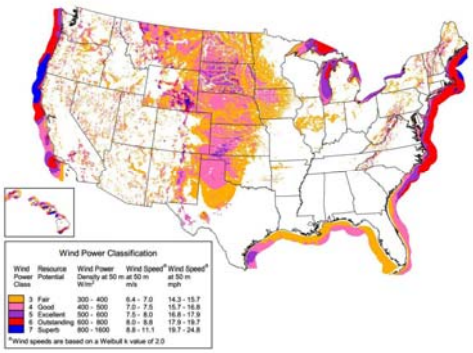
WIND AND WATER POWER – TEST FACILITIES AND INDUSTRY PARTNERSHIPS

EXPLORE AND COLLABORATE
AMERICAN INDUSTRY AND AMERICA'S NATIONAL LABS
MATERIALS FOR ENERGY APPLICATIONS



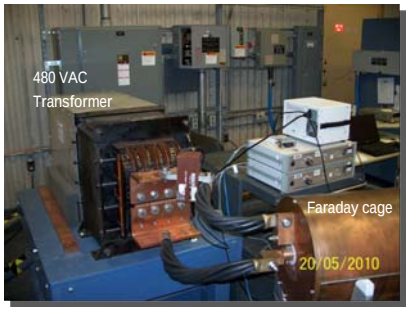
Current maps indicate there is approximately 10,200 GW of wind energy potential on land in the US and 4,200 GW of wind energy potential offshore of the US with a capacity factor of 35% or greater at 90 – 100m height. The map above illustrates the increased wind power density offshore. While the US does not currently have any installed offshore wind energy production the offshore wind resource represents the next frontier for wind energy. Technologies that lower the cost of energy

High Current Calibration Lab

(Savannah River National Laboratory)

•High current standards for the US with capability to calibrate Current Transformers up to 100,000 Amps

•Validate advanced high accuracy power measurement sensors and systems without high current faults and saturation



AC – Pulsed 2 - 100kA
Combined Uncertainty
of Standards: ±0.31%, 2σ

Test Facilities

Blade Testing

(National Renewable Energy Laboratory)

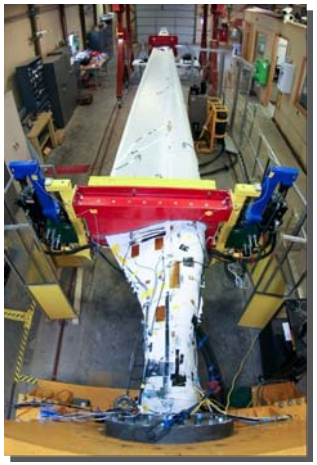
•National Wind Technology Center (NWTC)

•Static testing, Fatigue testing, Property testing (modal, mass distribution)

•ISO/IEC 17025, A2LA accredited for full-scale blade testing

•NWTC Test blades to 50m long

•WTTC Test blades to 90m, Boston, MA



Sandia sensor blade testing, blade tested in fatigue to failure at NWTC. Partners: LANL, Umass, Luna Innovations, Micron Optics, Intelligent Fiber Optic Systems, NASA, Laser Technology Inc.

Static test at NWTC

CURI Drive Train Test Facility

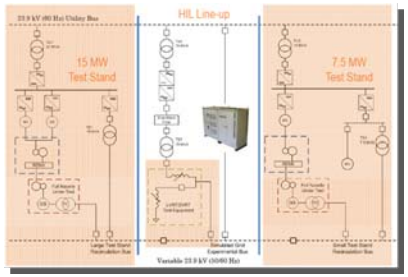
(Clemson University/Savannah River National Laboratory)

•15-megawatt (MW) and 7.5-MW dynamometers with the capability to apply loads to the main shaft of the specimen drive-train, replicating forces and moments along three axes thereby simulating actual blade forces experienced in the field.

- Development of 15 MW grid simulator with secure hardware-in-the-loop testing renewable energy integration.

Pier for off-loading large test specimens and rail transport to test bay in lab

15 MW dynamometer with 3d dynamic load applicator



Electrical design enables Utility Scale Hardware-In-the-Loop Testing with turbine under test and grid simulation.

NWTC Drive Train Testing

(National Renewable Energy Laboratory)

•225 kW, 2.5 MW and 5 MW dynamometers with controllable grid interface (2.5MW and 5MW) enable voltage fault tests, frequency response tests, continuous operation under unbalanced voltage conditions, and simulated strong and weak grid conditions.

Unit under test loaded into dynamometer at NWTC.

Industry Partnerships

Gear Box Reliability Collaborative

(National Renewable Energy Laboratory)

•Establish a collaborative of wind turbine manufacturers, gearbox designers, bearing experts,

•Universities, consultants, national laboratories, and others to jointly investigate issues related to wind turbine gearbox reliability and to share results and findings. • Design and conduct field and dynamometer tests using two redesigned and heavily

•Instrument wind turbine gearboxes to build an understanding of how selected loads and events translate into bearing and gear response.

•Evaluate and validate current wind turbine, gearbox, gear, and bearing analytical tools/models and develop new tools/models as required.

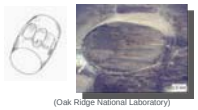
•Investigate condition monitoring methods to improve reliability.

•Establish a database of gearbox failures.

Fatigue spalling on bearing surface

Enlarged view of GRC gearbox

Plastic deformation of bearing



(Oak Ridge National Laboratory)

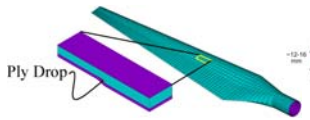
Blade Reliability Collaborative

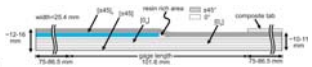
(Sandia National Laboratory)

Develop a collaborative framework to determine the causes of premature blade failure, the best inspection methods, and the adequacy of modeling tools and testing protocols

- Blade Defect and Damage Database – Aggregate data from blade manufacturers, service companies, and operators to determine largest sources of blade unreliability
- Inspection Validation – Evaluate the ability of inspection techniques to accurately characterize blade defects and damage in manufacturing plants and in the field
- Effects of Defects – Determine how common manufacturing defects affect blade strength and service life
- Analysis Validation – Assess the ability of design analysis tools to find and characterize potential failure modes
- Certification Testing – Evaluate the ability of certification testing to uncover potential reliability issues and find innovative ways for testing to provide better insight
- Standards and Partnerships – Interface with international standards committees and industrial partners to identify pathways to implementing improved design, manufacture, and inspection

Partners: SNL AANC, Montana State, NREL, EPRI, U-Mass. Lowell, GE, Vestas, Gamesa, TPI Composites, Rope Partners, EDPR, Dantec Dynamics





Complex Structured Coupon with Ply Drops

U.S. DEPARTMENT OF ENERGY
Office of Science

SRNL SAVANNAH RIVER NATIONAL LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Sandia National Laboratories

OAK RIDGE National Laboratory

BERKELEY LAB Lawrence Berkeley National Laboratory

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