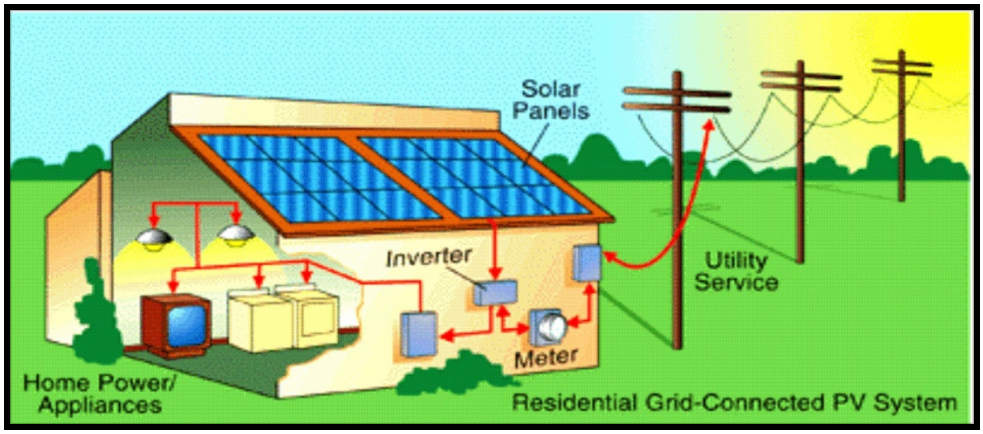
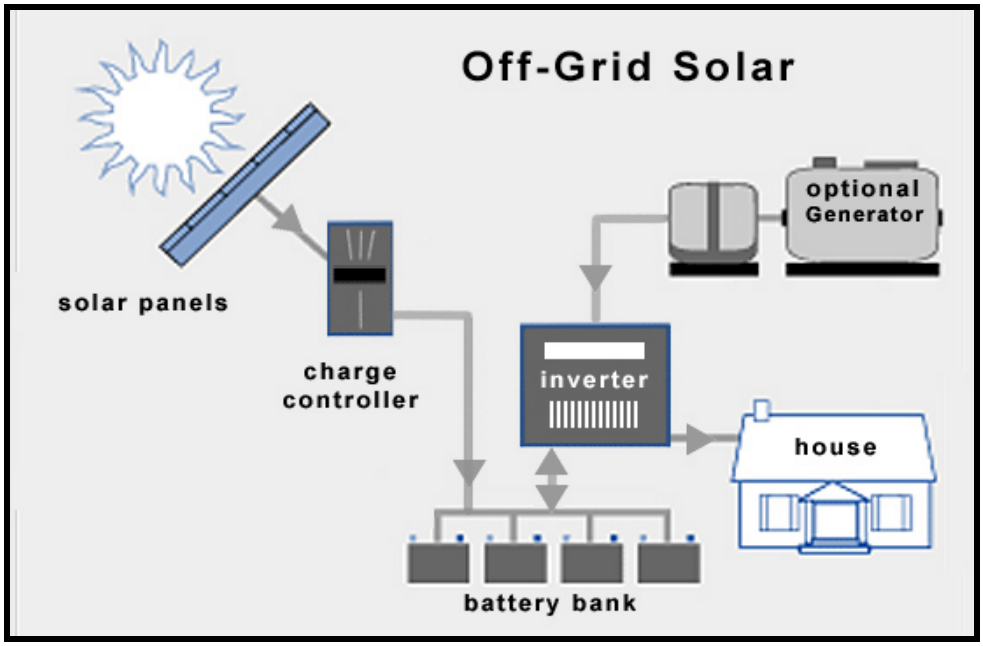
Solar Electric Power
Frequently Asked Questions & Answers

Introduction

Solar electric power is one of the most attractive solar technologies of our time. If you are interested in powering your home or just offsetting some of your fossil fuel power consumption, consider installing a solar electric power system.

The following information helps answer the most frequently asked questions concerning solar electric power systems. Keep in mind that much of this information is "rule of thumb"; your individual situation, if analyzed in detail, may differ somewhat from the general application.





Q: What is photovoltaics (solar electricity), or "PV"?

What do we mean by photovoltaics? The word itself helps to explain how photovoltaic (PV) or solar electric technologies work. First used in about 1890, the word has two parts: photo, a stem derived from the Greek phos, which means light, and volt, a measurement unit.

So, photovoltaics could literally be translated as light-electricity. And that's just what photovoltaic materials and devices do; they convert light energy to electricity.

Q: How does photovoltaic (PV) technology work?

PV takes advantage of the impurity characteristics of silicon crystals. Silicon impurities create crystal with a slight tendency to lose electrons, and other impurities create crystal with a slight tendency to attract electrons. When the two kinds of silicon are placed close together and exposed to sunlight, photons (particles of light) knock electrons loose on the unattractive side. An electrical current is created as electrons travel across the junction to the attractive side.

Sunlight is composed of particles of energy called photons. When sunlight strikes a PV material, photons will either pass through, be reflected, or be absorbed. If the photon is absorbed, its energy will be transferred to an electron in an atom of the PV material. With new energy, the electron is able to escape from its normal position in orbit around that atom. In this way, the electron can become part of, and augment, the current in an electrical circuit.

Q: What is a solar module?

Solar modules, or panels, are series of solar cells wired together into strings and enclosed in self-contained glass units for harsh weather protection. Solar cells are mounted into groups called modules that produce about 0.5 Volts of current to power lights and appliances. On the sunward side, cells are protected by a highly transparent solar glass pane. The underside takes the form of an insulating film or a second pane of glass. A connection socket picks up the generated direct current. Modules are connected together via cables, which link them to the inverter.

Q: Do solar cells store energy?

No. Solar cells just convert sunlight into an electric current that must be used immediately or stored in batteries to be used later.

Q; What is a PV array?

A PV array is an interconnected system of PV modules that function as a single electricity-producing unit. The modules are assembled as a discrete structure, with common support or mounting. In smaller systems, an array can consist of a single module. A complete set of components for converting sunlight into electricity includes a module, a support structure, wiring, an inverter, a meter and other equipment.

Q: What are the components of a photovoltaic (PV) system?

A PV system is made up of different components. These include PV modules (groups of PV cells), which are commonly called PV panels, batteries and a charge regulator or controller for a stand-alone system, an inverter for a utility-grid-connected system and when alternating current (ac) rather than direct current (dc) is required; wiring; and mounting hardware or a framework. Systems that are connected directly to your home (98% of all systems installed do not require batteries).

Q: What's the difference between PV and other solar energy technologies?

There are two main types of solar energy technologies:

1. **Photovoltaic (PV) systems**, which convert sunlight directly to electricity by means of PV cells made of semiconductor materials.
2. **Solar water heating systems**, which contain a solar collector that faces the sun and either heats water directly or heats a "working fluid" that, in turn, is used to heat water.

Q: Can I use photovoltaics (PV) to power my home or business?

PV can be used to power your entire home or business electrical systems, including lights, cooling systems, and appliances. PV systems today can be blended easily into both traditional and nontraditional homes. The most common practice is to mount modules onto a south-facing roof or wall. For an additional aesthetic appeal, some modules resemble traditional roof shingles or can be built right into glass skylights and walls. This building-integrated PV provides a dual-use building material, reduces PV system costs by using the building as the mounting or support structure, and reduces utility bills with on-site power production.

Q: My Electric Bill Is Too High, Will Solar Lower It?

This is a difficult question to answer. Due to the rising electrical rates the answer is not the same for everyone.

Yes. A solar system on your home will lower your electric bill. Unfortunately the initial layout of funds to purchase the system can be high. If you look at the cost per kilowatt hour for a solar system over its life it can be as low as $0.11 per kilowatt hour. If your goal is to save money over the life of the system and you are paying the power company more then $0.11 per kilowatt hour a solar system makes sense.

If you are paying less then $0.11 per kilowatt hour solar may not be for you from a cost savings stand point. A kilowatt hour of Solar will cost more than a kilowatt hour of utility electricity.

Q: Why should I purchase a PV system?

People decide to buy solar energy systems for a variety of reasons. For example, some individuals buy solar products to preserve the Earth's finite fossil-fuel resources and to reduce air pollution. Others would rather spend their money on an energy-producing improvement to their property than send their money to

a utility. Some people like the security of reducing the amount of electricity they buy from their utility, because it makes them less vulnerable to future increases in the price of electricity.

If it's designed correctly, a solar system might be able to provide power during a utility power outage, thereby adding power reliability to your home. Finally, some individuals live in areas where the cost of extending power lines to their home is more expensive than buying a solar energy system.

Q: What is net metering? Can I Sell Power Back To The Utility Grid?

Net metering is a policy that allows homeowners to receive the full retail value for the electricity that their solar energy system produces. The term net metering refers to the method of accounting for the photovoltaic (PV) system's electricity production. Net metering allows homeowners with PV systems to use any excess electricity they produce to offset their electric bill. As the homeowner's PV system produces electricity, the kilowatts are first used for any electric appliances in the home. If the PV system produces more electricity than the homeowner needs, the extra kilowatts are fed into the utility grid.

The real question is can I sell power back to the utility company. Most states have net metering bills that basically say the utility company will have to buy the power back from you at the same rate you buy power from them. The states that don't have net metering bills typically only pay the wholesale cost of the power about 1-3 cents. Until uniform codes have been adopted by all utilities it is best that you first check with your utility. Each utility has different interconnection standards that have to be meet before they will allow you to sell power back to the utility grid.

Q: How Much Solar Do I Need For My 2500 Square Foot Home?

The amount of solar you need to power your home is not dependent on the size of your home. The amount of solar depends on the amount of power you use in your home.

Look at your monthly bill from the utility company. It will list the total amount of power (kWh) you used in the last billing cycle. Divide this by the number of days in your last billing cycle. This will tell you how much power you use each day (kWh).

Q: What is an average break-even point for a solar energy system?

It depends. The break-even point for a system depends on financing and incentives, which vary from place to place, and it depends on your solar resources and what you would pay for another source of energy. A system designer that has information about your location, the amount of energy you typically use, how much land or roof area you have for the system, etc., could give you a more accurate answer.

Typically the payback period for a solar system is roughly 17 years, based on calculations assuming the cost of energy obtained from the utility grid is 15 cents a kilowatt-hour.

Q: How long do photovoltaic (PV) systems last?

A PV system that is designed, installed, and maintained well will operate for more than 40 years. The best way to ensure and extend the life and effectiveness of your PV system is by having it installed and maintained properly.

Q: How much electricity does a photovoltaic (PV) system generate?

A 10% efficient PV system in most areas of the United States will generate about 180 kilowatt-hours per square meter. A PV system rated at 1 kilowatt will produce about 1800 kilowatt-hours a year.

Q: Can I design and install a photovoltaic (PV) system myself?

Maybe! However, unless you are very handy or experienced in home wiring, we suggest using experienced professionals to design and install anything more than the simplest application.

The goal of a stand-alone system designer is to assure customer satisfaction by providing a well-designed, durable system with a 40-year life expectancy (or more). This depends on sound design, specification and procurement of quality components, good engineering and installation practices, and a consistent preventive maintenance program.

Q: How do I know if I have enough sunlight for PV?

A photovoltaic (PV) system needs unobstructed access to the sun's rays for most or all of the day. Climate is not really a concern, because PV systems are relatively unaffected by severe weather. In fact, some PV modules actually work better in colder weather. There is thus enough sunlight to make solar energy systems useful and effective nearly everywhere in the United States.

Q: How well do solar panels work in cloudy conditions?

A cloudy day provides sufficient diffuse light by which the panel will produce electricity. Optimum electrical production occurs with bright and sunny weather conditions. Under a light overcast, the modules might produce about half as much as under full sun, ranging down to as little as five to ten percent under a dark overcast day.

In remote, off-grid applications, a PV system is connected to a battery storage system as a backup power source. In grid-connected applications, the PV system works in parallel with the utility power grid. So, if electrical needs exceed the solar power output, the local utility makes up for the shortfall. Conversely, when the PV system generates more energy than the building requires, the excess power is exported to the utility grid, reversing the electrical meter!

Q: Can I use equipment directly from solar panels?

Yes, solar panels directly power equipment such as fans and pumps, as long as the load is accounted for correctly. Equipment load that is greater than the output of the solar panel will weaken equipment efficiency, as overcast or cloudy days reduce output. Equipment that requires a more stable voltage should pair solar power with a battery backup.

Q: What are the possible problems with solar panels and how can I prevent them?

Solar panel failure is most often caused by water damage to the panel, sealant, or connections. To prevent damage or failure, mount the panel carefully. Be sure not to fix it horizontally, which

encourages water collection in the frame. Also, allow for a sufficient air gap beneath the panel. Keeping your panel dry and clean will ensure efficient, maximum output.

Q: Are solar electric systems safe?

Yes. Solar cells are mostly silicon, the primary component of sand. There is no exhaust and no toxic materials to leak out of the system. The electricity coming through the inverter is just like the electricity coming from household wall sockets; you should use the same care you would with utility power. All components are approved for utility interconnection and are installed according to standard construction practices.

Q: Are solar power systems good for the environment?

Energy created through our solar electric system produces no pollutants. Our smallest system typically cuts greenhouse gas emissions as effectively as 50 trees.

Q: Can I Start Small And Add On Later?

Yes. Solar is quite unlike a computer. If you start with a couple of good base components it is easy to add to your system later.

Q: How many solar panels and what size are enough to meet my needs?

Each energy consumer has different needs, dependent upon the electric appliances being run. For instance, if you are powering two 27 watt compact fluorescent light bulbs for two hours, you would need to supply 108 watt-hours of energy (2x 27x 2 hours). In Dallas, which has a yearly average insolation of 5 hours a day, one Unisolar 32 watt photo voltaic (PV) module is more than adequate (32x 5 hours=160 watt-hours).

Q: Why choose solar over wind- or water-power generation?

Every energy source has its advantages and disadvantages. Wind- and water-power generation may be appropriate in certain situations. However, these technologies are

- Limited by seasonal variations
- Have moving parts that require maintenance
- Generate noise
- May negatively affect wildlife

PV modules, on the other hand, are:

- Silent
- Have no moving parts

Q: Are prepackaged ready to go systems available?

PV systems are increasingly being designed for ease-of-use. Prepackaged turnkey (plug-and-play) solar systems are available, and can be custom-designed.

For Battery based or back-up systems only

Q: How do battery based solar electric systems work?

There are four major components to battery based solar electric systems; Solar Panels, Charge Controllers, Batteries and Inverters. All of these components are necessary to have a functioning Solar Electric (PV) system. The solar panel is the basic building block of the system. This is your battery charger. If you have several solar modules wired together you have created a solar array. The size of the solar array determines the amount of power or energy that will be produced. Your location is also a factor in the amount of energy produced. If you live in Florida, Southern California, or Texas you will produce more than if you live in Oregon, Maine or Maryland. In general the closer to the equator you live your system will produce a larger amount of energy.

Charge controllers come in many different sizes and types. They all basically do the same thing. The charge controller prevents the solar panel or array from overcharging your battery. Batteries are the energy storage for your system. Without batteries there is no way to store the energy your solar panels produce during the day. Typically loads receive their power from batteries instead of directly from the output of a solar panel.

Batteries will provide you with the energy you need at night. The last major component is the Inverter. The inverter converts the DC energy stored in your batteries and turns it into the AC power you use in your home. Inverters are rated by wattage and the quality of their output. You can use a 50 watt inverter that plugs into your car 12 volt outlet to power a computer, or you could have a 4000 to 11,000 watt inverter system that powers your home. These major components can be put together in many different ways. Minor components like wire, disconnects, circuit breakers, and fuses are also needed for a complete system. Now that you know what the major components are, let me introduce you to you how these different components are used in system.

Q: What if there is hardly any sunshine for several days?

Different geographic regions provide various amounts of daily sunshine. It is recommended that a system has enough battery power to account for five days of inclement weather. The American southwest averages 5 sunshine hours per day and the northeast receives about 3 hours of daily sunshine. More solar panels will increase the amount of power generated when the sun is shining.

Q: How long do batteries normally last?

In the case of batteries, basic routine maintenance and discharge rates of no more than 10 -20% means your batteries should function effectively for 10 years or more.

Q: What maintenance is required for a solar electric system?

Solar electric systems are elegantly simple. Maintenance includes:

- Checking your deep cycle batteries every few weeks to make sure they have enough distilled water

Occasional checks of the connections between the solar modules and the inverter(s), and to tighten them when applicable.

Q: What is the best way to monitor the charge status of a solar system?

Battery volt meters are the most common way to monitor the charge status of a solar system. However, battery voltage readings can be inflated depending on charge and discharge rates. For this reason, an amp-hour meter is the most accurate way to monitor the system charge status.

Q: What special considerations should be observed where the batteries are placed?

Ideally, storage batteries would be placed in cool, dry and vented locations (batteries release hydrogen gas). Sheds or garages are good places. The contents of batteries should not be subjected to boiling or freezing. Freezing will only occur when the batteries are in a state of discharge.