2. Development of Solar Thermal Technology

Solar energy is usually divided into two categories, although they are sometimes employed together in installations.

- Solar thermal energy is generated from heat and employs heat directly to heat water or buildings, or to produce steam to power electricity generators.
- Solar photovoltaic electricity is generated from light, employing photovoltaic modules or cells, which convert sunlight into electricity using cells with semi conductors.

This report is concerned with the first of these technologies, solar thermal energy conversion. Solar photovoltaic energy is the subject of another report published by ABS, SPV Solar PV Report Ed 6, 2008.

The US Energy Information Agency characterises solar thermal collectors with low, medium, or high temperature collectors. Low temperature collectors are flat plates generally used to heat swimming pools. Medium-temperature collectors are also usually flat plates but are used for creating hot water for residential and commercial use. High temperature collectors concentrate sunlight using mirrors or lenses and are generally used for electric power production. These are known as CSP (concentrating solar power) units.

Low and medium temperature collectors solar thermal have a far higher installed energy capacity than solar thermal collectors used to generate electricity, and also far higher than the installed capacity of solar PV. At the end of 2007 there was 93,000 MW of wind power, 148,000 MW of solar thermal collectors for water heating and building heating or cooling installed but only 414 MW of high temperature solar thermal collector generating capacity and about 8,000 MW of solar PV capacity.

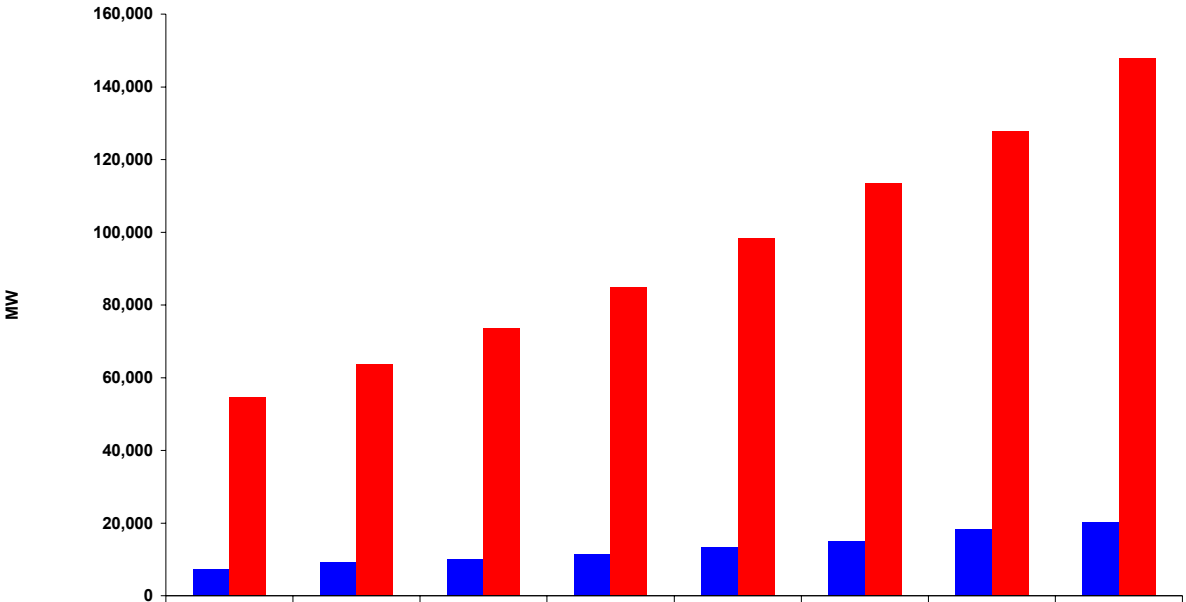
Solar thermal energy can be directly used for cooling and dehumidification. Cooling technologies include single- and double-effect absorption chillers, adsorption chillers, and solid or liquid desiccant systems. There are 81 solar cooling systems in the world, of which 73 have been counted in Europe, 7 in Asia and one in Mexico, with a total solar collector area of about 24,000 m2 and a total capacity of 9 MW chilling power.

China leads the world overwhelmingly, with over 80,000 MW of capacity by the end of 2007. The US was in second pace with 22,000 MW, Turkey third with 7,105 MW and Germany fourth with 6,821 MW. Apart from the Chinese lead, low and medium temperature collectors are most developed in the industrialised countries of Europe, but they are important in some developing countries where they enable large cost savings, with simple devices such as solar cookers and solar water heaters. These appliances use solar heat directly. All technologies operating through solar heating come under the category of solar thermal. These include non-grid solar thermal technologies; water heating systems, solar cookers and solar drying applications etc. These technologies help conserve energy in heating and cooling applications. Solar thermal appliances can be manufactured with a low level of technology and are ideally suited for developing countries. In industrialised countries, solar thermal technology has more advanced applications such as solar thermal building designs. All of these solar thermal devices use heat directly from the sun. They are cheap to manufacture and cost nothing to use.

The more advanced use of solar thermal energy, employing high temperature collectors, involves conversion from heat into secondary energy, electricity. Several technologies have been developed and tested to generate power from solar thermal energy and where some of these technologies are classified as mature, others are in their infancy. In common with most forms of renewable energy, the cost of solar thermal power generation is still high, but reduction in the cost of solar electricity to a level competitive with other power sources is expected to take place within the next 10 to 15 years. Hybrid solar-fossil fuel plants, making use of special finance schemes at favourable sites, can already deliver competitively priced electricity.

Competition with the economics of solar thermal power plants, comes mainly from conventional grid-connected fossil fuel-fired power plants, particularly the modern natural gas-fired combined cycle plants in mid-load or base-load operation mode. In small-scale, off-grid generation systems, such as islands or developing countries, the competition comes from gas oil or heavy fuel oil-powered diesel engine generators. However, a mixture of factors, including reform of the electricity sector, the rising demand for ‘green power’, the possibility of gaining carbon credits from pollution-free generation and direct support schemes for renewable energy in some countries, are all increasing the viability of such projects.

Figure 3.1: Solar collector sales and installed base, 2000 to 2007, MW

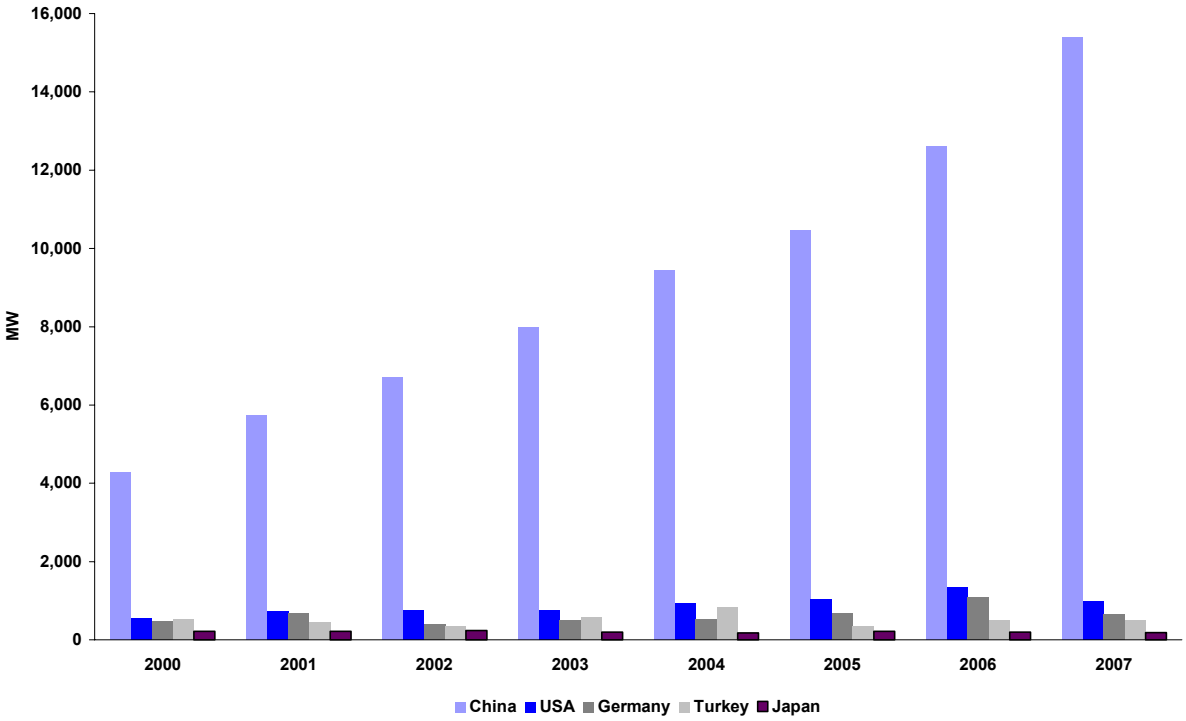


	2000	2001	2002	2003	2004	2005	2006	2007
Annual sales	7,339	9,160	9,864	11,485	13,406	15,027	18,257	20,150
Installed base	54,501	63,661	73,525	85,010	98,416	113,443	127,784	147,934

Source: ABS Renewable Energy Database, EIA

The global solar thermal market is dominated by China, which had a 59% share of global sales in 2007, amounting to 15,400 MW of capacity. The US had 986 MW or 4%, Germany sold 3% and Turkey and Australia 2% each, and no other country had more than 1%.

Figure 3.2: Leading countries sales of solar thermal collectors, 2000 to 2007, MW.



Source: ABS Renewable Energy Database, EIA

daily availability of drinking water is to the tune of 70 million litres. Bearing in mind the vast deposits of natural salt that Kachch is endowed with and its long coastal shores, solar pond desalination systems could prove to be very beneficial. This technology is especially appropriate for this region because its main inputs, namely salt/bittern and clay, are available in abundance here. Thus, the solar pond technology could be the most cost-effective if locally available materials are utilised for conversion of brackish/sea water into pure and soft drinking water.

Similarly, a solar pond water desalination system could also be used to meet drinking water requirements of the Army and the Border Security Force, stationed at the Indo-Pak border, all along the Great Rann of Kachch.

Israel

The use of solar thermal energy in Israel is a remarkable success story. Today, more than 90% of Israeli households own solar water heaters and the per capita use of SWH is the highest in the world. Like Japan, and unlike the United States and much of Europe, Israel found itself without sufficient fuel supplies in the early 1950s. The power situation became so bleak in the early days of the Jewish State that the Government had to forbid heating water between 10 pm and 6 pm. Despite mandatory domestic rationing of electricity, power shortages worsened, causing pumping stations to fail and threatening factory closures. A special committee empanelled by the Government could only suggest the purchase of more centralised generators to overcome the problem. An Israeli engineer, Levi Yissar, who advocated a change from electrical energy to solar energy for heating water, became Israel's first manufacturer of solar water heaters. By 1967, about one in twenty households heated their water with the sun. But cheap oil coming from Iran in the late 1960s as well as from oil fields captured during the Six Day War drastically reduced the price of electricity and the number of people purchasing solar water heaters. Israeli success in the Yom Kippur War brought on the infamous oil boycott of 1973 and the Israelis responded by mass purchasing of solar water heaters. By 1983, 60% of the population heated their water with the sun.

When the price of oil dropped in the mid 1980s, the Israeli government did not want people backsliding in their energy habits as has happened in the rest of the world. It therefore specified that water be heated with the sun and enacted a regulation requiring every new building with a height of less than 27m to have a solar thermal system on the roof. The majority of the systems sold today (~85%) are installed voluntarily on existing buildings.

With an average solar irradiation of 2.000kWh/m^2 per year, the installation of a solar DHW system is an economically sound investment allowing the user to save approximately 175 € of conventional fuels per year.

Since 1982, all systems produced, sold or installed in Israel must comply with the official SI standards and bear a Mark of Conformity.

Turkey

Solar thermal water heating is widely used in Turkey, and Turkey is now the third largest user in the world. The systems are manufactured locally by approximately 12 medium-sized companies and a large number of small workshops. Most of the systems are of relatively low quality, employing simple and cheap technology. A typical solar water heating system costs €200–250 (including installation and VAT). The poor quality has led to bad experiences by the customers and high maintenance costs after a couple of years. Standards exist, but are not strictly enforced.

USA

The solar energy industry in the United States has had a cyclical history, prospering or declining in direct relation to the price of fossil fuels. Although not the largest solar thermal user today, this type of water heating was pioneered in the United States. In the Nineteenth Century, no easy way existed to heat water. People generally used a cooking stove for this purpose, burning wood coal. In cities, the wealthier heated their water with gas manufactured from coal. To add to the practical problem of heating water, in many areas, wood or coal or coal-gas cost a lot and in many cases could not easily be obtained. To circumvent these problems, many farmers and rural dwellers devised a much safer, easier and cheaper way to heat water; placing in the sun a metal water tank painted black to absorb as much solar energy as possible. These were the first solar water heaters on record. The problem was that even on clear, hot days, it usually took from morning to early afternoon for the water to heat and as