

# An Introduction to Solar Energy

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**Welcome to our solar series of e-books brought to you by [DIY-Energy.org](http://DIY-Energy.org).** In this free material you will learn more about how solar energy works, practical applications, where to get solar panels, and the multitude of viable and alternative technologies which can be used by harnessing the power of the Sun. Did you know that Nine quadrillion, that's (9,000,000,000,000,000) kilo watts of solar energy fall on the continental United States every hour? This is the equivalent energy available from 4.25 trillion barrels of oil per day. Utilizing just 0.001% of this renewable resource would satisfy all our energy requirements.

## **Statement of commitment**

***DIY-Energy.org** is fully committed to providing information on sustainable and alternative energy products helping to reduce our dependence on fossil fuels, thereby helping to reduce emissions of greenhouse gases and actively promoting ways to help reduce consumer energy costs.*

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## Solar Power Uses

Solar power is used in a number of different ways. There are two very basic kinds of solar energy: Solar thermal energy collects the sun's warmth through one of two means: in water or in an anti-freeze (glycol) mixture.

Solar photovoltaic energy converts the sun's radiation to usable electricity.

### Here are the most practical ways that solar energy is used:

1. Small independent solar photovoltaic systems. We see these used everywhere, from office calculators to pathway lights. Portable solar power can be used for everything from providing [power to your RV](#), remote cabin, or for powering remote switches and other electrical devices.
2. Solar pool heating. Running water in direct circulation systems through a solar collector is a very practical way to heat water for your pool or hot tub.
3. Solar thermal energy using glycol to heat water. In this method (indirect circulation), glycol is heated by the sun's rays and the heat is then transferred to water in a hot water tank. This method of collecting the sun's energy is more practical now than ever. In areas as far north as Edmonton, Alberta, using a solar thermal system to heat water is economically sound. It can pay for itself in a relatively short period of time.
4. Integrating solar photovoltaic energy system into your energy grid. In many parts of the world, solar photovoltaics are an economically feasible way to supplement the power of your home. In Japan, photovoltaics are competitive with other forms of power. In the US, new incentive programs make this form of solar energy ever more viable in many states. An increasingly popular and practical way of integrating solar energy into the power of your home or business is through the use of building integrated solar photovoltaics.
5. Large independent photovoltaic systems. If you have enough sun power at your site, you may be able to go off grid. You may also integrate or hybridize your solar energy system with [wind power](#) or other forms of renewable energy to stay 'off the grid.'

Several less commonly used applications which also harness the power of the sun include:

## **Photovoltaic Solar Panels**

Photovoltaic: (PV) solar technology turns light into electricity. It doesn't require direct sunlight, so it works even in cloudy areas. The "clean" energy produced does not contribute to climate change - it produces no pollution, and is completely silent. There are no moving parts, so it is reliable and low-maintenance. There are no running costs, so once your system is installed the electricity is free.

## **How does PV solar work?**

PV solar operates on the principle that electricity will flow between two semiconductors (typically crystalline silicon) when they are put in contact with each other and exposed to light. By linking a number of these 'cells' into a panel (also called a panel); a useful flow of electricity can be generated. Any number of panels may be used in a system, providing a very flexible approach to power generation.

## **Power from light**

Photovoltaic (PV) devices convert light into electrical energy. PV cells are made of semiconductor materials such as silicon. When light shines on a PV cell, the energy is transferred to electrons in the atoms of the PV cell. These electrons become part of the electrical flow, or current, in an electrical circuit. The first wave photovoltaic cells used thick silicon-wafer cells but were cumbersome and costly. The second generation of photovoltaic materials were developed about 10 years ago and use very thin silicon layers. These brought the price down dramatically but still need expensive vacuum processes in their construction. The third wave of PV, can print directly on to other materials and does not use silicon.

## **Is the power produced by PV solar free?**

Once you have bought and installed your equipment, then yes, it's free. The system should not require any maintenance and uses no consumables; there are no ongoing costs in general.

## **What can I use PV solar for?**

PV solar produces electricity, and as such can provide power to any device that uses electricity. The electricity generated when light hits a PV material is direct current (DC), which is the same as that produced by a battery. This means that PV solar systems can run battery-operated equipment or charge batteries. Some typical examples of solar powered devices using DC power are: fluorescent lights, boat or caravan battery charging, phone charging, PDA charging, portable fridge, pumps. Using an inverter, the DC current produced by PV can be converted into alternating current (AC) to power mains-operated devices, like a portable television, laptop or radio/CD player.

## **Can I use PV solar to provide the main power to my house?**

Yes, PV can provide all or most of the power you use in your house. Buying and installing the equipment to provide this amount of power is expensive (typically at least \$10,000 or more), but can be cost-effective where grid connection would be expensive. Nevertheless, the most popular type of solar PV system for homes and businesses in the US is grid connected. Your solar system is connected to the local electricity network allowing any excess solar electricity produced to be sold back to the utility company. Electricity is taken back from the network outside daylight hours. Alternatively, you can achieve complete independence from the grid by connecting your solar system directly to a battery bank that stores the electricity generated and acts as the main power supply when the solar panels are not producing electricity. This is ideal for remote buildings, where the cost of connecting to the grid is high.

## Are there cheaper ways to get solar power?

Yes, you can buy solar panels individually or in the form of [solar kits](#). You can also purchase “how to” DIY guides for building your own solar panels from components that you purchase.

One of the advantages of buying pre-assembled solar panels is that they will typically be of better quality, and usually UL rated whereas a solar panel that you build yourself will not be UL rated. The solar panel kits are the easiest solution for those who do not want to assemble the solar panels themselves, but would like to save some money over a commercially installed system. Typically you will buy a certain number of panels depending on the amount of power you need, and set the system up yourself. You will need some technical know how and if you live in a city you will want to check with the code enforcement office to determine if you can install this yourself.

If you are looking for an even cheaper solution you can build the solar panels yourself. Typically what you will need to do is pick up one of the DIY guides such as [Earth4Energy](#) or [GreenDIYEnergy](#). Both of these guides are fairly comprehensive, and offer plenty of videos and diagrams and are a good way to learn how solar panels work.

The downside is the labor involved in assembling the solar panels. Typically you will purchase solar cells in bulk at places like eBay for example, build the framework, solder everything together and weatherproof it. If you are planning to assemble a number of solar panels then this will be a time consuming project, but a fun project if you enjoy building things yourself.

Again, if you choose this route, you may want to check with your local code enforcement office to see if there are any restrictions on adding homemade solar panels to your residence.

## What about clouds and cold weather?

PV solar panels actually operate better at colder temperatures (some of the best efficiencies ever recorded were at the South Pole!). They also continue to work even in cloudy conditions, although they do produce less electricity. Under a light overcast, the panels might produce about half as much as under full sun level, ranging down to as little as 5-10% under a dark overcast day.

## How do I use PV power at night or in bad weather?

When combined with a battery system, PV solar can be a reliable source of power day and night, rain or shine. PV systems with battery storage are being used all over the world to power lights, sensors, recording equipment, switches, appliances, telephones, televisions, and even power tools.

## What do I need?

We have especially tried to 'make solar simple' and have provided links to some of the better and lower priced kits for specific applications. These kits have been designed so that they include everything that you will need complete with instructions. If the kit does not provide a battery, you will usually need to know the voltage and capacity in Ampere Hours (Ah) of the battery that the system will be connected to.

Naturally, if you have an application for which we do not yet have a kit, contact us and we will try to help. You can also see a range of individual [panels and accessories](#) for those of you who are technologically confident!

## **How difficult is it to install and use?**

This depends on what you buy! Some of the kits we feature take the guesswork out of what components are required in a system. Simple kits, such as RV kits require little or no installation as they can be easily connected to a battery via a simple cable setup. Other kits require very simple wiring. Once installed correctly, PV is very simple to use. Some customers use their panels for multiple applications.

## **How I can work out what size panel I need?**

The type of panel you choose will depend on two things: how much power your panel will produce and what you want to use the panel for.

## **How much power will a kit provide?**

The average daily output of each solar kit assumes 4 hours of good sunlight, and that your panel is ideally orientated to the sun.

Output will be considerably less during overcast conditions, particularly during winter.

Conversely, there may be times when the output is higher.

The power (watt hours) produced from your panel can be estimated by multiplying the power rating by the number of hours peak sunshine.

## **Will this be enough?**

The amount of power you need can be calculated by multiplying the power of your appliance by the length of time you expect to use it each day. For example, if you expect to use a 30 watt CD player for two hours a day you will require 60 watt hours of power. The power (watts) used by an appliance should be written somewhere on the appliance. If you cannot find it, look for Amps (A) and volts (V) and multiply them together to estimate watts ( $A \times V = W$ ).

## **How do I choose the right batteries?**

Battery size (Amp hours, or Ahrs) will depend on the amount of power you need each day (see the previous question 'Will this be enough?'), and the number of days you want to be autonomous for (that is, how many days you want the battery to supply power without being recharged by the PV panel). The daily power (watt hours) required, multiplied by the number of days autonomy, gives you the amount of available power that the battery needs to be able to supply. Thus if you require 60 watt hours every day, and 5 days autonomy, you need 300 watt hours available. However, as most batteries cannot be drained more than half empty, total battery storage needs to be at least twice the available power. In our example the battery would thus need to hold at least 600 watt hours. Battery size in Ahrs is then obtained by dividing the battery storage by the battery voltage (usually 12 or 24 volts). Thus,  $600/12$  gives 50Ahrs. In this case, the battery would need to be at least 50Ahrs.

## **What type of batteries should I use?**

It is possible to use any 12V flooded or sealed lead-acid battery with our panels, though it is better to use a "deep cycle" battery. Deep cycle batteries are designed to endure sustained discharge whereas some batteries, e.g. car battery, are designed for short bursts of energy only. We recommend a 75Ahr flooded lead acid battery.

## **Is PV solar environmentally friendly?**

Yes. PV solar is a renewable energy that does not rely on burning fossil fuels (technically, the sun will stop burning in 4.5 billion years but for all practical purposes, it provides an endless source of energy!). More energy reaches the earth from the sun in one day than would be consumed by the world's population in 27 years. Even better, PV solar generates no CO<sub>2</sub> so does not contribute to global climate change. While operating, it is silent and emits no pollutants or waste, and it requires no fuel.

## **Is PV solar a new technology?**

Although PV was first described in 1839 (by French physicist Edmond Becquerel, when he was just 19), its commercial development began only in the 1940s. By 1954 Bell Laboratories had produced a 4% efficient crystalline silicon cell. Since then, development of sophisticated semi-conductors has increased operating efficiencies to more than 14% (and even more in the laboratory) and brought down prices. In the 1950s and 1960s PV cells were used in space, for example, powering radio transmitters on satellites, and solar-powered satellites continue to be launched every year. Today, however, PV is used around the world for applications ranging from large-scale power generation to building power to battery charging.

## **Summary**

If you enjoyed reading this guide, then please feel free to share this with your friends and family.

## **Reference**

[Find Solar Contractors](#)

[Solar Power Products](#)

[DIY Energy Wind Kit](#)