ASSESSMENT OF WIND ENERGY POTENTIAL FOR ELECTRICAL POWER SUPPLY IN MINNA, NIGER STATE, NIGERIA

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ABSTRACT

Electricity is very important and crucial in the development of any economy; Niger State is currently experiencing serious electricity supply problem. This research assessed the potential for using wind energy for electric power supply in Minna, located on latitude 9° 36′ 50″N and longitude 6° 33′ 25″E. Five years wind speed data (2012 – 2016) of five minutes integration time was obtained from the atmospheric weather station of Physics Department, Federal University of Technology, Bosso campus, Minna, using Davis Vantage Pro 2 atmospheric measuring instrument and was converted to monthly and annual mean wind speeds. The monthly and annual mean wind speeds were extrapolated from values at 4 m to heights of 10 m, 30 m and 50 m above ground level. The Weibull 2-parameter Probability Distribution Function (PDF) and its corresponding Cumulative Distribution Function (CDF) were used in the analysis of the wind potential and the wind distribution pattern in Minna. The results of the study show that the annual average wind speed from 2012 to 2016 are respectively 1.35 ms^{-1}, 0.82 ms^{-1}, 0.91, ms^{-1} 1.06 ms^{-1} and 0.74 ms^{-1}. Furthermore, the average wind speed for the various heights of 4 m to 10 m, 30 m and 50 m are respectively 0.98 ms^{-1}, 1.11 ms^{-1}, 1.30 ms^{-1} and 1.40 ms^{-1}. Annual wind speed for the PDF are respectively 1.10 ms^{-1}, 1.50 ms^{-1}, 1.90 ms^{-1} and 2.30 ms^{-1}; the annual cut-in wind speeds are also respectively 0.5 ms^{-1}, 0.7 ms^{-1}, 1.10 ms^{-1} and 1.30 ms^{-1} and the cut-out wind speed for all the heights is 4.7 ms^{-1}. The annual wind power densities are respectively 0.66 Wm^{-2}, 1.29 Wm^{-2}, 3.41 Wm^{-2} and 5.77 Wm^{-2}. Also, the annual wind energy resources assessments are respectively 0.02 $kWhm^{-2}$, 0.04 $kWhm^{-2}$, 0.14 $kWhm^{-2}$ and 0.25 $kWhm^{-2}$. Thus, from the wind power density obtained, Minna is classified into class 1 of the PNL wind power classification and therefore not suitable for sustainable electricity generation by wind energy. Further study on assessment of wind energy potential in Minna and other parts of Niger State such as Bida, Suleja, Kontagora, especially rural areas with reduced cluster of building and trees is recommended, and for longer duration.

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ABBREVIATIONS, GLOSSARIES AND SYMBOLS

AGL = Above Ground Level

ANN = Artificial neural network

AVG = Average

CDF = Cumulative Density Function

EWEA = European Wind Energy Association

HAWT = Horizontal Axis Wind Turbine

MAX = Maximum

NIMET = Nigeria Meteorological Agency

PDF = Probability Density Function

US = United State

VAWT = Vertical Axis Wind Turbine

V_E = Maximum energy carrying wind speed

V_F = Most probable wind speed

V_m = Mean Wind speed

WED = Wind Energy Density

WP = Wind Power

WPC = Wind Power Class

WPD = Wind Power Density

WPDa = actual Wind Power Density

WPDw = Weibull Wind Power Density

WS = Wind Speed