

EERE SEGIS-AC Workshop

**Utility-scale Grid-tied PV Inverter Reliability
Technical Workshop (Summary Results)**

**Hilton Arlington
950 N. Stafford St.
Arlington, VA 22203
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**Stanley Atcitty (Stan), Ph.D.
Energy Infrastructure and DER**

Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration, under contract DE-AC04-94AL85000.

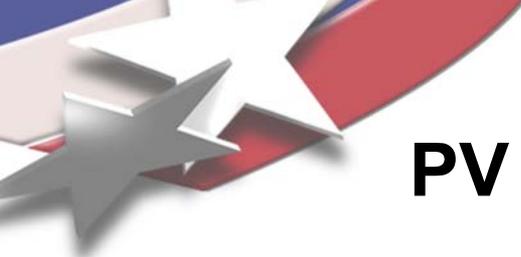




Utility-scale Grid-tied PV Inverter Reliability Technical Workshop

- **Hosted by DOE EERE and Sandia National Laboratories**
- **January 27 and 28, 2011 in Albuquerque, NM**
- **Reliability of large (100 kW+) utility-scale grid-tied PV inverters**
- **Number of attendees (47)**
 - **DOE (1)**
 - **Sandia (12)**
 - **NREL (4)**
 - **Universities (6)**
 - **Industry (24)**

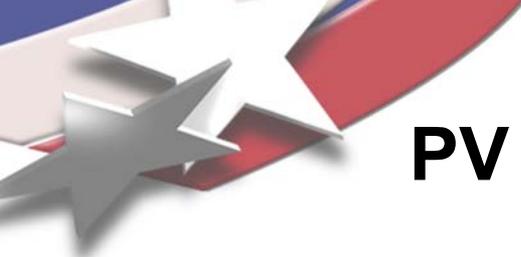




PV Inverter Workshop Agenda (Morning Day 1)

- **Inverter Manufacturer Perspective on Reliability**
 - SatCon, Jim Perkinson
- **Integrator Broad Perspective on Reliability**
 - First Solar, Tom Levitsky
- **Owner/Operator Perspective on Reliability**
 - SunEdison, Tassos Golnas
- ***Survey Results, Summary and Discussion***
 - *Sandia*





PV Inverter Workshop Agenda (Afternoon Day 1)

- **DOE \$1/Watt Workshop and Goals**
 - DOE, Mike Cliggett
- **Sandia's Approach to Reliability**
 - Sandia, Jennifer Granata
- **IGBT Reliability Issues and Needs**
 - Powerex, John Donlon
- **Sandia Semiconductor Switch Reliability Project**
 - Sandia, Bob Kaplar
- **Capacitor Reliability Issues and Needs**
 - AVX Corporation, Andy Ritter
- ***Facilitated Discussion – Approaches to Reliability***





Survey Summary

- **Many Component Reliability Issues Were Identified**
 - Capacitors, IGBT's, drive circuitry, power supplies, circuit boards
 - Supply chain management contributes to reliability issues
- **Concerns About Reliability Methodologies and Best Practices**
 - Design for Reliability
 - Reliability Metrics
 - Reliability Certification, Codes, Standards
 - Failure Identification, Failure Analysis
 - Testing: Function, Safety, ALTs
- **Vulnerabilities Identified as Concerns**
 - Thermal management
 - Grid Issues
 - Components
 - Environment
 - Communications
- **Cost of Reliability and Time Constraints Are Also Issues**





PV Inverter Workshop Agenda (Day 2)

- Overview of UL1741
- Existing Codes and Standards (Summary)
 - BEW Engineering
- ALT/Acceleration Factors
 - Sandia
- *Facilitated Discussion – Codes and Standards*
- Technology Advances to Improve Reliability
 - CALCE University of Maryland
- *Facilitated Discussions – Technology Advances & Wrap-up*
- Sandia DETL Tour

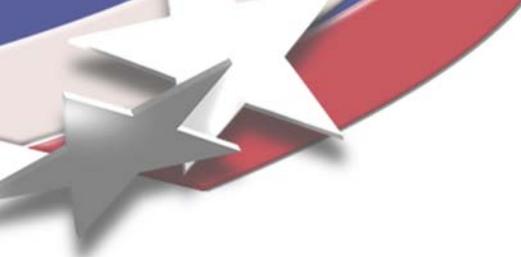




Session 6 Key Areas

- **Standards**
 - IEC62093 [BOS Components for PV Systems, Design Qualification Natural Environments] needs revisions
 - Reliability protocol based on “how-to”- use IPC9592A [Performance Parameters for Power Conversion Devices] as a guide
- **Modeling**
 - Modeling inverter as a system that includes environmental data (*i.e.*, use model)
- **Testing**
 - ALT and solar gain
- **Diagnostics**
 - Monitoring in the field
- **Data Sharing**
 - Everyone needs more data (still a challenge)
- **Workshop Specifics**
 - Have another workshop within 1 year





Key Points

- **In general, inverter reliability is still an issue (perspective issue)**
 - Utility-scale inverters most frequently affected subsystem
 - PCB subassemblies and software accounted for significant share of reliability events
- **Environmental conditions of large-scale PV (most discussed)**
 - Lack of understanding (reliability concern)
 - Temperature extremes (solar gain, enclosure, corrosion, thermal cycling, dust, dew, etc.)
 - Enclosure and defining environmental conditions such as dust, humidity, and insects
 - Field testing and case studies needed
 - Environmental qualification standards and guidelines/best practices
- **Existing standards and guidelines do not adequately cover PV inverters (similar option)**
 - Separate standards for micro/string inverters and larger utility-scale inverters
 - Harmonize and coordinate efforts among IEEE, IEC, etc. to develop standards
 - Need for integrators to set uniform/minimum set of requirements for the inverters
- **Cost of improving reliability only to the extent that it reduces overall LCOE**
 - Overall availability viewed more important than number of reliability events by integrators & owner/operators
- **Inverter manufacturers seemed to favor CBM instead of designing for 25+ year reliability**
 - “Reliability at any cost” was viewed not feasible to self-sustained business model by inverter manufacturers
- **Monitoring and data logging of critical components are key to improving reliability**
- **Reliability impact due to utility conditions on inverter**





For Additional Information Contact

Stanley Atcitty (Stan), Ph.D.
Principal Member of Technical Staff
Energy Infrastructure and DER
Sandia National Laboratories

Phone: 505-284-2701

Email: satcitt@sandia.gov

