Reliability of Offshore Wind Turbine Drivetrains based on Measured Shut-down Events - DTU Orbit (20/12/2018)

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The key objective of this paper is to investigate the frequency of normal shutdowns to be used in the design stage of wind turbines, based on measurements at an offshore wind farm and thereby quantify the impact on the fatigue loads on the drivetrain and tower top. The measured shut-downs observed on a fully instrumented multi megawatt wind turbine located in an offshore wind farm are correlated with corresponding observations of shutdowns on surrounding wind turbines. The observed wind turbines have multiple shut-downs at high mean wind speeds. The normal shutdown is brought about by initiating blade pitching to feather and also sometimes using the generator torques as a brake mechanism. The shutdowns due to wind speed variation near cut-out are predicted using an Inverse First Order Reliability Model (IFORM) whereby an expected annual frequency of normal shutdowns at cut-out is put forth.

A simulation model of the wind turbine is set up in the aeroelastic software HAWC2, based on which the observed shutdowns are simulated, along with normal operation. The simulated tower top moments are compared with the measured loads, thereby quantifying the amplification in the loads due to the shutdown action. The IFORM determined frequency of shutdowns at cut-out mean wind speed is used as an input to the fatigue load computations in the drivetrain, by which, the resulting damage equivalent loads are analyzed to quantify their coefficient of variation for varying site specific wind conditions under both normal operation and with shutdowns. The maximum coefficient of variation (CoV) due to varying wind conditions was found on the low speed shaft torsion, but the shutdowns by themselves were not seen to significantly change the fatigue loads.

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