



# 2014 Smart Grid R&D Program Peer Review

## Project Summary

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**Project Title:** Smart Grid Pre-Standard Testing Support

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**Organization:** National Renewable Energy Laboratory

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**Presenters:** Jim Cale

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**FY 2014 Funding (\$K):** 200

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### Project Objectives, Significance, and Impact

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The objective is to support evolution of the electric power system (EPS) infrastructure to an interoperable Smart Grid that modernizes the EPS, enhances its security and reliability, facilitates recovery from disruptions, and, provides for incorporation of clean technologies, customer participation in electricity use, and choice in load management. Standards and conformance testing play a major part in reducing technical, business and regulatory barriers and impacts, and toward increasing efficiency and resiliency of our electric infrastructure. Currently, local, national and international SG interoperability standards and conformance testing are a patchwork (gaps in overall validity or acceptance) or are non-existent. Conformance to proven Smart Grid standards, and, test protocols (using accepted test beds and methods) provides confidence in claims of performance, and transparency for, manufacturers, vendors, integrators, utilities, authorities having jurisdiction over the grid, and to electricity customers. The impact of this project includes: lowering the cost of compliance, increasing confidence in advanced technology functions and grid-interactive operations, accelerating technology development through validation, and, maintaining or improving the efficiency, reliability, safety, and resiliency of the grid with integrated DER.

### Technical Approach

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This approach is to work with and facilitate subject matter experts to identify and address gaps in, and recommendations for, standards testing requirements and procedures, and, establish, validate, and conduct advanced testing for: DER-EPS infrastructure including multi-path power/energy flows; improved operating practices; integration, and interoperability of power, communications and information technologies, and, for end-use applications and loads. This

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project supports official Standards Development Organizations including the IEEE and the International Electro-technical Commission (IEC) in facilitating accelerated development, enhancements, and maintenance of open consensus standards and harmonization among them, and, works targeted Smart Grid entities involved with testing and evaluation. The approach includes leadership and participation in collaborative groups addressing not only technology development, but also addressing the challenges of bringing consensus among the interested parties to agree on effective, practical testing standards that help the industry further develop and implement the 21st century Smart Grid. The approach is to focus on testing and evaluation of modified and new DER features, controls and operations; legacy and new, and, multiple (same and differing) schemes, for advanced DER-grid-interactive features including voltage ride through, frequency ride through, and volt/var, settings and schemes; and, testing and evaluation of commands/controls information exchanges to verify conformance to requirements and claims.

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## **Technical Progress and Results**

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Conducted testing of an advanced inverter performing volt-VAr control and abnormal voltage disconnection in a power hardware-in-the-loop (PHIL) environment. Confirmed that PHIL testing provides same results as non-PHIL testing. As part of this testing, introduced use of Thévenin equivalent circuit to fully capture all linear elements of a distribution circuit effects on the inverter terminal voltage and current. This work was documented in a draft preliminary report that also identified several areas for further testing, including testing of additional advanced grid support features, testing of three-phase inverters, and testing using grid models that include nonlinear elements. The following testing is underway with some initial results: testing new and multiple operational schemes – cross-over effects of the distribution grid effects: PHIL testing of volt-var control and voltage ride through; expanded PHIL system for 3-phase testing; incorporate frequency response into PHIL model; and, conduct 3-phase testing, and frequency testing. We will add these additional testing results to the prior draft report and submit by September 2014 as one report to OE.

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## **Project Collaborations and Technology Transfer**

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This OE project coordinates with, and supports, numerous Smart Grid stakeholders, including staff of Smart Grid Interoperability Panel (SGIP) and its Distributed Renewables Generation and Storage Subgroups - Distributed Energy Resources (DER) Interconnection Standards, and, Smart Grid Testing, Certification and Conformance; DOE/EERE; SNL; NIST; IEEE (e.g., P1547 full revision and P1547.1 testing); IEC; CA Smart Inverter Working Group; CA Rule 21 revision; UL; TUV; SunSpec Alliance; EPRI; PJM; NE-ISO; FERC/NERC; States (e.g., CA, NJ); Utilities (e.g., SCE, PG&E, PSE&G; Xcel); Universities (UFla, U-Pitt, CA Vaziri); manufacturers (e.g., SMA, Advanced Energy, Siemens); and system integrators and consultants (e.g., DNV).