U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

The American WAKE experimeNt (AWAKEN)

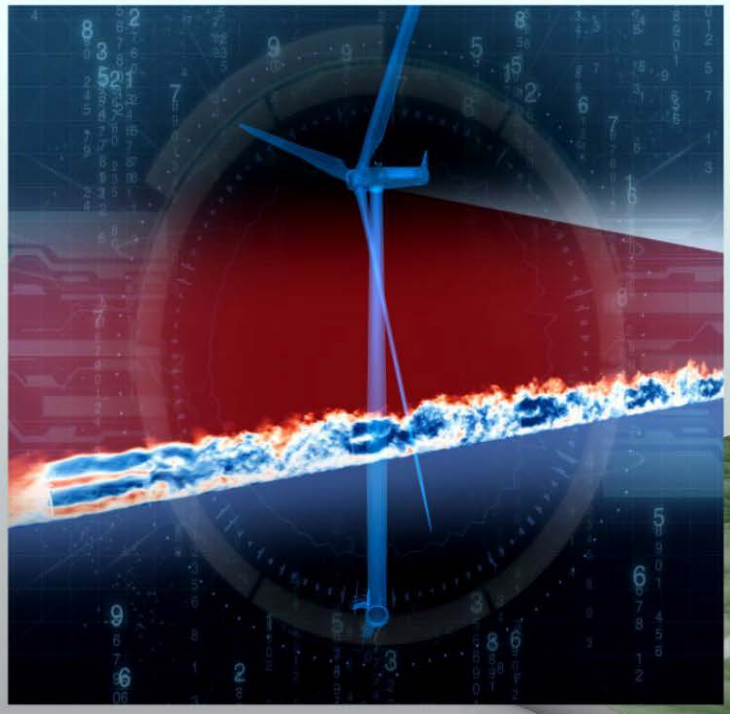
Groundbreaking International Field Research Addresses Wind Farm Atmosphere Interactions

Wind energy has become a low-cost renewable power source worldwide. To increase the energy output of wind farms, operators must minimize the effects of wakes—one of the least understood physical phenomena in wind plants today—which may result in a plant losing 10%–15% of its potential electric energy output.

As wind turbines rotate to extract energy and generate electricity from wind, they agitate the air around them, creating a wake like those formed behind a moving boat. Wakes reduce wind speeds, increase turbulence for other turbines downstream, reduce power output, and increase operation and maintenance costs. To reduce wake effects, operators need a better understanding of how air moves around turbines and how individual turbines interact with one another in the wind farm.

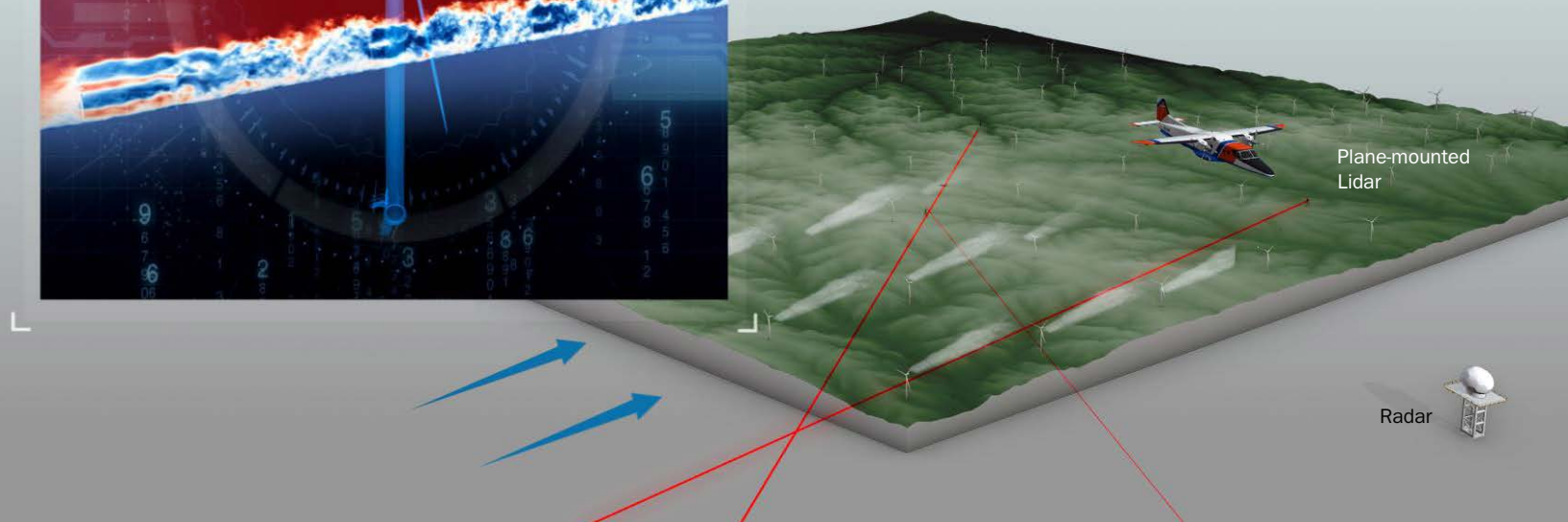
To help provide that understanding, the U.S. Department of Energy's (DOE) Wind Energy Technologies Office (WETO) funds the American WAKE experimeNt (AWAKEN). AWAKEN is an international, multi-institutional wind energy field campaign designed to answer the most pressing science questions about the impacts of wind turbine wake effects. From now through October 2023, AWAKEN researchers will use sensors, drones, and aircraft to gather data about the atmosphere and wind around and within operational wind farms. Researchers will analyze and report the data through 2024, with the aim to help validate wind farm models and advance understanding of wind farm behavior.

AWAKEN is part of a larger DOE effort to understand and improve the efficiency of wind plants. The project leverages the expertise and resources of a variety of partners—from DOE national laboratories to international academia, research institutions, and industry.



Visualized simulation of measurement data

How winds move between wind turbines in a wind plant is not well understood, but these data could help wind farm developers improve their plant's energy production and profits. That's why a team of researchers at the National Renewable Energy Laboratory launched an international study to create the most comprehensive map of atmospheric phenomena in and around wind turbines.



Field Research Benefits

With leadership from DOE national laboratories, AWAKEN project participants will organize, design, and execute the campaign, which is designed to:

- Produce a high-quality, comprehensive, globally available data set to advance the knowledge of how air moves within wind plants and between plants situated close to one another.
- Verify which of the tactics wind farms use to reduce wake losses and increase wind plant power production are most effective, reducing uncertainty for wind farm operators.
- Validate and improve existing wind plant simulation tools (e.g., ExaWind and FLORIS) that will create a more complete picture of how atmospheric changes affect wind turbines and wind farms.
- Inspire instrumentation innovation to enable better observations and enhance understanding of wake and other atmospheric interactions.

By collecting and sharing high-quality data and validated modeling techniques, AWAKEN's groundbreaking research will improve existing wind farm operations and develop new insights to enhance the capability of future wind farms.

The Wake Experiments

From 2022 to 2023, the AWAKEN research team will conduct field research in Oklahoma.

Designated Test Site: AWAKEN researchers chose a field campaign site that includes several wind farms in Oklahoma, between Ponca City and Enid. After equipment installation is completed in 2022, data collection will take place through 2023.

Data Collection Equipment: AWAKEN researchers will use scanning radars, lidars, and aircraft—each providing unique and complex measurements—to map the details of winds and turbulence around the wind turbines.

DOE's Wind Data Archive and Portal will host the data, allowing the AWAKEN research team and worldwide collaborators to paint a full picture of how wakes behave and to improve strategies to mitigate wakes and optimize power capture.

Data Analysis and Reporting: Collaborative efforts to analyze and report the data through various publications and dissemination efforts will conclude in 2024.

Project Outcomes

AWAKEN will result in a unique data set that will help:

- Significantly decrease the estimated 10%-15% loss of annual energy production caused by wake effects.
- Validate and improve wind farm models to predict future performance and wake impacts, ultimately reducing the uncertainty levels of current industry tools by half, if not more.
- Predict wakes, plant conditions, and turbine operation strategies to improve plant layout, power output, and turbine reliability.
- Improve understanding of how to design wind farms to optimize energy production and reduce operation and maintenance costs. ■

DOE National Laboratory AWAKEN Project Leads

National Renewable Energy Laboratory

Sandia National Laboratories

Pacific Northwest National Laboratory

Lawrence Livermore National Laboratory

Partnership Opportunities

If your organization is interested in working with world-class research institutes and having access to the unique data and research results, such as wind farm controls validation, prior to publication please contact Patrick Moriarty at the National Renewable Energy Laboratory.

Read more about AWAKEN.

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For more information, visit: energy.gov/eere/wind

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