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Cost of energy (COE) is the most important single factor in deployment of renewables in the energy system, and reduction of COE is therefore obviously a high priority. Reduction of COE is, among other things, directly related to operational control of Wind Power Plants (WPP) as a whole though specified control settings of the individual wind turbines (WT).

This presentation presents an optimization study performed with a newly developed platform for optimal open loop control of WPP's [1] from a production perspective, and to exploit the enhanced capability of the platform following from the generalization to evaluate the efficiency of different types of active wake control. The original platform included two design variables per WPP WT - tip speed ratio and collective pitch setting. In the generalized platform, the design space is expanded to three design variables per WT by adding the yaw error setting of each WT within the WPP, thus in addition to WT de-rating also facilitating active wake deflection as a control action.

By using the extremely fast full-blown linear CFD RANS model Fuga [3], [4] to simulate the internal WPP flow field, inclusion of all essential interactions between the WTs are assured. The individual WPP WTs are modeled as actuator discs and specified based on power- and thrust coefficients, $Cp(U|\alpha, \lambda, \theta)$ and $CT(U|\alpha, \lambda, \theta)$, both of which are conditioned on collective pitch setting (α), tip speed ration(λ), the WT yaw error (θ) and where U denotes the mean wind speed. In the WPP control optimization loop, $Cp(U|\alpha, \lambda, \theta)$ and $CT(U|\alpha, \lambda, \theta)$ are obtained from surrogate models based on full aerodynamic simulations of the WT rotors, however, assuming stiff blades and tower. The offshore Lillgrunden WPP will be used as a showcase.

Three different sets of optimized control schemes for the Lillgrund offshore wind farm are derived conditioned on ambient mean wind direction and wind speed: 1) Optimal WPP control schedules as based on WT de-rating; 2) Optimal WPP control schedules as based on WT wake re-direction (facilitated by yawing the WTs by purpose); and 3) Optimal WPP control schedules as based on integrated WT de-rating and yawing. For each set of control schedules, the aggregated increase of the annual energy production compared to the base case (no WPP supervisory control) is evaluated using the site sector Weibull distributions combined with the site wind direction probability density function.

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