Energy &
Homeland Security
energy.sandia.gov

WIND ENERGY PROGRAMS

Applying research and advanced technologies to improve wind turbine performance and lower the cost of wind energy.

For more than 40 years, Sandia National Laboratories has applied its research to develop innovative carbon-offsetting technologies, solve wind industry challenges, and reduce the cost of wind energy. Sandia also partners with the U.S. Department of Energy (DOE), other government agencies, industry, academia, and other national laboratories to increase the viability of wind energy technology. Sandia's science and engineering capabilities support U.S. progress toward a cleaner, safer, and more secure energy economy.

Rotor Innovation

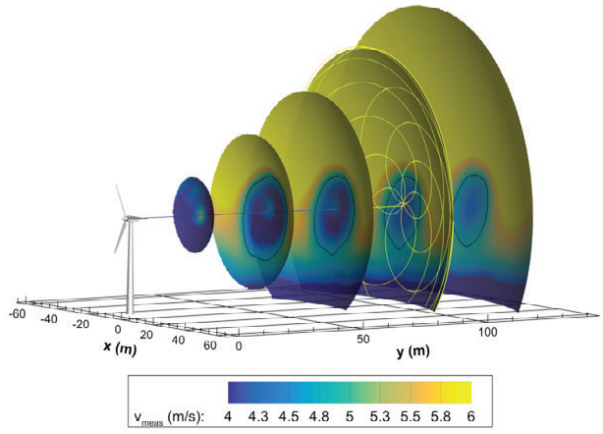
Advanced rotor concepts—from aerodynamics to instrumentation—offer great potential for further improving wind plant performance and reducing energy costs. Sandia leads research and development on next-generation rotors. Wind engineers are developing open-source design codes, evaluating new materials and manufacturing methods, testing load and aerodynamic measurement and control concepts, and creating new rotor designs.

National Rotor Testbed

Sandia designed the National Rotor Testbed (NRT), a research scale blade, to replicate the wake of utility-scale rotors on a smaller, more cost-effective scale. It uses a suite of mechanical and aerodynamic sensors that enable model validation and data gathering. The NRT, which was manufactured from the first-ever 3D-printed wind turbine blade mold, will be used for experimental campaigns at SWiFT.

Wind Plant Performance

In large wind farms, turbines "shadow" one another, creating wakes that reduce turbine output and increase fatigue issues that impact longevity and reliability. To address this problem, Sandia plays a key role in the DOE Atmosphere to Electrons (A2e) initiative, which strives to ensure that wind farms are sited, built, and operated to produce the most cost-effective and usable electric power. Sandia uses advanced simulation and wake imaging techniques to develop a deeper understanding of wind plant wakes and reduce turbine-to-turbine interaction.



Advanced instrumentation is used at SWiFT to quantify wind turbine wake interaction.

SWiFT

Sandia's Scaled Wind Farm Technology (SWiFT) Facility at Texas Tech University in Lubbock, Texas, is the principal research site for investigating wind turbine wakes as part of the DOE A2e initiative. SWiFT enables Sandia and its academic and industry partners to study turbine-to-turbine interaction and test new technologies. The facility features three variable-speed, variable-pitch modified wind turbines; two heavily instrumented inflow anemometer towers; and site-wide, time-synchronized data collection.

SWiFT enables rapid, cost-effective testing of wind turbine components and turbine-turbine interaction.

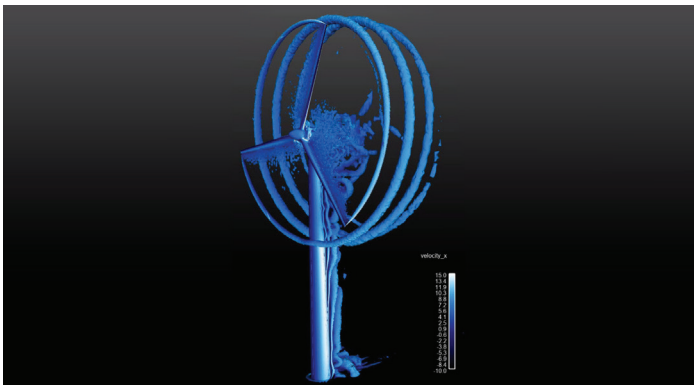
U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND2010-6954P

Sandia National Laboratories

Predicting Wind Plant Performance to Reduce Uncertainty

Sandia develops tools to help wind plant operators and planners more accurately predict the plant's power production and understand potentially damaging blade loading scenarios. Sandia applies high-fidelity modeling capabilities and uncertainty quantification techniques, originally developed for weapons research, to reduce uncertainties in wind plant operations.



A Nalu simulation for the detailed flow over a wind turbine that is being used to study wake physics.

The Nalu computational fluid dynamics code is emerging as a basis for a next-generation wind plant flow modeling capability that will be exercised on the nation's largest supercomputers. Under development in collaboration with other national laboratories and validated by experiments at SWiFT and other facilities, this capability will enable operators and developers to predict blade health, power production, and plant costs more accurately, thereby reducing the overall cost of wind energy.

Researchers conduct tests at SWiFT to collect data on wind plant performance and reliability.

Open-Source Codes

Sandia develops and maintains open-source tools that simplify the rotor design process.

- NuMAD (Numerical Manufacturing and Design), an open-source blade design tool.
- CACTUS (Code for Axial and Cross-flow Turbine Simulation), an open-source design and simulation tool for cross-flow and axial-flow wind turbines.
- Nalu, a computational fluid dynamics simulation tool being applied to wind plant applications.

Wind Plant Reliability

Unplanned maintenance and component failures are a concern to both wind plant owners and wind turbine manufacturers. Sandia leads efforts in wind turbine reliability research, specifically focusing on:

- Autonomous inspection
- Composite repairs
- Progressive damage modeling
- Lightning damage
- Economic modeling

SpinnerLIDAR mounted in nacelle at SWiFT for downwind wake measurements.

Work With Us

Because the future of U.S. renewable energy relies on industry success, Sandia National Laboratories supports the wind industry through fundamental research to enable innovation. To learn more about partnering with Sandia's wind energy programs, please contact the Wind Energy Technologies Department.

CONTACT:

Geoff Klise
Wind Energy Computational Sciences
gklise@sandia.gov
(505) 284-2500
wind.sandia.gov

Nick Johnson
Wind Energy Design and Experimentation
najohns@sandia.gov
(505) 844-5955
wind.sandia.gov

U.S. DEPARTMENT OF ENERGY NNSA National Nuclear Security Administration

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND2010-6954P

Sandia National Laboratories