Solar Energy

The use of Solar Energy by humans is not new. Solar radiation including heat and light falling on the earth's surface is responsible for all life on our planet. It has been harnessed by the human race since ancient times for a myriad of purposes. Only an infinitesimally small proportion of the solar energy incident on the earth's surface is harnessed.

There are two broad categories of solar technologies: active and passive. Active technologies increase the energy supply and include photovoltaic panels, which convert solar energy directly into electricity, and solar heat collectors, which use the sun's energy to heat a fluid. Passive techniques reduce the need for additional energy and include orientation of a building on a site to the sun, landscaping for shade, natural air convection for ventilation, techniques for bringing natural light into a building, etc.

The total amount of solar energy reaching the earth's surface at any time is estimated at 89 petawatts (10^{15} watts or one million billion), That's about half of the energy that actually reaches the outer edge of the atmosphere and is more than 5,000 times the total energy used by the entire human race in a year.

In one year, twice as much solar energy reaches the surface of the earth as all the energy that has ever been and will ever be produced from all the earth's fossil and nuclear fuels.

There is sufficient potential for renewable solar power production for more than 7,000 times the total energy needs of the human race. As residents of our planet, it is our responsibility to harness as much renewable energy as possible to save the earth's resources for future generations.

Current Application Technologies

There are currently many solar energy technologies in use and under development. These and other types of systems will each be covered in more detail in future articles.

Photovoltaic Solar Panels mounted on a home.

Photovoltaics

Photovoltaic panels convert sunlight directly into electricity. There are crystalline materials that release electrons when hit by light photons. This phenomenon is called the Photoelectric Effect and it was first noticed in 1839 by Edmund Bequerel, a French physicist. By capturing and directing the released electrons along a conductor, an electrical current is produced. Albert Einstein won the 1905 Nobel Prize in physics for describing the nature of light and the photoelectric effect. With the advent of the renewable energy movement, photovoltaic modules have continued to gain increasing popularity as costs have decreased and output, efficiency, and reliability have improved.

Photovoltaic power systems are most commonly used in residential and small commercial applications. They can be used in conjunction with utility connected power systems or as a stand-alone independent power system. With utility company rebates and state and federal tax credits for most residential and commercial systems, costs to owners are becoming more reasonable. However, the rules change frequently, so check with your installer for current requirements. The components for a grid-connected system are the panels, which generate DC (direct current), an inverter, which converts DC to AC (alternating current) used in the house, and a meter, which reads the magnitude of solar power produced. In cases where the solar power system produces more power than is used, the excess is automatically transferred back to the utility and the monthly electric bill is reduced by that amount. For off-grid systems, a battery bank is required to store power for after sundown. Utility power rebates are not paid for off-grid systems, but some tax credits still apply.

Rooftop Solar Water Heaters.

Solar Water Heating

Solar heating of fluids (usually water) is fairly straightforward. The most common use of this technology is in heating of commercial or residential domestic water or swimming pools. Water in an insulated storage tank is heated as it is circulated through a rooftop pipeline loop exposed to direct sunlight. The temperature of the water is gradually increased to a set high temperature limit. When the temperature limit is reached, the pump is stopped and the collector line is drained so it won't overheat and damage the collector assembly. When the water in the tank cools to a preset low limit, the pump is started and the circulating water is again heated by solar energy. A photocell is used to determine that it is daylight. If the circulating water temperature does not reach the preset high, conventional gas or electric heat is provided in the tank to make up the difference. Naturally, the better the insulation on the tank, the longer the water in the tank will maintain the heat collected.

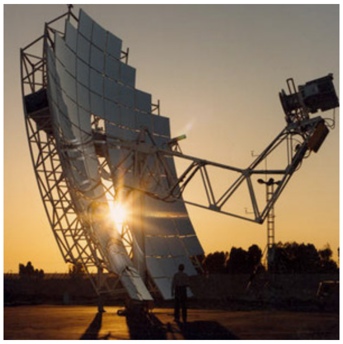
Concentrating Solar Power Systems

These systems are large utility scale power systems which use mirrors to focus the sun's light on a point or a line. Most concentrating solar power systems include provisions for thermal storage of high temperature fluid. This allows the system to continue to produce electricity during cloudy weather or at night.

A Linear Concentrator focuses solar energy on the heat transfer line.

Linear Concentrator

A pipeline carrying a high temperature liquid is positioned at the focal point of a horizontal trough of parabolic mirrors. The liquid is heated to a very high temperature by the concentrated solar energy. When the liquid leaves the trough, it travels to a closed loop and returns to the trough for reheating. Interlaced with the closed loop carrying the high temperature liquid is another closed loop pipeline carrying water. This assembly is called a heat exchanger and heat is transferred from the liquid to the water. Sufficient heat is available to turn the water to steam which is carried to a conventional steam turbine generator.

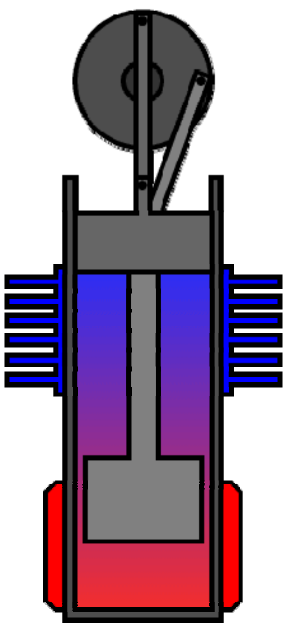


The Power Transfer Unit (right) receives solar energy focused by the mirrors.

<u>Dish Engine</u>

A large mirrored dish focuses solar energy on a point. Located at the focal point is the Power Transfer Unit - a high temperature Stirling engine. This engine uses the temperature difference between one end and the other to drive a piston turning a flywheel which drives a generator.

This type of power system usually uses mirrors made in sections to decrease manufacturing costs and allow easy replacement of mirror sections when necessary.



< A schematic drawing of a Stirling Engine.

In the Stirling engine illustration, the dark gray piston is the power piston which is moved by the flow of hotter and cooler gases inside the engine and provides the power to turn the flywheel. The light gray piston is driven by the flywheel and moves the gases from the hot end to the cool end of the engine.

Mirrors focus solar energy on the Receiver at the top of the tower. >

<u>Power Tower</u>

A power tower system uses a large field of flat, sun-tracking mirrors known as heliostats to focus and concentrate sunlight onto a receiver at the top of a tower. A heat-transfer fluid heated in the receiver is used to generate steam, which, in turn, is used in a conventional turbine generator to produce electricity. Some power towers use water/steam as the heat-transfer fluid. Other advanced designs are experimenting with molten nitrate salt because of its superior heat-transfer and energy-storage capabilities. A Stirling Engine could also be used to drive a rotary generator.

Bill Chase - 11/27/09