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Solar 101 — How Sunshine Can Electrify Your Life

Every year, 293 billion kilowatt hours of solar energy hits the Earth. The electricity needs of the entire planet could be met if we covered .0005% of the Earth with solar panels. Given the environmental and political issues associated with fossil fuels, this is indeed promising news. But how does solar work, and perhaps more importantly, how can solar work for you? Understanding solar is important if you are considering powering part of your world with solar.

The History of Solar

Almost 200 years ago, French Physicist, Edmond Becquerel discovered that exposing certain materials to sunlight could create electricity. It took close to another 50 years until Charles Fritts actually created the first solid state photovoltaic cells.

Then, in 1958, the **modern era of solar** power began. Bell Labs created solar cells for use in space exploration. Providing power to communications satellites became the first commercial use of solar. In 1977 the U.S. Government launched the Solar Energy Research Institute and one year later, the National Energy Act became the **first federal solar incentive program**.

The Carter White House was the first administration to make headlines relating to solar by installing 32 solar thermal panels (to heat water) on the roof of the executive residence. While the Reagan administration also made headlines when it removed those panels, the George W. Busch administration, more quietly, added the first solar electric panels to the White House roof and the Obama administration expanded those efforts.The biggest impact Washington has had on the solar industry was not by installing panels on government building but by providing incentives to homeowners and businesses to install solar panels. Almost 15 years ago, the George W. Busch administration passed the **Energy Policy Act of 2005**. Since then, the investment tax credit (ITC) that the Energy Policy Act provided has been extended and modified. **And the ITC has been a major driver of growth** for the solar industry since.

How Does Solar Power Work?

Obviously the key element for solar to work is sunlight. The term **photovoltaic** (PV) is often associated with solar panels as that describes the process used to convert light into power. Because solar panels require light to work, shaded roofs will not produce solar power as efficiently as non shaded roofs. Cloudy days generate less electricity than sunny days. And there is no power being generated at night when homeowners typically are using the most electricity.

Some people who are considering going solar have dreams about going off the grid – cutting the cord from the local utility. The reality is, few property owners can do this because, simply put, the sun is not shining all the time.

Plus, when the sun is shining strongly, it's possible that your system may be generating more electricity than you need. In a sense, this electricity would then be wasted if you are the only one connected to the solar power system and you have no way to save the power for when the rooftop system is not producing as much power.

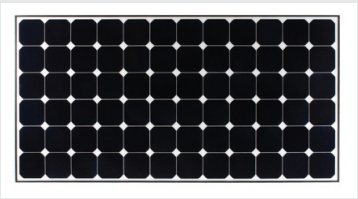
Energy storage will remedy this. Battery packs can absorb the excess power generated during the day and then you could pull from those batteries when the solar system is not generating enough power. Unfortunately battery technology or other energy storage solutions have not kept up with the solar power generation development and there are only a few viable and affordable energy storage options available at this time.

It is for these reasons that you most likely want to **remain connected to the grid**. When your solar system is unable to meet your full electricity needs, you are able to use power from an electricity supplier delivered over your utility's wires. And, when your system is overproducing, many states allow you to send that production out onto the grid for others to use it and, you may be able to get a credit for the electricity you produced

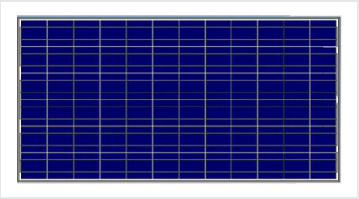
What Equipment is Needed for Solar?

The most visible piece of any solar system is the **panel** or module. Solar panels are the large rectangular structures usually placed on roofs, but sometimes added to parking lot carports or mounted on the ground in open fields. These PV panels often have a sheet of glass on the sun-facing side, allowing light to pass through it while protecting the semiconductor wafers inside. These wafers are what actually convert light photons, from the sun's rays, into clean direct current **(DC)** electricity.

There are essentially three types of panels:



Monocrystalline panels are the oldest and most developed of the technologies. As the name suggests, they are created from a single continuous crystal structure and the solar cells appear as a single flat color.



Polycrystalline (or multicrystalline) panels are a newer technology which was originally thought of as an inferior technology because the panels did not convert the sun's rays to power as efficiently as monocrystalline panels. However, because they are not as expensive to produce as monocrystalline panels, polycrystalline panels have become the dominant technology in the residential solar panel market.

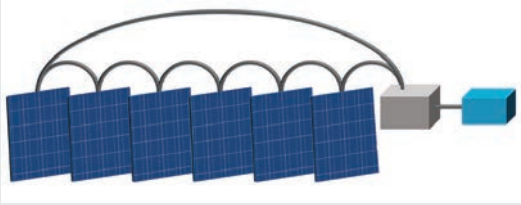
Thin Film panels use a completely different technology than monocrystalline and polycrystalline panels and generally are not as efficient. They are also a relatively new technology and major improvements are expected as the technology becomes more mature.

Different manufacturers produce different solar panel models and the manufacturer and its products may be more important than the technology used in the panel. Costs vary on all of these. How efficient panels are at converting light into electricity is an important factor to consider. While the upfront cost is obviously a consideration, how well the panels produce electricity ultimately affect the return on your investment and over time a more efficient panel may be a better investment. In recent years, the price of all panels has been falling dramatically while efficiency for most panels has also improved over the same time period.

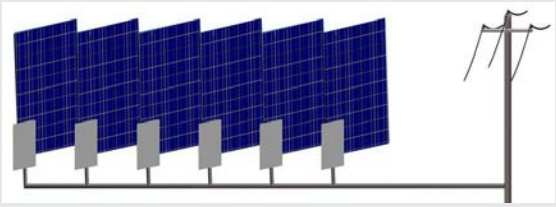
Racking systems attach the solar panels to the roof. Racks may be available in silver or black which is primarily based upon aesthetics and cost. So this is another important piece of equipment for your system but the actual racking system will be dictated by the panels selected.

An equally important, but less visible piece of equipment for a solar system is the **inverter**. While the panels are generating DC electricity, American homes run on alternating current (AC). The purpose of the inverter is to convert the solar generated DC power into usable AC power.

While there are many different manufacturers of inverters, there are two basic types. DC power into usable AC power.



String Inverters are connected to rows of panels. They have been in use the longest and tend to be the least costly option. However, if one panel in the string is shaded, the output of every panel on that string is reduced. (Similar to old fashioned Christmas lights where if one bulb went out, the entire strand went out.)



Microinverters are typically more expensive options than string inverters but have become more popular in recent years because they avoid the shared reduction in output that String Inverters can create. Microinverters are module-level electronics. They are basically working on the panel level versus a string of panels. Because of that, if there is a problem with one panel, only that one panel is impacted versus multiple panels connected in a string.

The final element in the solar system is one you already familiar with – the electric meter. However, for rooftop solar, you most likely will need a **bi-directional meter** since it measures electricity flowing into the building and electricity flowing back out from the solar system.

Basically the entire solar system is built "behind the meter" as many utilities refer to it. That means your property is getting energy directly from the solar system without going through the electric meter. However, in the event that you produce more electricity than you can use, the power flows out to the grid through your meter – literally turning it backward from how electricity has been traditionally measured.

Solar and the Environment

Many people are interested in solar because of the economic advantages it offers. It is very possible that you are able to **save money using the power generated** on your roof versus the power that can be delivered via the utility company's wires. However, there is another key advantage to using solar power. It can **help the environment**.

Depending on where you are located, the electricity available through the grid is generated from natural gas, oil, coal, nuclear and some renewables including hydro, solar and wind.

In addition to being finite resources, fossil fuels and nuclear require mining and drilling to access the fuels. This can lead to deforestation, pollution, and other issues in the area where they are produced. The fuels then need transporting and refining which can use additional energy and impact other geographic regions.

72% of water pollution is attributed to coal burning plants. Burning fossil fuels in general generates $C0_2$ – recognized by most scientists as a key contributor to global warming. Burning fossil fuels also contributes to the production of sulfur dioxide, nitrogen dioxide and dust particles which all are key factors in smog and acid rain. Nuclear power does not have the emissions issues, but there are environmental concerns over the disposing of the used radioactive fuel.

While the production of the solar equipment is not pollution free, coal and natural gas energy production creates between 8 and 51 times more greenhouse gases than solar. Solar equipment also has **no moving parts** and requires **little maintenance** so once the equipment is manufactured and installed, the solar electricity generation is relatively pollution free.

If you are in New York, Massachusetts or Connecticut and want more information on how solar works, and how solar can work for you, contact:

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