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Statistical calculation of thrust curve of a wind turbine based on available power curve and general specifications data

Evgeny Atlaskin, Irene Suomi, and Anders Lindfors
Finnish Meteorological Institute, Helsinki, Finland

Power curves for a substantial number of wind turbine generators (WTG) became available in a number of public sources during the recent years. They can be used to estimate the power production of a wind farm fleet with uncertainty determined by the accuracy and consistency of the power curve data. However, in order to estimate power losses inside a wind farm due to wind speed reduction caused by the wake effect, information on the thrust force, or widely used thrust coefficient (Ct), is required. Unlike power curves, Ct curves for the whole range of operating wind speeds of a WTG are still scarcely available in open sources. Typically, power and Ct curves are requested from a WTG manufacturer or wind farm owner under a non-disclosure agreement. However, in a research study or in calculations over a multitude of wind farms with a variety of wind turbine models, collecting this information from owners may be hardly possible. This study represents a simple method to define Ct curve statistically using power curve and general specifications of WTGs available in open sources. Preliminary results demonstrate reasonable correspondence between simulated and given data. The estimations are done in the context of aggregated wind power calculations based on reanalysis or forecast data, so that the uncertainty of wake wind speed caused by the uncertainty of predicted Ct is comparable, or do not exceed, the uncertainty of given wind speed. Although the method may not provide accurate fits at low wind speeds, it represents an essential alternative to using physical Computational Fluid Dynamics (CFD) models that are both more demanding to computer resources and require detailed information on the geometry of the rotor blades and physical properties of the rotor, which are even more unavailable in open sources than power curves.