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Structural Health and Prognostics Management for Offshore Wind Turbines: An Initial Roadmap

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Abstract

Operations and maintenance costs for offshore wind plants are expected to be significantly higher than the current costs for onshore plants. One way in which these costs may be able to be reduced is through the use of a structural health and prognostic management system as part of a condition based maintenance paradigm with smart load management. To facilitate the creation of such a system a multiscale modeling approach has been developed to identify how the underlying physics of the system are affected by the presence of damage and how these changes manifest themselves in the operational response of a full turbine. The developed methodology was used to investigate the effects of a candidate blade damage feature, a trailing edge disbond, on a 5-MW offshore wind turbine and the measurements that demonstrated the highest sensitivity to the damage were the local pitching moments around the disbond. The multiscale method demonstrated that these changes were caused by a local decrease in the blade's torsional stiffness due to the disbond, which also resulted in changes in the blade's local strain field. Full turbine simulations were also used to demonstrate that derating the turbine power by as little as 5% could extend the fatigue life of a blade by as much as a factor of 3. The integration of the health monitoring information, conceptual repair cost versus damage size information, and this load management methodology provides an *initial roadmap* for reducing operations and maintenance costs for offshore wind farms while increasing turbine availability and overall profit.