


National Wind Technology Center

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NWTC Transmission and Grid Integration

The rapid growth of alternative power sources, especially wind power, is creating challenges that affect the existing electric grid. To keep up with this rapid growth, researchers in the Transmission and Grid Integration Group provide scientific, engineering, and analytical expertise to help advance alternative energy and accelerate its integration into the nation's electrical grid. For example, we evaluate U.S. wind energy resources and collect and analyze data about the impact of wind development on the electrical grid. Researchers in the Transmission and Grid Integration Group offer assistance to utility industry partners in the following integration areas.

Operational Impacts and Integration Studies

Our researchers measure the impact of wind and solar power plant output and the additional needs that its variable and uncertain operation imposes on the overall grid. The ability of utilities to predict wind plant output remains low for short-term (sub-hourly, hourly, or daily) operation in wind power plants. We evaluate fluctuations in wind patterns to provide utilities with better data to enable them to make more informed decisions when considering wind power output for power plants. Our research includes efforts to quantify and estimate fluctuations in wind power on plant operational and engineering costs. Areas evaluated include:

- Regional Grid Operational Analysis
- Mitigation Analysis of Wind Variability and Uncertainty (e.g., balancing authorities, forecasting, and storage)
- Wind/Hydropower Studies.

Wind Plant Modeling and Interconnection

NREL uses wind generator electrical output models to provide better data to utilities and grid operation organizations that evaluate interconnection and dynamic stability system impacts of proposed wind plants. In addition, we provide public models usable for regional wind power interconnection studies. Our wind modeling and grid interconnection studies include:

- Wind Generator Modeling
- Wind Plant Data Monitoring
- Grid Code Standards Analysis.

Wind turbines at the Foote Creek Rim Project near Arlington, Wyoming. Tom Hall, DOE/PIX06588.

Transmission Planning and Analysis

NREL provides the data that allow planning organizations to evaluate the need for new generators and transmission lines. We evaluate potential wind power plant locations and power delivery profiles that are critical to accurately assessing potential transmission line upgrades or expansions. In addition, the reliability characteristics (e.g., capacity credits) resulting from wind and utility load temporal-profile matches have an impact on the valuation of wind from the planning perspective. We focus on two primary areas:

- Transmission Expansion and Renewable Energy Zone Planning
- Increasing Use of the Existing Grid.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Wind Resource Assessment and Forecasting

Transmission and Grid Integration Group researchers assess wind resources and work with partners to improve forecast accuracy and usability for power plant system operators.

Resource Characterization. We evaluate the wind and solar resource with the NREL Resource Information and Forecasting Group — including seasonal, daily, hourly, and sub-hourly data, where possible — to allow models to better characterize the potential benefits and impacts of wind on system operation and to assess transmission availability.

Forecasting. Forecasting allows system operators to anticipate wind generation levels and adjust the remainder of generation units accordingly. Improved short-term wind production forecasts let operators make better day-ahead market operation and unit-commitment decisions, help real-time operations in the hour ahead, and warn operators about severe weather events. Advanced forecasting systems can also help warn the system operator if extreme wind events are likely so that the operator can implement a defensive system posture if needed. The seamless integration of wind plant output forecasting—into both power market operations and utility control room operations—is a critical next step in accommodating large penetrations of alternative energy in power systems.

The need for improvements to the nation's electrical grid has an impact on the growth of renewable energy resources such as wind power. Warren Gretz, NREL/PIX10926.

NREL Wind Integration Studies

NREL is managing two large regional wind integration studies on behalf of the U.S. DOE (see http://www.nrel.gov/integration studies). These two studies are believed to be the largest ever undertaken in the United States. Both studies evaluate wind energy penetrations up to 30% of annual energy demand. Although there are some differences in the study objectives and characteristics, a common objective of both studies is to perform electric system production simulation modeling, using realistic wind energy data that covers three historic weather and electrical load years. In addition to the operational modeling that is performed on an hourly time step, each study also analyzes sub-hourly wind and load data to provide insight into the intra-hour impacts and variability characteristics. Each study also evaluates alternative wind energy build-out scenarios that help to show the impacts of developing local wind with lower capacity factors against more remote wind resources that require more transmission.

Western Renewable Energy Zones

NREL and the U.S. DOE are helping western states address a critical topic; how to best connect consumers with the region's abundant renewable energy resources. Many of the nation's most promising locations to generate power from solar, wind, and other renewable resources are in the West. The Western Governors' Association (WGA) supports the development of 30,000 megawatts of clean energy in the region by 2015, and a 20 percent increase in energy efficiency by 2020. But a regional analysis has not been undertaken — until now. DOE and WGA will spend $2.3 million over three years to address western regional power supply issues and increase coordination of renewable energy generation and transmission in 11 western states, two Canadian provinces, and areas in Mexico that are part of the grid. This crucial partnership is leading the way toward more proactive transmission planning, and eventually, regional cost allocation and cost recovery.

For More Information

Contact the National Wind Technology Center at 303-384-6900.

Wind Systems Integration
www.nrel.gov/wind/systemsintegration

National Renewable Energy Laboratory

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NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

NREL/FS-5000-45650 • Revised April 2011

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.

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