Introduction to Solar Photovoltaics
Annotated Instructor’s Guide

Module Overview

This module is designed for trainees who wish to pursue a career in solar energy. It covers the basic concepts of PV systems and their components. It also explains how PV systems are sized, designed, and installed. Successful completion of this module will help prepare trainees for the North American Board of Certified Energy Practitioners (NABCEP) PV Entry Level Exam.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: Core Curriculum. It is also suggested that the trainees shall have completed the following modules from the Electrical curriculum: Electrical Level One, Modules 26101-08 through 26111-08; Electrical Level Two, Modules 26201-08, 26205-08, 26206-08, and 26208-08 through 26211-08; Electrical Level Three, Modules 26301-08 and 26302-08; and Electrical Level Four, Modules 26403-08 and 26413-08.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify photovoltaic (PV) applications and advantages.
2. Identify system components and their functions.
3. Identify safety hazards associated with PV installations.
4. Trace a basic electrical circuit and perform calculations using Ohm’s law.
5. List PV system sizing considerations.
6. Identify PV electrical and mechanical system design considerations.
7. Describe the tasks required to complete a site analysis.
8. Identify the effects of the environment on panel output.
9. Describe how to install a simple grid-connected PV system.
10. Explain how to assess system operation and efficiency.
11. Recognize the tasks required when performing PV maintenance and troubleshooting.
12. Identify appropriate codes and standards concerning installation, operation, and maintenance of PV systems and equipment.

Performance Tasks

This is a knowledge-based module; there are no performance tasks.

Materials and Equipment

- Markers/chalk
- Pencils and scratch paper
- Whiteboard/chalkboard
- Multimedia projector and screen
- Desktop or laptop computer
- Appropriate personal protective equipment
- Access to various installed PV systems
- Digital AC/DC meter
- Clamp-on ammeter
- Pyranometer
- Infrared thermal device
- Torque wrench
- Sun path calculator
- Site survey checklist
- Angle finder
- Camera
- Compass
- Calculator
- Tape measure
- Ladder
- Various types of solar panels and mounting system components
- Inverter
- Batteries

(continued)
Charge controller
AC and DC disconnects
Panel with breaker for inverter connection
Conduit and wire

Copy of the latest edition of the National Electrical Code® (NEC®)
Module Examinations*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Ensure that all trainees are briefed on appropriate field safety procedures, including fall protection, electrical hazards, sun exposure, and battery hazards. If the training center does not have various simple PV systems set up on site, this module will require that the trainees visit one or more job sites in order to view installed PV systems. Ensure that trainees are briefed on site safety policies prior to any site visits.

**Additional Resources**

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.


**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 40 hours are suggested to cover Introduction to Solar Photovoltaics. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

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<td>A. Introduction</td>
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<td>B. Applications</td>
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<td>1. Standalone Systems</td>
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<td>3. Grid-Interactive Systems</td>
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<td>4. Utility-Scale Solar Generating Systems</td>
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Session III. Ohm’s Law and Power
   A. Ohm’s Law and Power
      1. Applying Ohm’s Law to Series and Parallel Circuits
      2. Ohm’s Law and Power
      4. Peak Sun and Power

Sessions IV and V. PV System Components
   A. PV System Components
      1. PV Panels
      2. Inverters
      3. Batteries
      4. Charge Controllers
      5. BOS Components

Session VI. Safety Considerations in PV Systems
   A. Safety Considerations in PV Systems
      1. Fall Protection
      2. Battery Hazards
      3. Electrical Hazards
      4. Meter Safety

Sessions VII and VIII. Site Assessment
   A. Site Assessment
      1. Customer Interview
      2. Power Consumption
      3. Roof Evaluation
      4. Array Orientation
      5. Equipment Location

Sessions IX and X. System Design
   A. System Design
      1. Panel Nameplate Data
      2. Solar Array Sizing
      3. Inverter Selection
      4. Battery Bank Sizing
      5. Selecting a Charge Controller
      6. Adjusting PV Conductors

Sessions XI and XII. Installation
   A. Installation
      1. Forces Exerted on the Panels/Support System
      2. Roof-Mounted Installations
      3. Ground-Mounted Installation
      4. Electrical System Installation
      5. Assessing System Output Power
Sessions XIII and XIV. Maintenance; Troubleshooting
A. Maintenance
B. Troubleshooting
   1. Loose or Corroded System Connections
   2. Inverter Losses
   3. Heat Fade
   4. Burnt Terminals
   5. Bypass Diode Failure

Sessions XV. Codes and Standards; Emerging Technologies
A. Codes and Standards
B. Emerging Technologies

Session XVI. Review and Testing
A. Module Review
B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.