A numerical analysis of unsteady inflow wind for site specific vertical axis wind turbine: A case study for Marsabit and Garissa in Kenya

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Abstract

Most of the wind analysis studies have been conducted under steady wind conditions. The study of real unsteady wind environment, however, is still an open-ended research question. This is attributable to the existing aerodynamic complexities under such conditions. In this paper, therefore, a numerical approach to investigate wind energy potential under unsteady conditions was proposed. In carrying out the study, the wind characteristics for two rural-urban towns in Kenya, namely Marsabit (2°19′N, 37°58′E) and Garissa (0°28′S,39°38′E), were selected. A CFD analysis method was used to evaluate both unsteady wind inflow performance and the flow physics that affects the performance on a Vertical Axis Wind Turbine (VAWT). Using the validated CFD model, unsteady wind simulations were performed and the results obtained compared with empirical methods. Compared to the prevailing methods, the proposed numerical approach is not only computationally inexpensive, but also robust in both steady and unsteady wind conditions. The numerical method demonstrates that Garissa station is unsuitable for grid-connected power generation, while Marsabit station is suitable for both grid-connected and stand-alone power generation activities. The study results will hopefully be of importance to the wind industries that require designs for wind turbines reflecting real unsteady wind environment.