World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:10, No:05, 2016

Wind Resource Classification and Feasibility of Distributed Generation for Rural Community Utilization in North Central Nigeria

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Abstract : This study analyzed the electricity generation potential from wind at seven sites spread across seven states of the North-Central region of Nigeria. Twenty-one years (1987 to 2007) wind speed data at a height of 10m were assessed from the Nigeria Meteorological Department, Oshodi. The data were subjected to different statistical tests and also compared with the two-parameter Weibull probability density function. The outcome shows that the monthly average wind speeds ranged between 2.2 m/s in November for Bida and 10.1 m/s in December for Jos. The yearly average ranged between 2.1m/s in 1987 for Bida and 11.8 m/s in 2002 for Jos. Also, the power density for each site was determined to range between 29.66 W/m2 for Bida and 864.96 W/m2 for Jos, Two parameters (k and c) of the Weibull distribution were found to range between 2.3 in Lokoja and 6.5 in Jos for k, while c ranged between 2.9 in Bida and 9.9m/s in Jos. These outcomes points to the fact that wind speeds at Jos, Minna, Ilorin, Makurdi and Abuja are compatible with the cut-in speeds of modern wind turbines and hence, may be economically feasible for wind-to-electricity at and above the height of 10 m. The study further assessed the potential and economic viability of standalone wind generation systems for off-grid rural communities located in each of the studied sites. A specific electric load profile was developed to suite hypothetic communities, each consisting of 200 homes, a school and a community health center. Assessment of the design that will optimally meet the daily load demand with a loss of load probability (LOLP) of 0.01 was performed, considering 2 stand-alone applications of wind and diesel. The diesel standalone system (DSS) was taken as the basis of comparison since the experimental locations have no connection to a distribution network. The HOMER® software optimizing tool was utilized to determine the optimal combination of system components that will yield the lowest life cycle cost. Sequel to the analysis for rural community utilization, a Distributed Generation (DG) analysis that considered the possibility of generating wind power in the MW range in order to take advantage of Nigeria's tariff regime for embedded generation was carried out for each site. The DG design incorporated each community of 200 homes, freely catered for and offset from the excess electrical energy generated above the minimum requirement for sales to a nearby distribution grid. Wind DG systems were found suitable and viable in producing environmentally friendly energy in terms of life cycle cost and levelised value of producing energy at Jos ($0.14/kWh), Minna ($0.12/kWh), Ilorin ($0.09/kWh), Makurdi ($0.09/kWh), and Abuja ($0.04/kWh) at a particluar turbine hub height. These outputs reveal the value retrievable from the project after breakeven point as a function of energy consumed Based on the results, the study demonstrated that including renewable energy in the rural development plan will enhance fast upgrade of the rural communities.

Keywords : wind speed, wind power, distributed generation, cost per kilowatt-hour, clean energy, North-Central Nigeria
Conference Title : ICSREE 2016 : International Conference on Sustainable and Renewable Energy Engineering
Conference Location : Montreal, Canada
Conference Dates : May 16-17, 2016