2.4 Increasing Certainty in Offshore Wind Energy

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Abstract (Technical Topics and Desired Outcomes):

Background: Wind turbine array wake analysis leads to uncertainty reduction and better wind farm layouts and control strategies. This (i) reduces costs, thus enabling a displacement of fossil fuels thereby (ii) cutting carbon emissions and (iii) reducing dependence on insecure imports. Offshore wind farm design based on improved wake modelling to reduce wake losses will result in at least 0.2% reduction in the Levelised Cost of Energy (LCoE).

Objectives: The use of numerical simulation techniques for a-priori design of wind turbine array layout and control strategies is highly desirable - if the simulation results are accurate. Underlying models for the use of CFD in aerospace, automotive and civil engineering have been well validated. This is not the case for wind energy.

Turbulence parameters for turbine wakes have been lifted directly from standard aerospace-scale models without great consideration of the tuning that has been applied - or in some cases the formal bounds of applicability. The industry is now inserting LIDAR and other direct measurement systems into large wind farm arrays to provide in-situ and in-service data feeds, but integration with design simulation models is virtually non existent.

The performance of the overall array is assessed in terms of the LCoE - a formal framework from the Department of Energy and Climate Change (DECC). LCoE includes operational, capital and risk of the array over its life. This provides a solid model for assessing the impact of uncertainty reduction. The model explicitly includes the cost of financing as a function of output power uncertainty over the lifetime of the turbine array.

The physical parameters to be included as input to the simulation process include location, layout, type and control laws for the turbines. More detail is included in the location and wind / sea characteristics; turbine model and definition - blade / section types, power curve and control laws; layout; simulation parameters (turbulence model, boundary conditions - atmospheric profiles). These parameters are all subject to uncertainty on input. The qualitative characteristic definition of many of these input uncertainties is not mature.

UQ&M Aspirations: Uncertainty in the pre-construction energy predictions for offshore wind farms can be reduced with accurate CFD-based wake analysis.

Resources Available for this Problem:

- Raw wind-tunnel data as a surrogate for wind farm data
- A technical reference guide for the CFD solver zCFD, and
- Access to zCFD

Potential Tools of use:

- Tools for time-series analysis

References:

1. Full problem details can be found here: Increasing Certainty in Offshore Wind Energy. A presentation will be given on the first morning of the Study Group.