Possible power of down-regulated offshore wind power plants

This paper proposes a method for real-time estimation of the possible power of an offshore wind power plant when it is down-regulated. The main purpose of the method is to provide an industrially applicable estimate of the possible (or reserve) power. The method also yields a real-time power curve, which can be used for operation monitoring and wind farm control. Currently, there is no verified approach regarding estimation of possible power at wind farm scale. The key challenge in possible power estimation at wind farm level is to correct the reduction in wake losses, which occurs due to the down-regulation. Therefore, firstly, the 1-second wind speeds at the upstream turbines are estimated, since they are not affected by the reduced wake. Then they are introduced into the wake model, adjusted for the same time resolution, to correct the wake losses. To mitigate the uncertainties due to dynamic changes within the large offshore wind farms, the algorithm is updated at every turbine downstream, considering the local axial and lateral turbulence effects. The PossPOW algorithm uses only 1-Hz turbine data as inputs and provides possible power output. The algorithm is trained and validated in Thanet and Horns Rev-I offshore wind farms under nominal operation, where the turbines are following the optimum power curve. The results indicate that the PossPOW algorithm performs well; in the Horns Rev-I wind farm, the strict power system requirements are met more than 70% of the time over the 24-hour data set on which the algorithm was evaluated.

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