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A Large-eddy Simulation Study of Vertical Axis Wind Turbine Wakes in the Atmospheric Boundary Layer

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Vertical axis wind turbines (VAWTs) offer some advantages over their horizontal axis counterparts, and are being considered as a viable alternative to conventional horizontal axis wind turbines (HAWTs). Nevertheless, a relative shortage of scientific, academic and technical investigations of VAWTs is observed in the wind energy community with respect to HAWTs. Having this in mind, in this work, we aim to study the wake of a single VAWT, placed in the atmospheric boundary layer, using large-eddy simulation (LES) coupled with actuator line model (ALM). It is noteworthy that this is the first time that such a study is being performed. To do this, for a typical 1 MW VAWT design, first, the variation of power coefficient with both the chord length of the blades and the tip-speed ratio is analyzed using LES-ALM, and an optimum combination of chord length and tip-speed ratio is obtained. Subsequently, the wake of a VAWT with these optimum specifications is thoroughly examined by showing different relevant mean and turbulent wake flow statistics.

Keywords: vertical axis wind turbine (VAWT); VAWT wake; Atmospheric Boundary Layer (ABL); large eddy simulation (LES); actuator line model (ALM); turbulence.