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SOWFA modelling for wind farm control strategies

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Wind farm control strategies are designed using wind farm models built to consider wind turbine wake interaction. The most diffused models are FLORIS and Jensen, which are tools able to model the wake characteristics based on wind turbine thrust and flow turbulence. The CL-Windcon H2020 project defines a set of wind farm arrangements using the reference Innwind 10MW turbines. One important task of the project is the high-fidelity modelling of wind farms using the SOWFA framework for modelling the wake interaction of wind turbines. The project is supported by Alisios PRACE grant.

Wind farm control strategies rely on wind farm power production, that is not based on maximum turbine power production, but looking at the larger wind farm picture. The main source of power losses in wind farms can be imputed to rotor wakes. Therefore, wake redirection or wake deficit reduction are strategies for maximizing the power extraction and/or extend the wind turbine's life.

The FLORIS model, like other wind farm control-oriented models, needs an accurate modelling of wind turbine wake and wake interaction. To tune these models, a set of SOWFA wind farm computations is realized to determine the wake characteristics. Wake characteristics are tuned as a function of wind turbine yaw with respect to incoming wind and wind turbine de-rating with respect to nominal power.

The SOWFA [1] numerical tool has been recently updated by NREL with the wind farm control features, using a wide range of rotor modelling tools, such as actuator disk, actuator line, and actuator line coupled with structural dynamics using OpenFAST. The different modelling details allow for different control algorithms, based on pure energy harvesting considerations, as well as for wind turbine loads.

CFD analysis allows to test the performance wind farm control strategies compared with standard wind farm operation, where each turbine is operating to extract the maximum power.



Figure 1: Wind turbine wake interaction on three not aligned Innwind 10MW wind turbines.

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^[1] Fleming et al. The SOWFA super-controller: A high-fidelity tool for evaluating wind plant control approaches, *EWEC 2013. 3. 1561-1570*, (2013)