INTERNATIONAL PHOTOVOLTAIC RELIABILITY WORKSHOP II
TEMPE MISSION PALMS, TEMPE, AZ
JULY 29-31, 2009

WORKSHOP OVERVIEW

As solar photovoltaic (PV) technology continues to capture a growing share of the world's electricity generating capacity, it becomes increasingly important for the industry to ensure the quality and reliability of its products. Failure to do so could result in irreversible setbacks and large-scale grid issues, which are not only costly but can lead to a loss of consumer trust in the technology. Additionally, as the PV market continues to globalize, safeguarding the use of product imports is crucial. Without international codes and standards, end-users of PV technologies will not be able to fully evaluate the substrate and component options available to them, nor will they be able to accurately predict the long-term reliability of their systems.

As part of the effort to address these concerns, the Department of Energy's Solar Energy Technologies Program (DOE SETP) and two of DOE's national labs partnered with industry organizations and international PV experts to develop two workshops. These workshops were designed to assist PV manufacturers with technical information and bring PV stakeholders together to discuss long-term reliability qualification and testing needs.

The July workshop, called the International Photovoltaic Reliability Workshop II (IPRW II), focused on how reliability codes and standards might help remove barriers to PV technology adoption. IPRW II was a follow-up to the first planned workshop, which took place in Shanghai, China, in December 2008. Initial support and planning for these workshops was provided by the Asia Pacific Partnership (APP).

IPRW II was hosted and supported by the PV reliability project at Sandia National Laboratories and the International Program at National Renewable Energy Laboratory and sponsored by TÜV Rheinland®, a leading provider of testing and certification services for companies entering the global marketplace. The audience of nearly 100 participants included representatives from all facets of PV manufacturing and use: research and development, cells and modules, inverters, installation, applications, and marketing. The workshop format included a full day of site tours and two days of presentations, collaborative discussion, and technical networking.

Discussions are in progress to evaluate whether and when another global reliability workshop will be held and how the findings of this two-year effort might be integrated into SNL's and NREL's reliability program activities.

EVENT DETAILS

WEDNESDAY, JULY 29, 2009
SITE TOURS

On Wednesday, participants were invited to join the co-organizers for a day of site tours at PV installations and test sites.

Morning Tours
The first tour of the day was the **Arizona Public Service Solar Test and Research Center** (APS STAR Center®, http://www.aps.com/my_community/STARtour/default.html?seq=1) facility in Tempe. APS STAR is a test site for current and emerging technologies, including several types of PV panel arrays, rooftop installations, tilted tracker arrays, and mini dish installations. The APS has partnered with another workshop participant – **Arizona State University (ASU)** – and workshop sponsor **TUV Rheinland® PTL** – to conduct long-term (>10 years) outdoor exposure testing at APS Star, and is currently working with Sandia National Laboratories and the National Renewable Energy Laboratory on various testing projects.

Participants were then taken to nearby Arizona State University to view PV installations on the campus. Led by Bonny Bentzin from the university's Global Institute of Sustainability, participants viewed two of the school's solar installations: an 880-kW system on the Apache Boulevard parking structure (PS 1), the largest in the ASU Solarization Initiative (http://solar.asu.edu/); and a 30-kW system on the Tyler Street Parking structure (PS 2). The university has several additional installations throughout their campus, including a 711 kW system on a third parking structure.

The next destination on the tour was TUV Rheinland®'s Photovoltaic Testing Laboratory (TUV-PTL, www.tuvptl.com), just minutes from ASU's main Tempe campus. TUV Rheinland® is a global leader in independent testing and certification services, and the PTL site tests a range of PV materials and components, including flat panel and thin film PV, concentrated photovoltaics (CPV), solar thermal, inverters, and more. On the tour, participants were introduced to some of TUV's methods and technologies for PV testing.

Following a lunch break, tour participants embarked on an hour-long drive west of Phoenix, to **Atlas Materials Testing Technology**'s new solar test site (www.solardurability.com). Atlas is a well-known leader in testing of materials such as car components and building materials. The company's capabilities in testing weather and environmental impacts, corrosion, flammability, and other attributes will be applied to a range of solar product in the new Solar Test Center. Participants had an opportunity to view numerous weatherization and environmental test technologies being employed at the site.

Tour participants indicated that the sites were all interesting and educational. Both tour schedules (morning and afternoon) were at capacity with56 people.

DAY ONE – THURSDAY, JULY 30, 2009
PRESENTATIONS AND TECHNICAL NETWORKING

The first full day of workshop proceedings began with opening remarks, followed by keynote presentations from representatives of DOE and Japan's New Energy and Industrial Technology Development Organization (NEDO). Presentations for the day were grouped into two key technical topics: (a) Certification and Quality Processes, and (b) Prequalification, Durability, and Reliability Assessments of PV Materials, Modules, Components, and Systems. The day concluded with special topics presentations on PV modeling tools and solar resource assessments, and a plenary presentation from Arizona State University.

THURSDAY JULY 30TH	
7:15 – 7:45 a.m.	**Registration and Continental Breakfast**
	Welcome and Opening Remarks Jeffrey Nelson, Sandia National Laboratories Mani G. TamizhMani, President, TUV Rheinland PTL and Professor, Arizona State University
7:45 – 9:00 a.m.	**Keynote**: Department of Energy Solar Energy Technologies Program Chris Cameron, DOE-SETP **Keynote**: Smart Grid and NEDO's Experience through Several Projects in Japan Mr. Hirofumi Nakama and Mr. Keiichi Watanabe, New Energy and Industrial Technology Development Organization (NEDO)
9:00 a.m. – Noon	***TECHNICAL SECTION I*** ***Certification and Quality Processes***
9:00 – 9:40 a.m.	Cell and Module Level Testing Procedures and Intercomparisons • Keith Emery, National Renewable Energy Laboratory (NREL)
9:40 – 10:00 a.m.	ISO 17025 QA Accreditation Process • Bindhu Raghuraman, TUV Rheinland PTL
10:00 – 10:20 a.m.	BREAK
10:20 – 10:40 a.m.	Polymer Material Standard Requirements and Test Methods • Chris Flueckiger, Underwriters Laboratories
10:40 – 11:00 a.m.	*China*: Technical Requirements and Specifications for Testing and Certification of BIPV in China • Mr. Wei Kang, China Quality Certification Center (CQC) *Presented by Mr. Shen Tao, China Quality Certification Center (CQC)*
11:00 – 11:50 a.m.	Q & A and Technical Networking
Noon – 1:00 p.m.	**Lunch and Continued Networking**

THURSDAY JULY 30TH CONTINUED	
1:20 – 4:40 p.m.	***TECHNICAL SECTION II*** ***Prequalification, Durability, and Reliability Assessments of PV Materials, Modules, Components, and Systems***
1:20 – 1:40 p.m.	Breakage Mechanism(s) of Photovoltaic Silicon Wafers: Theory and Experiment • Bhushan Sopori, NREL • Przemyslaw Rupnowski, NREL
1:40 – 2:20 p.m.	Reliability and Accelerated Aging Methodologies and Observations ▸ Overview of Current Methods ▸ Durability, Weatherability & Reliability ▸ System Level Reliability Methodologies • 1:40 p.m.: Mani G. TamizhMani, TUV Rheinland PTL • 2:00 p.m.: Jennifer Granata, Sandia National Laboratories
2:20 – 2:40 p.m.	*China:* Analysis Methods and Instruments for the Production of Polysilicon Material and Crystalline Silicon Wafers • Dr. YuePeng Wan, Chief Technology Officer, LDK Solar
2:40 – 3:00 p.m.	*China:* Performance Analysis of Solar Grade Crystalline Silicon Modules • Dr. Genmao Chen, Director of R&D at Canadian Solar, Inc. (CSI)
3:00 – 4:00 p.m.	Q & A and Technical Networking
4:00 – 5:00 p.m.	**BREAK**
5:00 – 5:30 p.m.	***Special Topic:*** **PV Modeling and Analysis Tools** Chris Cameron, Sandia National Laboratories
5:30 – 6:00 p.m.	***Special Topic:*** **Resource Assessment Tools** Dave Renne, NREL
6:00 – 6:30 p.m.	**Q & A, Discussion**
6:30 – 7:00 p.m.	**Plenary Presentation:** Arizona Institute for Renewable Energy Christiana Honsberg, Arizona State University
7:00 p.m.	**Dinner**

OVERVIEWS BY PRESENTATION

Listed below is a brief overview of some of the key themes covered in each presentation. Full presentations are available for download on the workshop Web page on the Department of Energy's Solar Energy Technologies Program website (solar.energy.gov).

OPENING REMARKS, KEYNOTES

Welcome and Opening Remarks
Jeffrey Nelson, Sandia National Laboratories

- Thanked workshop planning committee, event sponsors, and contacts within each tour site
- Identified workshop goal: Provide a Forum for international and domestic organizations and experts to share information and resources about photovoltaic (PV) systems reliability
- Asked participants to approach workshop with some key questions in mind about next steps (i.e., a third and/or ongoing workshops):
  - What will be most impactful going forward: Broader, all-encompassing meetings, or a series of meetings focused on one topic each?
  - What topics need more attention or haven't yet been addressed?
  - What are the most urgent issues in reliability?

Department of Energy Solar Energies Technology Program (DOE SETP)
Chris Cameron, Sandia National Laboratories/DOE SETP

- DOE SETP is focused on enabling high penetration of solar energy and grid parity by 2015
  - SETP FY09 Budget: $175M
  - PV technologies currently receive 71.1% of total Program funding
- Four sub-programs in DOE SETP
  - PV Applied Research and Systems Development
  - Concentrated Solar Power
  - Systems Integration
  - Market Transformation
- DOE SETP identifies current role as part of the entire solar RD&D supply chain
- DOE has identified several key reasons to focus on PV reliability:
  - Long-term Reliable Performance of Modules & Systems Critical to Cost Parity
  - Success of the industry depends on it
  - Growing Significance of Asian PV Module Production

Smart Grid and NEDO's Experience through Several Projects in Japan
Mr. Hirofumi Nakama, New Energy and Industrial Technology Development Organization (NEDO)
Mr. Keiichi Watanabe, New Energy and Industrial Technology Development Organization (NEDO)

- NEDO is Japan's largest public R&D management organization for promoting the development of advanced industrial, environmental, new energy and energy conservation technologies

- Japanese presence in PV expected to grow significantly by 2030 (~100 GW installed capacity)
- NEDO working with state of New Mexico on Green Grid Initiative (smart and micro-grids)
- NEDO projects in Japan include
    - Clustered PV power generation systems (Ota Jyoshi-no-m)
        - Systems include lead-acid battery storage
    - Large-scale PV power generation, grid stabilization (Wakkanai-city, Hokuto-city)

TECHNICAL SECTION I - Certification and Quality Processes

Cell and Module Level Testing Procedures and Intercomparisons
Keith Emery, National Renewable Energy Laboratory (NREL) Center for Photovoltaics

- NREL IV, QE calibration procedures and equipment are ISO 17025 accredited
- Identified Standard Reference Test Conditions
    - Includes: Continuous Illumination; 25 °C Junction Temperature; 1000 W/m2 Total Irradiance (1-sun); ASTM G173 Reference Spectrum
    - Adjusted direct beam irradiance, wind speed, and air temperature to conduct sensitivity analysis for varying conditions
- NREL uses a continuous concentrator (1-100 suns) for samples sensitive to bias rate (i.e., CIGS concentrators)
- Identified one of the key issues with modules to be company stability; nearly half of the companies represented in NREL's test site went out of business before testing was completed
- Offered caution about importance of avoiding calibration drift in cell testing; periodic inter-comparisons are critical

ISO 17025 QA Accreditation Process
Bindhu Raghuraman, TUV Rheinland® PTL

- Defined the distinction among *registration, accreditation,* and *certification:*
    - *Registration* identifies relevant characteristics, but does not certify or guarantee quality
    - *Accreditation* is formal recognition that a person, product, or body is competent to carry out specific tasks
    - *Certification* gives written assurance that a product, process, or service conforms to a specific set of requirements
- Test laboratories are usually *accredited,* not *certified*
- Technical requirements of ISO/IEC 17025 include nine elements, several of which were discussed in greater detail during the presentation:
    - Personnel
    - Accommodation/environment conditions
    - Test methods and method validation
    - Equipment
    - Measurement traceability
    - Sampling

- Handling of test items (samples)
- Assuring quality of test results
- Reporting results

Polymer Material Standard Requirements and Test Methods
Chris Flueckiger, Underwriters Laboratories

- Recent field issues indicate that materials requirements need to be more stringent in order to account for open circuit arcing fault failures in polymeric materials
- An increase in the use of encapsulants by the PV industry may require that standards be expanded to include direct contact / direct support requirements similar to other UL categories
- Other materials for which standards may need to be adjusted include backskins/substrates and superstrates and pottants
- *UL iQ for Plastics* shows relative ratings of materials
- Rating materials for roofs depend on local codes; need to develop standards for the impact of PV on roofing materials

Technical Requirements and Specifications for Testing and Certification of BIPV in China
Wei Kang, China Quality Certification Center (CQC)
Presented by: Shen Tao, China Quality Certification Center (CQC)

- CQC is the largest certification body in China
- Certification procedure applies to several distinct categories:
  - BIPV cSi
  - BIPV thin film
  - Grid-connected PV
  - Off-grid PV
  - Hybrid systems (wind and solar)
- China's BIPV Certification developed under guidance of national policy in 2009; still large gaps between U.S. and China on BIPV

TECHNICAL SECTION II - Prequalification, Durabilit,y and Reliability Assessments of PV Materials, Modules, Components, and Systems

Breakage Mechanism(s) of Photovoltaic Silicon Wafers: Theory and Experiment
Bhushan Sopori, National Renewable Energy Laboratory
Peter Rupnowski, National Renewable Energy Laboratory
Presented by: Bhushan Sopori

- 5-10% of PV wafers break during cell fabrication
- Silicon is very brittle at room temperature and its strength is limited by structural imperfections
- Use of wires to saw wafers creates rough edges
  - Diamond saws cause same issue

- Dominant cause of wafer breakage is the presence of micro-cracks
- Wafer strength may be improved through better preparation techniques
    - Gentler sawing, edge grinding, chemical etching, improved overall handling/transport

Performance Losses and Reliability of Photovoltaic Modules
Mani G. TamizhMani, TUV Rheinland PTL and Arizona State University

- Performance issues discussed: Higher operating temperature and long-term degradation, spectral issues – outdoor, and reliability issues
- Model based on two-year data from two identical sets of modules of varying technologies
- High temperature and rooftop module prediction models use ambient temperature, irradiance, and wind speed as parameters; additional model planned with wind direction parameter
- Also reviewed test results in degradation, spectral issues, etc.
- Reliability issues include: arcing, interconnection breaks, back sheet crumbling, junction box cracking

System Level Reliability Methodologies
Jennifer Granata, Sandia National Laboratories
Michael Quintana, Sandia National Laboratories
Presented by: Jennifer Granata

- Reliability is *not* about how long something will last; it is the probability of simultaneously satisfying a performance requirement, in a specific environment, at a particular time
- Systems approach: evaluates components with respect to how they fit in the overall system
- Systems reliability can be impacted by economics (incentives, COO, business model, etc.) and social/bureaucratic issues (politics, local codes, aesthetics, etc.) as well as performance issues
- Reviewed Sandia PVRAM (PV Reliability and Accountability Predictive Model)

Analysis Methods and Instruments for the Production of Polysilicon Material and Crystalline Silicon Wafers
Dr. Yuepeng Wan, LDK Solar Co. (China)

- Inspection and analysis for wafers and cells includes evaluating: Physical characteristics, appearance/edge defects, bulk crystal defects analysis, failure analysis
- LDK conducts solar cell failure analysis using CoRReScan:
    - **LBIC:** Light beam induced current mapping to locate low efficiency area of whole cell
    - **Voc Scan:** To locate low open voltage area of whole cell
    - **Shunt Scan:** To locate shunting area of whole cell
    - **Series Resistance Scan:** To locate high contact resistance area of the whole cell
- Low-efficiency analysis includes identification of cell analyte contents in best and worst efficiency areas of the cell

Performance Analysis of Solar Grade Crystalline Silicon Modules
Genmao Chen, Canadian Solar (China)
Shawn Qu, Canadian Solar (China)

Presented by: Genmao Chen

- Canadian Solar's solar grade Si modules("e-modules"), manufactured via same process as conventional Si, have less environmental impact, are less expensive, and have lower impurity levels; comparable to conventional Si in efficiency (overall, marginally less efficient)
- E-modules: lower peak power coefficient, degradation rates similar to conventional Si on annual basis
- Initial degradation caused by cell passivity; can also be caused by initial exposure of glass to sunlight

Special Topic: *PV Modeling and Analysis Tools*
Chris Cameron, Sandia National Laboratories / DOE SETP

- DOE's key Solar Program metric: Levelized Cost of Energy (LCOE)
- DOE's Solar Advisor Model (SAM) – developed by NREL
    - Designed to combine PV, CSP, thermal solar technologies into a single model, make DOE's National Lab and partnership models available, and allow comparisons and calculations across markets and technologies
- Free download: https://www.nrel.gov/analysis/sam

Special Topic: *Resource Assessment Tools*
Dave Renne, National Renewable Energy Laboratory

- Solar energy can provide 23,000 TW of energy per year (Dr. Richard Perez, SUNY)
- Accurate knowledge of solar resource critical to understanding PV performance
    - Magnitude and variability of resource with respect to changes in time (short- and long-term) and location
- Resource assessment tools include:
    - National Solar Radiation Data Base
    - High-Res Model developed by Dr. Richard Perez, SUNY
    - Solar maps
    - NREL's Solar Radiation Research Lab
        - Solar Resource and Meterological Assessment Project (SOLRMAP)
            - Six stations in AZ, CO, NV – updated by utilities
- Resource issues for reliability: "bankable" data, cloud variability (esp. for distributed PV), best practices for use of solar data, benchmarking

Plenary: *Arizona Institute for Renewable Energy (AIRE) and the Solar Power Laboratories*
Christiana Honsberg, Arizona State University

- Existing energy systems have limited technical applications; new energy technologies enable new industries and enable new applications (i.e., self-contained autonomous power; Smart Grid)
- AIRE focuses on: Outreach; basic and applied research; renewable energy education; and renewable energy industry
    - Solar cell efficiency, cSi research, ASU Campus Solarization

- Key challenges in PV: need higher efficiency, but in all materials higher efficiency increases cost
    - Transistors increase performance and decrease cost – why not in PV?
    - Moore's Law of Photovoltaics
    - Material efficient approaches
- All energy technologies eventually stabilize at a cost that's in high proportion to their thermodynamic capability
- Research includes silicon heterojunction, new solar cell structures, alternatives to aSi, InGaN cells, solar cell efficiency limits, new materials, transformative PV

DAY TWO – FRIDAY, JULY 31, 2009
PRESENTATIONS AND TECHNICAL NETWORKING

The second day of workshop proceedings featured two key technical topics: (a) Domestic and International Codes and Standards, and (b) Grid Interconnection and Integration, and a special topic presentation about the U.S. market transformation efforts of DOE.

FRIDAY, JULY 31ST	
7:00 – 8:00 a.m.	Continental Breakfast
8:00 a.m. – Noon	***TECHNICAL SECTION III*** ***Domestic and International Codes and Standards***
8:00 – 8:20 a.m.	A Guide to the World's Standards Organizations and the Differences Among Them • Liang Ji, Underwriters Laboratories
8:20 – 8:40 a.m.	U.S. Codes and Standards Structure and Supporting Organizations • John Wiles, Southwest Regional Experiment Station
8:40 – 9:00 a.m.	U.S. Solar ABCs • Larry Sherwood, Sherwood Associates
9:00 – 9:20 a.m.	Fire Hazards: Experience and Studies • Liang Ji, Underwriters Laboratories
9:20 – 9:40 a.m.	BREAK
9:40 – 10:20 a.m.	Summary of Emerging CPV Safety Standards • William Shisler, TUV Rheinland PTL • Liang Ji, Underwriters Laboratories
10:20 – 10:40 a.m.	Developing Codes and Standards for BIPV and Integrated Systems • Kurt Scott, Atlas Material Testing Technology LLC
10:40 – 11:15 a.m.	Q & A and Technical Networking
11:30 a.m. – 12:15 p.m.	**Lunch and Continued Networking**
12:30 – 1:30 p.m.	***Special Topic:*** **U.S. Market Transformation Efforts** Kevin Lynn, SENTECH, Inc. / U.S. Department of Energy

1:30 – 3:00 p.m.	***TECHNICAL SECTION IV*** ***Grid Interconnection and Integration***
1:30 – 2:00 p.m.	Impact of SolarSmart Subdivision on SMUD's Distributing System • Peter McNutt, NREL
2:00 – 2:30 p.m.	Solar Energy Grid Integration Systems (SEGIS) • Ward Bower, Sandia National Laboratories
FRIDAY, JULY 31ST CONTINUED	
2:30 – 3:00 p.m.	Q & A and Technical Networking, Break
3:00 p.m.	**Concluding Remarks**
3:15 p.m.	**Adjourn**

TECHNICAL SECTION III - Domestic and International Codes and Standards

A Guide to the World's Standards Organizations and the Differences Among Them
Liang Ji, Underwriters Laboratories

- Reviewed several standards organizations and explained the PV standards for each, both current and under development:
  - ANSI (American National Standards Institute)
  - NIST (National Institute of Standards and Technology)
  - ASTM (originally American Society for Testing and Materials, now International ASTM)
  - IEEE (originally Institute of Electrical and Electronics Engineers, now just IEEE)
  - UL (Underwriters Laboratories, independent product safety certification organization)
  - SEMI (Semiconductor and Equipment Materials International, non-profit industry group)
  - SAC (Standardization Administration of People's Republic of China)
  - CENELEC (European Committee for Electrotechnical Standardization)
  - IEC (International Electrotechnical Commission)

U.S. Codes and Standards Structure and Supporting Organizations
John Wiles, Southwest Regional Experiment Station at New Mexico State University

- In many states, electrical installations are not regulated by codes or standards; installers should be proactive in adhering to a standard
- NEC – National Electrical Code: defines installation standards for all electrical installations in the U.S.; updated every three years
- Sandia National Laboratories: PV Industry Forum, component modeling/validation

- PV systems designers and PV installers are critical to ensuring safe, reliable and cost-effective installations
    - Incorrectly installed systems will not last, no matter how good components are

U.S. Solar America Board for Codes and Standards (Solar ABCs)
Larry Sherwood, Sherwood Associates

- DOE-funded effort to provide coordinated recommendations to codes- and standards-making bodies for existing and new solar technologies
    - Public and private partnership (DOE national labs, universities, industry)
- Study report completed: *Crystalline Silicon Terrestrial Photovoltaic Cells – Supply Chain Procurement Specification Guideline* (http://www.solarabcs.org/cellprocurement/)
- Currently working on standards development for System energy ratings, inverter meters, Accelerated Lifetime Testing
- Currently working on codes revisions for NEC, building codes, fire codes
- Other priorities include grounding issues, expedited permitting, wind load issues

Fire Hazards: Experience and Studies
Liang Ji, Underwriters Laboratories

- Major considerations for fire safety of PV systems: fires caused by PV components and systems and fires caused by external sources
- New test methods underway for arcing; UL conducting AFCI research
    - May be a code in NEC by 2011
- Industry still needs to determine whose responsibility it is to capture and analyze data on fires
- UL conducting fire test simulations to determine impact of PV on roofing materials

Summary of Emerging CPV Safety Standards
William Shisler, TUV Rheinland PTL

- Unique safety concerns for CPV
    - Vision damage (humans, animals, birds)
    - Off-axis focal beam
    - Distance from land boundary
    - Vibration
- No one clear CPV safety standard available
    - IEC 62108 design type approval standard for CPV modules and assemblies published Dec 2007
    - Safety group formed to establish international safety standard compatible with IEC 62108
        - Will cover only PV modules and assemblies, but not balance of system (trackers, controls, motors, whether integrated or separate)
- Test requirements include: Fire, dielectric withstand, outdoor exposure/UV, hot spot endurance

Developing Codes and Standards for BIPV and Integrated Systems
Kurt Scott, Atlas Material Testing Solutions (Solar Energy Competence Center)
Allen Zielnik, Atlas Material Testing Solutions (Solar Energy Competence Center)
Presented by: Kurt Scott

- BIPV (building integrated PV) presents unique challenges
  - Should direct-contact PV materials be considered *part* of the building material?
  - Inverts concept of traditional grid protections
- As a building material, BIPV should help prevent or at least reduce fire risk; must be very stable
- Must integrate standards for PV with standards of building materials and codes
- Standards should distinguish between **reliability** (discrete, absolute failures) and **durability** (root cause of failures)
- Also need to consider BAPV (building-applied PV) and crossover products (other direct-adhered PV)

Special Topic: U.S. Market Transformation Efforts
Kevin Lynn, SENTECH, Inc. / DOE SETP

- Goal of program is to reduce market barriers to, and promote market expansion of, solar energy technologies through non-R&D activities
- Key activities
  - Solar America Cities
  - Solar America Board for Codes and Standards
  - State & Utility Technical Outreach
  - Solar America Showcases
  - Government Solar Installation Program
  - Workforce Development
- Market Transformation stakeholders: Government, Utility, Commercial, Institutional
- Offers technical outreach assistance to states, utilities
- Government Solar Installation Program (GSIP) – Works with Federal Energy Management Program (FEMP) to provide technical assistance to government entities; goal is to overcome market barriers to installation of solar systems at government facilities
- Workforce Development program includes
  - New funding opportunity for solar installer training
  - NABCEP certification
  - Institute for Sustainable Power Quality (ISPQ) accreditation
  - Interstate Renewable Energy Council (IREC) Workforce Development, Education and Training

TECHNICAL SECTION IV - Grid Interconnection and Integration

Impact of SolarSmart Subdivision on SMUD's Distribution System
Peter McNutt, National Renewable Energy Laboratory
Josh Hambrick, National Renewable Energy Laboratory
Mike Keesee, Sacramento Municipal Utility District
Dave Brown, Sacramento Municipal Utility District
Presented by: Peter McNutt

- Anatolia: Joint NREL/SMUD Research Project
  - Three years, beginning Mar 08
  - To analyze impacts of high penetrations of grid-integrated PV SolarSmart homes
    - Excessive service or substation voltage?
    - Inverter tripping or limited inverter generation?
    - Transformer issues (number of connections, transformer size)
  - 795 total homes, 600 of them SolarSmart (~2.0 kWac); 115 houses constructed to date
  - No energy storage in project
- Solar Resource Monitors: all wireless, take less than a day to install
- After one year, PV systems have not adversely impacted the Anatolia distribution system
- Continued work will include determining acceptable levels of PV, working with consumers to connect for voluntary Internet system monitoring, and isolating loads outside Anatolia

Solar Energy Grid Integration Systems (SEGIS)
Ward Bower, Sandia National Laboratories

- SEGIS is intended to bring together partners from diverse locations and areas of expertise to design and build entire "intelligent" systems
- SEGIS vision: Enable highly integrated, innovative, advanced inverters, controllers, critical BOS concepts and energy management for both residential and commercial PV applications
  - "Value-added" approach designed to reduce non-module costs
  - Focus: To develop intelligent hardware that interconnects PV to evolving "smarter" electrical grid
  - Designed to develop advanced communications and component applications
- SEGIS is a three-stage solicitation
  - 12 awards began June 2008 for nine months

PROGRAM CONCLUSION

The program ended with a short question, answer, and feedback session, during which participants were asked for thoughts on the topic of reliability as well as the content and format of the workshop. The consensus was that as new technologies and larger-scale manufacturing processes for PV emerge, tools for predicting and improving reliability will be increasingly important. Additionally, there is a need to

expand these tools to account for a progressively more global marketplace as PV manufacturing expands in China, India, Korea, and other countries.

NEXT STEPS

IPRW attendees indicated a strong interest in additional workshops. As a follow-up, participants were asked to send additional feedback to the planning committee, so that the scope of future events could be determined. The planning committee is evaluating the feasibility of organizing and funding additional reliability events. Any planned events will continue to focus heavily on interactive workshops so that key lessons can be shared among participants.