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Wind Energy Technology in Nigeria: Prospects, Challenges and Solution

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Abstract. This paper discusses some of the challenges of wind energy technology, solution and prospects in Nigeria. The major sources of electric power generation in Nigeria are fossil fuel and hydropower. Nigeria is well-endowed with vast resources for conventional energy (crude oil, natural and coal), as well as reasonable amount of renewable energy resources (e.g. hydro, solar, wind and biomass). It is obvious that Nigeria is lagging behind under the wind energy category. Wind power and wind electricity adoption in Nigeria, represents the least developed source of energy. Northern parts of Nigeria experiences wind speeds in the range 6.0 – 8.0 m/s, while parts of Southern Nigeria and mountainous area of the country are in the same range. It is recommended that Nigeria can effectively exploit wind energy technology, if the identified challenges are overcome and the suggested solutions are implemented.
Keywords: Wind Power, Nigeria, Wind Energy Technology (WET), Sustainable energy.

1. Introduction

Nigeria with an estimated population of above 180 million people, with an ever-increasing demand for energy. The country is located between longitude 80E and latitude 100N, and has two major seasons, wet and dry. The country's economy is largely dependent on oil. Nigeria has one of the lowest net electricity generation per capita rates in the world: 15,000 MW peak load demand to 6,050MW available capacity, resulting in an unreliable power supply and a correspondingly heavy dependence on fossil fuels in industries and residential areas [1]. Major sources of electricity production are fossil fuel, and large- and small-scale hydroelectric generation [3]. While

electricity from hydropower plant is widely acknowledged as environmentally friendly, those from fossil fuels and nuclear power have associated environmental limitations [2]. The country depends largely on thermal power plants for the generation of electricity. These are easily fuelled from the country's abundant gas reserves.

A national projection based on 13% Gross Domestic Product growth rate revealed that energy demand will increase from 5746 MW in 2005 to 297900 MW in 2030 while supply should increase from 6440 MW to above 300,000 MW within the same period of years. To accomplish this, requires an additional 11,686 MW every year to meet demand, costing for the period about $US484.62 billion (Ajayi, 2010). Nigeria is endowed with huge resources of conventional energy resources (crude oil, tar sands, natural and coal) as well as reasonable amount of renewable energy resources (e.g. hydro, solar, wind and biomass) [4-5]. The estimate of renewable energy resources in Nigeria are presented in Table 1.

Table 1: Renewable energy resources and estimated reserves in Nigeria *[4]*

Hydropower (Large/Small scale)	14,750 MW
Solar radiation	3.5 - 7.0 KWhm2/day
Wind	2 - 4 m/s at 10m height
Biomass	144million tons/year
Wave and tidal energy	150,000 TJ/year

Surprisingly, the hydropower reserve data (as shown in Table 1 and supported by other sources (e.g. [5] and [6]) is far less than the long-term target (Table 2) for this resource [4]. The overall targets of renewable energy and total electricity generation are presented in Table 2.

Table 2: Targets for renewable electricity generation (MW) in Nigeria *[6]*

Resource	Short Term (2008)	Medium Term (2015)	Long Term (2030)
Hydro (large)	1930	5930	48000
Hydro (small)	100	743	19000
Solar PV	5	120	500
Solar Thermal	-	1	5
Biomass	-	100	800
Wind	1	20	40
All Renewable	2,036	6,905	68,345
All Energy Resources	15,000	30,000	190,000

From Table 2, it is obvious that Nigeria is lagging behind under the wind energy category. On the other hand, the worldwide total cumulative installed electricity generation capacity from wind power as at the end of 2016 amounted to 486,749 MW, an increase of 12.5% compared to the previous year[7]. It is imperative to know that the amount of the economically extractable power that is available from the wind is said to be more than the current human power use from all sources [8].

However, the African continent though improving in generation capacities, represents the least developed in terms of installed wind power and wind electricity adoption. In sub-Saharan Africa, particularly the West African region, no country has yet generated grid electricity from wind despite the identified opportunities [1]. Table 3 shows the summary of the installed capacity of wind power capacity (MW) in Africa & Middle East as at the end of 2016.

Table 3: Installed Wind Power Capacity (MW) in Africa & Middle East*[7]*

Country	**Installed capacity in 2016 (MW)**
South Africa	1,471
Egypt	810
Morocco	787
Ethiopia	324
Tunisia	245
Jordan	119
Others	150
Total	**3,906**

From Table 3, the 'others' category include countries with small or minimal installed wind power capacity and they are Algeria, Cape Verde, Iran, Israel, Kenya, Libya, Nigeria

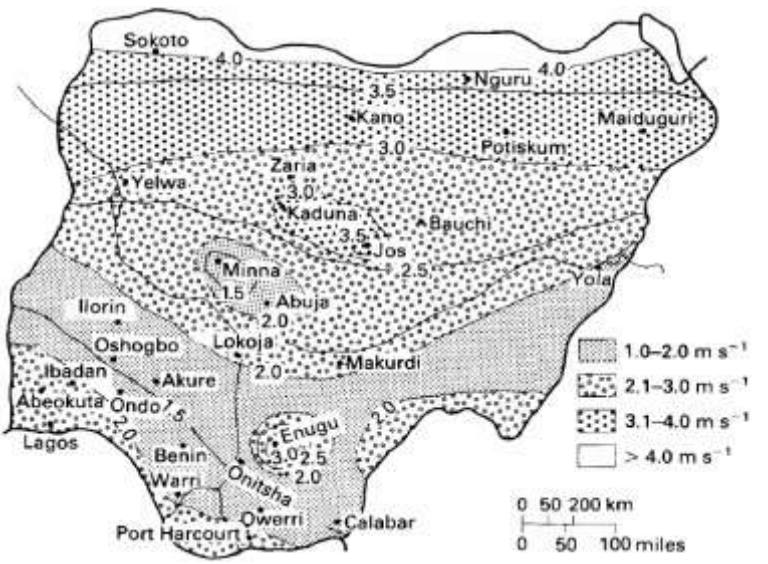
2. Wind Power in Nigeria

Individual researchers on their part have made various assessments of potentials and availability based on existing data to determine the magnitude of wind resources in Nigeria. Due to accessibility to wind speed data information, [9] and [10] reported wind speed data in one city while [11] and [10] reported wind speed data across the country [3]. The data collected by these researchers were obtained at different heights ranging from about 5 m to 15 m, but a mean average height of 10 m was agreed upon as the focal height [17-18].

The map (Fig. 1) shows the suitable use of wind power in each state, based on wind at 10 m elevation. From the map, it was deduced that Northern Nigeria experiences wind

speeds in the range 6.0 – 8.0 m/s whereas parts of Southern Nigeria and mountainous centers are in the same range. It was also noted that twelve states experience wind speeds between 2.5 m/s and 4.0 m/s thereby making it possible for borehole water pumping use. Fifteen states experience wind between 4 m/s and above, hence enabling wind generated electricity in those states. Also, ten states experience wind above 6 m/s giving them a very good potential for wind generated electricity. Further analysis of these wind resources revealed that the North, Central and South-East of the nation possess enormous potential for harvesting wind energy, with possible wind speeds reaching as high as 8.70 m/s in the north [12].

Figure 1: Nigeria Wind regime [13]



However, Fadare (2010) make use of artificial neural networks to predict the wind speeds distribution across Nigeria and compared the predicted wind speeds with measurements data from 28 stations that span between 1983 and 2003. He predicted monthly average wind speed ranging from a minimum of 0.8 m/s for Ondo (in south region) to maximum value of about 13.1 m/s for Kano (in north region) with both values occurred in December. The overall average annual wind speed of 4.7 m/s was predicted for Nigeria. The measured data presented in the study indicated that maximum average annual wind speed of 9.47 m/s was recorded in Jos (closely followed by 9.39 m/s in Kano) while minimum value of 1.77 m/s was recorded in Ondo [3]. Recorded samples of the monthly isovents for selected months using the predicted values are represented in the figure 2.

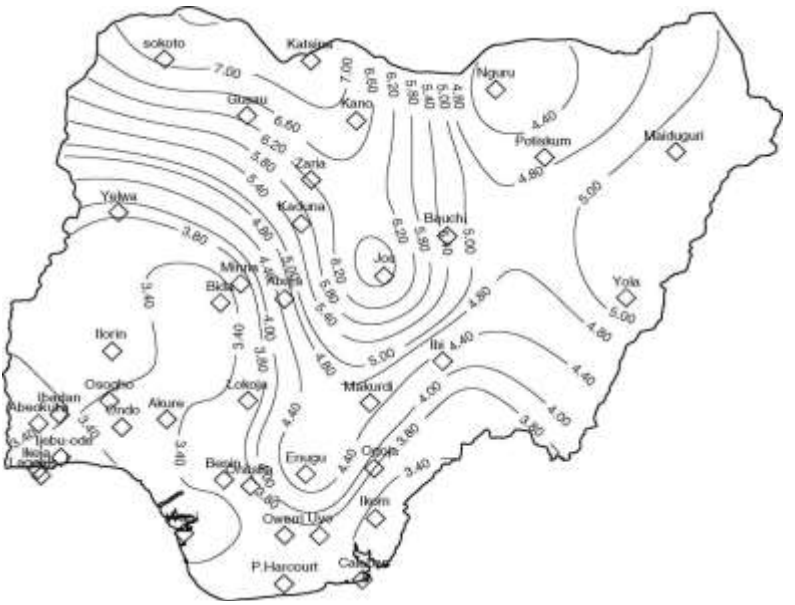


Figure 2: Predicted monthly average wind speeds (m/s) distribution (isovents at 10 m height) in Nigeria for the month of June [14].

3. Wind Energy Technology Challenges and its Corresponding Tackling Measures

3.1. Challenges

There are various challenges affecting the development of wind energy technology (WET) in Nigeria. Some of these problems are identified by [6] [15] as:

- reluctance of government and its agencies to encourage wind energy technologies,
- low government financial support and non-availability of fiscal incentives,
- lack of awareness,
- inadequate institutional framework and resource assessment, and
- technical ineptitude and limitation.

3.2. Tackling Measures

a) Development of a Robust Wind Energy Technology Policy

Investors need healthy government policy that will create a favorable environment for profitability. Incentives can be put in place such as sales tax, concessional import duties, and excise duty relief to encourage and attract investors in WET. The reassurance from the government for a viable market in WET is necessary. And this can only be expressed via policy making. This will serve as an index to rate the level of readiness the government has in supporting and promoting WET in Nigeria.

b) Research and Development

Advancement in WET can be achieved when there are established institutions, whose focus is to harness all aspects of WET, working round the clock in finding out how to increase the contribution of WET to the energy mix of the country, while laying emphasis on rural electrification as well. Having such a team on ground will ensure the growth of WET and will create a

sustainable system and accountability in WET in the country.

c) Adequate funding of WET

Interventions from government, investors, and other sources can be pulled together to setup sustainable funding for the advancement of WET projects in Nigeria. The government's serious involvement in WET will spur adequate funding as it will be easier to earn the trust of local and foreign collaborators. A special funding agency could also be setup that will solely bear the responsibility of sourcing for funds for WET.

d) Working plan & Road map

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 also funding R & D [2].

4. Conclusion

Nigeria has an enormous amount of wind energy resource that has not yet been tapped. Inland and onshore possibilities are vast for the growth of WET in the country. The government cannot afford to neglect this important aspect of energy, therefore deliberate steps must be taken to harness, preserve and sustain WET in Nigeria. This task is not a one-man affair; thus, the government must be willing to partner with countries that have vast and advanced knowledge in the technology. This will save time and set Nigeria on track with other countries developing WET around the globe. The determined pursuit and establishment of WET in Nigeria is important to the growth of the energy sector. It will reduce the fossil fuel consumption thereby preserving the environment and saving the planet at large. It will also aid in the realization of the country's vision of becoming one of the 20 largest economy in the world (vision 2020).

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