How solar cells work?

The solar cell works in three steps:

1. Photons in sunlight hit the solar panel and are absorbed by semiconducting materials, such as silicon.
2. Electrons (negatively charged) are knocked loose from their atoms, allowing them to flow through the material to produce electricity. Due to the special composition of solar cells, the electrons are only allowed to move in a single direction.
3. An array of solar cells converts solar energy into a usable amount of direct current (DC) electricity.

Photo source: ecovized.com

How Solar Panels Work
There are two main types of solar panels 1) solar electric panels and 2) solar water heating panels. We'll discuss water heating later. Right now, let’s talk about solar photovoltaic (PV) panels, which provide electricity.

**How PV Panels Work**

PV systems convert sunlight directly into electricity. “Photo” refers to light and “voltaic” to electricity. A PV cell is made of a semiconductor material, usually crystalline silicon, which absorbs sunlight. You’ve seen PV cells at work in simple mechanisms like watches and calculators. You’ve probably even seen them for signs on the road. More complex PV systems produce solar electricity for houses and the utility grid. The utility grid is the power source available to your local electricity provider.

PV cells are typically combined into modules, or panels, containing about 40 cells. Roughly ten modules constitute a PV array, or grouping of panels.

**Details on How PV Panels Work**

Most PV panels contain a top protective layer, two specially treated layers of silicon with collecting circuitry attached to the top layer, and a polymer backing layer.
The top layer of silicon is treated to make it electrically negative; the back layer is treated to make it electrically positive. When sunlight knocks electrons loose from the silicon, electrons move up from the bottom layer of silicon and crowd the electrons in the top layer. The electrons freed from the top layer are collected by electrical contacts on the surface of the top layer and routed through an external circuit, thus providing power to the electrical system attached to the panels.

New technology, which we’ll get to in a later section, uses different, less expensive materials than silicon in PV panels to capture sunlight more affordably.

**Where are PV Panels Installed?**

Most PV panels go on solar south-facing roofs parallel to the roof’s slope in the northern hemisphere, and on solar north-facing roofs in the southern hemisphere. Some arrays can be mounted on poles or on the ground, but such placement could be prohibited by local regulations or homeowners’ association rules. An important consideration is how many peak sun hours your system will get. Will your solar panels get year-round unshaded sun exposure from 9 a.m. - 3 p.m. (the ideal)? Is your climate stormy, foggy, dusty? The power of your system will vary depending on your geographical location. People in the northeastern US, for example, will need more solar panels on their roofs to provide the same amount of solar electricity as someone in Arizona.

**What Happens at Night and on Cloudy Days?**

Because solar electric systems only produce power when the sun is shining, many consumers also connect their solar system to a utility power grid that provides additional electricity when the solar panels are not producing enough. That type of solar system is called a grid-tied system.

**Off-Grid vs. Grid-Tied Systems**

Costs also vary depending on whether your solar energy system is grid-tied or off-grid. The cost of installing a typical off-grid PV system in a home ranges from $15,000-$20,000 per kilowatt hour. The cost lowers when the solar system is installed as part of the initial house construction, because it is easier and more cost-efficient to incorporate energy-saving design, PV panels and other equipment during construction than to add them after the house is already built.

Off-grid systems require batteries to store electricity and a charge regulator to make sure the batteries are not under- or overcharged. However, with the cost of extending power lines from the utility grid averaging from $20,00-$80,000 per mile, a PV system can be a wise investment for electricity in remote areas.
There are several varieties of off-grid systems:

- Small stand-alone solar electricity systems are often used for RV power, lighting, cabins, back-up and portable power systems.
- A complete stand-alone solar system provides independence from both fossil fuels and electric utility companies.
- A typical complete stand-alone system uses two inverters to make sure power is available for large loads such as air conditioners, and one inverter can supply power when the other may not be working or needs servicing.
- Such systems require sizable battery storage capacity so electricity is available when adverse weather diminishes solar power.
- Batteries are an expensive component of stand-alone solar systems, initially costing between $80-$200 per kWh for residential use.

Hybrid systems combine PV panels with additional power sources such as fossil-fuel generators.

- A hybrid system uses fewer solar panels than a typical stand-alone system, because a gasoline, propane or diesel generator produces power when solar panels are not producing enough.
- Such systems can be used for cabins, remote homes and to power small medical facilities in third-world countries.