A Review of the Status of Wind Energy Utilisaton in Nigeria

Baba M. T*‡, Garba I.**

* Department of Mechanical Engineering, Faculty of Engineering, MNimechE, Federal Polytechnic PMB 35 Mubi

** Department of Mechanical Engineering, Faculty of Engineering, MNSE, Reg.Engr.COREN, Bayero University Kano

(muhammadtankobaba@gmail.com, isagar2051@yahoo.com)

‡ Corresponding Author; Baba, M.T, MNimechE, Federal Polytechnic PMB 35 Mubi, Adamawa state, Nigeria, muhammadtankobaba@gmail.com

Received: 21.11.2013 Accepted: 05.01.2014

Abstract- The paper looked into the wind energy potentials, and the extent to which these potentials were utilized in Nigeria for a sustainable environment. Reviews of past literature, reports on the subject, as well as physical survey were used to collect materials in order to accomplish this work. The paper will contribute in developing wind energy technology and utilization of wind resources across the country. From the findings, it was established that Nigeria is blessed with enormous opportunities for harnessing wind for various applications more specifically in the core northern region of Nigeria, hilly parts of the eastern, central, and offshore areas which signifies around 86% of the likely over-all yearly wind energy flux density for the Nigeria. It was also found out that wind energy utilization in the country is faced with challenges such as absence of local manufacturing for wind energy components, reluctance of government to encourage wind technologies, lack of offshore wind mapping, and low financing. The paper recommends that Government of Nigeria through its various agencies should develop more wind farm sites across the country, establish local manufacturing industries for wind energy systems, create enabling environment for investors to widen research activities.

Keywords- Wind Energy, Utilisation, Potentials

1. Introduction

Energy has been well-defined as the ability to do work [1], and also as a force multiplier that improve man's ability to translate raw material in to useful product, that provides variety of useful services [2]. Energy is a vital constituent for the progress of social economic growth; it is an important input to all aspects of the present life and certainly a backbone of industrial production, the fuel for transportation and for that of generation of electricity in a conventional thermal plant [3]. However, energy production, distribution and consumption cause major environmental concerns such as deforestation, air and land pollution, flooding etc.

The consumption of too much fuel wood comes as a result of growth of population, low technical efficiency of the non-conventional three stone stoves and lack of embracing other sustainable cooking methods and also leads to deforestation. They also function as sink for carbon dioxide, maintain diverse plants and animal life and also control the flow of water. Their loss, as shown earlier, leads to soil erosion, desert encroachment and loss of soil fertility.

Combustion of fossil fuels, particularly in the industrial and transport organizations, brought about air pollution in towns and cities. Frequent contact with smoke from biomass combustion in unventilated kitchens is the main air pollution that causes threats to the health of both occupants of the cities and rural areas. Most important, contaminations from water and soil, oil spillages from the Niger Delta region of the country were has been reported frequently. Flooding of agricultural soil upstream caused by hydroelectricity dams have also been well-known to from time to time cause destruction of the ecosystem downstream. Therefore the need for a clean source of energy like the wind is necessary.

Presently, fossil fuels such as oil and coal constitute a significant proportion of the total energy output of the world. The Nigerian energy sector especially oil and gas, has

remained the contributor of more than 70% of the country's federal revenue. Developmental programmes and security depend mostly on the revenue generated from the energy sector. Renewable energy utilization will make the contribution of energy to GDP to be higher because it constitutes around 90% of the energy used by rural population [4]. it should be well-known however that Nigeria that is situated between 2.72^0 E and 14. 64^0 E with a land area of about 924, 000 sq km has about 140 million people (i.e 15% of the Africa's population) [5]. Despite its different kind and forms, energy have been broadly classified as renewable and non renewable sources with the non renewable been the most widely used. The renewable include wind, solar, biomass, hydropower etc. Presently, renewable energy technologies are gradually used to tackle energy deficiencies and to increase the variety of services in both rural and municipal areas; but one of its sources that was not receiving much concern is the wind energy.

The wind energy technology is mature and well established although, it is still undergoing more technical development. Because of its environmental advantages and technological advancements, there is now increased global concern of its usage as a source of energy.

Wind energy can be harnessed for electricity generation, water pumping, irrigation, and milling.

Wind energy is currently the most economic renewable energy apart from hydropower, its usage, versatility, and ability to use it as a decentralized energy form make its applications possible in rural areas where it is economically and technically viable in the country. This paper is aimed at finding out the wind energy potentials in Nigeria and also to what extent these potentials are being utilized through the following objectives:

i. To encourage wind utilization in Nigeria.
ii. To reduce the country's dependence on other sources of energy such as fossil fuels.
iii. To create ways to develop wind farms and wind energy technologies.

2. Wind Power in Nigeria

Both oil and gas (fossil fuels) is abundantly available in Nigeria and the investment made by the government in power sector has been mostly limited to hydro power stations, thermal coal, and gas plants. The prospects of utilization of wind energy in Nigeria had been examined by Adegoke and Anjorin [6]. They evaluated the obtainable wind data for Akure, Bauchi and Port Harcourt and came out with the following: that the average speed of wind measured at 10metres height above the ground level for Bauchi was 4.78m/s, that of Port Harcourt was 2.56m/s and that for Akure was 0.76m/s. This showed wind turbines installation will be more preferable in Bauchi than in Port Harcourt and Akure and that the disparity in mean wind speed annually was much lower for Port Harcourt than for Bauchi suggesting that wind turbines set up in Port Harcourt would function more frequently for several years.

It has been established that wind speeds of not less than 2.22m/s was favorable for uses by windmills in the northern part of Nigeria even though this may firmly be appropriate to the kind of windmill tested and that most windmills would not be able to start at wind speeds less than 3m/s. In 2003, federal government of Nigeria accepted a national energy policy that supports the utilization of the country's energy resources, which includes renewable energy, for sustainable national development through active involvement of private organizations. For wind energy, the following policies were articulated [5].

1. Nigeria should commercially develop its wind energy resources and integrate this with other energy resources.

2. The nation shall take indispensable measures to make sure that wind energy is harnessed at justifiable costs to both providers and consumers in the rural area.

The National Energy Commission of Nigeria (NECN) is currently at the far front in leading Research and Development (R&D) efforts to develop indigenous technology in wind energy conversion systems.

3. Potentials of Wind Energy in Nigeria

Universally, Nigeria is situated is positioned between low to temperate wind energy zone. Ojosu and Salawu [7] carried out a national survey on the availability of energy from wind and its potential in the country. Information on speeds of wind and wind direction for 22 meteorological stations from the Nigeria meteorological office, Oshodi close to Lagos were used. These were based on records taken every three hour of wind for periods between 12 to 33 years (1951 - 1983). Ojosu and Salawu [7] generally appraised the potentials in wind energy for its utilization in Nigeria. They approximated the greatest energy attainable for a 25m diameter wind turbine with an efficiency of 30% at 25m height to be around 97Megawattshour/year for Sokoto, 50 Megawatts hour/year for Kano, 25.7 Megawatts hour/year for Lagos and 24.5 Megawatts hour/year for Port Harcourt. Table 2 illustrates the wind energy densities for the other parts.

According to a version by Lehmeyer International Consultants [8], wind power reserved in Nigeria at 10m high shows that a number of sites have wind regime between 1.0 and 5.1 m/s, and demonstrate that Nigeria falls in to the poorly temperate wind regime.Also it was dicovered that off shore areas from Lagos through Ondo, Delta, Bayelsa to Akwa Ibom states have potentialities for harnessing strong wind energy throughout the year.

The wind is reported strongest in the mountainous regions of the north on on-shore. Aliyu et al [9] carried out a statistical analysis of wind energy potential in north central Nigeria and found out that there was high wind power density (135.84 w/m^2) in Jos, Plateau State.

According to a research by [10] , when modeling and simulating wind energy potential of Nigeria (1990-1999), where wind data was analyzed for ten states covering the five geopolitical zone of Nigeria taken a station in each state and two states in a zone showed that the level of potential for

annual wind energy flux density was, Southern – East, South – South, and South – West zone, respectively, with the first three zones of producing around 86% the total energy on calculated from the findings.

From the fore going, it can be seen that Nigeria is blessed with enormous opportunity for harvesting wind for agricultural and power generation particularly in the core northern parts, hilly parts of the central and extern states and also offshore sites where wind is in abundance throughout the year.

Table 1. Potential of Wind Utilisation According to End Use

S/No.	AREA	Small-scale Irrigation	Domestic water supply	Livestock Water Supply	Electric Power Supply
1	Semi-Arid, Hot dry areas: Sokoto, Kano Katsina, and Borno States	GP	GP	GP	GP
2	Along the shores of Lake chad	GP	GP	GP	GP
3	Temperate Areas: Plateau, Bauchi and Gongola States.	GP	GP	GP	GP
4	Savannah, warm Humid areas: Kwara, Benue and Gongola States	LP	MP	MP	LP
5	Along the shores Rivers Niger and Benue	MP	MP	MP	LP
6	Hot humid areas: Oyo, Ogun, Ondo, Bendel, Anambra, Imo,and Cross River States	LP	MP	LP	LP
7	Coastal Areas: Lagos, Rivers, Akwa Ibom, parts of Bendel and Ondo States	LP	MP	LP	LP
8	All other Areas	LP/MP	LP/MP	LP/MP	LP/GP
9	Off shore	-	-	-	GP

Source: (Ojosu and Salawu, 1990)
GP – Good Potential, MP – Medium Potential,
LP – Limited Potential, Up– Unknown Potential

Table 2. Wind Energy Density Estimations At 25m Height

Station	Mean wind speed at 25mLevel (ms)	Monthly mean Wind Energy KWh/yr.	Yearly Wind Energy KWh-2 year	Yearly Wind energy from a wind Energy turbine in KWh/year	
				Dia=10m	Dia = 25m
Benin City	2.135	2.32	27.86	2,187.81	13,673.78
Calabar	1.702	1.12	13.42	1,053.69	6,587.53
Enugu	3.372	7.83	93.91	7,375.75	46,097.96
Ibadan	2.620	4.15	49.78	3,.909.79	24,436.19
Ilorin	2.078	1.23	14.73	1,157.06	7,230.57
Jos	4.430	16.05	192.64	15,129.60	94,559.98
Kaduna	3.605	9.91	188.88	9,36.81	58,355.08
Kano	3.516	8.57	102.86	8,078.61	50,491.28
Lagos (Ikeja)	2.671	4.36	52.32	4,099.78	25,682.52
Lokoja	2.235	2.60	31.21	,451.23	15,320.17
Maiduguri	3.486	8.42	101.01	7,933.61	49,583.17
Minna	1.589	1.05	12.60	989.60	6,185.01
Makurdi	2.689	4.44	53.27	4,183.51	26,148.85
Nguru	4.259	14.48	173.74	13,645.19	85,284.42
Oshogbo	1.625	1.07	12.81	1,006.60	6,288.09
P.H.	2.640	4.17	49.98	3,925.48	24,533.88
Potiskum	3.636	9.44	113.25	8,894.35	55,591.46
Sokoto	4.476	16.47	197.68	15,525.75	97,035.94
Warri	2.027	2.02	24.20	1,.900.66	11,879.15
Yelwa	3.360	7.76	93.13	7,314.88	45,714.59
Yola	1.824	1.45	17.34	1,361.88	8,511.75
Zaria	2.891	5.32	63.88	5,017,26	31,357.02

Source: (Ojosu and Salawu,1990).

4. Challenges of Wind Energy Utilisation in Nigeria

Various wind energy projects sprinkled across the country are not adequately maintained and some even neglected. The current projects embarked upon are slow. These minimize the utilization of wind energy in Nigeria.

According to [11], Wind energy technology development and utilization in Nigeria is faced with series of challenges such as

1. Lack of off-shore wind mapping
2. Inadequate human capacity
3. Lack of indigenous production of wind energy systems
4. Low financing
5. Lack of awareness
6. Reluctance of government to encourage wind technologies.

5. Conclusion

Wind energy utilization is increasing worldwide. The availability of wind energy potentials and the extent to which wind energy is utilized in Nigeria have been considered. Although wind energy utilization in Nigeria is now receiving attention, it is faced with various difficulties or challenges. The challenges vary from lack of offshore wind mapping, reluctance of government to encourage wind technologies, lack of local manufacturing for wind energy machinery and systems, low financing etc. If these challenges that inflict the growth of wind energy resources are overcome, utilization of wind energy in Nigeria will prosper and the country will be relief of the major energy problems. Therefore, this review will a create breakthrough for further research in the area of wind power technology, create ways on how to develop wind farms and wind energy technologies, encourage wind energy utilization in Nigeria, as well as reduce the country's dependence on other sources of energy such as fossil fuels.

6. Acknowledgements

It is recommended that research agencies and individual researchers in the relevant field should carry out more work on the wind energy potentials and utilization as this work is only a preliminary study and therefore could be considered as basis for further research. The Government of Nigeria through its various agencies should develop more wind farm sites across the country, establish local manufacturing industries for wind energy systems, create enabling environment for investors to widen research activities. The Energy Commission of Nigeria should also carry out offshore mapping.

References

[1] P.E. Tippens, Physics, 2nded. Mc Graw-Hill, New York, 2001.

[2] H.A. Sorenson, Energy Conversion Systems, Wiley,NJ. 1983.

[3] A.S. Sambo, "Renewable Energy for Rural Development: The Nigerian Perspective", ISESCO Science and Technology Vision Vol. 1, pp. 12-22, 2005.

[4] A.S. Sambo, "Strategic Developments in Renewable Energy in Nigeria", International Association for Energy Economics, 2009.

[5] A.S. Sambo, "Renewable Energy Development in Nigeria", World future Council/Strategy Workshop on Renewable Energy at Accra, Ghana, June 2010.

[6] C.O. Adegoke, and A.S. Anjorin, "Wind as an alternative energy source". J.Sci.Engr.Tech Vol. 3 Issue 2, pp. 511-524, October 1996.

[7] J.O. Ojosu,and R.I. Salawu, "Wind Energy Development in Nigeria". Nigeria Journal of Solar Energy Vol. 9 pp.209-222, 1990.

[8] Lehmeyer International Consultants. Report on Nigeria wind power mapping projects Federal Ministry of Science and Technology, Abuja. 2005.

[9] A.B. Aliyu, et al, "Statistical Analysis of Wind Energy potential based on Weibull and Rayleigh Model in North Central Nigeria". Proceedings of Conference on Applications and Design in Mechanical Engineering Paper No: 072, October 2007.

[10] O.O. Ajayi, "Modelling the Wind Energy Potentials of Nigeria", Covenant University, Ota, 2007.

[11] O.O. Ajayi, "Assessment of utilization of Wind Energy Resources in Nigeria", Energy policy Vol.37, No.2,pp.750-753,2009.