Solar Energy

Definition of Solar Energy

Solar energy is energy from the sun.

When the sun's energy reaches the earth in the form of sunlight, it can be converted into other forms of energy.

How does the sun emit energy?

The sun is a huge ball of gas, mostly hydrogen with a little helium. The gravitational attraction of all that mass makes enormous pressure in the interior that forces the hydrogen atoms to fuse together in a nuclear reaction that creates helium atoms and radiant energy.

How does the sun's energy travel to earth?

The radiant energy is carried by packets of light called photons. The photons are bundles whose energy depends on frequency. The radiant energy corresponds to a range of wavelengths on the electromagnetic spectrum, of which visible light is only a small portion.

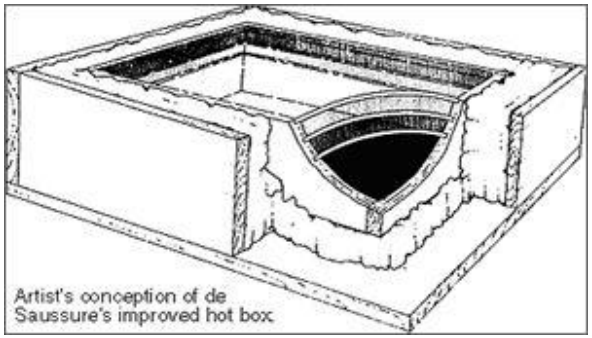
Why is the sun's energy important?

Solar energy makes life on earth possible. The sun is the source of energy for most of earth's processes. It enables plants to grow, rain to fall and wind to blow. Solar energy can also be converted into electricity, a necessity of the modern world.

Did you know?
In one hour, the sun provides more energy to the Earth's surface than the world's population uses in a year.

Brief History of Solar Energy

Centuries ago, people used magnifying glasses to focus sunlight on wood. This caused the wood to catch fire.



In the 1800s and early 1900s, scientists began experimenting with solar collectors, devices that could absorb sunlight to collect heat.

In the 1950s, scientists at Bell Labs generated a measurable electric current with the first silicon solar cell. During the 1960s, the space industry established reliable, less expensive solar power.

It wasn't until the oil embargoes of the 1970s that the public showed interest in the potential of solar energy.

Solar Energy Today

Today, solar energy is one of the most promising ***renewable energy sources***.
This means that we can use the sun's energy today, because the sun will shine again tomorrow.
To be useful, however, solar energy must be collected, converted and stored.

COLLECTING

Since sunlight is not concentrated in one place, solar energy needs to be collected. Solar power plants can capture a lot of energy since their collection devices are laid out over large, flat, open, sunny areas.

CONVERTING

On a small scale, sunlight can be used in its original form for heating a room. If converted to electricity, solar energy becomes useful on a large scale. Photovoltaic cells and solar power plants convert sunlight into electricity.

STORING

There's no sunshine at night, so solar energy needs to be stored. Solar power plants can store the sunlight's heat—sometimes in liquid salt tanks--and use it later to boil water into steam that spins a turbine to generate electricity.

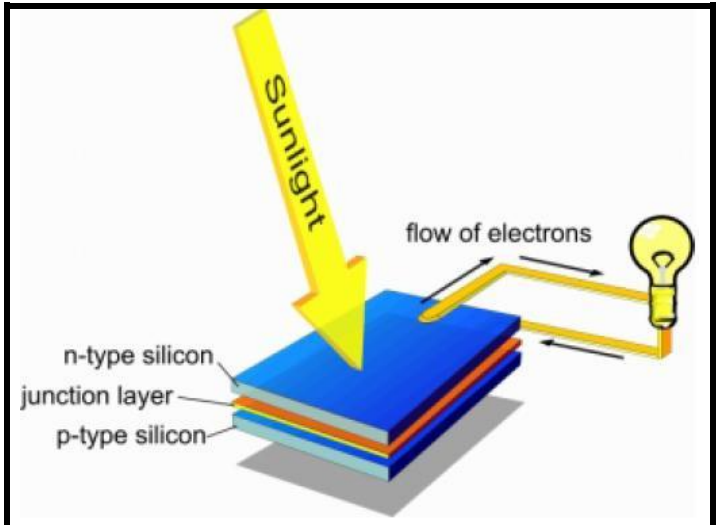
Generating Electricity with Photovoltaic Cells

One way to convert solar energy into electricity is through photovoltaic cells. The word photovoltaic is derived from the Greek world *phos*, which means "light," and the word *volt* which is a unit of measure for electricity.

A photovoltaic panel can produce differing amounts of electricity depending on the intensity of the sunlight, the number of cells on the panel, and how the cells are connected together.

Photovoltaics, also known as PV cells, are becoming more and more familiar in our everyday landscape. The more cells you put together, the more power you can generate.

An individual PV cell can provide a small amount of power for devices like watches and calculators. A small number of cells together can provide power to out-of-the-way places like road signs and power poles. Small buildings and houses are starting to generate some of their own power by installing photovoltaics on the roof. Of course, solar plants use of large number of PV cells to generate significant amounts of electricity for the grid.



When sunlight hits the photovoltaic cell…

- The n-type silicon layer releases electrons because it is "doped" with an element that has one too many electrons for its outer shell.
- The "extra electrons leave the n-side and find new "homes in the p-side, which is doped with an element that has one less electron than fits in the outer shell, thus making an electric field.
- A photon of just the right energy hits the p-side and knocks the electrons out of the adopted homes, so that they "notice" that they are in an electric field, which makes them move.
- Rather than letting them go directly back to the n-side, they are diverted through a wire, making an electric current that can be used.

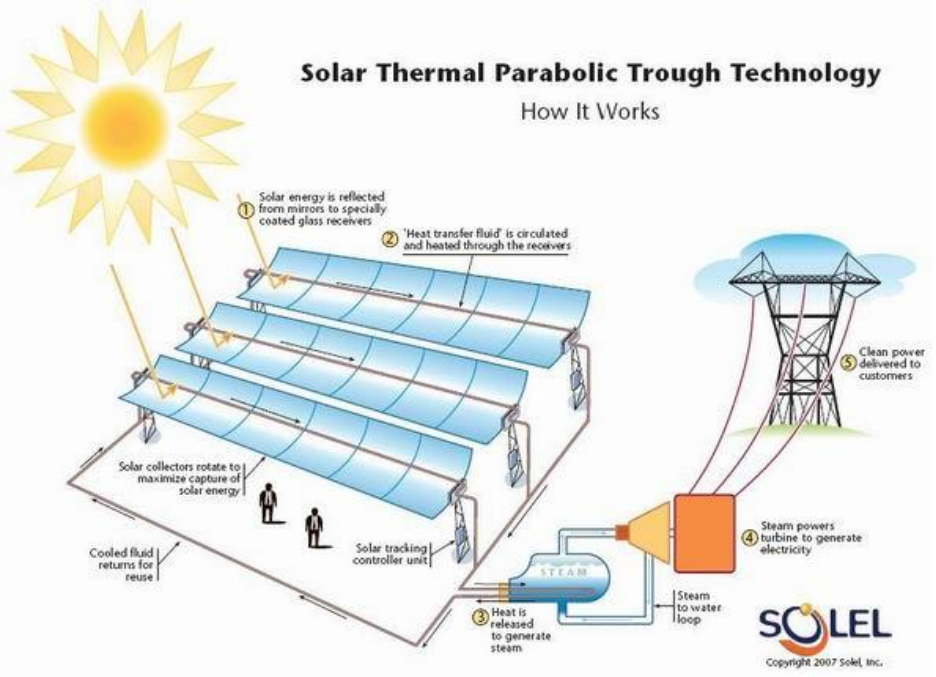
Generating Electricity with Solar Power Plants

Solar power plants represent another way to generate electricity from solar energy. They function in a similar fashion to regular power plants except they use concentrated sunlight—instead of fossil fuels--to generate heat to boil water to drive steam turbines.

MIRRORS: The solar field consists of specially designed solar collectors that use *mirrors to gather and focus sunlight*. The curved surface of the mirror concentrates the light towards a focal point. At that point, the concentrated light creates heat, or thermal energy.

HEAT: Pipes passing through the focal point carry fluid. The *heat drives up the temperature of the fluid*. The pipes circulate the hot fluid to a steam generator where the heat of the fluid is transferred to water. The water becomes steam.

STEAM TURBINE: The force of the *steam drives the rotation of the turbine*. The rotating turbine transfers energy to the generator. That *energy is translated into electricity* in the generator and sent to the electrical grid for use by the public.



California – The King of Solar Power

The world's largest solar power plant is located in California's Mojave desert. Solar Energy Generating Systems (SEGS) consists of nine individual plants in three major location including Daggett, Kramer Junction and Harper Lake.

Generating Heat Passively with Solar Energy

Just as sunlight is used to heat the circulating oil at a solar power plant, we passively use the heat of the sun's rays in our everyday life.

When sunlight hits something, it generates heat, or thermal energy. On a sunny day, the sunlight hits your car and heats up the inside. Sun shines on your couch and the cat snuggles there in the warmth. Sunlight hits your laundry on the line and the heat dries the clothes.



Passive solar heating systems rely solely on this principle. They do not concentrate the energy and there is no mechanical system. Therefore, no electricity is used. In homes and buildings, passive solar heating systems can be used to heat water or interior spaces. The problem with these systems is they rely on good sunshine and they function best in moderate climates.

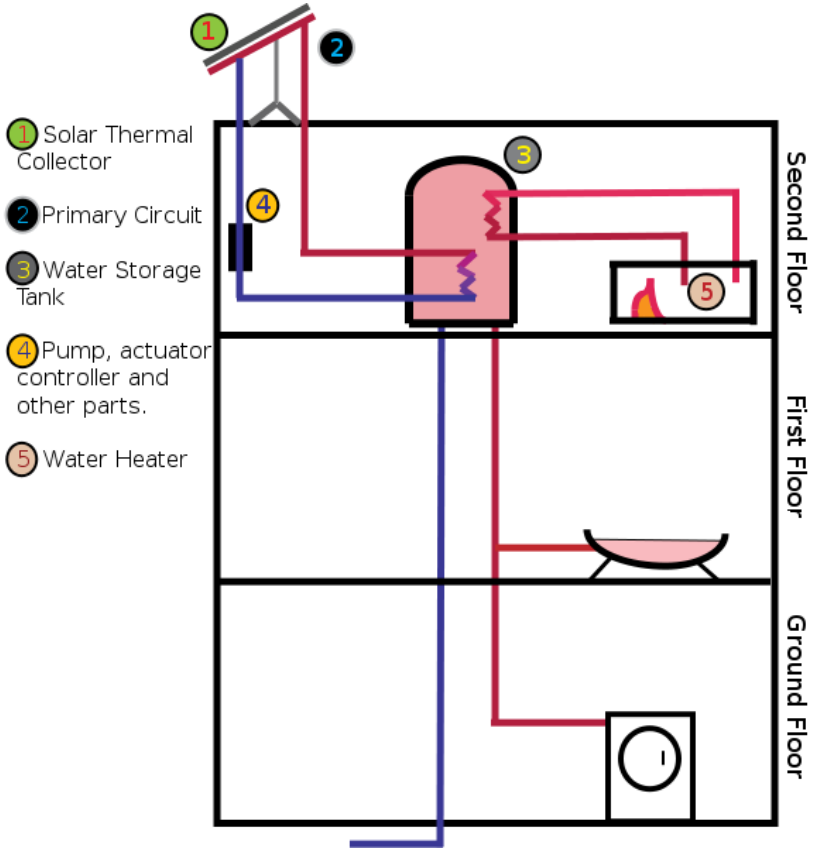
Heating Water: Homes can use passive solar heating to provide hot water for showers and washing dishes. Thin rectangular tanks with a glass front are positioned on the roof. The water circulating through the tank is heated by the sun's energy. The system relies on gravity to deliver hot water on demand.

Heating Spaces: Greenhouses use passive solar heating but homes and other buildings can too. Glass windows are transparent to visible light, which warms in interior space. However, glass is opaque to infrared wavelengths given off by the interior, so the heat is trapped (thus the "greenhouse effect"). In warmer weather, an overhang can prevent sunlight from entering through the windows.

Generating Heat Actively with Solar Energy

Active solar heating systems combine the mechanical components of a regular heating system with a passive solar system. Heat is collected with a solar collector, but fans or pumps are used to circulate the heated fluid. There is usually some type of storage system as well.

1. Solar Thermal Collector: Just like passive solar systems, heating water with an active system requires a flat plate collector to absorb the sun's energy. Mounted on the roof, the flat tank contains a black surface to maximize heat absorption. Tubes attached to the surface circulate water. As the black surface collects heat, it gets trapped in the tank and raises the temperature of the circulating water.



2. Primary Circuit: The solar collector and external part of the tank comprise the primary circuit.

3. Water Storage Tank: Just like an electric or gas-driven hot water system, an insulated tank is used to store hot water until needed.

4. Pump: Rather than relying solely on gravity, active systems use pumps to circulate the water. Cold water is pumped into the collector where it heats up. Then it's pumped to the storage tank. Hot water is pumped from the tank throughout the house.

5. Water Heater: Some systems use a backup water heater. The heater can supply extra hot water to the storage tank if needed.

Benefits and Challenges of Solar Energy

BENEFITS

Solar energy offers many significant benefits, which include:

- It's limitless and available worldwide.
- It does not pollute the water or air.
- It is essentially free. After the initial investment, the sun's energy energy is virtually free.
- It has lots of flexibility because it can be used as is or help add energy to the grid. It can also be used in conjunction with other sources.
- It has numerous applications for supplying heat and power.
- It's a perfect match for supplying high energy demands of the summer season.
- Solar systems provide customers more control since they utilize common materials and have minimal moving parts.

CHALLENGES

There are challenges to using solar energy, which include:

- It's not constant. It varies depending on weather conditions, time of day, time of year and location.
- In a given location, it supplies only a small amount of energy. Lots of surface area is required to collect it.
- Setting up systems requires substantial initial monetary investment.
- A small amount of environmentally harmful toxic waste is produced while manufacturing photovoltaic cells.
- Solar power plants can harm desert ecosystems.
- PV cells are relatively expensive (although cheaper technologies are being developed).

FINAL THOUGHT: As the future unfolds, finding more cost-effective solutions to harness solar energy will reduce our reliance on fossil fuels.