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Solar Thermal

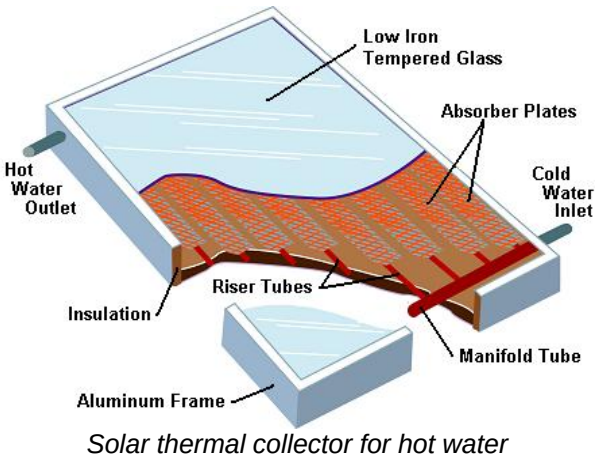
Solar thermal technologies use the sun's power to heat air or water. We use hot water in our homes for bathing and cooking. During the winter we like to have hot air to warm our houses. We can use the sun to supply some of this heat and do not need to use polluting fuels that cost a lot of money.

The Technology

The two types of solar thermal technology are passive and active. In passive solar technology, no mechanisms are used except for the sun's rays. This is useful to heat air for our homes or cooking. For our homes, windows on the south side will let the sun's light get inside. A thermal mass, any dark object that can hold heat, such as bricks or a black painted barrel of water, is placed where the sun shines inside the house. It will change the light energy into heat and store it for when the house gets cold. The dark color will absorb the light energy and warm up the object. When the room becomes cooler than the object it will give off heat. Solar cookers work the same way with a clear cover to let the light pass through and a dark absorbing surface to heat up. Because cooking requires higher temperatures a metal surface is used because it will heat up very quickly, and reflectors concentrate the sun's light onto the heating surface.

Active solar technology uses collectors that incorporate the transparent cover and dark absorbing surface with a pump to move liquids or air through it. These collectors are placed on roofs where they can get the most sun and absorb a lot of heat. The air system could help to heat your house, while the liquid system would heat your water or be used in radiant floor heating. The liquid systems use glycol or antifreeze because water could possibly freeze, expand, and break the pipes or collector. A heat exchanger, where the hot antifreeze liquid and water are separated by only a thin piece of metal that allows the heat to pass, is used to transfer the energy.

This same technology is used in the Southwest deserts of the U.S. to create steam for generating electricity in large power plants. These collectors highly concentrate the sun's light energy on a single pipe to heat water so it turns into steam. Solar thermal systems are very cost effective and useful, but they will not be able to supply all the heating requirements of the home. A backup system must always be used to supply heat on really cold nights, or during a week when clouds block a lot of the sun's energy.



Solar thermal collector for hot water

Global Example (www.solaroven.org)

Instead of cooking over a fire everyday where they were exposed to a lot of smoke, a women's group in Guatemala decided to start a program to make solar thermal ovens. Solar ovens were developed specifically for Central American families who continue to improve upon the design using their knowledge, experience and changing availability of materials. The original model consists of a wooden box surrounded by insulation and set inside another box. Sunlight passes through two panes of glass which rest on top of the box and heats the box to an average temperature of 150º C (300° F) with good sun. A reflector made of aluminum foil and plywood directs light and heat into the box and heats up the black metal plate on which the pots rest. All the materials can be obtained locally and purchased for approximately $100-$150 per oven including stand, food preparation drawer, wheels and thermometer.

Here in North Carolina

In North Carolina, solar thermal technology is mostly used for hot water. It is possible to meet 60% of your hot water needs with just one collector. The energy you save from not heating that water with electricity can pay back the cost of the system in five to ten years. Homes with passive solar systems could reduce their winter heating costs by 80%. Once installed the heating energy is free and creates no pollution.

Related Concepts/Topics

- Sun's changing path over each day and the year
- Absorbers and reflectors (materials/colors)
- Glass effect to let light pass but trap heat
- Heat/energy storage due to material properties
- Heat exchangers

Photovoltaics

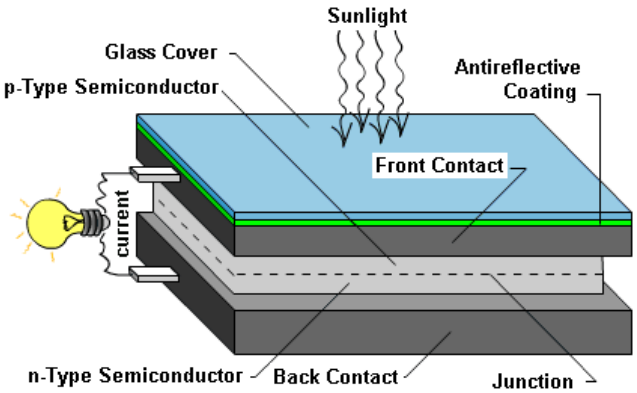
Photovoltaic solar cells convert sunlight energy directly into electrical energy. A simple single solar cell can be used for power in watches and calculators. Many solar cells can be put together to form a photovoltaic module or panel, which can operate a couple of lights for four to six hours. Placing many of these together creates a photovoltaic array that could be powerful enough to supply all the energy needs of a home.

The Technology

Photovoltaic solar cells use the energy of the sun's light to cause electrons to jump from semi-conductor materials, such as silicon. Once moved, the electron wants to return, but cannot jump back. It gets back by flowing through wires and circuits which creates electron flow or direct current (DC) electricity. Solar cells produce the most power when they directly face the sun. Some systems move the solar panels to track the sun as it moves across the sky. Other systems are fixed in a position to get the most direct sun over the entire year. In North Carolina, we would face the photovoltaics south at an incline of 35-36 degrees, equal to our latitude.

Photovoltaic solar cells will only produce electricity when the sun is shining, but we need electricity all the time, including at night for lighting. Therefore, we must store the electricity so we can use it when needed. In a stand-alone system, batteries are used to store the energy. These systems are good in places where electricity is not available for lighting, to pump water, or to provide power for electric fences. On the roads, many small photovoltaic systems are used for construction signs, emergency phones, or flashing lights for schools. In a grid-connected system the photovoltaics use an inverter to change the electricity to alternative current (AC) and connect with the utility grid. If the photovoltaics are producing more electricity than the house is using, typically during the day, power goes out to the utility grid for others to use. When the photovoltaics are not producing enough power, the house uses electricity from the utility grid.

Photovoltaics create electricity which is a useful form of energy because we can use it for many things. It does not create pollution, and once you have a system you never have to pay for the electricity that it creates.



Photovoltaic cell components

Global Example (www.self.org/nigeria.asp)

In Nigeria, the Solar Electric Light Fund brought photovoltaics to demonstrate the comprehensive use of solar-generated electricity in a village setting to improve education, water supply, health, agriculture, commerce, security and women's opportunities. Powerful solar-powered pumps supply the villages with clean, fresh water from deep wells. The village health clinics now benefit from solar energy by using lights to treat patients at night and refrigerators to store vaccines. Village primary schools now have at least two illuminated classrooms that are being heavily used in the evenings for adult education and as places for children to do their lessons. This project has introduced home lighting systems, which replace kerosene lights that create fumes and fire dangers. The project has also incorporated a solar-powered peanut oil expeller that will save time and labor while earning more income for women, who traditionally used a lot of time and hard labor to make the oil.

Here in North Carolina

In North Carolina, local Million Solar Roofs (MSR) communities have led the way in promoting photovoltaic usage and distributing information. Only a few houses have incorporated the technology, but small panels have replaced generators on some construction and school signs. Some high schools have photovoltaics to charge their electric vehicles used in the EV Challenge program.

Related Concepts/Topics

- Electricity flow, DC/AC power
- Series and Parallel circuits
- Battery storage of electricity
- Semi-conductor materials and properties