Solar Thermal

The sun's energy can be collected directly to create both high temperature steam (greater than 100°C) and low temperature heat (less than 100°C) for use in a variety of heat and power applications.

The Technology

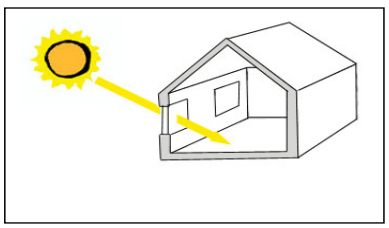
High temperature solar thermal systems use mirrors and other reflective surfaces to concentrate solar radiation. Parabolic dish systems concentrate solar radiation to a single point to produce temperatures in excess of 1000°C. Line-focus parabolic concentrators focus solar radiation along a single axis to generate temperatures of about 350°C. Central receiver systems use mirrors to focus solar radiation on a central boiler.

The resulting high temperatures can be used to create steam to either drive electric turbine generators, or to power chemical processes such as the production of hydrogen.

Low temperature solar thermal systems collect solar radiation to heat air and water for industrial applications including:

- *space heating for homes, offices and greenhouses*
- *domestic and industrial hot water*
- *pool heating*
- *desalination*
- *solar cooking, and*
- *crop drying.*

These technologies include *passive* and *active* systems. Passive systems collect energy without the need for pumps or motors, generally through the orientation, materials, and construction of a collector. These properties allow the collector to absorb, store, and use solar radiation. Passive systems are particularly suited to the design of buildings (where the building itself acts as the collector) and thermosiphoning solar hot water systems (explained later).



The orientation of a building towards the sun acts as a passive solar collector (courtesy CASE).

For new buildings, passive systems generally entail very low or no additional cost because they simply take advantage of the orientation and design of a building to capture and use solar radiation. In colder climates, a passive solar system can reduce heating costs by up to 40 percent while in hotter climates, passive systems can reduce the absorption of solar radiation and thus reduce cooling costs.

The most common active systems use pumps to circulate water or another heat absorbing fluid through a solar

The Solar Two project in California USA uses a field of mirrors to focus solar energy onto a central boiler to produce steam and electricity. (Photo courtesy NREL).

Costs

Domestic Solar Water Heating

Capital costs project:	*US$1500 - $3000*
Operating life:	*15 – 40 years*
Payback period:	*4 – 14 years*
Maintenance costs:	*$25 - $30/year*

average figures for home owners
source: Florida Solar Energy Center

Solar Thermal Electricity

Capital Cost	*US$2500-3500/kW**
Operating Life	*20 years*
Levelised Cost	*US$ 0.8-15/kWh***

** kW = kilowatt* *** kWh = kilowatt-hour*

Key Points:

- *Generating low temperature heat via solar technology for space and water heating is a proven and mature industry.*
- *Active solar technology uses pumps and/or motors to circulate the solar-heated fluid while passive systems use the orientation and design of the solar collector to collect energy.*
- *High temperature solar thermal technology for power applications is a specialized market that needs further research and development to become competitive.*

collector (see diagram right). These collectors are most commonly made of copper tubes bonded to a metal plate, painted black, and encapsulated within an insulated box covered by a glass panel, or "glazing". For pool heating and other applications where the desired temperature is less than 40°C, unglazed synthetic rubber materials are most commonly used.

For domestic applications, the solar hot water system (SHS) is a mature technology that can provide hot water to meet a significant (in some cases all) of the hot water needs in a domestic building. In Europe, a SHS can generally meet between 50–65 percent of domestic hot water requirements, while in subtropical climates, such as Asia and northern Australia, the percentage can be 80–100 percent of needs.

Example of a solar pool heating system.

A domestic SHS ranges in price from about $500 to $2,500. This is significantly higher than a conventional electric or gas hot water system, but a SHS can pay for the extra cost though energy savings. The payback period depends on many factors but is usually in the order of 4-12 years while the useful life of a SHS usually exceeds 15 years.

The same types of solar collectors used in a domestic SHS can also be used for space heating applications. In some countries, such as Sweden, large district heating systems have been built that heat large volumes of water during summer months for use in the winter heating season.

In developing countries, a solar cooker can provide basic cooking energy in areas of high solar radiation. In these areas, simple solar stills can also be used to purify water. These devices can be very simple and made using local materials and labour.

The Industry and Market Trends

Generating electricity from high temperature solar thermal devices is already a technical reality. There is a small existing market, and costs are currently cheaper than generating electricity from PV for large grid applications. However, there has been only a small increase in the market for this technology over the past decade, and its long-term future depends on the availability and success of further research and development.

For low temperature applications, the market is diverse, with about 180 manufacturers in Europe and the United States alone. At the end of 1998, about 30 million square metres of solar collectors worldwide were providing domestic and commercial hot water. In Europe, the market has grown by 18 percent per year throughout the 1990s and is expected to reach 15 million m^2 by the year 2003.

In Australia, five percent of domestic water heating comes via SHS technology. The growth of this technology and its related industries, however, depends very much on energy policy. Experience in Australia and the Netherlands shows that supportive regulations can increase production volumes, thereby lowering overall costs.

Risks

Technology

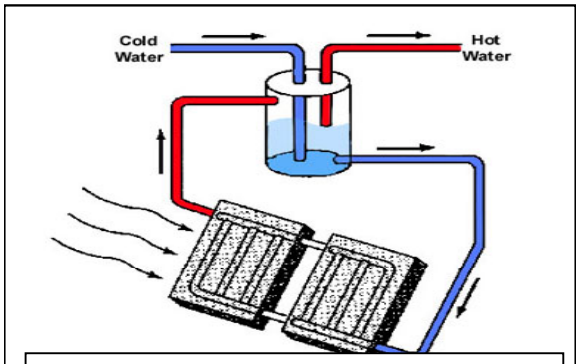
There are many different solar thermal technologies and some are more commercially advanced than others. There are few technical risks for domestic solar water heating and solar heating for agricultural and industrial processes. There is some technical risk for solar thermal power generation technologies in the early stages of commercialization.

Environmental

There are few environmental risks for solar thermal technologies. Only when the planned project is large enough to impact either land or water resources are there generally any environmental issues.

Planning

There are few planning risks, although power projects are generally subject to planning approvals.



A thermosiphoning solar hot water system allows cold water to enter the collector at the bottom where it is heated. The hot water rises into the storage tank by the process of convention and without the need for a pump (courtesy CASE).