Project: Reliability Evaluation Of Offshore Wind Power Systems

Key focus: offshore wind, reliability, lifetime estimation, thermal modelling

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Background

The UK is in the forefront of the world offshore wind industry both in terms of investments and overall installed capacity. It is expected that over the course of the upcoming decade, the Operation and Maintenance (O&M) of these assets will grow into an industry worth up to £2 billion and will create tens of thousands of jobs.

One of the main challenges that need to be tackled, in order for offshore wind to continue being the ultimate renewable energy success story for the UK and the world, is increased reliability. This becomes more important as the significance of offshore wind farms (WFs) grows in terms of share in total power generation. Therefore, an unforeseen loss of WF availability does not only mean isolated economic losses but can also pose a threat to the stability of the whole power system. Nonetheless, the economic importance is also highly encouraging.

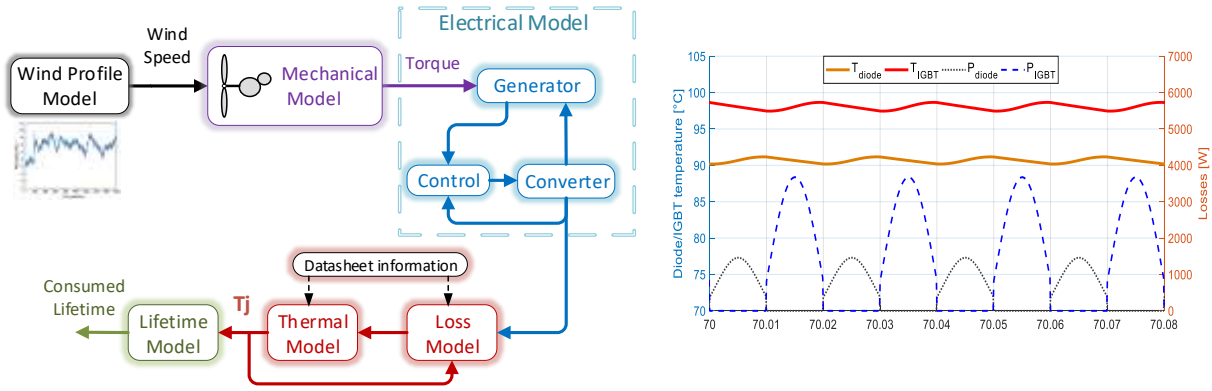

Figure 1 Power Electronic lifetime estimation methodology layout (left) and thermal cycling (right)

Project description

This project is focused on building models that ensure relevant operating and maintenance information for offshore wind power systems. It is an attempt to link a time-step operational model of a state-of-the-art technology Wind Turbine (WT) system with strength-stress reliability models for its specific components.

An extensive time-series model of a WT system combined with detailed reliability models based on physics of failure for its components is being built. Commonly these have been treated as separate disciplines because of the complexity and computational effort that the whole system requires. Hence, model order reduction is used in order to perform the analysis of interest with the necessary accuracy while also keeping the model as simple as possible. The complexity of the analysis rises because of the different failure rates and mechanisms for different WT components. One of the highest failing subassemblies is the Power Electronic (PE) unit. As part of this project, a PE lifetime estimation

methodology (Figure 1) is being developed. Other components will be added and case studies for the resulting overall WT reliability will be analysed.

Research outcomes/impact

A combined operational and reliability model can provide WT failure information which can ensure better scheduling of maintenance activity and optimal operation. As a consequence there would be a reduction of unnecessary interventions, reduction of turbine downtime, options for improved operating strategies in order to extend component lifetime. All of these ultimately lower the cost of electricity for offshore wind, which is translated to saved money for the consumers.

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