ABSTRACT: Traditional wind farm modeling and control strategies focus on layout design and maximizing wind power output. However, transitioning into the role of a major power system supplier necessitates new models and control designs that enable wind farms to provide the grid services that are often required of conventional generators. This talk introduces a model-based wind farm control approach for tracking a time-varying power signal, such as a power grid frequency regulation command. The underlying time-varying wake model extends commonly used static models to account for wake advection and lateral wake interactions. We perform numerical studies of the controlled wind farm using a large eddy simulation (LES) with actuator disks as a wind farm model. Our results show that embedding this type of dynamic wake model within a model-based receding horizon control framework leads to a controlled wind farm that qualifies to participate in markets for correcting short-term imbalances in active power generation and load on the power grid (frequency regulation). Accounting for the aerodynamic interactions between turbines within the proposed control strategy yields large increases in efficiency over prevailing approaches by achieving commensurate up-regulation with smaller derates (reductions in wind farm power set points). This potential for derate reduction has important economic implications because smaller derates directly correspond to reductions in the loss of bulk power revenue associated with participating in regulation markets.

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