ABSTRACT FOR EWEA 2016

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How to define the wake decay constant for onshore wind farms?

Modelling the wake effect generated by wind turbines is of high relevance for the assessment of a wind farm's expected energy production. Operating wind turbines disturb the downwind flow leading to decreased production and increased loads on the downwind turbines. The estimation of the expected wake losses is an integral part for calculating the net energy yield of a wind farm, since wake effects are often the largest source of production loss, ranging typically between 5 % and 10 % for onshore wind farms.

The N. O. Jensen model, published in 1983, is an industry standard wake model that assumes a linear expansion of the downstream wake. An important parameter in the description of the generated velocity deficit by this model is the so-called "wake decay constant" (WDC). WDC defines the expansion rate of the wake, and is strongly linked to the ambient turbulence intensity (TI): high ambient turbulence leads to a faster decay of the generated wake and therefore to lower wake losses and vice-versa.

The WDC is a user-defined parameter when running the N. O. Jensen model through the WindPRO software. The standard settings presented in WindPRO define fixed WDC values for different roughness classes; i.e. the WDC is not defined as a function of the measured turbulence intensity, but as a function of the type of landscape ("roughness-based WDC"). These settings have been used by WindPRO users when choosing the WDC. However, since the influence of the roughness on the ambient turbulence intensity is less significant at higher heights, the predefined roughness-based WDC values are rather uncertain for the current hub heights. Nowadays hub heights are considerably higher than at the time when the roughness-based WDC values were defined. Consequently, the estimated wake loss when using a roughness-based WDC is expected to underestimate the real wake loss by several percent as compared to using a WDC based on the measured TI (TI-based WDC).

This study presents results on the relation between WDC and TI based on operational data from two onshore wind farms. N.O. Jensen calculations are compared to the observed wake loss, and the WDC is adjusted until the estimated wake loss matches the observed wake loss. Based on these results, conclusions are drawn on the relation between the found WDC and the observed TI. The findings are further validated against studies from Peña et al. (2015) and Alblas et al. (2014). Even though this study is based only on data from two wind farms, the obtained results are of high relevance for the further discussion about how to more accurately define the WDC for onshore wind farms. Decreasing the uncertainty of the Jensen model while maintaining its user-friendliness will satisfy the demand for layout and yield prediction optimization for wind turbines at higher hub heights and is therefore a valuable contribution to industry practitioners.

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