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THE BLOCKAGE EFFECT AND LATERAL SPACING

A. Meyer Forsting[1], N. Troldborg[1]

[1] Technical University of Denmark, Department of Wind Energy, Correspondence: alrf@dtu.dk

ABSTRACT

The lateral spacing between wind turbines is an important parameter in wind farm development and even more so for wind turbine testing sites. The trend towards longer blades and, thus decreasing lateral spacing, necessitate a more thorough quantification and understanding of the blockage effect for an isolated wind turbine and their interaction at a wind farm level. The cases examined in this study hint towards a change in the power coefficients of neighbouring wind turbines, due to alterations of the local velocity field, even at industry common spacings. Existing research in this area is sparse, except for some low Reynolds number wind tunnel experiments [1,2]. To achieve a more thorough understanding a systematic numerical investigation is performed via Reynolds-averaged Navier Stokes (RANS) simulations, in which the wind turbine is modelled using the actuator disc method [3]. This allows prescribing a constant load over the entire radius, thus making the investigation independent of variations in the local thrust coefficient, as seen for real blades. The power coefficient evolution as a function of lateral spacing is firstly analysed for only two neighbouring wind turbines. In fig.1 the percentage increase in the power coefficient relative to that of a free wind turbine is shown to increase as the lateral distance is reduced. This effect is amplified in line with the thrust coefficient. That this is not an artefact of the constant load pattern is characterised by the curve calculated for the NREL 5-MW reference turbine [4]. In the future we will simulate configurations similar to those found at the test sites Høvsøre and Østerild with five and seven wind turbines respectively and investigate their mutual interaction for different wind directions.

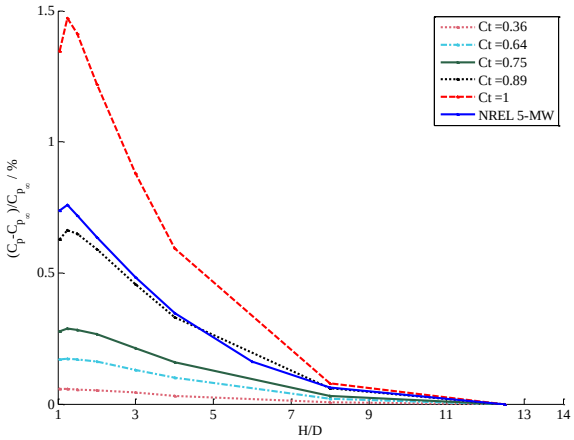

Figure 1: Relative percentage increase in the pressure coefficient as a function of non-dimensionalised lateral spacing for five constantly loaded rotors and the NREL 5-MW turbine ($U_\infty = 8$ ms^{-1}, $\overline{C}_t = 0.8$).

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