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Power Infrastructure and Electricity in Nigeria: Policy Considerations for Economic Welfare

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Abstract. Regular, adequate and affordable power supply, which are key indicators of improvements in economic welfare and by extension economic growth, are missing from Nigeria's clime hence the country faces a lot of developmental challenges including the risk of losing potential investors. This paper examined power infrastructure and electricity in Nigeria using descriptive demonstrations. Tables, charts and figures were used to provide evidences which support the huge gulf between electricity produced by the various power infrastructures and electricity demand in Nigeria. Electric power production, transmission and distribution capacities of 3,600MW, 5,838MW and 8,425MVA respectively are grossly inadequate to meet power demand of 10,000MW in Nigeria. This leaves estimated power generation, transmission and distribution deficits of 6,400MW, 3,502MVA and 6,740MW respectively. This study emphasizes that the infrastructure deficits requires about 8.1 trillion naira to finance and therefore recommends that the Nigerian government, the generating companies and the distribution companies should all make concerted efforts towards growing and developing the power infrastructure in the country. The government should also create a secure and enabling environment, free from corruption and undue interference, for the power sector to thrive and contribute positively towards improving the welfare of electricity consumers in the country.

Key words: economic welfare, electricity demand, electricity supply, Nigeria, power infrastructure

1. Introduction

Electricity is a cornerstone on which Nigeria and the welfare of its people depend and this essential commodity has no substitute. Unlike most commodities, electricity cannot easily be stored, so it must be produced (by the generating plants using any of the available energy resources - coal, gas, oil, hydro, solar, wind or nuclear) and consumed at the same time. It plays a very important role in the socio-economic and technological development of every nation as it is a sine qua non for the operation of production processes from designing to manufacturing of goods, distribution and services. Thus electricity affects every sphere of a nation's economy. Bearing this in mind, both developed and developing nations aim towards establishing an efficient electricity sector. Nigeria's population is the seventh largest in the world, with over 180 million people and largest economy in Africa. It accounts for nearly half of the total population of West Africa and more than 15% of the total population of the entire African continent

(Fernstrom, 2011). But Nigeria still faces formidable economic, social, industrial, and human development challenges, and because of all these challenges, the country is seen as one of the poorest countries in the world despite the huge resources from crude oil export (Nwankwo & Njogo, 2013). Electricity shortages constitute one of the main challenges facing the Nigerian nation. This situation is as a result of the inability of electricity supply to meet the consumers' demand as electricity supply in the country has been erratic and epileptic, thus resulting in frequent power outages that have impaired economic growth and development of the Nigerian state (Nwachukwu, Ezedinma, & Jiburum, 2014).

For any meaningful economic progress to take place, electricity supply and demand must remain uncompromising elements of the process because they accelerate the pace of structural transformation and diversification of the Nigerian economy (Olayemi, 2012). The electricity sector in Nigeria has been constrained by many factors, among which are regeneration deficits, weak transmission and distribution infrastructures, poor utility performances, and a long period of investment and maintenance neglect. Nigeria is blessed with an array of conventional energy-resources, prominent among which are crude oil, tar sands, natural gas and coal. In addition, there are substantive potentials for renewable energy-resources such as hydro, solar, wind, biomass, wave and tidal, and some geothermal (Adebanjo, 2012). Despite these resources, the country is still unable to generate enough electricity to meet its demand because poor infrastructure leading to load shedding and frequent power-outages.

Poor access to electricity in Nigeria has been a major impediment to Nigeria's economic growth as a nations' readiness to ensure adequate and regular power supply reveals how well it is ready for developmental take-off. It equally represents a crucial factor that supports economic growth in developing countries (Morimoto & Hope, 2001). Nigeria is presently faced with the challenge of providing sustainable, adequate, reliable and efficient electricity supply to residential, commercial and industrial consumers. This situation has adversely affected the social and economic life of the citizenry as it is widely accepted that there is a strong correlation between socio-economic development and the availability of electricity (Sambo, Garba, Zarma, & Gaji, 2012). Apparently, there are links between a sustained power supply and electricity in any developmental state. There is no doubt that expensive and unreliable power remains a major concern to Nigeria's industrial sector and household consumers. Multiple and unpredictable power cuts which have become a daily occurrence in Nigeria often result in equipment malfunctioning of all the sectors of the economy and make it difficult to produce goods and provide services efficiently (Ezenwe, (2001) as cited in Adebanjo 2012). Despite the attempts by private firms to supplement power supply, electricity demand by consumers' particularly domestic users has continued to increase.

In the view of Iwayemi (2008), Nigeria's electricity crisis is striking for a variety of reasons: First is its occurrence despite the enormous endowments of non-renewable and renewable primary energy resources. The resource endowments of crude oil and natural gas currently estimated at 35 billion barrels and 185 trillion cubic feet, respectively, are more than adequate to fuel much of Sub-Saharan Africa energy demand for several decades. Second is that coal reserves are also substantial at 2.75 billion metric tons. Also, large amount of renewable energy resources including hydroelectricity, solar, wind and biomass energy are present. One of the many paradoxes in Nigeria is energy/electricity poverty amid plenty. Third, despite being a world ranking exporter of liquefied natural gas (LNG), Nigeria's gas-dominated electric grid experienced frequent collapse linked largely to inadequate gas supply. Gas pipeline vandalization associated with resource control-linked militancy in the oil producing Niger Delta has compounded the supply problem. Huge gas flaring has been a regular feature of the Nigerian oil industry since production began in 1958. This wasteful gas flaring has consistently ranked Nigeria among the world's largest source of carbon emissions, a major factor in global

warming. Fourth, the several billion dollars of public investment that went into generation and transmission capacity expansion in the past decades contrast sharply with the extremely poor supply of electricity. Lastly, there are the high social, economic and environmental effects of poor public power supply and its extensive substitution with highly polluting generators. Overtime, the Nigerian economy has been described, by commentators on the power sector, as a power-generating set economy because of the enormous amount of off-grid electricity being generated to satisfy its power requirements (Onochie, Obanor, & Aliu, 2015).

The historic gap between the demand for power in Nigeria and the electricity available from the grid has led to widespread self-generating sets of power in the commercial, industrial and residential sectors; many individuals and businesses own their generators to compensate for lack of access to and supply of energy. Business reliance on self-generation via diesel-powered generators has environmental impacts which using cleaner fuels could reduce. This is because, typically, self-electricity-generation accounts for a significant portion of most business recurrent expenditure in Nigeria; such significant overhead costs are clearly being passed onto consumers. The historically low level of investment in Nigeria's power sector has been a significant barrier to private investment in the country (Idemudia & Nordstrom, 2016).

This paper sets out to examine the power infrastructure and electricity in Nigeria across a five-section arrangement by focusing on the status of the generating, transmission and distribution companies and the implications on economic welfare. In a bid to achieve its aim, the paper is organized thus: Following the introduction is Section two which provides a historic overview of Nigeria's power sector. Section three looks at the various power infrastructures in Nigeria. Section four examines electricity demand and supply in Nigeria while Section five concludes the paper and proffers solutions on the ways to bridge the Nigeria's electricity infrastructure gap.

2. The Literature

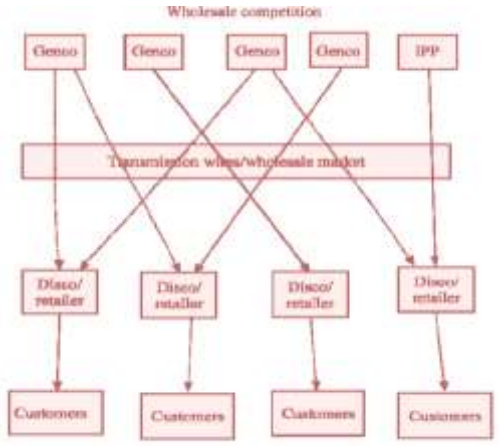
2.1 Historical Overview of Nigeria's Power Sector

Nigeria, with a total landmass of 923,768 sq. km, has a population of about 160 million people. The Electricity Corporation of Nigeria (ECN) was incorporated in 1950 via an Ordinance Act, for the purpose of controlling and regulating the electricity business in Nigeria (Eke, 2014). This paved the way for the development of power generation, transmission and distribution infrastructure in Nigeria. Prior to 1950, the electricity infrastructure in Nigeria comprised of two small generators installed by the British colonial masters in Lagos and other small domestic generators installed in some homes for purely domestic consumption. Electricity Corporation of Nigeria and the Niger Dam Authority were merged in 1972 to form the National Electric Power Authority (NEPA) (Nwabude, 2008). In 2005, NEPA was renamed Power Holding Company of Nigeria (PHCN) with the signing of the Electric Power Sector Act. ECN, NEPA and PHCN were 100 per cent owned and managed by the Federal Government of Nigeria. The existing power generation, transmission and distribution infrastructure was constructed at various times between 1950 till date largely through ECN, NEPA and PHCN. This infrastructure includes hydro and thermal power stations, a transmission grid and several distribution infrastructures (Eke, 2014).

Over the years, the power infrastructure was poorly managed; the industry was characterized by frequent equipment breakdown and very low system availability and reliability. It also became a financial drain on the country's treasury as government monopoly of the industry eliminated competition and encouraged corrupt practices (Eke, 2014). Network capacity expansion was very slow and could not keep pace with the growing demand for power supply. Thus, power generation, transmission and distribution infrastructure became over-loaded and load-shedding became characteristic. This informed the reason for the privatization of the power sector. In 2013, the federal government handed over power generation and distribution

infrastructures to the successful private investors after a competitive bidding exercise. However, power transmission infrastructure is still owned solely by the federal government via the Transmission Company of Nigeria (TCN). TCN has entered into a third party contract with a private equity investor, Manitoba Hydro International Ltd for the purpose of managing and operating the transmission network on its behalf (Eke, 2014).

Figure 2.1: The Expected Goal of the Unbundling Process



Source: Maduekwe (2011)

The operating environment as shown in Figure 2.1 is such that the distribution companies (DisCOs) can purchase power from generating companies (GenCOs) of their choice while GenCOs are allowed to optimize production cost and hence make competitive offers for sale of power. The TransCO on the other hand is an independent power operator (IPO), as well as an energy carrier with the responsibility of ensuring bilateral contracts exist between DisCOs and GenCOs with additional responsibility of issuing operational guidelines for efficiency of the system.

The drawbacks of this arrangement, as observed by Okolobah & Ismail (2013), are that the TransCO is government-owned and the inefficiencies inherent in government owned enterprises in Nigeria could still be found in it (one of the reasons given for the unbundling of NEPA); over concentration of generation sources will definitely give rise to heavy losses, which at present is between 30-35%compared with 3% in the United State and 0.5% in Japan (Babalola, 2009 as cited in Okolobah & Ismail, 2013); non-optimal load flow and a weak grid; and the grid control ties the whole of Nigeria together as a single unit.

3. Power Generation Infrastructures in Nigeria

Since the commencement of electricity production, the country has developed various power stations including gas-fired, oil-fired, hydro-electric and coal- fired stations owing to the availability of energy sources (water, oil, coal and gas) in the country. Nigeria is endowed with natural resources for power generation but this sector is still plagued by problems. The Nigerian power sub-sector is characterized by epileptic supply, improper pricing of power, energy theft and non-settlement of tariffs (Nwabude, 2008). Although concerted efforts are being made to address these issues, the situation is not expected to change in the immediate future.

Table 3.1 shows at a glance the rankings of about twenty countries based on their gross domestic product, population and power generation. Nigeria, which is the key interest, is ranked 31st with a GDP of 377.9 (billions of dollars), power generation of 20.13 (billions kWh) and a population size of 155,215,573. By way of comparison with Russia which has similar population (138,739,892), there is a stark difference between power generated in Nigeria and power generated in Russia.

Table 3.1 Rankings of some countries based on their GDP, Population and Power Generation

Country	Ranking	GDP (Billions of Dollars)	Power Generation (Billions kwh)	Size of Population
USA	1	14,660	3,953	313,232,044
China	2	10,090	3,446	1,336,718,015
Japan	3	4,310	982.3	126,475,664
India	4	4,060	835.3	1,189,172,906
Germany	5	2,940	556.4	81,471,834
Russia	6	2,223	925.9	138,739,892
United Kingdom	7	2,173	346	62,698,362
Spain	13	1,369	275.1	46,754,784
Indonesia	15	1,030	141.2	245,613,043
Taiwan	18	821.8	229.1	23,071,779
Poland	20	721.3	141.8	38,441,588
Saudi Arabia	22	622	194.4	26,131,703
Thailand	24	586.9	139	66,720153
South Africa	25	524	238.3	49,004,031
Malaysia	29	414.4	101.1	28,728,607
Nigeria	**31**	**377.9**	**20.13**	**155,215,573**
Sweden	32	354.7	129.4	9,088,728
Philippines	33	351.7	59.19	101,838,938
Switzerland	37	324.5	64.08	7,639,961
Ghana	85	61.97	8.167	24,791,073

NOTE: All population size estimates are as at July, 2011.
Source: Adapted from Okolobah and Ismail (2013)

Nigeria currently generates about 3.5GW of electricity out of an installed capacity of 7.59GW. However, current total estimated demand is 10GW. Thus Nigeria is only able to produce 35% of her electricity demand (Eke, 2014). The power generation infrastructure in Nigeria comprises three major infrastructure groups which are:

3.1 Generation Companies (GENCOs)

The electricity generating companies which consist of six recently privatized power stations known as GENCOs and are previously owned by the federal government are shown on Table 3.2.

Table 3.2 Generating Companies and their Capacities

Generation Company	Plant Type	Capacity (MW)
Afam Power Plc (1-V)	Thermal	987.2
Egbin Power Plc	Thermal	1,320
Kainji/ Jebba Hydro Electric Plc	Hydro	1,330
Sapele Power Plc	Thermal	1,020
Shiroro Hydro Electric Plc	Hydro	600
Ughelli Power Plc	Thermal	942

***Source**: KPMG Advisory Services (2013)*

The total installed capacity of these six GENCOS is 6.20GW. The six GENCOS and their installed capacities are shown on Table 3.2 which reveals that apart from the Kainji/Jebba which is a hydroelectric plant; most of all others which generate higher megawatts of electricity are thermal plants.

3.2 National Integrated Power Projects (NIPP)

The National Integrated Power Project (NIPP) is an integral part of federal government's efforts to combat the power shortages in the country. There are ten NIPPs owned by government and aimed specifically at improving power generation output in order to bridge the gap between power demand and supply. These projects are at various stages of execution. However the combined capacity of the present NIPPs is 5.46GW.

Table 3.3 NIPPs in Nigeria with their Capacities and Locations

NIPPs	Capacity (MW)	Location/State
Alaoji Generation	1,131	ABIA

Company Nigeria Limited		
Benin Generation Company Limited	508	EDO
Calabar Generation Company Limited	634	CROSS RIVER
Egbema Generation Company Limited	381	IMO
Gbarain Generation Company Limited	254	BAYELSA
Geregu Generation Company Limited	506	KOGI
Ogorode Generation Company Limited	508	DELTA
Olorunsogo Generation Company Limited	754	OGUN
Omoku Generation Company Limited	265	RIVERS
Omotosho Generation Company Limited	513	ONDO

***Source**: KPMG Advisory Services (2013)*

3.3 Independent Power Producers (IPPs)

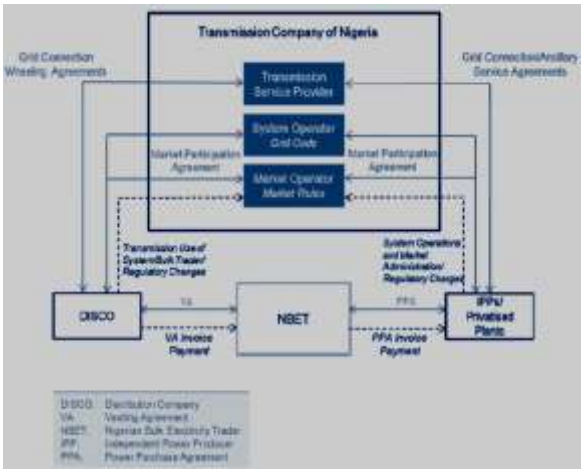
These are power plants owned and managed by the private sector. More than sixty five licenses have been issued by the Nigerian Electricity Regulatory Commission (NERC) to Independent Power Producers in order to improve the deplorable power situation in the country. The existing IPPs include Afam Power Station (Train VI) – operated by SPDC: 642MW; Okpai Power Station – operated by NAOL: 480MW and AES Power Station - operated by NAOL: 270MW. These three combined capacity of the IPPs that have been constructed is 1.39GW.

3.4 Power Transmission Infrastructure in Nigeria

Transmission network is the 'life-blood' of the entire electricity sub system. The Transmission Company of Nigeria (TCN) is being managed by a Management Contractor, Manitoba Hydro International (Canada). Manitoba is responsible for revamping TCN to achieve technical and financial adequacy in addition to providing stable transmission of power without system failure. The National Grid operates at 330 KV and 132 KV high voltage level (HV). The transmission capacity of the Nigerian Electricity Transmission system is made up of about 5,523.8 km of 330 KV lines and 6,801.49 km of 132 KV lines. The TCN is made up of two major departments: System Operator and Market Operator. The Market Operations (MO) is a department under TCN charged with the responsibility of administering the wholesale electricity market, promoting efficiency and where possible, competition. The system operator is focused on system planning, administration and grid discipline. In addition, it is expected that Manitoba Hydro International will re-organize TCN and ensure that the Market Operator and the System Operator become autonomous (KPMG Advisory services, 2013).

Figure 3.2 shows the responsibilities of the TCN.

Figure 3.2 Responsibilities of TCN



***Source:** Nigerian Energy Sector (2015)*

Nigeria has one of the highest transmission losses in the world; this is partly because the average age of the transmission equipment is 30 years, the consequence of long neglect (Ola, 2013). The network is also mostly radial. The existing transmission system is not sufficient to transfer the additional power injected to the grid by the new power plants (Omobobola 2012 as cited in Utazi & Ujam, 2014). The transmission system in Nigeria does not cover every part of the country. Currently it has the capacity to transmit a maximum of about 4,000 MW and it is technically weak, therefore very sensitive to major disturbances (Sambo, 2009). The Transmission Company of Nigeria (TCN), projected to have the capacity to deliver about 12,500 MW in 2013, has the capacity of delivering 4800 MW of electricity. Nigeria has a

generating capacity of 5,228 MW but with peak production of 4500 MW against a peak demand forecast of 10,200MW. This shows that if the generation sector is to run at full production, the transmission grid will not have the capacity to handle the produced power reliably (Utazi & Ujam, 2014). Therefore, there is urgent need to expand and modernize the electricity transmission infrastructure, in order to enjoy expected gains from the privatization of the power sector. Some of the major problems associated with the transmission system in Nigeria as observed by Emodi & Yusuf (2015) includes poor funding by the federal government, limited national coverage; it's current maximum electricity wheeling capacity is 6,056 MW which is below the required national need; frequent vandalization of the lines associated with low level of surveillance and security on all electrical infrastructure; inadequate of spare parts for urgent maintenance and poor technical staff recruitment, capacity building and training programme.

3.5 Power Distribution Infrastructure in Nigeria

For the market to operate freely, the generating companies must be able to sell their electricity to distribution companies who then sell it to the end consumers (Nigerian Electricity Sector, 2015). The Nigerian power distribution infrastructure is divided into eleven zones. These zones are grouped with the main purpose of distribution of power to the consumers. Table 3.4 shows at a glance the various DisCos, their areas of operation and average allocation of power from the National Grid.

As indicated on Table 3.4, Ikeja Distribution Company has the highest number with 15 percent load allocation, followed by Ibadan Distribution Company with 13 percent load allocation. Abuja Distribution Company and Yola Distribution Company are tied with the same number of load allocation of 11.5 percent each.

Table 3.4: The DisCos in Nigeria (Areas of Operation and Average Allocation of Power from the National Grid)

S/N	Name of DISCO	Areas of Operation	Percentage Load Allocation (%)
1	Abuja Distribution Company	FCT, Kogi, Niger	11.5
2	Benin Distribution Company	Edo, Delta, Ekiti, Ondo	9
3	Eko Distribution Company	Lagos (Island, Victoria Island, Lekki to Epe)	11
4	Enugu Distribution Company	Abia, Anambra, Ebonyi, Enugu and Imo	9
5	Ibadan Distribution Company	Kwara, Ogun, Osun and Oyo	13
6	Ikeja Distribution Company	Lagos (All of mainland, Ikeja to Badagry)	15
7	Jos Distribution Company	Bauchi, Benue, Gombe, Nassarawa, Pleteau	5.5
8	Kaduna Distribution Company	Kaduna, Kebbi, Sokotoand Zamfara	8
9	Kano Distribution Company	Jigawa, Kano and Kastina	8
10	Port Harcourt Distribution Company	AkwaIbom, Bayelsa, Cross River and Rivers	6.5
11	Yola Distribution Company	Adamawa, Borno, Taraba and Yobe	11.5

Source: KPMG Advisory Services (2013)

However in most locations in Nigeria, the distribution network is poor, the voltage profile is poor and the billing system is inaccurate. As the department, which inter-faces with the public, the need to ensure adequate network coverage and provision of quality power supply in addition to efficient marketing and customer service delivery cannot be over emphasized. Some of the major problems of DISCOs in Nigeria as identified by (Sambo, et al, 2012) are: weak and inadequate network coverage, overloaded transformers and bad feeder pillars, substandard distribution lines, poor billing system, unwholesome practices by staff and very poor customer relations, inadequate logistic facilities such as tools and working vehicles, poor and obsolete communication equipment, low staff morale and lack of regular training, and insufficient funds for maintenance activities.

Table 3.5 shows the tariff class descriptions of customers across the various Discos in Nigeria. Consequently, the distribution system like all other parts of the sector also plays its role in the

incessant power interruptions experienced by customers. This is evidenced by the under-equipped state of most of the distribution substations in dire need of urgent upgrades and expansion. This also adversely limits the number of customers connected to the distribution networks.

Table 3.5 Tariff Class Descriptions

S/N	**Customer Classification**	Description	Remarks
1	**Residential**		A consumer who uses his premises exclusively as a residence - house, flat or multi-storeyed house where people reside.
	R1	Life-line (50kwh)	
	R2	(1 and 3-phase)	
	R3	LV Maximum Demand	
	R4	HV Maximum Demand (11/33KV)	
2	**Commercial**		A consumer who uses his premises for any purpose other than exclusively as a residence or as a factory for manufacturing goods.
	C1	Single and 3-phase	
	C2	LV Maximum Demand	
	C3	HV Maximum Demand (11/33KV)	
3	**Industrial**		A consumer who uses his premises for manufacturing goods including welding and ironmongery.
	D1	Single and 3-phase	
	D2	LV Maximum Demand	
	D3	HV Maximum Demand (11/33KV)	
4	**Special**		Customers such as agriculture (agro-allied enterprises involving processing are excluded), water boards, religious houses, Government and teaching hospitals, Government research institutes and educational establishments.
	A1	Single and 3-phase	
	A2	LV Maximum Demand	
	A3	HV Maximum Demand (11/33KV)	
5	**Street Lighting**		
	S1	Single and 3-phase	

Source: Nigerian Electricity Regulatory Commission, Multi-Year Tariff Order (2012)

For a country with a then population of over 160 million people, only an approximate 65 million people (that is 36.5%) have access to electricity of which less than 5% are legally-connected to the distribution companies (Ekpo, 2012; Oseni, 2012). Further compounding this issue is the fact that only about 65% of these customers are metered while the remaining 35% are still billed on a monthly-estimated sum, creating a tremendous scope for electricity theft. These all combine to make the collection of electricity revenue inefficient & ineffective. This further shows that the proportion of illegally-connected electricity consumers (approximately 96.5%) far-outstrips the legally connected customers and the need for distribution companies to expand their networks into rural areas in other to accommodate customers in the hinterlands (Etukudor, Abdulkareem & Ayo, 2015).

The absence of a cost-reflective tariff is one of the reasons for the failure of the power sector to serve Nigerians well. Fully efficient cost recovery is mandated by S.76, EPSR Act, 2005. The NERC drafted the Multi Year Tariff Order (MYTO) as shown in Table 3.5 which envisages an efficient tariff system that gives the consumer right to a reliable electric service and transparent billing at the same time ensuring that the investor has reasonable return on investments (Usman & Abbasoglu, 2014).

In Nigeria, majority of the electricity consumers are unmetered. This situation has continued despite attempts by the Nigerian Electricity Regulatory Commission (NERC) to reduce the metering gap in recent years. The problem of billing without meter is that it gives room for information asymmetries which consumers who are on direct connection and get estimated bills. Billing by estimate has been observed to be excessive, thus provoking payment apathy. It is worthy to note that over eighty percent complaints received by NERC from electricity consumers in Nigeria are centered on issues such as estimated metering, excessive tariff in the

estimated metering methodology and poor metering infrastructure (Akah 2013, as cited in Okafor 2013). Available evidence suggests that electricity billing in Nigeria is asymmetric (Ofonyelu & Eguabor, 2014). Amadi (2013) as cited in Ofonyelu & Eguabor (2014) also observed that the issuance of estimated bills by the DISCOs gives room for cheating the consumers. He opined that metering all electricity consumers would assist the customer to effectively monitor their electricity usage, as well as enable the DISCOs to determine their revenue. The rising economic hardships tend to increase asymmetries in all sectors of the economy (Ogun & Ofonyelu, 2013). However from the view of the DISCOs, some electricity consumers indulge in varied forms of illegal connections and reconnections on its appliances. These activities distort correct mapping of electricity supplied to the feeder with revenue projection, as many of the unauthorized consumers tap into the supply (Ofonyelu & Eguabor, 2014).

4. Electricity Demand and Supply in Nigeria

Electric demand refers to the maximum amount of electrical energy that is being consumed at a given time. It is measured in both kilowatts and kilovolt amperes, depending on the rate tariff. The difference between the two terms is power factor. Another related term is kilowatt hours, which is a measurement of total electricity used for a period of time. A 1000 watt electrical load used for one hour consumes one kiloWatt hour (kWh).

Table 4.1 Electricity Demand Projections per Scenario, MW.

Scenario	2005	2010	2015	2020	2025	2030
Reference (7%)	5,746	15,730	28,360	50,820	77,450	119,200
High Growth (10%)	5,746	15,920	30,210	58,180	107,220	192,000
Optimistic I (11.5%)	5,746	16,000	31,240	70,760	137,370	250,000
Optimistic II (13%)	5,746	33,250	64,200	107,600	172,900	297,900

Source: Sambo, et al (2012).

Table 4.1 shows the electricity demand projections for various growth scenarios. It must be emphasized that the demand indicated for 2005 represents suppressed demand, due to inadequate generation, transmission, distribution and retail facilities. Suppressed demand is expected to be non-existent by 2010.For the 13% GDP growth rate, the demand projections rose from 5,746 MW in the base year of 2005 to 297,900 MW in the year 2030 which translates to construction of 11,686 MW every year to meet the demand. The corresponding cumulative investment (investment & operations) cost for the 25-year period is US$484.62 billion, which means investing US$80.77 billion every five years within the period (Sambo, et al, 2012). Similarly Table 4.2 looks at the total predicted demand in Nigeria.

The total predicted demand is derived by summing the individual demand forecast of residential, commercial and industrial. From the table, it is observed that the demand for electricity is increasing continuously, hence the need to make adequate infrastructural provisions for the future.

Table 4.2 Total Predicted Load Demand

Year	Predicted Load Demand (MW)	Year	Predicted Load Demand (MW)
2013	14812.99	2022	17334.61
2014	15093.17	2023	17614.79
2015	15373.35	2024	17894.97
2016	15653.53	2025	18175.15
2017	15933.71	2026	18455.33
2018	16213.89	2027	18735.51
2019	16494.07	2028	19015.69
2020	16774.25	2029	19295.87
2021	17054.43	2030	19576.05

Source: Adapted from Ezennaya, Isaac, Okolie & Ezeanyim, (2014)

Table 4.3 Demand and Supply Gap of Electricity around the Globe

Countries	Population of the countries	Demand (GW)	Supply (GW)	Excess DD (GW)
Germany	80	80	120	40
UK	60	60	80	20

South Africa	50	50	40	(10)
Egypt	80.5	80.5	24	(56.5)
Algeria	40	40	11	(29)
Brazil	200	200	100	(100)
Nigeria	160	150	3	(147)

Source: Adapted from Abubakar and Abdussalam, (2013)

Table 4.3 shows the demand and supply of electricity around the world. Out of the seven countries considered, only Germany and United Kingdom have an excess supply of electricity with 40GW and 20GW respectively. South Africa, Egypt, Algeria, Brazil and Nigeria all have deficit in electricity supply.

Table 4.4 Demand and Supply Gap of Electricity in Nigeria

Year	Demand (GW)	Supply (GW)	Excess Demand (GW)
2005	19.85	4	(15.85)
2006	15.59	7	(8.59)
2007	19.06	13	(6.06)
2008	22.11	8	(13.11)
2009	22.11	5	(17.11)
2010	21.92	3	(18.92)
2011	21.92	3.5	(18.42)
2012	20.13	4	(16.13)

Source: Adapted from Abubakar and Abdussalam, (2013)

Table 4.4 presents the demand and supply gap of electricity in Nigeria from 2005 to 2012. Evidence from Table 4.3 show that Nigeria has seriously been experiencing excess demand for electricity since 2005 and that excessive demand was at its peak in 2010 and 2011 with 18.92GW and 18.42GW respectively.

5. Bridging the Infrastructure Gap in the Nigeria Power Sector

The power sector is a capital intensive sector but the allocation of the federal budget for the development of the power sector is low compared to the potential of the sector. As noted by Emodi and Yusuf (2015), 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. Table 5.1 shows the power infrastructure capacity and demand in Nigeria.

Table 5.1 Power Infrastructure Capacities and Demand in Nigeria as at 2011

Infrastructure	Available	Need	Difference
Generation	3,600MW	10,000MW	6,400MW
Transmission capacity	5,838MVA	9,340MVA	3,502MVA
Distribution capacity	8,425MVA	15,165MVA	6,740MVA
Tariff collection efficiency	70%	95%	25%
Transmission losses	Over 40%	Less than 15%	-25%

Source: Adapted from Tinubu (2011).

Table 5.1 provides evidences that the Nigerian power sector suffers low generating capacity relative to installed capacity causing many of the country's citizens not to have access to uninterrupted supplies of electricity. On the average, electricity generation in Nigeria ranges between 2500 megawatts to about 3600 megawatts, while estimated national consumption is in excess of 10,000 megawatts. Potential demand in the next few years is approximated to about 15,000 megawatts. This gap is regrettable as Nigeria is endowed with massive reserves of hydro-energy, petroleum reserves and is one of the largest gas reserves in the world. Government policy for the sector during the 1980s and the 1990s and until recently did not properly foresee the national needs. Before 1999, the power sector neither witnessed improvements in infrastructural development nor the existing ones properly maintained and this has brought the power sector to a deplorable state. In 2001, generation went down from the installed capacity of about 5,600MW to an average of about 1,750MW, as compared to a load demand of 6,000MW. Also, only nineteen out of the seventy-nine installed generating units were in operation (Sambo, 2008). As at 2008 electricity generation ranged was from 2500Mv-3500Mv out of installed capacity of 5963 MW even with the three new gas powered independent power projects in the

Niger Delta region (Bolaji, 2008). In 2010 the power holding company of Nigeria could only supply 4,320mw of electricity while demand was 10,500MW, leaving an excess demand of 6180MW (Odiaka, 2006). Demand for electricity has grown at a rate of 8.2% per annum since 1984 against GDP growth of about 3.5% and per-capita generation relative to other countries is extremely low (Garba, 2002 cited in Adebanjo, 2012). It is estimated that an additional 10,000MW in capacity is required to meet the current demand which continues to grow in response to increasing population, urbanization, improved standard of living and economic development (Sambo, 2008).

The estimated costs of providing 1MVA of power generation, transmission and distribution capacity in Nigeria are US$2.3m, US$1.2m (assumed less than 15km of transmission distance) and US$0.3m (assumed radial distance of 20km) respectively. From this estimate, it can be deduced that the cost of providing the additional 6,400MW of power generation as US$18.4b, while the estimated cost of upgrading the transmission capacity from 5,838MVA to the required 9,340MVA is US$4.2b (Eke, 2014). Similarly, the cost of increasing power distribution infrastructure to 15,165MVA is US$2.0b. This gives a total cost of US$24.6b (N8.1 trillion based on US$1: N330) as the cost of increasing the power generation, transmission and distribution infrastructure to meet the current power demand in the country only.

In conclusion, electricity is essential for economic development. The reason for such necessity lies in the fact that electricity affects every sphere of a nation's economy, little wonder both developed and developing nations aim towards establishing an efficient and effective electricity sector. This paper has examined the power infrastructure and electricity in Nigeria using descriptive statistics and the findings reveals that there is a huge gulf between electricity produced in Nigeria by the various power infrastructures and the present demand by the electricity consumers in Nigeria.

To bridge this gap of power infrastructure capacity and electricity demand in Nigeria, the following policy options are recommended: The Nigerian government, the generating, transmitting and distributing companies should make concerted effort to grow and develop the power infrastructure by through improved investment and expansion programme. The Government should also create the enabling environment, free from corruption and undue interference, for enterprises in the power sector to thrive. Also, various improvements are needed in the Nigerian electricity value chain 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 training programs for the staff and engineers in the electricity sector to ensure excellent service delivery.

The paper recommends that government should intensify security measures in place to protect electricity generation, transmission and distribution equipments from being vandalized. This is because the vandalization of power infrastructure has a negative impact on electricity consumers at large. Government should also make a concerted effort in diversifying the sources of electricity in Nigeria if the nation is to be considered a major player in the global economy come 2020.

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