Performance and wake conditions of a rotor located in the wake of an obstacle - DTU Orbit

Performance and wake conditions of a rotor located in the wake of an obstacle

Obstacles like forests, ridges and hills can strongly affect the velocity profile in front of a wind turbine rotor. The present work aims at quantifying the influence of nearby located obstacles on the performance and wake characteristics of a downstream located wind turbine. Here the influence of an obstacle in the form of a cylindrical disk was investigated experimentally in a water flume. A model of a three-bladed rotor, designed using Glauert's optimum theory at a tip speed ratio \( \lambda = 5 \), was placed in the wake of a disk with a diameter close to the one of the rotor. The distance from the disk to the rotor was changed from 4 to 8 rotor diameters, with the vertical distance from the rotor axis varied 0.5 and 1 rotor diameters. The associated turbulent intensity of the incoming flow to the rotor changed 3 to 6% due to the influence of the disk wake. In the experiment, thrust characteristics and associated pulsations as a function of the incoming flow structures were measured by strain gauges. The flow condition in front of the rotor was measured with high temporal accuracy using LDA and power coefficients were determine as function of tip speed ratio for different obstacle positions. Furthermore, PIV measurements were carried out to study the development of the mean velocity deficit profiles of the wake behind the wind turbine model under the influence of the wake generated by the obstacle. By use of regression techniques to fit the velocity profiles it was possible to determine velocity deficits and estimate length scales of the wake attenuation.

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