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Investigating short-term power fluctuations of large offshore wind farms

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In recent years there has been a significant change in the distribution of wind capacity across the UK, with a shift towards very large offshore wind farms clustered together within several allocated zones. However, this change brings uncertainty for the operational planning of the power system. Firstly, wind farms of the scale built/planned are likely to influence the near surface winds sufficiently to impact the performance of adjacent farms. Secondly, small scale fluctuations in the wind can produce large local power swings (or "ramps"), which can lead to an imbalance between supply and demand if they are not well forecast.

This study investigates the power characteristics of a cluster of offshore wind farms located in the Thames Estuary region (1.7 GW of capacity across five separate wind farms). A fuzzy logic algorithm has been applied to metered generation data to identify the high frequency ramping events that occurred in 2014. For these events, the Weather Research and Forecasting (WRF) model has been used to investigate the nature of the wind resource at a high spatio-temporal resolution, taking into account the wake effects of the individual turbines. The output from the model has been used to determine the meteorological drivers for these events and determine the synoptic scale systems associated with large wind power fluctuations.

The analysis has shown that the largest ramping events typically occurred as a low pressure system and the associated weather fronts moved across the region. On 15 occasions there was at least a 40% ramp in capacity factor within a 30 minute time window which coincided with a small band of post-frontal rainfall. In comparison, the fluctuations due to a change in position of the wind farm wakes are relatively small (never exceeding a change in capacity factor of 7%).