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Energy Review and Policy in Nigeria

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Abstract : *Nigeria is rich in terms of energy resources, both renewables and non-renewables, which can provide the country's demand and long awaited ambition for sufficient and reliable electricity to all Nigerians. But unfortunately Nigeria's rate of electricity consumption per capita is among the lowest in Africa. This is associated with ineffective implementation of the energy policy in Nigeria. The objective of this paper is to presents a review of conventional and renewable energy to be used for constant and reliable electricity supply in the country. Conventional and renewable energy resources are discussed, also the current government policies are not left out. The challenges and forthcoming prospects of renewable energy are also discussed. Decentralized option of both conventional and renewable energy resources will enhance the welfare of rural communities and boost Nigeria's energy and economy.*

Keywords: *Nigeria, Energy, Renewable, Economy and Policy.*

I. Introduction

Energy is the back bone for the economic growth and development of all the countries in the world, Nigeria as a country is blessed with sufficient conventional and nonconventional energy sources, on the other hand, Nigeria depend solely on fossil fuel (coal, oil and natural gas) and biomass. Figure 1 shows the consumption of energy source by share in Nigeria. Sustainability is one of the element encouraging the viability of all the energy resources[1],[2]. Sustainable energy has been adopted not only because of the energy security issue, but because of the negative impact on the environmental and socio economic development by the fossil fuel such as the issue of air pollution, climate change and more so global warming. Renewable energy is the solution to all the problem associated with the conventional source of energy, it provide substantial benefit to the climate, health and economy, it is clean, improve public health and environmental quality[3].

The most populated country in Africa is Nigeria, with about 170 million, but comparatively speaking, it has the limited access to electricity.

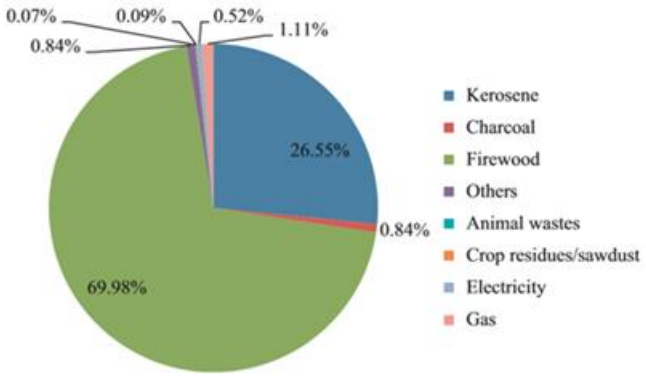


Fig. 1.1: Shares of energy consumption by source in Nigeria[4].

The advance in poverty level, poor economic growth, unemployment and other related issue is as a result of insufficient energy in the country. Energy demand in the country will continue to increase because of the rate at which the population is increasing. The insufficient energy in Nigeria has led large number of people to rely on combustible renewable energy sources notably for domestic cooking and heating.[4].

II. Energy Mix In Nigeria

Nigeria being the most populous nation on the continent is blessed with conventional and nonconventional energy resources, notably hydro (water), solar, wind, tidal and biomass. Being a key member of the

Organization of Petroleum Exporting Countries, Nigeria has a crude oil deposit of 28.5 billion barrels, with an average productivity of about 2.5 million barrels per day, including condensate, associated and no associated gas reserve estimated to be around 166 trillion standard cubic feet (TCF).[5].

2.1 Crude Oil

Crude Oil is the major source of income in Nigeria, it account for about 98% per cent of Nigeria revenue, exploration started in Nigeria with the discovery of oil in 1956 in the Niger Delta south-south region of the country. Nigeria joined the ranks of oil producers in 1958 with 5,100 barrels per day production (bpd). Oil production in Nigeria has rose to about 2.4 million barrels per day (bpd). With over 159 oil fields and 1,481 wells in operation, the country also has a proven oil reserve of 37.2 billion bpd (EIA, 2010). Nigeria has four standing oil refineries run by the Nigerian National Petroleum Company (NNPC) with a production capacity of 445,000 barrels per day corresponding to 22.2 million metric tons per annum (Table 1).[6].

Table 1: Refineries in Nigeria [6].

s/n	Year Commissioned	Capacity (barrels per day)				
		1965	1971	1978	1988	2010
1	Port-Harcourt Refinery I	35,000	60,000	60,000	60,000	60,000
2	Port-Harcourt Refinery II	-	-	-	150,000	150,000
3	Warri Refinery	-	-	100,000	125,000	125,000
4	Kaduna Refinery	-	-	100,000	110,000	110,000
	Total	35,000	60,000	260,000	445,000	445,000

2.2 Natural Gas

The rapid growth of the world population has indeed increased the demand of energy significantly. This increase in demand is supported by the search for environmentally clean source of energy in order to minimize the global challenges which include emission of greenhouse gases[7]. Gas is one of the major energy source in Nigeria, it was discovered in the course of exploration, and rose to a considerable commercial quantity of natural gas. The reserve is spread between associated gas with oil and natural gas. Presently Nigeria has an estimated 256 trillion scf of natural gas reserves, with a proven 120 trillion scf confirmed gas reserves and two billion associated gases, produced daily. In which about 1.75 billion scf gas is flaring every day.[8]. Available statistics of 2004 shows that over 8.5 TCF of natural gas vanished in Nigeria as a result of flaring during that year alone. This capacity of gas correspond to almost 5% of the country's entire confirmed reserves[9]. The much needed demand for foreign exchange can be achieved by developing the gas sector in the country[9].

2.3 Coal

Coal is the oldest source of energy in Nigeria, it was discovered in the lower Niger basin of Nigeria in 1909 at Enugu and exploration begun around 1916. The increased demand for local consumption led to the establishment of it market in some West African countries. A total of 1300 million tones has been estimated out of which, 300 million tones are confirmed recoverable reserves and 1000 million tones are estimated undiscovered reserves. Subsequently, the Nigerian coal reserve has been estimated to have life of 300 years out of the 1000 million tones production rate per annum. Nigerian coal have been tested through various Chemical analysis of different samples and it showed a calorific value of about 22.3 MJ/kg to 28.4 MJ/kg the average value being about 25 MJ/kg. With moisture content of about 3 to 17%, whereas the volatile content can be up to 40%. The ash content fluctuates between 3.9% and 28%, while the fixed carbon content has an average value of about 40%. Best on the above chemical characteristics, the Nigerian coal has been placed in groups A and B of the subbituminous class of the American Society of Testing Materials. Nigerian coal have been to be good as boiler fuel both in the pulverized and non-pulverized forms, and can simply be ignited and burns with a long flame. It has been used successfully as the prime energy source in a coal-fired steam power plant and a large cement factory for about three decades. However, due to the decreasing world demand for coal, other uses for the commodity have been explored. With a high resin and wax content, it is also tested to be good for the manufacture of plastics, tar and synthetic fertilizer.[10],[8].

III. Renewable Energy In Nigeria

The long awaited solution to the crises that engulf power sector in Nigerian can be achieved by using renewable energy as alternative energy source technologies which have great potential to provide solutions to the lingering energy problems being encountered by the developing countries such as Nigeria.[6]. Adopting renewable energy as an alternative source of energy will ensure sustainability in the energy supply and indeed it will improve energy efficiency and also provide solution to the issue of environmental impact. Today

environmental impact has become a major constraint in the economic growth and development.[11].

3.1 Biomass

Biomass comprises of different organic means which include firewood and other related plant-based from industrial waste and agriculture[12]. Environmental pollution is one of the severe problem faced by major cities around the globe. This is as a result of largely used kerosene and burning of firewood which is harmful to the air. The adoption of biofuel such as biodiesel and bioethanol has the potentials to reduce the problem of this harmful environmental condition[13]. The major source of fuel in the rural areas is biomass, roughly 13% of the world's primary energy is obtained from the forest while nearly 1.5 x 109 people in the developing countries such as Nigeria used biomass as their energy source, that is about 90% of the world develop their energy requirement from wood and charcoal. Table 2 shows the estimated quantities of biomass resources in Nigeria[14]. One byproduct of biomass technologies is biogas. Biogas is defined as a combustible mixture of gases produced by micro-organisms when livestock manure and other biological wastes are allowed to ferment in the absence of air in closed containers[15]. Figure 3.1 depict an urban trash in a community of Nigeria.

Figure 3.1: Urban trash[15].

Table 2: Biomass resources and the estimated quantities in Nigeria [16].

Resources	Quantity (Mtonnes)	Energy Value (GJ)
Fuel wood	39.1	531
Agro-waste	11.244	147.7
Saw dust	1.8	31.433
Municipal solid waste	4.075	

Moreover, the increase in population and industrialization in almost all the development countries has cause scarcity in the supply of indigenous firewood that is being used as a fuel. All this is as a result of deforestation carried out in search for timber, pulpwood and firewood. The rate of deforestation in the tropical countries is estimated as 17 million hectares annually.[14]. The slow growth of most indigenous tree in Nigeria has cause the scarcity of forest biomass for timber, wood product and firewood. It has been reported that about 90% per cent of people living in northern parts of Nigeria were affected by critical fuel scarcities in 1980. This can be improve by taking majors on deforestation due to over-exploitation of forest, the concept of growing high-yield hardwood plantations should be adopted[11].

3.2 Solar Energy

Sun is the most vital source of energy. Solar energy is considered as one of most economical in the midst of the renewable sources. The whole system comprises of solar collector and concentrators for collecting solar radiation for the purpose of heating air or water[17]. It supplies the earth with life providing heat, and without a doubt, all fossil sources are derived from the sun. The Sun releases about 3.8 × 1023 kW, amount of energy out of which, almost 1.8 × 1014 kW is being interrupted by the earth[18]. The full energy requirement of the country could be met by adopting solar energy as an alternative if one percent of the accessible solar energy can be tapped at 0.1 percent conversion efficiency[8]. Nigeria is directly situated in the tropics, with its land mass extending in the middle of latitudes 5-degrees south and 15-degrees north of the equator. As such, the country enjoys sufficient amounts of sunshine. Statistic has shown that, Nigeria has potential and viability of solar energy source with about 290 days of sunlight annually. The average solar insolation in Nigeria is estimated to fluctuate between 4.0 KWh/m2/day at the southern coasts to 7.0 KWh/m2/day at the northern coasts of the country. The daily average is projected at 5.5 KWh/m2/day. The accessibility of sufficient sunshine is an indication that Nigeria is the best nominee for investment in solar energy resource expansion. Solar power

electricity play a vital role in our rural communities which include, good health care delivery to rural areas and remote villages, community water pumping as shown in figure 3.2 and exposure to modern education and light. Therefore, social infrastructure can be developed using Solar energy resources in Nigeria[15].

Fig. 3.2: Rural and urban solar powered electrification[15].

Although solar energy has its own constraints which has to do with the tapping and effective utilization of solar energy. These consist of the problem of a storage system, which is compulsory, as the solar energy supply at any point on the earth's surface is not continuous. Also the technology adopted for solar energy conversion is at early stages level in the country. As soon as it is fully developed to its potential, solar energy is going to be adopted as an alternative source. Solar energy is clean, non-polluting and could complement the existing energy sources, principally in the rural areas. In these parts it can make considerable contributions to operations such as controlled drying of agricultural products, domestic cooking, water pumping for irrigation and drinking and small scale generation of electricity. Solar electricity is very well suited for the purpose of rural electrification, especially in solar borehole, clinic, schools and vaccine refrigeration. It is also used in street lightening, traffic and road sign lightening [8],[19].

3.3 Hydropower

In hydropower generation, the potential energy and the quantum of water or the flow of water is the source of energy. About one-fifth of the world's power is provided by hydro generation[21]. Putting into consideration the share of energy alternatives in Nigeria, hydropower can be considered as the main source of electric power in the nation [20]. Nigeria has reasonably capable rivers and some limited natural falls that can be used to harness hydroelectric power to its full potential. There are also small rivers and streams within the country, some of which retain minimum discharges all the year round. About 29% of the total electric power produced in Nigeria is from Hydropower. Recently survey conducted showed that there are over 278 unexploited small hydropower (SHP) within the twelve state and four river basin in Nigeria. Conversely, SHP can be built in virtually all parts of the country, with that, Nigeria has enough renewable energy resources to harness. About 282 micro dams have been discovered in Nigeria, in addition to that, there is also a private own company called (NESCO), located in Plateu State. Moreover (8) SHP plans were built which contributed additional 3.7 MW to the power generation. Hydropower technology is the noticeable commercial renewable energy technology in the electricity supply of Nigeria. Large hydropower technology has taken the major share of the entire commercial renewable energy resources for electricity generation. Not like fossil fuel, hydropower is replenishable and can supply uninterrupted power, apart from the water levels issue[22]. Considering the number of rivers which Nigeria has, an estimated 11,000 MW can be added to the present power generation out of which only 19% is being exploited currently[19], which is now being generated at Shiroro, Kanji and Jebba located in Niger state instead of about 30% of gross installed grid-connected electricity generation capacity of Nigeria[22]. Decentralized power plans can be achieved by using the water falls rivers and streams, and with that, accessible and affordable options to off-grid electricity service particularly in the rural areas can be delivered. Large hydropower development project in developing countries such as Nigeria has so many shortcomings, one of which is the issue of huge loans which later give rise to a high external debt levels that is associated with corruption allegation, hydropower plan also cause ecological problem as it require a hilly area to be built and the development is affected by poor rainy season which leads to silting of dams and siltation of dams reduces the amount of power generation over time[19].

3.4 Wind Energy

Wind can be used to generate electric power in different parts of Nigeria if it can be harnessed properly to its full potentials, as one of clean and nonconventional energy source, it can be used to minimize the environmental limitation caused by conventional source of energy [4].

Nigeria has not given much priority to wind energy generation due to lack of awareness in wind energy technology. Right now there is no local supplier or producer of wind energy equipment in Nigeria [3]. Wind

energy is one of the fast growing energy resource in the worlds[23] but reverse is the case in Nigeria, a series of research has been conducted in other to identify the pattern of wind speed in Nigeria, to know the location where wind energy can be harnessed to its full potential. It was discovered that the Northern part of Nigeria has higher wind speed than the southern part as presented in figure 3.3 and table 3[24].

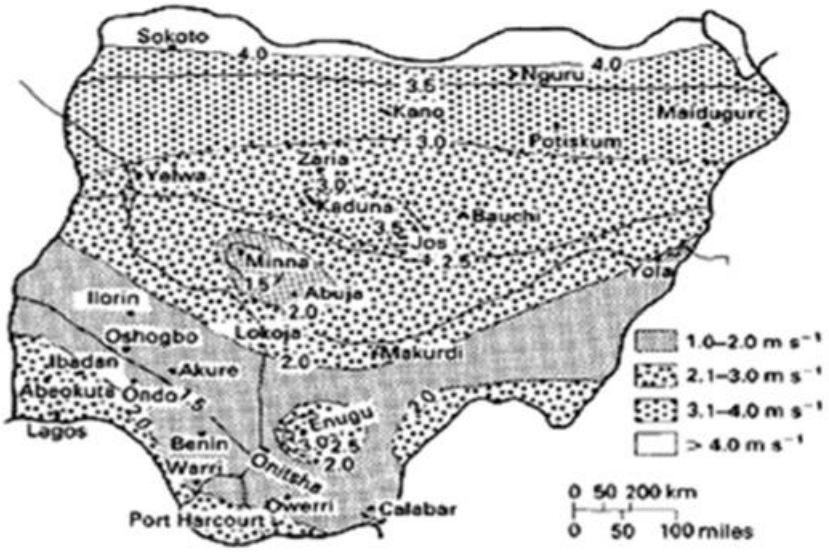


Figure 3.3 : Annual mean wind speed distribution in Nigeria[4].

Table 3: The annual mean wind speed, maximum extractable wind power density, power density and class wind[24].

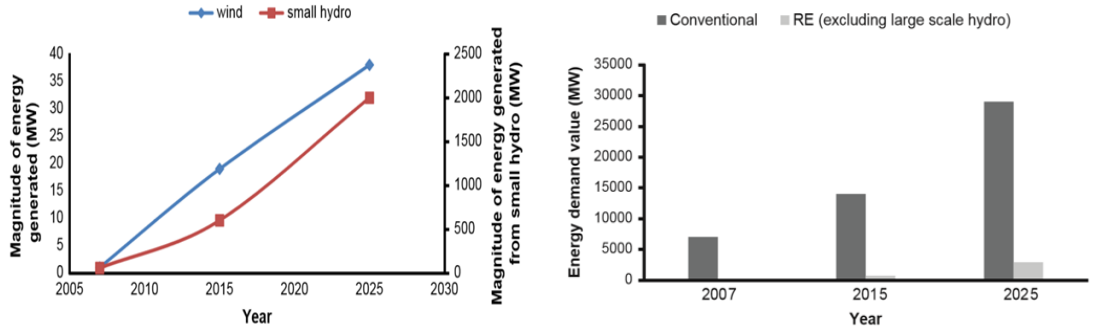
Locations	Mean wind speed (m/s)	Maximum extractable wind power density (W/m^2)	Mean power density (W/m^2)	Wind energy class	Geographical location
Jos	9.47	304.53	519.91	7	North
Kano	9.39	297.43	501.79	7	North
Sokoto	7.21	134.56	229.73	7	North
Gusau	6.18	84.47	144.22	2	North
Enugu	5.73	67.41	115.08	2	South
Minna	5.36	55.12	94.10	1	North
Potiskum	5.24	51.72	88.29	1	North
Maiduguri	5.23	51.18	87.37	1	North
Kaduna	5.13	48.32	82.49	1	North
Ilorin	5.04	46.00	78.53	1	North

IV. Energy Policy in Nigeria

A well design and functional policy will be of immense help in moving towards achieving efficient energy resources utilization in Nigeria and perhaps, the develop countries. A comprehensive Practical and long-term policy-oriented renewable and nonrenewable energy programs should be initiated by the senior decision-makers in both Government and the private sector.[26]. There was no complete energy policy in Nigeria until recently, when the national energy policy in Nigeria was set up by the federal government in 2003. The policy was named the National Energy Policy (NEP) with a broad objective of achieving optimum exploitation of the nation's energy resources; both conventional and nonconventional, for viable growth and with fully involvement of government and the private sectors. Also among NEP's, target include broad crude oil and natural gas exploration and development shall be pursued with the vision to increasing Nigeria's reserves base to the highest possible level; Continue to participate extensively in the improvement of electricity supply to meet 2020 goal by providing reliable electricity to 75% of the population, and to develop alternative technology for generating electricity[22]. A typical example is the innovative energy policy programme by African Energy Policy Research Network (AFREP- REN/FWD), which provided a classical example. The policy programmes should be planned in such a way that it will determine the economic and environmental benefits of both conventional and nonconventional energy know-hows to Nigeria's underprivileged, and also plan a small and medium-term policy creativities that would propagate renewables. The government should understand that energy is driven force in realizing quality education, health, agriculture security [26],[3].

In other to meet the August, 2005 Federal Government's instruction on automotive biofuels, NNPC was directed to create a conducive environment to set up a domestic fuel ethanol industry. The target is to

gradually cut the Nigeria's over dependence on foreign countries for importation of gasoline in other to achieve a biofuel economy. NNPC was in accordance with the policy directed to blend gasoline and diesel that has 10% bioethanol and up to 20% biodiesel, thus forming E10 and B20 blend [3], [27]. In line with the vision 2020, the energy policy extensively focused on meeting energy demand in all sectors of the economy as well as domestic with efficient, safe, clean and convenient energy at an affordable cost. And also in an economically feasible and environmentally sustainable method by fully exploiting renewable and nonrenewable sources. Figure 4.1 shows a demand curve for conventional sources which raised from 7000MW to 29000MW. The predicted constituents of RE are the small scale hydro, solar photovoltaic and solar thermal, biomass and wind as shown in the figure below with an additional increase of 1MW to 38MW and 56MW to 2000MW respectively[28].



(a) (b)

Fig. 4.1: Demand curve for conventional Sources (a), Combined contributions of wind and small hydropower production[28].

V. Conclusion

The fact that the capital for setting up a RE power source is high, can be compensated by its low cost of running and maintenance just like our conventional source of energy and perhaps, safety and environmental problems will be reduced. The federal government should make sure that incentives are put in place for private investors that are ready to invest. The development of small scale hydropower should also be encourage to decentralize the large central power production, this will bring competition among the power supply utilities. Experience has revealed that most of the renewable energy project, particularly the one that can be done at local level require supports only in the preliminary stages, and as time goes on, it will become fiscally sustainable and later the subsidy will be withdrawn gradually. Nigeria has laid down a concrete energy policy and much emphasis has been centered on the development RE and small scale hydro generation (SHP). But still strong implementation approach is required to facilitate speedy integration of RE in the country's energy mix. The present level of awareness on RE technologies is not adequate, government should invest more on various form of energy project throughout the country in other to display the level of performance and efficiency at which services are being delivered. By doing so, the public will become much more aware of RE and its potentials and eventually creates RE energy market. There is also need for the government to set up a viable energy efficiency programmes in other to minimize energy consumption and cost. There is also need to identify and acquire skills for building capacity at established and personnel level for technical, administrative, and decision-making for improved development of renewable energy

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