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Review of Wind Energy Potentials and the Possibility of Wind Energygrid Integrattion in Nigeria

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Abstract: This paper reviews the potential of wind energy in Nigeria. The paper collates and explains wind energy profile for some Nigeria states. It also analyzes the prospect of stand-alone and grid connected wind turbine, the stability conditions to be met before the wind turbine can be connected to the existing grid and how it can be connected.

Index Terms: Renewable Sources, synchronization, Stand alone and Grid connected wind generator, Reliability and stability.

I. Introduction

Energy is an essential element for socio-economic development of a nation. Most sources of energy used across several countries are fossil fuel and nuclear reactors [1]. In Nigeria the major sources of energy are fossil fuel and hydro power stations. However, energy demand and supply studies conducted by the Energy commission of Nigeria (ECN), taking into consideration the economic vision 2020, demography, available energy resources and modern developmental path has indicated that higher amount of power generation will be required to meet the energy demand of the nation [2].While electricity from hydropower plant is widely acknowledged as environmentally friendly there is growing concern that energy generation through fossil fuel are hazardous to both the environment and humans as such there is need to use renewable energy sources such as wind, which are eco-friendly to complement some of these increasing energy demands[3].

Nigeria is blessed with abundant renewable energy potentials like wind energy, solar energy, etc. in spite of the abundance of these energy resources, the power supply is still grossly inadequate, this can be attributed to the underutilization of these potentials. Wind energy is one of the fastest growing technologies in energy generation industry in the world nowadays. Wind energy as a source of electrical energy is one of the sources that can produce inexpensive electricity if fully harnessed for reliable power supply in Nigeria [1].A precise knowledge of the wind energy profile at a particular geographical location is of great importance for the development and performance estimation of wind energy systems.

The main advantages of electricity generation from wind are the absence of harmful emissions, very clean, the almost infinite availability of the wind that is converted into electricityandnot susceptible to fuel price volatility.In Nigeria, where the wind power prospect is estimated to be high or moderate has not integrated these renewable resources to the grid. It is not just sufficient to say that the wind turbines should be integrated to the grid because there are adequate wind speeds to drive the wind turbine. Mostly, the stability and reliability studies must be conducted whenever wind power is to be integrated to the grid system to predict the instability this may have on the grid to which the wind generators will be synchronized.

Wind turbine can range from single turbine for domestic use of about 400W, through to large commercial wind farm either onshore or off-shore of over 10MW. The energy generated is measured in watts per hour (kilowatts, megawatts and gigawatts), the turbines currently manufacture have power ratings ranging from 250 KW to over 10 MW. To put that into perspective, a 10 MW turbine will generate enough electricity to meet the annual electricity consumption of an average house hold in 10 rural villages in Nigeria [4]. Regardless of the size of the farm, the placement of the turbine is the key to its success.In general, wind energy can be classified according to speed control and power control ability.The speed control criterion leads to two types of wind turbines:

- Fixed-speed
- Variable speed.

While the power control ability criterion, on the other hand, classifies wind energy conversion systems (WECS) into three categories [5]:

- Stall-controlled
- Pitch-controlled
- Active-controlled wind turbine

Doubly-fed Induction Generator (DFIG) is widely preferred as the electrical generator for a wind turbine because it is easy to control and its robustness. DFIG is a wound rotor induction generator with voltage source converter connected to the slip-rings of the rotor. DFIG interacts with the grid through the rotor and stator terminal. The induction generator is connected to the grid through the stator terminals, but the rotor terminals areconnected to the grid via a partial-load variable frequency AC/DC/AC converter (V) [4].

II. Power in the Win

The power in the wind is extracted by allowing it to blow past moving wings or blades that exert a torque on a rotor shaft. The amount of power transferred is expressed as: P = $\frac{1}{2}C_p A\boldsymbol{\rho} v^3$ ……………………………….. (1) Where: P = power in watts, C_p = coefficient of performance, A = swept area of blade(s), m^2, $\boldsymbol{\rho}$ = densityof air (kg/m^3) and v = average wind velocity (m/s), the wind power available to a wind turbine varies as the cube of the wind speed [6]. When the wind speed is doubled the power is multiplied eight times (power equation). As wind speed increases linearly with height above sea level, it is also a fact that extractable power available in wind increases with height. Wind speed is the most important parameter in the design and study of wind energy conversion devices [6]. Because so much power is generated by higher wind speed, much of the average power available to a wind mill comes in short bursts. The consequence is that wind energy does not have as consistent an output as fuel-fired power plant. This is why it is customary to hybrid wind power with battery bank, to ensure stability.

III. Development of Wind Energy in Nigeria

Wind as a source of energy is gradually gaining prominence around the world, although backed by long history, the technology is still new in Nigeria, unlike the sun; its availability undoubted. Wind energy is available at annual average speeds of about 3.0m/s at the coastal regions of the South and 4.0m/s at the far Northern region of the country [7].

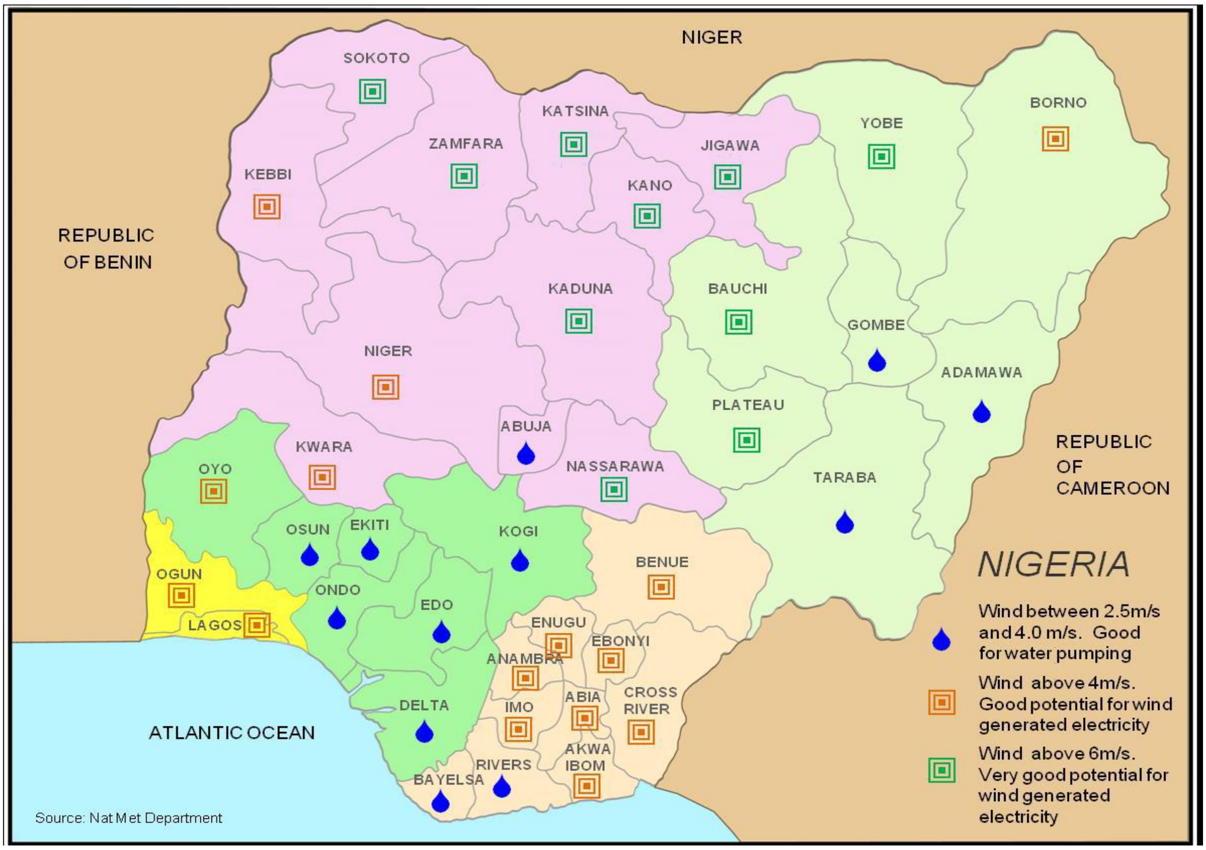

Fig. 1: Wind Speeds Across Nigerian States, Source: Nigeria Energy, Wind Power[8].

Fig.1.The Nigerian Meteorological Agency (NMA) helps to collate wind data in Nigeria from stations, mainly airports and urban centers, using various instruments. Generally, the southern parts of the country

experience relatively weak wind speeds as compared to the Northern parts, except for the coastal regions and offshore. The mountainous regions in the North, however, receive the strongest winds, consequently; major initiatives are found in the North [8]. It can be concluded that Nigeria indeed has the potential for substantial wind energy development and will need to invest in this renewable source starting from the Northern part of the country, as wind speed is highest in the region including Sokoto, Jos, Bauchi, Katsina and Kebbi States. Individual researchers on their part have made various assessments of potentials and availability to ascertain the extent of wind resources, studies have been conducted on wind turbine in Umidike, South-East, Nigeria. To assess economicviability of wind turbine at a hub height of 65 m above the ground with annual mean wind speed of 5.36 m/s using 10 years (1994–2003) [4]. Also, the statistical analysis of wind energy potential in Ibadan (a city in Oyo State of Nigeria), was carried out using the Weibull distribution function and 10 years (1995–2004) daily wind speed data. The outcome was that the city experiences average wind speed and power density of 2.947 m/s and 15.484 W/m2 [4], Work on the prospects of wind energy in Nigeria using 4 years of wind data from seven cities (Enugu, Jos, Ikeja, Abuja, Warri, Sokoto and Calabar). The annual wind speed at 10 m above the ground varied from 2.3 to 3.4m/s for sites along the coastal areas and 3.0 − 3.9 m/s for high land areas and semi-arid regions. Further works by researchers have profiled in each of these initiatives, have identified that great prospects exist for wind energy utilization for power in Nigeria [4].In 1998, a 5-KW wind electricity conversion system for village electrification was installed at SayyanGidanGada, in Sokoto State [9].

There are two larger wind farm projects been undertaking bythe federal government with the intention to improve electricity supply in Nigeria,namely 10 MW in Katsina, and 100 MW in PlateauState. As regards the 100 MW wind-power farm outsideJos, due diligence has been completed on the application for a license to operate. A provisional Independent Power Producer (IPP) license has been obtained from the National Electricity RegulatoryCommission (NERC) acknowledging that JBS WindPower Limited has met all regulatory requirements to commence operation. The smaller 10 MW Katsinapilot wind farm is being built by a French company onbehalf of the FMP and is about to be completed [10].

IV. Current State of Wind Power Innigeria

In Nigeria average daily wind speeds can be misleading since the pattern of wind can be that it is very windy in the night time with very little wind in the morning or afternoon. A few very productive windy hours can in fact be sufficient to generate the targeted amount of electricity since power is related to wind velocity cubed. The available wind varies with the seasons, with high summer (June-August) wind speeds averaging about 1 - 2 m/s less and winter (December-February) averaging about 1 - 1.5 m/s more than the yearly average. [12].

In Nigeria, currently the level of wind energy in the national energy consumption has remained low and with no commercial wind power plant connected to the national grid. Only a few number of stand-alone wind power plants were installed in some northern states mainly to power water pumps and for rural electrification, In recent times numerous studies havebeen carried out to assess the wind speed characteristics andassociated wind energy potentials indifferent locations in Nigeria. Promising attempts are being made in Sokoto Energy Research Centre (SERC) and AbubakarTafawaBelewa University, Bauchi to develop capability for the production of wind energy technologies [12].

V. The Potential for Wind Energy in Nigeria

Wind speeds are generally weak in the south except for the coastal regions and off-shore, which are windy. Off-shore areas from Lagos through Ondo, Delta, Rivers, Bayelsa to AkwaIbom States were reported to have potentialities for harvesting strong wind energy throughout the year [14]. Inland, the wind was reported strongest in the hilly regions of the North, while the mountainous terrains of the middle belt and northern borders demonstrated high potential for great wind energy harvest. It was however observed that, due to varying topography and roughness of the country, large differences may exist within the same locality [14]. The values for the wind speed ranges from a low 1.4 to 3.0 m/s in the southern areas and 4.0 − 5.12 m/s in the extreme North, at 10 m height. Peak wind speed was shown to generally occur between April and August for most sites in the analysis [15].

Table I. shows data of wind energy resources mapping for ten (10) sites in Nigeria including Sokoto collated from on ground measurement carried out between May 2004 and May 2005 also, by LahmeyerInternational. It can be seen from the table that the sites are potential wind farm areas [15]. This is because most wind turbines start generating electricity at wind speeds of around 3-4 meters per second (m/s), the table shows ranking of the wind speed at various measurement stations [15].

Table 1: Data of Wind Energy Resources [15]

Site ID	**Site Name**	**Measured mean wind speed at 30m Height (m/s)**
Sok 01	Sokoto/Badaga	5.40
Jos 01	Jos Airport/ Kassa	5.20
Gem 01	Gembu/Mambila plateau	5.00
Pam 01	South part of Jos plateau/Pankshin Hotel	5.00
Kan 01	Kano/ Funtua	4.90
Mai 01	Maiduguri/mainok	4.70
Lag 01	Lagos/ Lekki Beach	4.70
Enu 01	Enugu/Nineth mile corner	4.60
Gum 01	Gumel/ Garki	4.10
Ibi 01	Ibi metrological station	3.60

Further analysis of these wind resources also revealed that the core North, North Central and South-East of the nation possess enormous potential for harvesting wind energy, with possible wind speeds reaching as high as 8.0 m/s in the north [15].

VI. Wind Power Benefiting Nigerian States

Northern Nigeria has much better average wind speeds of 6 - 8m/s but parts of the South and mountainous Centre are in the same range. The available wind data shows that all Nigeria state can benefit from wind driven water pumping and the majority of the state can generate electricity using small wind turbines [16]. Individual locations and application will require a site survey to confirm available wind regime and guarantee long term successful operation of installed wind turbines and related applications. Individual sites will vary a lot. Worthy of note is the fact that sitting of a wind turbine
at a potential site does not just involve collation and analysis of wind data. It should also, of necessity, involve other factors and activities. These include the knowledge and analysis of the prevailing wind directions, surface roughness, topography, upwind obstacles such as trees or buildings, wind shear profile, and/or the influence of terrain contours [17].

Selected State	Area (Km^2)	Windy Area (%)	Effective Wind Area (Km^2)	1% Area (Km^2)	Potential Capacity (Mw) a	Potential Generation (Mwh/yr) B
Adamawa	37,957	45%	17,080	170	854	2244
Bauchi	48,197	50%	24,098	240	1204	3166
Borno	72,767	100%	72,767	727	3638	9561
Gombe	17,428	100%	17,428	174	871	2290

Jigawa	23,415	100%	23,415	234	1170	3076
Kaduna	44,217	6o%	26,530	265	1326	3486
Kano	20,389	90%	18,350	183	917	2411
Katsina	23,822	100%	23,822	238	1191	3130
Kebbi	36,320	25%	9,080	90	454	1193
Plateau	26,539	90%	23,885	238	1194	3138
Sokoto	32,146	90%	28,931	289	1446	3801
Taraba	59,180	40%	23,672	236	1183	3110
Yobe	44,880	100%	44,880	448	2244	5897
Zamfara	33,667	80%	26,933	269	1346	3539
Total				3,808	19,043	50,046

Table 2: Wind Energy Potentials for 14 states

Table 2 [18], indicates high wind energy potentials for fourteen selected states of the Federation. One percent of effective wind area of these 14 states has a potential to generate 50,046 MWh/yr of electricity assuming; (a) 5MW/km^{2}and (b) 30% capacity factor, from table 2 above there exit a great prospect for stand-alone and grid connected wind power in Nigeria.

VII. Stand-Alone Wind Energy

Stand-alone wind energy is an off grid power system generated from wind energy for locations that are not connected with the utility grid systems, If hybrid with battery bank it ensures uninterrupted supply of electricity to the local loads, appropriate stand-alone wind energy systems can be recommended for installation in government/private establishments, mounted on private buildings and on communication masts, thisis however base on the wind pattern of the particular location. In-ability of the wind energy system to shoulder the local loads within the standalone, when the load exceeds the output of the wind power, this will result in instability and may lead to collapse of the stand alone. This can be solved by hybridizing the stand –alone with battery bank of a reliable capacity or by allowing the wind turbine to rotate at the speed dictated by the load and wind velocity [19].

Table 2: Seasonal Variation of Wind Characteristics for Six Locations [17].

Season	Mean wind speed (10m)	K	C(m/s)	Average power density (W/m^2)	Mean wind speed (50m)
Bauchi					
Rainy season	4.39	2.60	4.94	80.37	7.11
Dry season	5.16	2.34	5.79	149.17	8.36

Nguru					
Rainy Season	3.78	2.12	4.26	78.14	6.13
Dry season	4.29	1.99	4.83	95.03	6.96
Maiduguri					
Rainy Season	5.21	3.82	5.77	116.18	8.44
Dry Season	5.36	3.96	5.94	112.52	8.69
Yola					
RainySeason	4.16	2.14	4.70	80.93	6.70
DrySeason	4.14	2.14	4.66	81.02	6.75
Potiskum					
RainySeason	4.77	2.76	5.36	101.56	7.73
DrySeason	4.84	2.82	5.41	103.03	7.82
Uyo					
Raining Season	3.67	2.14	4.13	60.71	5.93
Dry Season	2.77	1.62	3.11	58.98	4.48

Table 2, Shows wind characteristics based on the two seasons (rainy and dry) for the six towns highlighted. It can be seen that the highest wind speeds, mean power density and average energy for Bauchi, Nguru, Maiduguri,PotiskumamdUyo lies in the dry season whereas Yola observed a higher wind traits in the rainy period. As depicted in the table, Maiduguri has the highest seasonal mean wind speed of 5.36 m/s of all the six sites, occurring in the dry season together with a maximum and minimum wind power density of 122.12 W/m^2 and 116.18 W/m^2 respectively. Similar trend follows the values at 50m height with a maximum (8.69 m/s) and minimum (8.44 m/s) mean wind speeds in the dry and rainy seasons respectively. However, Uyo recorded the least seasonal wind speed and powerdensity of 3.67 m/s and 60.71W/m^2 in that order and observed in the rainy season [14]. The seasonal trend of wind speed shows that the dry periods of the year are windier than the rainy season for Bauchi, Nguru, Maiduguri,Potiskumand Uyo, while Yola has is windy in the rainy season. The six towns (Bauchi, Nguru, Maiduguri, Yola, Potiskum) analyzed above, all have good potential for stand-alone wind power the wind speed both in the rainy and dry seasons are above the minimum threshold of 4.0 m/s for wind turbine. Hence, the wind turbine in these locations can be utilized for generation and supply of wind energy to the community. However, battery banks needs to be incorporated to cater for unforeseen imbalances in the wind speed.

VIII. Prospect of Grid Connected Wind Power

In recent years, wind power generation has developed rapidly as a competitive and effective source of distributed generation. A major concern in synchronizing any level of wind generation into the grid system is siting suitable locations for wind farms. It is pertinent to state that the ability of a site to sufficiently accommodate wind generation not only depends on wind speed, but also on its ability to interconnect to the existing grid [4]. A number of literature works argue that the connection of wind power into the grid system may influence or affect power quality and stability of the system due to the;

- random nature of the wind
- characteristics of the generators technology used.

For the reasons stated above, it is important to predict the impact of the wind power on the grid system before the turbines are installed or connected at distribution level. It is not just enough to say that the wind turbines should be connected to the grid because there are sufficient wind speeds to drive the wind turbine. Mostly, the stability and reliability studies are carried out, whenever wind power is to be connected to power system to predict the instability it may have on the power system to which the wind power will be synchronized [19]. Synchronising two separate pieces of electrical network is a well-established practice it involves connection of a generator / alternator (wind turbine) to a life busbar / grid system, the following conditions must be met before two energized electrical systems can be connected; the phase angle, frequency and voltage magnitude differences between the two separate pieces of networks must be within acceptable tolerances, ± 5% tolerance between the frequency of the wind turbine and the utility grid and ±5% tolerance for voltage of the wind turbine and the utility grid. These conditions must be satisfied to limit excessive current flow when the wind turbine is connected to grid system. Hence, avoiding severe voltage and frequency fluctuations, and limiting mechanical shock to the wind turbine [20]. There are several proprietary devices and complete systems available for achieving these conditions. A complete scheme will contain; a synchroscope, phase angle voltmeter, synchronizing check relay and synchronizing relay. These devices check the differences in phase angle, frequency and voltage between two systems before allowing the circuit breaker to be closed or closing the circuit breaker automatically at the Point of Common Connection (PCC).

The synchroscope and phase angle voltmeter are used when adjusting network conditions prior to manually closing the interconnecting circuit breaker. A synchronizing check relay is used to provide an electrical interlock which prevents closing of the circuit breaker when the frequency, voltage and phase angle differences between the two systems are not within the acceptable limits [20]. At present, the share of wind energy in the national energyconsumption has remained nominal with no commercial wind power plants connected tothe national grid, only a few number of stand-alone wind power plants were installed mostly in northern states in and around the country.

Nevertheless, the prospect of connecting wind power to the national grid is quite high because of the enormous benefits to the power system distribution but the wind turbine size must be large. Wind power technology comes in a wide range of sizes suitable for a broad range of applications. Small wind turbines are up to 10 KW in size. They are used to power individual homes and are typically grid-connected, though in some cases are hybridized with dc battery system orwith solar PV. They are often used on small farms as well. Another use is for small off-grid applications such as battery charging stations, water pumping, or telecom sites [21]. Intermediate-sized turbines are typically 10 KW- 1 MW in size. They are used to power small villages, often in conjunction with hybrid systems relying on solar or diesel generators in remote areas. They can also be used to provide distributed power that is connected to the grid. Large wind turbines ranges from 1 MW and above these turbines typically are used in commercial, utility-scale wind energy applications for centralized power but can also be used for distributed power in smaller quantities. Large wind poweris also being used in off-shore wind farms. Off-shore sites tend to utilize the largest turbines, due to the costs associated with installation per turbine [21].

IX. (A) One-Line Diagram Of Wind Farm Connection To Grid System

Fig.2. .Illustrates an example of one-line diagram of wind farm connected to the grid system.

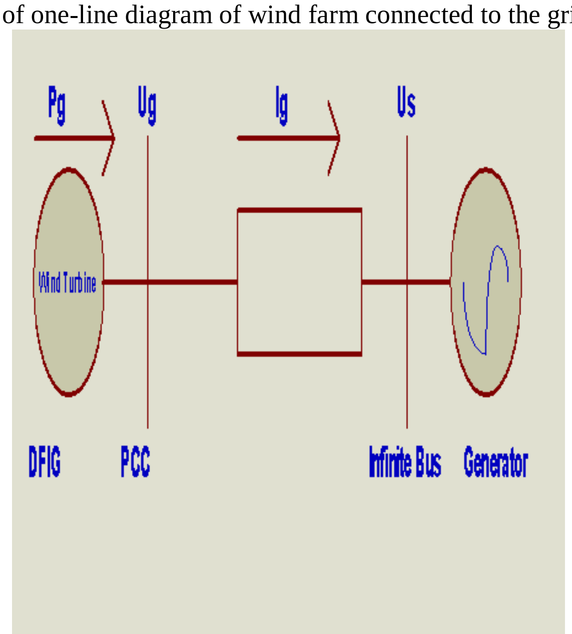

Fig. 2.0: A one line diagram of wind turbine connected to the grid system

Wind power is connected to the network with equivalent short-circuit impedance, Zk. The network voltage at the assumed infinite busbar and the voltage at the Point of Common Coupling (PCC) are Us and Ug, respectively. The output power and reactive power of the wind power are respectively Pg and Qg. The corresponding current is Ig. PCC is the point of connection of wind power with the existing system [22].

(B) CONNECTING WIND POWER TO THE GRID SYSTEM

The two methods of connecting wind turbine to the grid system are**;**

- **Parallel interconnection**
- **Roll-over**

In parallel interconnection, the wind power and the grid are invariably connected to the load and interconnected. If the wind power supply fails, the grid immediately takes over and therefore avoiding interruption of power flow to the load due to unforeseen instability [5]. This procedure applies equally when the grid supply fails. But in order to parallel wind power to the grid, a main requirement is the limitation of voltage deviation caused by the wind systems at the PCC, for which ±5% of the nominal voltage is a commonly established limit.

In roll-over mode at any given time one of the two sources is connected to the load, In case of any supply interruption then a human being or an automatic sensor operates the change over-switch so that it changes or connects the load to the other supply which is not faulty. This implies that if wind does not blow, then back-up supply from other power stations must supply the load [5].

X. Challenges Facing Wind Energy Development

The factors that tend to limit wind energy development within the country include;

(A) Non-Existent Policies or Regulatory Framework Relating To Wind Energy Technology:

The government needs to develop good policy and a framework of legal and regulatory mechanisms that would foster the development of Wind Energy Technology (WET), attract investors foreign and domestic, also to set standards for wind farm development. As of today, no regulatory policy exists for WET. Potential investors want 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 demonstrated in policy documents.

For Nigeria, the policy must contain important market components which will serve as incentives to investors. The act of making a single policy to represent energy sources (combining both renewable and nonrenewable or combining all renewable energy sources together) may not be very reassuring, because individual energy sources have specific dynamics and should be individualized in policy development. In addition, such policy should contain, among other issues, the quota of WET contribution to a national portfolio energy mix, which should be set and fixed for a specific entry year, probably 2030. With this, the nation and the public will be informed at what pace the WET development should go and what level of investment would be required [8].

(B) Poor Government Motivation on WET

Although Nigeria's governments have been looking for ways of getting the nation out of energy poverty, they have not done enough to create an enabling business environment encouraging WET development. It is well known that the initial capital cost for wind and other renewable energy technology is very high compared to other conventional energy sources. However, the governments (local, state and federal) should give tax incentives to willing investors, remove/reduce custom duties payable on importation of WET, give subsidies to sales/purchases of WET applications, provide low or interest free loans through banks for WET investors and restructure the energy framework of the nation to include WET there would be rapid embracing of the technology of wind for power generation [8].

(C). **Lack of Focus on the Renewable Energy Master Plan**

Nigeria's Renewable Energy Master Plan of 2005 (ECN-UNDP) says that the country should endeavor to increase the energy generation capacity from 5000 MW to 16000 MW by 2015 through the exploration of renewable energy resources. At present, there has not been a single grid generation of electricity from renewable energy sources besides the hydropower system, probably as a result of government's lack of focus and commitment to the plan. The government at all levels needs to be committed to a plan they have initiated and agreed to if there must be meaningful development. The Renewable Energy Master Plan will be a vital resource if there can be serious devotion to the suggestions contained therein. Part of this suggestion includes the suspension of the Renewable Energy (RE) import duties, integration of RE into non-energy sector policies, establishment of national RE development agency, standardization of RE products and establishment of RE fund to provide incentives, micro-credits schemes, training and funding. Moreover, there may be a need for the master plan to be broken down into renewable source components, with each addressing expected contributions from particular type of renewable resources [8].

(D) Lack of Adequate Funding

Lack of adequate funding has been a major setback in the growth of WET and other renewable energy technology in Nigeria. Annually, the percentage of the federal budget to education and power ministries has not been encouraging. With the meager sum made available to these ministries, much productive research and development may not be initiated or supported. Corporate bodies also need to be encouraged to collaborate with research institutions to fund research aimed at national development, some of which include wind-for-power projects (both small and medium scale turbines), nationwide wind energy resource assessment, development of adequate and explanatory national wind atlas/map that would provide information on quantity, distribution, quality and utilization possibilities to determine the commercial feasibility of wind energy generation and decision making on investment and development of national wind turbine tests and certification [8].

(E) Other Challenges

Apart from all the earlier mentioned challenges, which if overcome will move the nation forward in utilizing wind for power generation, there are other challenges which include lack of awareness and technical ineptitude. The level of awareness on the viability of wind power is very low in the country. The majority of schools' curriculum lack adequate information on wind energy and other renewable resources. Mass media too has not helped in any way, hardly any information regarding wind energy utilization or technology may be seen on the pages of newspaper or heard discussed on television or radio. This lack of awareness has also led to high level technical ineptitude, thereby making adoption of wind as veritable source of power generation a difficulty.

XI. Best Practices to Promote Wind Energy Development

In reviewing global experience with wind power development to date, and the implications for "best practices" to promote wind power development with respect to wind power deploymentin Nigeria, the following points stands out.

(A). A stable policyenvironmentis crucial to promoting wind power development. There are several different policies that have been shown to be successful in promoting wind power deployment, including feed-in tariffs, renewable portfolio standards,and tax incentives,and the choice of the best instrument may vary. However, no matter the instrument utilized, long-term certainty over the policy instrument is very important to shaping long-term investment decisions in wind power. For wind policy instruments, stable usually means at least a 5-10 year time horizon [23].

(B). Clear and transparent regulatory **guidelines** are also highly important, particularly in Nigeria setting where access to information can bemore difficult particularly for outside (often foreign) investors, but also for local investors. This can mean anything from making policies clear, easily available to the public, and accessible on the internet, to providing policy briefings and developer information and training sessions, as well as opportunities for local conferences and workshops to build stakeholder awareness. Subsidies can be useful in the early stages of wind power development, but as experience increases, assistance can be phased out over time. Cost declines should occur with experience and learning. Care should be taken to design policy support programs that allow for this gradual phase out with the rules and timing made clear up front so that investors are aware of the phase out, and so that projects don't become overly reliant on the subsidy [23].

(C). Community involvement in wind development can be critical, particularly in isolated areas or small townswhere a wind project will directly impact a local community and its support can make or break a project. Public education and outreach about wind energy can be very important to gaining project acceptance and success [22].

XII. Conclusion

The efficient synchronization of wind generators into the national grid system is very essential in order to enjoy green electricity production. This paper in particular identifies locations that are viable for stand-alone/grid connected wind power, prerequisites for synchronizing wind turbine to the grid system, It also identifies methods of integrating wind turbine into the national grid so as to ensure reliability and stability in thepower system. In most cases, modern wind plants can be added to a power grid without degrading system performance, and in some situations they can actually contribute to improvements in system performance. Research on the stability and reliability studies needs to be carried out whenever wind power is to be integrated to the grid system to predict the instability it may have on the power system to which is to be connected.

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