# Solar PV for the Associate Candidate

## Course Syllabus

## Course Description

This hybrid course is designed as a general introduction to Solar Photovoltaic (PV) technology and will help students achieve a basic knowledge of the applications, design, installation and operation of solar PV systems. Students will learn the fundamental concepts and skills involved within the solar PV industry. The course content is consistent with the North American Board of Certified Energy Practitioners (NABCEP) Solar PV Associate Learning Objectives. Percentage of time spent on course topics, and the weight placed on assessment questions match the learning priority levels established by NABCEP's course and test specifications. The course includes two onsite classes. One at the beginning to introduce the class, discuss expectations, and how to navigate the course. There will be an onsite class at the end of the course. This will include testing on two of the solar PV trainers, NABCEP testing parameters and awarding of certificates.

## Prerequisites

*None*

## Audience

This course is designed and presented at an introductory level, and is an important first step in preparing any audience entering the solar PV industry.

## Course Outcomes

- Certificate of Course Completion
- NABCEP Solar PV Associate Exam eligibility
- 18 NABECP Qualified Non-advanced Training Hours
- 24 Contact Hours/CEUs

***Note:*** *It is the nature of hybrid online courses to allow flexibility for students to take as much time as desired to learn the course content. Actual contact time will vary for different students.*

## Topical Outline

Units

Welcome

1. PV Markets and Applications
2. Safety Basics
3. Electrical Basics
4. Solar Energy Fundamentals
5. PV Module Fundamentals
6. System Components
7. PV System Sizing Principles
8. PV System Electrical Design
9. PV System Mechanical Design
10. Performance Analysis, Maintenance and Troubleshooting

Course Review
Final Course Assessment
Post-Course Survey

## Course Learning Objectives

### Unit 1: PV Markets and Applications

Learning Objective: *Participants will be able to identify the key concepts involved with the development, applications, benefits, advantages, and disadvantages of solar PV technology and understand current trends in the solar PV marketplace.*

### Unit 2: Safety Basics

Learning Objective: *Participants will be able to identify typical safety hazards, personal protective equipment, and OSHA standards involved with the installation and service of solar PV systems.*

### Unit 3: Electrical Basics

Learning Objective: *Participants will be able to understand the electrical terminology, components, testing equipment, and calculations involved with solar PV systems and electric utility systems.*

### Unit 4: Solar Energy Fundamentals

Learning Objective: *Participants will be able to understand basic solar terminology, sun path diagrams, solar radiation fundamentals, array shading consequences and identify their importance for proper solar PV array siting.*

### Unit 5: PV Module Fundamentals

Learning Objective: *Participants will be able to explain the photovoltaic effect, I-V curve parameters, and understand solar PV module construction, standards, testing, and performance ratings.*

### Unit 6: System Components

Learning Objective: *Participants will be able to describe the purpose and function of the components and balance of system components typically used in solar PV systems.*

### Unit 7: PV System Sizing Principles

Learning Objective: *Participants will be able to understand and perform the system sizing procedures for sizing a utility-interactive and stand-alone solar PV system.*

### Unit 8: PV System Electrical Design

Learning Objective: *Participants will be able to prepare simple one-line electrical diagrams, identify the properties of electrical conductors, understand how to select and size electrical components, and understand the requirements for code-compliant installation of solar PV systems.*

### Unit 9: PV System Mechanical Design

Learning Objective: *Participants will be able to identify common solar PV array mounting methods, and will understand the concepts involved with the mechanical installation of solar PV systems.*

### Unit 10: Performance Analysis, Maintenance and Troubleshooting

Learning Objective: *Participants will understand the concepts involved with performing analysis, maintenance, and troubleshooting for a solar PV system.*

## Course Assessments

Completion of all content involved within each unit is required. Each unit will be assessed by a quiz with the minimum passing grade of 70%. After successful completion of each quiz, that unit's content remains available for future review and the student can then progress to the next unit. Students are allowed an unlimited amount of attempts on the quizzes (and the final course assessment) and the highest achieved grades will be kept as the final grades. Students are allowed to use course content during the assessments. After successful completion of this course, students are eligible to register for the optional NABCEP Solar PV Associate Exam.

## Grading Rubric

The student's final grade is: weighted average of all Quizzes (60%) and Final Course Assessment (40%)

## Modifications

Students have the opportunity to help with the continued improvement of this hybrid course by completing an end of course evaluation.

## Course Resources

Required Manuals: *None*

Suggested Reference Manuals:

- Photovoltaic Systems, 3rd Edition, by James P. Dunlop, ISBN 978-1-935941-05-7, ©2012 by National Joint Apprenticeship and Training Committee for the Electrical Industry.
    - www.jimdunlopsolar.com
- The Electrician's Guide to Photovoltaic System Installation, by Greg Fletcher, ISBN-13: 978-1-111-63996-9, ©2014 by Delmar, Cengage Learning.
    - http://community.cengage.com/Site/electrical/b/weblog/archive/2013/03/25/new-photovoltaic-textbook.aspx
- Solar Electric Handbook, by Solar Energy International, ISBN 978-1-256-49061-6, ©2012 by Pearson Learning Solutions.
    - http://www.solarenergy.org/bookstore/solar-electric-handbook-photovoltaic-fundamentals-and-applications-media-bundle-textbook-e

Online Resources:

- NABCEP Solar PV Associate Learning Objectives
    - http://www.nabcep.org/wp-content/uploads/2016/08/NABCEP-PVA-Learning-Objectives-8.15.15.pdf
- Photovoltaic (PV) Resource Guide, by William Brooks and James Dunlop, ©2012 by NABCEP v.5.3
    - http://www.nabcep.org/wp-content/uploads/2012/08/NABCEP-PV-Installer-Resource-Guide-August-2012-v.5.3.pdf

# *Course and Test Specification*

The following provides a blueprint for courses taught to the NABCEP Associate Program, including the primary learning objectives and suggested percentage time allotment. NABCEP recognizes the diversity of training programs offered and their participants, including short courses, continuing educa-tion programs, and more in depth and lengthy programs of study, including formal apprenticeship, multicourse certificate programs, and degree-track programs. The NABCEP PV Associate is not intended as an installer in-training credential, but rather as an important first step in preparing individuals to become highly skilled, qualified and experienced tradespersons and professionals in the PV industry.

| Category | Course Time By % | Exam Items | Level of Testing | Study Materials |
|---|---|---|---|---|
| 1. PV Markets & Applications | 5% | 3 | Comprehension | References 1 and 5 below |
| 2. Safety Basics | 5% | 3 | Comprehension Application | References 1, 2 and 3 below |
| 3. Electricity Basics | 10% | 6 | Comprehension Problem Solving | References 1 and 5 below |
| 4. Solar Energy Fundamentals | 10% | 6 | Comprehension Application Problem Solving | References 1, 4 and 5 below |
| 5. PV Module Fundamentals | 10% | 6 | Comprehension Application Problem Solving | References 1, 4 and 5 below |
| 6. System Components | 15% | 9 | Comprehension Application Problem Solving | References 1, 4 and 5 below |
| 7. PV System Sizing Principles | 10% | 6 | Application Problem Solving Design | References 1, 4 and 5 below |
| 8. PV System Electrical Design | 15% | 9 | Application Problem Solving Design | References 1, 2, 4 and 5 below |
| 9. PV System Mechanical Design | 10% | 6 | Application Problem Solving Design | References 1, 4 and 5 below |
| 10. Performance Analysis, Maintenance and Troubleshooting | 10% | 6 | Analysis Problem Solving | References 1, 4 and 5 below |
| **Totals** | **100%** | **60** | | |

*Notes: Prerequisite or bridge training and/or experience in electrical systems, mathematics, and other subjects may be required for some students to fully comprehend and satisfactorily demonstrate knowledge of all of the learning objectives. Also, for intensive short courses (e.g., 40-hour, one-week workshops) students should be encouraged to spend approximately 2-3 additional hours outside of class (for each hour in class) to review the subject matter, solve problems, and study reference materials prior to taking the PV Associate Exam. This will usually require the student to take the exam at a later date rather than immediately following the course.*