Empirical and numerical analysis of small wind turbine aerodynamic performance at a plateau terrain in Kenya

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Abstract

Kenya's energy depends on fossil fuels and the country is yet to embrace alternative sources that are environmentally friendly. In this paper, empirical and computational approaches are presented to investigate aerodynamic performance of Small Wind Turbine (SWT) operation at arid rural Mwingi-Kitui plateau region, Kenya. We used empirical statistics to represent wind resource, and Computational Fluid Dynamics (CFD) to address SWT aerodynamic performance at the site. The numerical simulations, employing Transition Shear Stress Transport (SST) model and fully mesh resolved rotor, were performed and results obtained compared with empirical methods. From the Wind Power Density (WPD) values, 44.50–85.48 W/m2 between turbine hub heights 20 and 60 m, the site corresponds to wind class ≈1; hence unsuitable for grid-connected power generation. In addition, the numerical findings give useful insights to SWT aerodynamic performance with respect to empirical approach at a plateau terrain wind regime.