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Development of the DOE/SNL Scaled Wind Farm Technology Facility

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1. Purpose & Objectives

Problem Statement: A world-class, public, open-source testing facility is required to develop wind-plant technology from basic research up to commercialization.

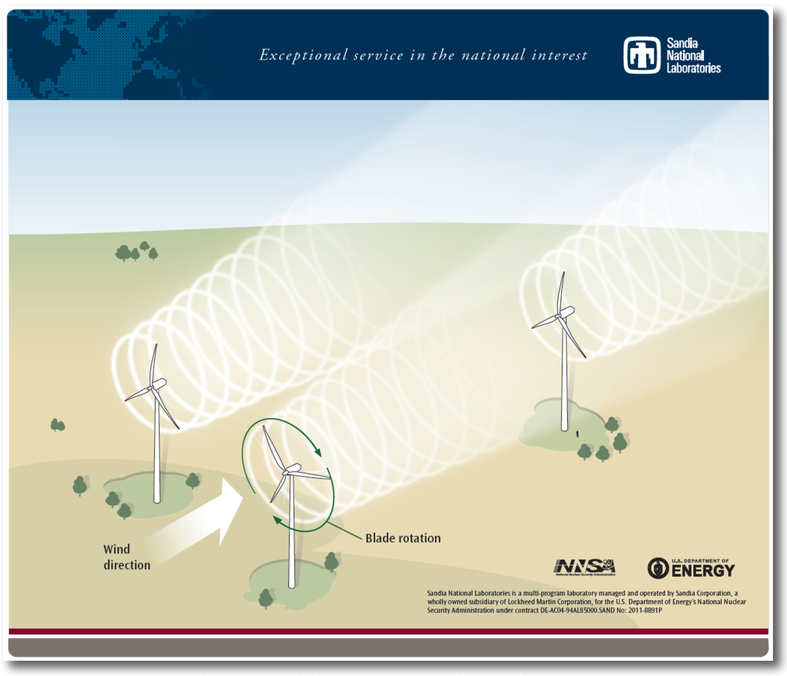
Impact of Project: Lower cost of energy with innovative advancements to wind energy, developed in the most rapid and cost-efficient process possible.

This project aligns with the following 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 the program focus its technology-development priorities and identify key drivers and hurdles for wind-energy technology commercialization

2. Relevance to industry

Provide 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
- Perform rapid, cost-efficient research in aeroacoustics, aeroelasticity, aero-dynamics, and reliability

3. Technical Approach

Innovating wind-energy plants requires:

- High winds in a consistent direction to minimize measurement time
- Flat terrain to minimize uncertainty for validation campaigns and to allow the discrete addition of well-understood, man-made terrain features.
- Open-source wind turbines that do not have restrictions to enable cross-cutting collaborative research between laboratories, industry, and academia
- An on-site, research-quality assembly building to prepare experiments and create rapid-response testing components
- An open-source, variable-speed controller that is integrated with data acquisition system to facilitate collaborative research
- A site-wide time-synchronized control and data-acquisition network to allow direct, time-based data analysis, instead of statistical representations
- Cost efficient testing required to enable high-risk early-stage technology
- A functional scaling methodology (including limitations) to transfer technology development to current and future utility-scale

4. Accomplishment and Progress

- Developed public, open-source variable-speed controller for SWiFT
- Installed three wind turbines & two meteorological masts without (safety) incident
- Performed rigorous characterization tests on component and full-system scales, to ensure the accuracy of a public wind-turbine model
- Commissioned three wind turbines—are being readied for open-source R&D
- Trained and employed technician and operational staff, in partnership with Texas Tech
- Refurbished a comprehensive on-site workshop for research preparation

Structural Dynamic Characterization of Tower

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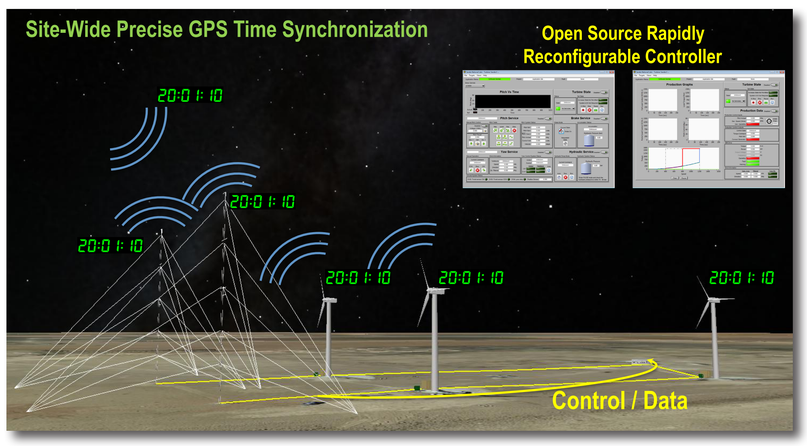


5. Research Integration & Collaboration

Partners, Subcontractors, and Collaborators:
2 OEMs: Vestas*, GE**
15 Companies: Group NIRE*, ATA Engineering*, Micron Optics*, National Instruments*, GL-DNV*, Broadwind*, ABB*, CC Jensen*, Cascade, Baker, Met One, Thies, ATI Inc., Rohn, GearWorks, Halus
3 Laboratories: NREL, SRNL, LANL
5 Universities: TTU, U-Minnesota, UC-Davis, Texas A&M, Purdue

Communications and Technology Transfer:
Technical Presentations: 2014 AIAA ASME Wind Energy Symposium, 2013 SNL Reliability Workshop, 2012 SNL Blade Workshop

Technology Transfer: Rotor Fiber Optic Instrumentation methods to Vestas, Variable Speed Controller to ABB, SWiFT Facility Commissioning, Public SWiFT Wind Turbine Model, Public Open-Source Variable Speed Controller

6. Next Steps and Future Research

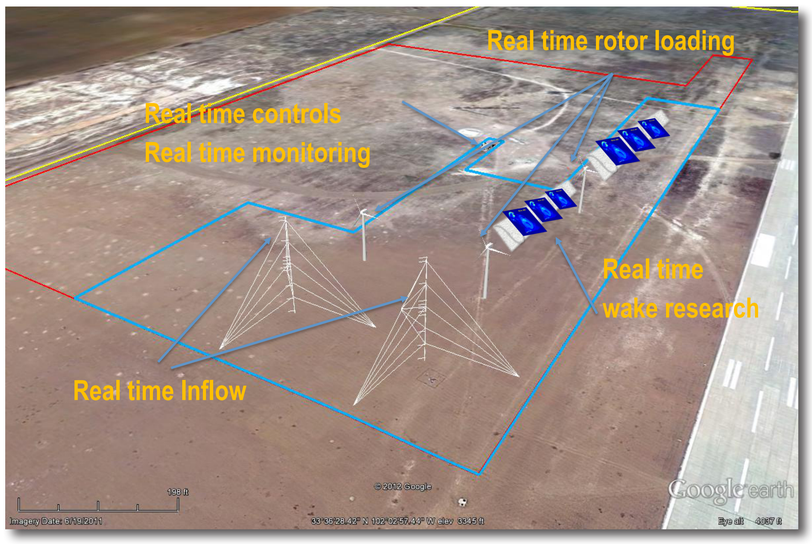
FY14/Current Research:

- SWiFT Baselining Project: Verify and validate instrumentation/data, site operations, and turbine performance in preparation for future DOE and collaborative R&D projects. Create a website to transfer SWiFT models, documentation and data to collaborators.
- Wake Measurement System: Preliminary field deployment of high-resolution wake-imaging measurement system.

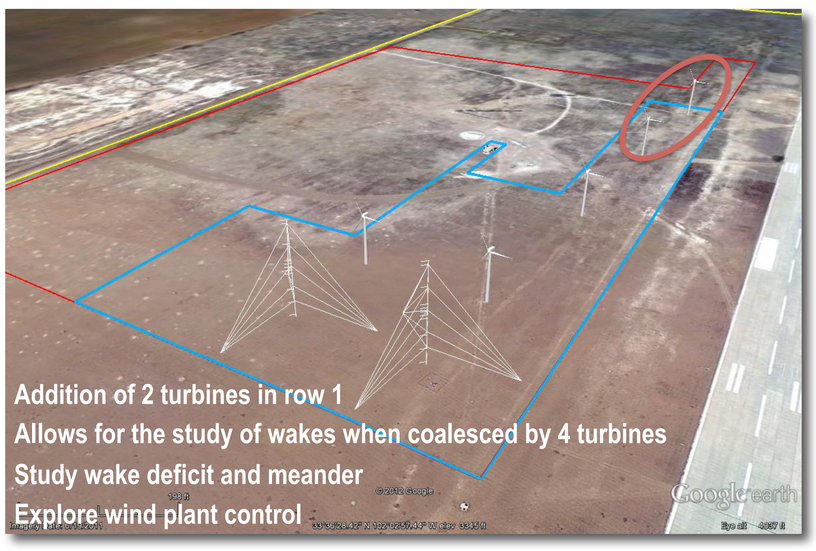
Proposed Future Research:

- Development of functional scaling methods in partnership with National Rotor Testbed, TTU Ka-band Radars and OEMs
- Detailed characterization and control of scaled wake structures to increase wind-plant performance
- Wake merging, meandering, and complex deep array studies
- Advanced rotor designs with passive and active load control
- Rotor aero-acoustic generation and propagation measurements

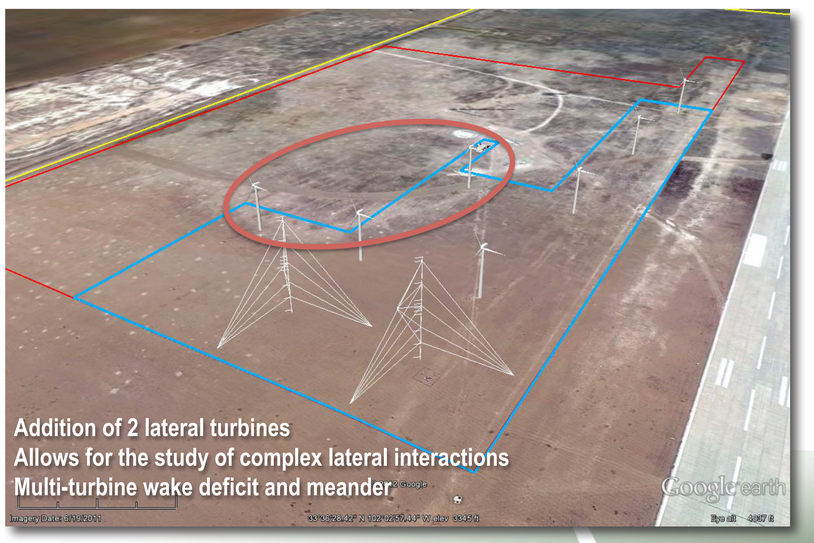
Basic Turbine to Turbine Interaction



Deep Row Wake Deficit and Meandering Studies



Complex lateral wake merging and meander



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