Development Trends and Measures to Promote China's Solar Cell Technology and the PV Industry

The energy demands of socioeconomic development keep growing. Like other major countries, China is also facing an increasing shortage of conventional energy supplies. The large-scale exploitation of fossil fuels is a major contributor to environmental pollution. Economic development under the dual constraints of limited energy sources and the need for environmental protection has become a matter of global concern. Therefore, developing diverse new energy sources is a strategic priority of governments around the world.

In light of this, a task force was set up by the CAS Academic Division of Technological Sciences to appraise the current situation of the world's photovoltaic (PV) industry and offer recommendations accordingly. The following is an English summary of its report.

Being renewable and clean, PV energy is an important component of new and green energy sources, the need for which is further confirmed after the Fukushima Nuclear Accident in March 2011. Driven both by technological progress and policies and regulations of various countries, the PV industry has become one of the fastest developing industries in the world, with a nearly 40% annual growth rate over the past decade. Solar cells that convert the energy of light into electricity are the foundation of the PV

industry. With the constant goal of improving efficiency and reducing costs, many organizations around the world are involved in the research and development of solar cells. Remarkable progress has been made in a variety of solar cell types, ranging from crystalline silicon, silicon thin-film, CIGS (copper, indium, gallium, selenium) thin-film and CdTe thin-film to III-V compound-base solar cells, dye-sensitized, organic and next generation high-efficiency solar cells. Technological progress has steadily reduced the costs of PV power generation.

China's PV manufacturing industry was started in 1995. Since 2007, it has been the world's largest producer of solar cells and modules. In 2010, China's mainland and Taiwan produced over 12 GW of solar cells (mainly crystalline silicon), accounting for 59% of the world total. While China is comparable to the world level regarding mass production of traditional crystalline silicon solar cells, it is lagging behind in terms of newly-structured high-efficiency silicon cells, and has a long way to go to catch up with the advanced world level in the production of various thin-film solar cells. We lack key knowhow and facilities to produce high-performance solar cells, and have to import high-end facilities and auxiliary materials even for producing crystalline silicon solar cells. Most of China's solar cell products are exported: the relatively small domestic market consumes less than 5% of its total output. In 2009, the total installed capacity of PV power generation in China reached 228 MW, making up only about 3% of the global total in the same year. Therefore, China is merely a large manufacture for solar cells, rather than big in terms of PV technologies and the application of solar cells. This has resulted in the situation in which solar cell production consumes energy and pollutes the environment in China while supplying clean energy to foreign countries.

Western countries have gained the upper hand in developing advanced technologies and high-end high-precision automated facilities for solar cell production, and at the same time they are promoting the development of the PV application market through policies such as feed-in tariffs. By contrast, China is simply approaching excess manufacturing capacity for solar cells and modules. With diminishing government support of the PV industry and the implementing of protectionist policies in foreign countries, China's PV industry is finding it ever harder to make profits, and some manufacturers have gone into the red. The reduction of governmental support of the PV installation industry in Western countries is justified by technological progress and cost reduction, and is also designed to curtail the development of China's solar cell industry. Multiple factors contribute to the difficulties facing China's PV industry. In addition to the small domestic market, blind expansion is another contributing factor. Excess capacity leads to cutthroat competition and wasted investment. More importantly, many PV enterprises in China purchase production facilities but have no key competency in PV technologies of their own. They therefore lag far behind the international advanced level in terms of product cost and performance.

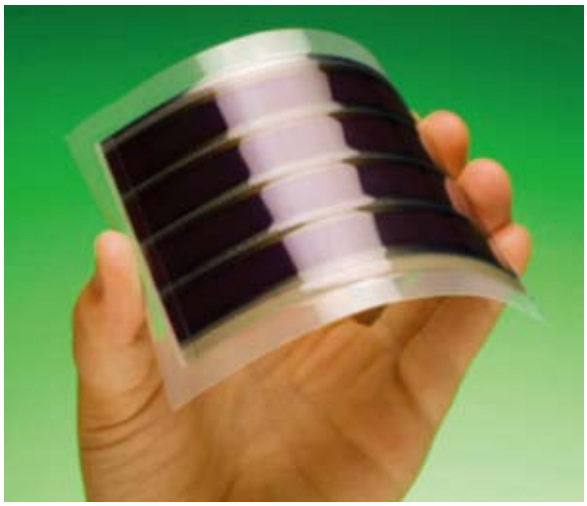
From a long-term point of view, the PV industry is sure to grow in terms of both performance and scale. PV power generation is a rising star in the global energy system. With the continuous reduction of PV power generation costs through technological progress, the industry will reach grid parity. According to the European Photovoltaic Industry Association (EPIA), PV power generation will be competitive with other electricity sources in as much as 76% of the EU electricity market by 2020.

There are several key conditions under which China's PV industry as a new energy source is beginning to take shape: its further development is restrained by both technology and markets; the global PV industry has a bright future; China's energy and power development is under the pressure of restructuring; expanding China's domestic market for PV applications will ensure the realization of the objectives of energy efficiency and emissions reduction.

From a strategic point of view, China should enhance and protect its PV industry and its position as the world's largest producer. In the domestic energy market, efforts should be made to encourage PV applications, so as to help overcome the situation in which solar cells are mostly exported and at the same time constrained by foreign countries. Therefore, in line with national demand, and aimed at building China's PV industry into a world leader in terms of technology, as well as scale, the taskforce offers the following recommendations:

1. Give more importance to PV energy by mapping out strategies for the future development of PV power stations and promoting PV energy applications and popularization.

Taking PV energy as an important approach to reducing carbon emissions and addressing fossil fuel shortages, efforts should be made to speed up the development of building integrated PV and PV power stations, and expand solar cell application so as to put an end to the situation in which China's solar cells are mostly exported and under the control of foreign markets. At the same time, the research and development of smart grid connection and large volume high-efficiency energy storage technology should be



urgently conducted. As it is easier to develop energy storage technology for small scale PV power stations and building Integrated PV, mandatory planning in this regard should be made as early as possible. China's northwest and Inner Mongolia regions are particularly suitable for developing large-scale PV power stations.

2. Build up risk resistance capacity by developing regional industrial clusters and industry chains on the market.

It is unwise to keep encouraging the establishment of medium- and small-scale firms in the field. To cut costs and strengthen lasting competency, 10 GW-level super large enterprises might be formed through merger or production capacity expansion in line with market development. To centralize management and address environmental pollution problems, enterprises producing silicon materials by chemical purification should be supported and encouraged to expand their annual production capacity to the 10-ton level. Repeated establishment of enterprises in the sector in coastal regions and hinterlands should be severely restricted. A responsibility system for the supervision of environmental protection and energy-saving in the sector should be implemented along with the enforcement of safety measures within a time limit. More support should be given to the physical purification approach, which is low in pollution and energy consumption, and other innovative methods. Challenges are both difficulties and opportunities. By taking advantage of the opportunities, we should make dramatic efforts to consolidate firms in an appropriate way, get rid of backward technologies and make reasonable deployment. We should build up capacity to reduce risks and change the wasteful practice of disorderly competition and duplicate construction through up- and down-stream coordination and encouraging consolidation to form regional industrial groups.

3. Coordinate development of various kinds of solar cells through classified support in line with market demand.

It is advisable to classify solar cells into four groups in line with their market applications: alternative energy sources, building integrated PV energy sources, energy sources for special purposes, and portable energy sources for consumers. Innovation in all kinds of solar cells should be encouraged to reduce PV power costs from the first stage of the production and application process. Efforts should be made to reduce the costs of PV power generation to the level of fossil fuel power generation in two to three years.

Alternative energy sources

Priority should be given to silicon cells with other kinds of thin-film cells as a necessary supplement. Governmental departments should blueprint development plans in this regard as soon as possible. Coordinated development should be encouraged under the guidance of the scientific outlook on development and by making enterprises the main player. Enterprises should be supported in their efforts for technological innovation and system integration to reduce costs and energy consumption.

Building integrated PV energy sources

Importance should be placed on thin-film silicon cells. Government investment and support should be strengthened so as to promote the development of key engineering processes and facilities, raise the efficiency of cells and reduce their manufacturing costs.

Energy sources for special purposes

For aerospace and military applications, importance should be attached to high-efficiency multiple-junction GaAs solar cells. Government should play the major role in their rapid advancement. However, the development scale should be evaluated and planned in a scientific way beforehand.

Portable energy sources for consumers

Importance should be placed on organic and dyke-sensitive cells. The government should encourage research institutions to conduct research and innovation in this

aspect, with the active involvement of medium- and small-scale enterprises.

4. Independent development of the accessories industry.

As to advanced PV manufacturing facilities, government should organize research and development and ensure their batch supplies. Efforts should be made to speed up the localization of production facilities in newly established and expanded enterprises. At the same time, importance should be placed on the research, development and supply of high-quality fundamental materials and key auxiliary components and devices. It would be advisable for the State Council to set up a special leading group to promote the development of PV accessories across different industries and sectors.

5. Research and development of next-generation ultra-high efficiency solar cells

It is suggested that the government should set up a national open research center for next generation solar cells on the basis of CAS and key universities. In light of frontier theories, it will focus on creative basic research in selected areas, make breakthroughs in the theoretical limits of conventional solar cell efficiency, and produce high-efficiency, low-cost next generation solar cells. Single junction solar cells will remain a priority focus.

6. Farsighted policy support and guidance

It is recommended that forward-looking, predictive and innovative guidelines and policies should be formulated to enforce macroscopic regulation of the power system. Under the direction of the State Council, efforts should be made to promote grid connection of PV electricity, implement mandatory plans for building integrated PV, satisfy the reasonable credit requirements of PV enterprises, and help the industry overcome the impact of the international financial crisis and tariff barriers.

Macroscopic regulation and strict supervision should be stressed during the implementation of the guidelines, policies and regulations so as to prevent the pursuit of departmental and short-term interests. It would be advisable to set up a technology foresight institution made up of experts and entrepreneurs to offer suggestions to the government.

To deal with the difficulties facing China's PV manufacturing industry, a national symposium is recommended, bringing together experts and officials from central governmental departments, local governments, enterprises and research institutes to formulate detailed planning for the industry.

In general, rapid and sound development of the PV industry is conducive to national growth and people's livelihoods. Economy of scale is now a major development trend of the PV power generation industry around the world. It is imperative to expand the PV application market in China. Therefore, government should formulate policy to support China's PV industry and plan for its development from the point of view of energy strategy. As to different kinds of solar cells, investments should be made in accordance with this strategy so as to accelerate technological innovation and reduce power generation costs. This would enable China to occupy a leading position in the future large-scale application of PV energy and transform China from simply being a big country for conventional solar cell manufacturing into a dynamic, strong country for advanced PV industry.