

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Power System Reliable Integration Support to Achieve Large Amounts of Wind Power (PRISALA) Project ID #M6

Dave Corbus

NREL



FY17-FY18 Wind Office Project Organization

“Enabling Wind Energy Options Nationwide”

Technology Development

Atmosphere to Electrons

Offshore Wind

Distributed Wind

Testing Infrastructure

Standards Support and International
Engagement

Advanced Components, Reliability, and
Manufacturing

Market Acceleration & Deployment

Stakeholder Engagement, Workforce
Development, and Human Use Considerations

Environmental Research

Grid Integration

Regulatory and Siting

Analysis and Modeling (cross-cutting)

Project Overview

M6 – Power System Reliable Integration Support to Achieve Large Amounts of Wind Power (PRISALA)

Project Summary

NREL's stakeholder activities focus on disseminating key research results from NREL analysis to regulators, policymakers, utilities, and power system industry stakeholders. Successes in these activities has resulted in decreased barriers to the integration of wind power and increased power system resiliency, reliability, and security.

Project Objective & Impact

To limit wind integration barriers and enable wind energy to reach high penetrations, it is essential that analysis and results on effective mitigation options reach utilities and other stakeholders. Utilities need tools and data to study high wind penetrations on their power systems. This project helps minimize electrical disturbances and increase the resilience and reliability of the U.S. power grid, thereby benefiting consumers, grid stakeholders, and the nation with a more robust and reliable electricity supply.

Project Attributes

Project Principal Investigator

Dave Corbus

DOE Lead

Charlton Clark

Project Partners/Subs

Energy Systems Integration group (ESIG)

Project Duration

April 2016–April 2019

Technical Merit and Relevance

- NREL brings tremendous research, data, methods, and results from wind integration work by NREL and others to power system stakeholders to help remove barriers and encourage the adoption of cost-effective solutions
- NREL stakeholder engagement activities aim to educate decision makers on operational and market impacts of wind energy and dispel common misconceptions
- The Energy Systems Integration Group (ESIG) is a key partner for this work
- Stakeholder work incorporates research performed, lessons gained, ideas proposed, and practices incorporated over many years.

Approach and Methodology

- **Key activities aimed to engage targeted audiences regarding impactful research on topics such as forecasting, energy imbalance markets, North American Electric Reliability Corporation (NERC) and Federal Energy Regulatory Commission (FERC) task forces on wind and renewable integration, reserves, market design, reliability metrics, system resiliency best practices, and wind integration studies.**
 - Encourage collaboration and information interchange through ESIG
 - Actively participate in select technical committees and task forces to ensure that wind energy characteristics are properly considered and accounted for
 - Provide unique access to credible information and applied research to facilitate wind energy integration
 - Ensure that state-of-the art results, methods, and data in wind integration reach critical decision makers
 - Synthesize key results from NREL grid integration work and work of others
 - Disseminate information, results, data, and tools to key stakeholders.

Approach and Methodology – ESIG A Key Component

- **The mission of ESIG is to chart the future of energy systems integration and operations**
 - This is done by providing information, education, and networking to support total energy systems integration and operations through the collaborative efforts of ESIG members—utilities, power producers and energy operators, system and component manufacturers, government laboratories, universities, consulting firms, forecasters, developers, and other energy organizations

Approach and Methodology – ESIG A Key Component

- **ESIG does this by providing:**
 - Collaborative thought leadership at the forefront of energy systems integration and operations
 - Technically-grounded information and education without lobbying, selling, or advocating
 - Timely review and distribution of research on emerging technologies and practices
 - Solutions that maximize asset utilization and optimize profits.



Accomplishments and Progress – NERC

- **Accomplishments include engagement with NERC, including participating in task forces and working groups and sharing results of NREL research**
 - Participate in NERC Essential Reliability Services Working Group
 - Participate in NERC Frequency Response Study
 - Participate in NERC Inverter-Based Resource Performance Task Force
 - Participate in NERC Probabilistic Assessment Working Group

Accomplishments and Progress – FERC

- Engagement with FERC includes participation in task forces and working groups and disseminating results to key FERC staff, including:
 - FERC briefings, including presentation on the Eastern Renewable Generation Integration Study
 - Hosted David Kathan (Office of Energy Policy and Innovation) at NREL for detailed discussions on distributed energy resource aggregation and participation in wholesale energy markets
 - Disseminate NREL work to FERC Office of Electric Reliability on reliability and loss of load planning

Accomplishments and Progress – ESIG and IEA

- **Work with ESIG includes the following:**
 - Presentation at ESIG on the Interconnection Seam Study to the largest ESIG audience on record
 - Numerous presentations of key wind integration findings and study results at ESIG
 - Leadership roles in technical working groups and membership on the board of directors
 - Implement subcontract to ESIG at approximately \$300,000/year
- **Leadership for IEA Task 25 (“Design and Operation of Power Systems with Large Amounts of Wind Power”)**
 - Publish conference and journal papers and participate in thought leadership

Accomplishments and Progress – Summary

- **Engagement with NERC, including participation in NERC task force and working groups and sharing results of NREL studies**
 - Participated in NERC Essential Reliability Services Working Group, NERC Frequency Response Study, NERC Inverter-Based Resource Performance Task Force (IBRPTF), and NERC Probabilistic Assessment Working Group
- **Engagement with FERC, including participation in task force and working groups and dissemination of results to key FERC staff including:**
 - FERC briefings, including presentation on the Eastern Renewable Generation Integration Study; hosted David Kathan (Office of Energy Policy and Innovation) at NREL for detailed discussions on DER aggregation and participation in wholesale energy markets; shared expertise and information on distributed energy resources Integration research, IEEE 1547 standards; disseminated NREL work to FERC Office of Electric Reliability on reliability and loss of load planning
- **Work with ESIG includes the following:**
 - Presentation at ESIG on the SEAMS study to the largest ESIG audience on record; numerous presentations of key wind integration findings and study results at ESIG general meetings and technical workshops; leadership roles in technical working groups and member of the board of directors; implement subcontract to ESIG at approximately \$300k/year
- **Leadership for IEA Task 25 (“Design and Operation of Power Systems with Large Amounts of Wind Power”)**
 - Publish conference and journal papers; leadership in IEA Task 25 meetings

Accomplishments and Progress – Summary

- Support and participate in the Utility Variable-Generation Integration Group fall and spring technical workshops and special topic workshops (e.g., forecasting) and present more than **12** key technical presentations
- Conference paper: Bethany A. Frew, Michael Milligan, Greg Brinkman, Aaron Bloom, Kara Clark, Paul Denholm. "Revenue Sufficiency and Reliability in a Zero Marginal Cost Future: Preprint.": 10 pp. December 2016.
- Journal article: Niina Helistö Juha Kiviluoma, Hannele Holttinen, Jose Daniel Lara, Bri-Mathias Hodge: "Including operational aspects in the planning of power systems with large amounts of variable generation: a review of modelling approaches." Accepted for *WIRES Energy and Environment*.
- Journal article: Jari Miettinen, Hannele Holttinen, Bri-Mathias Hodge: "Simulating wind power forecast error distributions for spatially aggregated wind power plants." In review with *Wind Energy*.
- Conference paper: Hannele Holttinen, Juha Kiviluoma, Damian Flynn, Jody Dillon, Barry Mather, Bri-Mathias Hodge, Til Kristian Vrana, Lennart Söder, Kazuhiko Ogimoto, Emmanuel Neau, Nicolaos Cutululis, J. Charles Smith: "Recommendations for Wind and Solar Integration Studies." Submitted to The 16th International Workshop on Integration of Wind Power into Power Systems, October 25-27, 2017, Berlin, Germany.
- Conference paper: Söder et. al. 2018. "Wind Generation in Adequacy Calculations and Capacity Markets in Different Power System Control Zones." Published in the Proceedings of the 17th Wind Integration Workshop.
- **All milestones were completed on time; there were no go/no-go decision points.**