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Effect of the wake behind wind rotor on optimum energy output of wind farms

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Abstract

This study deals with the modeling of the wake effect on the energy extracted from the wind farms. It covers the wake effect of the interaction of the upstream wind rotor with/without the upstream right and/or upstream left wind rotor. A mathematical model representing a single wake model based on the linear description of the wake is developed in order to predict the wind speed inside the wake region at any downstream distance within the wind farm. Two different types of turbines with diameters of 62 m and 100 m are considered. Accordingly the effect of the wake on the energy produced from the wind farms is estimated.

A number of different wind farm layouts are studied. Case studies including 3 × 3, 4 × 4, 6 × 6, 1 × 16, 16 × 1, 2 × 8, and 8 × 2 layouts are considered. Extracted energy is calculated in each case and an optimum layout is determined from different layouts. The effectiveness of the other layouts with respect to the optimum is obtained. The results showed that there is a drop in the annual extracted energy from the above mentioned layouts depending on the W.T. distances separating the W.T.'s. The wind speed was assumed to be 15 m/s with 10*D* downstream distances. The losses are estimated to be 20% for 3 × 3 (rows × column), 32% for 4 × 4, 46% for 6 × 6, 12.8%

for 16 × 1, 23.3% for 2 × 8, and 29% for 8 × 2 when these layouts are compared to 1 × 16 layout as an optimum layout.

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Keywords

Wake effect; Wind farm; Downstream distance; Extracted energy; Wake wind speed; Wind speed behind the rotor

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