control and Uncertainties in Real-Time Power Curves of Offshore Wind Power Plants

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WP1: Preparation, Market investigation, Literature Review
Study the state of the art to form a basis for WP2
- Literature survey on Uncertainty Quantification & propagation & reduction
- Selection of candidate models & implement on historical data

WP2: Estimation and Mitigation of Uncertainty in (Available) Active Power
Develop the uncertainty module using the literature survey performed in WP1 for both online and forecast power
- Uncertainty Quantification for the real-time available power
- Convolution of the uncertainty in the real-time power & forecast available power
- Enhancement of the available power algorithm (both forecast and real-time) using machine learning uncertainty reduction techniques

WP3: Multi-Objective Wind Farm Control
Develop Wind Power Plant controller that will combine several objectives:
- Increase power production through down-regulation of the most upstream wind turbines, to extend wind turbines lifetime through better load management
- To provide cost efficient upward regulation taking uncertainties into account by optimizing the individual wind turbine set points
- A real-time load estimation procedure
- Development of WPP controller
- Integration and implementation of the dynamic WPP controller

WP4: Experimental Verification & Trading Market Aspects
Assess the economic outcome of the reduced uncertainty in WP2 and investigate the market structure after WP3 is implemented
- Offshore downregulation experiments to test outcomes of WP3 & validation
- Demonstration of the economic outcome of WP2
- Analysis of the market structure with the smart active wind farm control execution

First results

Quantification of Uncertainty in Real-Time Power Estimation
- The real-time (1-sec) power estimation performed using PossiPOW algorithm [1,2]
- The input uncertainty from SCADA [3,4] is propagated
- There is a clear advantage in using turbine manufacturer’s (e.g., “original”) CS surface for SCADA-based algorithms
- For PossiPOW, the uncertainty in the second-wise power estimation is quantified to be 5%.

Effect of Flow Model on Optimum Operation Strategy
- Commonly used flow models are compared on 8 turbine array from Liljgrund wind farm
- Large variability in optimum operation strategies and predicted power gains shows need for further investigation in LBS [5]

References
3. “IEA 64.0 kW-3L, and turbines: part D: 3L: Power performance of windly producing wind turbines based on a turbine array”, in: Technical Reports, Sønderborg (DK)
4. “IEA 64.0 kW-3L, and turbines: part D: 3L: Power performance of windly producing wind turbines”, in: Technical Reports, Sønderborg (DK)

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