U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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U.S. Department of Energy Wind and Water Power Technologies Office 2014 Wind Power Peer Review Two-Page Summary: Scaled Wind Farm Technology (SWiFT) Facility

1. Project Information

a. Full Project Title: Development of the DOE/SNL Scaled Wind Farm Technology Facility
b. Organization or Affiliation: Sandia National Laboratories
c. Principal Investigator: Jonathan R. White
d. Project duration (Start and End Date): 1/1/2012 -

2. Project Purpose and Objectives

A world-class, public, open-source testing facility is required to develop wind-plant technology from basic research up to commercialization. The facility's impact is to lower wind-energy cost with innovative advancements; developed in the most rapid and cost-efficient process possible. Additionally, the facility provides a public, open-source, experimental wind-plant facility with a validated model that can be used by international consortia of industry, academia, and national laboratories to: reduce power losses and damage caused by turbine-turbine interaction through study of complex wake flows; enhance wind-plant energy capture by developing the next generation of rotor technology; and perform rapid, cost-efficient research in aeroacoustics, aeroelasticity, aerodynamics, and reliability.

3. Alignment with Program

The SWiFT Facility can perform research from subcomponent through wind-plant complexity scales, and therefore, has the ability to support all DOE Program objectives and priorities:

- **Optimize Wind Plant Performance:** Reduce Wind Plant Levelized Cost of Energy (LCOE)
- **Accelerate Technology Transfer:** Lead the way for new high-tech U.S. industries
- **Mitigate Market Barriers:** Reduce market barriers to preserve or expand access to quality wind resources
- **Advanced Grid Integration:** Provide access to high wind resource areas, and provide cost-effective dispatch of wind energy onto the grid
- **Testing Infrastructure:** Enhance and sustain the world-class wind testing facilities at universities and national laboratories to support mission-critical activities
- **Modeling & Analysis:** Conduct wind techno-economic and life-cycle assessments to help program focus its technology development priorities and identify key drivers and hurdles for wind-energy technology commercialization

4. Technical Approach

To innovate wind-energy plants and support the breadth of the DOE Program objectives, a testing facility requires many key capabilities and approaches. High-velocity winds in a consistent direction minimize measurement/research time, experiment cost, and accelerates technology development and transfer. Flat terrain minimizes uncertainty for validation campaigns and allows the discrete addition of well-understood, man-made terrain features. Open-source wind turbines that do not have restrictions enable cross-cutting collaborative research between laboratories, industry, and academia. An on-site, research-quality assembly building allows experiments to be prepared and rapid-response to creating testing components. An open-source, variable-speed controller that is

integrated with a data-acquisition system will facilitate collaborative research. A site-wide time-synchronized control and data-acquisition network will allow direct, time-based data analysis, instead of statistical representations. Scaled testing will be developed in order to perform cost-efficient high risk technology development.

A key issue for the SWiFT Facility will be the development of the methods and [understanding the?] limitations of scaled testing. This effort will be collaborative with other projects, such as the National Rotor Testbed, TTU Advanced Radar, and SNL Wake Measurement System, resolved with guidance and review from external stakeholders, such as Original Equipment Manufacturers and Owner/Operators.

5. Technical Accomplishments and Progress

The SWiFT Facility construction was planned in FY12 and executed in FY13 with the following accomplishments. A public, open-source variable-speed controller was developed and commissioned. Three wind turbines and two meteorological masts were installed without (safety) incident. Rigorous characterization tests on component and full-system scales were performed, to ensure the accuracy of a public wind-turbine model. Three wind turbines were commissioned and are being readied for open-source R&D. Technician and operational staff have been trained and employed, in partnership with Texas Tech. A comprehensive on-site workshop has been remodeled and upgraded for preparation of research-quality experiments.

6. Research Integration, Collaboration, and Technology Transfer

SWiFT relies on a broad collaborative team to develop and guide its development. This teams includes two OEMs (Vestas*, GE**), fifteen companies (Group NIRE*, Micron Optics*, National Instruments*, GL-DNV*, Broadwind*, ABB*, CC Jensen*, Cascade, Baker, Met One, Thies, ATI Inc., Rohn, GearWorks, Halus), three laboratories (NREL, SRNL, LANL) and six universities (TTU, U-Minnesota, UC-Davis, Texas A&M, Purdue, UT-Austin). (*Providing cost share, **Providing advisory guidance) The facility's development was presented at the 2014 AIAA ASME Wind Energy Symposium, 2013 SNL Reliability Workshop, and 2012 SNL Blade Workshop. The SNL rotor fiber-optic measuring technology has been transferred to Vestas and the open-source variable-speed controller technology has been transferred to ABB who is looking to use the technology in other product offerings. Additional technology transfers include the SWiFT Facility Commissioning, Public SWiFT Wind Turbine Model, and Public Open-Source Variable-Speed Controller.

Current project include the SWiFT Baselining Project that will verify and validate instrumentation/data, site operations, and turbine performance in preparation for future DOE and collaborative R&D projects. The project will also create a website to transfer SWiFT models, documentation, and data to collaborators. Additionally the Wake Imaging System will provide preliminary field deployment of a high-resolution wake-imaging measurement system.

Future work will include development of functional scaling methods in partnership with the National Rotor Testbed Project, TTU Ka-band radars, and OEMs. Also, a detailed characterization and control of scaled wake structures to increase wind-plant performance will be performed. Included in this will be wake merging, meandering, and complex deep array studies. In a parallel path, advanced rotor designs with passive and active load control will be developed and studies of rotor aero-acoustic generation and propagation measurements will be completed.

7. Budget History

FY2012		FY2013		FY2014	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
Budget / Spent $4020k / $2006k	$1050k	Budget / Spent $2928k / $2457k	$2200k	$1422k	