



The Solar Energy Institute course will teach you the basic principles of solar power, as you acquire skills by performing hands-on activities. No prior knowledge of alternative energy trades is required as the Solar Energy Institute curriculum will introduce you to professional tools, materials and provide a step-by-step instruction to be used in a skill practice.

- Before working on the skill set activity you will learn;
- The history of the solar power industry
- The career opportunities that exists in the alternative energy industry
- The components of a solar power system
- The difference between a grid tie and stand alone solar power system
- The principles of using photovoltaic panels to generate solar power
- Basic residential wiring skills and electrical safety

After you have learned about solar power systems and basic residential wiring, you will work with industry grade materials to install a set of solar panels on a roof. You will use a screwdriver, measuring tape, Multimeter, wire stripper, and wrenches to name a few of the tools you will use in this course. You will work with solar panel mounting systems, electrical wire, power inverters and battery back-up systems to tie into a residential electrical service panel.

WORKSTATION OVERVIEW

- You will complete the following tasks;
- Mount a solar panel anchor system, to an asphalt shingle, tile and metal roofs
- Attach a solar panel rail system to roof anchors
- Mount a solar panel to a roof rail system
- Wire a solar panel to a solar controller
- Wire power inverter to an electrical service panel
- Test circuits for voltage
- Calculate the voltage of all devices in a circuit
- Disassemble solar panels



SOLAR PANEL INSTALLER SKILLS OBJECTIVE

Chapter 1

- Define solar energy
- Define solar power
- Define renewable and non-renewable energy
- List non-renewable energy sources
- List renewable energy sources
- Explain the advantages and disadvantages of solar power
- List the skills required of a solar installer

Chapter 2

- Draw and label a diagram of an atom
- Define the terms current, voltage, power, and resistance
- Describe the water analogy associated with current, voltage, power, and resistance
- Define the terms conductor and insulator
- Define what a circuit is
- Describe how current flows in a circuit
- Define the term ground and state the purpose of a ground wire

Chapter 3

- Define passive solar power and list examples
- Define active solar power and list examples
- Differentiate between solar thermal power plants and solar thermal heat systems
- Define photovoltaic cell
- Identify the characteristics of single-crystal, multi-crystal, and amorphous silicon

Chapter 4

- Define reference voltage
- Define charge controller and state its function in a solar electric system
- Differentiate between solar thermal power plants and solar thermal heat systems
- Define inverter and state its function in a solar electric system
- List the three common types of solar electric system
- Identify the components in the three types of solar electric



Chapter 5

- Define roof-flush mount and describe its characteristics
- Define roof/ ground- tilt mount and describe its characteristics
- Define pole mount and describe its characteristics
- State the difference between fixed, adjustable, and tracking solar panel mounts
- Define tape measure
- Identify different parts of a tape measure
- Define chalk line
- Identify the different parts of a chalk line
- Use a tape measure to accurately measure a rafter location
- Use a chalk line to mark the center on a roof rafter

Chapter 6

- Define ratchet and socket
- Identify the different parts of a ratchet
- Be able to distinguish clockwise rotation from counter- clockwise
- Define standoff
- Install standoffs onto anchor bases
- Install roof flashing
- Use a ratchet to tighten bolts fastening L-foot brackets to standoffs

Chapter 7

- Define Multimeter
- Identify the different parts of a Multimeter
- List the steps for testing continuity, voltage, current, and resistance with a Multimeter
- Safely use a Multimeter to test a solar panel's open voltage
- Center and install a solar panel onto a rail system using panel clamps

Chapter 8

- Explain the function of a strain relief connector
- Define fish tape
- Identify the different parts of a fish tape
- Use a fish tape and electrical tape to run wires through conduit



Chapter 10

- Describe the function of hot, neutral, and ground wires
- Explain the importance of wire size
- Calculate the length of wire needed from one electrical box to another
- Define wire stripper
- Identify the different parts of a wire stripper
- Safely use a wire stripper to strip 14 gauge wire

Chapter 11

- Define service panel
- Identify the different parts of a service panel
- Define entrance cable
- Define bus bar, and state the functions of hot, neutral, and ground bus bars
- Define circuit breaker
- Safely connect a ground wire to a ground bus bar and a neutral wire to a neutral bus bar
- Safely connect a hot wire to a circuit breaker

Chapter 12

- Define solar array
- List the considerations when designing a solar power system
- Define angle of inclination
- List the steps for determining the number of solar panels wired in parallel required for given power consumption.
- List the steps for determining the number of solar panels wired in series required for given power consumption

Chapter 13

- List safety tips specific to solar panel installers
- Safely use screwdrivers to remove electrical box covers and loosen terminals screws on electrical components
- Disconnect a circuit breaker
- Pull out wire runs
- Safely use side cutters to trim wire ends
- Use ratchet and adjustable wrench to disconnect and remove a solar panel and rail mount system





Chapter 1

Overview of Solar Power

Solar Panel Installer Skills Objective

- 1) Define solar energy
- 2) Define solar power
- 3) Define renewable and non-renewable energy
- 4) List non-renewable energy sources
- 5) List renewable energy sources
- 6) Explain the advantages and disadvantages of solar power
- 7) List the skills required of a solar installer

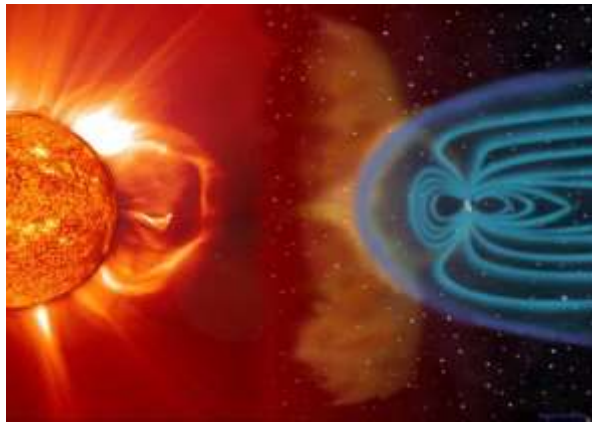
Chapter 1 Activities

- 1) Complete the Solar Installer Pre-Test. Give instructor your finished test.
- 2) Read the section Solar Power, Solar Power History, Advantages to Solar Power, Disadvantages to Solar Power and Solar Installers
- 3) Complete the chapter 1 workbook questions.



Solar Power

What is solar power? Solar power is when you harness the radiation of the sun. This process is based on how plants also process the sun radiation called "Photosynthesis". Earth also uses the solar energy that is not deflected by our magnetic field to evaporate moisture from the surface this produces clouds and other greenhouse gas, which provides our plant with atmosphere. The sun's energy is the key ingredient for life on our planet, in example. Plants use the sun's light to grow animals eat the plants. Also a fun fact that decaying plants hundreds of millions of years ago produced the coal, oil and natural gas that we use today. In a way, solar energy provided us with fossil fuel.



THE SUN'S RADIATION INTERACTING WITH EARTH MAGNETIC FIELD

There are two major ways to convert the energy from the sun into usable energy, such as thermal heating and electric generation. Solar energy that has been converted to useful work is called solar power. Thermal solar is primarily used to heat bodies of water, the most common examples is the heating of the hot water in your home, swimming pools and to heat spaces like greenhouses. Electric generation can be used to power anything that has traditionally runs on electricity, as well as new technology like electric vehicles.





Solar Power History

Most people think that the use of solar power is new, but it actually has a long history. Ancient people learned to start fires using the sun, and to keep their homes warm by designing walls and floors that collected heat during the day that was released at night.

In the 1800's, it was discovered that certain materials were photovoltaic, or having the capability to produce electricity when exposed to sunlight. Photovoltaic cells also known as solar cells and are devices that convert solar energy into electric energy. In the 1960's they used solar cells on satellites to provide power as they orbited the earth was the first long-term practical use for solar power.



SATELLITE HARNESSING THE POWER OF THE SUN

As a society we use solar in more ways than most people realize. From buildings, vehicles and aircrafts to calculators, traffic signals and cell phones. As we progress more and more, uses for solar power are being developed.



SUN TRACKING SOLAR PANELS

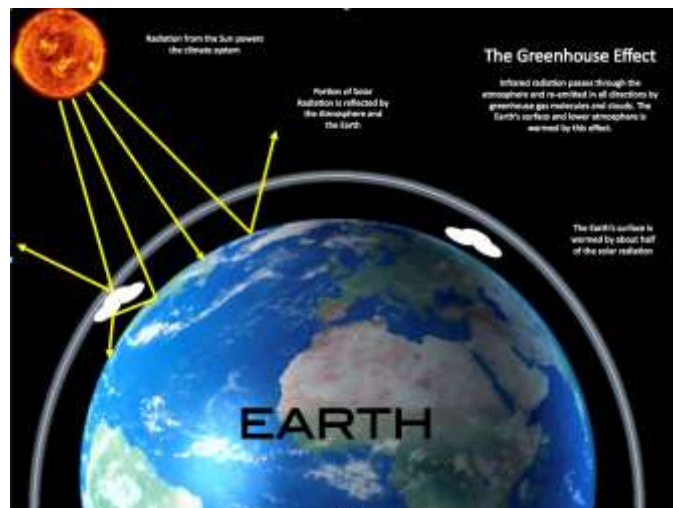


Advantages to Solar Power

There are two general categorizes of energy resources, renewable and non-renewable. The major differences between the two are that renewable energy can be replenished in a short time compared to non-renewable energy will eventually be exhausted.

Some examples of non-renewable are Uranium, coal, oil and natural gas. As of 2011 fossil fuels provide 80% of the energy used in the world and is expected to drop to 78% by 2040, and most experts say that it will continue to drop, as renewable energy becomes a bigger part of our lives. In the United States the use of fossil fuels provide about two thirds of our electrical needs, but with that we are pumping billions of tons of pollutants into our atmosphere, water and soil. Carbon Dioxide and other greenhouse gases are being put into our atmosphere,

which will trap the sun's heat causing the temperature of the planet to rise, also know as global warming. There are a few side effects from pollution in our air, Asthma, Acid rain and Smog to name a few. Acid rain is when the emissions of carbon dioxide and nitrogen oxides react with water molecules in the atmosphere. This Acid rain will leach aluminum from the soil that is harmful to plants



THE GREENHOUSE EFFECT

Solar Energy, Hydroelectricity, Biomass Energy, Geothermal Energy, Tidal Energy and Wind Energy are the main producers of renewable energy and these sources can never be depleted. The classification of Alternative Energy Sources was given to these forms of energy production in the 1970's, as they are the Alternative to fossil fuels.

Most governments are mandating the use of Alternative energy sources since the demand for fossil fuels is increasing and fossil fuels cannot be replenished in a timely manor. The United States is producing solar since it does not produce and water or air pollution and reduces the dependence for foreign oil, coal and natural gas. Most people also like the fact that the United States is strengthening our nation security by not depending on regions, which can be considered politically volatile areas.



Disadvantages to Solar Power

When it comes to solar power there are a few disadvantages because sunlight is not a constant. Some of the factors are location, time of day, and time of year and weather conditions. Since sunlight does not deliver large amounts of energy to a small surface area at one time you need a large surface area to collect the energy that can be considered useful. 100 square feet of solar panels will generally produce one kilowatt of power per day. Some people will want to produce what is called a solar farm, this is a system that takes up acreage and is mounted on the ground. Now this type of system can harm desert ecosystems by not allowing plants to receive the normal amount of light, causing them to not grow to normal size or not at all. Since an ecosystem depends on all factors, this shift is known as the “Dark side to solar farms” and may damage the local ecosystem.



SOLAR FARM IN CALIFORNIA DESERT

Although solar is a renewable source of energy the process can produce some waste products and some pollution, but when you compare this to the waste and pollution produced by the burning of fossil fuels to generate electricity most businesses and customer would rather use the solar power. With researchers working hard to reduce the cost of producing solar cells the cost analysis will be undeniable and companies that could not use solar in the past, will then be able to afford to reduce their dependence on fossil fuel electricity.



What is a Solar Installer? In our industry anyone that can install any type of solar panels from Pool Solar Hot Water to Photovoltaic panels is considered a Solar Installer. The most successful installer has experience in a wide range of construction skills for example electrical, Plumbing, Roofing, and General construction. This does not mean that if you do not have any training in those skills you can not be a solar installer, there are just skills you learn in those trades that make learning solar easier.

As a solar installer you will learn the following

- Reading blueprints or plans
- Cutting, bending, running, and fastening Electrical conduit
- Welding or Soldering copper pipes
- Cutting, Running, Gluing PVC pipe
- Reading electrical meters
- Connection system to building existing electrical circuit
- How to use the proper power tool for the job.

As a Solar Installer you are expected to have good communication, Math, and reading skills. Solar installers have an easier time if they are physically fit, can work in cramped positions, have no fear of heights, and had any high school classes in blue print reading or electronics.

There are some hazards in the solar field like electrical shock, Heat exhaustion, Sprained muscles from lifting heavy equipment incorrectly, but following safe installation practices can minimize all of these.

The hours for a solar install are 40+ hours per week and may work into the early evening and even some weekends. Most solar companies give vacation during the summer and give some holidays, but that depends on the individual company.

When looking for employment in the solar industry most solar contractors are looking for installer who have completed a technical training school and received their license and/ or certification from an recognized solar energy regulatory organization for example the North American Board of Certified Energy Practitioners also known as NABCEP.

NABCEP certifies that a Solar Installer possess the skills needed and the knowledge necessary to configure and install these systems, inspect and maintain them in a way that meets the local building code and customer's satisfaction, also the knowledge of installation of the system in a safe and timely manner.



The use of renewable energy like solar power is expected to continue to grow and is considered one of the fastest growing jobs by 2023. The Bureau of Labor Statistics release on Tuesday, October 24 of 2013 that the job of Solar Photovoltaic Installer is the number one out of the top ten fastest growing occupations, projected 2020-2030.



PROFESSIONAL SOLAR INSTALLER SAFELY PUTTING PANELS ON ROOF

The pay of a Solar Installer may vary depending on experience and location. Most entry-level workers earn between \$15 and \$21 per hour compared to experienced and certified installers may earn between \$21 and \$45 per hour. If you have been working for the same company for more than 3 years you may be able to make even more than that with benefits, company vehicles and full-time salary pay.



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Solar Power – Chapter 1 Workbook Questions

1) Define solar energy.

2) Define solar power.

3) Define renewable energy.

4) List six renewable energy sources.

1. _____	2. _____
3. _____	4. _____
5. _____	6. _____

5) List four non-renewable energy sources

1. _____	2. _____
3. _____	4. _____

6) List two adverse effects of pollutants from burning fossil fuels

1. _____	2. _____
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7) Give example of how fossil fuels are being consumed _____

8) List four skills necessary for a photovoltaic system installer to possess to earn a NABCEP certification.

1. _____	2. _____
3. _____	4. _____

True or False

9) Using solar power produces no air or water pollution? _____

10) Manufacturing photovoltaic cells produces no air or water? _____



Optional STEM Activity

Use the following questions and activities to strengthen your core skills in the areas of science, technology, engineering, and mathematics.

STEM ENHANCEMENT

- S-** List and define eight different forms of energy.
- T-** What techniques/ technology did Charles Fritts use to build the first solar cell in 1852?
- E-** How is the Law of Conservation of Energy related to solar power?
- M-** Calculate the solar panel area required to generate 0.5 kilowatts of power per hour.

