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Integration of Renewable Energy Sources to the Nigerian National Grid - Way out of Power Crisis

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Abstract: The state of electricity supply in Nigeria is apologetic and almost defying solution. This pathetic situation is directly affecting the manufacturing section of our economy. The social services and the residential sectors are not left out of this erratic power supply. The inadequate generation and transmission of electricity to its citizens in the country have in no doubt contributed to the wastage of a lot of agricultural produce which otherwise would have contributed to our gross domestic product (GDP) and services. This paper attempts to suggest a way forward for the Federal government, to meaningfully invest in alternative sources of energy by reviewing the power sector and the renewable energy potentials in her domains. Identified problems for the poor performance of the national power supply should be used a bench mark to under study the situation to avoid repeated mistakes.

Keywords: Pathetic situation, erratic power supply, alternative sources of energy

INTRODUCTION

No nation can have any development without constant electricity supply. Electricity supply is the pivot in which the wheel of development of any nation rotates. In Nigeria, this commodity forms the hub of its growth in the production of goods and services. It is highly needed in the industrial sector, agriculture, health and education [22]. Fortunately, Nigeria otherwise known as "the giant of Africa" is endowed with abundant amount of fossil fuel and renewable resources of energy, but paradoxically, the country battles acute and erratic power situations. According to recent World Bank data; about 49.1% of Nigerians have no access to electricity [30].

The May, 2014 World Economic Forum on Africa which was held in the Nigerian Federal capital Abuja, pledge an investment boost of $68 billion from foreign and domestic investors in the service and industrial sectors. Inadvertently, this huge investment will not see the light of day if the current power situation does not improve. The problems of insufficient and inefficient power plants to supply power, the out dated transmission lines from the national grid to distribution facilities due to negligence, outdated meters, illegal electricity connections by the consumers [22] are some of the problems plaguing the Nigerian power sector. How can this situation be addressed to salvage the country from this present situation? That is the aim of this research. This paper reviews the current power situation in the country and suggests a deliberate effort to integrate renewable sources of energy to augment the national grid.

This paper attempts to concentrate on:

1. Introduction;
2. Historical overview of the nation's power sector;
3. Potentials of the alternative/renewable sources of energy that can be tapped to augment the power from the national grid;
4. Policy recommendations and
5. Conclusion.

These should be of great help to solving our energy supply problems.

2. OVERVIEW OF POWER SECTOR IN NIGERIA

2.1. History

The colonial masters in Nigeria, with the then federal capital in Lagos started electricity generation from few kilowatts with the first generating plant in 1898 [11]. In 1951 by the Act of Parliament, the Electricity Corporation of Nigeria (ECN) was established. In 1962, the Niger Dams Authority was established to develop hydroelectricity. This was later merged with ECN in 1972 to form what was called the National Electric Power Authority (NEPA). This body monopolized the electricity market and mustered effort at managing the power sector by providing electricity to the ever increasing population. In the 1990s, NEPA could not meet up with the increasing electricity demand. As a way of solving this problem, the National Electric Power Policy (NEPP) was introduced to take up the power sector reform in 2001 that led to the formation of several other reforms [12]. The Nigeria's Power Sector Privatization was kick-started by NEPP in 2001 but this new policy; was only signed into law in 2005 due to government bureaucracy. This document became the Electric Power Sector Reform (EPSR) Act, expected to bring a level play ground for potential investors and competition that should improve the power supply to the citizens. This Act brought to bear the incorporation of the Power Holding Company of Nigeria from NEPA, and later defunct and divided into three major sub-sectors [11] [12].

2.2. Sub-Sectors

These major power sub-sectors are:

(I) Generation - Nigerian Electricity Supply Industry (NESI), with 23 grid-connected generating plants currently in operation and a total installed capacity of 10,396 MW with available capacity of 6056 MW. The thermal based installed capacity is 8457.6 MW with available capacity of 4996 MW. The supply of the three major generating plants from the

hydropower accounts for 1938 MW of the total installed capacity with 1060 MW as available capacity. This generation segment is further divided into [12]:

- National Integrated Power Projects (NIPP): owned and managed by the government with 10 generating facilities.
- Independent Power Producers (IPPs): owned and managed by the private sector with three generating facilities.

(II) Transmission - Transmission Company of Nigeria (TCN) as a successor of the PHCN. This is made up of System Operator and Market Operator departments. It has a transmission capacity of about 5523.8 km of 330 KV lines and 6801.49 km of 132 KV lines [12].

(III) Distribution - distribution companies (DISCOS) and comprises of eleven companies [12]:

Abuja, Benin, Eko, Enugu, Ibadan, Ikeja, Jos, Kaduna, Kano, Port Harcourt and Yola distribution companies.

2.3. The Nigeria Regulatory Agencies and Key Institutions

We will now look at the various regulatory agencies and key institution in the power sector.

2.3.1. Regulatory Agencies

There are five (5) regulatory agencies [12] namely:

1 The Federal Ministry of Power (FMP) which is the administrative arm of the federal government which is responsible for the policy formulation and provides a leading role other power sector agencies.

2 Nigerian Electricity Regulatory Commission (NERC) which is an independent regulatory agency, established in 2005 by the EPSR Act to monitor and regulate the Nigerian Power Sector.

3 Energy Commission of Nigeria (ECN) was a stator established in 1988 mandated for strategic planning and coordination of national energy policies.

4 Rural Electrification Agency (REA), established by the EPSR Act saddled with the statutory responsibilities of promoting, supporting and making available electricity accessible to rural and semi-urban areas of the country.

5 Presidential Task Force on Power (PTFP), established in 2010 to oversee power sector reform implementation in the country.

2.3.2. Key Institutions

There are 7 key institutions [12]:

1 Niger Delta Power Holding Company Limited (NDPHC) which is controlled by the three tiers of the government, that is, federal, state and local and it is responsible for the implementation of the National Integrated Power Project (NIPP).

2 Operator of the Nigerian Electricity Market (ONEM). It was licensed as a market operator for the Nigerian Electricity Supply Industry in wholesale electricity market also saddled with the responsibility of operation in the electricity market and settlement arrangements. It is the key responsibility of the ONEM in the metering system among generation, transmission and distribution companies.

3 Nigerian Bulk Electricity Trading PLC (NBET): It was established by the EPSR Act. It is owned by the government and is licensed as an electric trading company that engages in the purchase of electric power and ancillary services (from the independent power producers and the successor generating companies) and for subsequent resale to distribution companies and eligible customers.

4 Nigerian Electricity Liability Management Company Limited (NELMCO): It manages the non-core assets, liabilities and other obligations that would not be taken over by the successor companies. It was established in 2006 as a limited company by guarantee.

5 Gas Aggregation Company Nigeria Limited (GACN): The purpose its incorporation in 2010 was for the stimulation of growth in the natural gas utilization in the domestic market.

6 National Power Training Institute of Nigeria (NAPTIN) was the focal point for human resource development and work-force capacity building. It was established in 2009 as a research center on matters relating to power in the country.

7 Nigeria System Operator (NSO): This provides system operation services to the Nigerian Electricity Supply Industry. It is responsible for the planning, dispatch, operation of the transmission system, security and reliability of the nation's electricity grid network.

2.4. Nigeria's Current Electricity Situation

2.4.1 Energy Situation in Nigeria

Nigeria is located between longitude 8°E and latitude 10°N, and has dry and wet as the two major seasons. This makes water availability at the different hydropower stations variable, leading to an intermittent supply at times of low water levels. Also, the thermal power stations have been plagued by inadequate supplies of natural gas from the various Niger Delta gas wells, thereby making continuous energy production from these installations difficult [3].

This has left Nigerians at the mercy of private or alternative power generation through the use of diesel and petrol generators [6].

The country is faced with the electricity generation, transmission, distribution and marketing.

Generation: The current overall installed capacity of the generating plants in the country is 10,396.0 MW, but with the available Capacity of less than 6056 MW as at December 2013. The situation is more dire now between December, 2015 to the present time when a lot of militancy in the Niger-Delta region where oil and electricity installations are being bombed daily. Again we are confronted with the fact that seven out of the twenty-three generation stations are getting obsolete. They are over 20 years old and the average daily power generation is lower than the peak forecast for the current existing infrastructure. There are planned generation capacity projects for a brighter future because the current epileptic power generation in the country presents challenges to economic development due to inadequate power generation and availability, delayed or lack of maintenance of facilities, insufficient funding of power stations, outdated equipment, tools, poor safety facilities and operational vehicles, obsolete communication equipment, lack of research and exploration to tap all sources of energy from the available resources and low staff morale [23] [20].

Transmission: The current transmission system in Nigeria incurs high power losses due to excessively long transmission lines. Some of these lines from the grid include Benin—Ikeja West (280 km), Oshogbo—Benin (251 km), Oshogbo—Jebba (249 km), Jebba—Shiroro (244 km), Birnin Kebbi—Kainji (310 km), Jos—Gombe (265 km) and Kaduna— Kano (230 km) [20].

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The efficiency of the power system is directly dependent on the amount of it reaching the consumers. Where losses are high, the fraction reaching the consumers will be low leading to inadequate power to run the consumers appliances. Increasing demand from the consumers therefore pushes the power transmission and distribution networks beyond their installed capacity thereby straining the system to a breakdown point. This will result in the total collapse of the entire system [20][25].

The entire country is not covered by the transmission system and the current maximum transmission capacity of 6056 MW is technically weak, which is great disturbance. This current capacity is grossly inadequate to cover the needs of the populace. There is poor funding by the government, some sections of the grid are outdated, vandalization of the power lines, which is associated with low level of security and surveillance for the infrastructure are the problems plaguing the country's power sector. Other problems are inadequate working tools and functional operating vehicles for patrolling the facilities, lack of communication and transformer monitoring devices to check overloads, lack of spare parts for urgent maintenance, poor technical staff recruitment, poor staff training and capacity building [23][20].

Most regions in Nigeria have very poor distribution and marketing networks. The billing system is inaccurate due to poor voltage profile. The distribution and marketing department which is directly dealing with the consumer service delivery needs to be up and doing if there should be improvement. They have weak and inadequate logistic facilities working vehicles thereby leading to poor network coverage [23][20].

By rule of thumb we know that there is power deficit in Nigeria from the statistics that the total installed capacity of generating plants in the country is 10,390 MW and with available capacity of less than 6056 MW, with recent power generation which has been below 4500 MW. The power generation of 1000 MW is for one million people and the Nigerian population is 174,567,539 [8], we should have about 174,508 MW for the Nigerian people but with the current generation that has not exceeded 4500 MW, we can say that Nigeria has a power deficit of 170,008 MW. The current Nigerian national power grid system is shown in Figure 1 [5].

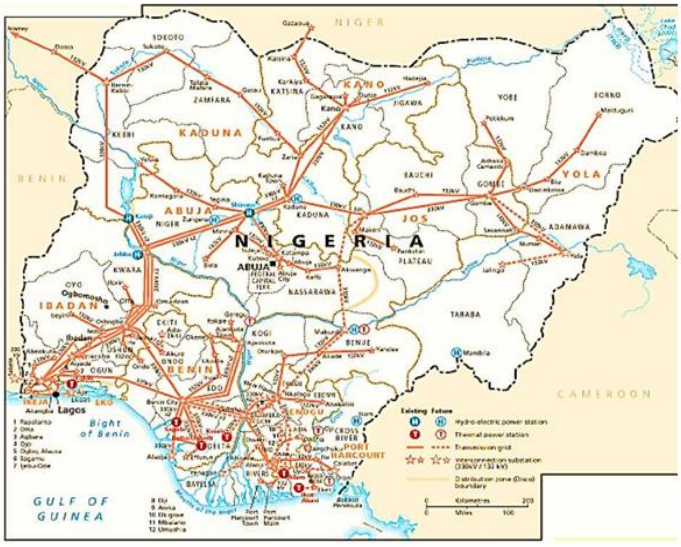

Figure 1: The Nigerian national grid system. Source: *Google*

3. RENEWABLE ENERGY RESOURCES IN NIGERIA

Nigeria is greatly endowed with sufficient renewable energy resources to suffice its present and future development requirements. However, hydropower is the only sustainable resource currently exploited and connected to the grid [19].

The renewable energy resources available in Nigeria are diverse and enormous. A summary of the Nigeria's renewable energy potentials is shown in Table 1 [5].

Table 1. Renewable energy resources.

Renewable Energy Source		Capacity
Small Hydropower		3500 MW
Large Hydropower		11,250 MW
Wind		2 - 4 m^2 annually at 10 m height
Solar Radiation		3.5 - 7.0 KMh/m^2/day
Biomass	Fuel Wood	13,071,464 hectares of forest and woodland
	Animal Waste	61 million tons/year
	Crop Residue	83 million tons/year

Source: Energy Commission of Nigeria, 2005.

3.1. Solar Energy

The sun is the most readily and widely available renewable energy source capable of meeting the energy needs of whole world [6].

One of the greatest assets that Nigeria has that can facilitate her solar energy generation is her geographical location, that is, the equatorial region which is full of large quantity of solar radiation. Solar radiation is fairly distributed in Nigeria with average solar radiation of about 19.8 MJm^{-2} day^{-1} and average sunshine hours of 6 hours a day; ranging between about 3.5 hrs at the coastal areas and 9.0 hrs at the far northern boundary [18]. At a medium radiation intensity of 5.0 $kWhm^{-2}day^{-1}$ and with good conversion efficiency, if solar collectors modules were employed to cover 1 % of land area in Nigeria can generate approximately the daily energy equivalent of 192.0 MW of energy from a gas power plant working at full capacity for 24 hours a day [2] [13].

Solar electricity may be used for power supply to remote villages and locations not connected to the national grid. It can also be used to generate power to feed into the national grid. Other areas of solar electricity application include low and medium power application such as: water pumping, village electrification, rural clinic and schools power supply, vaccine refrigeration, traffic lighting and lighting of road signs [22]. Nigeria's yearly average of daily sun is shown in Figure 2 [27].

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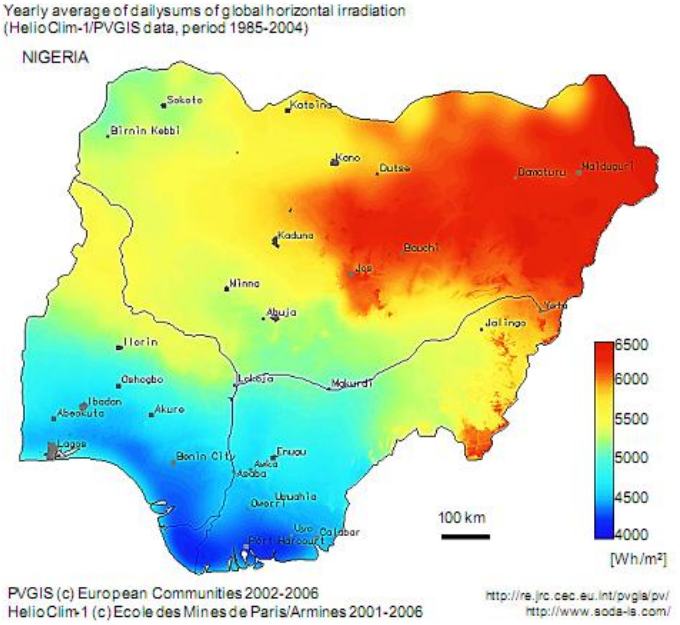

Figure 2: The Yearly average of daily sun in Nigeria.

3.2.**1 Solar Power Technologies**

Solar energy can be used to generate power in two ways; solar-thermal conversion and solar electric (photovoltaic) conversion.

I. Solar-thermal Conversion: This is the heating of fluids to steam level to drive turbines for large-scale centralized generation. Solar thermal systems, like solar cells, also called concentrated solar power (CSP), use solar energy to produce electricity, but in a different way. Most solar thermal systems use a solar collector with a mirrored surface to collect and focus sunlight onto a receiver that heats up a liquid. The super-heated liquid releases steam to produce electricity in the same way that coal plants do. This aspect of power generation was not covered by the Renewable Electricity Action Program (REAP) of the Federal Ministry of Power and Steel in 2006, which was published by the International Centre for Energy, Environment and Development in Nigeria.

II. Solar Electric (Photovoltaic) Conversion: It is the direct conversion of sunlight in to electricity through a photocell which could be in a centralized or decentralized fashion. Solar-electric (Photovoltaic) technologies convert sunlight directly into electrical power. This system is made up of a balance of system (BOS), which consists of mounting structures for modules, power conditioning equipment, tracking structures, concentrator systems and storage devices. Photovoltaic conversion could be large scale or small scale for stand-alone systems connected to the national grid.

Solar cells are referred to as photovoltaic (PV) cells, which as the name imply (photo meaning "light" and voltaic meaning "electricity"), converts sunlight directly into electricity. A group of modules connected mechanically and electrically together is termed "panel". A module is a group of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays. Photovoltaic cells are made of semiconductors, such as silicon which is most commonly used. When light strikes the cell, a portion of it is absorbed within the semiconductor and the energy of the absorbed light is transferred to the semiconductor and knocks electrons loose, allowing them to flow freely [7].

3.2.2 **Solar Installation Problems in Nigeria**

1. **Affordability**

Nigeria is still an underdeveloped country with high percentage of her population living under poverty level. The ability of individuals or groups to acquire solar energy devices is low since they are considered expensive.

2. **Ignorance of the Government**

Those people who make policies in government are very much unaware of the capacity of solar energy; because many still assume that solar energy can only power small bulbs or at most television set. Our media outlets also have not produced enough publicity on the subject matter. Nigeria's problems of solar energy, though enormous, can be addressed within short period of time if the government were to give proper attention to research, development, commercialization and installation of solar equipment through good policy evolution.

3. **Component Failure**

Since this technology of solar energy is very new in the country, users easily get turned off if the equipment does perform up to the years of guarantee which it is rated. Equipment and component failure occurs mostly with components that do not have manufacturer's address or guarantee.

4. **Cost of generation**

In the short run, equipment and installation cost of solar energy when compared with other energy supply sources, is more expensive. However, it is cheaper in the long run. The results show that the PV source is more expensive within the first 4 years after installation. This is because solar energy components are imported and very expensive except the cables and few accessories. The PV power becomes more attractive because of low running cost beyond 5 year. Since a high percentage of the population is low income earners, they cannot afford or acquire solar power. On the other hand, higher income earners have access to other energy sources like petrol or diesel generators apart from the grid.

5. **Political Problems**

There is no political will behind acquisition and installation of solar energy at both the governmental and technical level in Nigeria and this is not encouraging. There is no clear cut legislation backing the utilization of renewable energy by the government. The government has not embarked on giant step by installing or acquiring large solar power plants at any time.

6. Identification of Suitable Geographical Location

Geography problem can be solved by integrating the most relevant and important aspects of solar energy installation and generation into the curriculum of the professional training schools. The civil and surveying departments are the first contact point for proponents and users of solar energy. In the 2007, the National Energy Forum (NASEF) identified additional challenges among others, to solar energy development in Nigeria as: cultural restriction on land use, lack of appropriate institutional framework, low level of technical expertise, vandalization and theft of system components and lack of local manufacturing of system component-PV.

3.3 **Biomass Energy**

Biomass is plant derived from matter. The biomass resources of Nigeria are crops, forage grasses and shrubs, animal wastes and

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waste arising from forestry, agriculture, municipal and industrial activities, as well as, aquatic biomass [29].

Crops such as maize, sweet sorghum, sugarcane, etc are the most promising raw materials for biofuel production. Plant biomass is utilized as fuel for small-scale industries. It could also be anaerobically fermented by bacteria to produce a cheap fuel gas (biogases). Nigeria's biomass energy resources are identified as fuel wood with capacity of about 13 million hectares of forest and wood land, animal waste of about 61 million tons/year and crop residue is currently limited to thermal application as fuel for cooking and crop drying. However, these biomass resources could be utilized as fuel for small scale industries [9]. Figure 3 below shows the crop zones that can produce the raw materials for biofuel.

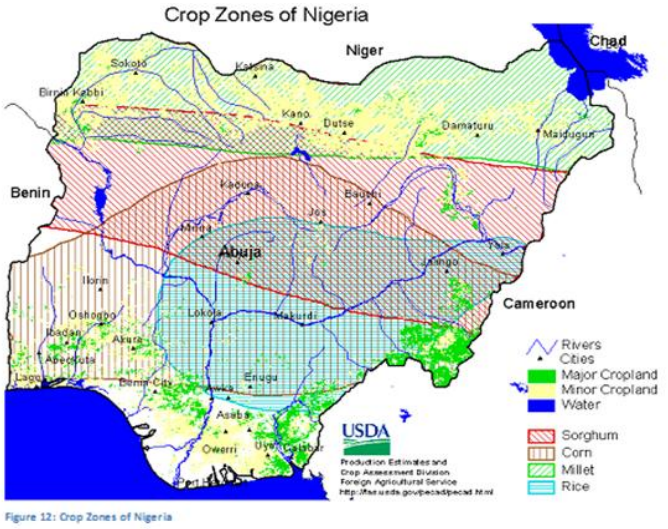

Figure 3: Crop zones in Nigeria. Source: *Google*

3.4. Hydropower

Hydro power is released from the potential energy stored in water due to the height difference between its storage level and the tail water to which it is discharged. Electrical power is generated by mechanical conversion of the energy through a turbine, at a usually high efficiency rate. The amount of power derived is dependent on the volume of water discharged, height of fall (or head), and the efficiency of the energy conversion [18].

Nigeria is endowed with large rivers and some few natural falls. Some small rivers and streams do exist within the present split of the country forming eleven river basin authorities. Researchers have shown that Nigeria possesses potential hydro-energy resources along her numerous river systems consisting of a total of 70 micro dams, 126 mini dams and 86 small sites [1]. The total exploitable potential of the country's large hydropower stands at about 11,250 MW by estimate while the small hydropower stands at 3500 MW [23]. These rivers, waterfalls and streams with high hydropower potential, will lead to decentralized use and provide the most affordable and accessible option to off-grid electricity service especially to the rural communities if properly harnessed [8]. Figure 3 shows the various water ways in Nigeria [14].

3.5. Wind Energy Potential

Although, wind power is not used in Nigeria for electricity production but the desire to seek for a lasting solution to the energy situation of country has prompted the government as well as independent researchers to assess the nation's potential for wind energy [20].

The uneven heating of the earth's surface by the sun and its resultant pressure inequalities produces wind. Wind energy potential varies with its speed and is available in Nigeria at annual average speeds of about 2.0 m^2 at the coastal region and 4.0 m^2 at the northern region of the country. With air density of 1.1 kg/m^3, wind energy intensity, perpendicular to the wind direction, ranges between 4.4 W/m^2 at the coastal areas and 35.2 W/m^2 at the far northern region [22].

There exist wind energy conversion systems like wind turbines, wind generators, wind plants, wind machines, and wind dynamos as devices which convert the kinetic energy of the moving air to rotary motion of a shaft, that is, mechanical energy. This technologies have, over the years been tried in the northern parts of the Nigeria, mainly for water pumping from open wells in many secondary schools of old Sokoto and Kano States as well as in Katsina, Bauchi and Plateau States. It is reported that an average annual wind speed of not less than 5 m/s at a height of 10 m above ground level is the feasible speed for the exploitation of wind energy at today's cost. Figure 4 shows the various wind energy location across the Nigeria [16].

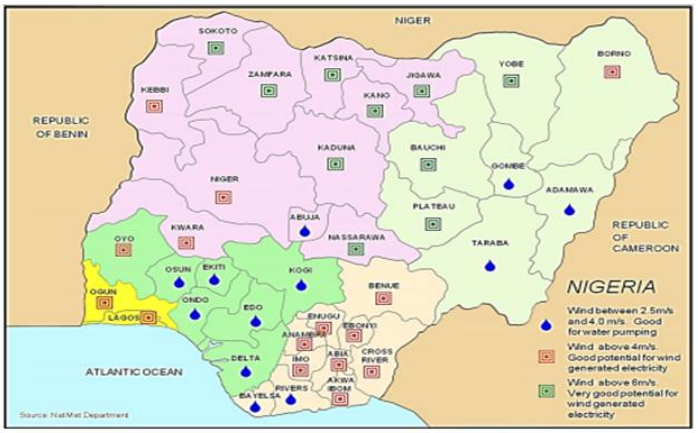

Figure 4: Wind energy location in Nigeria. *Google*

3.5.1. Challenges facing Wind Development in Nigeria

1. Non-existent policies or regulatory framework:

To foster the development of Wind Energy Technology (WET) and attract both foreign and domestic investors, the government needs to develop good policy and a framework of legal and regulatory mechanisms. This will and also set standards for wind farm development. There is no regulatory policy exists for WET as at today. Potential investors are waiting to see the level of seriousness demonstrated by the government and what opportunities will be put in place to enhance marketability of WET within the country before investing their money. Such seriousness is already being demonstrated in policy documents [18].

The WET policy must contain important market components which will serve as incentives to investors. When separate policies are made for individual energy and not a single policy to represent energy sources (combining both renewable and nonrenewable or combining all renewable energy sources together) may not be very profiting, because individual energy sources have specific dynamics and should be individualized in

policy development. Such policy should in addition, contain among other issues, the quota of WET contribution to a national portfolio energy mix. There should be specific time frame, say a specific entry year, probably 2020 which will inform the government at what pace the WET development should go and what level of investment would be required [3].

4. RECOMMENDATIONS

Here are some policy recommendations given in order to facilitate proper integration of renewables into the Nigerian electricity grid;

4.1 Wind Energy Recommendations

There should be an amendment to the Land Use Act of 1979 to encourage wind farm establishment. This should involve the activities of town planning and rural development authorities to formulate policies that will favor wind farm development to be so entrenched in such a way that it will be difficult to alter in future. Lands for the establishment of wind farms should be subsidize to encourage investors embark on WET across the country since such farms require large areas land to do so. For such farms to be of high standard, the areas marked for wind farms should be devoid of wind breaks. The nation's planning authorities should develop appropriate standards for establishing wind farms. Then WET should be integrated into the Independent Power Project of Nigeria. This will invariably encourage investors to own their standalone wind energy applications and enables avenues for linking excess generation with the national grid. The other very important step is to integrating WET into the rural development plan. In planning for the development of rural areas, concerned authorities should encourage rural-urban integration by taking note of the advantages of wind energy for power generation and how such can be used to power communities that are not connected to national grid. It would be very good innovation if wind-for-power could be considered as complementary standalone energy sources for rural development. The leveling of playing ground in the energy market between renewable and nonrenewable energy sources, by focusing on the developments of wind farms and technologies. The creation of viable and sustainable markets for the sale of wind energy within the country and developing a suitable wind map for the nation to serve as information resource for the public and willing wind energy investors will be an added incentive. There should be intensive study on wind energy as an alternative resource of energy available in the country. There should also establish a National Energy Databank which should be up-to-date as this will aid the government agency, local and international organization to properly analyze energy situation in Nigeria.

4.2 Solar Energy Recommendations

To efficiently utilize the full potential of our solar energy in the country the following are suggested:

1 The government should encourage research in the techno-economies involving the initial and subsequent costs of solar plants and their power efficiencies.

2 Subsidizing the cost of importation of Renewable Energy Technologies (RET), most especially solar PV to bring down high costs.

3 Private investors and organizations should be encouraged to invest in solar technologies.

4 The wide gap between our research bodies (universities, polytechnics and research institutes) and manufacturing industries must be bridged.

5 Awareness on solar technology and the advantages of Renewable Energy Technologies (RET), such as solar technologies should be stepped up.

6 The government can also consider placing restrictions on the importation of diesel and petrol engine generators because of their adverse effects on the environment.

7 Funding of solar technology researches and development initiatives in Nigerian Universities, Polytechnics and Research Institutes to develop solar PVs with greater efficiency and which are adaptable to our environment is advocated.

4.3 Hydro Power Recommendations

1 Develop R&D centers on renewable energy, particularly on hydro power

2 Nigeria stands to lose if its sustainable hydropower potential is not tapped. For now hydropower is her easily harnessed indigenous power source. It is also one of the very few competitive advantages for the country, since land, labor and other inputs to industrial development are costlier in Nigeria compared to other countries. Proper and efficient harnessing of hydropower will bring rapid economic development to the country since power is indispensable in any manufacturing industry. Constant power will also reduce wastage of our agricultural product such cocoa and some other fruits whose shelve life is short without being dried or refrigerated.

3 there should be mandatory energy education programs oh hydropower in all the educational levels in Nigeria. Hydropower is the nation’s major source of energy and accounts for the development of our major industries. We know that reliable and adequate electric power will reduce the cost and losses currently suffered as a result of inadequate power. Since Nigeria faces a power shortage during the peak hours, integrating other sources with hydropower will increase its capacity. This additional capacity will help in improving the voltage in the distribution network if the equipment in well maintained.

In addition to the all the above recommendations, the introduction of degree courses on renewable energy technology in Nigerian Universities.

The government should build demonstration and training projects on renewable energy in every state to encourage more participation in the learning process on this technology.

There should be energy education programs in schools, service and industrial sectors to bring renewable energy technology awareness closer to a larger portion of the society.

The output of energy will improve when there is a replacement of old energy consuming appliances and electric bulbs with new low energy saving bulbs.

There should also be a replace the old metering still in use in some part of the country to pre-paid Smart meters.

Incentives should be created for electricity retailers, utility companies as well as for final electricity consumers.

CONCLUSION

In this work, we have observed that the Nigerian electricity grid is plagued with a lot of problems ranging from insufficient and inefficient power generation facilities, transmission lines and distribution facilities, which are inadequately maintained, outdated metering system.

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Nigeria recently privatized her power sector implying that over the next decade new power plants can spring up as shown in the privatization documents.

This is a good position for Nigeria to invest and build large scale power plants from any or combined renewable sources highlighted above. The initial cost of installation of renewable energy (RE) devices in short-term is high but in the long-term, the cost is competitive with conventional energy sources. It is suggested that the government should ensure that fiscal and non-fiscal incentives are put in place to encourage private investors that are willing to invest. A deliberate effort by the government itself must be to invest intensely in yearly RE development before she can achieve great improvement in energy generation by the integration of renewable energy sources the nation's grid. The development of RE services should be linked to many other sectors like agriculture, small scale, industrial enterprises or the Millennium Development Goals. This will likely be successful if implemented in line with activities that will ensure sufficient demand for the energy services that may attract funding.

Subsidies should be provided for the initial stages of renewable energy technologies, especially those that can be locally manufactured to become financially sustainable in the short- to medium-term after a certain level of technology dissemination has been attained. Nigeria should pursue vigorously the implementation strategy of integrating other RE sources to the national grid now that she has a published energy policy which emphasizes the development RE

The current flow of information on renewable energy technologies is inadequate. Demonstration projects on various energy forms should be established widely to show case the performance and efficiency with which services are delivered. When the public is sensitized, they will as well assist in the creation of markets for RE system. There is need for capacity building both at institutional and personnel level for acquiring technical, organizational, and managerial skills in the development of renewable energy technologies. Entrepreneurship and managerial skills development training programs and technical courses in RE technologies to develop energy service companies to providing services to rural areas need to be introduced. Existing research and development centers and technology development institutions should be adequately funded to support the shift towards increased renewable energy utilization.

The limitations in this work is the lack of discussion on cost analysis benefit, Portfolio Standards, Feed-in-Tariffs and Renewable Energy Certificate to determine the best policy mechanism for renewable energy. This will be tackled in the next investigation.

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