Quest Journals
Journal of Research in Mechanical Engineering
Volume 2 ~ Issue 11 (2016) pp: 08-10
ISSN(Online) : 2321-8185
www.questjournals.org

Research Paper

"Practical Analysis of A Small Wind Turbine for Domestic Use on Latitude 7.067^{0}N, Longitude 6.267^{0}E"

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Received 13 July, 2016; **A**ccepted 26 July, 2016© The author(s) 2014. **P**ublished with open access at **www.questjournals.org**

ABSTRACT: *This work focuses on the design and construction of a small wind turbine suitable for generating electricity in low wind speed regimeon Lat7.067^{0}N, Long 6.267^{0}Eat very low cost. The wind turbine was designed to generate 250 Watts of power at the rated speed of 6.5m/s. In the design process,the various components of the wind turbine were considered and all the loads liable to occur during all temporary and operating conditions were calculated theoretically and the designs were optimized to ensure that the turbine operates at full capacity.The turbine's performance was such that generation hovered between 60 and 100 in the months of October and November while it skyrocket towards 200 watts in the month of December.From performance point of view the turbine has proved to be relatively efficient for power generation in Auchi, Edo state where this work was carried out.*
Keywords: *Wind, turbine,power,energy, design, blade*

I. INTRODUCTION

The conversion of wind energy into electrical energy represents one of the most promising and challenging energy technologies that could replace the depleting and controversial contemporary energy sources. Continuous research and development, aimed at enhancing the efficiency and reliability of the system at its present state is the goal of most researchers.If this is achieved, the wind turbine, with its little maintenance costs and ecology impact will become the energy machine of the future. The kinetic energy of the wind is free, practically inexhaustible, involving no polluting residues of greenhouse controversies. Wind is a renewable energy source worthy of further studies.The primary application of wind turbines is to extract energy from the wind for mechanical and electrical applications. Hence, aerodynamics as the science and study of the physical laws of the behaviour of objects in air flow and the forces that are produced by air flows is often very apt for the design of the functional elements of a wind turbine.

The aim of this workis to design, build and investigate a 2.0m blade Horizontal Axis Wind Turbine that can work in relatively low wind regime.

II. METHODOLOGY

The windmill was built and installed inAuchi, Edo State, it should, however, be noted thatAuchidoes not represent the highest point of concentration of wind energy in Nigeria as the Northern part of the Country records higher wind power density.

Applying the governing equations while treating the blade as an aerofeol section, that is(Martin O.L., Hansen, 2008).:

$$P = F.U \qquad (1)$$

Where:

P is the power, F is the force vector, and u is the speed of the moving wind turbine part.

$$P\omega = \frac{1}{2}\rho A V^3 \qquad (2)$$

Where, vis the velocity of wind at the blades
ρ is the density of the air, A is the area of the blade (Ragheb, M., 2011).

$$P_{max} = \frac{16}{27} P_\omega = \frac{16}{27}\left(\frac{1}{2}\rho A V^3\right) \qquad (3)$$

Where $^{16}/_{27}$ = 0.59259 = 59.26% is the Betz coefficient.

$$A = \pi r^2 \qquad (4)$$

And treating the practical power extractable from the wind as
$P_p = 0.35 \times \eta_t \times P_{ma}$ (5).

Where η_t is the transmission efficiency taken as 56%
$P_p = 0.35 \times 0.56 \times P_{max} = 0.196\, P_{max}$ (6)

Then given, blade Length, L_1 = 2m, rated wind speed, AV = 6.5 m/s
Blade thickness, t = 0.0008m, air Density, ρ = 1.23kg/m,^{3}
Breath at base, b = 0.210m, L = r = 2m, $A = \pi r^2 = \pi \times 2^2 = 12.57\text{m}^2$
From the design, the power expected from the wind turbine will be,
$P_w = ½ \times 1.23 \times 12.57 \times (6.5)^3 = 2123$ Watt
And from equation (2) the maximum power available will be,

$$P_{max} = \frac{16}{27} x P_w = \frac{16}{27} x 2123 = 1258 watt$$

While from equation (6)
$P_p = 0.196\, P_{max} = 0.196 \times 1258 = 247$ Watts.
The wind turbine was consequently built, installed and experimented over a period of time.

III. PRESENTATION AND ANALYSIS OF RESULT

The technical viability of a 2.0m blade HAWT and its application in low wind regime has been assessed. Data were obtained for the months of October, November and December as shown in fig.1 and it was observed that the wind speeds which were higher during the harmattan(which became most active in the Month of December), resulted in higher power generation for the period. Point labeled H on the graph shows that the harmattan started in the second week of December.

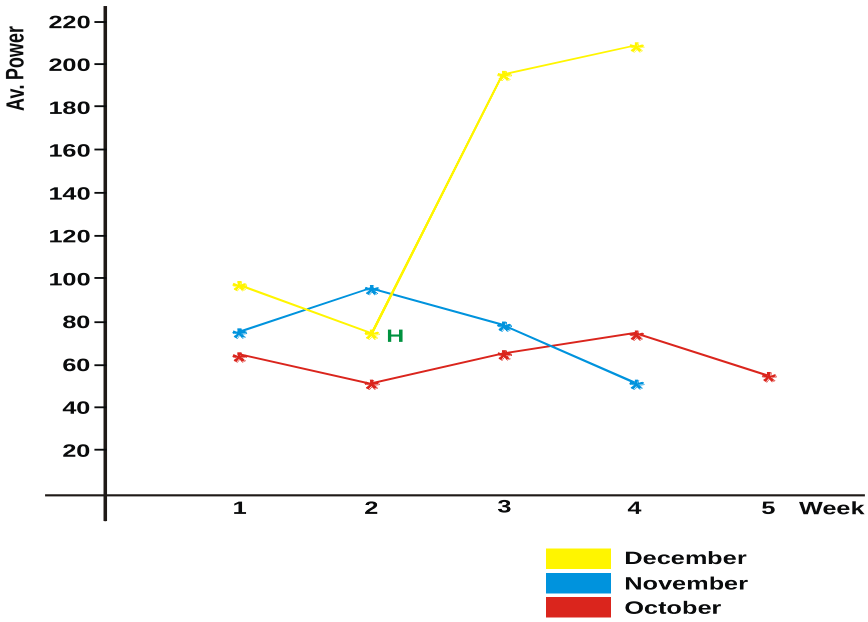


Fig.1. Graph showing power generated per week

It may be noted that generation hovered between 60 and 100 in the months of October and November while it skyrocket towards 200 watts in the month of December. Also the turbine ran over 90% of the day during the harmattan which made the selected region suitable for the technology in terms of the available wind speed. With an average wind speed of 5m/s, adequate power could be generated that would be sufficient for electricity generation.

IV. CONCLUSION

Wind power utilisation for electricity generation is a huge resource and has been proven to be capable of producing a substantial amount of the electricity meant for consumption. Small wind turbines are mostly suitable in low wind speed regimes because they have the characteristics of starting at low wind speed, thereby extracting power from the wind. However to ensure low cost and for reasons of efficiency, a careful selection of materials is necessary. Also, with higher turbine height more wind could be assessed and this will increase the prospect for higher power generation.

REFERENCES

[1]. Calvert, N.G, 1979. "Windpower Principles: Their Application on the Small Scale", Charles Griffin & Co. Ltd, London, England.

[2]. Dane Wittrup, 2013. Wind Power for the World: The Rise of Modern Wind Energy.www.academia.edu/…/9814364932

[3]. De Vries, O. 1979. Fliud Dynamic Aspects of Wind Energy Conversion, Agardograaph.No.243, Advisory Arough Aeronautical Research and Development.https://books.google.com.ng/books

[4]. Enrich Hau, 2006. Wind Turbines. Fundamentals, Technologies, Applications and Economics, Third, Translated Edition, Springer Heidelberg, New York.

[5]. Martin O. L. Hansen, 2008. Aerodynamics of Wind Turbines, 2nd Edition, Earthscan Publications, UK.

[6]. Morthorst, Paul Erik, 2002. A Green Certificatation Market for Developing Renewable Energy Technologies: Conference Article- Annual Report.ENERBulletin,No25, P.41-47

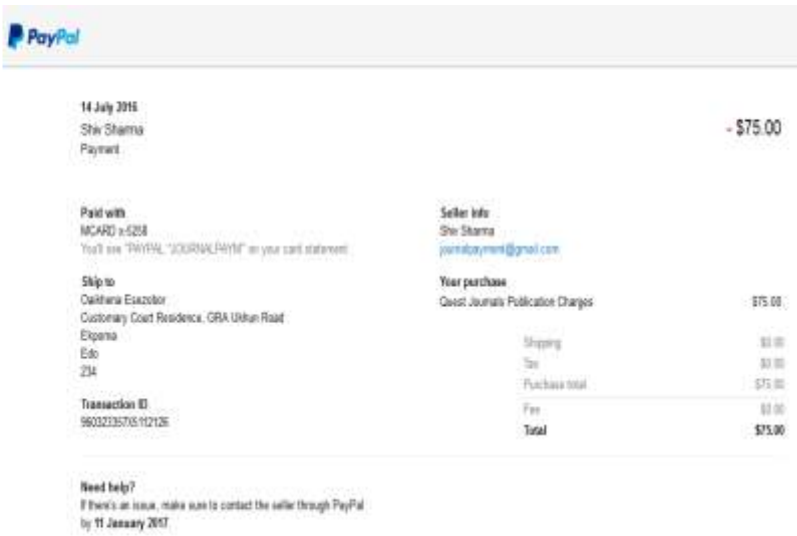
[7]. Morthorst, P.E;2003. Wind Power and the Conditions at a Liberalized Power Market. Journal Article- Annual Report, Vol.6, P.297-308.

[8]. Prandtl, L. and Tietjens, O.G,1957. Applied Hydro and Aerodynamics, Dover Publications, New York.

[9]. Ragheb, M, 2011. "wind Power Systems. Harvesting the Wind".http://netfiles.uiuc.edu/mragheb/www

[10]. Thomas Ackerman, Ed; 2005. "windpower in Power Systems", John Wiley and Sons, Ltd.UK

[11]. Triton ,D.J,1988. Physical Fluid Dynamics, 2nd Edition, Oxford University Press



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