

Reducing Turbine Interaction Damage with Advanced Fluid Dynamics and Wind Farm Control

Wind power has become an increasingly important source of renewable energy. While wind turbines today are more powerful and efficient than ever, challenges remain for the large-scale integration of wind energy into the electric grid. Electrical power from wind farms is highly intermittent, and turbines in wind farms require frequent maintenance. In addition, wind farm operators currently lack the ability to accurately model and account for the spatial and temporal variability of the wind and the complex turbine-turbine wake effects that occur in large wind farms. The enhanced turbine maintenance in wind farms is thought to result from high-frequency blade forces and accelerations that result from interaction between the turbulent vortices shed from upstream turbines impacting and being cut by downstream turbine blades. The unsteady force and bending moments on the blade caused by vortex interaction translate into increased wear on the turbine drive train and gearbox. We seek to develop improved wind farm control methods, based on a better understanding of the fundamental physics of turbine wake interactions, which reduce both power intermittency and turbine interaction damage. Specifically, we are employing computational fluid dynamics codes to simulate interactions between wind turbines and to use results from these simulations to improve turbine wake interaction models. These improved models are then being implemented to enhance wind farm operation using a model predictive control approach.