# Large Eddy Simulations of large wind farms using a body force technique to estimate power production, fatigue loads and farm wakes.

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Large-eddy simulations are performed using the EllipSys3D Navier-Stokes solver developed at DTU/Risø by Michelsen [1][2] and Sørensen [3] to compute the power production, fatigue loads and wake effects of wind turbines and wind farms. The turbines in the farm are modelled using an actuator disc (ACD) method, Mikkelsen [4]. The ACD method models the rotor with body forces determined from drag and lift coefficients that are tabulated as functions of the angle of attack. The atmospheric conditions are modelled using pre-generated synthetic turbulence, Mann [5], and a prescribed boundary layer in order to save computational costs.

When turbines operate in the wakes of other turbines there are two main disadvantages. First, the turbines are exposed to higher turbulence induced dynamic loads and second, these turbines produce less energy than freestanding turbines. Power curtailment of a turbine moderates the wake generated by this turbine, which results in reduced dynamic loading and increased production for any turbine placed downstream. However, these benefits have to be put in relation to the decreased production of the curtailed turbine. A certain loss in a farm's total production could indeed be justified by a reduction of fatigue damage, especially in offshore conditions where wake effects are strong and maintenance expensive.

Large offshore wind farms are also known to produce long distance wakes. As many offshore wind farms are built, there will be more occasions when the wake from one wind farm will interact with other neighbouring wind farms. Simulation results show very good agreement for power production inside wind farms. [6] Load evaluations also show that the curtailment of individual turbines can reduce the turbine loading while maintaining the power production loss at a reasonable level. The study further shows that the internal power outtake distribution inside the wind farm affect the farm wake.

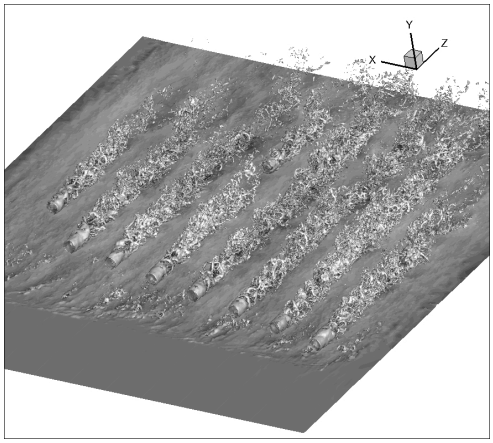


Figure 1: The figure shows simulation results of the Lillgrund wind farm using LES with a body force approach.

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