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ENERGY CRISIS IN NIGERIA: THE WAY FORWARD

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ABSTRACT

Electricity is the prime mover that drives the economic development of every country and any nation that desires to develop will ignore the power sector to its peril. Any nation whose energy need is epileptic in supply, prolongs her development and risks losing potential investors. The greatest engineering challenge in Nigeria today is the issue of the provision of steady, adequate, affordable and efficient electricity supply. This paper presents the energy situation and challenges in Nigeria and discuss about renewable energy as the way forward to ending the energy crisis in Nigeria.

KEYWORDS: Nigeria, Energy crisis, Electricity, Renewable Energy, Energy policy.

INTRODUCTION

Regular and adequate power supply is the hallmark of a developed economy. Any nation whose energy need is inadequate in supply, prolongs her development and risks losing potential investors [1]. Electricity is the prime mover that drives the economic development of every country and any nation that desires to develop will ignore the power sector to its peril [2]. It is the fundamental source of our development. It is needed in residence to power domestic appliances and lighting purposes, in the industries to drive various machines, equipment and processes, and by commercial and institutional consumers for the provision of services and driving various devices.

Nigeria produces about 2.5 million barrels of oil each day, yet many of its citizens live without electricity. Nigeria is one of the most populated countries in Africa but only about 40% of the people are connected to the energy grid. The people who actually have power, experience difficulties around 60% of the time [3]. The pink lines on the map show the routes the power grid takes and explains why much of Nigeria does not have access to electricity [4].

The greatest engineering challenge in Nigeria today is the issue of the provision of steady, adequate, affordable and efficient electricity supply by the public utilises to various residential, commercial, institutional and industrial consumers in the country. Nigeria is facing an issue of inadequate supply of electricity from the public utilities which has led to a situation where the nation is wallowing in darkness and the economy is underdeveloped despite the vast energy resources. Thus, the entire citizens of the country have been put into what could be called “Power Cage” [2] and only those individuals, establishments, institutions, industries; companies etc. who possess the financial means or muscle have liberated themselves from the cage by generating electricity to meet their needs. Nigerians spend almost $5 billion a year on fuel to generate their own electricity, this alone keeps many in poverty.

The Nigeria economy has been described by commentators on power sector as a generator economy because of the enormous amount of the off-grid electricity been generated to satisfy their power requirements. An integrated and pragmatic approach [2] to the issue of power challenges in Nigeria will entail carrying out an overview of the power sector and proffering solutions that provides the way forward to ensuring availability of regular, affordable and efficient supply of electricity. The harnessing of renewable energy to make significant contribution to the energy mix has been reported in several research findings.

BRIEF HISTORY OF ELECTRICITY IN NIGERIA

The history of electricity in Nigeria dates back to 1896 when electricity was first produced in Lagos, fifteen years after its introduction in England [5]. The total power of the generators used then was 60kW. In other words, the maximum demand was less than 60kW in 1896. In 1946, the Nigerian government electricity undertaking was established under the jurisdiction of the Public Works Department (PWD) to take over the responsibility of electricity supply in Lagos State. In 1950, a central body was established by the legislative council which transferred electricity supply and development to the care of the central body known as the Electricity Corporation of Nigeria, ECN [5].

Other bodies like Native Authorities and Nigerian Electricity Supply Company (NESCO) had licenses to produce electricity in some locations in Nigeria. There was another body known as Niger Dams Authority (NDA) established by an act of parliament. The Authority was responsible for the construction and maintenance of hydro dams and other works on the River Niger and elsewhere generating electricity by means of water power, improving navigation and promoting fish brines and irrigation [6].The energy produced by NDA was sold to ECN for distribution and sales at utility voltages.

On the 1st of April 1972, the operation of ECN and NDA were merged in a new organization known as National Electric Power Authority (NEPA). Since ECN was mainly responsible for distribution and sales and NDA created to build and run generating stations and transmission lines, the primary reasons for merging the organizations were [7]:

1. It would result in the vesting of the production and the distribution of electricity power supply throughout the country in one organization which will assume responsibility for the financial obligations.
2. The integration of the ECN and NDA should result in the more effective utilization of the human, financial and other resources available to the electricity supply industry throughout the country.

Since inception of NEPA, (renamed Power Holding Company of Nigeria, PHCN, in year 2004), the authority expanded annually in order to meet the ever-increasing demand. Unfortunately, majority of Nigerians have no access to electricity and the supply to those provided is not regular [8]. It is this backdrop that the federal government embarked on aggressive power sector reforms with the intention of resuscitating PHCN and making it more efficient, effective and responsive to the yawning of the teeming populace.

Again, according to the Nigerian Energy Policy report from 2003, it was estimated that the population connected to the national grid system is short of power supply, over 60% of the time [9]. On a fundamental level, there is simply not enough electricity generated to support the entire population. This was also what informed the call for the power sector reform. It was a time to seek direction and solutions to the sector's crisis.

THE POWER SECTOR REFORM

In accordance with the Electricity Power Sector Reform Act 2005, the privatization of PHCN was finally established in 2013. PHCN was subsequently unbundled into a transmission company, TCN, 6 generating companies, Gen-Cos, and 11 distribution companies, Dis-Cos. The Federal Government retains the ownership of the transmission assets. Manitoba Hydro International (Canada) is responsible for revamping TCN to achieve and provide stable transmission of power without system failure. Currently, 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 [10]. However, the generation and distribution sectors were fully privatised and owned by private individuals.

The operating environment is such that the Dis-COs can purchase power from Gen-COs of their choice while Gen-COs are allowed to optimise production cost and hence make competitive offers for sale of power. The Trans-CO 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 Dis-COs and Gen-COs with additional responsibility of issuing operational guidelines for efficiency of the system [11].

Table 1: The Gen-Cos

N/S	GENERATION COMPANY	PLANT TYPE	CAPACITY (MW)
1	Afam Power Plc	Thermal	987.2

2	Egbin Power Plc	Thermal	1320
3	Kainji/ Jebba Hydro Electric Plc	Hydro	1330
4	Sapele Power Plc	Thermal	1020
5	Shiroro Hydro Electric Plc	Hydro	600
6	Ughelli Power Plc	Thermal	924

Source: Nigerian Electricity Regulatory Commission

Table 2: The Dis-Cos

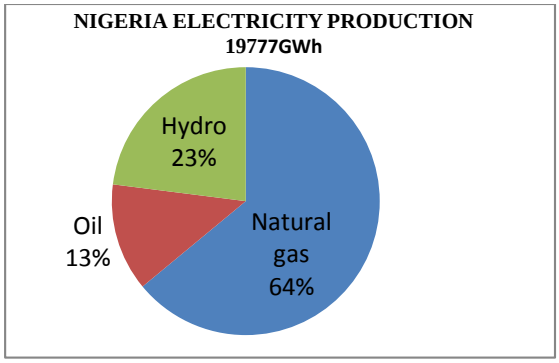
S/N	DISCOS	PERCENTAGE LOAD
1	Abuja Distribution Company	11.50%
2	Benin distribution company	9%
3	Eko Distribution Company	11%
4	Enugu Distribution Company	9%
5	Ibadan Distribution Company	13%
6	Ikeja Distribution Company	15%
7	Jos Distribution Company	5.50%
8	Kaduna Distribution Company	8%
9	Kano Distribution Company	8%
10	Port Harcourt Distribution Company	6.50%
11	Yola Distribution Company	11.50%

Source: Monthly Energy Balance Sheet, October 2013,
Transmission Company of Nigeria (TCN)

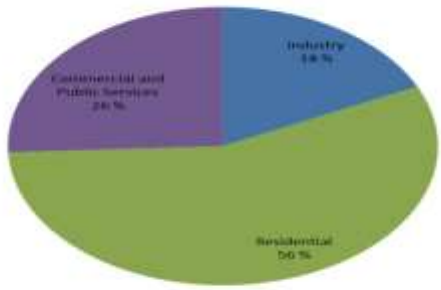
ENERGY CAPACITY & CONSUMPTION

According to [12], approximately 50.6% of the population have access to electricity. About 10% of the rural population have access to electricity services. 82% of urban population had access to electricity in 2006. Primary transmission of electricity is facilitated by 330 kV and 122 kV lines, with 33 kV and 11 kV distribution feeders supplying major population centres. The annual electricity demand growth is projected to be 7% - 13% depending on economic growth scenarios. There is an 80% demand/supply gap in Nigeria. Most businesses self-generate their power. Additionally, the transmission network is overloaded, with a poor voltage profile in most parts of the network. There are frequent system collapses and exceedingly high transmission losses, often in the region of 30-35%.

Available power production capacity represents about half of the installed capacity. Government plans to boost power production through new gas plants and the further promotion of Independent Power Producers (IPPs). IPPs currently account for approximately 20% of installed capacity, with a further 4,755 MW of National Integrated Power Projects (NIPP), funded by the Government and commissioned on Operation and Maintenance contracts prior to full privatisation.



Source: IEA, (2009)



Nigeria, Sectoral electricity consumption 18,0 TWh

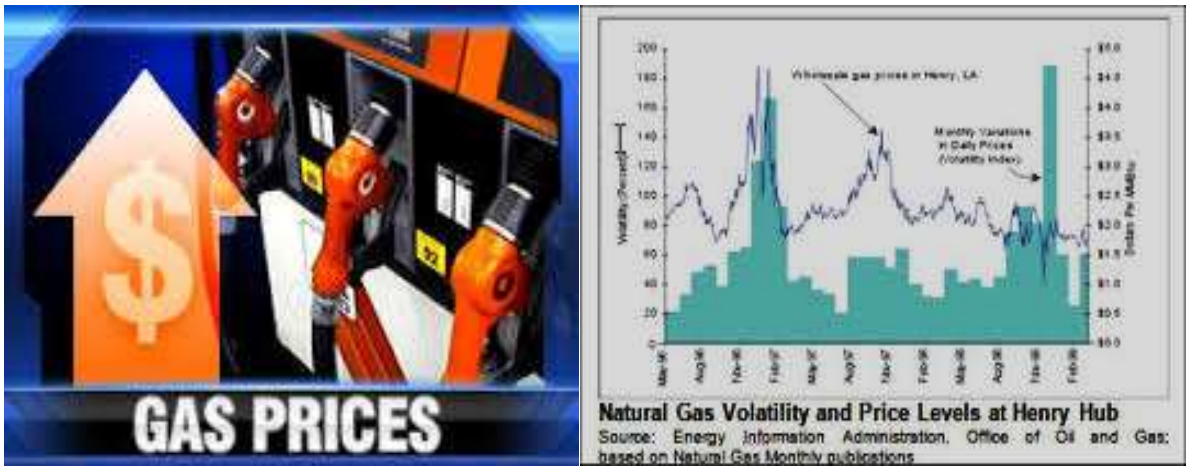
Source: IEA, (2009)

ENERGY CRISIS AND CHALLENGES IN NIGERIA

Energy crisis in Nigeria has become a norm for several decades and is the bane of her economic development. There is an extreme electricity deficiency in Nigeria and the causes of this deficiency are related to financial, sociopolitical, and structural issues [13]. One of the major problems facing electricity supply in Nigeria is the issue of pipelines that is frequently vandalized by militancy. These pipelines include: Trans-Niger line which passes through Bayelsa to Rivers State and goes to Delta State, Escravos line that passes from Delta State and goes to the South West and Forcados line that passes from Delta State to the South West. When you get to pipelines, most of them are ruptured and attacked fairly frequently. Between June 2014 and June 2015, NNPC recorded between 3400 to 4000 attacks on the various pipelines in the country [14].

Pipeline Vandelization by militants

Secondly, the issue of purchasing gas from the oil and gas companies to ensure adequate delivery of gas to fire the thermal plants is another problem due to the price at which natural gas is sold to the electricity generating companies, Gen-Cos. For instance, in December 2014, the price of natural gas for power plant was raised to $2.5 per 1000 standard cubic feet. This was done in order to address the huge debts owed the gas firms by companies in the power sector, thus increasing the price of electricity which led to high cost of doing business and resulted to massive job losses.



Increase in gas price

Again is the issue of industrial action (strike) by oil and gas workers. In late May/early June 2015, because of the strike embarked upon by NUPENG/PENGASSAN, the gas supply to the thermal power stations were shut off, the quantity of power available from the National Grid dropped from around 3500MW(after privatization) to a remarkable low of less than 1000MW [2]. About 20 out of 23 major power stations in Nigeria, putting electricity into the National Grid are fired by natural gas. Thus, the supply of electricity to consumers is highly dependent on the delivery of natural gas to these stations by the oil and gas companies. The then prevailing fuel scarcity in the country worsened and almost shut down the economy.

NUPENG/PENGASSAN Strike in late May/early June 2015

The implication of this reality is that Nigeria power sector is extremely vulnerable to the availability of gas and adequate gas supply infrastructure; hence there is need for an alternative supply of power.

The Nigerian government has not been able to find permanent solutions that will resolve the problems. The irony of the situation is that, as the abundance of the vast oil and gas reserves are in Nigeria, so also are abundance of renewable energy potentials, but the country still depends on alternatives that are still within the limits of fossil fuels, which are the only source that currently powers the nation economy [13].

Acting out of the papers has become very necessary. Alternative energy sources are at present the only panacea that will 'bail the cat' as seen practiced by many other countries including neighboring Kenya, Ethiopia and South Africa, which the Bloomberg New Energy Finance has confirmed is leading in the renewable energy revolution in Africa, leaving Nigeria, the "Giant of Africa behind." Renewable energy sources are still the best and wonderful option because they are limitless.

THE WAY FORWARD

Renewable energy is also called non-conventional energy that is continuously replenished by natural processes. It is a clean and inexhaustible energy. We will not run out of them as we may do the fossils fuels [15]. Renewable energy resources include: biomass, hydropower, solar, wind, tidal and ocean thermal and geothermal energy. Renewable energy resources in Nigeria is in abundant but have not been fully exploited.

Nigeria should not be lagging behind in towing this viable path that other visionary and proactive nations are towing to save their countries from impending energy cataclysm. Long-term investments in renewable energies like biomass, solar and wind have the potentials to contributing significantly to electricity generation. The theoretical framework of the energy policy outlined by the Nigerian government seems promising, but there is a discontinuity, however, between implementation and theory. Table 3 shows the energy policy in Nigeria.

Table 3: Nigeria Energy Policy

EENRGY FORMS	POLICIES
Oil	Increase refining capacity. Endorse exploration looking for more oil reserves. Privatize the oil industry. Derive more economic benefits from the oil reserves.
Natural gas	Utilize the nation's NG reserves into the energy mix. More gas exploration. Encourage privatization. Eliminate flaring by 2008.
Tar sands	Encourage tar sands exploration driven by the private sector. Extract oil from tar sands.
Coal	The nation will resuscitate the coal industry for export in an environmentally friendly manner
Nuclear	Pursue nuclear as part of the energy mix
Hydropower	Fully harness the hydropower potential (in particular small-scale) through environmentally friendly means and through the private sector. Promoting rural electrification through SHP
Fuel wood	Promote the use of alternative energy sources to fuel-wood De-emphasize fuel-wood as part of the nation's energy mix
Solar	Help develop the capabilities to utilize solar energy
Biomass	Promote biomass as an alternative energy resource
Wind	Help develop capabilities to utilize wind energy
Hydrogen	Help develop local production capacity for hydrogen
Other Renewables	Will remain interested in other emerging energy sources

Source: [16, 17]

Table 4: Renewable Energy Contribution to Electricity Generation (MW)

RESOURCES	SHORT	MEDIUM	LONG
Hydro (large)	1930	5930	48,000
Hydro (small)	100	734	19,000
Solar PV	5	120	500
Solar Thermal	-	1	5
Biomass	-	100	800
Wind	1	20	40
All Renewables	2,036	6,905	68, 345
All Energy Resources	16,000	30, 000	192, 000
% of Renewables	13%	23%	36%

Biomass Energy

Several research institutions [19] and international agencies, such as the ESMAP programme administered by the World Bank [20], rated biomass as one of the cheapest available renewable energy resource for power generation. Using biomass to generate energy has positive environmental implications and creates a great potential to contributing considerably more to the renewable energy sector, particularly when converted to modern energy carriers such as electricity, liquid and gaseous fuels [21]. Producing electricity from biomass is one of the various ways of responding to the challenges of energy crisis in Nigeria. Total biomass potential in Nigeria, consisting of animal, agricultural and wood residues, was estimated to be 1.2 PJ in 1990 [22]. In 2005, research revealed that bio-energy reserves/potential

of Nigeria stood at: Fuel wood 13071,464 hectares, animal waste, 61 million tonnes per year, crop residues, and 83 million tonnes [23].

According to [24], Nigeria has a total of 1,160 constituted forest reserves, covering a total area of 10,752,702 hectares, representing about 10 % of the total land area. Most of the forests in Nigeria are man-made for the purpose of timber exploitation, and in some cases for fuel wood and furniture making industries. Fuel wood is the most widely used domestic renewable energy resource in rural Nigeria and especially by low income groups in the urban areas.

Solar Energy

From the NIMET's info sheet, Nigeria is endowed with an annual daily sunshine that is averagely 6.25 hours, which is ranging between about 3.5 hours at the coastal areas of the northern boundary of the nations and also has an annual average daily solar radiation of about 3.5 KWm2/day in the coastal area which is in the southern part and 7.0 KWm2/ day at the northern boundary [13]. Nigeria receives about 4909.212 kWh of energy from the sun which is equivalent to about 1.082 million tonnes of oil; this is about 4000 times the current crude oil production per day, and also put at about 13 thousand times of daily natural gas production based on energy unit.

Hydro Energy

The total technically exploitable hydropower potential based on the country's river system is conservatively estimated to be about 11,000 MW of which only 19% is currently being tapped or developed [25]. These rivers, waterfalls and streams with high potentials for hydropower, if properly harnessed will lead to decentralized use and provide the most affordable and accessible option to off-grid electricity services especially to the rural communities.

Wind Energy

Wind energy is available at annual average speeds of about 2.0 m/s at the coastal region and 4.0 m/s at the far northern region of the country. With an air density of 1.1 kg/m3, the wind energy intensity perpendicular to the wind direction ranges between 4.4 W/ m2 at the coastal areas and 35.2 W/ m2 at the far northern region [18]. In recent times, numerous studies have been carried out to assess the wind speed characteristics and associated wind energy potentials in different locations in Nigeria. Promising attempts are being made in Sokoto Energy Research Centre (SERC) and Abubakar Tafawa Balewa University, Bauchi, to develop capability for the production of wind energy technologies. Table 4 shows the target for renewable energy contribution to electricity generation in Nigeria by 2025.

CONCLUSION

The Federal Ministries of Environment, Power and the Energy Commission of Nigeria should implement their blueprints of renewable energy policies and technologies. Vast populations of Nigerians are not aware about the environmental impacts and economic benefits of adopting renewable energy. The public awareness of the renewable energy technologies is generally low. Consequently, the Nigerian public does not have

much influence that will compel the government to formulate decisive policies and initiatives that will enhance and promote the application, development, dissemination and diffusion of renewable energy technologies and resources in the Nigerian energy market. The environment will surely benefit from the elimination of fossil fuels, which will also boost most sectors of the economy. This is where it becomes the business of the general public in Nigeria to prod the government to divest to renewable energy to better the socio economic lives of the citizens and enhance the economy of the nation.

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