



Optimization of Wind Farm Performance Based on Yaw Angle Control

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Inside wind farms, the wakes of upwind turbines result in a significant reduction in power production. Yawing upwind turbines can be used to deflect the wakes away from turbines. Even though this reduces the power production of upwind turbines, it can potentially result in increasing the power production of the whole wind farm. The present work aims to investigate the possibility of improving the performance of wind farms by controlling the yaw angle of turbines. In this regard, wind-tunnel experiments were carried out to study the wake interactions of model turbines and their performance at different yaw angles and different layout configurations. First, it is observed that the power production of the two model turbines, located in a line parallel to the wind, is not considerably improved by yawing the first one. Next, the effect of yaw angle on the performance of a row of ten model turbines parallel to the wind flow, leading to full-wake conditions, was studied. Two configurations were considered: (a) turbines are yawed to the same direction with respect to the wind flow, and (b) each two consecutive turbines are yawed to different directions. The first configuration is found to have a better performance in terms of power production, whereas fatigue loads are lower in the second one. In the first configuration, the best power production is observed when the first turbine has a large yaw angle, and it progressively decreases for the next turbines.

Yaw angle control was also considered for the case that turbines are located in partial-wake conditions. These conditions, which commonly occur in real-scale wind farms, are achieved in the wind tunnel by shifting the downwind turbines laterally with respect to the first turbine. In this case, not only can yawing upwind turbines potentially increase the power production of wind farms, but also it can decrease the fatigue loads on downwind turbines by totally deflecting the wake away from them. In general, it is found that the control of the yaw angle in this situation can significantly improve the power even for just two turbines, unlike the case in which the wind flow is exactly parallel to the row of turbines.