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Modeling the Influence of Wind Characteristics and the Atmospheric Stability on Wind Turbine Performances DARKO KORACIN, DRI, RADIAN BELU, Drexel University — The uncertainty of wind turbine performance measurements is closely related to the uncertainty of the wind velocity and other meteorological parameters. An inherent uncertainty in the power curve estimate is by using the wind speed measured at the hub height, as such considerable deviations often occur between the expected and produced power. Wind shear, direction changes, turbulence and atmospheric stability vary with height because of either meteorological and/or terrain conditions. The rotor size combined with the hub height of large turbines implies that turbines are often exposed to highly varying wind conditions (large wind and direction shears, turbulence and atmospheric stability) within the rotor span. These parameters will affect turbine structural safety and production. Velocity, temperature, and turbulence intensity are generated using a model developed from Monin-Obukov similarity theory and the k-ε turbulence model to resolve the atmospheric parameters (friction velocity, Monin-Obukov length, temperature scale, and roughness length). The resulting nonlinear equations were solved numerically and tested against the observations. The rotor averaged wind speed is evaluated by numerically integrating the resulting velocity profile over the rotor area. Power output estimates were compared with the available data (manufacturers and literature) and are used in the turbine design.

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