Mapping Wind Farm Loads and Power Production - A Case Study on Horns Rev 1

This paper describes the development of a wind turbine (WT) component lifetime fatigue load variation map within an offshore wind farm. A case study on the offshore wind farm Horns Rev I is conducted with this purpose, by quantifying wake effects using the Dynamic Wake Meandering (DWM) method, which has previously been validated based on CFD, Lidar and full scale load measurements. Fully coupled aeroelastic load simulations using turbulent wind conditions are conducted for all wind directions and mean wind speeds between cut-in and cut-out using site specific turbulence level measurements. Based on the mean wind speed and direction distribution, the representative 20-year lifetime fatigue loads are calculated. It is found that the heaviest loaded WT is not the same when looking at blade root, tower top or tower base components. The blade loads are mainly dominated by the wake situations above rated wind speed and the highest loaded blades are in the easternmost row as the dominating wind direction is from West. Regarding the tower components, the highest loaded WTs are also located towards the eastern central location. The turbines with highest power production are, not surprisingly, the ones facing a free sector towards west and south. The power production results of few turbines are compared with SCADA data. The results of this paper are expected to have significance for operation and maintenance planning, where the schedules for inspection and service activities can be adjusted to the requirements arising from the varying fatigue levels. Furthermore, the results can be used in the context of remaining fatigue lifetime assessment and planning of decommissioning.

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