DOE Solar Energy Technologies Program Peer Review

Technical Track: Market Transformation

Project Name: Technical Partnerships – *Southwest Region Experiment Station*

Principal Investigator: Andrew L. Rosenthal

Denver, Colorado

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Quality, Productivity, Accomplishment

- SWRES has worked within the DOE National Photovoltaic program since 1979.
- Currently, the SWRES has 9 full-time staff that includes: 4 electrical engineers, 1 mechanical engineer, 1 industrial engineer, 2 MBA's.
- SWRES staff works in the following areas:
  - Leadership and support roles in technical Tiger Teams for Solar America Cities, Showcases, GSIP projects
  - Nationally recognized leadership in development and training for PV Codes and standards
  - Years of expertise in PV system field and acceptance testing, system rating, system performance and economic analyses
- Physical Plant: SWRES is a 3-acre test site in Southern New Mexico with one and two-axis trackers, lan-based data network for testing modules, inverters, batteries with real-time accessible data via the Web.

- SWRES is in its last year of 3-year contract (funded by calendar year):

  Budget for Jan-Dec 2007: $1,000k ($113k cost share)

  Budget for Jan-Dec 2008: $1,135k ($48.5k cost share)

- <u>Productivity: Market Transformation</u>
  - Tiger Team Lead for two Solar America Cities: Tucson, Santa Rosa
  - Tiger Team Lead for one GSIP: Papago Park Military Reservation (Phoenix, AZ)
  - Tiger Team Participants in several ongoing Solar America Cities: NY, Pittsburgh, San Jose, Salt Lake City, Madison, Austin
  - Tiger Team Participant in Solar America Showcase: Forest City Hawaii, LLC
  - Codes and Standards Development: Secretary of PV Industry Forum (*National Electrical Code*), Service on UL Standards Technical Panels 1703 and 1741, IEEE SCC-21 battery standardsgroup, IEC TC82, NABCEP Exam Committee, *NEC* review for *all* Solar Decathlon entries 2007/9

- Productivity: Test and Evaluation
  - Supported program-wide review of test and evaluation requirements (labor, hardware, software, travel) for all SAI TPP award winners.
  - Participated in stage gate field testing of Amonix CPV systems (activity led by SNL)
  - Operate Inverter Long Term Test Facility (ILTF), 6 residential inverters undergoing a five-year test of performance and reliability (includes regular laboratory re-characterizations and reinstallation)
  - In the current reporting period, SWRES performed the following:
    - Acceptance testing of 30 kW PV system, City of Phoenix Pecos Park Municipal Building
    - PV system field test and array rating for 1 MW PV system at the Sonoma Mountain Village in Rohnert Park, CA.
    - PV system field tests and array ratings for two 100 kW PV systems owned by Salt River Project, Phoenix, AZ (Pinal Customer Center and SRP Power Operations Building)

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- Tiger Team Lead, *Solar America City Tucson, AZ*
  - Field tests of 10 city-owned PV systems
  - Developed SOW for CH2MHill to prepare an RFP for 1 MW PV system PPA (deliverable shared among other SAC participants)
  - Provided technical review of 10 PPA proposals during procurement cycle
  - Provided technical review of proposals for 8 CREBS-funded PV systems
  - Provided one-day PV/NEC training workshop (presented by SWRES)
  - Organized two-day Solar Thermal design and installation workshop (presented by others) for installers and city employed plumbers
  - Developed a web page for presenting city-owned PV systems on a Google map and trained city staff to update and maintain this themselves
  - Developed an integrated process across city departments for specification, purchase, installation, and operation of future PV systems

  - City of Tucson has been deploying PV on municipal facilities since 1999. The activities of the Tiger Team and the SAC-funded Solar Coordinator focus on developing the procedures and infrastructure to meet Tucon's goal of effectively increasing solar installations several times while offering increased support for renewables to residents of

Quality, Productivity, Accomplishment

- Tiger Team Lead, *Solar America City Santa Rosa, CA*
  - Technical Assistance MOA *just* signed with Golden in February 2009. However, working in pre-award status, SWRES performed the following:
  - Developed SOW for CH2MHill to support CREBS training and support for ten Sonoma County municipalities
  - Developed technical activities for Sonoma State University Environmental program to support Sonoma County with market research, solar resource assessment, and data collection of fielded PV and solar thermal systems
  - Provided technical review of four Web-based solar mapping services from four different vendors
  - Provided one-day PV/NEC training workshop (presented by SWRES)
  - Co-authored an ASES paper with local installer on new innovative PV system design optimized for revenue return and system energy
  - Santa Rosa SAC program is implemented by Solar Sonoma County (SSC) a partnership of ten municipalities. The challenges to this program are to develop common regulations and permitting and to coordinate activities that support both the public and the very mature and active vendor community in California (vendors are also members of the SSC)

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- Tiger Team Lead, *GSIP Papago Park Military Reserve (PPMR)*
  - Arizona Army National Guard Facility (Phoenix, AZ) requested engineering and economic analyses in order to apply for funding from U.S. Army Energy Conservation Investment Program (ECIP)
  - SWRES performed modeling of PV system configurations, identified the most favorable design (based on restrictions of local utility incentives, time of use rate tariff, and facility distribution system)
  - Analysis showed PPMR would not meet ECIP minimum requirements of SIR and minimum years to payback
  - Tiger team analysis demonstrated that PPMR would not be eligible for ECIP funding, however, favorable economics were still available via PPA instead. The PPMR energy manager has changed his request for support to now include a briefing (scheduled for later this month, March) to present the energy and economic returns possible for a PPA-funded project implemented on-site.

Quality, Productivity, Accomplishment

- Professional Training, *PV and the National Electrical Code*
  - SWRES provides high level, professional training for electrical inspectors, PV system designers, private industry, Federal and municipal agencies, and architects
  - SWRES has been training PV professionals in this way for over ten years (note: this deliverable is not funded via the Solar ABCs)
  - Over the reporting period, three to four workshops have been given every month to audiences of from 50 to 150 attendees – a total of from 3000 to 4000 attendees per year
  - Partial list of workshops given in the last 2 years follows:

Presented PV/NEC day long workshop for 63 California electrical inspectors, PV installers, and electricians in San Jose, CA. *February 2007*.
Presented PV/NEC day long workshop for 71 Arizona electrical inspectors, PV installers, and electricians in Tucson, AZ. *February 2007*.
Presented PV/NEC day long workshop for 100 Colorado electrical inspectors, PV installers, and electricians in Denver CO. *February 2007*.
Presented PV/NEC day long workshop for 475 California electrical inspectors and IBEW members in Los Angeles, CA. *March 2007*.
Presented PV/NEC webcast for 50 NABCEP certified PV system installers nationwide. *March 2007*.
Presented PV/NEC day long workshop for 55 PV professionals in association with Solar Energy International in Denver, CO. *March 2007*.

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- Professional Training, *PV and the National Electrical Code*

Presented PV/NEC day long class on PV system design fundamentals for 23 students, engineers, and electricians at San Juan College in Farmington, NM. *April 2007*.
Presented PV/NEC day long workshop for 83 Colorado electrical inspectors, professional engineers, and utility engineers in Denver, CO. *May 2007*.
Presented two PV/NEC day long workshops for a combined total of 150 California electrical inspectors in San Diego, CA. *June 2007*.
Presented PV/NEC day long workshop for 100 California electrical inspectors and IBEW members in San Francisco, CA. *March 2007*.

Presented PV/NEC workshop for 49 attendees at the American Solar Energy Society annual meeting in Cleveland, *July 2007*.
SWTDI staff were on a panel during the forum, presentation, and discussion of Inverter Design and its impact on codes and standards at the SEPA conference in Long Beach, CA., *September 2007*.
SWTDI staff participated NABCEP training in Long Beach during the SEPA conference, *September 2007*
Presented PV/NEC day long workshop for a combined total of 73 electrical inspectors at the IAEI chapter meeting in Grand Junction, CO. *August 2007*.
Presented PV/NEC day long workshop for 82 University RE students, electrical inspectors and IBEW members in Boone, NC. *September 2007*.

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- Professional Training, *PV and the National Electrical Code*

Presented PV/NEC day long workshop for a combined total of 73 electrical inspectors in Vancouver, BC and Seattle, WA. *October 2007*.
Presented PV/NEC day long workshop for a combined total of 75 electrical inspectors, PV professionals and electricians in Burlington, VT. *October 2007*.
Presented PV/NEC day long workshop for a combined total of 20 electrical inspectors in Albany, NY. *November 2007*.
Presented PV/NEC day long workshop for a combined total of 35 SRP utility engineers in Phoenix, AZ. *November 2007*.
Presented PV/NEC day long workshop for 62 electrical inspectors and PV system designers in Los Angeles, CA. *November 2007*.
Presented PV/NEC day long workshop for 65 electrical inspectors and PV system designers in Palm Springs, CA. *November 2007*.
Presented PV/NEC day long workshop for a combined total of 80 electrical inspectors and installers in San Jose, CA. *April 2008*.
Presented PV/NEC day long workshop for a combined total of 120 electrical inspectors in Novato and Santa Rosea, CA. *July 2008*.
Presented PV/NEC day long workshop for a combined total of 60 electrical inspector,s in Tucson, AZ. *April 2008*.

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- Professional Training, *PV and the National Electrical Code*

Presented PV/NEC day long workshop for a combined total of 60 electrical inspectors in Houston, TX. *April 2008*.
Presented PV/NEC day long workshop for a combined total of 150 electrical inspectors in Salt Lake City and St. George, UT. *July 2008*.
Presented PV/NEC day long workshop for a combined total of 50 electrical inspectors in Boone, NC. *August 2008*.
Presented PV/NEC day long workshop for a combined total of 220 electrical inspectors in Hilo, HI. *September 2008*.

Presented PV/NEC day long workshop for a combined total of 105 electrical inspectors, PV professionals and electricians in Detroit, MI. *October 2008*.
Presented PV/NEC day long workshop for a combined total of 110 electrical inspectors, Charleston and Morgantown, WV. *October 2007*.
Presented PV/NEC day long workshop for a combined total of 100 electrical inspectors, PV professionals and electricians in Ontario, CA. *Novemberr 2008*.
Presented PV/NEC day long workshop for a combined total of 80 electrical inspectors, PV professionals and electricians in San :Luis Obispo, CA. *October 2008*.
Presented PV/NEC day long workshop for a combined total of 60 electrical inspectors, PV professionals and electricians in Phoenix, AZ. *December 2008*.
Presented PV/NEC day long workshop for a combined total of 100 electrical inspectors, PV professionals and electricians in Madison, WI. *December 2008*.

Quality, Productivity, Accomplishment

- Codes and Standards Development
  - PV Industry Forum: 54 final proposals submitted to NFPA for the 2011 NEC
    - SWRES is responsible for collecting, circulating, and preparing all stakeholder submitted changes for the *NEC* to NFPA. Acceptance rate by NFPA of SWRES-submitted PV proposals is >90%.
  - SWRES provides ongoing support for most major PV codes and standards:
    - UL STP 1703/IEC 67130, UL STP 1741
    - NABCEP Exam Committee
    - IEEE SCC-21 Battery Group
  - Partial List of Companies either visiting or contacting SWRES for consultation on PV design, safety, and code-related issues in the last 18 months:
    - Enphase Energy, Schott Solar, SolarEdge Technologies, Positive Energy, Carrier Corporation, TYCO, Solar Edge, Lennox

Relevance/ Impact of Research

- The SWRES staff provides support at the professional engineering level to thousands of PV stakeholders every year.
- The Market Transformation program is about removing barriers and facilitating increased use PV in the U.S. SWRES brings experienced, applied engineering capabilities to this process in direct support of the transfer of technology from research labs to factory production to end user.
- *Impact* is often hard to measure in a rigorous way. What is the value of the fire that doesn't happen or the system that passes inspection first time without callback?
- The engineering activities of the SWRES promote safety and reliability and, through these, the increased market assurance necessary for a developing technology.

Future Directions

- The SWRES will continue to serve in the activities and roles outlined here to support the rapidly increasing use of PV in the U.S. thorough both the greater deployment of existing technologies and the effective introduction of new technologies.