



Interstate Renewable Energy Council (IREC)

RENEWABLE ENERGY TRAINING

**BEST PRACTICES &
RECOMMENDED GUIDELINES**

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The Interstate Renewable Energy Council (IREC) 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 sources and technologies. IREC is a non profit organization formed in 1982.

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Introduction

The framework for creating a strong workforce for the renewable energy industries is built on a multi-prong approach that connects labor market needs, occupational and training standards, educational providers, and third-party programs that verify competencies.

Gathering labor market information is the starting point for developing a workforce development strategy. Labor market studies focus on what kind of jobs are in the renewable energy industries, where these jobs are, and what are the trends.

Quality training for the workforce is a critical component to support labor market needs. Workforce education and training requires attention to at least three main components:

- Types of skills, skill sets, knowledge, and abilities.
- Types of instructional activities that will promote different skills and skill sets.
- Types of institutions that can provide the learning experiences.

The final component in this framework is developing third-party verification of workers and instructional activities. This has become the era of accountability. Self declaration of competency is no longer enough validation for consumers, financiers, policy makers and others to have confidence in services or products. In the renewable energy field, certification programs have been developed for practitioners and instructors and an accreditation process is in place for training programs.

The following pages bring together recommended training guidelines, training criteria, assessment tools, task analyses, credentialing programs, and other related resources for renewable energy training programs.

Section 1 – Guidelines for Training

Working with educators and subject matter experts, the Interstate Renewable Energy Council recommends six major guidelines for Renewable Energy Training:

1. Practitioner training courses should provide educational, training, and skill development experiences that lead to defined workplace knowledge, skills, and abilities.
2. Training should appropriately address issues of safety, codes, and core competencies of an industry-approved task or job analysis.
3. Training should be taught in an environment with appropriate facilities, tools, and safe practices.
4. Training should offer a formal and planned learning structure where the learner receives some sort of feedback and the learner's progress is monitored.
5. Training should be taught under the administration of a legally registered entity.
6. Training should be offered by an entity that has proven administrative and managerial quality and has received third-party verification through conventional accreditation or government or trade approval or the Institute for Sustainable Power's quality accreditation (ISPQ) or similar quality assessment auditing process.

Recommended Steps to Take

Since 2006, IREC has organized the national Workforce Education Conference, *New Ideas in Educating a Workforce in Renewable Energy and Energy Efficiency*. These conferences have brought together Community Colleges, Technical Schools, independent training organizations, the trades, companies, and other non profits and skill centers. With over 100 presentations, recommended steps for training development have been compiled and include:

- Curriculum needs to include real-world preparation for an occupation. Planners of renewable energy courses and training programs should conduct a skills assessment by surveying local business, industry and government representatives. An expert in the field is the best source for recognizing and describing job tasks. Required certifications and licenses should be identified and a list of tools and equipment that students should be proficient with should be compiled.
- Conduct a labor market assessment to match training curriculum with local labor needs. Clearly define the target population. Determine who currently employs or may be a source of employment for the selected occupation(s). What is the projected number of full-time and part-time openings for technicians?
- Emphasis should be on high quality course development. Instructional system design has been successfully used in the renewable energy field. Utilize a team-based approach for developing curricula. Assess the use of classroom, technical shop, online, computer-based and internship delivery systems.

- Make sure prerequisites have been established for each course or program and student's performance is evaluated by written exams or other assessment methods. Develop skill proficiency measurements.
- Field and laboratory experiences should be provided.
- Develop alliances and establish an active advisory committee with business and industry. Utilize members for program support, potential adjunct faculty, internship sites, donations of equipment and supplies, and news about changing technology and skill sets. Meet on a regular basis to seek their guidance, assistance and program promotion.
- Establish partners for articulation and develop articulation agreements with technical high schools, community colleges, and four-year degree colleges and universities.

In response to the increase of web-based renewable energy training, IREC has released *Guidelines for On-Line Courses*. Highlights include:

- The instruction is presented in an organized and sequential learning format.
- The learning management system should provide the necessary assessment and reporting capabilities to help monitor and track the learning process.
- Instructor provides timely and specific feedback.
- Learning shall provide frequent and meaningful interactions among learners, between learners and instructional material and between learners and the instructors.
- Assessment should be an integral part of the learning experience.
- Advertising of any type is prohibited within the educational content though references to spec sheets and product descriptions can be useful learning tools.

Section 2 – The Task (Job) Analysis

The task (or job) analysis is a formal process for determining what people do, under what working conditions they do it, what they must know to do it, and the skills they must have to do it. Usually a technical committee of subject matter experts is convened to develop the task analysis.¹

One of the best sources that defines a general set of knowledge, skills and abilities typically required of solar electric installers is the North American Board of Certified Energy Practitioners' Task or Job Analysis.²

NABCEP-Certified Solar PV installers are required to specify, configure, install, inspect and maintain a solar electric system that meets the performance and reliability needs of customers, incorporates quality craftsmanship, and complies with all applicable safety codes and standards.

For the purposes of developing training curricula, assessment mechanisms and certification criteria, specific tasks are classified as either cognitive or psychomotor skills. Skills are further categorized as Critical, Very Important, and Important for job performance.

The NABCEP PV Task Analysis covers 8 major areas:

1. Working Safely with PV Systems
2. Conducting a Site Assessment
3. Selecting a System Design
4. Adapting the Mechanical Design
5. Adapting the Electrical Design
6. Installing Subsystems and Components at the Site
7. Performing a System Checkout and Inspection
8. Maintaining and Troubleshooting a System

NABCEP also has approved a Task Analysis for solar thermal that defines a general set of knowledge, skills and abilities typically required of practitioners who install and maintain solar hot water or pool heating systems.³

¹ Performance-Based Certification: How to Design a Valid, Defensible, and Cost Effective Program. Judith Hale, November 1999.

² <http://www.nabcep.org/pvtaskanalysis.cfm>

³ <http://www.nabcep.org/solarthermalta.cfm>

The NABCEP Solar Thermal Task Analysis covers 12 major areas:

1. Working safely with solar hot water and pool heating systems
2. Identifying systems and their components
3. Adapting a system design
4. Conducting a site assessment
5. Installing solar collectors
6. Installing water heater and storage tanks
7. Installing piping, pipe insulation and connecting system piping
8. Installing mechanical/plumbing equipment and other components
9. Installing electrical control systems
10. Installing operation and identification tags and labels
11. Performing a system checkout
12. Maintaining and troubleshooting a solar thermal system

This task list assumes the installation contractor starts with an approved solar system design package, complete with major components, manufacturer installation manual, system schematics, and assembly and troubleshooting instructions. While the solar installation contractor may not design the system, in many cases they must be knowledgeable about many aspects of systems design, and may be required to adapt certain designs to fit a particular application or customer need.

Another process for establishing standards is the DACUM method. The DACUM (Developing A Curriculum) process uses interviews, focus groups, and surveys to develop training material and programs. DACUMs are mainly used for identifying instructional needs, instructional program planning, curriculum development, training materials development, creating and revising job descriptions and standards, and career guidance. Colleges use the DACUMs as an efficient and effective way to develop curriculum topics.

For a very good description of the DACUM method, visit the Advanced Technology Environmental And Energy Center (ATEEC) at www.ateec.org/learning/instructor/dacum.htm

Section 3 – Types of Educational Programs

The renewable energy industry is fortunate to have a number of first-rate training centers including the Florida Solar Energy Center, Solar Energy International, the Midwest Renewable Energy Association, the North Carolina Solar Center, the Great Lakes Renewable Energy Association, and Solar Living Institute. These dedicated programs at these centers have provided experienced instructors and well-trained students but as the market grows, the workforce need is outstripping the training opportunities.

There are many programs in established educational institutions that can add courses to existing curricula, develop specialized curricula, or offer continuing education courses to address identified needs. These include:

- Continuing education courses at universities and community colleges. Every college and university in the country offers continuing education courses, which provide significant revenue for their institutions. As an example, continuing education courses in PV system permitting and inspection at community colleges makes sense because of local variations in code requirements.
- Construction Trades Apprenticeship Programs. These include electrical, roofing, iron works, carpentry, air conditioning, plumbing, sheet metal, surveying, welding, and swimming pool construction. Community colleges and vo-tech institutions have the opportunity to introduce cross-discipline training into the curriculum (e.g., electrical plus roofing for PV and plumbing plus roofing plus electrical for solar thermal, etc.).
- Associate in Applied Science Degree (AAS). These programs stress technology to prepare students for the workforce that will lead to employment in a specific occupation, such as a PV technician. They do not require general education credits and are generally not meant as preparatory for a follow-on degree. Lane Community College uses the AAS degree for its energy programs.
- Associate in Science Degree (AS). These are two-year programs for career education and the degree can be transferred from the community college to a four-year program, such as a Bachelor of Science in Engineering Technology. These programs are well suited for curriculum enrichment for students who might want to pursue PV system design or energy management.
- Applied Technology Diploma (ATD). These programs consists of a new course of study as part of an AS or AAS degree. They typically involve less than 60 vocational or college semester credit hours, approximately 50% technical, and lead to employment in a specific occupation, which could include PV system design or energy management.

- Post-Secondary Adult Vocational Certificate (PSAV). These certificates are offered at a skilled employee level with emphasis on theory and practical applications. They are designed to prepare the student for entry-level employment, to supplement employed workers with education and training to increase competency in their occupational field. Earned credits can be applied toward the AS degree.
- Associate in Arts Degree (AA). These are two-year general education preparatory programs that are designed to transfer to a four-year university bachelor program. Possibly 3 to 15 semester credit hours in a technical field, such as PV systems, could be credited to a four-year engineering or architecture program.
- Bachelor of Science in Engineering Technology (BSET). For these programs, applied mathematics and science are focused on implementing and improving existing technologies. They prepare students to apply engineering principles to product improvement, design, manufacturing and engineering operations. Majors include air conditioning, architectural, construction, mechanical, electrical, electromechanical, electronics, manufacturing, mechanical design, telecommunications, surveying, information systems, and computer systems. They offer an excellent vehicle for incorporating PV into the curriculum, possibly closely aligned to building design and construction.
- Bachelor of Science in Engineering (BSE). Undergraduate programs in engineering use advanced mathematics and science focused on creating new knowledge. They prepare students for graduate school and the use of theoretical aspects of science and engineering to perform research, development and conceptual design. Majors include aerospace, biomedical, ceramic, chemical, civil, computer, electrical, environmental, industrial, mechanical, metallurgical, and nuclear. Engineering faculty are an excellent source for offering continuing education courses for architects and engineers in all aspects of PV system design, construction, installation, operation and maintenance.
- Engineering vs. Engineering Technology: Engineering is more conceptual and focuses on creating new products and technology through research, complex analysis, complex design, development, and prototype testing and evaluation; Engineering Technology is more applied and focuses on turning new concepts into marketable products through product testing and evaluation, manufacturing, construction, production, technical analysis, distribution and sales.
- Architecture and Building Design. These degree programs are becoming much more attuned to the need to incorporate energy efficiency and renewable energy technologies into their curriculum to complement traditional emphasis on building form and function.

Section 4 – Essential Steps of Designing a Training Course

Instructional Systems Design (ISD) is a process used to develop courses, programs, and lessons. It is defined as the systematic design, development, implementation, and evaluation of instructional materials, lessons, courses, or curricula in order to improve student learning and teaching efficiency.

While there are a wide variety of ISD models that can be used to develop instruction, all models have four or five basic components: conducting a needs assessment, specifying objectives and test items, developing learning activities, strategies, and media, and conducting program evaluation. All the models are systems models meaning that they are dynamic and iterative, not linear. A basic principle when using any ISD model is to think first about *what students need to learn* in order to perform effectively and proficiently on the job. Using an ISD model requires that course developers think first about the competencies and learning objectives that are necessary for students to acquire *before* they make decisions about how to present information, topics and content to students in the classroom.

The ADDIE Model

The ADDIE model has been used successfully in the renewable energy field to design and develop instruction. ADDIE stands for **A**nalysis, **D**esign, **D**evelopment, **I**mplementation, and **E**valuation. Using the five major processes and a question and answer format, some of the key aspects of designing instruction using an ISD model are presented.

The **Analysis** phase is the process of determining the needs and the goals of the proposed instruction. The following questions must be answered:

- Is training really necessary?
- Who are my learners?
- What is the setting where the training will take place? That is, what equipment, resources, and facilities are available?

ISD begins by asking questions about the root cause of any *performance problem*. If the root cause is that workers do not have the knowledge, skills and attitudes required for adequate job performance, then a training or education course or program is necessary. However, if the performance problem is caused by something other than worker deficiencies, for example, inadequate materials (e.g., faulty inverters or PV modules) or poor policies and procedures (e.g., inattention to safety on the job), then a training program may not be needed.

Once it is established that training is needed, course developer must determine what experience and knowledge the learners bring to the training. They must determine what students' subject matter expertise is, how much experience they have, what their attitudes are toward training, and if they have any special needs and constraints. In addition, the course developers will want to know what equipment and resources are available to be used in the training. Also during the analysis of the setting, course developers will ascertain if there is adequate lab space, enough qualified trainers for course delivery, and what conditions the learners will face when they go back to the job so that the training can address and, if possible, mirror those conditions.

The purpose, then, of the Analysis phase of the course design process is to get as complete a picture as possible of the cause(s) of any performance problems. Once it is determined that a training course can remedy the problem, then an assessment of the learners and the setting is performed. This is to insure that the instruction starts at the right point for the learner and that the necessary equipment and facilities are available.

The purpose of the **Design** phase is to specify the learning objectives and the criterion-referenced testing procedures. The following questions are critical:

- Is there a task analysis to guide the design process or do I need to create one?
- What competencies and objectives must the students learn?
- What test items and checklists can I use to determine whether students are competent?

A task analysis is the process of breaking a main task down into subordinate tasks and showing the relationships among the tasks. It provides a list of competencies (knowledge, skills, and tasks) that are required for a particular job. NABCEP has approved task analyses for Solar PV Installers, Solar Thermal, and Small Wind. (See Section 2.)

The competencies specified in the task analysis are used to define the learning objectives for a training or education course or program. A learning objective is a specific, measurable statement that describes what the learner must accomplish at the end of a course. There are four components: who the target audience is, what behavior or action they must perform, under what conditions, and to what standard(s). A sample objective is: Given the specifications for a PV array installation, each student will specify how the system will be installed by answering 8 of 9 installation questions.

Learning objectives are then used to design criterion-referenced tests that are used to determine whether or not students met the objectives. Multiple choice tests and criterion-based product and performance checklists are widely used. The trend in testing is to use test items and checklists that ask students to perform on the test as closely as possible to the real-life situation they will face on the job. These are called problem-based or situation-based tests and use scenarios and situations that mirror actual job performance.

During the **Development** phase, lessons, learning activities and strategies, and media are selected, constructed, and produced for the training. Some key questions that should be answered are:

- How do I create a lesson plan? How should the content be organized?

- What instructor and student activities should be included?
- How do I provide practice for the learners?
- How can I present confirming and corrective feedback?
- What media should I use when teaching?

When creating lessons and lesson plans, an eight-step lesson design is useful. It includes introducing the learner to the topic, explaining the objectives, presenting the materials, showing the learner the correct performance, letting the learning practice, providing feedback, assessing learner performance, and providing summaries and reviews.

The instructor can either directly present the information to the learners or he/she can use an inquiry/discovery method. Using the inquiry method takes more time as students are led to the correct performance using any number of indirect methods, e.g., question and answers, case studies, scenarios. With the direct method, instructors are more likely to use the lecture method. However, with both strategies, instructors must provide the learners with the opportunity to practice the skills they are learning and they must provide feedback that either confirms for the student that they are on the right track or that corrects incorrect behavior. The rule of thumb is that learners should have an opportunity to succeed and/or fail in the classroom rather than on the job. We want to help students correct their mistakes in a controlled environment.

Media that is available for teaching includes PowerPoint, video, slides, pictures, flip charts, and real objects, to name a few. Adapting media rather than creating it from scratch is usually both time and cost efficient. Some ways to adapt media is to add or delete parts, add practice and/or feedback, rewrite it to match learner characteristics, and to add content relevant examples.

When designing PowerPoint slides, the number of words on each slide should be around ten or fewer. If learners need a complete set of notes, prepare two sets of slides, one for the students to take with them and one to use during presentation. Avoid at all costs having text-dense slides that are projected and then read during the instruction.

Implementation is the actual presentation of the lessons to the learners. Some of the questions listed below are determined during the Develop phase of the process but are carried out during Implementation.

- How do I motivate the learners?
- How do I summarize and review each lesson or presentation?
- What kinds of questions are best to use?
- How do I introduce the lesson?
- How do I use PowerPoint or other presentation media?
- How do I use my time wisely during the lesson?

One of the best ways to motivate learners is to show them the benefits of what they are learning. That is, make it relevant to them. Another motivational strategy includes making the tasks moderately difficult. Stretch the learners but do not make the task unattainable. This also instills confidence in the learners when they succeed. Finally, reward learners when they do succeed. Focus on their abilities, not on luck, when you reward them.

A good introduction is a good motivational strategy. Start each lesson with a review so that learners can reconnect with what they have previously learned. Use problems, case studies, overviews, and probing questions to engage the learner in the lesson. Use open-ended questions when you want students to think through a problem or issue; use closed-ended questions when you are looking for one correct answer. Summarize each lesson by highlighting the major points that students are responsible for learning.

When using PowerPoint or other presentation media, do the following: (a) summarize or paraphrase what is on the screen, do not read the slide, (b) face the audience, (c) make sure everyone can see the projected image, (d) turn the projector off when you are not using it (students will look at the bright light rather than at you), and (e) use a pointer.

Finally, use your time wisely. If you are running late, pick out the most important aspects of the lesson and focus on those. Do not try to rush through everything you have prepared. Students will not remember very much of it and will be overwhelmed. Also, use more examples and fewer explanations. Examples often "teach" better than explanation. Learners can assess their understanding to see if the examples fit their frame of reference. Lastly, use the designations in the task analysis (Critical, Very Important, Important) to help you decide how much time to spend on any task or objective.

During **Evaluation**, data is collected to determine if the lessons, course, or program have been successful. Some the questions that are asked include:

- How do I know if my course has been successful?
- Which experts should review the materials before the course is presented?
- Which changes should be made to improve the course after it is presented?
- Was the time and effort spent developing the course worth the cost of developing it?

Several types of evaluation data are collected to determine if a course has been successful. This is called program evaluation. It is partly based on whether or not the students successfully met the objectives that were specified. The first type of evaluation is learner *reactions* to the course. Students are asked their perceptions of the course, for example, were the objectives clearly stated, were the instructional materials easy to read and follow, were the classroom and labs adequate, was the instructor knowledgeable and engaging, etc.? The second type of evaluation is *objectives-based*. That is, did the participants meet the learning objectives that were established? The next type of evaluation is called *transfer* evaluation. This asks whether or not the students were able to perform the tasks once they were back on-the-job. And finally, the last type of evaluation is *payoff* evaluation, that is, was the course worth the costs of developing it.

While evaluation is an on-going process in ISD, a course is usually evaluated as it is being developed (*formative evaluation*) and after the course is presented to the target audience (*summative evaluation*). The data collected allow a course developer to make decisions about which changes, if any, should be made to produce a more effective, higher quality course.

Summary

Instructional Systems Design is a process for designing and producing high quality lessons, courses, programs and curricula. The ADDIE model has been successfully used to develop renewable energy courses. A key idea when using an ISD model is to determine what the learner needs to know on the job, i.e., the knowledge, skills and tasks, before planning the instruction. Such knowledge paves the way for deciding what and how the instruction will be presented.

Section 5 – A Checklist for Assessing Learning Outcomes

It is important to evaluate students' performance after instruction has been given by using measurable and objective criteria. When a student's performance is evaluated by written exams, the following checklist will guide you through test development, test administration and creating testing policies.

A. Test Development

1. Is the test based on a validated *task or job analysis* or on specific, measurable learning objectives?
2. Is some portion of the examination *application-based* rather than recall-based? That is, are test-takers required to apply their knowledge and skill to real-life problems and settings?
3. Are the test questions and the instructions for taking the test written at an appropriate *language level* for the test-takers?
4. Have all the *resources* that test-takers can use, e.g., manuals, books, calculators, etc, been specified?
5. Are there reasonable *time limits* for taking the test?
6. Do the test questions follow *standard guidelines for specific types of test items*, e.g., multiple choice test questions have only one correct answer, there are no clues in the items, one item does not provide the answer for another question, etc.).
7. Has a subject matter expert, other than the test developer, *reviewed* the test items for accuracy and relevance to the job market? Have necessary changes been made to improve the test? Are these recorded?
8. Are there clear criteria for defining a *passing vs. a non-passing score*?

B. Test Administration

1. Are testing *facilities* adequate with regard to:
 - Lighting?
 - Space?
 - Temperature?
 - Noise level?
 - Interruptions or distractions?

2. Are all necessary *resources provided* that are not the responsibility of test takers, e.g., answer sheets, manuals, PV modules and arrays, tools, etc.?
3. Are *time limits*, if any, clearly specified to the test takers?
4. Are *clear directions given to test-takers* before the test so that they know exactly what is expected of them?
5. Is there a *proctor or test administrator* present who understands the test and testing process well enough to answer questions correctly and clearly?
6. Does the proctor or test administrator know exactly what his/her *responsibilities* are and how much, if any, assistance can be provided to test takers?

C. Testing Policies and Procedures

Are there *written testing policies* that:

1. Clearly state how the exam:
 - Was *developed and administered*, including the adequacy of the facilities?
 - Is *secured*, e.g., in a locked file cabinet or office without test-taker access?
 - Is *scored* so that that it is fair to all test-takers?
2. State how *the exam results are recorded* fairly and accurately?
3. Specify how test-takers can get *test results*?
4. Describe what, if any, options test-takers have to *repeat a test and/or appeal the results* if they feel the results are incorrect?
5. Describe how *test administrators are prepared* to give the exam so that all test-takers are treated fairly and have the same chance of success?
6. Specify *how often a test is revised* or redeveloped?

D. General Considerations

1. Are the *same standards applied* to every test-taker?
2. Are accommodations made for students with *special needs*, e.g., are they screened out prior to testing or are they provided assistance during the testing?
3. Are records kept that describe what *percentage of test-takers pass* and do not pass the test?

Section 6 – Certification & Accreditation

Accreditation for Renewable Energy Training & Certification for Instructors

The Interstate Renewable Energy Council has been working closely with the Institute for Sustainable Power to implement their international framework of standards and metrics to ensure legitimacy of what's being taught and by whom. As of July 2005, IREC is the North American Licensee for the ISPQ 01021 International Standard for Renewable Energy Training Accreditation and Instructor Certification programs. IREC is responsible for the full accreditation and certification cycle including processing applications, assigning registered auditors, awarding the credential, and maintaining all records of applicants, candidates and certificants.

Through the application and auditing process, the Institute for Sustainable Power Quality (ISPQ) framework offers evaluation for the following categories:

1. Accreditation of Training Programs
2. Accreditation of Continuing Education Providers
3. Certification of Independent Master Trainers
4. Certifications of Affiliated Master Trainers
5. Certification of Instructors

Training programs and continuing education programs are accredited to, and instructors and master trainers are certified to these standards. The aim of the ISPQ Standard is to ensure that all technicians (practitioners) working in the renewable energy industry are all trained to a similar standard.

The ISPQ International Standard describes the ethical and practical requirements for candidates, including commitments to confidentiality, non-discrimination, quality, and professionalism. The ISPQ Standard also outlines requirements for quality program management and administration. It sets forth requirements for facilities, resources, tools, and safety. It requires trainers and program staff to have appropriate experience, defined job descriptions, and adequate training to perform their jobs competently.

Using the ISPQ Standard as a guide, with an approved Task Analysis as a content guide, ISPQ-Registered Auditors evaluate candidates for accreditation and certification through a desk and/or on-site audit. The Auditors prepare the results of their evaluation and report to the Accreditation Award Committee, which is responsible for the final decision on training accreditation and trainer certification.

The ISPQ quality framework is implemented in Europe by ISPQ Europe located in the UK and in the Asia-Pacific region by Global Sustainable Energy Solutions Pty Ltd which is located in Australia.

Providing an independent external review, the ISPQ designation offers training programs and instructors the opportunity to achieve accredited or certified status that provides evidence of quality assurance, quality improvement, and fiscal stability. The ISPQ mark is a signal to students, employers, government officials and funding sources that standards for the curriculum, student services, and trainers have been met.

For more information on the ISPQ Standard and Programs, please visit www.ispqusa.org.

Certification of Installers

Since 2003, the North American Board of Certified Energy Practitioners (NABCEP) has been awarding professional credentials to renewable energy installers. NABCEP's rigorous competency standards for certification sends a clear message to consumers, financiers, and public officials that the Industry stresses high quality, safe and ethical business practices and workmanship standards.

NABCEP has three Certification Programs:

1. A professional credential for Solar Electric (PV) Installers
2. A professional credential for Solar Thermal Installers
3. An entry level certificate of knowledge for PV

NABCEP is also developing a professional credential for Small Wind Energy System Installers.

To become certified and maintain certification, the applicant must:

- Be at least 18 years of age
- Meet prerequisites of related experience and/or education
- Complete an application form documenting requirements
- Sign and agree to uphold a code of ethics
- Pay application and exam fees
- Pass a written exam
- Complete continuing education and installation requirements within the 3 year certification period in order to be recertified

There are several ways that an applicant may qualify to sit for the certification examination. NABCEP recognizes that professionals in the field of renewable energy technologies receive their training and work experiences in a variety of ways. Therefore, each requirement to qualify for the exam stipulates specific training and/or experience. Exams are scheduled twice a year.

The NABCEP credentials are voluntary and are not licenses to practice electrical, plumbing or any other form of construction contracting in any state or jurisdiction.

NABCEP also offers an entry level Certificate of Knowledge aimed at students wanting to get into the solar photovoltaic field. After taking a course from an approved provider and passing a national exam, this Certificate shows that the recipient has achieved basic knowledge, comprehension and application of key terms and concepts of photovoltaic (solar electric) system operations. The Certificate by itself does not qualify an individual to install PV systems.

As the market grows for photovoltaics, the person holding this industry-sponsored Entry Level Certificate is likely to find that their employment opportunities are enhanced by starting the job with an understanding of the basic terms and operational aspects of a PV system and that their NABCEP Entry Level Certificate is noticed by potential employers.

Side Note: *Terms can get confusing. NABCEP's PV installer certification is a high-level credential based on proven installation experience, an extensive application process, and successfully passing a rigorous written examination. It verifies that the certificant has met predetermined and standardized criteria. It is a mark of excellence for the PV practitioner and it becomes a way for consumers to differentiate among vendors.*

The PV entry level program is an instructional program that stresses basic concepts and specific skill sets that underlie photovoltaic system applications. Participants receive the PV Entry Level Certificate of Knowledge after attending and completing a course, and passing a NABCEP-approved entry level test.

For more information on NABCEP, please visit www.nabcep.org.

Section 7 – Equipment Recommendations for Training

PV Systems Training Programs Suggested Facilities, Hardware and Materials

Compiled by Jerry Ventre, Consultant to the Interstate Renewable Energy Council

- Complete grid-connected PV system package(s), including modules, mounting hardware, inverter, BOS components and documentation. Note: If only one complete system can be obtained, a system consisting of a greater number of smaller modules is preferred over one with a fewer number of larger modules. This will provide instructors with greater flexibility in conducting student hands-on activities.
- Several UL-listed utility-interactive inverters from major suppliers.
- Assorted types, sizes and models of flat-plate PV modules and BIPV products. Note that a sufficient number of modules is needed to assemble and check out inverters and systems.
- Several battery subsystems of various sizes, voltages and types, including flooded and valve-regulated lead-acid technologies. Battery test equipment includes hydrometers and high-rate load testers.
- Assorted cables, wiring, connectors, terminal blocks, junction boxes, disconnects and over-current devices (fuses and circuit breakers) of various sizes, types and ratings required for code-compliant assemblies of major components.
- Mounting structures and kits, roof mockups, mechanical hardware and weather sealing materials.
- Site survey equipment, including lines, levels, tapes, markers, inclinometers, sun path calculators and checklists.
- Basic electrical meters and diagnostic equipment, including volt/ohm/ammeters, clamp-on DC ammeters, power analyzers, conventional and electronic watt/watt-hour meters, contact and IR temperature probes, solar irradiance meters, high voltage tester and ground resistance testers.
- Typical construction and electrician power and hand tools required for PV system installations.
- Safety equipment, including warning signs, eye protection and washes, gloves and aprons, first aid kits, lifting equipment, hard hats, safety harnesses and life lines, fire suppression equipment and electrolyte neutralizer.

Solar Water Heating Training Programs Suggested Facilities, Hardware and Materials

Compiled by John Harrison, Florida Solar Energy Center

- Site survey equipment, including lines, levels, tapes, markers, inclinometers, sun path calculators and checklists.
- Solar collectors: Samples of flat plate (glazed and unglazed) collectors; Evacuated tube collector samples; Collector certification forms (FSEC/SRCC) to discuss certification requirements and ratings (as well as labels on the collectors); Power drill to disassemble the collector; Drill bits (metal) to remove pop rivets; Screw drivers to remove screws (or use power drill above); Socket set; Pop rivet gun and rivets (to reassemble if rivets are used).
- Collector Mounting: Roof structure (replication of a real roof) with trusses and various roof surfaces (shingle, tile, etc.) Hammer; Power drill; Drill bits; Small nails; Chalk line; Lag bolts; J bolt; Wood 2x4s for spanner type mounting; Sealant (polyurethane); Collector mounting bracket, and accessories; Collector.
- Controller: Controllers, differential (US and European models) and their specification sheets; Sensors; VOM meters; Temperature and Thermistor Resistance Table; Controller testers (if manufacturer has available for various models); Sensor wiring; Sensor lead/wiring connectors (wire nuts and other wire connection devices); Silicone or applicable sealant.
- Piping Penetration: Copper flashing & copper coolie cap; Rubber boot flashing and samples of various flashing materials; Pitch pockets; 5/8" & 7/8" paddle bit (wood drill); Copper piping; Sealant (for both copper flashing and pitch pockets); MAP gas and torch; Solder & Flux.
- Pumps: Samples of small to mid-sized AC pumps and their performance curves; Samples of DC pumps and their performance curves; Screw drivers, Phillips and Standard; Pliers; Allen wrenches; socket set.
- Tools for service or repair.
- Safety equipment, including warning signs, eye protection and washes, gloves, first aid kits, lifting equipment, hard hats, safety harnesses and life lines.

Wind Electric Systems Training Programs Suggested Facilities, Hardware and Materials

Compiled by Roy Butler, Four Winds Renewable Energy, LLC

- Complete wind system package(s), including a small wind turbine with tilt up tower, ground anchors, inverter and/ or controller, BOS components and documentation. A battery charging turbine is best for keeping cost and complexity to a minimum, but a direct grid-tie system is more representative of the type of system needed for work force training.
- Electric winch for raising the tilt tower, 12 volt DC if vehicle mounted or 120/ 240 volt AC for fixed mount. A Griphoist type hand winch can also be used but is much slower and may not be appropriate for some turbine/ tower configurations. Load cell (dynamometer) for determining tower pull up forces.
- For the battery charging turbines, several battery subsystems of various types, including flooded and valve-regulated lead-acid technologies. Battery test equipment should include hydrometers and high-rate load testers.
- Various UL listed battery-based grid-tie, direct grid-tie and stand-alone inverters.
- Micro turbines in the 200 to 750 watt range mounted on portable stands for lab work. Include a portable drill or other means to spin the generator for indoor use.
- Basic electrical meters and diagnostic equipment, including volt/ohm/ammeters, clamp-on AC/DC ammeters, power analyzers, conventional and electronic watt/watt-hour meters, insulation resistance tester (megger) and ground resistance testers, wind data acquisition equipment.
- Assorted cables, wiring, connectors, terminal blocks, junction boxes, disconnects and over-current devices (fuses and circuit breakers) of various sizes, types and ratings required for code-compliant assemblies of major components.
- Site survey equipment, including string lines, stakes, marking flags and paint, optical levels and transits, measuring tapes and wheels, handheld GPS units, digital camera, calculators and checklists.
- Foundation plans for various types and heights of tower for foundation layout exercises. Topo maps, wind maps, computer based wind speed and turbine energy production estimators.
- Typical construction, electrician, rigger and millwright power and hand tools required for wind electric system installations.
- Safety equipment, including warning signs, eye protection and washes, gloves and aprons, first aid kits, lifting equipment, hard hats, climbing gear, life lines, fire suppression equipment and electrolyte neutralizer.

Section 8 – Resources & Text Books

Photovoltaics: Design & Installation Manual

Solar Energy International
2007

This is an updated and revised textbook manual on how to design, install and maintain a photovoltaic system. This manual offers an overview of photovoltaic electricity, and a detailed description of PV system components, including PV modules, batteries, controllers and inverters. Electrical loads are also addressed, including lighting systems, refrigeration, water pumping, tools and appliances. The manual covers chapters on sizing photovoltaic systems, analyzing sites and installing PV systems. The manual also includes detailed appendices on PV system maintenance, troubleshooting, and insolation data for over 300 sites around the world.

Photovoltaic Systems

National Joint Apprenticeship and Training Committee (NJATC)
American Technical Publishers
2007

Developed in partnership with American Technical Publishers, the NJATC has written a textbook that covers the fundamentals, design and installation of PV systems with emphasis on safe, code compliant and quality installations. The book covers the principles of photovoltaics and how to effectively incorporate PV systems into stand-alone or interconnected electrical systems. The content includes system advantages and disadvantages, site evaluation, component operation, system design and sizing, and installation requirements and recommended practices. Common scenarios and procedures are discussed throughout. Specified electrical requirements are in accordance with the 2005 edition of the National Electrical Code.

Study Guide for Photovoltaic System Installers

North American Board of Certified Energy Practitioners (NABCEP)
August 2008

This Study Guide presents some of the basic cognitive material that individuals who install and maintain photovoltaic (PV) power systems should know and understand. The Guide is based on the North American Board of Certified Energy Practitioners' (NABCEP) task analysis for the PV system installer. It is organized in the following manner: Reference Resources and Additional Reading; Study Guide; Study Questions; and Answer Key. The study questions span fundamental trade knowledge, codes and standards, and accepted industry practice in the relevant design, installation, and maintenance of PV systems. Many questions are based on system installation scenarios, requiring the use of schematics, diagrams, and equipment specifications. Guidelines for determining solutions to the questions may be found in the text of this Guide, or from the references listed.

Solar Water Heating: A Comprehensive Guide to Solar Water and Space Heating Systems

Bob Ramlow with Benjamin Nusz

The book reviews the history of solar water and space heating systems, then presents the basics of solar water heating, including an introduction to modern solar energy systems, energy conservation and energy economics. The book also covers: Types of solar collectors, solar water and space heating systems and solar pool heating systems, including their advantages and disadvantages; System components, their installation, operation, and maintenance; System sizing and siting; and choosing the appropriate system.

Solar Hot Water Systems: Lessons Learned 1977 to Today

Tom Lane

The book covers: Detailed system CAD drawings; Each System with manufacturers components; Drain back; Closed Loop glycol; Single and double pumped; Open Loop; Passive ICS and thermosyphon; System testing and monitoring; Solar space heating and hot water system; Collector and storage sizing; Roofing and flashing; Manufacturers component access; and Solar pool heating.

SRCC OG-300 Solar Water Heating System Design and Installation Guidelines

Solar Rating and Certification Corporation (SRCC)

These guidelines are presented as a tool to be used by solar installers and any other interested parties in assuring that systems are installed in a manner that meet SRCC requirements. The guidelines have been separated into subsystem categories: Collector, Control, Transport, and Storage. Readers are able to select the major subsystems, as listed above, and then proceed to the specific guidelines within the selected subsystem.

www.solar-rating.org/education/og300education.htm

Solar Thermal Manual: Florida Solar Energy Center Solar Water and Pool Heating: Design and Installation & Maintenance and Troubleshooting

The intent of this manual is to equip the reader with the knowledge and skills needed to design, install, operate and maintain the most common types of solar water heating systems. The manual presents an overview of solar thermal applications, provides basic information on the principles of solar energy, reviews solar thermal technologies, and provides detailed instruction on the safe, efficient installation of solar water heating and pool heating systems. The manual is divided into six sections, with each separated into individual modules.

www.fsec.ucf.edu/en/industry/resources/solar_thermal/manual/index.htm

Study Guide for Solar Thermal System Installers

North American Board of Certified Energy Practitioners (NABCEP)

This guide presents some of the basic cognitive material that individuals who install and maintain Solar Thermal systems should know. The Guide is based on a task analysis for the solar thermal system installer, which includes the eight major job/task areas when installing solar water heating and solar pool heating systems, also contains sample exam questions with an answer key.

Installing Small Wind-Powered Electricity Generating Systems – Guidance for Installers and Specifiers

Energy Efficiency Best Practice in Housing, Energy Saving Trust, UK
November 2004

This guide aims to provide system designers and installers with sufficient information to ensure that small wind energy systems comply with current UK standards and with industry Best Practice. 'Small' in this context means between about 500W and 25kW output, though most parts of this guide also apply to systems of other sizes.

<http://www.energysavingtrust.org.uk/uploads/documents/housingbuildings/ce72.pdf>

References in this document to any specific product, publication or service do not necessarily constitute or imply IREC's endorsement or recommendation.