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Energy, growth and economic development: A case study of the Nigerian electricity sector

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Abstract

It is apparent that the poor performance of the electricity power sector in Nigeria since inception has been a significant obstacle preventing private investment, the overall development and economic growth in the country. The market structure prevalent in the sector like other sectors in most economies of the developing world is dominated by the state-owned Power Holding Company of Nigeria (PHCN), which is a monopolistic, vertically integrated business model. With the government's recent commencement of the review of its Power Sector Roadmap, this paper seeks to examine the reform process in the country's electricity power sector with the view of attaining sustainable growth and development of the economy. The method of analysis used in this study is the descriptive and statistical technique of analysis. It is expected that the reform process as would be postulated by this paper if adopted, should bring about the desired growth and developmental benefits to the Nation via: job creation in the sector and other sectors arising by rechannelling of funds into those sectors from the power sector, reduction in electricity tariffs, improve service standard as well as increase export earnings, etc.

Keywords

Economic Growth, Economic Development, Electricity, Energy, Reform, Nigeria

1. Introduction

There is a universal consensus on the essential role electricity plays in modern life, bringing in economic benefits and developmental progress to various sectors such as transportation, manufacturing, communication, agricultural, as well as the mining sectors. Such benefits accrue in terms of: production and productivity, human development such as life expectancy, knowledge and decent standard of living. Electricity makes it possible to achieve the full potentials of any society and makes life worthwhile in a modern society. Electric power is vital for economic growth and quality of life not only because it fosters the productivity of capital, labour and other factors of production, but also that increased consumption of energy, particularly commercial energy like electricity signifies high economic status of a country (Jumbe, 2004). These facts have interested authors to investigate the role electricity plays in economic growth and development in different countries; starting with the pioneer work of Kraft and Kraft (1978).

Unfortunately, but true, Nigeria does not only have a problem with the electricity sector but the problem appears to be defining all possible solutions. This is despite our national endowment in terms of: gas, water, wind, solar, etc. The historic gap between the demand for electricity and the available capacity has led to the current widespread power shortage and inefficiency and, consequently, self-generation of power by both industrial and residential consumers. The Manufacturers Association of Nigeria (MAN), and the National Association of Small Scale Industries (NASSI), have estimated that their members spend an average of about N2billion (about $12 million) per week on self-power generation (Vanguard Newspaper 4 March, 2013). To this end, the Nigerian power sector presents immense opportunities for private investment in the electricity power sector; if the country is to achieve the goal of becoming one

of the twenty most industrialized economies by 2020, as well as improving the standard of living of the people. This is borne from the fact that a nexus exists between electricity, economic growth and national development. Hence, in producing and distributing efficient and affordable electricity for the growth of the national economy, it must be done in a responsible and sustainable manner, i.e. a manner that not only meets the needs of the present but also guarantees the future generations to meet their needs.

2. An Overview of the Electricity Power Sector in Nigeria

Electricity generation in Nigeria could be said to have began in 1898 when the first generating plant was installed in Lagos under the jurisdiction of Public Works and Transport. Though, the Nigeria Electricity Supply Company (NESCO) commenced operations as an electricity company in Nigeria in 1929 with the construction of a hydroelectric power station at Kurra near Jos, Plateau State. Since then it has undergone many reforms in trying to connect every part of the country to the national transmission grid. In 1950, the British colonial administration passed the Electricity Corporation of Nigeria ordinance, known as the ECN Ordinance No.15 of 1950. The ordinance sought to integrate electricity supply to make it more efficient. In 1962, the Niger Dam Authority (NDA) was established with the first 132kv supply line. Eventually by 1972, the ECN was being merged with the NDA to form National Electric Power Authority (NEPA). As at the time of this formation, the targeted supply of electricity was 1030mw, while peak demand was 390mw. The law establishing NEPA gave her the power to develop and maintain an efficient, coordinated and economic system of electricity supply throughout the country. In 1988, NEPA was partially commercialized with an upward review in tariffs. In 1990, the Shiroro power station was commissioned. The station contributed 600mw, to the nation's electricity supply. As part of the restructuring, the Electric Power Sector Reform Act 2005 was enacted. Subsequently, the defunct NEPA is currently known as Power Holding Company of Nigeria (PHCN). The reform act paved way for the unbundling of NEPA into 18 companies: 6 generating companies, 1 Transmission Company and 11 distributing companies. The generating companies are made up of 2 hydro and 4 thermal (gas based) stations.

Nigeria's estimated available capacity from the grid of approximately 3,200 MW meets only approximately one third of the estimated current demand for power from the grid (BMI, 2011). As demand for electricity in Nigeria is expected to more than double in the next 10 years (BMI, 2011), an even greater supply gap would be created in the future without some form of market intervention and fundamental reform of the power sector. Current electricity generation is from either gas-fired or hydro power plants. Most assets are owned by state-owned companies, though some private investors have been able to establish IPPs following recent legislative reforms. The tables present the current power generation assets in Nigeria.

Table 1. *Existing government owned power stations (Thermal).*

	Name of generation company	Year of construction	Location	Installed capacity (MW)	Available capacity (MW)
1	Oji river power station	1956	Oji River, Achi, Enugu State	10	Nil
2	Calabar power station	1934	Calabar, Cross River State	6.6	Nil
3	AFAM (IV-V) power plc	1963	Afam, Rivers State	726	60
4	Sapele power plc	1978	Sapele, Delta State	1020	90
5	Delta power plc	1966	Ughelli, Delta State	900	300
6	Olorunsogo power plc	2008	Olorunsogo, Ogun State	304	76
7	Omotosho power plc	2007	Omotosho, Ondo State	304	76
8	Geregu power plc	2007	Geregu, Kogi State	414	276
9	Egbin power plc	1986	Egbin, Lagos State	1320	1100
		Totals		5,004.6	1,978

Source: Nigerian Bureau of Public Enterprises 2011.

Table 2. *Existing government owned power stations (Hydro).*

	Name of generation company	Year of construction	Location	Installed capacity (MW)	Available capacity (MW)
1	Kainji/Jebba hydroelectric plc-Kainji power station	1968	Kainji, Niger State	760	480
2	Kainji/Jebba hydroelectric plc-Jebba power station	1985	Jebba, Niger State	540	450
3	Shiroro hydroelectric plc	1989	Shiroro, Niger State, Nigeria	600	450
		Totals		1,900	1,380

Source: Nigerian Bureau of Public Enterprises 2011.

The low power generating capacity as presented in table 1 and 2 above, has led to government's reform of privatization and commercialization of the electricity sector; with the aim of promoting greater efficiency in the sector. This has led to the establishment of National Independent Power Projects (NIPP's). The IPP's are the non-FGN funded investment in the Nigerian power generation industry. The NIPP is funded and owned by the three tiers of government (federal, states and LGAs.). These facilities are currently being constructed and will be operated via Operations and Maintenance contracts, when commissioned, prior to the privatisation of these stations.

Table 3. *Independent Power Projects (IPP's).*

	Name of power plant	Location	Installed capacity (MW)	Available capacity (MW)
1	AES power station	Egbin, Lagos State	224	224
2	Shell-Afam VI power station	Afam, Rivers State	650	650
3	AGIP-Okpai power sttaion	Okpai, Delta State	480	480
4	ASG-Ibom power station	Akwa Ibom State	155	76
5	RSG-Trans Amadi power station	Port Harcourt, Rivers State	100	24
6	RSG-Omoku power station	Omoku, Rivers State	150	30
	Totals		1,759	1,484

Source: Nigerian Bureau of Public Enterprises 2011.

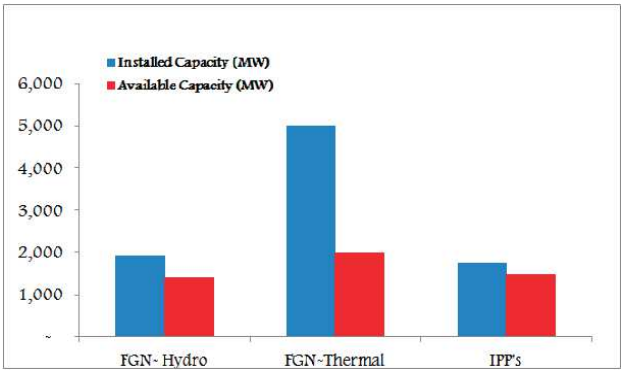
Table 4 below, presents a list of ongoing IPP's in the country. The approximated installed capacity of these IPP's is about 4.800MW; expected to be completed in 2013. It is believed that when these plants are finally commissioned and running, they would significantly help in boosting the electricity supply of the country. The Presidential Task Force on Power has announced its intention to privatize the NIPPs in future rounds of privatization, following completion of construction (BPE, 2011).

Table 4. *Ongoing NIPP's .*

	Name of power plant	Location	Designed Capacity (MW)	Current Capacity (MW)
1	Calabar power project	Calabar, Cross River State	563	Nil
2	Egbema power project	Ebgema, Imo State	338	Nil
3	Ihovbor power project	Ihovbor, Edo State	451	Nil
4	Gbaran power project	Gbaran, Bayelsa State	225	Nil
5	Sapele power project	Sapele, Delta State	451	Nil
6	Omoku power project	Omoku, Rivers State	225	Nil
7	Alaoji power project	Alaoji, Abia State	961	Nil
8	Olorunsogo-phase 2 project	Olorunsogo, Ogun State	676	Nil
9	Omotosho-phase 2 project	Omotosho, Ondo State	451	Nil
10	Geregu-phase 2 project	Geregu, Kogi State	434	Nil
	Totals		4,775	Nil

Source: Nigerian Bureau of Public Enterprises 2011.

Table 5. *Installed VS Available Capacity.*



Source: Nigerian Bureau of Public Enterprises 2011.

The table on the next page illustrates the contrast between the ratio of installed to available capacity in the government-owned versus IPP generation facilities. The Presidential Task Force on Power has pointed to this "capacity gap" as a key driver behind the government's privatization plans (BPE, 2011).

Addressing the supply and capacity gaps in the demand for power from the grid in Nigeria, the Presidential Task Force on Power set a goal of increasing available capacity by 3,000 MW per year, through 2020 and thereafter by 1,500 MW per year through 2033 (BPE, 2011). The Presidential Task Force on Power also announced that it expects such growth in generation capacity, to be driven largely by the private sector (BPE, 2011). The government anticipates that such new power generation facilities will be primarily powered through: gas, hydro and coal which are to serve as fuel sources, through a combination of issuing concessions for hydro plants, privatizing government owned assets and creating a framework to encourage the development of gas- and coal-fired green field IPPs (BPE, 2011).

3. The Reform Process in the Electricity Sector

Not quite long after Goodluck Ebele Jonathan was sworn in as President, following the death of Umaru Yar'Adua, the new government left no one in doubt about its thinking on the thoroughly embarrassing inefficiency in Nigeria's power sector. It was taking too long to fix the electricity problem and things actually got so bad that Nigeria, statistically speaking, became the preferred destination for ships conveying all kinds of generators to this part of the world. Efforts by a succession of previous administrations to tackle the electricity needs of the country yielded very little. The darkness in Nigeria persisted and the problems of the power sector seemed too difficult to tackle. What was to be done? President Goodluck Jonathan had barely settled down in office, when he announced an ambitious plan now known as the Power Reform Roadmap, for the implementation of reform in broad accordance with the 2005 Reform Act. The government's priority is to attract private investment to all facets of the power sector. To many Nigerians, that was the day that our President declared war against persistent darkness in Nigeria, an ugly phenomenon that has held back and substantially frustrated efforts to develop Nigeria and grow its economy.

In 2005, the Government of Nigeria enacted legislation intended to restructure fundamentally the Nigerian electrical power sector. The Electric Power Sector Reform Act, 2005 (the *2005 Reform Act*) was designed to move the electricity sector in Nigeria from a government controlled, heavily subsidized system to a privatized, largely market-based endeavour. Implementing the 2005 Reform Act has been challenging for the Nigerian government and largely seems to have stalled in recent years. However, the process of implementing the 2005 Reform Act was revitalized when President Goodluck Jonathan established the Presidential Task Force on Power and published a roadmap for power sector reform in August 2010, potentially opening the door to significant private investment in the Nigerian power sector. Key features of the reforms being implemented include the following (BPE and CPCS consortium, 2011).

3.1. Privatization of Existing Grid Assets

The Nigerian power system formerly was controlled by a single government entity. Pursuant to the 2005 Reform Act, the Nigerian power system now has been unbundled into one Transmission Company, six generation companies (*GenCos*) and 11 distribution companies (*DisCos*). The six GenCos and 11 DisCos now are in the process of being privatised in pursuant to the government's revitalized reform process:

• *Gas-fired GenCos:* The gas-fired GenCos were to be privatized through the sale by the Nigerian government of at least a 51 percent equity stake to investors in pursuant to a transparent bidding process. Expressions of interest were due February 18, 2011, while final technical and financial bids were due April 20, 2011.

• *Hydro GenCos:* The Nigerian government was to grant long-term concessions for the operation of the hydro GenCos. The operators of the hydro GenCos were to receive three key payments: the throughput charge, annual charge and upfront charge. The government was to fix two of the charges up front and bids were to be evaluated on the basis of the third (after technical bids have been assessed). Expressions of interest were due February 18, 2011. Final technical and financial bids were due April 20, 2011.

• *DisCos:* The DisCos were to be privatized through the sale by the Nigerian government of a 51 percent equity stake to investors pursuant to a transparent bidding process. Bids were to be evaluated as much on the ability of the bidding consortium to reduce technical and commercial losses as on cost/pricing. Expressions of interest were due February 18, 2011. Final technical and financial bids were also due April 20, 2011. The Nigerian government anticipates that it will sell its residual equity in each of the gas-fired GenCos and DisCos after a transitional phase, so that ultimately, the gas-fired GenCos and DisCos would be solely held by private sector investors. The government will retain control of Nigeria's sole power transmission company. However, the government anticipates entering into operation and maintenance arrangements with private sector companies. The Nigerian government estimates that operating entities will be required to invest approximately US$6 billion a year in the GenCos and DisCos in order to bring electricity supply in line with demand (Renaissance Capital, 2008). While this represents a substantial financial commitment, certain investment incentives will be available to a successful bidder, such as tax exemptions/holidays, World Bank Group credit support for GenCos, the establishment of a state controlled entity to take over outstanding liabilities (Nigeria Electricity Liability Management Company NELMCO), and a uniform tariff, all of which may increase investor appetite for Nigerian power assets. The privatization process — and the fundamental reforms on which it is predicated — likely will have substantial spill-over effects for IPPs.

3.2. Regulatory Clarity: Establishment of the Nigerian Electricity Regulatory Commission

The Nigerian Electricity Regulatory Commission (NERC) was established as an independent regulator pursuant to the 2005 Reform Act to undertake both the technical and economic regulation of the Nigerian electricity sector (NERC presentation, 2011). Two of NERC's key regulatory functions are:

• *Licensing*: NERC issues licenses for on-and off-grid generation of power, as well as for distribution of electricity to end users. To date, NERC has issued more than 25 generation licenses for an installed capacity of over 10,500MW. The generation IPP licenses issued by NERC predominantly have been for gas-fired projects, but licenses also have been issued for a hydro-station and for a coal-fired power plant.

• *Tariff*: NERC manages price regulation through the Multi-Year Tariff Order (*MYTO*). The MYTO provides a 15 year tariff path for the electricity industry with minor reviews each year in light of certain parameters (including inflation, exchange rate and gas prices) and major reviews every five years. NERC has been a key participant in the current reform process. Among other things, NERC is tasked to provide regulatory clarity as it is intended to operate as a one-stop shop for all regulatory functions in the power sector.

Cost Reflective Tariff

A new uniform tariff — MYTO — has been established by NERC and is currently undergoing a major review. MYTO is calculated on a cost-of-power basis, with a capacity and an energy component, and includes adjustments to take into account the following factors, among others:

• Cost of financing
• A reasonable return for invested capital
• Inflation
• Exchange rate
• Deprecation
• Fuel costs
• Operating costs

Currently, MYTO is based on the efficiency level assumptions of an open cycle gas turbine plant. The Presidential Task Force on Power expects that the current average tariff level must at least triple (to around NGN22 / kilowatt hour (KWh)) if investment in the Nigerian power sector is to be an economically viable proposition for private investors (NERC presentation, 2011) — a step that each of NERC and the Nigerian government have taken in recent times. As noted above, MYTO also introduced to the Nigerian market the concept of periodic tariff reviews. The major tariff reviews, which are to be conducted every five years, are intended to take into account input from all relevant stakeholders, including investors. Indeed, the government's intention to factor in operating information from the current IPPs coupled with the building blocks approach of the overall tariff system should be viewed by investors with optimism that the reformation of the power sector in Nigeria will provide an attractive investment forum.

3.3. Gas Supply: Establishment of the Gas Aggregator

The lack of an adequate and consistent supply of gas to fuel the power sector often has been given as a reason for power sector reforms having stalled in the past in Nigeria (Renaissance Capital, 2008). The Nigerian government has implemented a gas master-plan strategic framework to tackle the gas supply problem. As a key part of such framework, the Gas Aggregation Company Nigeria Limited (the *Gas Aggregator*) has been established to manage the government's domestic gas supply obligations. One of the main aims in establishing the Gas Aggregator was to coordinate a streamlined process for wholesale gas supply from gas producers to eligible gas purchasers, including GenCos. Among other things, the Gas Aggregator has developed a form gas supply agreement to be used with GenCos. The Gas Aggregator has indicated that such form of gas supply agreement was developed to conform to international industry standards and to be a part of a financeable package of power project contracts (GACN presentation, 2011).

3.4. Off take: Establishment of the Bulk Electricity Trader

The Nigeria Electricity Bulk Trading Company Limited (the *Bulk Electricity Trader*) has been established as a government owned trader with bulk purchase and resale licenses. The Bulk Electricity Trader will enter into what are intended to be industry acceptable and financeable power purchase agreements (PPAs) with IPPs and other GenCos (including the newly privatized GenCos). The Bulk Electricity Trader will on-sell electricity to the DisCos until such time as the DisCos are able to enter into direct purchase arrangements with the GenCos on market terms.

Table 6. *Key Players in Nigeria's Reformed Power Sector.*

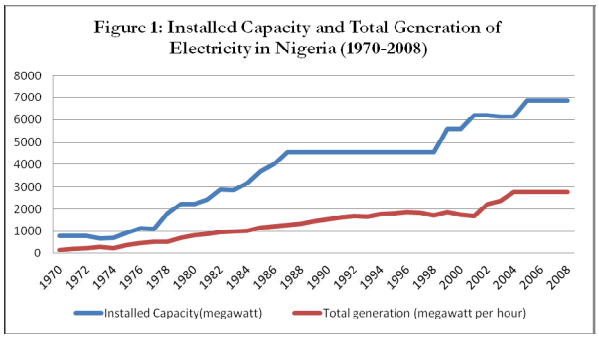
Key players	Functions
Presidential task force on power	Drives implementation of reform by uniting different stakeholder agencies; monitors planning, execution and implementation of projects
Bureau of Public Enterprises	Drives the privatization of existing government-owned power companies (GenCos and DisCos)
Nigerian Electricity Regulatory Commission	Sector regulator; issues licenses and sets tariff
Gas Aggregation Company in Nigeria Limited	Manages domestic gas supply requirements
Nigeria Electricity Bulk Trading Company Limited	Special trader with bulk purchase and resale licenses; manages PPAs with IPPs and other GenCos
Nigeria Electricity Liability Management Company (NELMCO)	Manages legacy liabilities and stranded assets
Electricity Management Services Limited	Carries out consulting services and provides shared services such as logistics and meter testing
National Power Training Institute of Nigeria	Provides training to support the power sector

4. Nigeria's Electricity Paradox

4.1. Current State of the Nigerian Electricity Power Sector

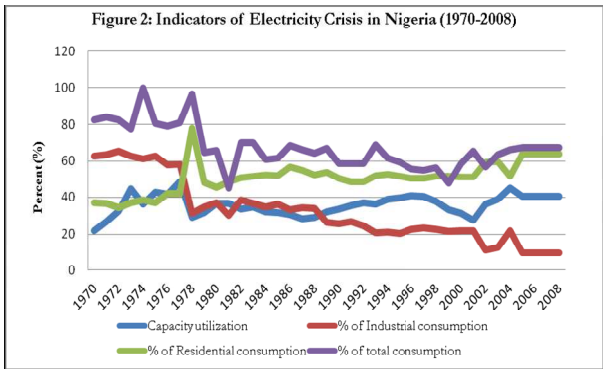
The supply of electricity is believed to be one of the critical infrastructural requirements for rapid and sustained growth of any nation. It can be seen as an indicator of modern development in a country. Hence, the provision of an adequate, affordable, accessible, reliable and sustainable electricity supply is essential to the attainment of the broad goals of industrialization, productivity as well as improved quality of life. It is generally recognized that Nigeria is

richly endowed with both renewable energy resources (e.g. solar, hydro, wind, biomass and wood fuel) and non-renewable energy resources (e.g. crude oil, natural gas, lignite and coal). However, in spite of this abundance, the country is still unable to generate enough electricity to meet its domestic demand. Approximately 50.6% of the population as at 2009 has access to electricity (WDI & GDF, 2012) but experience frequent disruptions to supply and often depend on back-up generators with the immense environmental consequences. Available statistics as at 2008 shows that the country has about 6862 megawatts (MW) of installed electricity generating capacity, but actual generation is as low as 2779 MW (see Figure 1).



Source: Derived from CBN Statistical Bulletin, 2007 & CBN Economic Report for the first half of 2008.

The electricity industry in Nigeria is being controlled on the supply side by PHCN which has remained largely inefficient in service delivery, innovation and management. As shown in figure 2 below, the proportion of total electricity consumed in the industrial sector has been on a steady decline; while the industrial capacity utilization rate fluctuates between 22% and 45% between 1970 and 2008. An important feature in figure 2 is the fact that the proportion of total electricity consumed in the industrial sector between 1970 and 1977 was consistently higher than the corresponding share by the residential sector. This trend was however reversed in the latter periods. This is attributable to the fact that more than 90% of business establishments in Nigeria tend to rely more on expensive backup petrol and diesel generators that add as much as 20% to total cost of industrial enterprises (Nnaji C et al, 2010).



Source: Derived from CBN Statistical Bulletin, 2007 & CBN Economic Report for the first half of 2008.

Factors that contribute to the current electricity crisis in Nigeria have been identified to include generation deficits, weak distribution and transmission infrastructure, poor utility performance, long period of investment and maintenance neglect (Ibitoye and Adenikinju, 2007). In effect, deficient transmission and distribution networks have often result in a large difference between the amount of electricity produced and the amount delivered to end users. In most cases, load shading has to be adopted to avoid system wide blackout. Although, the Nigeria government has spent considerable amount of money in the power sector, the crisis is far from over. Efforts are currently being made to increase power supply in the country to about 10,000 megawatt following the lunching of the Roadmap on the power sector by the present administration. It is yet to be seen how far this objective could be achieved.

4.1.1. The Electricity Demand Situation in Nigeria

Electricity consumers in Nigeria are mostly classified into three major distinct groups namely: residential sector, commercial sector and street lighting, and industrial sector. In most countries, the industrial sector constitutes the largest consumer of electricity followed by residential sector and then commercial sector and street lighting. Based on available data, the observed pattern in Nigeria shows the reverse. Figure 3 shows electricity consumption trend of the different sectors. The figure reveals that the residential sector had remained the largest consumer of electricity in Nigeria. It is also observed that for many years now, electricity consumption by industrial sector has not only decreased but had been diminishing while the electricity consumption by residential sector is growing rapidly. Thus, there is a decreasing trend in industrial sector consumption of electricity and increasing trend in residential sector consumption of electricity.

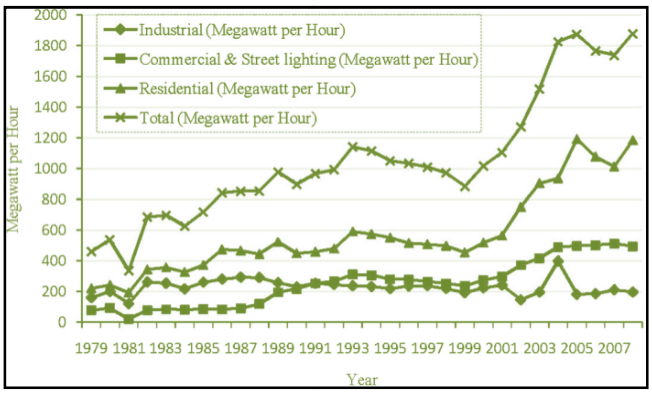


Figure 3. *Electricity consumption pattern in Nigeria. (Source: CBN statistical bulletin 2009)*

Electricity utilization by the industrial sector has been fairly static because of the unreliable nature of the public electricity supply system in the country. Resulting in a situation whereby, many companies have resolved to provide their own power-generating sets as sources of

electricity, leading to huge transfer costs on their products and services. By all indications, the residential sector remains the largest electricity consumer in Nigeria. It is followed by the commercial sector and street lighting and then, the industrial sector (Ekpo, 2010). To most industrial firms in Nigeria, electricity generated from their private generating plants serves as the primary source of electricity supply while supply from public electric power source serve as alternative. In a study conducted by Ekpo (2010), he reports that in a survey of Nigerian firms in the 1980s, about 90% of the firms had their own private generators.

Primarily, the demand for electricity is influenced by two basic variables, namely, income and electricity prices (Sa'ad, 2009). The level of economic activity as well as standard of living which is proxy by the level of income is perhaps the most important determinant of electricity demand. The demand for electrical goods and services (e.g., television, refrigerators, air-conditioners etc.) increases as income rises. This puts significant pressure on the demand for electricity for their usage. This implies that a positive correlation exist between income and electricity consumption. Another essential factor affecting electricity consumption is the price consumers pay for electricity usage. Higher prices in the short-term causes substantial reduction in the demand for electricity while in the long-term, it stimulates alternative purchase of more efficient energy appliances. Other notable factors include population, prices of energy substitutes, urbanization, climatic condition and the level of industrialization. Population is an important structural factor which affects the level of electricity consumption in an economy. The relationship is precisely positive as higher population is expected to increase the demand for electricity. The industrial base of an economy also puts significant pressure on the demand for electricity. As rapid industrial growth intensifies, electricity is consequently demanded for the powering of production equipments and machineries for enhanced capacity utilization. Urbanization and climatic condition are rarely incorporated except in cases where data is available.

4.2. Country Comparison with Selected African Countries

The electricity consumption, transmission and distribution loss data in table 7 and 8 below respectively, highlight two dimensional challenges confronting the electricity power sector in Nigeria. The first is the low level of energy consumption, evident in low level of electricity consumption per capita when compared with some other African countries. This can be said to be an indicator of energy and income poverty in the country. The second dimension stems from high level transmission and distribution losses. The high level of loss in transmission and distribution of generated electricity power has rendered Nigeria as being the largest importer of generators in the world (Iwayemi, 2011).

Table 7. *Electric Power Consumption (Kwh Per Capita) in African Countries 1971 to 2009.*

Country	1971	1980	1990	2000	2009
South Africa	2246.14	3644.44	4431.48	4416.57	4532.02
Ghana	310.17	421.23	323.12	330.39	265.11
Gabon	207.51	770.54	939.68	875.11	922.5
Egypt, Arab Rep.	196.35	368.03	669.37	994.05	1548.59
Libya	191.36	1177.28	1614.04	2275.58	4170.11
Tunisia	154.18	402.1	638.43	991.27	1311.26
Cameroon	145.11	147.75	192.52	173.42	271.24
Algeria	140.55	337.51	541.24	694.67	970.98
Morocco	130.33	241.99	359.55	490.05	755.57
Angola	91.94	66.24	60.96	88.61	202.15
Kenya	77.98	104.93	124.96	109.72	147.43
Senegal	76.58	106.2	107.71	105.72	196
Nigeria	27.87	66.15	84.99	73.64	120.51
Sudan	24.56	34.98	48.39	63.47	114.27
Ethiopia	18.54	17.92	22.39	22.98	45.76

Source: World Development Indicators & Global Development Finance 2012.

From table 7, comparing the per capita power consumption of Nigeria to that of some other African countries, Nigeria is third from bottom among the countries. While South Africa, Ghana and Gabon with relatively smaller population occupy first, second and third positions respectively. This therefore shows that for Nigeria to attain the goal of being among the twenty most industrialized countries in the world by year 2020, its energy consumption has to be increased in relation to the large size of its population. The developmental benefit of such policy is a reduction in the level of income poverty among its citizens and the potential tendency to fast track the nation's path towards industrialization.

Table 8. *Electric Power Transmission and Distribution Losses (% of Output) in African Countries 1971 – 2009.*

Country	1971	1980	1990	2000	2009
Angola	25.07	25.04	25.09	14.6	10.09
Sudan	24.65	14.08	15.38	15.53	28.11
Libya	21.65	24.875	31.2	23.18	14
Kenya	15.38	14.6	15.02	21.16	15.53
Senegal	15.18	14.94	17.46	37.34	16.97
Tunisia	13.28	12.21	10.34	10.54	13.03
Nigeria	13.25	29.07	38.42	38.15	5.87
Algeria	10.72	10.91	14.36	16.15	20.57
Morocco	10.61	9.76	8.53	8.4	11.71
Egypt, Arab Rep.	9.78	12.65	9.96	13.76	10.52
South Africa	7.07	7.63	6.03	8.2	9.84
Ethiopia	6.91	7.84	9.98	9.98	9.52
Ghana	6.11	5.19	3.15	18.87	23.31
Cameroon	5.21	7.36	13.05	21.87	9.41
Gabon	1.75	0.75	10.74	17.79	18.18

Source: World Development Indicators & Global Development Finance 2012.

Table 8 above shows the electric power transmission and distribution losses among some selected African countries. From the table, Nigeria is ranked higher than its West African neighbours such as: Gabon, Cameroon, and Ghana

who are ranked lowest. The high level of transmission and distributional losses has led to electricity blackouts and pervasive reliance on self-generated electricity. This development has occurred despite abundant energy resources in Nigeria. The electricity market, dominated on the supply side by the state-owned PHCN, has been incapable of providing minimum acceptable international standards of electricity service reliability, accessibility, and availability for the past three decades (Adenikinju, 2005). The double-digit transmission and distribution losses are extremely large by international standards and are among the highest in the world. The system losses are five to six times higher than those in well-run power systems. The high level of power losses and the significant illegal access to the public power supply are indicative of the crisis in the industry. Though the peak electricity demand has been less than half of the installed capacity in the past decade, load shedding occurs regularly. This poor service delivery has rendered public supply a standby source as many consumers who cannot afford irregular and poor quality service, substitute public supply for more expensive electricity supply source to minimize the negative consequences of power supply interruptions on their production activities and profitability. An estimated 20% of the investment into industrial projects is allocated to alternative sources of electricity supply (Nnaji C et al, 2010).

Table 9. *Electricity Access (% by population).*

Country	HDI	National	Rural	Urban
Algeria	0.754	99.3	98	100
Angola	0.564	26.2	10.7	38
Botswana	0.694	45.4	12	68
Cameroun	0.523	29.4	9	45
Cape Verde	0.708	70.4	44.9	87.5
Cote d'Ivoire	0.484	47.3	18	78
Egypt	0.703	99.4	99.1	100
Ethiopia	0.414	15.3	2	80
Gabon	0.755	36.7	18	40
Ghana	0.526	54	23	85
Kenya	0.541	15	5	51.3
Libya	0.847	99.8	99	100
Mauritius	0.804	99.4	99	100
Morocco	0.654	97	96	98
Nigeria	0.511	46.8	26	69
Senegal	0.464	42	18	74.7
South Africa	0.683	75	55	88
Sudan	0.531	31.4	19	47.5
Tunisia	0.769	99.5	98.5	100
Uganda	0.514	9	4	42.5

Source: UNDP/WHO (2009) Energy Access op. cit

Access to electricity serve as a key factor which is widely recognised in achieving the goal of sustainable human development and significant improvement in human well-being across the globe. Table 9 above puts further perspective on Nigeria's electricity challenges with focus on the rural-urban dichotomy. The above data show the relatively low access to electricity in Nigeria and most African countries especially for the rural dwellers where most of the population in these countries live and work. From the table, it could be observed that Cape Verde, Botswana and South Africa are the African exception with HDI of 0.708, 0.694 and 0.683 respectively compared to Nigeria's 0.511. A further comparison of Nigeria's electricity situation with countries such as : Algeria, Egypt, Libya, Mauritius, and Morocco, shows an almost equal balance in access to electricity by both the rural and urban centres for these countries, compared to the high unequal access to electricity supply by both the urban and rural centres in Nigeria. This phenomenon can be said to be probably responsible for the high HDI recorded by these countries and also the rapid growth and development being experienced over time by these economies. Unlike Nigeria where majorly the population dwell in rural centres and are denied access to electricity; thereby resulting in the low HDI for the country.

5. Opportunities and Challenges for Investment

The revitalization of the reform process in the Nigerian electricity sector and the strong effort by the government to privatize much of the existing grid, serve as a door opening to private sector investors willing to significantly invest in the Nigerian power sector. However, the following are some of the technical, financial and manpower challenges that potential investors are presented with:

5.1. License Duration

The 2005 Reform Act and NERC regulations provide for a generation license to have duration of 10 years, renewable for a further five years. While this aligns with the total duration of the uniform tariff envisaged by the MYTO, a total license duration of 15 years may present challenges to potential investors and their lenders given that such a 15-year period likely is well short of the useful life of the assets involved, either in a privatisation or an IPP transaction. In addition, 15 years likely would be shorter than the tenor of long-term debt financing that an investor would target in a finance plan for a green-field IPP. NERC representatives recently stated at the Nigeria Power Sector Investment Forum in London that it would address concerns surrounding the duration of licenses by granting a further 10-year license towards the end of the initial 10-year license (with such second 10-year license would then be followed by the five-year renewal license). Thus, resulting in a 25 year total license period. Though helpful, investors have questioned the level of discretion given to NERC at each renewal phase during such 25-year period. In response to this, NERC representatives indicated that so long as the operator was compliant with its license obligations, the second 10-year license and the five-year renewal license would be granted automatically. While certainly a step in the right direction, investors will want to be sure that such undertakings are reflected properly in law and in regulations.

5.2. Cost Reflective Tariff — but Subject to Periodic Review and Modification

The proposed uniform tariff for the power sector — the MYTO, presents many appealing characteristics for potential investors: it is derived from a building blocks approach that intends a cost-reflective outcome, including a capacity and an energy component; financing costs and other key costs (operating costs, depreciation) are intended to be accommodated; and key fluctuating costs (fuel costs, foreign exchange, inflation) also are intended to be reflected. However, investors will want to analyze the level of uncertainty inherent in any review, in particular in the major reviews that are intended to be held every five years. Investors will note that the duration of the MYTO is only 15 years — likely well short of the useful life of the assets involved and shorter than the tenor of longer-term debt financing that is most attractive to many investors in the sector.

5.3. Quality of Privatized Assets and Government Equity Retention

Investors likely will have concerns about the quality of the existing assets to be privatized, particularly given the government's intention to retain a significant amount of the equity in the enterprises that own such assets. As the assets will require significant investment in order to meet the government's power supply objectives, there may be conflicting interests between the private investors and the government acting as equity stakeholders. If the government as an equity stakeholder is unwilling to contribute the substantial sums required to upgrade any significantly deteriorated assets, an investor would want to know that it will have full control of the asset, as well as protections in respect of their equity position, at a minimum. The Presidential Task Force on Power has sought to reassure investors in this regard by stating that successful bidders from the outset would exercise control over the privatized companies. The degree of investor control and other protections will be studied once the form of documentation, including share purchase agreements and shareholders' agreements, are made available to potential investors.

5.4. Credit Support

World Bank Group representatives have indicated Partial Risk Guarantees and possibly a MIGA termination guarantee may be available for appropriate projects in the Nigerian power sector to backstop Nigerian government obligations. This is valuable credit support that can underpin Nigerian country risk and may make the difference in an investor reaching a final investment decision.

5.5. PPA Counterparty and Duration

The establishment of the Bulk Electricity Trader provides a degree of certainty in managing PPA counterparty risk, but the Nigerian government's plan regarding the future transition to a wholesale market (including with respect to timing) remains uncertain. PPAs entered into with the Bulk Electricity Trader should provide adequate protection to projects, investors and lenders for any transition arrangements and the duration should be sufficient to attract long-term debt financing. Investors may wish to consider a range of options that have been put in place in other locations around the world in PPAs with monopoly off takers to address this risk including appropriate credit support and/or "put" options. The tariff reflected in the PPA also will be a primary focus for investors. Other key factors will include the proposed duration of the PPA (does it match the tenor of the investor's financing; the duration of the fuel supply); commercial reasonableness of terms (*i.e.* pricing, pass through costs); risk of non-dispatch; and foreign currency risks.

5.6. Gas Supply Counterparty and Duration

Gas supply remains a real concern for investors. Investors should review the form gas supply agreements being developed by the Gas Aggregator. Key factors will include the proposed duration of such agreement (does it match the tenor of the investor's proposed financing; the duration of the PPA); commercial reasonableness of terms (*i.e.,* pricing, pass through costs); and risk of non-supply, both in reasonably foreseeable circumstances and in the event of force majeure.

5.7. Nigerian Domestic Bank Participation

Nigerian domestic banks traditionally have been reluctant to participate in long-tenor debt financed projects in Nigeria (it has been rare to see debt financing for longer than a five year tenor in recent energy financings). A challenge for power projects will be to try to attract longer-term Naira debt, which is a good match with the Naira-based revenues that Nigerian power assets will generate. In 2010, the Central Bank of Nigeria announced the establishment of a NGN300 billion (approximately US$1.97 billion) Power and Airline Intervention Fund to foster investment in the power and aviation sectors in Nigeria. The funds will be channeled through the Nigerian Bank of Industry for on-lending at a concessionary "all-in" interest rate of not more than 7.0 percent and for a tenor of 10-15 years. The African Finance Corporation will serve as technical adviser to the fund (CBN PAIF guidelines, 2011).

6. The Way forward to Achieving Sustainable Electricity Supply for the Growth and Development of Nigeria

6.1. Projected Electricity Demand and Supply for Nigeria

Throughout the world, electricity is the most widely used and desirable form of energy. It is a basic requirement for economic development, national development, meeting the Millennium Development Goals (MDGs), and for an adequate standard of living. As a country's population grows and its economy expands, its demand for electrical energy multiplies. If this demand is not met adequately, a shortage in supply occurs. This shortage can assume crisis proportions and possibly affect achieving sustainable energy development.

The International Atomic Energy Agency (IAEA) developed a model for the Analysis of Energy Demand (MAED), which is based on four scenarios as shown in table 9 below. The scenarios were used to estimate the demand of the Nigeria energy sector. The same scenarios were used with a second model of IAEA, the model for Supply Systems Strategies and the General Environmental implications (MESSAGE) to estimate the supply.

Table 10. *Electricity Demand Projection per Scenario.*

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 1 (11.5%)	5,746	16,000	31,240	70,760	137,370	250,000
Optimistic 2 (13%) Presidential Pronouncement	5,746	33,250	64,200	107,600	172,900	297,900

Source: www. energy. gov. ng

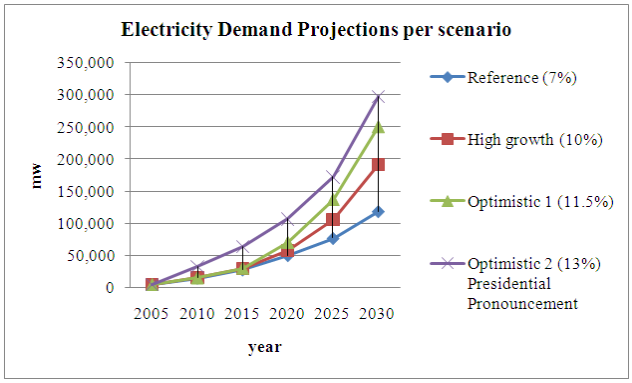


Figure 4*. Projected electricity demand between 2005 and 2030. (Source: www.energy.gov.ng)*

The four scenarios are based on the following guidelines:

- Reference Growth Scenario
  - GDP grows by an average of 7% per annum
  - The main driver of growth is the manufacturing sector
  - Manufacturing accounts for 15% of GDP by 2020
  - Consistent with the MDG objective of reducing poverty by half by 2015.
- High Growth Scenario
  - GDP grows by average of 10% p.a
  - Manufacturing contributes 22% to GDP by 2030
  - Nigeria is transiting from an agrarian economy to an industrializing nation.
- Optimistic Growth Scenario I
  - GDP grows by an average of 11.5% p.a
  - Manufacturing contributes 22% to GDP by 2030
  - Nigeria is transiting from an agrarian economy to an industrializing nation.
- Optimistic Growth Scenario II
  - GDP grows by an average of 13% p.a
  - Manufacturing contributes 22% to GDP by 2030
  - Nigeria is transiting from an agrarian economy to an industrializing nation.

The electricity demand shows an increasing trend from the base year 2005 to 2030 in the four adopted growth scenarios respectively, as shown in Figure 4 above. This indicates a high economic growth rate level leading to a substantial increase in electricity demand.

Table 11. *Projected Electricity Supply by Fuel Mix for 7% Growth.*

Scenario	2010	2015	2020	2025	2030
Coal	0	2,393	6,515	9,305	15,815
Gas	13,555	23,617	37,733	56,086	85,585
Hydro	3,702	4,962	6479	9,479	11,479
Nuclear	0	0	3,530	7,005	11,872
Small hydro	40	90	140	227	701
Solar	5	10	34	75	302
Wind	0	126	1471	3019	5,369
Total supply	17,303	31,197	55,903	85,196	131,122

Source: Energy Commission of Nigeria (2008)

Table 12. *Projected Electricity Supply by Fuel Mix for 13% Growth.*

Scenario	2010	2015	2020	2025	2030
Coal	0	7,629	16,913	30,874	63,896
Gas	31,935	52,860	78,717	120,286	192,895
Hydro	3,902	4,962	6,479	9,479	11,479
Nuclear	0	3,530	11,005	18,005	36,891
Small hydro	208	360	1,000	1,956	2,353
Solar	30	80	750	2,670	4,610
Wind	500	1,200	3,971	6,920	15,567
Total supply	36,578	70,620	118,836	190,190	327,690

Source: Energy Commission of Nigeria (2008)

6.2. The Role of Renewable Energy Technologies in Sustainable Development

There is a global need for conservation and the use of renewable and non- polluting energy resources. Renewable energy alternatives such as: water power, wind power and solar energy are efficient, cost- effective and substantial in Nigeria. However, they are currently under-utilised because of the ready availability of inexpensive, but exhaustible fossil fuels.

6.2.1. Harnessing Wind Energy for Electricity Generation

Apart from gas and hydro power plants which the country currently rely on for electricity supply, the government can also embark on the executioning and commissioning of wind energy pilot projects in selected areas of the country. These wind projects can be preferably carried out in selected parts of the country where stronger wind movements occur, compared to other parts of the country. Particularly in seabed, hilly areas and seashores, wind is easily available and hence it is less expensive source of energy. By utilizing the momentum and transferring it to rotor blades, energy can be produced from wind. The process of producing energy from this source does not create any type of pollution but the maintenance can produce negligible amount of water or air pollution.

The usage of windmills or wind turbines to produce energy is constrained to installing them in windy areas where wind flows with high speed as otherwise wind cannot be utilized to produce energy. Also, there should be provision of fiscal incentives such as: import duty exemptions, tax holidays, and investment grants to encourage investment in wind powered generating plants and water pumps. All government rural electrification agencies at the federal, state and local governments should be adequately sensitized on the importance and potentials of wind energy as viable source of electricity.

6.2.2. Harnessing Solar Energy for Electricity Generation

The sun is the most important source of energy. The sun rays can be used as a mean of producing the energy. Photovoltaic cells possessing the characteristic of converting heat to energy are used to generate electricity. When sun rays strike the surface of these photovoltaic cells, electric current is produced. This device is also less expensive as it is made up of silicon which is one of the most abundant elements on earth. The only limitation of using solar energy or solar panels or photovoltaic cells is that they can produce electric current only in the day, when bright sunlight is available in abundance. Installing photovoltaic cells or solar panels hence cannot produce energy in rainy or snowy seasons.

There should be an execution of pilot projects to ensure that the general public is aware of the potentials of solar energy technologies; which will as well assist in creation of markets for solar energy systems. There should also be the provision of fiscal incentives such as: import duty exemptions, tax holidays, investment grants to encourage investments in solar powered generating plants and local manufacturing of solar photovoltaic applications.

6.2.3. Harnessing Nuclear Energy for Electricity Generation

Nuclear power plants produce electrical power by harnessing heat energy from atomic fission of fissile atoms (such as uranium-235) in nuclear fuel. Fission is the process in which a heavy atomic nucleus splits into two smaller fragments (daughter nuclei). The daughter nuclei are in very excited states and emit neutrons and other forms of radiation. The neutrons can then cause new fissions, which in turn yield more neutrons, and so forth. This continuous self-sustaining series of fissions constitutes a fission chain reaction, but it is controlled in a nuclear reactor, so that it would not explode like an atomic bomb. A large amount of heat energy, along with different forms of radiation, is released in this process. The generated heat energy produces steam for driving the steam turbine that, in turn, drives the electrical generator that produces electricity.

Although nuclear energy is one of the most capital intensive form of energy supply, its benefits can be said to outweigh is cost in the long run. There should be the establishment of unambiguous nuclear policy guidelines for the nuclear energy sector. The policy should clearly define the role of relevant government organizations and the private sector as the main drivers of nuclear power programmes. There should also be the establishment of the Nuclear Power Programme Coordination and Implementation Organization (NPPCIO) to serve as the planning, coordinating and implementing organization for the nuclear power programmes. Manpower training and the provision of adequate infrastructure for nuclear science and technology centres around the country should also be intensified.

6.2.4. Biomass Energy

Biomass power is the electricity generated from biomass and is obtained from wood, crops, harvest residues, urban refuse and industrial wastes known as biomass. It is one of the important sources of renewable energy and serves as an essential part of waste management process. Biomass (plant materials and animal wastes) can be burned to produce steam from water. The steam drives a steam turbine that, in turn, drives the electrical generator that produces electricity. Biofuels such as bioethanol (produced by fermenting plant materials), biodiesel (made from plant oils combined with alcohol to form ester) and biogas (produced by allowing organic matter to decay) can also be burned to generate electricity. Biomass is a renewable resource, as it can be replaced over time through natural processes. Biofuels are equally renewable resources, in the sense that they are produced from biomass. The fuels are also readily transported, making it possible for the power plants to be located where the cost of electricity transmission can be

minimised. Pulp and paper industries in the United States are prominent generators of biomass. Obtaining power from biomass substances is more cost-effective than that of obtaining it from wind using wind turbines or windmills or any other source as it requires less investment.

6.2.5. Geothermal Energy

Geothermal energy is the thermal energy generated and stored in the earth that verifies the temperature of the matter. This clean and sustainable type of energy is found in shallow hot ground water, hot rocks a few miles beneath the earth's surface and in the molten magma if we go deeper. Geothermal energy is the heat contained in hot- water deposits within the earth's crust. Geothermal reservoirs may contain hot-water at temperatures of more than 3500C .This heat energy can be tapped into to produce electricity in geothermal power plants. Geothermal energy is a renewable resource. This is because the earth's heat is continuously radiated from within, and rainfall supplies new water to geothermal reservoirs on annual basis. Geothermal energy produces few emissions and is consistently available for use.

6.2.6. Tidal Power

Tidal power, or tidal energy, is a form of hydro power that exploits the tidal movements of the ocean as water flows back and forth. Tidal power can be harnessed in a couple of ways: kinetic energy that powers turbines as the water moves between full and ebb tide, and; potential energy in which barrages are used to exploit the difference between high and low tide. When there's a substantial amount of water that rushes in and out of some rivers and inlets it's possible to harness the energy created to drive generators to produce electricity. To tap this energy a barrage is built across the mouth of the river. Water turbines sit in the barrage wall and as the water rushes through, the turbines generate electricity.

The effectiveness of the installation to produce significant levels of electricity depends entirely on the range of the tide and the volume of water that is pushed through the barrage. In order to make the process worthwhile the tidal range must be at least 4 metres. Tidal plants are similar in mechanics to hydropower plants with the obvious difference being that the flow of water driving the turbine in a tidal plant comes from purely natural forces. When a suitable site has been found and established, tidal power is more predictable than wind and fluctuates less drastically than solar insulation. It's a reliable producer of electricity; once built and running, there are virtually no costs associated with the production of electricity.

7. Growth and Development Expectations for the Economy

7.1. Double Digit Growth in GDP

With the increase in electricity to meet fully demand, GDP of the economy in ten years could be in two digits annually. This is because the availability of electricity supply would encourage private investors who have always cited the epileptic power supply, as an excuse to move their businesses to other neighbouring African countries. Furthermore, existing businesses in the country would have lower cost of production. This would result in firms increasing output, which if sustained over time; would yield double digit growth in GDP for the country.

7.2. Job creation in the Sector

The reform processes when completed tend to benefit the economy in the area of job creation. This is because with improvement in supply to meet demand, the economy would witness growth in small and medium scale enterprises in the country. Thereby complementing the government's effort at reducing the high level of unemployment the government is currently battling with. Thus, improving the standard of living of the people vis-a-vis higher per capita income.

7.3. Rechanneling of Funds into Other Sectors

A major benefit of the electricity reform process is the freeing up of capital used in subsidizing the sector. Such capital can then be used to develop other vital sectors of the economy such as: health, education, agriculture, etc. Also, the huge amount spent by business owners in purchasing and maintaining generating sets to power their businesses, can be rechanneled into improving the quality as well as increasing their output levels. Therefore, resulting in lower cost of production to business owners, improved business profits, and lower product prices to consumers.

7.4. Reduction in Electricity Tariffs

As the industry tariff gets stabilized over time, there would be tariff reduction in real terms. This happened in several countries including Spain. This is because full privatization of the sector would encourage competition between firms in the industry over time. Consumers tend to benefit from such competition in terms of lower prices being offered them by competing firms. An example of such benefit is the telecommunication sector, where tariffs are at significantly low rates compared to when the sector was initially being privatized.

7.5. Improved Service Standard

It is expected that with the reform program in the electricity sector, consumers stand to benefit from better service delivery from electricity providers in the country. Since firms would be much concerned with efficiency in their operation in terms of generation and distribution. A wider distribution coverage of electricity to the rural areas of the country is expected by firms, so as to expand their market size. Furthermore, the NERC would also ensure better regulation of the sector; to ensure that consumers are not worse off in terms of quality of service they recieve

from the electricity service providers. This would then bring about better service delivery to consumers of electricity.

7.6. Increased Export Earnings

An efficient electricity sector has the potential of improving the country's foreign earnings. This is achieved through lower export prices of exportables. Thus, making the country's exportables competitive in the international market, and raising the country's foreign earnings from the sales of this exportables. Thereby strengthening the value of the naira against the US dollar.

8. Conclusion and Recommendations

It is a generally known fact that Nigeria is blessed with abundant resources of fossil fuels as well as renewable energy resources. However, the major challenge is an inefficient usage of energy in the country. As a result, there is an urgent need to bring into play an energy mix that will emphasize the conservation of petroleum resources in such a manner that would enable the continued exportation for foreign earnings for as many years as possible.

In order to ensure the sustainability of electricity supply and subsequently the sustainable economic development of the country, the government has to step up further implementation of renewable energy and energy efficiency programs. As observed in quite a number of successful countries promoting renewable energy, such as Germany, Denmark, and Japan, a strong and long-term commitment from the government as being emphasised is crucial in implementing any kind of policies which will lead to the development of renewable energies, in particular, and a sustainable development, in general.

The development of the electricity sector must be integrated into sustainable development in which sustained improvement in the general well being of the people and enlarging their social choices are key elements. Debatably, increased electricity supply and demand affixed on a more efficient utilization of resources encouraged by market-driven incentive structure is indispensable to achieving sustainable energy and human development. Furthermore, success in achieving sustainable electricity and economic future in Nigeria must be based on the design and implementation of appropriate and harmonized national, state and local government policies backed up by adequate financial, technical and other support from the international community.

Finally, sustainable development should also be about economic, social and political freedom. Hence, the well being of the poor and disadvantaged people is of utmost importance and must be explicitly factored into the process of development of energy resources.

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