

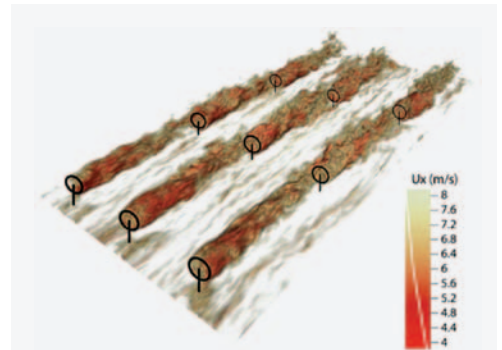
New Aerodynamics Simulations Provide Better Understanding of Wind Plant Underperformance and Loading

Researchers at the National Renewable Energy Laboratory (NREL) develop a high-fidelity large-eddy simulation model designed to predict the performance of large wind plants with a higher degree of accuracy than current models.

As the market for wind energy grows, wind turbines and wind plants are becoming larger, but the power production of these large plants has, in some cases, been lower than initially predicted. Wind plant underperformance has become an industry-wide issue that could cost developers millions of dollars over the life of a plant. Another issue with wind plants is the higher-than-expected mechanical loading that is leading to higher maintenance costs.

The primary contributor to these issues is a misunderstanding of the power losses caused by the wake from upwind turbines. A wake is a slower, more turbulent flow that exists downwind from a turbine. Current models rely on simplified empirical methods that are not always representative of realistic atmospheric turbulent events. NREL's simulation tool, designed for operation on NREL's new 15,000-processor computer, uses the OpenFOAM framework to study wind turbine wake interaction with other wind turbines, the interaction of the wakes with the surrounding atmosphere, and the effect of both of these on power production and mechanical loading.

NREL researchers are currently coupling this wind plant simulation tool, which simulates the region within and immediately surrounding the wind plant, with a mesoscale weather forecasting tool that simulates the weather on a scale of a few hundred kilometers surrounding the wind farm. Such a coupled tool will allow NREL researchers to simulate events such as frontal passages through a wind plant and their effect on turbine power production and mechanical loading.



Key Research Results

Achievement

NREL researchers have developed a high-fidelity large-eddy simulation model that predicts the performance of large wind plants with a higher degree of accuracy than current models.

Result

NREL's more accurate wind plant aerodynamics model will provide insight into dominant physical phenomena that may impact the planning of large wind plants for maximum performance with minimum maintenance requirements.

Potential Impact

This research will increase the performance of large wind plants, reduce the cost of wind energy, and save wind plant developers millions of dollars in lost revenue through more efficient planning processes and more optimal operation of wind plants.