Assessment of blockage effects on the wake characteristics and power of wind turbines - DTU Orbit (08/11/2017)

Assessment of blockage effects on the wake characteristics and power of wind turbines

Large Eddy Simulations (LES) are performed in order to study the wake and power characteristics of a horizontal-axis wind turbine in a wind tunnel. Using an actuator line technique, the effect of wind tunnel blockage ratio (defined as the ratio of the rotor swept area to the tunnel cross-sectional area) is investigated for a wide range of tip speed ratios from 1 to 12, and for four blockage ratios (0.2, 0.09, 0.05 and 0.02). The results demonstrate how the blockage effect increases with the tip speed ratio. When the tip speed ratio is close to or above the optimal design value, blockage ratios of larger than 0.05 affect both tangential and normal forces on the blades and therefore on the power and thrust coefficients. At the highest blockage ratio of 0.2, the mean velocity of the wake is also affected significantly, although the effect on the wake mixing rate is less pronounced. Further, the effect of the Reynolds number on the wake development is illustrated and the impact of numerics and subgrid-scale models are investigated by comparing two different LES codes. Finally, the importance of tip loss correction in actuator-line modeling of wind turbines is illustrated using comparative computations.

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