Efficient wind turbine

Efficient wind turbine

Official websites use .gov A .gov website belongs to an official government organization in the United States.

Secure .gov websites use HTTPS A lock (Lock Locked padlock) or https:// means you"ve safely connected to the .gov website. Share sensitive information only on official, secure websites.

Like musicians in an orchestra, the components of a wind system deliver the best performance when they work in concert. Finely tuned and synchronized instruments are the key to striking the right pitch-and propelling wind energy forward.

As momentum for clean energy continues to build across the United States, U.S. Department of Energy DOE-funded efforts are underway to dramatically increase the maximum amount of electricity wind farms can produce when operating at full capacity. Two recent projects funded by DOE"s Wind Energy Technologies Office are helping industry expand wind power capacity.

The American WAKE experimeNt (AWAKEN) is compiling the world"s largest and most comprehensive dataset on wind energy atmospheric phenomena, detailing how wind and surrounding air particles interact with wind turbines and wind farms. This dataset could be used to improve the flow of wind through the average wind power plant and boost potential electricity output by 5%-enough to power approximately 4,000 homes each year.

Turbine placement--either within a single wind farm or across several--can impact wind speed and the amount of power downwind turbines can produce. This is known as the "wake effect," or the change in the flow of wind after it interacts with a wind turbine or plant.

The project leverages the expertise and resources of DOE"s National Renewable Energy Laboratory (NREL) and its partners, including Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory, and Sandia National Laboratories, as well as universities, research institutions, and industry.

Wakes are among the least-understood physical phenomena in wind plants. Until recently, models and simulations could estimate how winds might move through multiple turbines, but insufficient observational data existed to back up projections. This means researchers, developers, and operators still needed to estimate how much energy loss occurs in wind systems downwind from other plants but could not accurately quantify wake effects.

New observations made by the AWAKEN team, which confirmed the existence and measured the extent of wind farm wakes, are likely to trigger new innovations in wind farm siting and operation.

As a result of the team"s findings, "designers and developers may decide to spread wind turbines over more acres or position them differently to regenerate winds between plants," said NREL Senior Engineer and AWAKEN Project Lead Patrick Moriarty. "In some cases, wind plants may intentionally capture less wind and allow some of it to go through to neighboring downwind wind turbines or plants."

Researchers already knew wakes reduced wind speeds and power output while increasing costs and turbulence for downstream turbines, but they had not quantified the cumulative impact of these effects. Recently, the AWAKEN team gathered more precise observational data using an array of sensors and created a 3D picture of how wind currents move around the turbines. This made it possible for the team to study the effects of large-scale wakes across distances of 20 miles and encompassing multiple wind plants, then conduct unique simulations of interactions based on observations.

Not surprisingly, wind turbines reduce the wind speeds not just within the immediate wake but also above the wind plant, making less energy available downwind. This means there may be some mutual benefit from cooperation between neighboring wind farm operators if they are waking each other at different times.