

Solar Photovoltaic Installer Certificate

Description:

Learn the skills necessary to become a successful, professional Photovoltaic (PV) Solar Installer. Designed for individuals in the trades or going into the trades. The *PV Solar Installer Certificate* provides skills and knowledge to enter the job market and be prepared to take on the tasks of installing a PV power plant in a residential environment. This certificate is the first step for the North American Board of Certified Energy Practitioners (NABCEP) PV Installer program and provides foundation knowledge to pass the *NABCEP Entry Level Exam*. Related on-the-job PV experience in conjunction with the PV Solar Installer Certificate prepares you for the *NABCEP Certification*.

Before enrolling in this program:

You should have a basic high school diploma.

What can I do with this certificate?

Career Options: PV system installers, PV system sales, in conjunction with a contractor's license this certificate would enable one to start a business in PV system integration.

Academic Options:

Continue your studies by completing the *Building and Construction Technologies* degree, any vocational construction career path directed towards a skilled profession or trade, and optionally pursue nationally recognized PV specific credentials (NABCEP)

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Required Core Courses		<i>A grade of C or better is required for graduation</i>
MODULE	TOPIC	CREDIT HOURS
1	Introduction to Safety	1
2	Windows Operating System: Level I	1
3	Computer Networks Residential	1
4	Construction Mathematics I	1
5	Concepts of Electricity & Electronics	2
6	Basic Electronic Theory	1.25
7	Basic Roofing	1
8	Communication and Employability	1
9	Hand and Power Tools	.5
10	Introduction to residential wiring	3
11	Hand bending conduit	.25
12	Fasteners and Anchors	.25
13	Photovoltaic Installation	6
	Total credits as displayed	19.25

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Credits:

- ✓ Material developed by: Randy Dutton, Estrella Community College
- ✓ Modified and updated by: Heidi Vasiloff, Heidi Vasiloff P.C.

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Module 1: Basic Safety for the Building Trades

Information: Successful completion of this course qualifies the student for the 10 hour safety training card.

Introduction to federal safety training standards. Includes employer responsibility-employee right to know, personal protective equipment, material handling, hand and power tools, electrical hazards, scaffolds, fall protection, cranes, and stairways and ladders.

Certification(s): Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Describe the employer's responsibility/employee right to know safety policies.
2. Describe personal protective equipment needed for eye, hand, foot, head, skin, hearing, and fall protection.
3. Describe material handling and hazardous material procedures.
4. Describe safe and proper use of hand and power tools.
5. Describe electrical hazard procedures such as lock-out/tag-out.
6. Explain the Occupational Safety and Health Administration (OSHA) Hazards Communication Standard.
7. Describe fire prevention in dealing with various specific flammable materials and fire safety guidelines.
8. Describe the proper use of scaffolding.
9. Describe fall protection training requirements, systems, and equipment.
10. Describe operator hand signals, safety procedures and crane equipment failures.
11. Describe the training requirements, ANSI guidelines, and the safe and proper use of stairways and ladders.

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Module 1: Basic Safety for the Building Trades

Expected Outcome	Topic	Suggested Activities
1.	Employer Responsibility-Employee Right to Know A. Unsafe conditions B. Regulations C. Hazards D. Exposure E. Accident prevention	
2.	Personal Protective Equipment A. Eye protection B. Hand protection C. Foot protection D. Head protection E. Clothing F. Skin protection G. Breathing-respiratory H. Fall protection I. Hearing protection	
3.	Material Handling A. Signaling B. Barricades C. Storage D. Housekeeping E. Rigging F. Hazardous materials	
4.	Hand and Power Tools A. Hand tools 1. Wrenches 2. Saws 3. Pliers 4. Screw drivers 5. Hammers 6. Files 7. Knives B. Power tools 1. Electric power tools 2. Pneumatic power tools 3. Fuel powered tools 4. Hydraulic power tools 5. Powder-actuated tools 6. Abrasive tools 7. Woodworking tools	

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5.	Electrical Hazards A. Lock-out/tag-out B. Static and dynamic electricity C. Current and conducting D. Circuits E. Training F. Amperes G. Volts H. Resistance I. Electric shock	
6.	Hazards Communication Standards (HAZCOM) A. Material Safety Data Sheets (MSDS) B. Worker responsibilities under HAZCOM	
7.	Fire Safety A. Fire prevention guidelines B. How fires start C. Fire prevention 1. Flammable and combustible liquids 2. Flammable gasses 3. Ordinary combustibles 4. Other D. Fire fighting 1. Classes of fires	
8.	Scaffolds A. Erectors and dismantlers B. Capacity C. Scaffold platform construction D. Criteria for supported scaffolds E. Suspension scaffolds F. Access G. Fall protection (belts, lanyards, guard rails, toe boards) H. Cross bracing I. Midrails	
9.	Fall Protection A. Training requirements B. Controlled access zones C. Safety monitoring systems D. Guidelines for fall arrest systems E. Guardrail/covers F. Connecting activity G. Positioning device systems H. Deceleration device I. Fall protection plan J. Protection from falling objects K. Safety net	

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10.	Cranes A. Operator error B. Site conditions C. Mechanical failure D. Structural failure E. Rigging failure F. Crane signal/radio communication failure G. Derricks H. Hand signals I. Wire rope J. Platform K. Transit L. Overhead hazards	
11.	Stairways and ladders A. Risers B. Platform/landing C. Stair rails and handrails D. Midrails E. Ladder loads F. Rungs G. Cleats H. Spreaders I. Cages for fixed ladder J. Training requirements K. Ansi guidelines	

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Module 2: Windows Operating System: Level 1

Description:

Specific topics include Windows basics, navigating and customizing the desktop, maintaining hardware and software, improving performance, configurations, securing your computer, taskbar,

files, installing and uninstalling applications, Internet Explorer fine tuning, security, and searching, including advanced search techniques, keyboard shortcuts, and current topics.

Certification(s): Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Perform start-up, shut down, standby, and hibernate procedures on the computer.
2. Customize the desktop, including gadgets.
3. Maintain the hardware and software.
4. Track the status of application programs currently being used through the Task Manager and task bar functions.
5. Secure your computer.
6. Use the Help utility to obtain information.
7. Manage folders and files.
8. Install and uninstall application programs.
9. Use Internet Explore to navigate and efficiently search the web.
10. Use Windows built in applications.

Module 2: Windows Operating System: Level 1

Expected Outcome	Topic	Suggested Activities or Resources
1	Start Up and Shut Down Procedures and Options A. Power on the computer B. Shut down options 1. Powering off 2. Restarting (including standby and hibernate)	
2	Customizing the Desktop A. Components of the desktop 1. Desktop icons 2. Control Panel 3. Taskbar	
3	Maintaining the Hardware and Operating Software A. Disk utilities B. Restore points C. Installation and removal of Windows Components	
4	Taskbar Functions A. Concept of taskbar buttons B. Time/date indicator C. Positioning of the taskbar	
5	Securing Your Computer A. Virus protection B. Firewall C. Adware and spyware D. Passwords and user accounts	
6	Help Utility A. Help contents 1. Text 2. Online B. Alphabetical topics list C. Key word search	
7	Managing Folders and Files A. Understanding file types B. Cut, copy, paste, send to C. Short cut menus D. Folder management 1. Creating 2. Moving 3. Renaming 4. Deleting	

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	Managing Folders and Files (continued) E. Sorting, stacking and grouping files 1. Tags 2. Properties 3. Views F. File management 1. Copying 2. Moving 3. Renaming 4. Deleting	
8	Install and Uninstall Applications A. Programs submenu of the start menu B. Control Panel C. Uninstall or repair	
9	Internet Explorer A. Brief overview of IE B. Effective searching C. History D. Favorites E. Security levels F. Configuring mail preferences G. Working with options 1. Security 2. Privacy 3. Connections 4. Browsing history	
10	Using Windows Built-in Applications	

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Module 3: Computer Networking

Description:

Fundamentals of networking for the home user including internet connectivity, wired and wireless local area networks, networking device configuration, integration of entertainment electronics, security and ethics.

Certification(s): Solar Photovoltaic Installer

Prerequisite: Windows Operating System Level I

Required Materials: None

Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Explain home Internet access methods.
2. Install and configure a residential network router.
3. Implement wired and wireless Local Area Networks (LAN).
4. Install and configure a wireless access point.
5. Demonstrate understanding of appropriate Personal Computer (PC) hardware and software in a home network.
6. Design and implement home network security strategy including a router firewall.
7. Demonstrate understanding of home network design methodologies.

Module 3: Computer Networking

Expected Outcome	Topic	Suggested Activities
1	Home Internet Access Methods A. Dial-up B. Cable C. DSL D. Satellite	
1– 7	Local Area Network for the home A. Network Design B. Configuring a residential router C. Configuring a residential wireless access point D. Configuring a PC for home network use E. Securing home networks against intrusion and viruses F. Portable data devices including Portable Desktop Assistants (PDA) and removable storage devices.	
3 & 7	Equipment integration A. Cabling and interfaces B. Integrating portable devices	

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Module 4: Construction Mathematics I

Description:

Introduction to basic mathematical concepts. Includes whole numbers, measurements, fractions, decimals, conversion process, metric system, and construction geometry.

Certification(s): Solar Photovoltaic Installer

Prerequisite: Mathematics assessment test is required before enrolling in this course.

Required Materials: None

Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Add, subtract, multiply and divide whole numbers, without a calculator.
2. Use a standard ruler and a metric ruler to measure.
3. Add, subtract, multiply and divide fractions.
4. Add, subtract, multiply and divide decimals, with and without a calculator.
5. Convert decimals to percentages and percentages to decimals, fractions to decimals, and decimals to fractions.
6. Define the metric units of length, weight, volume, and temperature.
7. Apply basic geometry to measure the basic shapes used in the construction industry.

Module 4: Construction Mathematics

Expected Outcome	Topic	Suggested Activities
1	Whole Numbers A. Parts of a whole number B. Adding whole numbers C. Subtracting whole numbers D. Multiplying simple whole numbers E. Dividing whole numbers F. Using the calculator to add, subtract, multiply, and divide whole numbers	
2	Measurements A. Using the standard ruler B. Architect's scale	
3	Fractions A. Finding equivalent fractions B. Reducing fractions to their lowest term C. Comparing fractions and finding the lowest common denominator	

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	Fractions (continued) D. Adding fractions E. Subtracting fractions F. Multiplying fractions G. Dividing fractions	
4	Decimals A. Reading a machinist's rule B. Comparing whole numbers with decimals C. Comparing decimals with decimals D. Adding and subtracting decimals E. Multiplying decimals F. Dividing with decimals G. Rounding with decimals H. Using the calculator to add, subtract, multiply, and divide decimals	
5	Conversion Process A. Converting decimals to percentages and percentages to decimals B. Converting fractions to decimals C. Converting decimals to fractions D. Converting inches to decimal equivalents in feet	
6	Metric System A. Units of weight, length, volume, and temperature B. Using the metric ruler C. Converting measurements	
7	Construction Geometry A. Angles B. Shapes C. Areas of shapes D. Volume of shapes	

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Module 5: Basic Concepts of Electricity and Electronics

Introduction to electrical concepts used in Ohm's Law applied to DC series circuits. Includes atomic theory, electromotive force, resistance, and electric power equations.

Certification(s): Solar Photovoltaic Installer

Prerequisite: Mathematics assessment test is required before enrolling in this course.

Required Materials: None

Credit Hours: 2

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Explain what atoms are and how they are constructed.
2. Define voltage and identify the ways in which it can be produced.
3. Explain the differences between conductors and insulators.
4. Define the units of measurement that are used to measure the properties of electricity.
5. Explain how voltage, current, and resistance relate to each other.
6. Use the formulas for Ohm's Law to calculate an unknown value.
7. Explain the different types of meters used to measure voltage, current, and resistance.
8. Use the power formula to calculate the amount of power used by a circuit.

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Module 5: Concepts of Electricity and Electronics

Expected Outcome	Topic	Suggested Activities or Resources
1	Introduction to Electrical Theory A. Definition and structure of atoms 1. The nucleus 2. Electrical charges	
2, 3	Electrical Charge and Current A. Current flow B. Voltage	
4	Resistance A. Characteristics of resistance B. Ohm's Law	
4, 5	Schematic Representation of Circuit Elements A. Pictorial and Schematic form	
6	Resistors A. Function B. Using Ohm's Law C. Resistor color codes	
7	Measuring Voltage, Current, and Resistance A. Basic meter operation B. Voltmeter C. Ammeter D. Ohmmeter	
8	Electrical Power A. Power equation B. Power rating of resistors	

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Module 6: Basic Electronic Theory

Introduction to the function and operation of basic electronic devices. Includes semiconductors, diodes, rectifiers, and transistors.

Certification(s): Solar Photovoltaic Installer

Prerequisite: Electrical Theory II

Required Materials: None

Credit Hours: 1.25

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Identify basic electronic system components.
2. Describe the essential characteristics of semiconductors
3. Connect diodes.
4. Connect silicon-controlled rectifiers.
5. State the essential characteristics of transistors.

Module 6: Basic Electronic Theory

Expected Outcome	Topic	Suggested Activities or Resources
1	Electronic System Components A. Electricity under magnification B. Electronic system components 1. Conductors 2. Insulators 3. Semiconductors 4. Diodes 5. Rectifiers 6. Light-emitting diodes 7. Transistors 8. Diacs 9. Triacs	
2	Semiconductors A. Materials B. Conductivity C. Other characteristics	

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3	Diodes A. Identification B. Characteristics C. Connecting D. Reverse bias	
4	Rectifiers A. Characteristics B. Connecting	
5	Transistors A. Types 1. Negative-Positive-Negative (NPN) transistors 2. Positive-Negative-Positive (PNP) transistors B. Transistor leads C. Field-effect transistors	

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Module 7: Basic Roofing

Description:

Steep roofing practices and procedures. Includes asphalt roll material and shingles, wood and asbestos shingles, slate and tile.

Certification(s): Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. List basic roof components.
2. Choose and apply appropriate asphalt roll roofing materials.
3. Use various methods to create and apply asphalt roll to create a steep roof.
4. Identify various application guidelines to be considered when applying asphalt shingles to a steep roof.
5. Apply asphalt shingles to create a steep roof.
6. Identify and demonstrate re-roofing methods using asphalt shingles.
7. Identify various tile types used in steep roofing.
8. Apply tile to create a steep roof.

Module 7: Basic Roofing

Expected Outcome	Topic	Suggested Activities
1, 2, 3, 4	Steep Roofing With Asphalt Roll Material A. Terminology B. Roof components C. Roll roof materials 1. Organic felts 2. Glass fiber base mats D. Methods of applying asphalt roll roofing materials 1.Exposed nail method 2. Concealed method 3. Plastic cement 4. Hot asphalt E. Applications procedures 1. Exposed nail 2. Concealed nail 3. Plastic cement 4. Hot asphalt	

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5, 6	Steep Roofing With Asphalt Shingles A. Terminology B. Roof selection 1. Building type 2. Roof slope 3. Exposure 4. Composition C. Shingle application guidelines 1. Deck preparation 2. Drainage 3. Ventilation 4. Nailing 5. Specifications D. Fastener requirements E. Asphalt shingle types F. Flashing	
7 & 8	Steep Roofing with Tile A. Terminology B. Tools C. Tile types: Clay and Concrete D. General preparation requirements 1. Wood deck 2. Clay tile 3. Cement Tile E. General application guidelines 1. Flat clay tile 2. Clay roll tile 3. Cement tile 4. Flashing	

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Module 8: Communication and Employability

Description:

Reading, writing, listening, and speaking skills, thinking and computer skills, relationship skills, and workplace issues.

Certification(s):

Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Interpret information and instructions presented in both written and verbal form
2. Describe how to communicate effectively in on-the-job situations using written and verbal skills.
3. Explain entrepreneurship and entering the construction workforce.
4. Solve problems in planning and scheduling for the construction industry.
5. Explain computer systems and common uses of computers in the construction industry.
6. Describe effective relationship skills with teammates and supervisors.
7. Discuss workplace issues involving harassment, stress, and drugs and alcohol.

Module 8: Communication and Employability

Expected Outcome	Topic	Suggested Activities
1, 2	Reading and Writing Skills A. Reading on the job B. Writing on the job	
1, 2	Listening and Speaking Skills A. Active listening on the job B. Speaking on the job	
3	Employability in the Construction Business A. Entering the construction workforce B. Entrepreneurship	

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4	Critical Thinking Skills A. Barriers to problem solving B. Solving problems using critical thinking skills C. Problems with planning and scheduling	
5	Computer Skills A. Computer terms B. Basic software packages C. Electronic mail (email) D. Computers in the construction industry	
6	Relationship Skills A. Self-presentation skills B. Conflict resolution C. Giving and receiving criticism D. Teamwork skills E. Leadership skills	
7	Workplace Issues A. Harassment B. Stress C. Drugs and alcohol	

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Module 9: Hand and Power Tools

Description:

Selection and safety procedures. Includes trades terms, hand tool, and power tool use to specific jobs in the construction industry.

Certification(s): Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: .5

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. List and define trade terms related to hand and power tools.
2. Describe basic safety procedures and the selection of appropriate safety equipment for use with specific hand tools.
3. Describe basic safety procedures and maintenance procedures for specific power tools.
4. Demonstrate the proper use of select tools and power tools.

Module 9: Hand and Power Tools

Expected Outcome	Topic	Suggested Activities
1, 2	Trade Terms A. Hand tools 1. Alloy 2. Beveled 3. Dropped-forged 4. Kerf 5. Plumb 6. Other B. Power tools 1. Ground fault protection 2. Electric 3. Hydraulic 4. Pneumatic 5. Powder (explosive) 6. Revolutions per minute (RPM) 7. Tempered 8. Other	

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1& 2	Hand Tool Use A. Selection - Hammers - Claw - Ball peen - Screwdrivers - Slotted - Phillips - Sledgehammers - Double face - Cross peen - Ripping bars and nail pullers - Wrenches - Adjustable - Nonadjustable - Pliers and wire cutters - Slip-joint - Long-nose - Lineman - Levels - Squares - Framing - Combination - Rulers and measuring tapes - Vises and clamps - Bench vise - C-clamp - Saws - Crosscut - Rip - Files, chisels and punches - Plumb bob - Sockets and ratchets B. Safe use C. Maintenance	
3, 4	Power Tool Use A. Selection - Drills - Electric - Cordless - Hammer - Electro-magnetic - Pneumatic - Saws - Circular - Saber	

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	c. Reciprocating d. Band e. Jig 3. Grinders and sanders a. Angle b. End c. Bench 4. Miscellaneous a. Jackhammer b. Porta-power c. Powder actuated B. Safe use C. Maintenance	
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Credits:

- ✓ Material developed by: Randy Dutton, Estrella Community College
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Module 10: Residential Electrical Wiring & Codes

Description:

Analyze and interpret residential drawings, local codes and specific sections of the National Electrical Code. Includes needed materials derived from plans and specifications and the proper procedures for wiring a residence.

Certification(s): Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Identify and interpret blueprint symbols.
2. Specify and describe plan specifications.
3. Interpret plans of a specific residence.
4. Interpret the current edition of the National Electrical Code (NEC) as it applies to residential wiring utilizing appropriate articles.
5. Calculate total general lighting loads.
6. Determine the minimum number of small appliance circuits.
7. Determine conductor sizes, types and wiring methods.
8. Determine switching requirements.
9. Determine locations for Ground Fault Circuit Interrupter (GFCI) protection.
10. Determine branch circuit requirements.
11. Determine branch circuit requirements for appliances.
12. Determine need for special purpose outlets.
13. Determine circuit requirements for oil and gas heating systems.
14. Determine wiring requirements for communications.
15. Calculate and determine service requirements.
16. Determine minimum requirements for swimming pools.
17. Define smart house wiring and explain the basic components of the concepts.

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Module 10: Residential Wiring and Codes

Expected Outcome	Topic	Suggested Activities
1	Blueprint symbols A. Materials B. Components C. Other	
2	Plan specifications A. Description B. Sets	
3	Blueprint reading - residential A. Symbols B. Specifications C. Materials	
4	National Electric Code (NEC) A. Terms B. Wiring practices - residential C. Local codes	
5	Calculating circuits A. Branch B. Feeder	
6	Small appliance circuits A. Location B. Division of load C. Allowable appliances	
7	Conductors A. Types B. Sizing C. Connections D. Voltage drop	
8	Switching requirements A. Color coding B. Switch types and rating C. Proper connections D. Bonding	
9	Ground Fault Circuit Interrupters (GFCIs) A. Transient Voltage Suppression System (TVSS) B. Isolated Ground Receptors (ISO)/ground receptors C. Immersion Detector Circuit Interrupter (IDCI)	

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10	Branch circuit requirements A. Bedrooms B. Bathrooms C. Hallways D. Front entry, porch E. Living rooms F. Garages G. Other	
11	Appliance branch circuits A. Dryer B. Ranges, cooking units, ovens C. Water heater D. Water pump E. Air conditioning/electric heating F. Other	
12	Special purpose outlets A. Food disposer B. Dishwasher C. Trash compactor D. Bathroom ceiling- heat/vent/lights E. Attic fan F. Hydro massage tub G. Other	
13	Heating systems - oil/ gas A. Components B. Schematic wiring diagrams C. Control circuit wiring	
14	Communications A. Television B. Telephone C. Low voltage signal/remote control systems D. Heat and smoke detectors E. Security systems F. Other	

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15	Services A. Definitions B. Minimum code requirements C. Grounding D. Proper fusing E. Available interrupter current F. Calculations	
16	Other electrical requirements A. Swimming pools B. Spas C. Hot tubs D. Other	
17	Smart house wiring A. Definition B. Basics C. Code requirements D. Terminology E. Symbols	

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Module 11: Hand Bending Conduit

Description:

Introduction to the methods and procedures used

methods for conduit, conduit installation, calculating conduit bends, using the hand bender, and finishing conduit.

Certification(s): Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: .25

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Identify the methods of hand bending conduit.
2. Identify the various methods used to install conduit.
3. Use math formulas to determine conduit bends.
4. Make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
5. Cut, ream, and thread conduit.

Module 11: Hand Bending Conduit

Expected Outcome	Topic	Suggested Activities
1	Art of Hand Bending A. Hand bending equipment B. Hand bending use	
3	Geometry required to make a bend A. Making Bends B. Making a 90 degree bend C. Gain D. Back-to-back 90 degree bends	
4	Making an offset A. Parallel offsets B. Saddle bends C. Four-bend saddles	
5	Cutting, reaming, and threading conduit, A. Hacksaw method of cutting conduit B. Pipe cutter method C. Reaming conduit D. Threading conduit	
2	Cutting and Joining Polyvinyl Chloride (PVC) conduit A. Fine-tooth hand saw B. PVC cutter C. Installation	

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Module 12: Fasteners and Anchors

Description:

Introduction to fasteners and anchors. Includes applications and procedures for their installation. Includes threaded fasteners, non-threaded fasteners, anchors, fastener and anchor applications, and fastener and anchor installation.

Certification(s):

Solar Photovoltaic Installer

Prerequisite: None

Required Materials: None

Credit Hours: .25

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Identify and explain the use of threaded fasteners.
2. Identify and explain the use of non-threaded fasteners.
3. Identify and explain the use of anchors.
4. Demonstrate the correct applications for fasteners and anchors.
5. Install fasteners and anchors.

Module 12: Fasteners and Anchors

Expected Outcome	Topic	Suggested Activities
1	Thread Standards A. Thread series B. Thread classes C. Thread identification D. Grade markings	
2	Installing Fasteners A. Non-threaded fasteners 1. Retainer fasteners 2. Keys 3. Pin fasteners 4. Dowel pins 5. Taper and spring pins 6. Cotter pins 7. Blind and pop rivets 8. Tile wraps B. Special threaded fasteners 1. Eye bolts 2. Anchor bolts 3. J-bolts 4. Applications and Installation	

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3	Using Screws A. Wood screws B. Lag screws and shields C. Concrete and masonry screws D. Thread-forming and thread-cutting screws E. Deck screws F. Drywall screws G. Drive screws	
4	Using Pins, Studs, and Tools A. Hammer-driven pins and studs B. Powder-actuated tools and fasteners	
5	Classifying and Using Anchors A. One-step anchors 1. Wedge anchors 2. Stud bolt anchors 3. Sleeve anchors 4. One-piece anchors 5. Hammer-set anchors B. Bolt anchors 1. Drop-in anchors 2. Single-and double-expansion anchors 3. Lead (caulk-in) anchors C. Screw anchors D. Self-drilling anchors E. Guidelines for drilling anchor holes in hardened concrete or masonry F. Hollow-wall anchors G. Toggle bolts H. Sleeve-type wall anchors I. Wallboard anchors J. Metal drive-in anchors K. Epoxy anchoring systems.	

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Module 13: Photovoltaic Installation I

Description:

power plants and related systems. Understand the impact of environmental influences. Develop an

and reliably operate for decades with little maintenance. Appreciate the dangers and requirements of high voltage photovoltaic arrays, and understand the proper procedures and standards in order to safely install a residential power plant according to local and specific sections of the National Electric Code. Understand permitting and inspection procedures and economic analysis of photovoltaic systems. Field trip is required to get full appreciation for various systems & craftsmanship.

Certification(s): Solar Photovoltaic Installer

Prerequisite: Basic Roofing, Basic Safety for the Building Trades, Basic Electronic Theory, Residential Wiring and Codes, Windows Operating System Level I

Required Materials: None

Credit Hours: 6

Expected Outcomes:

Upon successful completion of this course a student would be able to:

1. Demonstrate knowledge and application of key photovoltaic system terms and concepts.
2. Describe the nature of solar radiation energy and the impact of location and climate.
3. Determine and document proper power plant location for optimal energy harvest.
4. Describe purpose and operation of photovoltaic system components.
5. Describe purpose, trade-offs, and operation of photovoltaic modules, cells and arrays.
6. Demonstrate knowledge of battery principles, types, and systems.
7. Describe charge controller features, type, basic configuration needs, and system limitations.
8. Describe inverter features, types, and basic system limitations.
9. Determine a grid interactive system configuration.
10. Determine an off-grid system configuration.
11. Demonstrate knowledge of system mechanical integration.

Solar Photovoltaic Installer

12. Demonstrate knowledge of system electrical integration, following NEC rules.
13. Demonstrate knowledge of permitting and inspection procedures.
14. Describe system commissioning, maintenance, and troubleshooting approach.
15. Describe specific safety issues unique to solar photo voltaic systems.
16. Demonstrate basic knowledge of PV power plant economics.
17. Describe design considerations for extreme climates (desert).

Module 13: Photovoltaic Installation

Expected Outcome	Topic	Suggested Activities
1	Photovoltaic systems A. Photovoltaics (PV) B. PV applications C. PV industry D. Solar energy technologies	
2	Relationship between the solar radiation and the array A. Nature of the sun B. Solar radiation C. Earth-sun relationships D. Array orientation E. Solar radiation data sets F. Estimating array performance	
3	Power plant location planning and survey A. Preliminary assessment B. Site surveys C. Preparing proposals D. Installation planning	
4	System components and configurations A. Components B. Electrical energy sources C. PV system configurations	
5	Cells, modules, and arrays A. PV cells B. Current-voltage curves C. Device response D. Modules and arrays	
6	Batteries A. Principles B. Types and tradeoffs C. Systems	
7	Charge controllers A. Features B. Types	

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	C. Setpoints D. Applications	
8	Inverters A. AC power review B. Types C. Features D. Basic internal architectures E. Applications	
9	Grid interactive system configuration A. Methodologies B. System sizing	
10	Off-grid system sizing A. Methodologies B. Load analysis C. Critical design analysis D. Battery bank sizing E. Array sizing	
11	System mechanical integration A. Considerations 1. Support 2. Thermal 3. Aesthetics B. Mounting systems 1. Building mounted 2. Building integrated 3. Ground mounted 4. Sun-tracking systems C. Integration 1. Loads 2. Environmental and location criteria 3. Attachment methods 4. Structural analysis	
12	Electrical Integration & NEC A. Overview of NEC B. Article 690 C. Effect of the environment D. Array conductor sizing E. Insulation types F. Array connectors and terminals G. Array combiners and protection H. Cable and wire management I. Over-current protection J. Utility interconnection K. Disconnects L. Energy metering M. Basic grounding N. Ground faults O. Surge suppression P. Color coding	

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13	Permitting and inspection A. Listing agencies B. NEMA ratings C. PV permit overview D. Site drawings E. Electrical diagrams F. System specifications G. Utility checklist H. Safety placard requirements I. Licensing requirements (AZ)	
14, 15	Commissioning, maintenance, and troubleshooting A. Formal commissioning B. Critical measurements C. Start-up procedure D. Performance measurements E. Performance calculations F. Inspection of systems	
16	Maintenance A. Environmental parameters B. Troubleshooting approach	
4	Economic analysis A. Incentives B. Cost analysis C. Financial payback D. Online tools	
5	Studies of grid-tied PV installations A. 8KW dual inverter grid tied B. 15KW micro inverter C. Seasoned 5KW dual inverter D. 7.4KW single inverter E. Dangerous 4KW single inverter F. Commercial 1MW G. Older 80KW utility tracking system H. Tips and tricks of the trade	

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