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Influence of atmospheric boundary layer wind speed and direction shear on utility-scale yaw misaligned turbines[1] MICHAEL HOWLAND, Stanford University, JOHN DABIRI, California Institute of Technology — The intentional yaw misalignment of turbines in a wind farm to deflect energy deficit wake regions, or wake steering, has demonstrated potential as a wind farm control approach to increase collective power production. The potential for wake steering depends, in part, on the power reduction of yaw misaligned turbines. In the atmospheric boundary layer, the sheared wind speed and direction may change significantly over the rotor area, resulting in a relative inflow wind speed and angle of attack to the blade airfoil which depends on the radial and azimuthal positions. In order to predict the power production for an arbitrary yaw misaligned turbine based on the incident boundary layer velocity profiles, we develop a blade element model which accounts for wind speed and direction changes over the rotor area. A field experiment is performed using multiple utility-scale wind turbines to characterize the influence of yaw misalignment and the incident velocity profiles on the resulting turbine power production, and the model is validated using the experimental data. The power production of a wind turbine is asymmetric as a function of the direction of yaw misalignment and depends on a nonlinear interaction between the yaw, the incident wind conditions, and the turbine control system.

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