Photovoltaic Installer/Designer (PV2)

Competency Requirements

RENEWABLE ENERGY TECHNOLOGY

As a renewable energy technician, a second level Photovoltaic Installer/ Designer (PV2) will focus not only on the installation of a PV system, but also the design and integration of the PV system. Determining energy requirements, system configuration options, grid-tied or standalone, component options, array project sizing, project management and supervision are many of the competencies in which a PV2 should be proficient. Certification skill demonstrations are based on the topical outline provided in the Job/Task Analysis list and training is required from an approved school before sitting for the knowledge examination questions.

The Photovoltaic Installer/Designer (PV2) will be required to properly do the following Jobs/Tasks:

- Determine Customer Energy Requirements – both Residential and Commercial
- Explain the various system options and determine which configuration is best suited for a specific application
- Describe how the grid operates and how the PV system will integrate into the larger system
- Conduct a site survey to assess the optimal location, orientation and configuration of the system identifying any hazards or restrictions the site presents
- State the features and limitations of various system components and select them for the project
- Size the array for a project
- Summarize the codes and standards that apply to PV systems and comply with them during the design and installation process
- Oversee the project management, for design, preparation of bid packages, permitting and scheduling
- Supervise the installation crew
- Implement a safety plan and ensure all aspects of the project are conducted safely
- Test and troubleshoot the system
- Commission the system and orient the customer to its operation
- Develop an operation and maintenance document and maintain the system as required

The prospective Photovoltaic Installer/Designer (PV2) will have earned the following pre-requisites prior to awarding of the PV2 certification:

- A minimum of 60 verified hours of photovoltaic installation training, which can be acquired through the ETA PV1 photovoltaic installation training courses (40 hours) and an additional 20 hours of advanced PV training
- An OSHA10 card or equivalent
- The Customer Service Specialist (CSS) workforce readiness certification, which can be earned during PV2 training
- On-The-Job experience can be documented with a minimum of 150 points as defined in the Solar Level 2 Application Process experience checklist

The following is a listing of the major categories and items considered necessary to be included in the course of study directed towards the education of workers needed in the photovoltaic installation industry.

1.0 HISTORY AND BACKGROUND OF PHOTOVOLTAICS (PV)

- 1.1 Explore how the declining price structure of PV components has impacted the economics of distributed energy systems
- 1.2 Identify renewable energy incentive programs and their impact on the economics of the project
  - 1.2.1 state/utility incentives
  - 1.2.2 federal tax credits
  - 1.2.3 depreciation schedules
  - 1.2.4 Renewable Energy Certificates (RECs)
  - 1.2.5 Describe other renewable energy informational/educational websites
- 1.3 Identify historical issues in integrating distributed energy systems onto the grid including:
  - 1.3.1 grid growing pains
  - 1.3.2 Grid Operators'
    - 1.3.2.1 economic concerns
    - 1.3.2.2 technical concerns
- 1.4 Evaluate the impact of future trends on the industry
- 1.5 Identify the various installer certification programs in the PV marketplace

- 1.5.1 ETA-I – Electronics Technicians Association, ETA International
- 1.5.2 NABCEP – North American Board of Certified Energy Practitioners
- 1.5.3 UL® – United Laboratories, Inc

1.6 Identify the relevant sections of the National Electrical Code® (NEC) (NFPA70®) affecting PV

2.0 ADDITONAL PV PROJECT SAFETY

2.1 Explain typical safety hazards not previously described in the PV1 competency or in OSHA 10
2.2 Describe safety policies and procedures not previously described
2.3 Prepare a work site hazard assessment
2.4 Summarize personal protective equipment (PPE) including
- 2.4.1. Safety glasses
- 2.4.2. Hard hats
- 2.4.3. Fall protection

2.5 Describe guardrail systems
2.6 Explain the proper use of ladders in reference to OSHA and ANSI A14:
- 2.6.1 Ratings
- 2.6.2 carrying ladders
- 2.6.3 placing a ladder
- 2.6.4 securing ladders
- 2.6.5 climbing ladders

2.7 Explain how to properly use power tools
2.8 Explain heat exhaustion and de-hydration
2.9 Describe how to maintain an uncluttered work space
2.10 Define proper lifting and carrying techniques
2.11 Explain electric shock and arc flash risk
2.12 State how to prevent electrical injuries
2.13 Explain lock-out/ tag-out processes define by OSHA
2.14 Explain how to assemble scaffolding including:
- 2.14.1 Supported scaffolds
- 2.14.2 Suspended scaffolds
- 2.14.3 Aerial scaffolds
- 2.14.4 Trigger height

2.15 Describe trenches use while installing a PV system
- 2.15.1. Spoils
- 2.15.2. Trench access

3.0 HOW THE GRID WORKS

3.1 Define the national electrical grid including:
- 3.1.1 who owns it
- 3.1.2 state regulation
- 3.1.3 regional regulation

3.2 Explain how grid operators manage load demand incorporating:
- 3.2.1 base load
- 3.2.2 peak load
- 3.2.3 nameplate (i.e., rated, nominal, installed) capacity

3.3 Describe how electrical power works per the US Energy Information Administration (EIA) including:
- 3.3.1 “Real” (active) power
- 3.3.2 “Apparent” power
- 3.3.3 “Reactive” power
- 3.3.4 “Power Factor”

3.4 Identify power quality issues”
- 3.4.1 Voltage Issues – overvoltage, transients, surges, dips
- 3.4.2 Frequency Issues - harmonics
- 3.4.3 How utilities control power quality

3.5 Explain how utilities store energy
3.6 Explain utility pricing structures including:
- 3.6.1 Time-of-Use Rates
- 3.6.2 Demand Charges
- 3.6.3 Federal Energy Regulatory Commission (FERC)

3.7 Contemplate future changes to a grid that must integrate more distributed energy systems

4.0 DETERMINING CUSTOMER NEEDS Describe how to conduct a Load Assessment:

- 4.1.1 Determine the System Load
- 4.1.2 Implement energy efficiency measures
- 4.1.3 Calculate the Maximum Power Draw
- 4.1.4 Identify Cycling Loads
- 4.1.5 Calculate Weighted Loads

4.2 Explain how to calculate load factors

4.3 Describe how integration of electric vehicles may impact the system

4.4 Determine the PV system configuration:

- 4.4.1 Grid-Tied Systems
  - 4.4.1.1 Microinverters
  - 4.4.1.2 Power optimizers
- 4.4.2 DC-coupled systems
- 4.4.3 AC-coupled multimode systems
- 4.4.4 Stand-Alone systems
- 4.4.5 Hybrid systems

4.5 Identify options for commercial PV systems

- 4.5.1 subarrays
- 4.5.2 Bipolar PV Systems

4.6 Summarize the concept of Microgrids and how they are designed

4.7 Explain how to calculate the Return on Investment (ROI):

- 4.7.1 initial system costs
- 4.7.2 operation and maintenance costs
- 4.7.3 “Cost of Electricity” charges including:
  - 4.7.3.1 Energy
  - 4.7.3.2 Access
    - 4.7.3.2.1 Transmission
  - 4.7.3.3 Distribution
  - 4.7.3.4 Demand

4.8 Explore cost saving options containing:

- 4.8.1 Power Shifting and Load Shedding
- 4.8.2 maximizing financial incentives
  - 4.8.2.1 Federal Business Energy Investment Tax Credit
  - 4.8.2.2 Modified Accelerated Cost-Recovery System (MACRS)
  - 4.8.2.3 Net Energy Metering
  - 4.8.2.4 Solar Renewable Energy Certificates (SRECs)
  - 4.8.2.5 Property Assessed Clean Energy (PACE) Financing

4.9 Describe how to conduct a financial analysis of the project including:

- 4.9.1 Average Blended Cost versus Avoided Cost
- 4.9.2 Payback Period

4.10 Explore the various ownership options of solar PV systems

- 4.10.1 Direct Ownership
- 4.10.2 Leases
- 4.10.3 Power Purchase Agreements
- 4.10.4 Community Solar

4.11 Identify the Authorities Having Jurisdiction (AHJ) and Utility Restrictions comprising:

- 4.11.1 City and County Building Departments
- 4.11.2 Sub-Division Rules and Covenants
- 4.11.3 Planning and Zoning Restrictions
- 4.11.4 Historical Preservation Requirements
- 4.11.5 State Rules and Regulations
- 4.11.6 Utility Restrictions and Requirements

4.12 Explain how to develop the Application Package

- 4.12.1 One-Line Drawing
- 4.12.2 Plan View

5.0 CODES AND STANDARDS

- 5.1 Explain the National Electrical Code (NEC®) distributed by the NFPA pertaining to PV identified in 1.4:
  - 5.1.1 Article 250 Grounding and Bonding
  - 5.1.2 Article 685 Integrated Electrical Systems
  - 5.1.3 Article 690 Solar Photovoltaic Systems
  - 5.1.4 Article 700 Emergency Systems
    - 5.1.4.1 Article 705 Interconnected Electric Power
  - 5.1.5 Article 100 General Wiring
    - 5.1.5.1 Article 230 Services Installation
  - 5.1.6 Article 445 Generators
- 5.2 Discuss NFPA 5000 Building Construction and Safety Code
- 5.3 Discuss International Code Council standards links to the:
  - 5.3.1 International Building Code (IBC)
  - 5.3.2 International Fire Code (IFC)
- 5.4 Discuss IEEE 1547, Standard for interconnecting distributed resources with electric power systems
- 5.5 Discuss UL 1703, Standard for flat-plate photovoltaic modules and panels
- 5.6 Discuss UL 1741 Standard for static inverters, converters & controllers for use in photovoltaic power systems

6.0 CONDUCTING A SITE SURVEY

- 6.1 Describe how to determine available sunlight
  - 6.1.1 Standard Test Conditions (STC)
  - 6.1.2 Irradiance (watts per square meter)
  - 6.1.3 Insolation (watt-hour per square meter)
- 6.2 Explain site shading issues including:
  - 6.2.1 Inter-Row Shading calculations
  - 6.2.2 determining Ground Cover Ratio
  - 6.2.3 Solar Pathfinder, SunEye evaluations
  - 6.2.4 calculating Total Solar Resource Factor
- 6.3 Describe how to determine the orientation of the array
  - 6.3.1 Azimuth
  - 6.3.2 Altitude
  - 6.3.3 Declination
- 6.4 Discuss various tracking system options
  - 6.4.1 Fixed Mount
  - 6.4.2 Single-Axis
  - 6.4.3 Dual-Axis
  - 6.4.4 Horizontal Axis
- 6.5 Explain advantages and disadvantages of various mounting options:
  - 6.5.1 Roof Mounted
  - 6.5.2 Ballasted Systems
  - 6.5.3 Ground Mounted
  - 6.5.4 Pole Mounted
  - 6.5.5 Building Integrated
- 6.6 Explain how to evaluate factors affecting mounting systems including
  - 6.6.1 loading issues:
    - 6.6.1.1 live weight
    - 6.6.1.2 dead weight
  - 6.6.2 ‘Passive Cooling’
  - 6.6.3 ‘Setback’ requirements
  - 6.6.4 geotechnical evaluations
  - 6.6.5 foundation types
- 6.7 Explain how to determine the effect of array on building's Load/Power Factor
- 6.8 Describe how to determine the location of the balance of systems (BOS)
  - 6.8.1 clearance issues
  - 6.8.2 service entrance location
- 6.9 Describe how to determine the location of battery banks
  - 6.9.1 use of battery types

- 6.9.2 potential hazards
- 6.9.3 storage room requirements
- 6.9.4 storage cabinet requirements
- 6.9.5 NEMA® (National Electrical Manufacturers Association) enclosure ratings

6.10 Explain how to find and evaluate existing electrical equipment
- 6.10.1 load side connections
- 6.10.2 supply side connections
- 6.10.3 integrating generators into the system
- 6.10.4 evaluating existing service panel

7.0 COMPONENTS SELECTION

7.1 Explain how to determine the appropriate solar panel technology
- 7.1.1 Monocrystalline panels
- 7.1.2 Polycrystalline panels
- 7.1.3 Thin film panels
- 7.1.4 emerging technologies

7.2 Describe solar panel ratings
- 7.2.1 Nominal Voltage
- 7.2.2 open circuit voltage (Voc)
- 7.2.3 maximum power voltage (Vmp)
- 7.2.4 short circuit current (Isc)
- 7.2.5 maximum power current (Imp)
- 7.2.6 efficiency

7.3 Summarize panel connector types and termination processes

7.4 Explain how to select a combiner box
- 7.4.1 pre-wired
- 7.4.2 data monitoring
- 7.4.3 rapid shutdown combiner boxes
- 7.4.4 overcurrent protection devices (OCPD) within combiner boxes
- 7.4.5 limitations and listings
- 7.4.6 arc fault protection
- 7.4.7 lightning and surge protection
- 7.4.8 incorporating multiple combiner boxes

7.5 Describe how to evaluate DC disconnects
- 7.5.1 ratings and listings
- 7.5.2 number of poles
- 7.5.3 overcurrent devices within DC disconnects

7.6 Explain selecting grid-tied inverters
- 7.6.1 Anti-Islanding issues
- 7.6.2 Maximum Power Point Tracking (MPPT)
- 7.6.3 multiple string inverters
- 7.6.4 grounded versus ungrounded inverters
- 7.6.5 Three-Phase power inverters
- 7.6.6 multiple tracking zones of MPPT
- 7.6.7 Bimodal inverters
- 7.6.8 Smart inverters

7.7 Summarize microinverter systems by:
- 7.7.1 determining the inverter load ratio
- 7.7.2 sizing branch circuits

7.8 Explain how to evaluate power optimizer systems including
- 7.8.1 string size calculations

7.9 Describe how to select AC disconnects
- 7.9.1 limitations and listings
- 7.9.2 determining the location of the main system disconnects

7.10 Compare electric meters including:
- 7.10.1 Smart meters

7.11 Describe how to select components for stand-alone systems including:
- 7.11.1 charge controllers:
  - 7.11.1.1 Buck/Boost charge controllers

7.11.1.2 load diversion
7.11.1.3 use in charging lithium ion batteries
7.12 Distinguish and demonstrate stand-alone inverters
7.12.1 inverter wave forms
7.12.2 continuous power rating
7.12.3 surge rating

8.0 ARRAY SIZING

8.1 Explain how to select a solar panel including:
8.1.1 manufacturing standards (UL1703, etc)
8.1.2 efficiency
8.1.3 peak watts
8.1.4 power tolerance
8.2 Describe how to Future-Proof the design
8.3 Summarize how to size the array including:
8.3.1 load analysis - (similar to 3.1)
8.3.2 calculating array generating capacity
8.3.3 Derate Factor components
8.3.4 maximum panels per string determination
8.3.5 minimum panels per string determination
8.4 Explain string calculations for microinverter systems
8.5 Explain string calculations for power optimizer systems
8.6 State how to calculate space required for an array of panels

9.0 WIRING THE SYSTEM

9.1 Differentiate between the types of wire available for PV systems
9.1.1 aluminum or copper
9.1.2 solid or stranded
9.1.3 insulation options
9.2 Differentiate between the wire color coding system per the AHJ
9.2.1 solid ground versus functional ground
9.2.2 color coding with tape on larger wires
9.3 Describe resistance in relation to:
9.3.1 calculating voltage drop
9.3.2 Ohm's Law definition and formulas
9.3.3 ways to minimize voltage drop
9.3.4 showing ‘Voltage Rise’, negative voltage drop
9.3.5 impedance definition
9.4 Describe ampacity rating of conductors including:
9.4.1 effects of temperature on wire
9.4.2 by wire size (AWG-American Wire Guage)
9.5 Define overcurrent protection including:
9.5.1 ampere interrupt rating
9.5.2 Back-fed breakers
9.5.3 Ground-fault breakers
9.6 Explain circuits used in a system including:
9.6.1 PV source circuit
9.6.1.1 terminating MC4 connectors
9.6.1.2 ampacity safety factor adjustment
9.6.1.3 solar ampacity adjustment
9.6.1.4 sizing overcurrent protection
9.6.1.5 adjustment for sun exposure
9.6.1.6 adjustment for conduit fill
9.6.1.7 systems with multiple combiner boxes
9.6.2 PV output circuit
9.6.3 Inverter input circuit
9.6.4 Inverter output circuit
9.6.4.1 three-phase output
9.6.4.2 multiple inverter systems

9.6.4.3 'Six handle' rule [NEC Section 230.71(A)]
9.6.5 Battery input circuit
9.7 Explain how to connect to the utility including:
9.7.1 Load side connections
9.7.1.1 120% Rule [NEC Section 705.12(D)(2)]
9.7.1.2 feed-thru lugs
9.7.1.3 load side feeder connection
9.7.1.4 10-foot tap rule [NEC Section 240.21(B)(1)]
9.7.1.5 25-foot tap rule [NEC Section 240.21(B)(2)]
9.7.2 Supply side connections
9.7.3 Labeling wires including TIA 606 requirements
9.8 Differentiate between conduits and raceways definitions:
9.8.1 electrical metallic tubing (EMT)
9.8.2 rigid metal conduit (RMC)
9.8.3 flexible metallic tubing (FMT)
9.8.4 rigid polyvinyl chloride (PVC)
9.8.5 liquid-tight flexible nonmetallic (LFNC)
9.9 Explain how to install conduit including:
9.9.1 spacing from roof deck
9.9.2 conduit fill issues
9.9.3 conduit support
9.9.4 conduit expansion
9.9.5 underground Installation
9.9.6 conduit durability
9.9.7 bending conduit
9.9.8 pulling wire through conduit:
9.9.8.1 Fish tape
9.9.8.2 pull string
9.9.8.3 cable tugger
9.9.8.4 cable lubricant
9.9.8.5 separating AC and DC conductors
9.10 Explain grounding and bonding [NEC Section 250] including:
9.10.1 Equipment grounding
9.10.1.1 WEEB (Wiley Electronics: 'washer, electrical equipment bond') ground strategy
9.10.1.2 bonding jumper
9.10.1.3 galvanic corrosion
9.10.2. System grounding
9.10.2.1 ground electrode conductor
9.10.2.2 grounding electrode
9.10.2.3 system grounding options
9.10.2.4 ground loop
9.10.2.5 grounding electrode conductor taps
9.10.2.6 Transformerless inverter grounding
9.10.2.7 Ufer ground
9.11 Explain ground faults more in depth than 8.5.3 use
9.11.1 Ground fault current path
9.11.2 Ground fault protection device
9.12 Define arc faults (explained more in depth in 13.13)

10.0 ENERGY STORAGE SYSTEMS

10.1 Explain the major types of batteries including:
10.1.1 Lead-acid:
10.1.1.1 Flooded
10.1.1.2 Gelled, gel-filled
10.1.1.3 Absorbed glass mat
10.1.1.4 Depth of discharge
10.1.1.5 Effect of temperature on batteries
10.1.1.6 C-rating
10.1.2 Lithium-ion :

- 10.1.2.1 types of lithium-ion chemical symbol batteries
- 10.1.2.2 charging lithium-ion batteries
- 10.1.3 Saltwater batteries
- 10.1.4 Nickel iron batteries

10.2 Describe how AC coupled and high voltage batteries work including:
- 10.2.1 conversion losses
- 10.2.2 energy storage systems
  - 10.2.2.1 load-shifting
  - 10.2.2.2 peak-shaving

10.3 Describe how to build a lead-acid battery bank including:
- 10.3.1 bank load determination
- 10.3.2 system voltage
- 10.3.3 Days of Autonomy
- 10.3.4 depth of discharge calculations
- 10.3.5 inverter efficiency factors

10.4 Explain how to install lead acid batteries into a bank including:
- 10.4.1 Inspect and test each battery by:
  - 10.4.1.1 Open-circuit voltage test
  - 10.4.1.2 Specific gravity test

10.5 State the wiring diagram of a battery bank system

10.6 Summarize battery safety guidelines from PV1 and designing in your project application

10.7 Explain how electric vehicle charging stations affect storage solutions

11.0 PV MOUNTING SYSTEMS

11.1 Define a PV racking system including:
- 11.1.1 Roof Mounted Systems
  - 11.1.1.1 Flush-to-roof
  - 11.1.1.2 Standoff mounting
  - 11.1.1.3 Footings
  - 11.1.1.4 Shear loads
  - 11.1.1.5 Pull-out loads
  - 11.1.1.6 Wind exposure category
  - 11.1.1.7 Occupancy category
  - 11.1.1.8 Roof zone
  - 11.1.1.9 Tributary area to footing
- 11.1.2 Mounting panels on rails require:
  - 11.1.2.1 Top-down mounting clamps
  - 11.1.2.2 Landscape/portrait
  - 11.1.2.3 Rail-less systems
  - 11.1.2.4 Shared rail systems
- 11.1.3 Installation on flat roof systems
- 11.1.4 Installing ground mounted systems require:
  - 11.1.4.1 Footings
  - 11.1.4.2 Site preparation
  - 11.1.4.3 Site access
  - 11.1.4.4 Conductor accessibility

12.0 PROJECT MANAGEMENT

12.1 Summarize the bid package(s) preparation including:
- 12.1.1 Request for Proposal (RFP)

12.2 Explain capital costs determination:
- 12.2.1 Direct
- 12.2.2 Indirect

12.3 State how to review project design

12.4 Explain how to coordinate project schedule

12.5 Describe how to direct project procurement of:
- 12.5.1 materials
- 12.5.2 equipment
- 12.5.3 services

12.6 Explain how to manage the project budget including:
- 12.6.1 'moves, adds and changes'
- 12.6.2 change orders
- 12.6.3 As-built drawings
- 12.6.4 key project indicators

12.7 Explain AHJ permits and contracts procedures:
- 12.7.1 Utility agreements:
  - 12.7.1.1 interconnection agreement
  - 12.7.1.2 'Net Metering' agreement
  - 12.7.1.3 insurance requirements
- 12.7.2 County or city building department:
  - 12.7.2.1 electrical permit
  - 12.7.2.2 mechanical permit
  - 12.7.2.3 building permit
  - 12.7.2.4 other licenses or certifications

12.8 Explain to whom a completed application package must be delivered including:
- 12.8.1 One-line drawing (more in depth than in 3.12 above)
- 12.8.2 Plan view
- 12.8.3 Three-line drawing

12.9 Define a 'toolbox talk'

12.10 Explain project documentation including:
- 12.10.1 filings
- 12.10.2 registrations

12.11 Summarize operation and maintenance documentation

12.12 Describe customer orientation

13.0 TESTING AND TROUBLESHOOTING

13.1 Explain how to conduct an inspection of a system

13.2 Describe how to check mechanical connections
- 13.2.1. torque

13.3 Describe how to check electrical connections

13.4 Explain how to demonstrate continuity testing

13.5 Explain how to demonstrate polarity testing

13.6 Explain how to demonstrate voltage and current testing

13.7 Explain how to demonstrate insulation testing
- 13.7.1. Megohmmeter®

13.8 Explain testing the grounding system including:
- 13.8.1. Earth resistivity
- 13.8.2. Ground resistance test
  - 13.8.2.1. Fall-of-potential test
  - 13.8.2.2. Clamp on test
  - 13.8.2.3. Measuring ground and leakage current

13.9 Describe how to startup an inverter

13.10 Describe system function tests

13.11 Explain how to verify energy production

13.12 Explain testing phase rotation

13.13 Explain arc faults in more detail:
- 13.13.1. series arc faults
- 13.13.2. parallel arc faults

13.14 Describe other typical system problems including:
- 13.14.1. poor system output
- 13.14.2. sudden system failure
- 13.14.3. battery failure

14.0 COMMISSIONING THE SYSTEM

14.1 Explain how to verify the installation

14.2 Summarize the compliance with codes and standards

14.3 Explain how to verify safe operation

14.4 Summarize the PV System Project documentation not previously covered in 11.0

14.4.1. Additional labeling on the system
14.5 Explain how to do an inspection of the system

15.0 MAINTAINING THE SYSTEM

15.1 Describe how to monitor system performance
15.2 Define system maintenance procedures including:
15.2.1. Solar panels
15.2.1.1. warranties
15.2.1.2. damage repair of panels
15.2.1.2.1. hail
15.2.1.2.2. wind
15.2.1.3. snow removal
15.2.1.4. soiling
15.2.2. Panel mounts and racking systems including:
15.2.2.1. vibrational loosening
15.3 Define inverter maintenance
15.4 Describe battery bank maintenance

End of Photovoltaic Installer/Designer Level 2 Competency

Find An ETA Test Site: http://www.eta-i.org/testing.html

Additional Study Materials and Resources for ETA PV2 Certification:

SOLAR LEVEL 2 APPLICATION PROCESS.pdf https://www.eta-i.org/renewable_energy.html

Designing and Installing Solar PV Systems: An Easy-to-Follow Study Guide for Advanced Solar Electric Certification Programs ; 1E; Jay Warmke; ISBN: 978-0979161162; BRS Media; 2019; Softcover: 438 pages. Available through http://www.bluerockstation.com or through ETA 800-288-3824, www.eta-i.org

Understanding Photovoltaics; 2E; Jay and Annie Warmke; ISBN: 978-0979161155; BRS Media; 2017; Softcover: 294 pages. Available through http://solarpvtraining.com/understanding-photovoltaics/ or through ETA 800-288-3824, www.eta-i.org (1st edition, 2014, still available)

Photovoltaic Systems, 3E; James Dunlop; ISBN: 978-1-935941-05-7; American Technical Pub.; 2012; Hardcover: 450 pages.

Solar Electric Handbook: Photovoltaic Fundamentals and Applications, 2E; ; Solar Energy International (SEI); ISBN-13: 978-1256918165; Pearson; 2013; Softcover 504 pages.

Photovoltaics Design and Installation Manual; Solar Energy International (SEI); ISBN-13: 978-0865715202; New Society Publishers (September 1, 2004); Softcover 336 pages.

Mike Holt's Illustrated Guide to Understanding the NEC Requirements for Solar Photovoltaic Systems, 2017 NEC; ISBN: 978-0997467260 (Book & DVD Set); ISBN: 978-0986353444 (Book Alone); Mike Holt; Softcover: 608 pages.

National Electrical Code 2017 Handbook (International Electrical Code); ; National Fire Protection Association (NFPA); ISBN-13: 978-1455912841; Delmar Cengage Learning; (2016); Softcover; 1306 pages.

Other valuable website information:

- **https://solarpvtraining.com/;**
- **https://www.eta-i.org/industry_links_and_resources.html**
- **https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70;**
- **www.eia.gov;**
- **www.nrel.gov;**
- **www.osha.gov**
  - **https://www.osha.gov/dte/outreach/cardhierarchy.html**
  - **https://www.osha.gov/dte/outreach/faqs.html**
- **www.bluerockstations.com;**
- **www.batteryuniversity.com;**
- **www.mikeholt.com;**

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