

## Potential Large Wind Research

- **Operations and Maintenance (O&M) Research** – A comprehensive cataloging of operations and maintenance activities could be analyzed for time, requirements, tools and materials, transportation, and safety. Results could be incorporated into training requirements.
- **Reliability Tracking, Availability, Maintainability, Safety (RAMS)** – The NWRTC turbine offers practical and hands-on research of availability, maintainability, and safety parameters. Safety, in particular is highly important because of the human consequences and the need to minimize both risks and effects. As part of Operations and Maintenance (O&M) training, systems for tracking component failure rates, in terms of reliability analysis metrics such as mean time between failures, mean time to repair, availability impacts and spare parts consumption, can be integrated into the O&M curriculum. Ongoing inspection, monitoring, and tracking of durability or degradation of materials and components could be part of O&M training.
- **Conditioning Monitoring Systems** – The installation of conditioning monitoring capability for gearboxes and blades, widely considered possibilities for improving fleet reliability, could assist in a better characterization of these industry-wide issues.
- **Supervisory Control and Data Acquisition (SCADA) and other Data Collection Systems** – Operational control and time series data collection systems will enable analysis of a wide array of operating, off-normal and fault conditions. Turbine performance and structural data acquisition analysis could offer a rich data set for future R&D. A remote performance testing capability with enhanced data capability offers opportunities for partnership throughout the US.
- **Lightning Effects** – Wind turbines in the West often face issues and shut down due to lightning events. Frequency and magnitude of lightning strikes could be monitored and grounding techniques assessed. Structural performance, sensitivity to electromagnetic effects, and training for proper grounding techniques could be performed including detection, damage assessment tools, ancillary effects, cumulative damage, measures for mitigation, etc.
- **Power Conversion and Grid Interface** – The turbine's electronic power converter offers enhanced utility interface functions and this is a point of investigation for overall wind farm efficiencies and utility operation. The grid interface could be monitored for power quality, and distributed generation applications.
- **Visual Considerations** – Visual impacts of windfarms are an issue of acceptance in some areas. Also, FAA daytime and nighttime visibility requirements and compliance methods can be tested. Neighborhood

acceptance of the visual impact, as well as varying methods to reduce visual impact can be surveyed.

- **Repair of Critical Components** – Research into areas for on site repair of critical components could be made to minimize replacement impacts. Assessment of candidate components, repair capabilities, research into repair techniques, capabilities, tools and training could enable cost savings in O&M for wind farms.

- **Sensor Characterization and Non-Destructive Testing** – Research to characterize new sensor technologies is critical to improve wind turbine efficiencies. The research turbine provides an excellent platform to test and evaluate advanced sensor concepts. Non-destructive testing techniques can be evaluated to improve O&M and minimize turbine downtime.