

Past and Contemporary Issues of Power and Electricity Supply in Nigeria: Implications for Sustainable Community and National Development

Kofo A. ADEROGBA

kofoaderogba@yahoo.com

+234 803 312 5490

Department of Adult Education

College of Specialized and Professionalized Education

Tai Solarin University of Education, Ijagun, Ijebu-Ode

Abstract

After over \$20 billion dollars of spending in about two decades, Nigeria remains embarrassingly stagnated with only about 5,000 MW of power generation capacity. Nigerians have become so critical of the governments. The objective of this work is to identify the contemporary challenges and make recommendations for sustainable energy and power for sustainable growth and development. The sector is bedeviled with a number of challenges: Security of gas transportation and sabotage; time lag for completion of large projects; sabotage of generation, distribution and transmission equipment coupled with intractable labour crisis; and government policies, programmes and political will. There is multiplicity of potential for energy mix that can be explored and harnessed to improve the energy sources: Natural gas, hydro, coal, wind, solar and bio. It is suggested that any solution that will be long lasting and sustainable must, of necessity, address: the unalloyed political will in the political party and the governance; inclusion of a portfolio of short term projects that will deliver tangible results in a timely manner; resolution of satisfactory and equitable concerns of all stakeholders in the sector; adoption of strategies that will effectively mitigate all forms of sabotage; creation of a platform for system-wide infrastructure development in ancillary sectors; harnessing energy mix as the immediate environment can provide and support; and direct facilitation of economic multiplier effects and job creation. There must be education of members of the public, Genco and Disco staff on the ethics of the job, and safety and security in the industry.

Keywords: Electricity and power, sabotage, energy mix, sustainability, community development

Introduction

The historical development of electricity and power has come a long way (Aderogba, 2016; Awosope, 2014). But the power sector has acquired a reputation as the graveyard for performers, and it is littered with the tattered remains of the résumés of some of the best minds of the country (Fabiya, 2016; Chioma, 2014): Bola Ige, a Senior Advocate of Nigeria and an accomplished lawyer and politician, struggled to get a grasp of the sector but eventually, he got assassinated. Bart Nnaji, a highly-respected academia with private sector experience in the energy sector was bogged down in the miasma swamps of the power sector. Raji Babatunde Fashola another Senior Advocate of Nigeria and one-time governor of Lagos State in Nigeria is the latest accomplished performer that Nigerians have sent to the power sector. With very rich credentials: He was governor of Lagos state, and in that capacity raked up some relevant experiences managing the Lekki-Epe Expressway Toll Road Project and midwife many state supported power sector projects. He recently apologized to Nigerians, on behalf of the central government of Nigeria for the slow pace of progress; and the government has publicly acknowledged that the sector and the government are bedeviled by the seemingly intractable challenges in the Nigerian power sector (Fabiya, 2016).

According to Fabiya (2016), after over \$20 billion dollars of spending in about two decades, Nigeria remains embarrassingly stagnated with only about 5,000 MW of power generation capacity. Nigerians have become so critical of the governments.

The ever-increasing demand and meager supply of energy has been a great challenge to development (Agbamuche-Mbu, 2014; Aderogba, 2015 and 2016; Fabiya, 2016). State governments, organizations and individuals have been making efforts to boost, supplement and/or complement the efforts of the national government.

Each organization that has to do with electricity for their inputs, outputs and/or processes have been generating power through standby generators of various sizes, capacities and makes. The oil and gas companies (Shell Petroleum Development Company, Chevron Nigeria Ltd, Agip Group of Companies, Nigerian National Petroleum Corporation and its subsidiaries and others), banks and insurance

brokers, telecommunication companies, government secretariats and their parastatals, Non-Governmental Organizations, clubs, hotels and brothels, recreation centers and others are in this group. Their contributions over space and time have been commendable (Kolawole, Rahaman, Bello, and Komolafe, 2008; Ogunmade, 2008; Tanimu 2009; Aderogba 2015). In Jos, the Plateau State capital, there is a firm that has solely championed uninterrupted power supply over the years. The following multinationals and the National Companies are also known for supplying and servicing standby electricity generating plants and spare parts: SCOA Power Limited, Leventis Power System Limited, Mantrac Nig. Limited, John Holt Plc, R.T. Briscoe Nigeria Plc, Mikano International Limited, Jubaili Brothers Engineering Limited, Marapco Generators, Plangeria, and Estendo Generators Limited, among others.

The generators provided and sold to different sectors of the economy and social lives are of various capacities ranging from 600 WAX to 10,000 KVA. This is the hub of the nation's economy because they have become interveners by establishing companies that sell and service generators, solar energy packs, inverters, electricity automations, electricity generators and other energy related products as well as power stabilizing equipment. These sources of contribution have prevented the total collapse of the energy sector. Some of them deliver with various contract agreements and the patronage is high.

Table 1: The Independent Power Projects (IPPs) in Nigeria by State, Location, Installed/Licensed Capacity (MW) and Feed Stock

State	Power Plant/Station	Location	Installed/Licensed Capacity (MW)	Feed Stock
Edo	Azura Power Plant	Benin City	459	Gas
Ogun	Western Tech. & Energy Services Ltd.	Shagamu	1,000	Gas
	Magboro Power Plant/Bresson A.S. Nigeria Ltd.	Magboro	9 0	Gas
	Agbara Shoreline Power Ltd.	Agboro	100	Gas
	Paras Energy & Natural Resources Development Ltd.	Ogijo	9 6	Gas
	Westcom Tech & Energy Services Ltd.	Shagamu	1,000	Gas
	Farm Electric Supply Ltd.	Ota	150	Gas
	Hudson Power Ltd	Warawa	150	Gas
	Ibafo Power Station Ltd.	Ibafo	200	Gas
Lagos	AES Barger Power Plant	Egbin	270	Gas
	Anita Energy Ltd.	Agbara	9 0	Gas
	MBH Power Ltd.	Ikorodu	300	Gas
	Energy Company of Nigeria (NEGRIS)	Ikorodu	140	Gas
Anambra	Century Power Generation Ltd	Okila	498	Gas
Akwa Ibom	Ibom Power Ltd	Ikot Abasi	190	Gas
Gombe	Mabon Ltd	Dadinkowa	3 9	Hydro
Kogi	Itobe Power Plant (Zuma Energy Ltd)	Itobe	1,200	Coal
	Knox J & L Energy Solution Ltd	Ajaokuta	1,000	Gas
	D & L Power Plc	Obajana	135	Gas
Plateau	JBS Wind Power Ltd	Maranban Peshit, Mangu	100	Wind
Enugu	Minaj Holding Ltd	Adu-Amorji	115	Coal
Cross River	Fortune Electric Power Company Ltd	Odukpani	500	Gas
Abia	Aba IPP	Aba	141	Gas
	Supertech Ltd	Akwete	1,000	Gas
Rivers	Eleme Petrochemicals Coy. Ltd Eleme Complex	Port-Harcourt	135	Gas
	Notore Power Ltd	Onne	5 0	Gas
Delta	Okpai Power Plant/Nigeria Agip Oil Company	Opai	480	Gas
	Delta Electric Power Ltd	Etiophe	116	Gas
	Ethiope Energy Ltd	Sapele	2,800	Gas
National	Total		12,544	Mostly Gas

Source: Nigeria Electricity Regulatory Commission, Abuja; and National Integrated Power Project (NIPP) (2014). *A Report of the NIPP on Power Sector Reform Act*, Abuja: The Presidency, Federal Republic of Nigeria

Table 1 shows the current Independent Power Projects (IPPs) in the country by states, location, installed/licensed capacity and feed stock. Feed stock is mainly gas. Apart from Gombe (Mabon Ltd at Dadinkowa of 39 MW with hydro feed stock) and Plateau (JBS Wind Power Ltd at Maranban Peshit, Mangu, 100 MW, with wind as feed stock), there is none of the states of the north that has any remarkable effort. They are concentrated in the states of the south and the total installed/licensed capacity is about 12,544 MW only.

At individual residences, workshops, business centers, churches, mosques and communities, there are electricity generating plants. Again, they are of various sizes (capacities), shapes and makes. The capacity depends on the business and sizes of equipment and tools to be motorized and the individual capabilities too. While some of these are supplied by the multinational and national companies, the others are obtained from markets and retail shops. They are plentiful on the road sides. There is a miniature of less than 0.65 KVA, popularly known and referred to as *I better pass my neighbor*. The first two categories are mainly diesel engines, but the last group are of petrol and diesel engines. Invariably therefore, there is virtually no urban household nor serious business without an electricity generating plant, that is, irrespective of capacity. Despite these, the supply is inadequate, epileptic and costly (Ogunmade, 2008; Agbamuche-Mbu, 2014; Aderogba, 2016; Fabiyi, 2016).

As of December 2013, the total installed or nameplate capacity (maximum capacity) of the power plants was 6,953 MW. Available capacity was 4,598 MW. Actual average generation was 3,800 MW. As of December 2014, the total installed capacity of the power plants was 7,445 MW. Available capacity was 4,949 MW, actual average generation was less than 3,900 MW. The Presidential Task Force on Power peak demand forecast was 12,800 MW (Federal Republic of Nigeria, 2013). The problems probably stem from political will, quantity, quality, the system, costs, policies and programmes. This situation is becoming critical, with increasing population not balanced by an adequate energy development programme. The incessant power failure has grossly affected the economy, seriously slowing down development in rural and sub-rural settlements, with present “poverty of the sector” (Toure, 2015).

Ugbabe (2014:11) believes “the country is bedeviled with unstable electricity, the deafening sound of individually owned petrol and diesel generators in most residential, commercial and industrial premises in urban areas has become the norm. Citizens spend their savings to buy expensive petrol and diesel fuel to power their individually owned generators, pollution is the order of the day as fumes are uncontrollably released into the air for the citizens to inhale at their own peril.” “The rural dwellers have accepted their faith of no hope to public grid electricity supply, they survive by lighting their nights with kerosene lanterns, candles, and wood” (Sambo, 2011:10). Everyone seems to be frustrated with the lack of power and failed promises by governments.

By and large, there must be energy and power for sustainability of individuals, businesses, communities, and national growth and development. The objective of this work is to identify and reiterate the contemporary challenges and identify sustainable sources/alternatives for sustainable electricity for sustainable growth and development in Nigeria.

Objectives

Specifically, the work:

1. Identified and reiterated the contemporary challenges in the electricity and power sector in Nigeria; and
2. Identified and justify sustainable sources/alternatives for sustainable electricity for sustainable growth and development of every other sector in Nigeria.

Research Questions

- i. What are the contemporary challenges in the electricity sector in Nigeria? and
- ii. What are sustainable alternatives for sustainable electricity for sustainable growth and development of every other sector in Nigeria?

Materials

The Federal Republic of Nigeria: It is commonly referred to as Nigeria. It is a federal republic in West Africa, bordering Republic of Benin in the

west, Chad and Cameroon in the north-east and east respectively, and Republic of Niger in the north. Its coast in the south lies on the Gulf of Guinea in the Atlantic Ocean. It comprises 36 states and the Federal Capital Territory, Abuja. The country is officially a democratic secular country. It has been home to many kingdoms and tribal states over the millennia (Falola and Paddock, 2012). According to them, modern state originated from British colonial rule beginning in the 19th century, and took its present territorial shape with the merging of the Southern and Northern Nigeria Protectorates in 1914. The British set up administrative and legal structures whilst practicing indirect rule through traditional chiefdoms. Nigeria became a formally independent federation in 1960. It experienced a civil war between 1967 and 1970. It thereafter alternated between democratically elected civilian governments and military dictatorships until it achieved a stable democracy in 1999. The nation is often referred to as the “Giant of Africa”, owing to its large population and economy. With approximately 186 million inhabitants, the country is the most populous in Africa and the seventh most populous country in the world (Shillington, 2005; Falola and Paddock, 2012). It has the third-largest youth population, after India and China, with more than 90 million of its population under age 18. The country is viewed as a multinational state as it is inhabited by over 500 ethnic groups, of which the three largest are the Hausa, Igbo and Yoruba; these ethnic groups speaking over 500 different languages with variety of cultures (Gordon, 2013).

As of 2015^[update], Nigeria is the world’s 20th largest economy, worth more than \$500 billion and \$1 trillion in terms of nominal GDP and purchasing power parity respectively. It overtook South Africa to become Africa’s largest economy in 2014. The 2013 debt-to-GDP ratio was 11 percent. The nation is listed among the “Next Eleven” economies set to become among the biggest in the world. It is a founding member of the African Union and a member of many other international organizations, including the United Nations, the Commonwealth of Nations and Organization of Petroleum Exporting Countries (OPEC). The country has been embracing industrialisation. It currently has an indigenous vehicle manufacturing company, and few Electronic

manufacturers like Zinox, the first Branded Nigerian Computer and Electronic gadgets (like tablet PCs) manufacturers. Ogun State is the current Nigeria's industrial hub, followed by Lagos State. It has a wide array of underexploited mineral resources which include natural gas, coal, bauxite, tantalite, gold, tin, iron ore, limestone, niobium, lead and zinc (Falola and Paddock, 2012). Despite huge deposits of these natural resources, the mining industry in Nigeria is still in its infancy.

Methodology

Secondary sources of data and information were largely used: Federal Government Departments and Ministries (Energy, Power, and Water Resources, Abuja), and four Power Stations across the country were visited and they provided useful data and information. The officials of the Federal Ministries (and Departments), and the power stations also made useful suggestions for sustainable power and electricity. Similarly, five electricity Generating Companies (GENCOs) and five Distribution Companies (DISCOs) were visited. The offices and the top echelon of the officers provided data and information used. Newspaper cuttings were massively used. The researcher has been resident in different parts of the country (northern, eastern and western parts) for over three decades. Her experiences of the energy and power sector in the country were brought to bear. Plates, tables and content analysis were used for data analysis and presentation.

Results

Contemporary Challenges in the Sector: The power sector is bedeviled with series of challenges: Man, materials, method and machines. Namely: Security of gas transportation and sabotage; time lag for completion of large (100-1,000 MW and above) projects; sabotage of generation, distribution and transmission equipment; ineptitude of the government and people; and unsustainable government policies, programmes. Sabotage of gas pipelines, generation, transmission and distribution equipment coupled with rampant intractable labour crisis that occur more frequently than can be imagined. There is no enabling environment for the materialization of grand schemes. The six legacy plants (Afam,

Egbin, Kainji, Sapele, Shiroro, and Ughelli) have an average size of about 1,000 MW each. The average size of the ten planned or commissioned National Integrated Power Projects is about 540 MW only: So meager compared to national requirement.

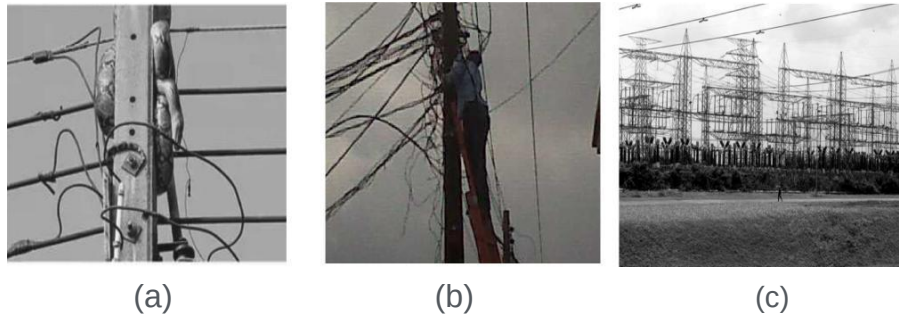


Fig. 1: Unsafe Scenes/Acts: (a) A python found top of electricity pole with power cable as its habitat; (b) A Staff of an electricity company fixing electricity cable at J'imeta, Yola; and (c) An employee walks past electricity pylons carrying high voltage power lines at Egbin energy generation plant in Lagos, Nigeria.

Even at that, Fig. 1 (a), (b) and (c) depict selected aspects of ineptitude in the sector: A python on electricity pole with power cable; a staff of a Disco fixing faults with little or no safety precaution; and an employee of Egbin Energy Generating Plant walking past electricity pylon that is carrying high voltage power. These are heights of unprofessional scenario and practices in the industry.

The Guardian (2009: 16) has this to say regarding the feelings of the private sector, the impact of the epileptic supply on the cost of running businesses, remarkable suffering of businesses and cost of production of goods and services:

... many artisans are out of work.... furniture makers, mechanics, welders, vulcanizers, electronic technicians, traders and tailors can no longer properly transact/run businesses the hub of the nation's economy becomes the intervener by establishment of companies that sell and service

generators, solar energy packs, electricity automation and other energy related products as well as power stabilizing equipment... contributions have prevented the total collapse of the energy sector... There is certainly no greater source of frustration to any individual or institution in Nigeria than irregular electric power supply. Everybody or everything is in one way or the other a victim and at the mercy of the perennial irregular and insufficient power supply that limits income generating opportunities of the informal sector...

leads to increase in the cost of doing business for both informal and formal sectors; it compromises the operations of security agencies and paralyses power-dependent social activities... industrialization, business and commerce have all suffered... worsened by the non-availability and high cost of fuel... to be served in private power generators.....resulted in untimed closure of many enterprises, massive loss of job and unemployment, high cost of finished goods and services and diversion of potential foreign investment to other countries.

Suffice to say that the urban dwellers have been forced to get use to the erratic supply using supply from national grid as standby and their generators as major sources. The rural dwellers have lost hope. They make do with standby generators or nothing. The type and capacity of generator used depend on capability and affluent of the user. Meanwhile, Ogunmade (2008: 22) concludes his own reports that:

Nigerians now grope in utter darkness. Outright power failure has now become norm... The generality... have had to depend on power generating sets to power their houses and offices. And worse than it had ever been... use of charcoal iron to get their clothes pressed. This, in the view of patriotic minds implies that Nigeria has taken several steps backward from the level it attained about three [four] decades ago... to the extent that the President purported to declare state of emergency in the sector.

Over half a century of political independence, the power sector remains an albatross and in the wood. To keep any business going, huge sums of money must be expended on generating electricity (through the standby generators). It cannot support any healthy business. There is no bank, insurance broker or any office outfit that does not have a set that runs for at least twelve to fifteen hours a day. Schools, Laboratories, hospitals and maternity homes and others must run generators for twenty-four hours, seven days; whereas, the nation is endowed with human, material and natural resources to develop this sector to an enviable and sustainable levels (Nigerian Electricity Regulation Commission (NERC), 2014). All over, there are increasing spates of vandalism of facilities and it is “serious threat to the business of provision of power,” (Odeyinka, 2009). Most of the projects appear moribund. Even when all the equipment, tools, materials, machines etc are on ground, most of the projects are not on schedule (Ngozi Okonjo-Iweala Polls (NOIPolls), 2014). There have been series of international, national and regional meetings, workshops, discussions, aids and others but to no avail.

Almost a decade ago, Akparanta (2009) quoting Ijebor (2009:12) assert that Nigerian retrogression can be attributed to lack of planning by successive administration as he says that:

... had Nigerian leaders planned the country's development very well, the current failure in the economy such as dilapidated infrastructure, abandoned projects, power crisis and poor access to education due to high cost would have been avoided... No point in time did the government go into proper planning or ensure proper execution of some of its policies...Nigeria at no point had problems with evolving good policies and programmes. But most of the policies never achieved the set goals because of deviation from the original plans.

Almost 10 years after, there has not been any remarkable improvement (Odiah, 2011; Toure, 2015; Ugbabe, 2014; Joseph, 2014; Aderogba, 2016). With the avalanche of challenges, the centrality of adequate power

supply to families and businesses makes it extremely important that current efforts to revamp the sector should not go wrong again for any reason. With the growing population and increasing domestic, commercial and industrial needs, the time is ripe to act vigilantly and meticulously.

Potential Alternatives and Justification for Sustainable Electricity and Power Supply: There is multiplicity of potential alternatives that can be explored and harnessed to improve the energy sources in the country. Natural gas, hydro, coal, wind, solar and bio, that is, apart from petroleum related sources.

Natural gas: Natural gas is naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulfide or helium (Christopherson, 1997; Awosope, 2014). It is fossil fuel used as a source of energy for heating, cooking, and electricity generation. It is also used as fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals. It is, however, non-renewable. It is in commercial quantity in Borno, Rivers, Edo, Delta, Akwa Ibom and Bayelsa States.

Hydro: Flowing water creates energy that can be captured and turned into electricity called *hydroelectric power* or *hydropower*. The most common type of hydroelectric power plant uses a dam on a river to store water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which in turn activates a generator to produce electricity. But hydroelectric power does not necessarily require a large dam (Fellman, Getis and Malinowski, 2005). Some hydroelectric power plants just use a small canal to channel the river water through a turbine (Gujba, Mulugetta and Azapagic, 2011).

Another type of hydroelectric power plant - called a *pumped storage plant* – also stores power. The power is sent from a power grid into the electric generators. The generators then spin the turbines backward,

which causes the turbines to pump water from a river or lower reservoir to an upper reservoir, where the power is stored (International Energy Agency, 2011). Hydroelectric power generates about 10% of the energy used in the United States of America (Kessides, 1993). According to him, “a small or micro-hydroelectric power system can produce enough electricity for a home, farm, or ranch.” According to Prentice-Hall Inco (1985) complemented by Amayah (2003), the rivers of Nigeria are characterized by v-shaped valleys, rapids and falls, and gorges that make them suitable to dam and generate power for use, each to serve some communities: (1) To the north are Lake Chad, Katsina Ala, Ankwe, Donga, Wase, Taraba, Gurara, Kaduna, Malendo, Sokoto, Yobe, Komadugu Gana, Yama'are, Hadejia, Ngada and Yedseram rivers; (2) To the west are Ogun, Oshun, Ose, Oyan, Ofiki, Ona, Ogunpa, Erinle, Oba and Omi-Osun rivers; (3) to the east and south-south are Escravos, Forcados, Chanomi, Nun, New Calabar, Anambra, Imo, Okwa, Mada, Bonny, Kwa Ibo, Cross River, Anyim, Great Kwa and Akwayafe rivers; and (4) Rivers Niger and Benue - the longest and the most viable for hydroelectric power, that is, in addition to the existing systems on these rivers (Amayah, 2003). This source of energy is cleaner and safer.

Coal: The Minister of Solid Minerals, Kayode Fayemi (2017:4) asserts that “coal is expected to generate 1,000 MW of power by 2020 to supplement other fuels currently used in power generation.” At least two projects have been proposed in Enugu state by Nigerian and Chinese investors (500-1000 MW in size), both of which would require locally-mined coal. Also, the power minister, Babatunde Fashola (2017) has said that coal should form a large part of the country's future electricity mix, because gas alone cannot tackle the decline in power generation. Coal is in commercial quantity in Benue, Enugu, Kogi, Plateau and Zamfara States (Amayah, 2003; Fayemi, 2017). The Nigerian Bulk Electricity Trading (NBET) is working on a suitable tariff for coal-to-power that will form the basis of a Power Purchase Agreement (PPA). Efforts can be intensified for a realization of sustainable power from this source.

Wind: Wind power is the use of air flow through wind turbines to mechanically power generators for electric power. Wind power, as an alternative to burning fossil fuel, is plentiful, renewable, widely distributed, clean, produces no greenhouse emissions during operation, consumes no water, and uses little land space (Christopherson, 1997; Fellman, Getis, Getis, and Malinowski, 2005). The net effect on the environment are far less problematic than those of non-renewable power sources.

Wind farms consist of many individual wind turbines which are connected to the electric power transmission network. Onshore wind is an inexpensive source of electric power, competitive with or in many places cheaper than coal or gas plants. Offshore wind is more steady and stronger than on land, and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energy into the grid or provide electric power to isolated off-grid locations (Christopherson, 1997).

With the development of electric power, wind power found new applications in lighting buildings remote from centrally-generated power. Throughout the 20th century, parallel paths developed small wind stations suitable for farms or residences, and larger utility-scale wind generators that could be connected to electric power grids for remote use of power (World Economic Forum, 2013). Today, wind powered generators operate in sizes ranging between tiny stations for battery charging at isolated residences, up to near-gig watt sized offshore wind farm that provide electric power to national electrical networks.

Even in rocky localities, there are expansive spaces whereby wind turbine could be installed and operated for supply of energy. Relief and drainage may not be any significant challenge.

Solar Energy: Solar energy is radiant light and heat from the sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis (Perlin, 1999). According to him, it is an important source of renewable energy and its technologies are broadly characterized as either passive or active solar depending on how the solar energy is captured and converted into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy.

The large magnitude of solar energy available makes it a highly appealing source of electricity. The United Nations Development Programme in its 2000 World Energy Assessment found that the annual potential of solar energy was 1,575-49,837 exajoules (EJ). This is several times larger than the total world energy consumption, which was 559.8 EJ in 2012 (Wallace, 2015; World Economic Forum, 2013).

The International Energy Agency (2011) said that “the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits.” It will increase energy security of the community through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating global warming, and keep fossil fuel prices lower than otherwise.

Many industrialized nations have installed significant solar power capacity into their grids to supplement or provide an alternative to conventional energy sources while an increasing number of less developed nations have turned to solar to reduce dependence on expensive fuels oil. Long distance transmission allows remote renewable energy resources to displace fossil fuel consumption. Solar power plants use one of two technologies (Perlin, 1999; Mills, 2004). Discussion of these is beyond the scope of this work. But, Nigeria has advantage of being in the tropics with huge amount of insolation all year round.

Bio Fuel: Bio Fuel is the generic name for some renewable energy sourced from raw material or waste products. The most popular types of Bio fuel are Ethanol, Bio diesel and Biomass (Perlin, 1999). It is derived from palm oil, vegetable oil, groundnut oil, canola oil and several other types of oil. It can be blended with regular diesel or used 100 percent on any vehicle or diesel engines. It is also obtained from other biological materials and sources such as trees, grasses, plants and others. It can be used in solid, liquid or gaseous states. Organic wastes from municipalities and industries can be used to produce biomass (International Energy Agency, 2011).

According to the energy agency, the global clamour for Renewable Energy is based on two strategic issues: (1) Global Warming; and (2)

increase in the price of crude oil occasioned by diminishing sources and high demand. Sugar cane, cassava and a good number of agricultural produce are readily available, that is, in addition to massive agricultural and municipality waste. It may be a beginning to sustainable management behaviour for waste: Waste to wealth; and waste to energy.

Conclusion

The nation has come a long way in the tortious journey of procuring electricity for use in every sector. Production and services are unnecessarily taken so much of the resources of the nation, yet no satisfactory level of accomplishment is achieved. There are unnecessary and avoidable challenges forestalling sustainable electricity in all the nooks and cranny and for every use in both urban and rural settings. There must be satisfactory electricity and power; and there should be no excuse for “national darkness” any longer - enough of rhetoric. With the spate of development, demands and expectations of the citizens, the nation should aspire to have not less than 25,000 MW before 2020 and 40,000 MW before 2040.

The current government of All Progressive Party (APC) has less than two years to demonstrate that it can deliver on its promises. If its plans for increasing power for sustainable development from the current level of just about 5,000 MW are based on large scale power projects, then it is almost certain that those accolades will not be realized in this dispensation.

Any solution that will provide long lasting and sustainable must, of necessity, address the following:

- (a) Unalloyed political will in the political party and the governance;
- (b) Inclusion of a portfolio of short term projects that will deliver tangible results in a timely manner of less than a year;
- (c) Resolution of satisfactory and equitable concerns of all stakeholders in the sector;
- (d) Devise of strategies that will effectively mitigate all forms of sabotage;
- (e) Creation of a platform for system-wide infrastructure development in ancillary sectors like transportation;

- (f) Harnessing energy mix as the immediate environment can provide and support; and
- (g) Direct facilitation of economic multiplier effects and job creation.

Specifically, to make a headway in developing a virile and robust power sector, there must be holistic power sector plan that must include the three levels of government, organized Labour Unions, particularly PENGASSAN, NUPENG and Major and Independent Oil and Gas Marketers as stakeholders to become investors in the generation companies (GENCOs) and or distribution companies (DISCOs) and as potential enablers of LNG-based fuel diversification strategy. Policies must be put in place that will encourage their unreserved participation in a transformation that might kill their existing businesses but offers them a stake in the new economic reality that will emerge.

The multinational companies supplying and servicing standby electricity generating plant and spare parts to the country, namely, SCOA Power Limited, Leventis Power System Limited, Mantrac Nig. Limited, John Holt Plc, R.T. Briscoe Nigeria Plc, Mikano International Limited, Jubaili Brothers Engineering Limited, Marapco Generators, Zintec Generator Nigeria Limited, Plangeria, and Estendo Generators Limited; among others, should be part of the scheme.

The solutions to the numerous problems confronting power generation should include, among others, full deregulation from the existing facilities and amenities, energy mix, structured maintenance, adequate funding, and power sharing with neighbouring countries. Other measures that should be taken in resolving the crisis should include provision of community and military security to prevent vandalism of oil, gas and electrical equipment and cables. In addition:

- The NERC must ensure that the DISCOs fulfill their obligation to customers and make the necessary investment needed to improve their capacity to reduce the load on already existing equipment. The consumer rights must be protected always. The NERC must also ensure that the DISCOs respond more efficiently to applications for electricity connection.

- There is a need to improve the energy mix and encourage investments in renewable, nuclear and other technologies to boost electricity generation across the country.
- At least, 20 - 25% of the national annual budget should be set aside to take care of power generation expansion programme for the next twenty-five years.
- The process of reform and liberalization of the current capacity-deficient electricity power sector should include the following key elements: mandating operators to operate according to commercial principles, introduction of competition, restructuring of the existing supply chain to enable full liberalisation, development of economic regulation that is independent of government and industry, and restricting the roles of government to policy formulation and execution.
- Electricity generating plants should be installed in areas where there is less need for transmission. To boost the reliability and economy of electricity supply, there must be constant investment in transmission lines to meet the growing demand.
- Tax discounts and low interest loans can be offered to support small renewable energy GENCOs to boost the industry.
- Renewable energy plants can be recognized as very important infrastructure for remote areas with no connection to the national grid as they can easily be deployed with the right policies in place. For instance, Solar Photovoltaics (PV) can be promoted in rural areas by giving subsidies or making credit facilities available to residents.
- A critical look must be taken at the regulatory aspect of gas production and delivery with a separation of the regulatory, licensing and policy environments of petroleum and gas.

- The need to promote investment and private participation in the development of gas facilities is imperative to boost the sector. Private investors should be encouraged to invest by the prospect of high profitability, and government can support this by making and supporting policies to restructure the industry, and by the introduction of incentives such as incentive pricing and tax credits. The government could also consider absolute deregulation of the gas market so that a free market determines the price of gas.
- The World Bank zero routine flaring by 2030 submit must be accepted and adopted; gas should be refined and directed to electricity generating plants; and the unutilized natural gas must be re-injected back to the ground for future use.
- Effective strategies must be developed to tackle pipeline vandalism. The government must empower security agencies with the tools, training and encouragement to fight vandalism effectively, and there should be stiffer penalties for pipeline vandalism. The Nigerian National Petroleum Corporation (NNPC) and the gas companies must employ state-of-the-earth technology in the surveillance of the pipelines.
- More importantly, all employees of the industry must be adequately educated and trained to safe guard against unsafe acts in the industry.

Recommendations

- ☐ The problem of gas flaring needs to be addressed more earnestly.
- ☐ Other infrastructures and sectors such as public water supply, the circumstances of Nigerian Telecommunication Limited (NITEL) that has been consigned to the past, the railways and the Nigerian Railway Corporation; the national carrier, Steel Rolling Mills, and the textile mills should be revisited.

- The education sector and the standard of education which remain albatross to functional and sustainable growth and development of the nation should also be seriously considered.
- There must be a reengineering of these sectors for sustainability, growth and development of the nation.
- Education and training of the employees on safe acts in the power sector must be of the state-of-the-earth.

References

- Aderogba, K.A. (2015). Inadequacy and Dysfunctional Infrastructure for Sustainable Growth and Development in Nigeria: Paucity of Power Supply and Panacea for Sustainable Development, *Sokoto Journal of the Social Sciences (Formerly Journal of Social Science and Administration)*, 5 (1): 3-25.
- Aderogba, K.A. (2016). Magnitude of Poor and Scanty Electricity Supply in Nigeria and Selected Guidelines for Sustainable Development, Paper Presented at the World Conference on Adult Education on *Repositioning Adult Education for Greater Relevance in a Globalized World*, University of Ibadan Conference Center, 8th-12th August.
- Agbamuche-Mbu, M. (2014). When Will the Lights Stay On? *ThisDay*, Abuja: ThisDay Newspapers Limited. 19 (6853),: 3.
- Akparanta, M. (2009) Why Nigeria's Growth is Stunted. *The Guardian: Conscience Nurtured By Truth*. 16 (1068); 5.
- Amayah, P. (2003). *Regional Geography of Nigeria at a Glance* Lagos: Palamaja Publications.
- Awosope, C.A. (2014). Nigeria Electricity Industry: Issues, Challenges and Solutions 38th Public Lecture Series, Covenant University, Vol. 3 (2), (October).
- Chioma, Gabriel (2014). Electricity: The Power to Zero Transformation, *Vanguard Newspaper: Towards a Better Life for the People*, Vol. 25 (62212): 16.
- Christopherson, R.W. (1997). *Geosystems: An Introduction to Physical Geography*. London: Prentice-Hall International. (Third Edition); pp 240 – 259.

- Encyclopedia Britannica (2004). *A World of Knowledge at Your Fingertips*. Encyclopedia Britannica. Bristol. (Deluxe Edition).
- Fabiyi, M. (2016). Three Challenges and Three Solutions Needed to Transform the Power Sector, *Falola, T. and Heaton, M.M. (2008). A History of Nigeria*. Cambridge: Cambridge University Press. p. 23.
- Falola, T. and Paddock, A. (2012). *Environment and Economics in Nigeria*. New York: Routledge. p. 78.
- Fayemi, Kayode (2017). Ministerial briefing on the Activities of the Ministry of Mines and Steel, Abuja: Federal Ministry of Mine and Steel.
- Federal Republic of Nigeria (2005). *Electricity Power Sector Reform Act*, Federal Republic of Nigeria Official Gazette Number 77, Vol. 92, (8th August) Government Notice Number 150, Lagos: Federal Government Press.
- Federal Republic of Nigeria (2013). Ministerial Key Note Address at the Retreat Titled Gas to Power Brainstorm Retreat. Transcorp Hilton Hotel Abuja. (October).
- Fellman, J.D., Getis, A., Getis, J. and Malinowski, J.E. (2005). *Human Geography: Landscape of Human Activities*. Boston: McGraw Hill Higher Education (Eighth Edition), pp. 397-400.
- Gordon, A.A. (2003). Nigeria's Diverse Peoples: A Reference Sourcebook. Santa Barbara: ABC-CLIO. pp. 44–54.
- Gujba, H., Mulugetta, Y. and Azapagic, A. (2011). *Power Generation Scenarios for Nigeria: An Environmental and Cost Assessment*, New York: Elsevier.
- International Energy Agency (2011). *World Energy Outlook, 2011*, Paris Cedex: WEO Publications, International Energy Agency.
- John, P.B. (1994). *Electricity at the Columbia Exposition*. Columbia: R.R. Donnelley 4 Sons Company; p. 1.
- Kaseke, N., Hosking, S. (2013). Sub-Saharan Africa Electricity Supply Inadequacy: Implications. *Eastern Africa Social Science Research Review* 29(2): 113-132.
- Kay, C. (2016). Challenges Facing the Nigerian Power Sector, Economist, Bloomberg (February).
- Kessides, C. (1993) 'The Contribution of Infrastructure to Economic Development: A Review of Experience and Policy Implications', World Bank Discussion Paper No. 213.

- Kolawole, S., Rahaman, T., Bello, E., and Komolafe K (2008). Not Yet an Applause for Power Holding Company of Nigeria (PHCN): *Thisday* 13 (4885):19.
- Mills, David (2004). *Advances in Solar Thermal Electricity Technology*. *Solar Energy*. 76 (1-3): 19-31.
- National Integrated Power Project (NIPP) (2014). *A Report of the NIPP on Power Sector Reform Act*, Abuja: The Presidency, Federal Republic of Nigeria.
- Ngozi Okonjo-Iweala Polls (NOIPolls) (2014). *Ngozi Okonjo-Iweala Polls for Monitoring Power Supply Situation and Citizen' Complaints*, Abuja: The Presidency, Federal Republic of Nigeria. (December 2013-April 2014).
- Nigerian Electricity Regulation Commission (NERC) (2014). *Fourth Quarter Report of the Electricity Regulation Commission on the Performance of NIPP*, Abuja: The Presidency.
- Odeyinka, B. (2009) "Why Vandalisation of Electricity Cable is a Lucrative Business." *Daily Sun*. 4 (1520): 43.
- Odiah, R. I. (2011). Challenges surrounding power investment in Nigeria: Insights and perspectives from owners and developers, Paper presented at the Summit on Energy and Sustainable Economic Growth, Energy Commission of Nigeria Organized workshop at LadiKwali Hall, Sheraton Hotel and Towers, Abuja, (9-10 March).
- Ogunmade. O. (2008) "Power Supply: The Eclipse of Nigeria." *Thisday* (Wednesday, July 9). 13 (4827): 22.
- Perlin, John (1999). *From Space to Earth (The Story of Solar Electricity)*. Havard, USA: Harvard University Press.
- Prentice-Hall Inco. 9 (1985). *American World Atlas*, New York, United States of America: Prentice-Hall Inco., p. 16.
- Sambo, A. S. (2011). Energy Options for Sustainable Economic Growth in Nigeria: Status, Issues and the Way Forward. Key note Address at the Summit On Energy and Sustainable Economic Growth, Energy Commission of Nigeria Organized workshop at Ladi Kwali Hall, Sheraton Hotel and Towers, Abuja, (9th-10 March).
- Shillington, K. (2005). *Encyclopedia of African History*. Michigan: Michigan University Press. p. 1401.

- Tanimu, Yakubu (2009) Yar'adua 7 Point Agenda and Vision 2020: Political Slogan or Economic Growth Mechanism, *Daily Sun* (Tuesday, April 7). 4 (1513): 26.
- The Guardian (2009) Special Report on Power Generation, Distribution, and Electricity Automation Equipment. *The Guardian: Conscience Nurtured by Truth* 26 (11079): 16.
- Toure, B. (2015). *Bribes, Debts, \$1000 Billion Lost: Nigeria Can't Keep the Power On*, Abuja: International Festival for Business (Abuja Edition).
- Ugbabe, A. (2014). Poor Planning Slowed Down NIPP. *ThisDay*, Abuja: ThisDay Newspapers Limited. 19 (6853): 11.
- Wallace, P. (2015). *Nigeria Gets World Bank Guarantee for 450 Megawatts power plant*. *Bloomberg.com*. Retrieved 24 August 2015.
- World Economic Forum (WCF) (2013). *Relationship between Quality of electricity Supply and Gross Domestic Product (GDP)*, Davos-Klosters, Switzerland: World Economic Forum (WCF) (23-27 January).