China's solar thermal industry: Threat or opportunity for European companies?

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Introduction

China has a well established commercial solar thermal industry with over a thousand factories manufacturing and selling solar systems. Most of these collectors are used to heat water, and are sold without subsidies. Solar water heating technology has made great progress and provides people in urban and rural areas with cost-effective energy services. By the end of 2000, the accumulated installed area of solar water heater systems in China was 26 million m^2. As the industry grows, Chinese businesses are turning towards markets in Europe.

Solar thermal energy is competing with electricity in the supply of hot water in China. By the end of 2000,[1] the accumulated installed area of solar water heater (SWH) systems in China was 26 million m^2 - considerably greater than the European Commission's target of 15 million m^2 in 2004. The annual sales volume was 6 million m^2 in 2000, and the annual sales grew by 41% and 27% in 1999 and 2000 respectively. In terms of exports, 1% of national production went to Japan, Germany, Belgium, Italy and other Asian countries; this may not be much, but the average annual growth rate of exports has been about 40% in recent years. With figures like this, should the Chinese solar water heater sector be seen as a threat to manufacturers in Europe and the US, or as an opportunity for them?

In Europe, solar energy is viewed as a renewable energy option with high environmental value and low economic value. In order to meet their national and international commitments, many European governments are stimulating domestic markets through a number of incentive programmes - by providing support for R&D, demonstration projects, market dissemination and raising public awareness.

In most provinces of China, however, the solar solution for domestic hot water supply is viewed as the most economical. China is a country with a rich solar resource: 66% of the national geographical area has more than 2200 solar hour equivalents per year, annual radiation is greater than 5020 MJ/m^2, and solar insolation with 50,000 EJ (50,000 x 10^{18} J) absorbed at the surface annually. As the domestic hot water supply infrastructure in most cities is not well developed, the significant natural solar resource makes solar water heater systems an excellent alternative to fossil fuel boilers or electric water heaters, in providing hot water to households. The market potential is there for the provision of hot water for bathing - a fundamental aspect of modern civilized, hygienic and healthy life - to a population of 1.3 billion.

1. Industry

Products

The products in China are mainly of three types: flat-plate, vacuum tube and combined storage tank.

Flat-plate

The solar collector is the key component for the flat-plate type of water heater, which are mainly made of copper-aluminium, all copper, or anti-corrosion aluminium collectors. The copper-aluminium is the most popular type in China. The system consists of a flat-plate solar collector and a hot water tank with natural circulation (thermosyphon). The collector is a framework or box with metal heat absorber, a transparent cover and a back/side insulation layer. This type of system could also provide a household with 70-100 litres hot water (at 40-60°C) per day.

[1] Annual report 2000: China Solar Water Heater industry Development.

Vacuum tube

There are two kinds of vacuum tube water heater on the market: one is the all-glass vacuum tube, and the other is the heat-pipe vacuum tube.
The first one of these is a double layer, coaxial glass tube made of borosilicate glass. Its features include high temperature capacity (250-280°C at stagnation) and an easy coating process, due to the highly adhesive coating on the inner glass surface. This system can be used year-round for households in cold climates. It is also suitable for use in industrial applications, such as industrial process heat, drying, air conditioning, seawater desalination and so on.
The second type is combined pipe and vacuum technology. This is characterized by a limited thermal loss factor, high temperature resistance, good freeze resistance performance (freeze cracking at -250°C), and good pressure resistance. However, its price is high; limited volume is sold in China, and some of this product is for the foreign market.

Combined storage tank

The combined storage tank type is not that popular in China and is mainly produced by small and medium-sized companies. In this system, the solar collector is combined into the hot water tank, which is black in colour and without insulation. The characteristics of this type are its simple structure, easy installation and low cost. It is suitable for use between May and October in the northern part of China, and from March to November in southern regions. On average, about 2-3 m^2 of collectors could provide sufficient hot water for a family of three to four members. The disadvantages of this type of heater are heat loss in the night, and that it is sometimes unable to provide hot water in the night and or in the winter. As it is lower in cost, it is is suitable for low-income families, and is mostly used in rural applications.

Production

Manufacturers are mostly small- and medium-sized companies, of private ownership. The national annual production capacity was 9 million m^2 in 2000; this was made up of 5 million m^2 of vacuum tube systems, 3 million m^2 of flat-plate systems, and about 1 million m^2 of combined storage tank systems.[2][2]
There were about 300 production lines nationally manufacturing vacuum tube SWH systems in 2001. More detailed figures for 2000 are shown in Table 1; these represent a 30% increase over the 1998 figures. Such high growth led to a significant boom in the vacuum tube business. The growth of production capacity for flat-plate systems is very stable compared with the development of vacuum tube systems.

TABLE 1. Production capacity in 2000

Type	Geographical Location	Number of production lines	Production capacity
Vacuum tube	Shangdong	141	5 million m^2
	Beijing	62	
	Jiangsu	34	
	Hebei	26	
	Zhejiang	21	
	Anhui	8	
	Others	8-12	
Flat-plate	Yunan, Guangdong, Sichuan	28	3 million m^2

Source: Annual report 2000: China Solar Water Heater industry Development

Manufacturers of vacuum tube SHW systems are mostly located in Shangdong, Beijing and Hebei, where there is a strong vacuum tube production industry, while flat-plate system manufacturers are mostly in the south of China. However, 70% of total SHW system production is in Shandong, Beijing and Jiansu.
The SHW sector in China is a profitable business, even without government subsidy. As a result, the number of manufacturers increased to over 1000 in 2001.

[2] As the industry includes a great number of small, family-owned businesses, it is impossible to have absolutely accurate data for production.

2. Policy and framework

In the 'Tenth Five Year Plan of New and Sustainable Energy Sector Development', the government of China set the national target for cumulative installation area at 64 million m^2 for 2005 - which means the government has to provide policy to stimulate the industry to meet the national commitment.

Government incentive programmes

There are currently no officially expressed support policies for solar thermal utilization, though the government has provided finance for administration and research. Research on solar thermal utilization has been included in the list of key national priorities to be addressed in every Five Year Plan. The government has allocated special funds to support the establishment of an advanced laboratory and testing facility.

Standards

To increase the market penetration, the government of China recognized that it was essential to develop a series of comprehensive technology and quality standards. The current standards in China cover small solar fields but not the whole industry sector. These standards are as follows:

Two basis standards

- terminology for solar energy utilization I, GB/T12936.1 - 1991
- terminology for solar energy utilization II, GB/T12936.2 - 1991.

Four test standards

- thermal characteristics test method of solar water heater for household, GB/T12915 - 1991
- assessment method of elastic material for solar absorber, fittings and accessories for solar water heater, GB/T15513 - 1995
- solar spectrum irradiation standards for various geographical areas I, GB17683.1 - 1999
- performance test method on flat-plate absorb collector, GB/T4271 - 2000.

Three product standards

- technical condition for flat-plate absorb collector, GB/T T6424 - 1997
- full-glass vacuum tube collector, GB/T17049 - 1997
- vacuum tube collector, GB/T17581 - 1998.

One sector standard

- technical condition of solar water heater for household, NY/T343 - 1998.

3. Marketing

China's SWH market has expanded dramatically in recent years, with a significant increase in the range of quality products. The 'self-build' sector is becoming a major new part of the industry, and generates 150,000 employment opportunities.

Products and price

The vacuum tube type is the most popular system in China. Figure 1 illustrates the share of the market by different products in 2000.

The price normally depends on the type of the system, its size, raw material and brand name. In general, the price of vacuum tube type systems is about RMB Y1000 (£140) higher than the flat-plate type, and well known brands with a so relatively expens

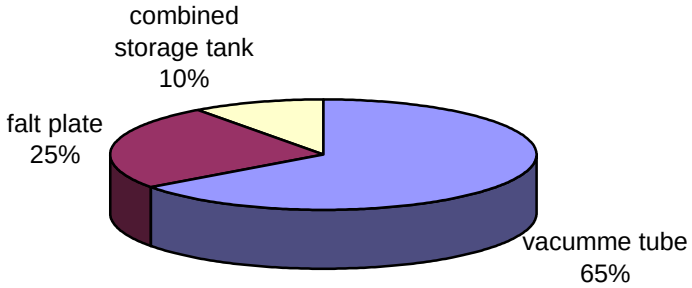


FIGURE 1. Market share by different product in 2000

TABLE 2. Products and prices

Type (2 m^2 collector)	Price	
Vacuum tube system	Using 180 litre water tank of normal material - RMB ¥3000 (€430)	Using stainless steel 180 litre water tank - RMB ¥3700 (€528)
Flat-plate system	RMB ¥2000 (€286)	

Current market

The SWH systems are mostly installed in the suburbs of cities, in medium-sized and small towns, and in rural areas. The market share of solar thermal by different geographic areas is shown in Figure 2. Comparison with Table 1 reveals, for instance, that although Beijing is one of the largest production bases for SWH systems, the market penetration here is at almost the lowest levels of utilization. The average income in big cities is higher than in small ones - so why is utilization so much lower than in small cities and rural areas?

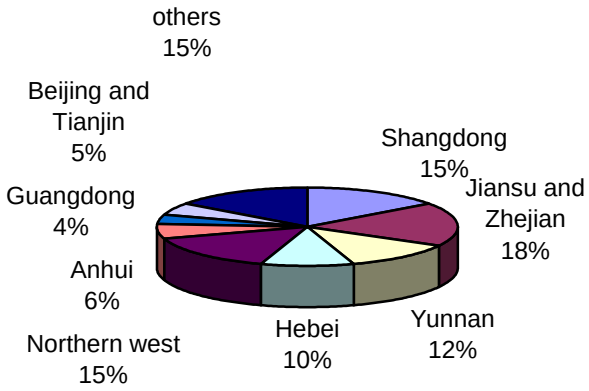


FIGURE 2. Share of solar thermal market by region in 2000

The main reasons are:

- *availability and reliability of natural gas boilers:* Beijing is the first city to have natural gas in residential buildings, and individual natural gas boilers have developed significantly
- *poor durability and reliability of SHW systems:* poor-quality products are also available in the market, and this has damaged consumer confidence
- *building integration:* it is difficult to install collectors and water tanks in existing tall buildings with a high density of dwellings. A number of cities have also put restrictions on installation on the roofs of the buildings, for aesthetic reasons.

Public awareness

To expand the market share, public awareness-raising and demand-side stimulation can be used; these are viewed as powerful tools in countries such as the Netherlands. The national campaign, radio and TV programmes, national publicity, national information centres, studies on the value of the consumer market and so on have positive impacts on market development. In China, nationwide communication focused on the supply side and less on the demand side. The government and industry will work together on communication with the consumers on awareness of SHW technology and the environment.

Distribution systems

The distribution channel for SWH systems is a simple one; the manufacturers sell their products to wholesalers, who will act as their agent, in provinces or big cities, and these wholesalers sell on to dealers. The end-user would purchase their product from dealers (see Figure 3).

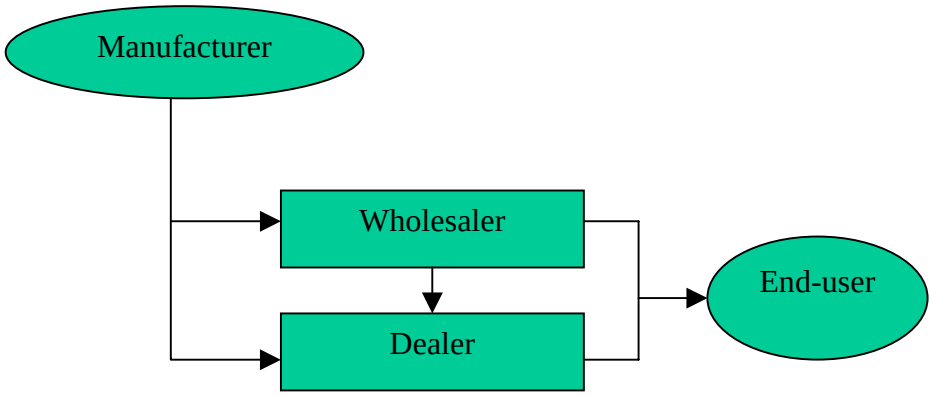


FIGURE 3. Distribution channel for SWH systems in China

A number of manufacturers have more than 300-400 dealers; some have as many as 1000 dealers nationally. If you walk along the shopping street in Kunming, Yunnan Province, you find a number of shops - dealers - next to each other, selling SWH systems as well as parts and plumbing supplies such as pipes or taps. The products are more or less the same, and are similarly priced. Kunming is known as 'Spring City' as its location in the south-west of China gives it a warm climate. About 30-40% of Kunming households have SWH systems.

Solar energy is so successful in Kunming for a number of reasons:

- *excellent solar resource:* the warm climate offers tolerance for the system, there is no risk of freezing, and hot water is produced even on cloudy days
- *poor resources of other forms of energy:* Kunming does not have other local energy resources, such as coal or natural gas etc., and as a result, electricity is relatively expensive in this region
- *SWH is the most economic option for hot water supply:* its economic value is well recognized by consumers
- *local production:* there are more than 150 manufacturers in the province, and simple systems are available at very low prices.

Promotion

In order to promote renewable energy, the government, governmental agencies and sector associations sponsor and organize trade fairs. At a recent trade fair for renewable energy in rural areas, held in Beijing, most (115 out of 177) of the exhibitors were from the SWH industry.

More than ten Chinese SWH manufacturers participated in 'Sustain 2001', a renewable energy trade fair held in Amsterdam, to promote their products in Europe and look for European partners for product/technology improvement and market development. They did not have to transport the products they were exhibiting all the way home, as the trade visitors appreciated the Chinese products very much, taking them back to Spain and Germany.

International organizations, such as the International Finance Corporation, are also very interested in the Chinese SWH sector, as it is the leading industry in the commercialization of renewable energy. Interest from international organizations on matters such as equity investment would be a strategic initial step for the Chinese sector, in terms of entering into the international market and expanding its business abroad.

Solar thermal business have a significant presence at trade fairs

Competition

Over 1000 manufacturers, more than 1000 brand names, countless dealers as each other's neighbours in cities, towns and villages in China - can you imagine the competition?

To confront what could be very serious competition, a number of manufactures seek to survive by investing in R&D and in promotional campaigns. These manufacturers also spend a certain amount of capital on registering their patents, so as to avoid today's innovation becoming a neighbouring dealer's product of tomorrow.

However, the SWH industry is a profitable sector and very successful in the domestic market. Financially, the sector could be described as a 'cash cow'; it is looking for potential markets for further growth, both nationally and internationally.

4. Market potential

Residential buildings

Continued economic growth in China, with rising living standards, urbanization and the privatization of the housing sector, has created a significant demand for high-quality residential space. The construction industry completed 13.7 billion m^2 of new residential buildings from 1981 to 1995, and the Ministry of Construction projected an additional 15 billion m^2 in the 'Ninth Five Year Plan' and 'Outline of Long-term Objectives for 2010 for the Construction Industry and Project Construction'. Construction of about 7.74 billion m^2 new building are planned for the next ten years.

Assuming 10% market penetration, and 2 m^2 of collectors and 50 m^2 of living space per family, the potential market for SWH system would be at least 3 billion m^2 per year.

Solar thermal application

The provision of hot water to households is just one application of solar thermal energy. It can also be employed in industrial processes, timber treatment, agricultural processes, cooling and space heating, for example.

Xin Ying Solar Energy Equipment Works, a manufacturer in Yunnan, is developing a ceiling with a solar collector, intended to provide a comfortable level of space heating in wintertime. The annual average temperature of Kunming, the Spring City, is normally around 23-25°C, though it may be colder for a few days in the winter period. Due to the rise in living standards within the city, people there want to enjoy the comfortable temperatures they are used to in the spring.

75% of the Chinese population lives in rural areas, and central and district heating systems are not available there. They normally burn coal to keep warm in the winter. Most of the cities and towns south of the Yellow River are without central heating systems, even though temperatures drop below freezing in the winter. Therefore, the development of central heating would benefit the whole population in China.

5. Challenges for further development

Although China is in the leading position in SWH development, it is currently facing the same challenges that Europe and the US faced in the 1990s.

Integration

When SWH developed in Europe and the US about 20 years ago, maximum technical performance was the priority, and appearance was not that aesthetically pleasing. For instance, before the 1990s, the US introduced restrictions on the new homes market, regarding what could be placed on the roof and street side of a house. In China, a number of municipal governments have forbidden, or intend to forbid, cities to install SWH systems on rooftops.

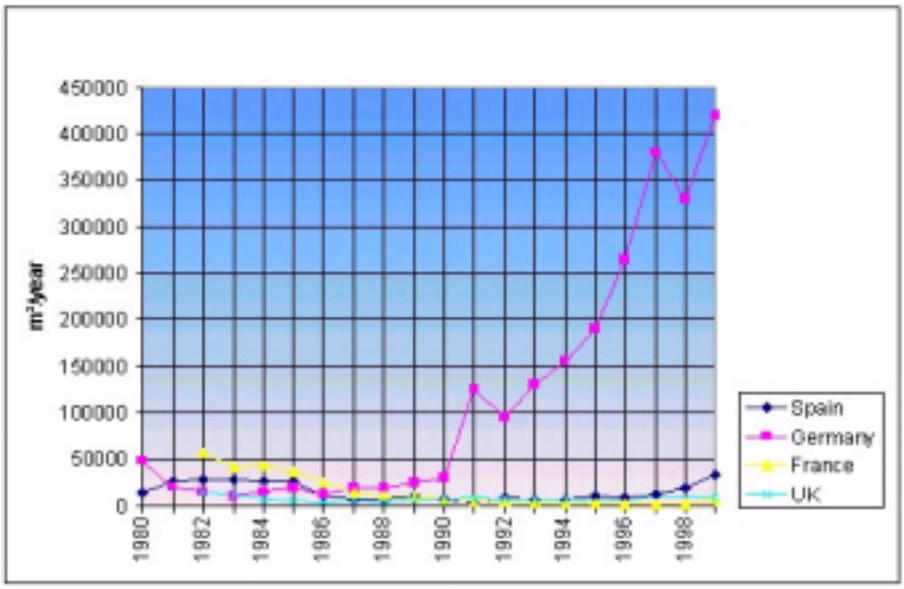
SWH systems are often installed on the roofs of residential buildings in China

The SWH sector is taking the initiative to work together with the house developers and architects to maintain the expansion of applications in the residential building sector. It has been shown that buyers who purchased systems individually which they installed on their roofs themselves, do not in general consider the aesthetics of the building or the living environment. In the construction of new buildings, the main considerations for SWH systems collectively installed on the roof are harmonization of colours or positioning to reduce visibility - they are mostly quite acceptable.

SWH systems are often installed on the roofs of residential buildings in China

Durability and reliability

Figure 4 shows collector sales in four European countries (1980-1998), and demonstrates that the market penetration increased significantly in Germany during the 1990s. Technically speaking, Germany does not have any problems in building up consumer confidence in the durability and reliability of SWH systems. However, in the UK, SWH systems still suffer, to some extent, from a reputation of poor quality in the professional target groups, although any unreliability occurred at least two decades ago.



Collector sales in four European countries (1980–1998)
Sources: Commission of the European communities – DG TREN, Thermie B programme 2001

Experiences in Germany and in the UK can act as a warning to the Chinese SWH sector, to build up a reliable image in order to ensure further development. Otherwise, the sector could be damaged by poor-quality products.

Services

The strategy of expanding business in China's old economy was product-focused, while the new economy is service-focused. The inputs for product improvements and services are not balanced in China's SWH sector; for instance, qualitative installation could guarantee a system's operation and the manufacturer (or their subsidiary) could help buyers to have quality installation. The sector needs to provide quality assurance and offer a guarantee of maintenance and service. Provision of service is the weakness for development of the whole sector - the industry has to invest in building capacity in terms of 'after sales' staff, installers, and maintenance technicians. The industry has to educate consumers not only on why to buy SWH systems, but also on how to use them.

Wider applications

The value of the consumer market for space cooling and space heating in rural and urban areas would lead to a revolution in the SWH industry in China in product and market development.

Raising public awareness

The economic value of SWH is well recognized in China, but awareness of its environmental value needs to be improved. In China, it costs as much to invest in an SWH system as a mobile phone, but market penetration for such devices is much higher than for SWH. The government and the SWH sector need to communicate with consumers and professionals to raise awareness of the environmental and climate change benefits of the systems.

Internationalization

With the recent developments in the energy sector in Europe, including challenges to fossil and nuclear energy and the importance of climate change issues, the market is evolving towards favouring solar energy. Yet levels of market

penetration are very different in the different European countries. For instance, cloudy Germany has installed more collector surface than sunnier southern countries such as France and Spain.

The survey of the European Commission's DG TREN, Thermie B programme in 2001 showed that public awareness in Germany is very high, but that only a minority of respondents in France, UK and Spain consider the public aware of SWH. However, the acceptance of SWH is high in Europe, with approval of renewable energy technologies in general and SWH in particular. Therefore, the market is mature for internationalization, and it is a good opportunity for China to expand the domestic market into an international market.

6. A threat or an opportunity for European and US companies?

Threats

At the beginning of the 1990s, many Chinese-made toys were exported to the European market and New York was full of shoes 'made in China'. In recent years, you would also find more Chinese electric consumer goods and personal computers in the shops. The company Philips has built its largest overseas factories in China.

SWH manufacture is not yet a high-tech industry - yet there is certainly potential for it to develop in this way in China, as happened with the toy, shoe and electronics businesses. The difference between China and other developing countries is that China has a well established industrial infrastructure in sectors such as metallurgy, chemicals, petrochemicals, glass and other branches of the energy industry (such as coal).

In the United States, growth of the solar thermal market still requires massive efforts to increase public awareness. The Chinese SWH sector is particularly interested in the European markets, as the public in countries such as Germany, Austria and the Netherlands generally favours green energy - the only barrier is cost. As mentioned earlier, representatives of the Chinese SWH sector participated at the Sustain 2001 event in Amsterdam, holding a half-day workshop on SWH as a side-event at the conference (one of Europe's leading shows in this sector). The Chinese delegates also visited other European countries to build up business contacts and to develop further business alliances.

The solar energy business, in terms of market development, is similar to the toy, electronics and computer businesses. New Chinese players are expected to enter into the European home market, and the World Trade Organization offers China an excellent opportunity here. European companies need to prepare for the arrival of the new players.

Opportunities

- Strategic partner on product and technology improvement

Whether satisfying domestic or international consumers, product quality and technology must improve. The Chinese sector is looking for technology co-operation with European partners.

- Joint projection

Decreasing production cost would help SWH penetration in Europe. It is a trend for multinational companies to move their production to countries offering cheaper labour.
On the other hand, a German company - Paradigma Deutschland Ritter Energie- und Umwelttechnik GmbH & Co. KG - has a joint venture in China, and the products are mostly sold in the Chinese domestic market. The joint venture is going to launch a new product that is same as a system in common use in Germany, with a natural gas auxiliary unit and all-copper water piping. The proposed sales price of new system is similar to that in Germany.

Conclusions

Since they appeared on the market in the 20th century, solar water heaters have become a success in China and a number of European countries. China now has a well established solar thermal industry with over 1000 factories manufacturing and selling systems. Most of these collectors are used to heat water and are sold without subsidies.

The development and application of solar water heating technology have made great progress and provide people in urban and rural areas with cost-effective energy services; however, the inconsistent quality of product and the fragmented nature of the solar industry frequently impede overall market penetration and long-term market growth. Significant growth in the Chinese solar water heater sector would capitalize it for entry into the European market - a source of competition, or opportunities, for European companies.

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