Letter from the Program Manager for IREC
National Administrator of the Solar Instructor Training Network

As a boy, I was fascinated with tools while working with my father, and later, as an electrician in the construction industry. The phrase, the right tool for the right job, became readily apparent to me. I appreciated the value of using the right tool to complete a task efficiently, producing a high-quality result. As a former community college professor of 32 years, I look at the Best Practices documents with the same appreciation of the right tool for the right job.

IREC assembled some of the best experts in the country on solar training, education, and workforce development to create this compendium of Best Practices. I am forever indebted to them for their efforts. The documents were thoughtfully designed to give solar instructors the right tools for the job of training a highly-skilled, globally-competitive solar energy workforce for the 21st Century. This suite of Best Practices documents builds on IREC’s earlier versions of Best Practices from 2008 and 2010.

As a college professor building my solar program, I had scarce resources and tools to choose from to support my efforts. Separately and collectively, these Best Practices documents enable instructors to easily enhance current solar curriculum, while providing a detailed roadmap for instructors who are considering adding solar to related trades curriculum. These documents have the potential to significantly enhance the quality of solar education and training. How I wish I had something like these Best Practices when I was developing my solar program.

And now, thanks to the SITN, you do. As National Administrator of the SITN, IREC believes these documents will hasten the development of exemplary solar training programs. I am enormously proud to be associated with such an erudite team of solar educational professionals.

IREC will be working closely with the Regional Training Providers (RTPs) of the SITN to further enhance these Best Practices documents. By tapping the strengths of each RTP, the SITN will garner even more resources and best practices to share with solar instructors, creating an even brighter future for solar education and training here in the U.S.

From all of us at the SITN and IREC Team, we are pleased to offer these tools for you in your work.

Joe Sarubbi
PROJECT MANAGER
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About IREC
The Interstate Renewable Energy Council, Inc. supports market-oriented services targeted at education, coordination, procurement, the adoption and implementation of uniform guidelines and standards, workforce development, and consumer protection. IREC’s mission is to accelerate the sustainable utilization of renewable energy and energy efficient sources and technologies. IREC is a nonprofit organization formed in 1982.

About the SITN
Launched in 2009, the U.S. Department of Energy established the Solar Instructor Training Network, composed of nine Regional Training Providers (RTPs) to help fulfill a critical need for high-quality, local, and accessible training in solar system design, installation, sales, and inspection through train-the-trainer programs. The nine RTPs are well-established solar training institutions that offer expert trainers and first-class training facilities across the U.S. The institutions and organizations are listed by region:

Region 1: Kennebec Valley Community College and Hudson Valley Community College

Region 2: Pennsylvania State University

Region 3: The Solar Center at North Carolina State University.

Region 4: Florida Solar Energy Center at University of Central Florida

Region 5: Midwest Renewable Energy Association

Region 6: Houston Community College-Northeast and Ontility

Region 7: Salt Lake Community College, Solar Energy International and Utah Solar Energy Association

Region 8: California Community Colleges Board of Governors, California Energy Commission, California Centers for Sustainable Energy, the Labor Management Cooperation Committee

About DOE SunShot Initiative
The U.S. Department of Energy SunShot Initiative is a collaborative national initiative to make solar energy cost competitive with other forms of energy by the end of the decade. Reducing the installed cost of solar energy systems by about 75% will drive widespread, large-scale adoption of this renewable energy technology and restore U.S. leadership in the global clean energy race.

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Textbooks, References and Other Instructional Resources
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Textbooks, References and Other Instructional Resources

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Textbooks, References and Other Instructional Resources
Introduction

The purpose of this document is to assist instructors in designing, developing, and implementing courses in photovoltaic (PV) systems and solar heating and cooling (SHC) systems. It lists recommended training suites for both PV and SHC instructors—as well as textbooks, key references, and teaching materials that may be useful. Key references relate to occupational safety and health, electrical codes, structural building codes, and plumbing codes in addition to design and installation, minimum standards for equipment certification, and effective training methods.

In addition to technical references for both PV and SHC systems, there are links to magazines, online documents, and Web sites that may be useful to you.

A Recommended Training Suite for PV Installation Instructors

Any institution interested in training PV system designers or installers should have a suite of training materials that instructors can use to design, develop, and implement their courses. These materials provide the substantive content for training. Instructors should be intimately familiar with the documents that are directly related to their areas of responsibility. Such a training suite might include the following documents:


This text, which is based on the Photovoltaic Installer task analysis developed by the North American Board of Certified Energy Practitioners (NABCEP), has been accepted by almost all of the electrical industry and many other education and training institutions as the primary reference for PV system design and installation training.


Please check the website for a new edition expected in the coming months.

Available in both English and Spanish, this reference has been regularly updated to keep pace with changes in technology, codes and best practices. It has been used extensively by SEI to train PV practitioners in the U.S. and throughout the world. SEI also licenses the use of slides and other teaching material to accompany the text.


This sixteen-set compendium of Microsoft PowerPoint® slides covers all aspects of solar PV systems technology and deployment. The explanatory notes that accompany the slides are very useful. The resource guide was
developed to help faculty and instructors create and teach courses in PV systems. It is a companion resource to the textbook Photovoltaic Systems by James P. Dunlop (listed above). Together, the textbook and resource guide can be used for both introductory and advanced courses and for audiences ranging from entry-level, young-adult learners to incumbent professionals in related trades and disciplines.


Safety is the single most important issue associated with PV system installation and maintenance. PV installers should become very familiar with Chapter 29, Part 1926 of the OSHA regulations for construction. It is recommended that instructors introduce a fairly comprehensive overview of this reference and associated safety issues early in PV installer training courses. Reference to specific safety issues should be reinforced throughout the courses.


This reference is the key document that governs installation practices for most electrical systems, including PV. All PV installers should be familiar with the latest version of the National Electrical Code, with special emphasis on Article 690 Solar Photovoltaic Systems.


This guide is essential for course participants preparing for the PV entry-level exam or the PV installer certification exam. Instructors should use the examples and sample problems in this reference as practice exercises in problem solving, decision-making, and applying knowledge gained in training courses. This reference is updated by NABCEP periodically, check the website provided for the latest version.

**Other Useful References for PV Designers and Installers**


This text covers fundamental and advanced system design principles for PV systems. It includes numerous sizing, design, and code calculations and examples and is suitable for both advanced undergraduate and graduate level design courses.

This reference covers all applicable requirements for PV system installations, including illustrated examples, and is based on the 2011 National Electrical Code.


This reference provides a fundamental and in-depth discussion on grounding and bonding all electrical systems. Complementary instructional resources and study guides are available.


PV designers have a much greater need for this reference than PV system installers. However, installers should be introduced to this document, informed that it is the basis for the structural requirements in most building codes, and presented information on how most installation contractors satisfy those requirements.


These model building codes are adopted in all U.S. states and territories by nearly every jurisdiction, and govern all aspects of commercial and residential building construction. In particular, the ICC codes have adopted the National Electrical Code® and the ASCE 7 standard.


This reference provides details of maintenance requirements, practices, and procedures for lead-acid batteries.


This work provides details of typical roof construction methods and materials, including weather-sealing techniques, and applies to roof-mounted PV installations.

This standard defines safe working practices for electrical system installations and is referenced in the National Electrical Code and OSHA standards. It provides guidance on defining the extent and magnitude of electrical hazards and permissible methods for avoiding or mitigating the hazards, including specifications for personal protective equipment.


This reference provides methods for determining withdrawal loads for screw and other attachments to wood structural members. It is especially useful for structural calculations for roof-mounted PV arrays and other solar collectors.

• **IEEE Standards Association**—http://standards.ieee.org/

The IEEE publishes consensus standards on a variety of electrical technologies, including PV systems under IEEE Working Group SCC 21.

• **International Electrotechnical Commission (IEC)**—http://www.iec.ch/

This organization coordinates and produces consensus international standards, including standards for PV systems and components under the TC82 working group.

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**A Recommended Training Suite for Solar Heating and Cooling Instructors**

Institutions interested in training solar heating and cooling designers and installers should also have a suite of training materials that can be used by instructors in designing, developing, and implementing courses. A training suite recommended for this area includes the following documents:


Safety is the single most important issue associated with the installation and operation of solar heating and cooling systems. System installers need to become very familiar with Chapter 29, Part 1926 of the OSHA regulations for construction. It is recommended that instructors introduce a fairly comprehensive overview of this reference and associated safety issues early in their solar heating and cooling training courses and reinforce specific safety issues throughout the courses.


Solar heating and cooling system designers have a much greater need for this reference than installers. However, system installers should at least be introduced to it, informed that it is the basis for the structural requirements in most building codes, and presented information on how most installation contractors satisfy those requirements.

• The Copper Tube Handbook—Copper Development Association, www.copper.org


Other Useful References for Solar Heating and Cooling Designers and Installers


  This work provides details of typical roof construction methods and materials, including weather-sealing techniques, and applies to roof-mounted SHC installations.


  This reference provides methods for determining withdrawal loads for screw and other attachments to wood structural members. It is especially useful for structural calculations for roof-mounted PV arrays and other solar collectors.


- **Solar Hot Water Systems Lessons Learned 1977 to Today, 2004**—Tom Lane Energy Conservation Services


General Reference on Teaching-Learning Principles for Educators and Trainers

- **Telling Ain’t Training, Harold D. Stolovitch and Erica J. Keeps**—ASTD Press, 2011

This book is an invaluable tool for anyone interested in understanding the learning process, developing training programs that enhance learning, or becoming a better instructor. The text is based on the latest research on human learning and training methods for performance improvement. It is very readable and can be practically applied to all solar training courses.

Links to Useful Magazines

- PHOTON International ............................................................................................................. http://www.photon-international.com/
- Home Power .................................................................................................................. http://homepower.com/
- SolarPro ........................................................................................................................... http://solarprofessional.com/home/

Web Sites that Include Links to Useful Information, Publications, and Software

- Solar Instructor Training Network (SITN) ............................................................................. http://www.sitnusa.org/
- U.S. DOE SunShot Initiative .............................................................................................. http://www1.eere.energy.gov/solar/sunshot/index.html
- The Solar Career Map ....................................................................................................... http://www1.eere.energy.gov/solar/careermap/
- North American Board of Certified Energy Practitioners .................................................. http://www.nabcep.org/
- Solar Electric Power Association ........................................................................................... http://www.solarelectricpower.org
- The Solar Foundation .......................................................................................................... http://thesolarfoundation.org/
- PV Watts ............................................................................................................................. http://www.nrel.gov/rredc/pvwatts/
- Southwest Technology Development Institute, PV Codes and Standards Website .......... http://www.nmsu.edu/~tdi/
- Database of State Incentives for Renewable Energy (DSIRE) ............................................. http://www.dsireusa.org/
- OnGrid Solar ........................................................................................................................ http://www.ongrid.net/
- RETScreen International ....................................................................................................... http://www.retscreen.net/
  *(new interactive textbook series to be published in 2012/2013)*