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SWIFT: SCALED WIND FARM TECHNOLOGY

Facility offering rapid, cost-effective testing to improve wind farm performance and to advance wind energy technology.

Sandia National Laboratories' Scaled Wind Farm Technology (SWiFT) facility is located at Texas Tech University's National Wind Institute Research Center in Lubbock, Texas. SWiFT is the principal facility for investigating wind turbine wakes as part of the U.S. Department of Energy Atmosphere to Electrons research initiative (DOE-A2e). The SWiFT facility supports A2e's goal of ensuring that future wind farms are sited, built, and operated to produce the most cost-effective and usable electric power possible, given technological advances.

Through the SWiFT facility, Sandia partners with industry and academia to

- Reduce turbine-to-turbine interaction and wind plant underperformance
- Develop advanced wind turbine rotors
- Improve the validity of advanced simulation models

SWIFT SITE FEATURES

Sandia and its partners conduct collaborative and proprietary testing at the SWiFT site using research-grade turbines, atmospheric observation tools, a reconfigurable network, and state-of-the art equipment.

RESEARCH-GRADE TURBINES

SWiFT is home to three variable-speed variable pitch modified Vestas V27 wind turbines with full power conversion and extensive sensor suites. Because the turbines are smaller than most utility-scale turbines, blades and molds are less expensive, crane scheduling is faster and cheaper, and the risk of failure is substantially lower than would be the case with full-scale turbines.

Two turbines are spaced three rotor diameters apart, side-by-side for typical oncoming wind direction. The third turbine is five rotor diameters downwind. This turbine configuration is ideal for studying complex wake flows.

A hardware-in-the-loop testbed provides exact-replica testing of the turbine controller prior to deployment on the turbine.

Visit the SWiFT facility virtually at tours.sandia.gov/SWIFT

HIGHLY CHARACTERIZED SITE

SWiFT turbines are heavily instrumented with state-of-the-art control and data-acquisition systems featuring GPS-based, site-wide time synchronization. The technical details of the turbine, including the control software, are well documented and available, making site data both valuable and easy to share and publish. The atmospheric conditions at the site are also well characterized from more than two years of historical data.

CONTROL BUILDING

The SWiFT facility's control building offers 640 ft^2 of computing space, including a prepping area for field work and an office for proprietary work. Each turbine has an individual fiber-optic bundle connection, offering data transfer capabilities and flexible site network reconfiguration.

Operators can easily reconfigure the controls systems at SWiFT.

ANEMOMETER TOWERS

Two 60 meter anemometer towers are equipped with research-grade, 3D sonic sensors to measure air flow at five levels.

ASSEMBLY BUILDING

A 7500 ft^2 environmentally-controlled, high-bay assembly area with additional 2000 ft^2 of office space is located near the site for rotor and component preparation.

NATIONAL WIND INSTITUTE

SWiFT takes advantage of its proximity to the state-of-the-art observational facility at Texas Tech's National Wind Institute, including the 101-station West Texas Mesonet, a regional Sonic Detection and Ranging (SODAR) network, two mobile Doppler radars, and the DOE-X radar prototype.

SWIFT FACILITY PARTNERSHIPS

Technology Development

Sandia partners with OEM suppliers to enhance the research capabilities of the SWiFT site. For example, Sandia researchers have developed three modified Vestas wind turbines to enable wind plant technology research. Working with Vestas Wind Systems and National Instruments, SWiFT facility researchers have developed an integrated turbine data acquisition and control system that is open source, fully re-configurable, and capable of ongoing research in wind plant control methodology. With ABB Power Systems, Sandia installs variable-frequency drive technology in the modified wind turbines to provide modern power conversion and a flexible platform for electric power systems research. With Windar Photonics, Sandia investigates nacelle-mounted LIDAR instrumentation for wind plant performance optimization.

Field Research

Sandia has collaborated with the National Renewable Energy Laboratory, Technical University of Denmark (DTU), and Texas Tech on a wake steering experiment to study the use of wind farm controls to mitigate the impact of wind turbine wakes on farm performance. Researchers characterize the wake location and structure under a variety of inflow and turbine states using DTU's Spinner-LIDAR and instrumentation provided by Texas Tech. The ultimate objective is to calibrate and validate the models to improve predictions of future wind plant performance through the release of public data.

Exchanging rotor components at SWiFT requires minimal time and cost.

Within a microgrid, ESS asset size and placement can affect overall system performance, return on investment, and interactions with the larger grid. Sandia capabilities can help a utility optimize its choices.

Cost-effective research at the SWiFT facility is relevant to utility-scale wind farms. For example, the National Rotor Testbed (NRT) rotors are designed to demonstrate the ability to functionally scale utility rotor characteristics as indicated by the wake it generates. Future rotor designs could demonstrate wake mitigation, damage-mitigating active load control, and other innovative design concepts.

Finally, Pentalum Technologies, Texas Tech, and Sandia have partnered on a Binational Industrial R&D Foundation grant. The team is advancing a new approach to light detection and ranging (LIDAR) system technology to better characterize and operate wind plants through wind flow measurement.

Education & Training

Sandia partners with Texas Tech to offer undergraduate year-round internships at the SWiFT site to support experimental research and to maintain the SWiFT facility turbines. After graduation, students can potentially transfer to an operating utility-scale NextEra wind farm.

The SWiFT facility is available for both collaborative and highly proprietary research. To learn more about partnering with Sandia's wind energy technology program, contact the Wind Energy Technologies Program.

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