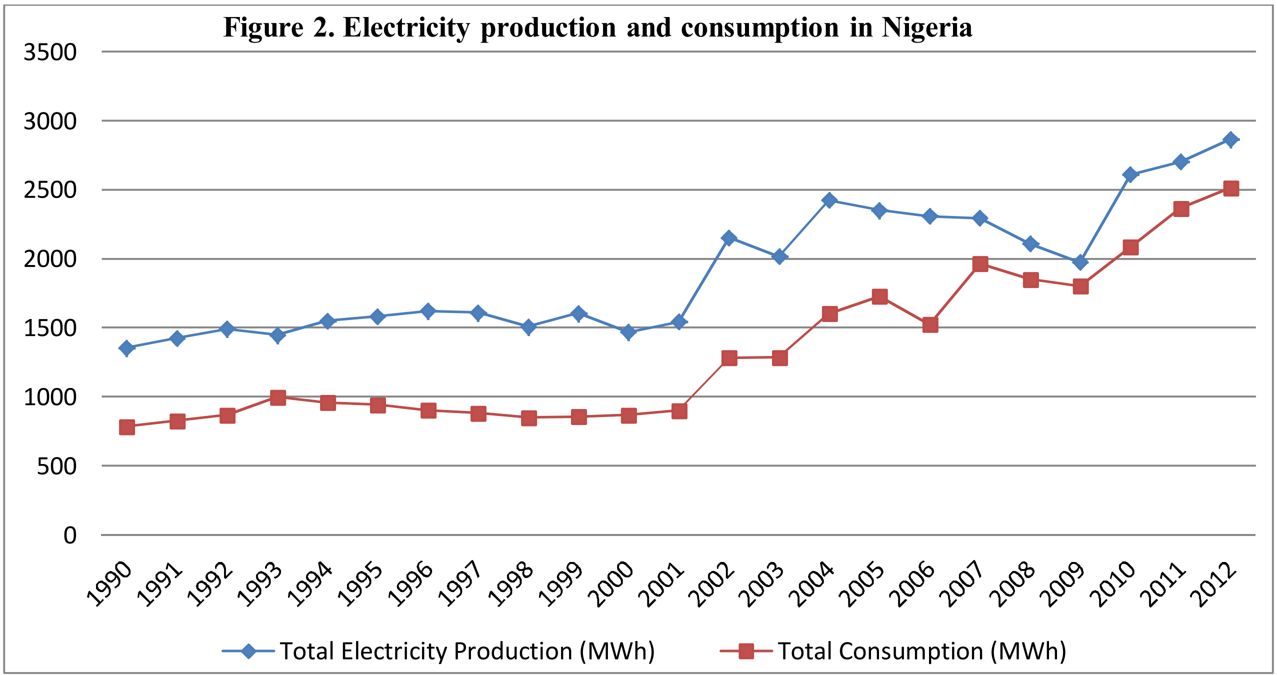
Electricity has been in existence in Nigeria for more than 100 years with various reforms of the electricity sector but its development and availability to Nigerians have been a dilemma. The nation's electricity utility grid as shown in Figure 1 comprises of three (four after 2012) hydro power plants and six thermal generating stations with total installed capacity of 10942 MW but the production have never exceeded 3000 MW. Table 1 shows the current electricity plants in Nigeria. The electricity generated are transmitted through transmission lines that use three phases namely alternating current (AC), single-phase AC current and high-voltage direct current system. However, transmission of electricity using high voltage (110 KVA or 330 kVA used in Nigeria) aids in the reduction losses (Oseni, 2011).

Table 1. Current Power plants in Nigeria and their location

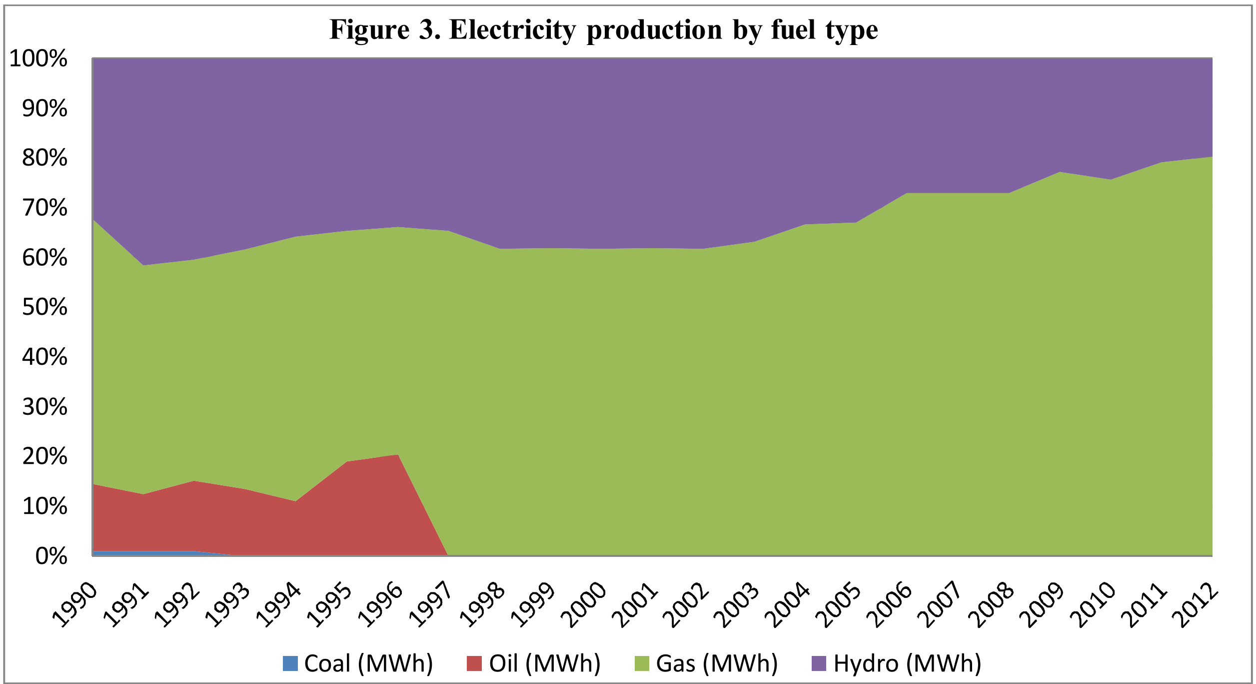
Power Station	Location	Type	Installed Capacity (MW)	Year Completed
AES Barge	Egbin	SCGT	270	2001
Aba	Aba, Abia State	SCGT	140	2012
Afam IV-V	Afam, Rivers State	SCGT	726	1982
Afam VI	Afam, Rivers State	CCGT	624	2009
Alaoji (NIPP)	Abia State	CCGT	1074	2013
Calabar (NIPP)	Cross River State	SCGT	561	2014
Egbema (NIPP)	Imo State	SCGT	338	2013
Egbin	Egbin	Gas-fired steam turbine	1320	1986
Geregu 1	Geregu, Kogi State	SCGT	414	2007
Geregu 11 (NIPP)	Geregu, Kogi State	SCGT	434	2013
Ibom (NIPP)	Ikot Abasi	SCGT	190	2009
Ihorbor (NIPP)	Benin City	SCGT	450	2013
Okpai	Okpai	CCGT	480	2005
Olorunsogo	Olorunsogo	CCGT	336	2007
Olorunsogo 11	Olorunsogo	CCGT	675	2012
Omoku	Omoku	SCGT	150	2005
Omoku 11 (NIPP)	Omoku	SCGT	225	2013
Omotosho 1	Omotosho	SCGT	336	2005
Omotosho 11 (NIPP)	Omotosho	SCGT	450	2012
Sapele	Sapele	Gas-fired steam turbine	1020	1981
Sapele (NIPP)	Sapele	SCGT	450	2012
Ughelli	Delta State	SCGT	900	1990
Itobe	Kogi State	CFB Technology	1200	2015-2018
Kainji	Niger State	Reservoir	800	1968
Jebba	Niger State	Reservoir	540	1985
Shiroro	Kaduna State	Reservoir	600	1990
Zamfara	Zamfara State	Reservoir	100	2012
Kano	Kano State	Reservoir	100	2015
Kiri	Benue State	Reservoir	35	2016
Mambilla	Taraba State	Reservoir	3050	2018

Current capacity=13,603 MW, Under-construction=4,385 MW, Total= 17,988.
Source: National Control Centre, Osogbo

Nigeria's electricity production and consumption pattern are shown in Figure 2. We can observe that the nation's electricity consumption from the national grid is just a little above 2500 MW. The Nigerian electricity production from fuel source is shown in Figure 3. The oil power plants in Nigeria have been converted to gas plants. The number of gas and hydropower plants has been increased since the last conversion of oil power plants in 1997 as also shown in Figure 3.



Source: Worldbank



Source: National Control Centre, Osogbo

2.1 Energy Security

Energy security definition and scope vary between studies, researchers categorize and embody the results into various levels according to criteria and thus develop an index to measure the defined level of energy security (Ryu et al. 2014). According to the IEA, energy security is the uninterrupted availability of energy sources at an affordable price. Energy security has many aspects; long-term energy security which deals with timely investments to supply energy in line with economic development and environmental needs while the short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance. On the other hand, energy insecurity can be defined as the loss of welfare that may occur as a result of a change in the price or availability of energy (Bohi & Toman, 1996).

The measure of the price implications due to resource concentration consists of two components. First, a measure of market concentration in each international fossil fuel market, referred to here as energy security market concentration (ESMC), represents the price risk resulting from fossil fuel resource concentration (Ryu et al, 2014). Second, for a given country, exposure to price risks is incorporated into an energy security measuring the share of each fuel of total primary energy supply. Because fossil fuel resources are often located in politically sensitive areas of world, which depend on the reliability of supply from top exporting countries we account for political stability in the measure of ESMC as follows.

$$ESMC_{pol-f} = \sum_{i}(r_i \times S_{if}^2)$$

Sif is the percentage share of each supplier in the international market for fuel f as defined by its net export potential. Scale-up term, ri), is the political risk rating for country i which was obtained from the Worldbank Worldwide Governance indicator. For the simplicity we calculated based on the five top countries net export. Then energy security price index for the electricity generation index (ESPI) is calculated based on the following equation.

$$\mathrm{ESPI_{gen}} = \sum_{\mathrm{f}}\left\lfloor \mathrm{ESMC_{pol-f}} \times (\mathrm{toe/MWh})_{\mathrm{f}} \times \mathrm{EGS_f/TEGS}\right\rfloor$$

Where (toe/MWh) is a heat rate for electricity generation of fossil fuel f based on considerations of the characteristics of fossil fuel resources and efficiency of the electricity-generating technologies. TEGS is total electricity-generation supply and EGSf is the electricity- generation supply from fossil fuel f. The modified terms allow for the conversion process from primary energy resource to electricity Energy security index calculation based on the above equation.

In Table 2, we present the three electricity generating technology in Nigeria (oil is no longer in use), their energy security in percent, energy security market concentration (ESMC), electricity generation supply security price index ($ESPI_{Gen}$), the plants efficiency, amount of CO_2 the technologies emit, investment cost, fuel cost, operation and management cost (O&M) and the levelized cost of energy (LCOE).

Table 2. ESMC, ESPI &Cost of electricity generating technologies in Nigeria

Fuel Resource	Technologies	Energy Security (%)	$ESMC_{Pol}$	$ESPI_{Gen}$	Efficiency (%)	CO_2(TC) per MWh	Investment Cost (US$/MWh)	Fuel Cost (US$/MWh)	O&M Cost (US$/MWh)	LCOE
Oil		10.97	3627.8	0	86	0.279	17.57	67.16	19.91	104.6
Gas	CCGT	2.56	5338.9	646.8	57	0.23	8.07	28.14	2.81	39.02
Hydro	Hydro Power	0	0	0	55	0	15.39	0	8.85	24.24

Note: The cost is based on 8% discount rate.

Data Source:

Data for energy security was obtained from Korea Energy Statistic Information System (KESIS).

Energy security market concentration (ESMC) calculated based on estimated market share of top five oil and gas exporting countries in 2012 and the data used was obtained from Worldbank Worldwide Governance indicator (http://info.worldbank.org/governance/wgi/index.aspx#doc).

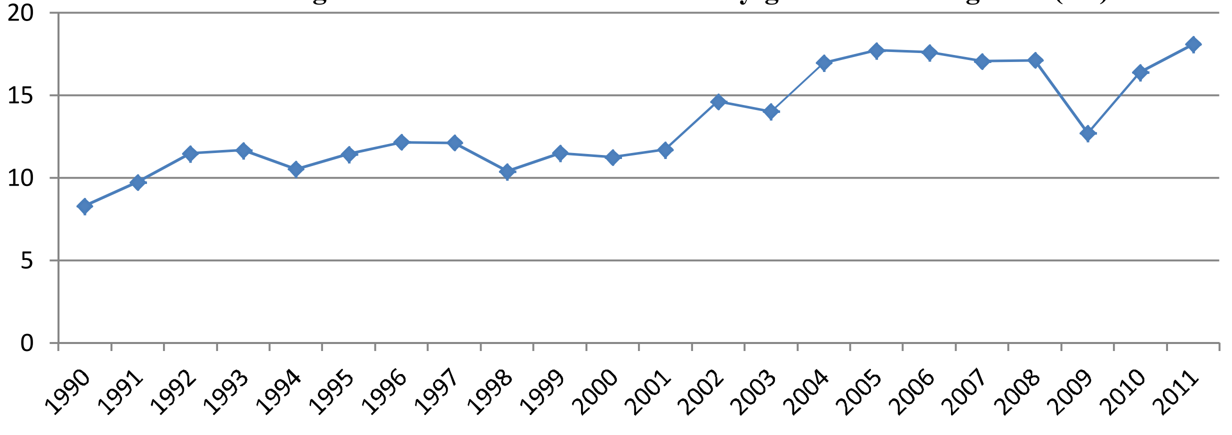
CO_2 emission for the technology was obtained from the Intergovernmental Panel on Climate Change (IPCC) inventory guidelines (www.ipcc-nggip.iges.or.jp/public/2006gl).

Data for plant efficiency, investment cost, fuel cost, O&M cost was obtained from the National control center, Osogbo in Nigeria.

2.2 CO_2 emission

Nigeria is not under the Annex 1 parties and not compelled to reduce carbon emission under the Kyoto protocol. From Table 2 we can observe that CCGT plants have less emission compared to oil plants. The amount of gas plants in Nigeria has been on the increase which is due to the recognition of channeling flared or associated gas to power generation. The Nigerian government realized that since oil price are higher in the international market than gas and was important for other economic activities such as transportation, it was a good move to shut down or convert oil power plants to gas. Nigeria's CO_2 emission from electricity generation is shown in Figure 4.

Figure 4. CO2 emission fro electricity generation in Nigerian (Mt)



Source: Worldbank

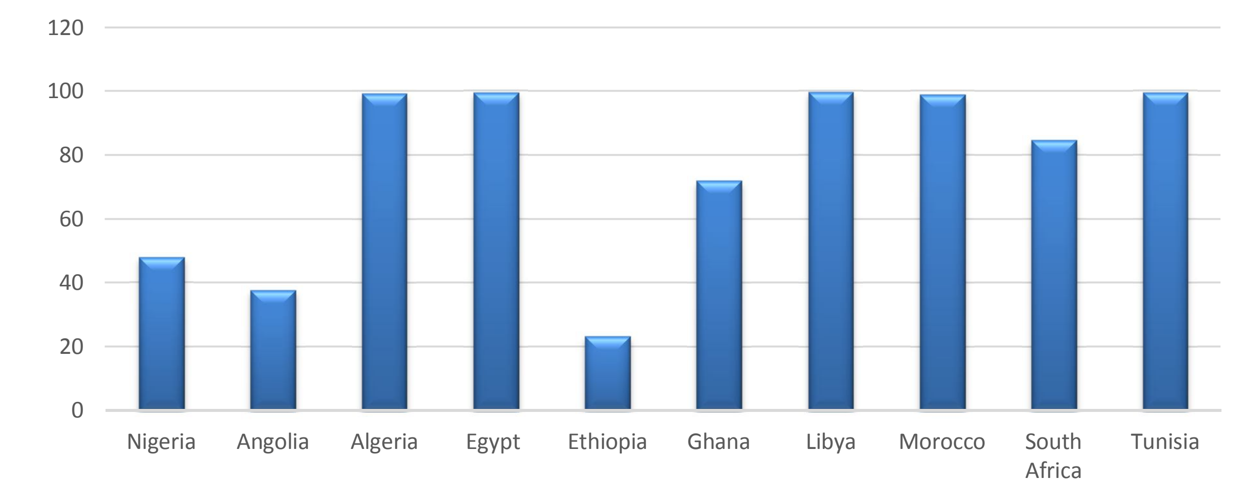
2.3 Production Cost

The cost of the electricity generating technologies (LCOE) was presented in Table 2. Gas thermal power plant (CCGT which was considered in this paper) has a lower cost compared to oil power plants. We did not consider single cycle gas turbine (SCGT) due to data limitation. Hydropower as observed (Table 2) was the lowest with no ESMC, ESPI risk, no CO_2 emission and no fuel cost. However, O&M cost is high compared to CCGT. Oil power plants have the highest efficiency but the investment cost is high coupled with the fuel cost and O&M cost.

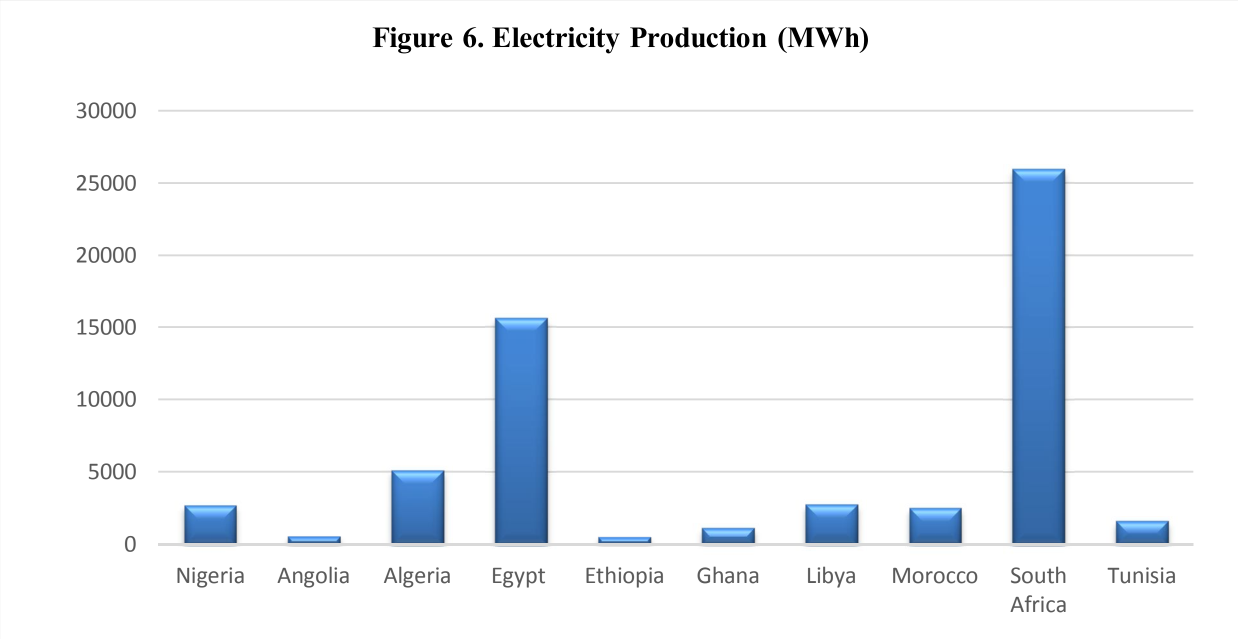
3. Obstacles to electricity access in Nigeria

Electricity access is low in Nigeria which is the largest economy in Africa in terms of GDP and population. In comparison with the top ten economies in Africa, Nigeria's access to electricity is low (Figure 5), while electricity production is also among the lowest in among the top 10 African countries (Figure 6). However, efforts made by the government have not yield fruit as the country still battles with electricity crisis. We will discuss the various obstacles and issues relating to electricity access in Nigeria in the following sub sections.

Figure 5. Access to Electrcity (%)



Source: Worldbank

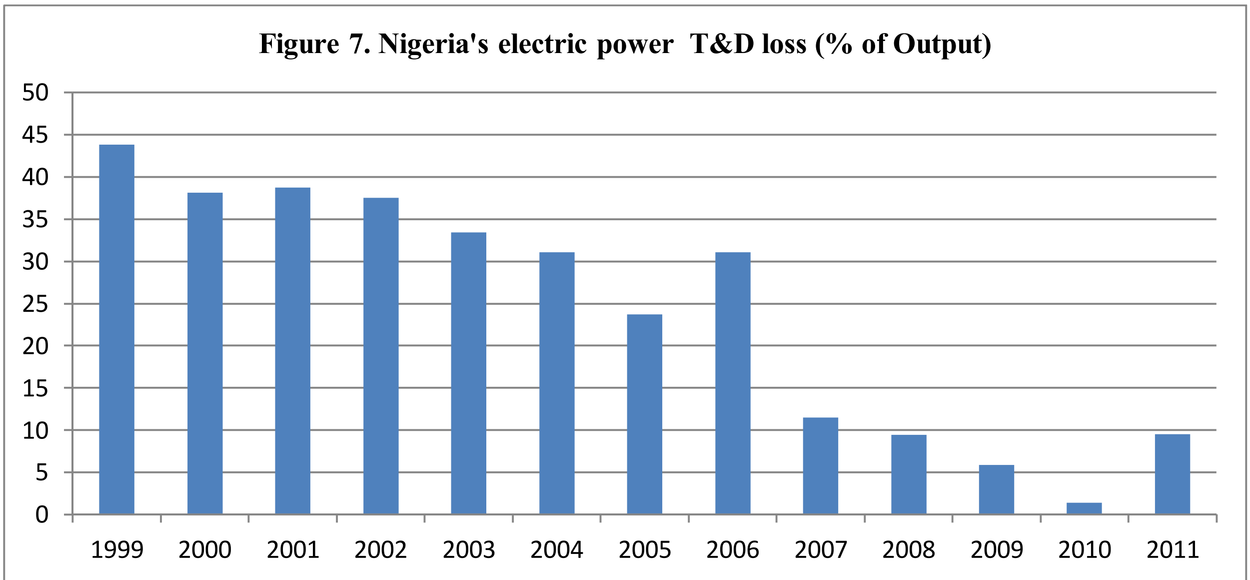


Source: Worldbank

3.1 Efficiency and Performance

In terms of efficiency and performance, the Nigerian electricity sector has been rated by the UNDP/World Bank Report 1993 as having one of the highest rate of losses (33%), the lowest generating capacity factor (20%), the lowest revenue at 1.56c/kWh, the lowest rate of return (-8%) and the longest average account receivable period (15 months), among a group of 20 low income and upper income countries.

However, over a decade after the conclusion of the UNDP/World Bank Report, the story has not radically changed as observed in Figure 7. Electricity tariffs are below the cost of service and there is poor revenue collection. According to Tallapragada and Adebusuyi, (2008), about 30-40 per cent of power supplied is never billed. The power sector incurs a cash loss of around US$2billion per month. Over US$400 million annually is spent by the Federal Government of Nigeria as an annual subsidy to cover losses and investment, an amount that is higher than the Federal budget for health.



Source: www.tradingeconomics.com

An interesting comparison of selected power sector indicators of technical and financial efficiencies between Nigerian and the average for a group of African countries is presented in Table 3.

Nigeria efficiency performance on all counts is much worse than for a set of middle income African countries. In 2004/05, installed generation capacity in Nigeria was a mere 42MW per million people compared to 404MW for middle income African countries. The share of self electricity generated in total electricity generated in Nigeria was 52 per cent compared to less than 1 per cent for Middle income African countries. The number of unplanned outages in Nigeria was also 30 times more than what obtained in the former group of countries. Labor efficiency is also poorer in Nigeria. Labor costs account for 48 per cent of operational costs compared to 29 and 11 per cent for low middle and middle income African countries respectively.

Table 3. Technical and financial efficiency comparison

Indicators		Nigeria	Low Income African Countries	Middle Income African Countries
Technical efficiency	In-generation capacity (MW)	598	918	13651
	MW per million pop.	42	32	404
	MW in operation condition as % of installed capacity	61	84	97
	Per capita (kWh/cap)	173	141	1912
	Self-generated as % of electricity generated	42	10	0.7
Effective residential tariff (cents/kWh)		4.1	12	32
Quality Number of unplanned outages per year		1059	3082	39
Efficiency	Labor efficiency (ann. labor costs as % of operational expenses)	48	29	11
	Average revenue (cents/kWh)	NA	NA	NA
Efficiency ratios (%)	T & D losses	30	25	13
	Cost recovery (based on effective tariff)	36	64	56
	Implicit collection (based on effective tariff)	52	83	95
Total hidden costs of inefficiencies	as % of GDP	1.4	2	0.6
	as % of utility revenue	229	125	13

Source: Adenikinju (2008)

A bane of the power sector remains the low funding of the sector as well as the inability of revenue to cover costs. Cost as a percentage of tariff declined from 83.3 per cent in 2001 to 42.6 per cent in 2003 before rising to 66.5 per cent in 2004. In view of other demands on its revenues, the government has shown itself unable to continue to shoulder past energy financing responsibilities.

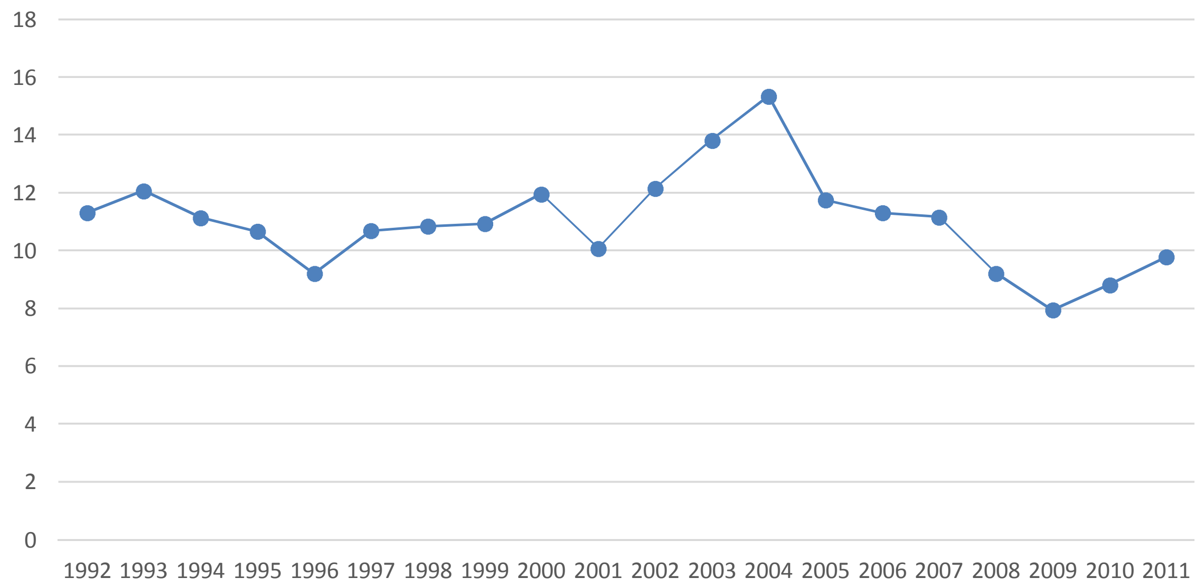
The electricity generation efficiency is shown in Figure 8 where can observe that the power plants in Nigeria are operating at a very low efficiency. This inversly has a negative effect on electricity generation which is shown in Figure 2. The low efficiency is due to lack of proper maintenance culture in the power plants. On the consumer side, low efficiency on electricity consuption occurs when the utility consumers don't switch off their electrical appliance or use energy efficient appliances.

3.2 Security of fuel source for power generation

3.2.1 Hydro

The increasing global climate change is becoming a serious threat to the future of the electricity sector in Nigeria. Its effect on water supply has severely hindered electricity generation from hydro sources in Nigeria. Since the power output of hydro plants is dependent on the water level, with less water, there is less potential energy to harness. Besides the issue of climate change lies seasonal droughts which also affect electricity generation from the large hydropower in Nigeria. The Kainji, Jebba and Shiroro hydropower plants are long overdue for rehabilitation and the actual energy output is below projected capacity.

Figure 8. Nigeria electricity generation efficiency



Source: National Control Centre, Osogbo

3.2.2 Gas

The supply of gas to the nation's power plants has been affected by the security problems in Nigeria. The Northern part of the country have been contending with the rapid increase in political violence and this part of the country is host to the all the hydro power plants in Nigeria. To the south where most of the thermal power plants are located still face vandalism of gas pipes that supply gas to the various power plants which supplies the country with electricity. Most gas plants are not connected to the oil companies and depend on supplies from tankers to supply them with the required fuel for their operation. To crown it all, these gas plants are not producing electricity at their full capacity.

The problem of inadequate gas supply has also been an important challenge faced by the power sector. Gas currently accounts for 75 per cent and 67 per cent of installed and available electricity capacities in the country respectively. However, as the current experiences with the new power plants built by the government have shown, gas security will continue to pose a major challenge for the power plants now and in the near future (Adenikinju, 2008). The issue of gas flaring in Nigeria has not been properly addressed; oil companies still do not capture their associated gasses given off during refining process. This could be channeled to gas plants to improve electricity generation in Nigeria.

3.3 Data Inadequacy

There is no data for correct estimation of the customers to plan for. This greatly accounts for the uneven allocation and distribution of available resources like transformers. This has equally affected decision making in the sector as evident in the poor siting of NIPPs away from areas where gas facility is readily available to far off areas motivated by political reasons (Okolobah & Ismail, 2013).

3.4 Regulatory barriers

As on date, the country is still in need of a market-oriented policy that will increase RE investors' participation in constructive development of the available resources. Effective policy making is an incitement that can strengthen the prospect for investment and development of RE technology. Feed-in tariffs, investment tax credits and renewable portfolios are some policy issues that could be useful to enhance better share of RE in the nation's power generation mix. The suggested issues are regulatory strategies to lower the costs of RE while increasing the adoption of RE sources. With the fact that soaring upfront investment expenses of RE development is sometimes responsible for their being ignored by potential investors, well-structured policies can be employed to resolve issues regarding subsidies and tax waivers (Mohammed et al, 2013)

3.5 Lack of institutional arrangement

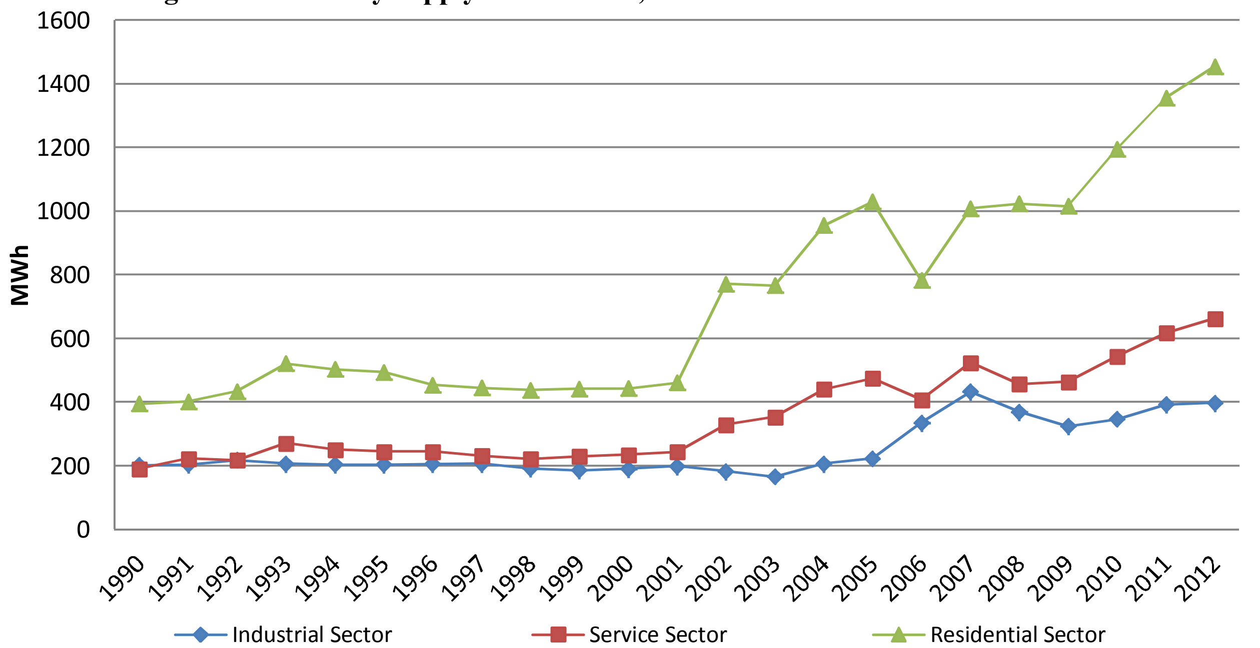
The lack of implementation of clean energy policies and the lack of coordination among relevant government agencies has created distortions and makes clean energy development more difficult.

Inter-ministerial rivalries, overlap of mandates and outright protection of space often send wrong signals to potential investors. The absence of a clear political vision and leadership, weak regulatory institutions and inadequate human capacity, coupled with limited funding by government, all add up to make Nigeria's renewable energy market look dwarfed compared to that of much smaller countries like Kenya. Currently, there is little hope for a quick transition to a green economy. No program to equip rural women with small-scale renewable energy education and knowledge. The proposed Climate Change Commission under the Presidency would have the potential to increase synergies across ministries, and government agencies at the federal, state and local levels. However, the Bill to establish the Commission remains unsigned by the President (Emodi & Yusuf, 2014).

3.6 Grid Structure

The Nigerian electricity grid network (Figure 1) has been going through a lot of challenges for a long time. The state-owned electric monopoly, NEPA was characterized by poor operation performance which could be drawn from the fact that only 426 out of the 774 local government area (LGA) in Nigeria are connected to the utility grid (Central Bank of Nigeria, 2010). Due to the pathetic state of the nation’s power sector, the cost of doing business in Nigeria is high compared to other African countries. The South African mobile phone company MTN who operates the largest mobile phone company in Nigeria is estimated to have installed 6,000 generators to supply its base stations for up to 19 hours a day which raises the cost of diesel to $5.5 million a month to run their generators (Emodi & Boo, 2014). However, electricity supply to industries has been on the decrease for quite some time as shown in Figure 9.

Figure 9. Electricity supply to industrial, service and residential sectors

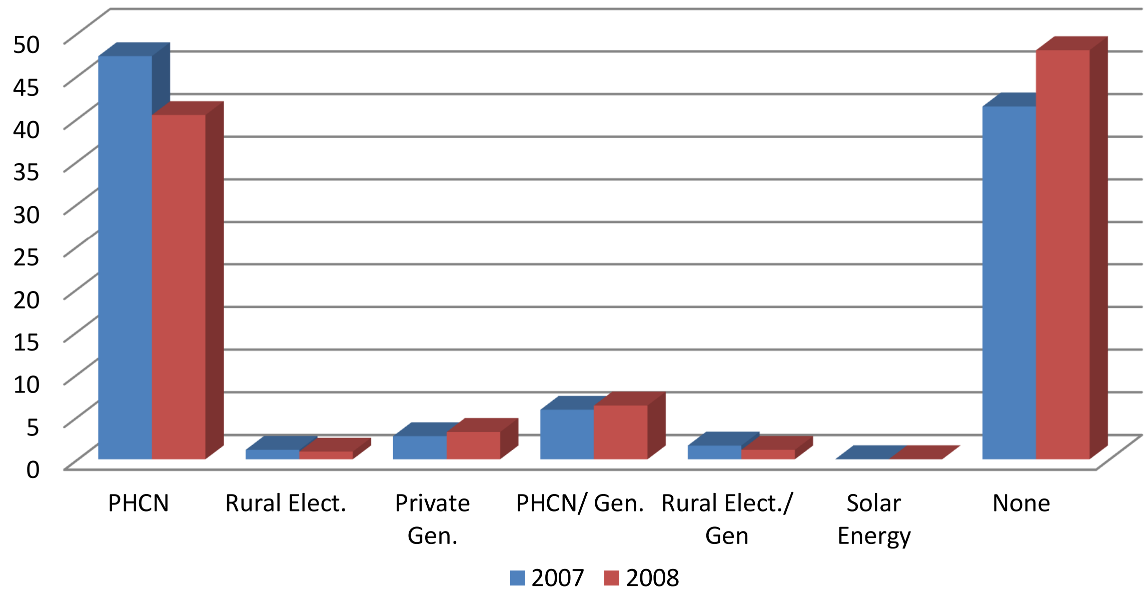


Source: National Control Centre, Osogbo

Electricity access have been below 50% in Nigeria as reported by the Energy Commission of Nigeria while Nigerians have turned to the use of private generators and those in the rural areas depend on rural electrification programs as shown in Figure 10. There is a problem of zoning on the electricity grid. This occurs when property zoned for residential use are converted to industrial use which requires more energy.

This has caused grid overload and transformer explosions in some locations. The current privatization of the power sector has increased the physical sabotage of the grid system through the dismantling of parts in the grid by both the old and new utility operators. On the consumer side, the use of obsolete meter contributes to inaccurate billing while other consumer connects their residence or business enterprise to the utility grid without a proper metering infrastructure. This electricity leak is known as “rocking” in the Nigerian context.

Figure 10. Percentage distribution of electricity in 2007 and 2008



Source: Energy Commission of Nigeria, 2009

3.7 Transmission and Distribution network

The Nigerian transmission and distribution network is outdated with inadequate redundancy as opposed to the required mesh arrangement, regular vandalism of the lines, associated with low level of surveillance and security on all electrical infrastructures. The level of electricity loss during transmission and distribution is still high as shown in Figure 11. Electricity losses result in lower power availability to the consumers, leading to inadequate power to operate the appliances. Thus, the high efficiency of the power system is determined by its low power losses.

Increased power demand pushes the power transmission and distribution networks to their upper limits and beyond, resulting to shortening of the life span of the network or total collapse. The Nigerian transmission system does not cover every part of the country (Sambo et al., 2012).

It currently has the capacity to transmit a maximum of about 6056 MW and it is technically weak, thus very sensitive to major disturbances. Major problems associated with transmission systems include;

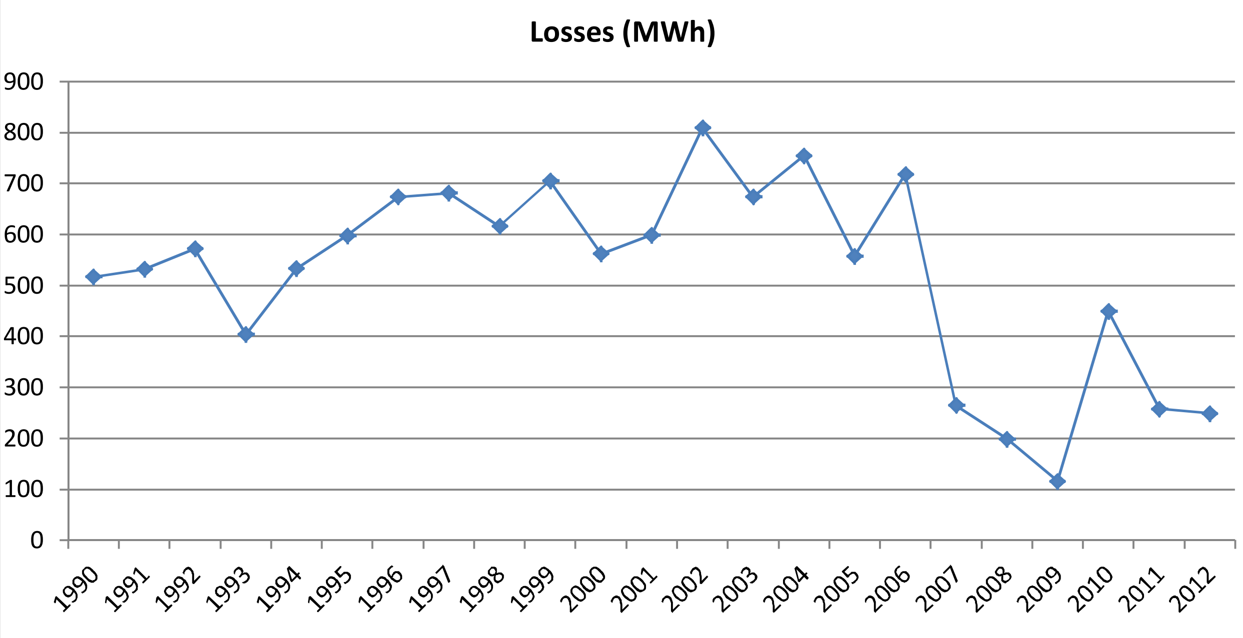
- poor funding by the Federal Government,
- it is yet to cover many parts of the country,
- it's current maximum electricity wheeling capacity is 6,056 MW which is awfully below the required national needs,
- regular vandalization of the lines, associated with low level of surveillance and security on all electrical infrastructure,
- inadequate of spare parts for urgent maintenance,
- poor technical staff recruitment, capacity building and training programme.

3.8 Financial investment

The Nigerian power sector is a capital intensive sector which requires a lot of capital. The allocation of the Federal budget for the development of the power sector is low compared to the potential of the sector. Figure 12 shows the power sector funding from 1974 to 2003. The Ministry of Power and steel projected the amount of investment to meet domestic power system expansion in 2030 at an estimated US$262 Billion. To increase transmission capacity from 5800MW to over 13000MW in 2013 cost the government US$1.4 Billion while increasing generation capacity from 4200MW to 13000MW in the same year cost the government another US$3.5 Billion.

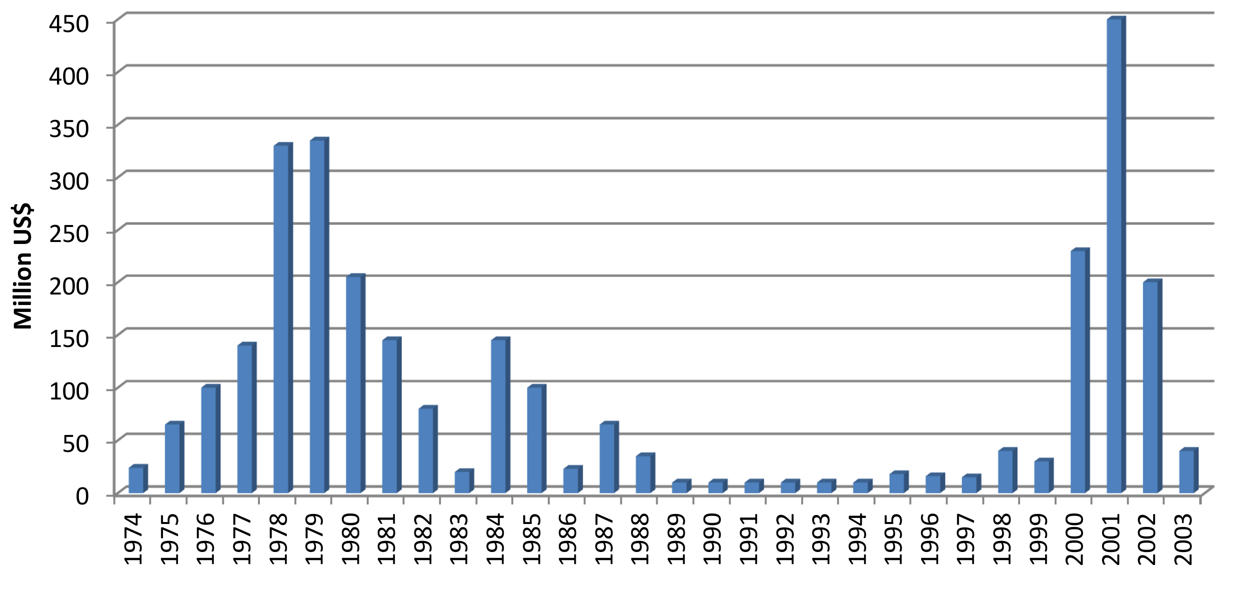
The total capital expenditure and the power sector capital expenditure are shown in Figure 13. We can observe that the required capital by the power sector was not met from 2008 to 2011. This amount was high for the Federal government of Nigeria to provide considering the fact that other sectors yarns for funds. However, proper institutional framework and co-ordination by the government, incentives structure and security of investment will guarantee the flow of capital for the power sector development.

Figure 11. Transmission and distribution losses in Nigeria electricity grid



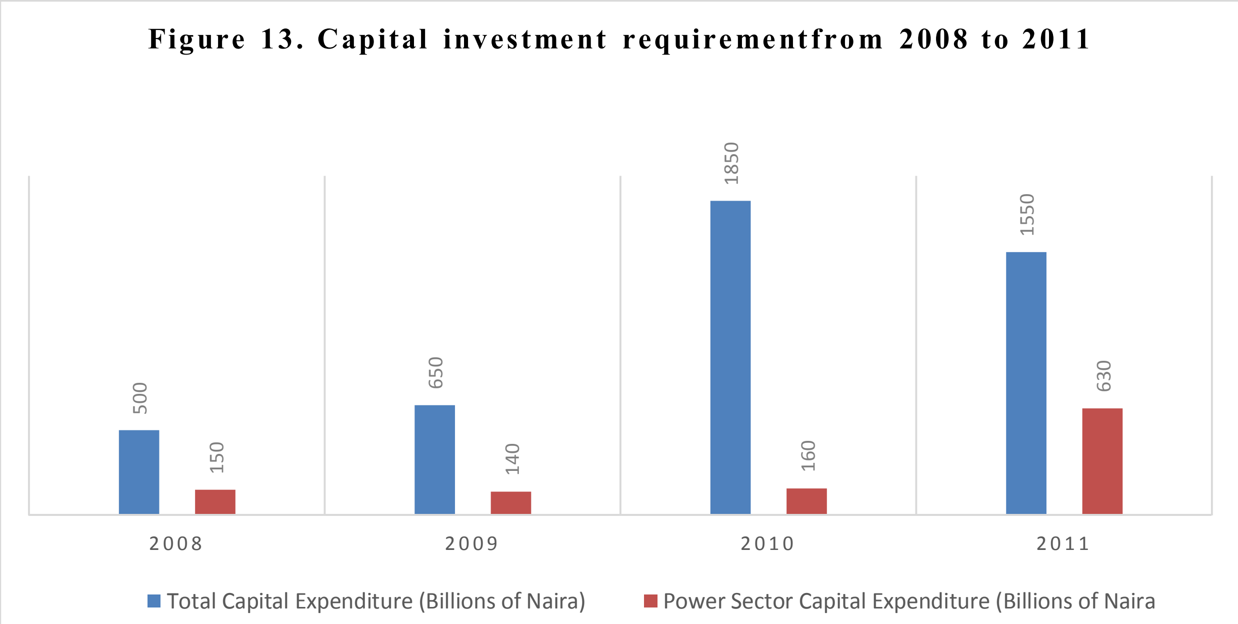
Source: National Control Centre, Osogbo

Figure 12. Power Sector Funding in Nigeria



Source: Adenikinju (2008)

The risk involved in financial investment has to be identified in order to strengthen the refinery and pipeline distribution network, and power supply system. The risk includes economic, sociopolitical, technological and environmental risk. There is need for proper sharing of this risk among the three actors namely consumers, investors/producers and the government. Proper incentive structure built on industrial restructuring, full privatization and sound regulatory framework will improve the power sector's performance (Adenikinju, 2008).



Source: Central Bank of Nigeria, 2010

3.9 Policy and project continuity

Due to the political system in Nigeria that is constantly changing, energy policies are not ineffective. When a new administration comes in, old policies are abandoned and new policies initiated. There is lack of proper policy evaluation in the Nigerian power sector. Most rural electrification projects lunched by the government do not reach completion stage while others are built with substandard electrical appliance.

4. Issues Raised

4.1 Energy Subsidy

Energy subsidy can be defined as any government action that lowers the cost of energy production, raises the revenues of energy producers or lowers the price paid by consumers (IEA). Energy subsidy comes in two forms: those designed to reduce the cost of consuming energy are called consumer subsidies and those aimed at supporting domestic production are called producer subsides (www.iisd.org). In Nigeria, consumer subsides exist for three energy products gasoline, household kerosene and electricity. Electricity subsides are conferred by charging tariffs that are too low to cover the cost of electricity production. The utility companies are usually reimbursed for as part of the lump sum they paid to cover all their operational activities.

4.2.1.1 Electricity subsidy

Difficulty arises when estimating the scale of subsidies in Nigeria which is due to the government's inability to provide specific payments to electricity agencies to compensate for low-cost electricity pricing. Instead, electricity providers are given huge sums of money every year to carry out all their activities. A study carried out by Foster & Pushak (2011) estimated the cost of electricity subsides in Nigeria between the period of 2005 and 2009 based on the assumption that the average cost of electricity generation should be roughly US$0.14 per KWh. Meanwhile, this benchmark is used to estimate the extent to which the average tariff is effectively a subsidy. This method used by Foster & Pushak (2011) puts electricity subsidy to be between the range of US$1.5 to 2.3 Billion in the studied period. The result is shown in Table 3. The electricity utility companies are being paid these subsidies in order to enable then carry out repairs, reinvestment and purchase gas for their power plants.

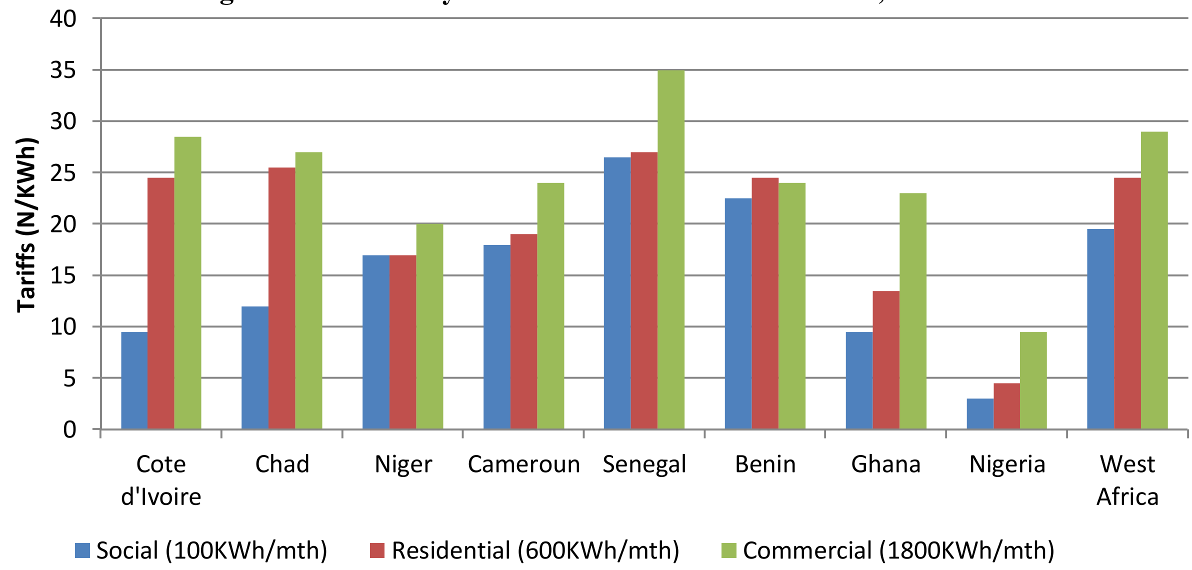
According to Machunga –Disua & Machunga-Disua (2012), there have been an underpricing of gas to the tune of US$0.12 in 2012 which amounted to the annual subsidy of US$50-90 Million per year. The problems related to the administrative management of subsidy have led to the loss of a substantial amount of public funds. The Nigerian government often makes late payments to the electricity generating companies and this according to the Nigerian Electricity Regulatory Commission (NERC) hinders the utility companies from generating revenue.

It was reported in 2010 that the government owed electricity utility companies a subsidy debt of US$0.7 Billion (Ohiare, 2014). About US$1.1 Billion was unilaterally imposed by the NERC as the subsidy for the year 2009-2012 to clear the debt that rose due to low tariffs production unit cost for all electricity consumers (Tallapragada, 2009). Loss in electricity revenue has in general been due to low electricity pricing and failure of the utility companies to bill and recover the bills from electricity consumers. It has been reported that in 2010, only 64 percent of billed revenue were recovered from the electricity consumers (Foster & Pushack, 2011).

4.2 Electricity Tariffs

Nigeria electricity tariff is the lowest among the West African countries as can be observed in Figure 14.

Figure 14. Electricity Prices in West African Countries, 2009



Source: Citizens' Guide to energy subsidies in Nigeria, 2012

Nigeria's changing energy pricing system is also creating huge problems for electricity subsidies. In the mid-1990s to 2002, the tariffs were between US$0.01 to US$0.03 for the residential and commercial consumers respectively. The price was later adjusted to US$0.04/KWh in 2008. This increase in tariffs could not cover the cost of electricity production which is estimated at US$0.14-0.15 (Alike, 2012).

In 2008, a 15-year roadmap towards cost reflective tariffs called the Multi-Year Tariff Order (MYTO) was created. The first two phases, 2008-200 and 2012-2017 were designed to keep consumer prices relatively low, through still affecting the price increases in a gradual manner. The final regime is intended to provide the necessary incentives for power producers and investors to operate and maintain electricity infrastructure (Citizens' Guide to energy subsidies in Nigeria, 2012). The MYTO tariff structure is presented in Table 4.

Table 4. MYTO tariff structure

	2012 Fixed Charge, N/month	Energy Charge, N/KWh	2013 Fixed Charge, N/month	Energy Charge, N/KWh	2014 Fixed Charge, N/month	Energy Charge, N/KWh	2015 Fixed Charge, N/month	Energy Charge, N/KWh
Residential R1 (Life line <50KWh)		4		4		4		4
Residential R2 (Single 3-phase (50KWh - 600KWh))	500	12.45	750	12.83	895	13.21	1,067	13.61
Residential R3 (Low voltage maximum Demand	17,513	21.84	26,269	22.5	31,332	23.17	37,371	23.87
Residential R4 (High voltage maximum demand (11/33KVA))	109,449	21.84	164,174	22.5	195,818	23.17	233,561	23.87
Commercial C1 (Artisans, Entrepreneurs, SMEs (Single & 3-Phase))	500	16.56	750	17.06	895	17.57	1,067	18.01
Commercial C2 (Low voltage maximum demand	15,876	20.3	23,814	20.91	28,404	21.54	33,879	22.18
Commercial C3 (High voltage maximum demand (11/33KVA))	99,224	20.3	148,835	20.91	177,523	21.54	211,740	22.18
Industrial D1 (Single & 3-phase	500	16.38	1,000	16.87	1,193	17.38	1,423	17.9
Industrial D2 (Low voltage maximum demand	97,626	21.28	195,252	21.92	232,887	22.58	277,775	23.25
Industrial D3 (High voltage maximum demand (11/33KVA)	99,224	21.28	198,447	21.92	235,697	22.58	282,320	23.25
Special (Single & 3-phase)	500	15.68	750	16.15	895	16.63	1,067	17.13
Special 2 (Low voltage maximum demand)	35,938	15.68	43,125	16.15	51,437	16.63	61,352	17.13
Special 3 (High voltage maximum demand (11/33KVA)	43,750	15.68	65,625	16.15	78,274	16.63	93,361	17.13
Street lighting S1 (Single & 3-phase)	500	12.04	650	12.4	775	12.77	925	13.16

Source: Citizens' Guide to energy subsidies in Nigeria, 2012

5. Way Forward

To solve the problem of electricity access in Nigeria is as complex as it can get. To begin, we have to look at the problem from a top-down, bottom-up approch. The first step is to begin with the power plants. As shown in Table 1, most of the power plants in Nigeria consist of single cycle gas turbine (SCGT) which is less efficient in power generation as compared to the more efficient combined cycle gas turbine (CCGT). The SCGT is an outdated technology.

Another issue is the location of the power plants which is mostly situated in the southern part of the country. As shown in Figure 1, it is nessesary for the federal government to build some power plants in the northern rgion especially in the North-easthern part of the country. The Nigerian government can also mandate independent power producers (IPPs) to position their power plants in areas where there is no extenaion of the national grid. The government should also encourage the use of movable CCGT which could be moved from one part of the c out ountry to another.

Matching electricity supply with demand in Nigeria is almost impossible considering the low electricity output from the power plants. The power plants are not operating at their full capacity which negatively affects the grid because of low electricity supply. It should be noted that the actual electricity demand far exceed the supply. The best way to address ths issue is to initaiate an energy conservation practice. These can be done by saving electricity in one part of the country in order to use it in another region.

The power sector in Nigeria needs to improve on their efficiency standards and the consumers need to be elightined on proper efficiency practice of electricity use. This can be achived by ecouraging the use of efficienct lighting bulbs and electrical appliances. The security of fuel source for power generation could be improved by channeling flarred associated gases to the various power plants within the country and also providing proper security for the gas pipelines. Pump-storage technology in hydropower plants should be constructed in order to trackel the issue of seasonal droughts in the country.

The Nigerian government needs to implement policies that will foster the development of renewable energy in the country and also enourage investors to invest in renewable energy technology for the off-grid supply. This will be possible and effective if the government minitries and agencies properly coordinate their activities.

Various improvement is needed in the Nigerian electricity grid as a whole. The improvement includes proper maintenance of the transmission and distribution network, security of the grid and its components which should be vested on the benefiting communities. Human capacity development should be improved through regular traning programs for the staffs and engineers in the electrcity sector to ensure excellent service dilevery.

Since the power sector requires a lot of capital, the government should improve the business climate for foreign investor in the electricity sector. The government need to also increase funding for the power sector. The issue of policy and project continuity should be taken seriously. This can be addressed by the esterblishment of an agency that will esnure project completion and policy continuity inrespective of the change in government.

6. Conclusion

Electrcity access is an important factor which speed up development in most economies of the world. Nigeria's access to electrcity has been below economically acceptable level and has not improved in recent times due to some obstacles. These obstacles were identified in this paper and they include; low efficiency and performance, security of fuel source for power generation, data inadequacy, regulatory barriers, lack of institutional arrangement, poor grid structure, delapidated transmission and distribution network, low financial investment, lack of policy and project continuity. A way forward have been presented in order to improve electricity access in Nigeria. The expected improvement may not be immediate but will be a gradual process.

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