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Nigeria: Pathway to Potential Renewable Energy Development

*Chukwuemeka H. Aniodoh, Chukwuemeka F. Anyichie
Center for Environmental Management and Control, University of Nigeria Nsukka, Nigeria.Engineering Management, Cyprus International University,Nicosia, North Cyprus, Turkey.
Corresponding Author: Chukwuemeka H. Aniodoh

Abstract: *Nigeria is on the fast track for economic development and growth, but should and can be in a better economic shape than its current state. This is as a result of the enormous cost of production and provision of economic resources which is reliant on the high cost of energy consumption especially in the area of fossil fuel utilization. Evidently, with the world energy focus gradually drifting from the dependence on non-renewable energy sources, to renewable energy sources, due to the diminishing and environmental nature and effects of non-renewable energy sources, it is imperative that Nigeria must plan its energy sector towards significant Renewable Energy (RE) to maintain or continually improve its economic status in the world's future. This paper discusses the country's potential and development so far in Renewable energy. There have been insignificant developments in the renewable energy sector, due to certain hindrances such as technical incapability, cultural limitations, energy policies, and limited funding which in turn has resulted in low availability of resources required for RE development.*

Keywords*: Economic;Fossil Fuels;Renewable; Energy; Potential; Development; Nigeria*

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I. Introduction

Nigeria has relied on fossil fuels over the years for the generation of its revenue despite the fact that the non-oil sector showed a significant contribution to its Gross Domestic Product (GDP) in 2014. The country has the highest GDP and is seen to be the fastest growing economy in Africa, with a population of over 177 million. Its relevance in the oil industry in the world has resulted to its huge revenue accumulation and the dependence of these fossil fuels for the generation of power to boost economic growth. It is not a new knowledge about the correlation between economic growth and energy availability and consumption. The major fossil fuels used in Nigeria today are the crude oil and natural gas, and because of their abundance the country heavily rely on them for economic growth. Unfortunately with the economic status in the oil industry globally, there is an evident negative ripple effect that looms the economy of Nigeria.

Fossil fuels are regarded as non-renewables because they exist in finite quantity andmay not be capable of being replenished or have a very slow replenishing nature. At the end of 2014, the total global oil reserve was at1,492.9 billion barrels [1] and according to the International Energy Agency (IEA)2014 forecast, production and consumption of crude oil would be at 35.4 and 35 billion barrels respectively in 2015. In respect to these correlated results and considering the time length for crude oil formation, at hundreds of millions, its non-renewable nature is further stressed.

Mostdeveloped countries have prognosticated these effects and are expanding their energy mix by embarking on more reliable and cheap alternative sources of energy with major focus on Renewable Energy (RE)[2]. It would be a matter of time for Nigeria to realize that the quest for such alternative source should have started years ago in order to avoid the looming economic illness accompanied with fossil fuel activities or reliance.This paper tries to provide a path which should lead to the development and deployment of Renewable Energy in Nigeria with respect to its vast potential for RE sources and the predicted damaging economic effect of the dependence on fossil fuels.

Nigeria is located within the tropical region of the world accompanied with tropical climate which makes it a pool of renewable energy raw materials. The major sources of renewable energy in Nigeria are hydro, solar, wind and biomass. Other RE provenances such as geothermal, ocean and wave; have scant potential but have zero degree of development in the country. The level or degree of potential and the development of these RE sources would be discussed in this paper. We will also highlight and discussinitiatives that have been undergone and possible challenges limiting RE development and deployment in the country.

II. Nigeria's Economic Status

Nigeria can be referred to as an emerging economy or market, with expanding sectors such as communications, entertainment, technology, financial, and services sectors. It ranks 21st in the world in terms of economic size and the fastest growing and ginormous economy in Africa[3]. It is also one of the two African countries among the 3G (Global Growth Generating) countries with a population of over 177 million people driving income and economic growth. Despite the recent trend of security unrest and poor accountability and management of resources,Nigeria has, through strict economic reforms, strived furthereconomically, recording a GDP of $568.5billion USD in 2014, from $369.1billion USD in 2010 [4]. This is a significant indicator of economic progress, with gratitude to its capabilities in oil production and exportation,and its growing non-oil sectors. Nigeria currently, is the 13th richest crude oil producing country in the world, with production of over 2million barrels per day (bpd)[5].

III. Fossil Fuel Implication In Nigeria

There is a particular trend that is observed in rich oil producing or consuming countries, which of course is the rate of economic growth in such areas. Energy is the ability to get work done, so without energy human activities such as cooking, transportation, nutrition, manufacturing etc. cannot be performed. Human activities drive economic growth as we have come to understand from the concept of GDP, thus it's simple to understand that human activities are carried out with energy which in turn drives economic growth. The higher the availability of the energy source or fossil fuel in most cases, the higher the potential for economic growth as shown in Fig. 1[6]. Since the early days fossil fuels have been the greatest source of energy,especially crude oil, natural gas and coal though its application today has expanded. The major types of fossil fuels produced in Nigeria are the crude oil and natural gas, which are both mainly used for power generation to perform economic activities.

3.1 Crude oil and natural gas utilisation

Nigeria produces over 2 million bpd of oil and is reported to have a reserve of about 37 billion barrels, making it the largest producer in Africa and the second largest reserve in the continent, after Libya. The country has an estimated 180 trillion cubic feet (Tcf) of proven natural gas reserve as at January 2015 [7] ranking it the 9th largest natural gas reserve in the world and largest in Africa. An estimated 1.35 Tcf of dry natural gas was produced in 2013 [8], ranking the country among the top 30 largest producers in the world. Therefore, in view of these potentials, the economic use of these fossil fuels becomes relatively dominant in the country as evident in its current activities.

The major use of crude oil in Nigeria is probably revenue generation, as it accounts for close to 90% of exports androughly 75% of itsintegrated budgetaryrevenues [9], foreign exchange and production of petrochemicals, which is unfortunately insignificant in reference to its refining capacity. Gas consumption for domestic and industrial use is a primary objective of Nigeria's petroleum and energy policies.Natural gas is mainly used for power production, evident in gas plants providing 81% of the total electricity supply, domestic cooking and heating fuel [10].

3.2 Economic implications

Nigeria's generation capacity was 6,090 megawatts(MW)in 2012, of which 65%came was from fossil fuelsources[7]. This indicates Nigeria's reliance on fossil fuel for power generation to foster economic growth. Irrespective of the

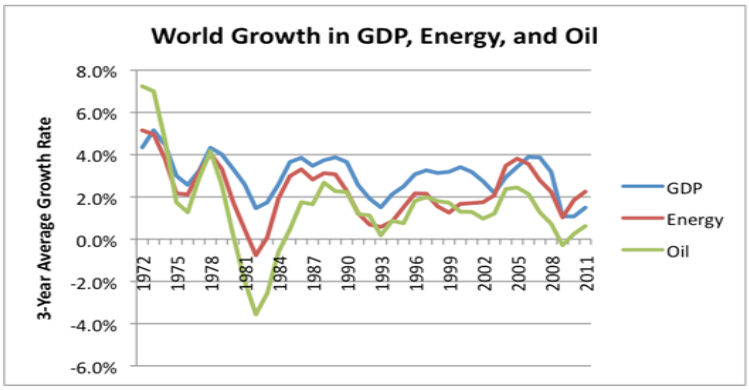

Fig. 1. World growth in energy use, oil use, and GDP (three-year averages). Oil and energy use based on BP's 2012 Statistical Review of World Energy. GDP growth based on USDA Economic Research data[6]. country's fossil fuel potential, it suffers serious economic setback due to lack of resources or infrastructure required

toharness its full potential to meet energy demand. In 2012, crude oil accounted for 14% of the country's GDP, unlike the 28% contribution it had in 2007 [4].

It was observed that in 2014, the non-oil sectorof the economy, which comprises mainly of agriculture,services and industry, recorded its highest contribution to the GDP at over 70%, which indicates that other economic activities are increasing rapidly, coupled with population growth, hence the growing need and demand for energy. Even though production has remained constantly and considerably high, consumption of energy is seen to be very low in the fossil fuel sector, due to poor existence and destruction of infrastructure, lack of petroleum products (since the country has a very low refining capacity), poor rural development, shortages in gas supply and poor power distribution.More than 62% of Nigerians rely on wood burning for domestic energy consumption, which account for over 75% of the country's total energy consumption, and has heavily resulted in deforestation [11]. There has been power supply shortages, resulting in many businesses and manufacturing companies to sort for an alternative source,which have over the yearsbeen petrol anddiesel fuels for powering electric generators. Therefore, increasing their cost of production, which reflects in inflation on prices of goods and services provided to the consumers.

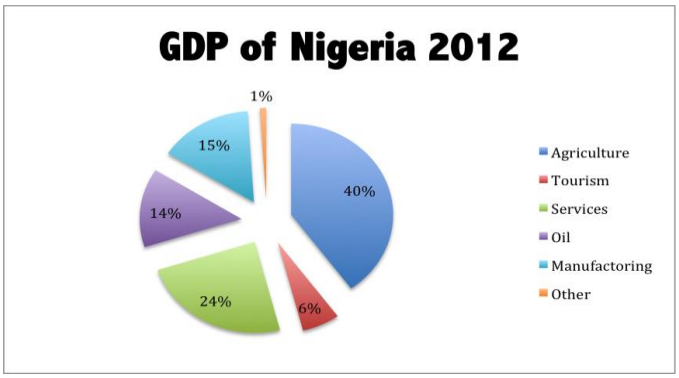

Fig. 2. Chart showing sectorial composition of Nigeria's GDP in 2012

Between 2014 & 2015, Nigerians spent within the range of $16 - $18 on an actual power supply and spent within the range of $42 - $56 on alternative sources (petrol and diesel fuels) [12]. This has only propagated the country's reliance on fossil fuel for economic growth.

The final blow to the economy of the country is the current trend of reduced oil prices globally from around$100 per barrel in 2014 to $33 in 2016 [13], as a result of decreasing demand for oil. Nigeria lost its major customer of oil, USA, to the exploration of shale oil potential, and with prices further reducing; a reflection would be made on revenue generated from oil exportation and the national budget. There is a ripple effect with this situation, as the supply remains constant and demand decreases as a result of alternative energy sources, the price reduces thereby reducing revenue and foreign exchange, which has further plundered the value of the Naira in the country. Inflation follows next with all its ills on the standard of living for an average Nigerian.

We will not bother to mention the environmental effects of fossil fuel exploration in the country, even thoughit's a popularknowledge that it poses negative threats to the well-being of its people and indirectly affects some sectors of its economy.

Therefore in light of these negative economic effects of fossil fuel reliance in the country, resulting from both global and domestic forces, it is important that Nigeria seeks more reliable and adequate sources for power production to foster economic growth in the future. The Nigerian government have reviewed energy policies and implemented reforms in the energy sector to no avail, as most Nigerians confirm the effects have been insignificant compared to demand [12].Developed countries around the world have also predicted the possibilities of these negative economic effects due to fossil fuel dependence for power generation and, of course, the adverse ill of environmental implications of fossil fuels and have over recent years started exploring alternative sources such as renewable energy.

IV. Renewable Energy Potential

Nigeria's reliance on fossil fuel, even with positive developments would not be enough to meet the energy demand of the growing population, due to its surrounding limitations as discussed earlier. Studies have shown that 60% of the rural areas and 80% of Nigerians in total use about 50 million metric tonnes of fuel wood (being a major cause of erosion and deforestation), which makes it obvious that a greater percentage of the population will not meet their energy demands using fossil fuel generated power in due time.This may be because investors feel these rural areas have a very low power purchasing potential, leaving them socially and economically backward [14]. It is then necessary that Nigeria directs a significant attention of the energy sector towards cleaner and reliable renewable energy sources.

Renewable energy is generally referred to as energy resulting from resources which are naturally produced or restored on a human timescale, such as sunlight, wind, tides, waves, and geothermal heat. Renewable energy can replace conventional fuels in four prominent areas: electricity generation, motor fuels,air and water heating/cooling, and rural (off-grid) energy services. It is derived from natural processes that are restored or replaced constantly [15].

Nigeria lies between longitudes 2° and 15°E, andlatitudes 4° and 14°N near the equator. It has a total area of 92.4 million hectares (Land 86%, Water 14%) and has a coastline of at least 853 km. its position puts it in the tropical region of the earth, which is accompanied with climate the promotes adequate sunshine, wind flow and humidity for rainfall.The various renewable energy sources available to the country are, Hydro, solar (sun), wind and biomass energies.

4.1 Hydro Energy

Hydro energy is the energy derived from the potential and kinetic energy of water bodies. It is responsible for around 16 percent of global electricity generation, making it the most widely used form of renewable energy [16].The country is richly endowed with river basins that are capable of producing both small and large scale hydro powered electricity. About two-third of Nigeria lies in the bay of the Niger River, which empties into the Atlantic at the NigerDelta, with its major tributaries[17]. The Benue, Kaduna, Sokoto rivers in the north, and Southeastern Anambra River. The Niger is African's third longest river and fifth largest in term of discharge. Several rivers of the watershed flow directly into the Atlantic notably the Cross river in the Southeast and the Ogun, Osun and Oyan in the Southwest. Several rivers of Northeastern Nigeria, including the Komadugu Gana and its tributaries, flow into Lake Chad. The lake rests in the center of a major drainage basin at the point where Nigeria, Niger, Chad and Cameroon meet. Kainji Lake created in the late 1960s by the construction of the Kainji Dam on the Niger River in Nigeria. The country's topography ranges from lowlands a1ong the coast and in the lower Niger valley to the high plateau in the North and mountain along the eastern border, most part of the country is linked with productive rivers which are scatted virtually all over the country [17].

The country has an exploitable large hydropower LHP, potential, based on the river systems, estimated at about 11,000MW, with small hydropower SHP, estimated at about

Fig. 3. Map of Nigeria showingriver networks. (Source: mapsoftheworld)

3,500MW. SHP is defined hydropower plant that can generate 10MW in Nigeria [18]. Research have shown that there are about 70 micro-dams, 126 mini dams and 86 small sites capable of producing hydropower have been identified [14].

4.2 Solar Energy

Solar energy is energy harnessed through the conversion of sunlight into electricity through the use of solar cells in solar panels. Due to the country's tropical location, there is an average distribution of sunshine throughout the year, therefore making it a harvest for solar energy.

The country's annual daily average of total solar radiation has been estimated to be 12.6 MJ/m^2/day (the equivalent of 3.5kWh/m^2/day) in the coastal region and 25.2MJ/m^2/day (7.0kWh/ m^2/day) in the far north. Based on these figures, an average of 6,372,613 PJ/year (E 1,770 thousand TWh/year) of solar energy is estimated to fall on the entireland area of Nigeria [18].It is said that if solar panels were mounted on 1% of the totalland area, the possibility of generating 1.85 million GWh of solar electricity per year is not far-fetched [14].

Table 1. Small Hydro Potentials in the surveyed States in Nigeria[18]

S/No	State	River Basin	Total Sites	Potential Capacity (MW)
1.	Sokoto	Sokoto-Rima	22	30.6
2.	Katsina	Sokoto-Rima	11	8.0
3.	Niger	Niger	30	117.6
4.	Kaduna	Niger	19	59.2
5.	Kwara	Niger	12	38.8
6.	Kano	Hadeja	28	46.2
7.	Borno	Jama'are	29	20.8
8.	Bauchi	Chad	20	42.6
9.	Gongola	Upper-Benue	38	162.7
10.	Plateau	Upper-Benue	32	110.4
11.	Benue	Lower-Benue	19	69.2
12.	Cross River	Lower-Benue	18	28.1

The application of solar energy, in various sectors of economic activities, can beneficial to the Nigerian environment especially in the rural areas for pumping water, rural electrification and improving health services in the form of storage facilities. There is a common belief this potential capability is likely to increase as a result of climate change due to global warming.

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4.3 Wind Energy

Energy can be harnessed from wind by using wind turbines that have generators inbuilt to generate electricity as wind propels the turbine. Average daily average wind speeds can be confusing since the sequence of wind velocity can be that it is very windy in the night time with very less windy in the morning or afternoon. The exciting nature of wind energy is that, to generate the targeted amount of electricity since, less wind can be sufficient since power is related to wind velocity cubed (v^3).

The results of a study conducted by Fagbenle et al showed that wind speeds range from 3.18 to 7.04 m/s. Some similar studies showed that the North-West and North-East geopolitical regions have mean wind speeds above 4.8 m/s and annual mean wind speeds that range from 2.747 m/s to 4.570 m/s for North-Central region. Nationally, the annual wind speed at 10m above the ground variedfrom2.3to3.4m/s for sites along the coastal areas and 3.0 to 3.9 m/s for highland areas and semi-arid regions with peak wind speed occurring between April and August for most sites [19]. Fig. 5 shows the suitable use of wind power in each state, based on the wind speed at 10m elevations [20].

Small wind turbines generally require 4 m/s to work, whereas mechanical wind pumps generally require2.5 m/s to work. Individual sites will vary a lot. Based on the currently available wind data it is safe to say that all of Nigeria can benefit from wind driven water pumping and the majority of states in Nigeria can generate electricity using small wind turbine.

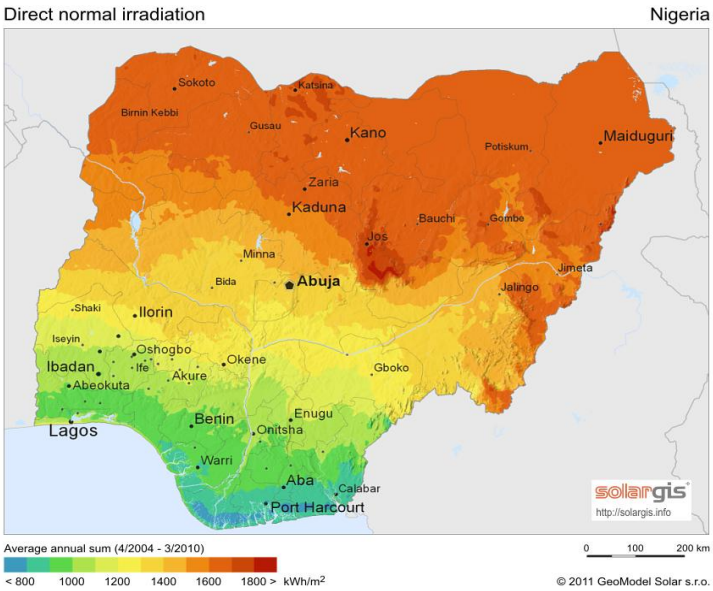

Fig. 4. Solar radiation distributionin Nigeria. (Source: Solar Gis)

4.4 Biomass Energy

Biomass is organic matter derived from living organisms which can be used as a source of energy and it most often refers to plants or plant-based materials which are not used for food or feed, specifically called lignocellulose biomass [21]. Being a source of energy, biomass can either be used directly for the production of heat through combustion, or indirectly for producing various biofuels through chemical processing.

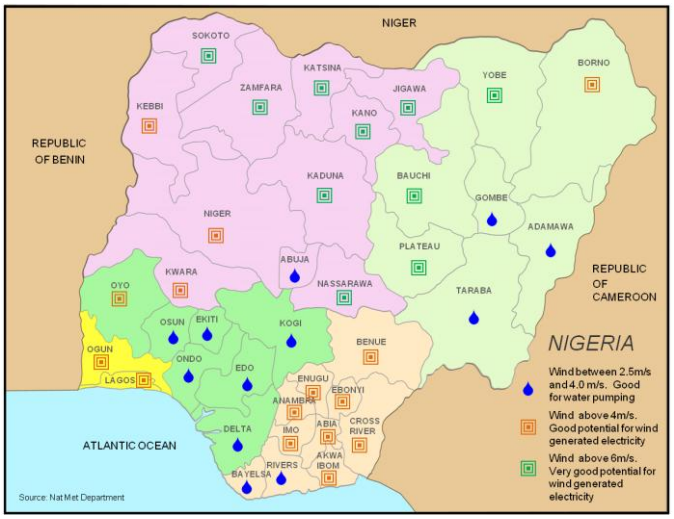

Fig. 5. The potential of different states according to wind speed. [20]

Crops such Sweet sorghum, maize, Sugarcane were the most promising feedstock for biofuel production [22]. Thebiomass resources of Nigeria have been estimated to be about 8 x 102 M.J [23]. Plant biomass such as wood, forage grasses and shrubs, can be utilized as fuel for small-scale industries. It could also be fermented by anaerobic bacteria to produce a cheap fuel gas (biogases). In Nigeria, identified feedstock substrates for an economically feasible biogas production include water lettuce, water hyacinth, dung, cassava leaves and processing waste, urban refuse, solid (including industrial) waste, agricultural residues and sewage [24]. An estimation of about 227,500 tons of fresh animal waste produced in the country daily has been deduced. According to Akinbami et al in 2001, Since 1 kg of fresh animal waste produces about 0.03m3 of biogas, then Nigeria can potentially produce about 6.8 million m3 of biogas every day from animal waste only [14][24]. The potential of bioenergy resources in Nigeria for bioelectric power generation and the role of bioenergy in curtailing the country's electricity crisis are promising.

V. Re Development In Nigeria

5.1 Hydro Power

Currently hydro power accounts for around 30% of the total electricity power supply in the country which comprises of Kainji Hydropower station as the first power station on Niger River which was commissioned in December 1968 with a capacity of 760MW, Jebba Hydropower station with a total capacity of 940MW [25], Shiroro and Zamfara power stations. Table 2 shows a comprehension of installed LHP stations. The country is said to have a potential of 11,000MW but only 19% has been harnessed so far. There are planned LHP projects which are currently completed or on-going, as shown in table 3, which if completely installed and maintained properly has the capacity of doubling the current total electric power supply.

With SHP potential of 3500MW, very insignificant percentage has been harnessed. There are 278 identified SHP potential sites and only 3 of them have been harnessed, generating a total capacity of 49MW[25]. The development of the country's SHP potential can go a very long in enhancing power provision in rural areas which can be used in electrification, agricultural practices, and water supply.

Challenges such as adequate funding, lack of human capital, poor rural manufacturing capacity and security for possible foreign investors and engineers, has been observed to pose limitations to the development of hydro power in Nigeria.

Table 2.Commissioned LHP stations in Nigeria [25]

LOCATION	CAPACITY (MW)	COMMISSIONED DATE	RIVER
SHIRORO	600	1990	KADUNA
KAINJI	760	1968	NIGER
JEBBA	940	1984	NIGER
ZAMFARA	100	2012	BUNSURU

Table 3. Planned LHP projects [17]

Location	Capacity (MW)
Ikom	730
Lokoja	1050
Zungeru	450
Mambilla hydro	3960
Makurdi hydro	1062
Onitsha hydro	1050
Gurara (Abuja hydro)	300

5.2 Solar Power

Despite the country's solar radiation potential, the development of technology for power generation and applications using solar radiation on a large scale is insignificant. Several pilot projects have been undertaken by the Sokoto Energy Research Center (SERC) and the National Center for Energy Research and Development (CERD) under the supervision of the Energy Commission of Nigeria (ECN) [26]. Several PV-water pumping, electrification, and solar-thermal installations have been put in place. Such Solar thermal applications include solar incubators, solar crop drying, solar cooking and solar chick brooding. Other areas of the utilization of solar electricity include low and medium power implementation such as: traffic lighting and lighting of road signs, water pumping, rural clinic and schools power supply, vaccine refrigeration and village electrification[14]. Figures 6, 7, and 8 below show some of the pilot projects completed or undergone at the moment.

Again, just as discussed above for hydro power, proper public and private investment, and poor manufacturing capacity are some of the challenges that haunt the development of solar power development in the country.

5.3 Wind Power

In developed countries today, the concept of harnessing power from wind energy is fast developing, irrespective of the cost, because of its power generation potential, but unfortunately that concept has not been significantly shared by Nigeria. The only notable wind power development in country is the first Nigeria Wind Farm in Rimi village (Katsina state). At 55 meters, the average annual mean monthly wind speed for Katsina state has been estimated to be 6.044 m/s and it is through this potential that the farm is expected to generate 10MW of electricity using 37 wind turbines which haverated power of 275 kW each. The project was first envisioned by the Katsina State government but gained full support from the federal government and also funded by the Japanese International Cooperation Agency (JICA) [26] wind based power generations are the 5KW in Sayya Gidan-Gada (Sokoto state) (Fig. 9), 0.75KW in Dan-Jawa village (Sokoto state), 1KW at Benin energy research centre (Edo state) andrehabilitated windmill for water pumping at Kadawa village (Kano state). Many other wind mills used for water pumping installed in the 1950s and 1960s in the Northern part of Nigeria are no longer functioning[18]. Coastal areas like Lagos state are supposed to be frontiers in the development of wind power due to their higher potential for wind energy. Endeavorswere being made few years agoatAbubakar Tafawa Balewa University, Bauchi and Sokoto Energy Research Centre (SERC) to develop the production of wind energy technologies with insignificant results so far.[14].

5.4 Biomass

With a potential of 800MJ of biomass production and anestimated 6.8 million m^3 of biogas that can be produced daily,large scale application of energy production from biomass is yet to be seen in Nigeria. Currently over 80% of Nigerians cook and produce heat using fuel wood, which has been found tobe the major cause of deforestation and increasing trend of erosion occurrences in the country. There exist a general mentality about the sacred value of food from crops and livestock, therefore limiting the idea of large scale applications of biomass energy or bioenergyto an unconventionalstate inthe country.

Fig. 6.Solar powered traffic light in Nigeria.

Fig. 7. Solar PV Internet Back-up at Nunet, UDU, Sokoto. [27].

Fig. 8. Community Based Pilot Water Heater, UDUTH. [27].

Fig. 9. 5KW wind power in Sayya Gidan-Gada (Sokoto state)[27].

Biogas waste technology is found to be infrequent, thoughvarious pilot projects and researches are being conducted on a very small scale for domestic and industrial use. Biogas waste does not require irrigation or land use, which makes a cleaner enviroment and promotes a decrease in the usage of fuel wood for energy production and consumption.

Figure 1. Nigeria's total primary energy consumption, 2012

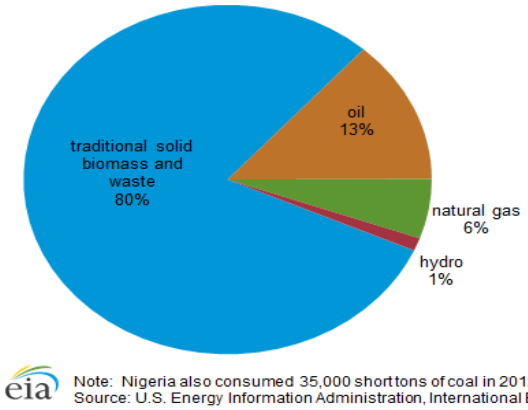

Fig 10. Chart showing total energy consumption for Nigeria in 2012. [8][9]

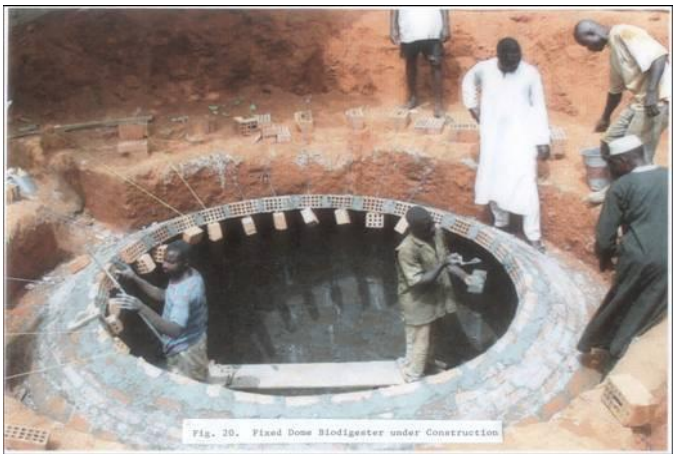

Fig. 11.Fixed dome Biogas digester at Mayflower Secondary School, Ikenne, Ogun state. [27]

VI. Challenge To Re Development

The development of renewable energy technology in Nigeria, in reference to its vast potential capacities, has been stagnant. It is obvious that new measures ought to be taken in order to drive RE development to its full potential that will boost power generation in the country. Government policies can act as a guidance to promote the development of RE if executed properly. Before discussing possible challenges, we will look at some policies created as a measure for the development of Renewable Energy in Nigeria.

6.1 National Energy Policy (NEP)

A National Energy Policy (NEP) was approved by the Government in 2003 with theoverall thrust of optimal utilization of the nation's energy resources; bothconventional and renewable, for sustainable development and hinges on the active participation of the private sector[27]. The NEP in 2005 gave birth to the Nigerian Electricity Regulatory Commission (NERC) and the Rural Electrification Agency (REA), with the assistance of an Act of the National Assembly passed into law to liberate the electricity sector. The key elements in the NEP position on the development and application of renewable energy and its technologies are summarized by Okafor et al, as follows:

- To develop, promote and hardness the Renewable Energy resources of the country and incorporate all viable ones into the national energy mix
- To promote decentralized energy supply, especially in rural areas, based on RE resources
- To de-emphasize and discourage the use of wood as fuel
- To promote efficient methods in the use biomass energy resources
- To keep abreast of international developments in RE technologies and application.

6.2 Renewable Energy Master Plan

The Renewable Energy Master Plan (REMP) for Nigeria was developed in 2005 and launched in 2006, with support from the United Nations Development Programme (UNDP) which articulates Nigeria's vision for achieving sustainable development through RE development and a road map for renewable energy to help achieve this vision.The REMP map to increase the share of RE in the national energy supply mix was proposed to be achieved through three development stages: short term, medium term and long term as shown in Table4.

The REMP as at 2006 provided a comprehensive framework for developing renewable energy will ensure:

- Expanding access to energy services to Nigerians by stimulating an increase in the energy source mix,
- Stimulating economic growth,
- Increasing rural development in order to stem the migration to urban areas,
- Reducing environmental degradation and health risks. [27]

6.3 Challenges.

Despite the Nigeria's vast RE sources potential, it's unfortunate that the perceived level of development has becomeappalling. Previous studies on individualperspectivesto the possible challenges to RE development depict a highdegree of similarities because the various challenges noted are generally shared by people knowledgeable of the concept of RE development and deployment. We will discuss some the possible challenges to RE development.

Table 4.Targets for Renewable Energy contribution to electricity generation in Nigeria. [29]

S/N.	Resource	Short-2015 (Mw)	Medium-2020 (Mw)	Long-2030 (Mw)
1	LHP	4000	9000	11,250
2	SHP	100	760	3500
3	Solar PV	300	4000	30,005
4	Solar Thermal	200	2136	18,127
5	Biomass	5	30	100
6	Wind	23	40	50
	All Renewables	4728	15,966	63,032
	All energy sources	47,490	88,698	315,158
	Renewable sources	10%	18%	16%

The technical factor is and will still remain the greatest challenge to RE development if not addressed properly. The existing poor human technical expertise, especially in the rural areas undermines the possibility for developing or deploying RE technology. According to the World Bank and Bloomberg indexes for Research & Development (R&D) in the world, Nigeria is nowhere to be seen on the map, hence making innovation a non-priority in the country[28]. Developing and deploying RE requires adequate R&D to improve knowledge, human expertise to deploy and maintain such technologies, and infrastructure to access areas for deployment and maintenance, yet Nigeria cannot be seen to possess any of these qualities.

The absence of these technical capabilities has resulted in the challenges that arise from economic factors in regards to funding. RE deployment is generally has high cost and slow returns, which discourages potential investors from investing in such a venture. This has been worsen by the lack of technical capabilities coupled with low income per capita and high manufacturing costs in Nigeria today. With the current economic condition in the world, investors including banks in Nigeria have become conscious of their investment capacities, therefore hindering both domestic and foreign investments.

Activities of the government are highly instrumental to the success or failure of any matters of national interest including the programmes that will tend to enhance the very life status by introduction of new ways of living [23]. The degree of active interest and participation of the government towards RE can go a very long way in determining its development can drive this to a higher level. The REMP has not been because they are in control of the resources and policies that passed into law, limiting its relevance in the country and in reference to Table 4; it's obvious their targets may never be met.

The sociological and cultural mentality of an environment can pose a major challenge to RE development [23] especially in Nigeria that is culturally diverse with various cultures that do not promote technological or educational developments. Development of RE becomes almost impossible in areas with such qualities as they tend to reject such innovations. The deployment of RE technology in its business sense cannot function if there is no demand, thereby discouraging investment. One major aim of RE development in Nigeria is rural development but unfortunately majority of these areas possess this limiting cultural qualities, hence lacking the educational background to even understand the implication of these innovation.

VII. Conclusion

Nigeria is really an endowed country with its vast renewable and no renewable energy resources. Its dependence on fossil fuels has been predicted, evident in current events in the oil sector, with posing an economic threat to the country. It is necessary she embarks on the development of alternative energy sources in order to increase its energy mix, improve rural development and boost its economic status further.

The various sources for RE in the country was outlined and discussed and their degree of development using data on installed or pilot projects executed, was made available. It can be noted that irrespective of the vast potential for RE, Nigeria has very insignificant development in that sector.

Challenges such as inadequate domestic and foreign investment, poor existence of technical expertise in both the human and manufacturing sense, sociological and cultural limitations, and poor achievement-driven policies tend to pose limitations to the development of RE in Nigeria. In order to move forward it is necessary that the Nigerian people address these challenges especially the technical part, if they are going to make any impact on developing and deploying RE in the country to increase the energy mix and boost urban and rural development.

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