

China's industrial sector continues to grow fast – particularly the manufacture of electronics and high-tech products. So what about photovoltaics? **Zhu Li** reports on recent developments.

Total photovoltaic cell and module production worldwide in 2002 was over 500 MW, and growth over recent years has been consistent at 30%. According to a report recently published by the European PV Industry Association (EPIA), global production needs to reach a total of 2.89 GW in 2010 in order to fulfil the official targets for installations in the US, Europe and Japan. In 2000, 95% of PV was manufactured in IEA member countries, the majority being in Europe, the US and Japan. As the PV market keeps growing, the industry will get into production on a massive scale, but

PV manufacturing is moving to developing countries, which will soon take a greater share of the global PV market

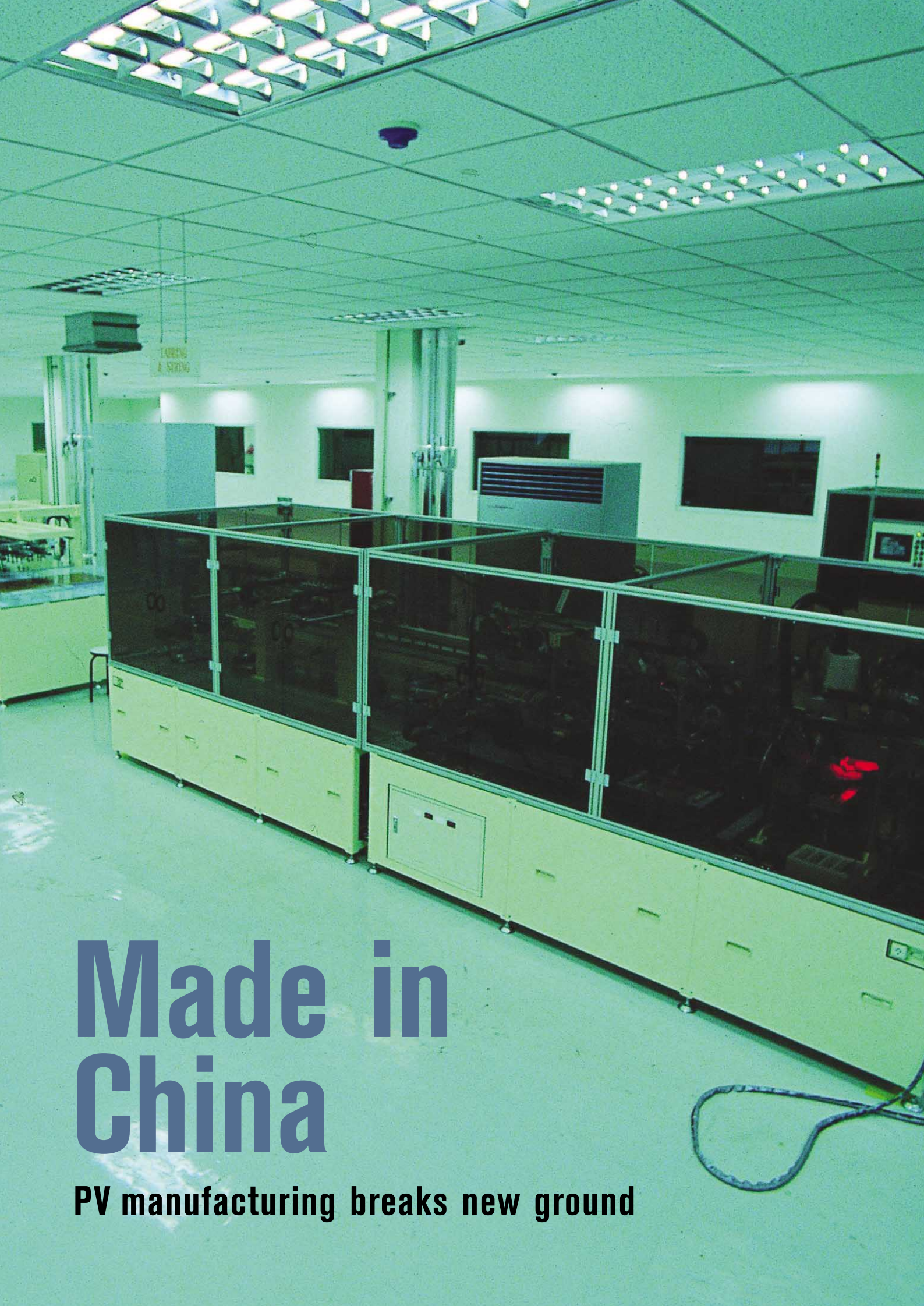
these countries will face more serious competition. The trend in the industry shows system assembly and manufacturing increasingly moving to the developing countries; this is not only because the production cost is cheaper, but also because these countries are expected to take a greater share of the global PV market in the near future. Investing in PV manufacturing in developing countries in the long term is therefore a cost-effective way to penetrate the market in such countries, and to be more competitive on the global market:

this has already been recognized by European, US and Japanese manufacturers.

In comparison with other developing countries, China has a uniquely diversified economy. It has remained the fastest growing economy in the world in the last 15 years, with an average annual GDP growth rate of 8%. On the other hand, more than 80% of China's total population still lives in rural areas, supplying 130 million migrant workers for the labour market, so that its labour costs remain the

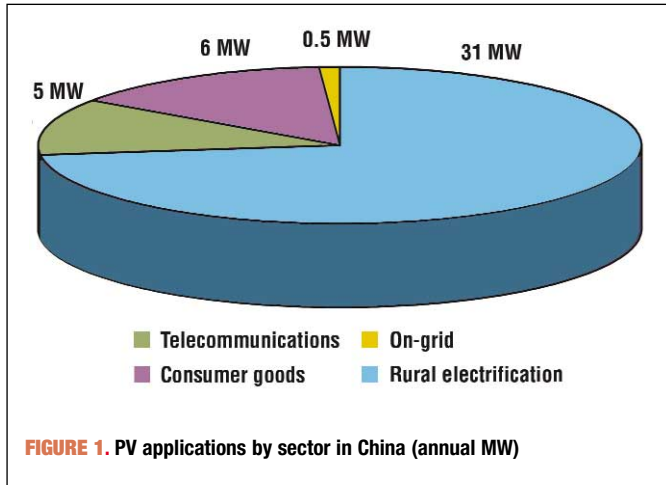


ABOVE LEFT Products made in China **ZHU LI** **RIGHT** PV module production line at Wuxi Suntech **WUXI SUNTECH**



Made in China

PV manufacturing breaks new ground



lowest in the world. China's diversified economy not only presents significant potential market for PV, but also offers a cost-competitive opportunity for PV manufacturing in the future.

THE CHINESE PV APPLICATION MARKET

The market for PV applications in China is made up of a number of different sectors, as shown in Figure 1.

Rural electrification – ambitious programmes, more challenges

The Chinese PV market is dominated by rural electrification projects, and seems to be booming at the moment. Total installed PV capacity nearly doubled in the space of one year, from 23.5 MW in 2001 to 43.5 MW at the end of 2002, with even more to be added in 2004. The biggest market driver in China is the National Rural Electrification Programme, the so-called *Song Dian Dao Xiang* ('Sending electricity to townships' - see the article in *Renewable Energy World* Sept–Oct 2003). So far, this is the largest and most prompt village power programme in the world, as ¥2 billion (US\$242 million) has been invested for the electrification of nearly 1000 rural townships in north-western provinces within two years.

Rural electrification now accounts for more than 60% of the total PV market in China. Apart from the various donor-aided, off-grid PV rural electrification programmes, which will see 20 MW of installations in the next two to four years, there is a more ambitious rural electrification programme. This is the so called *Song Dian Dao Cun* ('Sending electricity to villages') being prepared by the Chinese Government, with the aim of installing 100–150 MW of PV village power systems in the period 2005–2010. The *Song Dian Dao Xiang* (the township programme) has already doubled PV installation in just one

year, adding 20 MW of PV capacity in 2002. However, the big excitement ended with an overheated short-term market; as the resulting serious competition in the PV module market saw the price drop from US\$4.5/Wp to \$3.5/Wp in the space of two years, which excluded most of the local manufacturers from participating in the programme.

It is estimated that a total of 55,000 technicians are urgently needed for the first phase of these programmes. Having realized the challenge faced by what is the largest rural electrification programme so far, the Chinese Government and



ABOVE The 150 kW PV village power system in Beitashan, in the Xinjiang Autonomous Region; it is estimated that a total of 55,000 technicians are urgently needed for maintaining such village power systems **IT POWER** **BELOW** People in Beitashan anticipating the arrival of local and national officials for system inspection **IT POWER** **BOTTOM** Officials on their way **IT POWER**





some of the donor agencies have held a series of technical training seminars and workshops for the local technicians. However, compared to the scale of installations necessary, this technical training is far too small to meet the demand.

Even putting aside the issue of the length of time for which people in these rural areas will receive the electricity service provided by these government-sponsored programmes, these endeavours are, in fact, having a negative impact on the PV market and industry.

Ironically, the other main PV rural electrification scheme, the World Bank/GEF renewable energy development project, has not yet added much capacity since beginning in 1997. After six years of preparation, and with \$15 million in its PV component to promote the solar home system (SHS) market in north-western provinces, the project only achieved 2% of its target to install 10 MW of systems by 2002. The 17 local PV integrators who qualified to receive \$1.50/Wp for SHS they sell

Government-sponsored programmes are in fact having a negative impact on the PV market and industry

in six north-western provinces, took part in a series of business development training programmes over six years, but they are now facing an enormous challenge on the SHS market, due to the unpredictability of competition from the *Song Dian Dao Xiang* programme.

PV does provide a technical power supply solution for people living in remote rural areas, where access to electricity services by grid connection is impossible. In particular, PV village power systems are in the majority of cases the most cost-effective way of providing reliable, good-quality electricity services to the rural poor. As China still has 70 million people without access to electricity, the use of PV for rural electrification has great market potential. However, as a result of political interests, electrification programmes seldom last as long as they should, due to the lack of attention paid to their sustainability. This certainly gives the technology and the PV industry a negative image, and in addition to this, the highly unpredictable market makes it difficult for the industry to develop long-term strategies and targets. The potential of PV installation for rural electrification, though, remains very exciting.

Commercial PV application market

Despite fluctuations in the PV market due to the rural electrification programmes, the commercial PV market maintains its steady growth each year. China has the fastest-growing market for

The market for PV in Chinese consumer goods is completely commercial and competitive

telecommunication in the world, and in the PV sector for telecommunications and transportation growth is comparatively steady at 5 MW annually.

The global market for PV consumer goods has increased quite quickly in recent years, with the main product being the domestic garden light (see photo below). The market for PV in consumer goods is completely commercial and competitive, with total annual consumption of solar cells at around 6 MW. Most products are for the export market. Of about 30 private electronic light companies in China involved in solar garden light assembly and sales, most are based in the provinces of the south-east coast, the richer areas of China such as Zhejiang, Jiangsu, Shanghai and Guangdong.

As with the markets for other exported consumer goods made in China, the profit margin for the solar garden light companies cannot really be determined. While the solar cells are all imported from Europe, the US and Japan, products are sent back to these markets at highly competitive prices. 'The overall added value of Chinese solar garden lights isn't very high, so Chinese manufacturers try to make a profit by the quantity they sell,' says Miao Hong, project manager of the China-Canada Climate Change Programme. Ms Miao also refers to the example of Photowatt, a joint Canadian-French PV manufacturer which



has invested in a solar light assembly factory in Zhejiang province, selling the products back to Europe and the US.

Chinese solar garden lights have a very impressive market share in the EU and the US, while the market for solar cells in consumer goods in China has a 20% annual growth rate. There seems to be a very optimistic market for PV at the moment, benefiting from the Chinese Government's export subsidy and the low cost for labour.

However, this incentive also raises the risk of Chinese exporters facing dumping charges from the EU and the US. As China's exports grow, this has become a serious, long-term issue for business. Since 1997, more than



ABOVE Solar home systems shop in Lhasa, Tibet **POWER LEFT** Solar garden light made in China



Domestic PV manufacture uses out-of-date technology on a small scale, and market supply relies largely on imported products

400 dumping lawsuits have been filed against Chinese products, affecting at least \$10 billion in Chinese business, and electronic products play a major part in this. One recent case saw energy-efficient light bulbs from China blocked from the EU market, as a result of losing an anti-dumping suit. This could serve as an early warning to solar garden light manufacturers.

BIPV – a sustainable, long-term market, but how long?

Shanghai, Beijing and Shenzhen – the city across the border of Hong Kong – are the beacons of prosperity in China. However, these cities, the richest in the country, are facing severe environmental problems. While housing construction in medium and large-scale cities is growing by more than 50%

Down with the old, up with new: rebuilding Chinese cities. China needs to build 1 billion m² in the next 10 years ZHU LI



each year, according to Ministry of Construction estimates, China will need 1 billion m² of new housing in the next decade. Building-integrated PV (BIPV) systems are one option for tackling environmental problems in the larger cities in China, and would contribute to a sustainable PV market in the long term. However, even in OECD countries, BIPV applications are at present generously subsidized by governments.

It is difficult to say when China will issue a clear policy on BIPV systems, though the Government has at least started to spend money on demonstration and R&D in this field. The Ministry of Science and Technology has funded two BIPV demonstration projects, one of 25 kW capacity in Shengzhen, and the other a 10 kW installation in Beijing. Although the Chinese Government has clearly expressed interest in BIPV applications, this will very likely result in a similar situation as in the Chinese wind power market; the wind sector has gone without clear incentive policies for many years, even though it has great market potential.

PV MANUFACTURE IN CHINA

PV manufacture in China began in the early 1970s – no later, in fact, than in the rest of the world. However, manufacturing capacity is still a long way behind other countries. By 2000, there were only seven PV manufacturers there, with a total production capacity of just 12 MW for cells *and* modules. All of the production lines were financed through government R&D schemes or international aid programmes for technical demonstration, and all are fairly small in scale. By 2000, the largest of the lines, in terms of production capacity, is only 2 MW/year. Chinese domestic PV manufacture still generally uses out-of-date technology on a fairly small production scale, and market supply of PV relies to a great extent on imported products. Figure 2 provides an overview of PV production capacity by type over recent decades.

The production cost of solar cells and modules of local manufactures remains high at the moment. This is mainly because the major fabrication materials, such as silicon wafers, silver paste and high-quality ethylene vinyl acetate (EVA) and back sheet (TPT), depend on imported products, and the local manufacturers cannot benefit from the import duty exemption if their products are only sold on the domestic market. However, joint venture and foreign companies can take advantage of exemption from raw material import duty – part of the Chinese Government’s policy for encouraging the establishment of manufacturing facilities by foreign investors. Table 1 shows the level of import duty on the raw material used for PV.



TABLE 1. Import duty of raw material for PV. Source: Wuxi Suntech

Item	Import duty
Silicon wafer	14%
Silver paste	13%
EVA	8.4%
TPT	8.5%

Overseas firms in China

With manufacturing jobs being relocated to countries with low wages, one of the most popular of these countries is China, and this is no exception for the PV industry. Foreign investment in PV manufacture only began in the last two years, but at least four new PV production lines have been planned since 2001, with the largest line's capacity ranging up to 25 MW. Some of these lines have already started production.

Wuxi Suntech Power Co. Ltd is a Chinese-Australian joint venture in PV manufacturing. With total investment of \$18 million and 10 MW production capacity, the company has declared itself the largest PV manufacturer in China. 'Suntech is expanding [its] manufacturing capacity,' says Dr Zhengrong Shi, the company's president. 'By November 2003, [its] second solar cell production line will be in operation, [bringing] total capacity to 25 MW'.

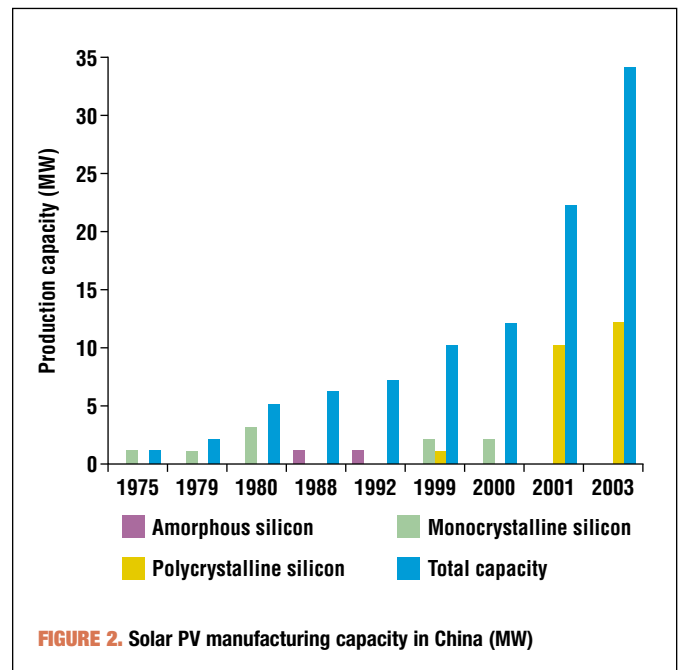


FIGURE 2. Solar PV manufacturing capacity in China (MW)

In terms of PV manufacture in China, Japanese companies are ahead of their competitors in Europe and the US, given China's geographical convenience and similar culture. In the case of PV manufacture, the fast-growing, more competitive PV market in Japan has also driven companies there to look at moving manufacturing facilities to China. With 40% of the global market, Japanese PV manufacturers represent around a half of total PV shipments worldwide; furthermore, the government target for PV installation there is 3 GW by 2010, which will ensure it retains its leading position on the global market and in production.

Kyocera is the first Japanese company to produce solar modules in China, having recently announced the launch of its



TABLE 2. Chinese PV manufacturers. Source: China Renewable Energy Industry Association

Manufacturer	Products	Production capacity (MW)	Year commissioned	Expansion plan
Kyocera Tianjin Solar Energy Co. Ltd	Polycrystalline silicon solar cells	12	2003	–
Wuxi Suntech Power Co. Ltd	Polycrystalline silicon solar cells	10	2001	25
Shanghai Solar Energy Science and Technology Corporation	Monocrystalline silicon solar cells and modules	2	2000	–
Baoding Yingli New Energy Resources Co. Ltd	Polycrystalline silicon solar cells	1	1999	48
Shanghai JiaoDa Guofei Green Energy Co.,Ltd	Monocrystalline silicon solar cells and modules	2	1999	–
Shengzhen Yukang Solar Energy Ltd	Amorphous silicon solar cells	1	1992	–
QinhuangDao Huamei Photoelectricity Equipment General Company	Monocrystalline silicon solar cell and modules	1	1989	–
Harbin-Chronar Solar Power Company	Amorphous silicon solar cells	1	1988	–
Ningbo Solar Power Source Company Ltd	Monocrystalline silicon solar cells and modules	3	1980	–
Yunnan Semiconductor Device Factory	Monocrystalline silicon solar cells and modules	1	1979	–
Kaifeng Solar Cell Factory	Monocrystalline silicon solar cells and modules	1	1975	–

12 MW production line in Tianjing City. Production at the new plant commenced in October 2003. The plant is also Kyocera's first solar module production line outside of Japan, and total investment was \$2.2 million. Kyocera's new joint venture with Chinese partner Tianjin Yiqing Group shares 10% of the total capital, and will focus its business on PV system manufacture, sales, and installation and maintenance on the international market. MSK, another Japanese solar module manufacturer, also

has plans to establish a 10 MW solar module production line at Donghuan, in Guangdong province. Table 2 lists some Chinese PV manufacturers.

China now takes about 5% of goods exported globally and this proportion rose by 21% during the past year, so the current figure is now at ~6%. The country is described as 'a big assembly workshop' for the world economy, in a recent report from the Beijing Dajun Economic Observation Institute. This is



ABOVE Kyocera's Tianjin plant **KYOCERA** **LEFT** Wuxi Suntech's solar cell production line **WUXI SUNTECH**

mainly due to the Chinese Government's export subsidy, and the low cost of production.

The future for Chinese PV manufacture

Although rich countries are blaming China's 'artificially undervalued' currency for the loss of manufacturing jobs,

invest in manufacturing there. It can be anticipated that China will have large-scale production capacity in PV - as it will in other manufacturing industries - just a few years later.

Zhu Li is a project co-ordinator at ISPQ-Europe, UK.
e-mail: li.zhu@ispq.org

