

## Electric Distribution R&D Peer Review 2006 Project Summary

<b>YOUR ORGANIZATION:</b>	<b>NATIONAL RENEWABLE ENERGY LABORATORY (NREL)</b>
<b>PROJECT TITLE:</b>	<b>STANDARDS DEVELOPMENT AND VALIDATION/TESTING</b>
<b>PRESENTERS:</b>	<b>TOM BASSO (R. DEBLASIO AND B. KROPOSKI)</b>
<b>FY 2005 FUNDING:</b>	\$400,000 (Standards) \$300,000 (Validation/testing)
<b>FY 2006 FUNDING:</b>	\$400,000 (Standards) \$50,000 (Validation/testing)
<b>START/COMPLETION DATES:</b>	Funding: October 1, 2005 – September 30, 2006

### Overall Project Purpose and Objectives:

The objectives of this project are to develop and harmonize national and international standards for interconnection and integration of distributed energy resources (DER) and electric power systems and to help develop advanced technologies for integration, interface and interconnection with electric power systems and local loads for seamless operations. The project contributes to DOE goals to transform today's electric distribution infrastructure toward increased affordability, reliability, security, and resilience, through integration of advanced communications, information, sensors and controls, and DER with electric power systems. Specific milestones include: developing and publishing - IEEE Std 1547.1 (test procedures), UL Std 1741 (equipment testing), IEEE Std 1547.3 (communications/information), and other IEEE P1547.x series; improved integration, interconnection and interface technologies - transition from analog to digital, increased interoperability, advanced operating strategies; and provide standards and technology tests and conformance validation for enhanced performance. Expected benefits include the following -- improved quality: designs, engineering implementation, interoperability, and installation; lower cost; simplified conformance assessment; increased system quality, resilience, and reliability; advanced communication and software platforms; enhanced grid intelligence; safeguards against hazards; increased competitiveness; market expansion and creation; facilitate trade/commerce; confidence/assurance when products meet standards then further testing or evaluation is minimized.

### FY 2005 and FY 2006 Results and Accomplishments:

- IEEE 1547 cited/required in Federal 2005 EPACT (Chair IEEE SCC21 & 1547, and IEEE Standards Board Liaison to DOE: R. DeBlasio, NREL; > 500 volunteers developed or balloted std.)
- IEEE 1547.1 (2005) - published July 2005 (Test Procedures Std; Chair: J. Daley, ASCO Power Technologies, Inc. >150 volunteers developed/balloted std.)
- P1547.2 (guide to 1547) - start 12/01; Chair: R. Saint, NRECA, 70 members, Draft 4; planned ballot 2007.
- P1547.3 (communications/information) - start 6/02; Chair: F. Goodman, EPRI, 100 members, **May '06 ballot.**
- P1547.4 (DR Islanding Systems) – start 12/03; Chair: B. Kroposki, NREL, 75 members (initial draft).
- P1547.5 (>10 MVA to Transmission) – start 9/04; Chair: M. N. Satyanarayan, Xcel Energy (initial draft).
- P1547.6 (DR Networks) – start 3/05; Chair: J. Koepfing, IEEE Standards Board Emeritus Member, 55 members (initial draft).
- IEEE/1547 members and users: identifying additional priority needs and expansions.
- UL1741 developed/published “Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources”
- Harmonization of national and international standards, codes, and certification/laboratory accreditation.
  - Dual-logo standards: ongoing discussions IEC/IEEE.
  - USA inputs to IEC and TC8: (T. Basso TC8/USA Co-Technical Advisor along with J. Koepfing – who is also IEC Standards Management Board Member: TC8 draft white paper (i.e., 1547.2 outline), plan/prioritize TC 8 projects; IEC electric restructuring docs
- IEC additional NREL participation: IEC JCG Distrib. Ren. Energy Systems, IEC/TC82 PV; IEC/TC 88 Wind.
- Additional participation: other IEEE stds, PJM stds, ANSI-DHS standards coordination, DOE Hydrogen Fuel Cells Stds Coordinating Comm. Etc.,
- Represented standards development/feedback at various meetings (national/international, federal, regional states, and local meetings (strategy, planning, implementation, R&D technologies).
- Coordination/harmonization, e.g., Hydrogen/Fuel Cells, Wind; Photovoltaics; Solar America Initiative; IEC Joint Coordinating Group for Distributed Renewable Energy Systems (drafts on distributed resources interconnection practices, including renewable-hybrid systems and village or mini-grids.
- Completed past contracts with: GE “Reliable, Low-cost Distributed Generator/Utility System Interconnection” and “GTI/Encorp “Innovative Distributed Power Grid Interconnection and Control Systems” and with UL “1741 standard update” to harmonize with 1547 and 1547.1.”

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### **FY 2007 Plans and Expectations:**

#### Problems and Needs

- Incomplete set of standards and guidelines
- Lack of standards coordination and harmonization
- Untested or non-validated technology
- Technology non-uniformity/interoperability, quality, and acceptance
- Improved DER integration and proven/agreed upon advanced operating strategies
- Lack of standardized interfaces – both hardware and operational/informational

#### Progress/Accomplishments

- Ballot/publish P1547.3 DR communications (2006);
- Revise IEEE Std 1547 (start/publish 2007/2008);
- Complete/publish P1547.5 >10 MVA on trans (2009);
- Initiate additional priority stds (2006 - 2008) e.g., power electronics, sensors/controls, interfaces, integration. These would address priority established areas, e.g., improved power quality, voltage regulation, fast switches/relays, reliability, interoperability, information exchange, electric power systems (EPS) impacts, EPS networks, DR-EPS penetration, and, technology for autonomous and semi-autonomous control and operations.
- Sample publications follow. IEEE Std 1547.1; UL 1741; “Network Distribution Systems Background and Issues Related to the Interconnection of Distributed Resources” NREL/SR-560-38079; Chapter “Interconnection of Alternative Energy Sources with the Grid” B. Kroposki, T. Basso, R. DeBlasio, and N. R. Friedman (Wiley); “Reliable, Low-cost Distributed Generator/Utility System Interconnection” GE-NREL SR-560-38017; “Study and Development of Anti-Islanding Control for Synchronous Machine-Based Distributed Generators” GE-NREL SR-560-38018; “Innovative Distributed Power Grid Interconnection and Control Systems’ GTI/Encorp NREL SR-560-38982; “The Energy Policy Act of 2005 And Its Impact on Renewable Energy and Distributed Generation” NREL (Kroposki), Sen (Colorado School of Mines), Malmedal (NEI Electric Power Engineering).
- In summary: - Standards Are Being Developed and Validated In a Timely, Ongoing and Cohesive Manner  
- IEEE Stds 1547 (as they may be amended) Cited and Required in 2005 EPACT  
- Standards Are Promoting Advanced Technology Incorporating Next Generation Functionalities  
- Standards Are Enhancing Systems Integration Modernizing Our Electric Infrastructure

#### **Public/Private Partnerships.**

Cost share standards is \$3 non-DOE : \$1 DOE (est.); cost share validation/testing is \$2 non-DOE : \$1 DOE (est.); and CEC is wholly funding a \$2M multiyear NREL Technology Partnership Agreement – 3 NREL subcontracts. Comprehensive set of R&D partnerships established and nurtured, e.g., ANSI; ASCO Power; Basler Electric; Capstone; CEC; CEIDS DER/ADA; CTC; DOE National Labs; DTE Energy; DHS; DUA; EEI; EGSA; Electrotek; Encorp; EPRI & PEAC; FERC; GTI; GE; IEC; IEEE; IntelliGrid; MADRI; NARUC; NEMA; NiSource; NRECA; NIPSCO; Northern Power; NYSERDA; PG&E; PJM; RealEnergy; RDC; Siemens; SoCalEd; UL; US National Grid; U Wisconsin; VA Tech; Westinghouse; Xantrex; Xcel; ... others.

A major challenge is to bring together all of the interested parties and agree on consensus based standards that help the industry develop and implement the 21st century grid. NREL has led through the IEEE Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage (R. DeBlasio Chair, IEEE Standards Board Member and Board Liaison to DOE) the development of a series of interconnection standards that is addressing the needs. Harmonization of national and international standards, codes, and certification and laboratory accreditation is requisite to assuring that electric power system reliability, operation, and safety will not be compromised. NREL operates as the IEC/TC8/USA Co-Technical Advisor (T. Basso) along with Joe Koepfinger (IEEE Standards Board Emeritus Member), and NREL manages the membership in the USA TC8 Technical Advisory Group. Another technical challenge is validating/testing practical and cost-effective implementation of standardized functionalities into the design, acceptance, and availability of low-cost interconnection integration and interface hardware. This work focuses on the validation/testing development of advanced technology for interconnection and control of distributed resources and technologies that allow interoperability and integration for DR and the distribution system to operate in different configurations to ensure test requirements and procedures are appropriate, while also examining related performance effects, e.g., standard criteria/issues related to aggregation or planned islands/micro-grids. This validation/testing work is a collaborative effort with manufacturers of distributed power equipment to improve current interconnection system designs and fully develop test methods for determining performance to interconnection requirements.