



# SOLAR PV BOOTCAMP

NABCEP COMPETANCY ALLIGNED

*We've used the sun for drying clothes and food for thousands of years, but only recently have we been able to use it for generating power. The sun is 150 million kilometers away, and amazingly powerful. Just the tiny fraction of the sun's energy that hits the Earth (around a hundredth of a millionth of a percent) is enough to meet all our power needs many times over. In fact, every minute, enough energy arrives at the Earth to meet our demands for a whole year - if only we could harness it properly"*



**BE A  
SOLAR PV  
EXPERT**



**ENROLL NOW!**

Program investment costs  
Php 39,200 (VAT Inclusive)

**Pay on or before Oct. 31  
to avail 10% early bird  
discount.**

## Learn to Install and Design PV Systems

This 40- hour comprehensive training workshop will teach participants how solar photovoltaic (PV) systems work, how they are designed, how to predict output of a system, and how systems are installed. The program will cover the fundamentals of PV, such as how voltage, current, power and energy interrelate (which is very different from the conventional electric systems) and including the economics and expected payback period. Participants will deter-

mine how to calculate for variables, such as roof slope, weather patterns, shading, tilt angles, and temperature effects on voltage and equipment variables.

Most of all, they will enjoy learning how to install and design safe and cost effective photovoltaic systems.

Those who complete this course will earn credit units for the USA/Canada NABCEP (North American Board of Certified Energy Practitioners) Entry Level PV Examination.

Moreover, upon completion of this course, the participants should be able to demonstrate understanding of the

basic concepts, principles and applications required by NABCEP:

- Renewable Energy Opportunities
- PV Markets and Applications
- Safety Basics
- Electricity Basics
- Solar Energy Fundamentals
- PV Module Fundamentals
- System Components
- PV System Sizing Principles
- PV System Electrical Design
- PV System Mechanical Design
- Performance Analysis,
- Maintenance and Troubleshooting
- Net-Metering guide and standards
- Grid connection considerations

# 5-DAY SOLAR PV BOOTCAMP

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## DAY 1

### Solar PV Introduction

Renewable energy trend (global and local)  
Solar PV opportunities  
PV markets & applications

### 1-Safety Basics

- PV specific safety hazards & the Philippine Electric Code
- OSHA
- PV electrical shock, electrocution and arc flash
- Ladder safety and angles
- Fall protection

### 2-Electrical Basics

- Electrical circuit components
- Electrical test equipment
- Utility systems, generation, transmission, distribution & electrical service
- Using a digital multimeter to test voltage, current and resistance
- Measuring Voc, Isc and voltage and current under a load
- Using a power meter to make an IV curve

### 3-Solar Energy Fundamentals

- Making a sun path diagram
- Reading sun path diagrams
- Magnetic vs. true azimuth
- PV shading principles
- Shade analysis tools (Solmetric, Pathfinder, CAD & common sense)
- Shading ratios, 9am-3pm solar window & inter-row dist.
- Irradiance & irradiation measuring devices

### 4-PV Modules

- Plotting Voc, Isc, Vmp, Imp and Pmp on the I-V curve
- Testing current, voltage, power and energy
- Making IV curves
- Measuring Irradiance and temperature & the IV curve
- Testing load on I-V curve without MPPT
- PV & battery charging
- Similar and dissimilar PV experiments. Module mismatch v. matching modules in series & parallel on I-V curves.
- STC, NOCT, PVUSA, CEC and PTC
- Touching 99.99999 pure refined silicon.
- Examining crystalline and thin film PV module construction
- Testing PV efficiency (commissioning a module)
- Testing PV as a limited current & power source
- Testing bypass diodes
- Understanding and documenting labeling PV standards, CE, IEC & UL

### 5-Installing System Components

- Turning on PV, inverters, chargers, storage & sources
- Testing anti-islanding
- Installing BOS
- Programming power conditioning
- Installing PV system components for different PV system types
- Small off-grid PV system installation
- Inexpensive phone charging direct coupled systems.

### 6-PV System Materials

- Choosing your own PV system
- Students will try their skills at choosing PV, Inverters, Racking, etc.
- Finding materials on the internet
- Finding the correct inverters for the Philippine grid.
- Making a materials list
- Instructor will help and critique systems.
- Lab:
- Shading Analysis with Solmetric SunEye
- Irradiance Meter & IV Curve Trace

### 7-PV System Electrical Installation

- Applying the Philippine Electric Code

## DAY 2

- Line drawing exercises
- Performing PV series & parallel connections for different applications
- Choosing and using conductors, ampacity, conductor sizing & OCPD requirements
- PV & BOS installation parameters
- Settings for charging batteries with correct current, voltage & rates
- Installing labeling
- Installing grounding systems
- Voltage drop & voltage rise testing
- The process of installing a PV system according to code
- Philippine Electric Code. Looking for code violations

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## DAY 3

### 8-System Mechanical Installation

- Installing Roof, Ground, Pole, Trackers, BIPV
- Compare different types of PV integration
- Installing for PV temperature and wind variables
- Installing Building-integrated PV (BIPV) applications
- Installing materials for a harsh outdoor environment
- Installing roofing & PV
- Estimating mechanical loads
- Mech. installation/components
- Mechanical installation for thermal, orientation & electrical performance
- Installing to manufacturers' instructions & Philippine Electric

Code

### 9-Performance Analysis, Maintenance, Commissioning & Troubleshooting

- Performance problems
- Performance monitoring & parameters
- Expected v. actual performance
- Maintenance
- Operation & Management (O&M) safety
- Most common system failures
- Maintenance planning to manufacturers' instructions
- Dx & treatment of unhealthy PV systems

### Solar PV NetMetering

- NetMetering rules & guide
- DU Net-Metering application and guide
- Grid connection standards and guide

### Hands on PV Installation: Flat Roof Exercise

- Racks, PV, Fasteners, Hardware
- UniRac SolarMount Rails
- IronRidge Rails
- Tilt-up racking system
- PV Module Installation with mid & end clamps
- Grounding with WEEBS, Lugs, WEEB Lugs, Bonding Rails
- PV Source Circuits to Combiner Box
- Inverter Interconnection & Power to Grid
- Testing AC & DC Voltage & Current with Digital Multi-meter
- Breakdown

### Fastening PV to roofing systems

- Composition Asphalt Flashing
- Tile Roofs (Flat Tile & Spanish Tile)
- Shake Roofs
- Penetrations
- Hardware
- Galvanic Corrosion with Dissimilar Metals
- Finding Rafters
- Hangar Bolts/Pull Out Strength Tests
- Blocking
- Rafter Spans

### Hands on roofing & PV

- Composition Asphalt, Flat Tile & Barrel Tile Roofs
- Methods for Finding Rafters
- Removing Roofing Nails to Make Room for Flashing
- Drilling Holes
- Installing Hangar Bolts
- Waterproofing Gaskets
- Caulking Tips
- ProSolar Racking
- IronRidge Racking
- UniRac ClickSys Racking
- Grounding & Bonding
- Rail Splicing
- Inverter Connection

## DAY 4

### Hands on PV on Sloped Roofs with Microinverters and AC modules

- Microinverter and AC module Installation
- Microinverter and AC module Grounding
- Microinverter and AC module Monitoring

### Breakdown of Sloped Roofs

- 10- Wiring at Panelboard/Inverter Wall & in Classroom
- 120% Rule
- Supply Side Connection
- Breaker sizing
- DC conductor sizing
- Grounding

### Solar PV Parts OEM/Supply

- Parts and supply options
- Standard compliance

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## DAY 5



### Hands on Ground Mount PV Exercise

- ProSolar GroundTrac System
- Installation According to ProSolar Manufacturers Instructions
- 250 series Watt PV Modules
- Measuring Distances
- Hooking up the System to Grounded & Transformerless Inverters

- Discussion of Combine Fuse Calculations
- Discussion of Conductor Sizing for PV Source Circuits & Output Circuits
- Breakdown of Ground Mount
- Color coding and labeling of conductors

### Discussion at Panelboard/Inverter Wall:

- Transformerless v. Transformer Based Inverters
- Differences in Fuse Requirements
- Differences in DC Disconnect Requirements
- Grounded Conductor Requirements
- NEC 2011 Maintenance Disconnect Exception

### Other Considerations

- Local rules (LGU, NBCP, PEC, Distribution Code, etc.)
- Standard practices

### 11- Advanced Topics

### Exam preparation NABCEP Practice Exams

#### Discussion:

Mapping your future. Further study, licensing & certifications

### Final Examination & Award Presentation

#### Discussion:

Mapping your future. Further study, licensing & certifications

### Final Examination & Award Presentation

## YOUR GLOBAL EXPERT



### MASTER TRAINER

Sean White

Certified PV Independent Master Trainer by the US Interstate Renewable Energy Council and NABCEP (North American Board of Certified Energy Practitioners) certified PV Installation Professional

*Sean will also be complemented by*

*Meralco Experts/Engineers to discuss standards and practices on regulatory environment, Net-Metering, Grid connection and power industry trends.*

## FOR MORE INFORMATION

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