Bridgewater Review

Volume 35 | Issue 2 Article 4

Nov-2016

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Xiangrong Liu
Bridgewater State University, xiangrong.liu@bridgew.edu

Recommended Citation
Liu, Xiangrong (2016). Power, Promise and Problems: The Solar Photovoltaic Industry in China. *Bridgewater Review*, 35(2), 3-6.
Available at: http://vc.bridgew.edu/br_rev/vol35/iss2/4

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Power, Promise and Problems: The Solar Photovoltaic Industry in China

Xiangrong Liu

Since 2008, China has seized the solar-power generation opportunity and leapfrogged into the largest producer and user of Photovoltaic (PV) systems in the world. In this time, its rate of PV capacity growth has been truly astounding. According to a China Photovoltaic Industry Alliance (CPIA) report released in January 2016, China reached 43 Giga-Watts (GW) in cumulative installed capacity by the end of 2015 (see Figure 1) and has more than 20% of the world's cumulative installed capacity. Even more remarkable is that more than one third of this total (about 15GW) was installed within the year 2015 alone. The emerging solar PV industry in China is due to the three reasons: first, a rapidly changing and booming international PV market; second, China's PV-targeted government policies and incentives; and finally, the increasing demand for clean energy (especially electricity) in China and the need to remediate the deteriorating environment due to pollution emissions from coal-fired power plants. China's decisive move into photovoltaic power generation is an intriguing example of how 21st-century globalization works. A solution to some of its own domestic energy needs, PV production has thrust China unavoidably into international markets and the entangled politics of supply.

PV: International Markets and Trade Wars

The emergence of China's PV industry has relied principally on the international market. In 2004, high-level feed-in tariffs and other PV subsidy policies initiated by several countries, including Germany, stimulated private investment in PV production all over the world. According to data from International Energy Agency (IEA), the Chinese domestic market for solar PV installation was less than 1 GW in 2010, and 95% of PV modules produced there were exported to countries other than the U.S. (B. Lombardozzi, "True Cost of Chinese Solar Panels," www.americanmanufacturing.org [2014]). In 2012, China exported large amounts of solar cells and modules worth $2.8 billion, and accounted for 56% of all PV-related imports in the U.S. China's large exports in this field are a result of the country's low cost of production, which is itself a result of the low labor costs and government subsidies.

The swift rise of PV exports from China has caused concerns about dumping in the importing countries. Dumping is when a company exports a product at a price lower than the normal price it usually sells for on the market in its own country. In 2011, the Coalition for American Solar Manufacturing (CASM), a coalition of 250 U.S. companies involved in solar manufacturing and installation and led by U.S. Solar World, filed anti-dumping and anti-subsidy duty petitions with the U.S. Department of Commerce (DOC) and the International Trade Commission (ITC) in order to prompt investigations into this misconduct.

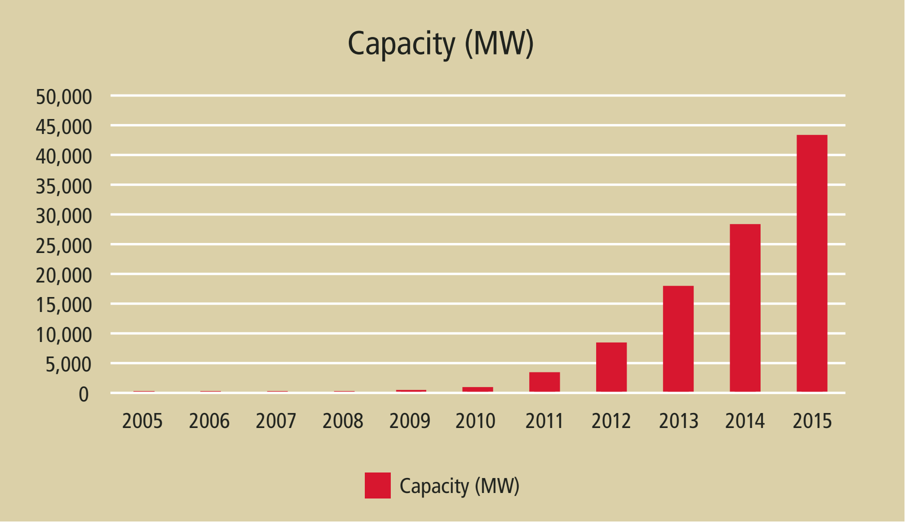

Figure 1. China's Installed Capacity of Solar Electricity
Source: https://en.wikipedia.org/wiki/Solar_power_in_China.

The cases resulted in penalties of 18.32-249.96% for anti-dumping duties and 14.70-15.97% for anti-subsidy duties against solar cells and modules imported from China. Similarly, EU Prosun, an industry association of European solar PV manufacturers, filed a suit with the World Trade Organization (WTO) in 2012. The European Commission launched its own dumping investigation in 2012, which mandated that Chinese PV modules and component imports into the European Union (EU) be subjected to an average anti-dumping duty of 47.6%. In addition, the EU now requires China to commit to an import quota and a minimum import price based on the Bloomberg average international price for PV modules.

Following these dumping investigations and repercussions, China experienced an 18% decrease in PV panel exports, including a 62% decrease to European markets. Although these trade wars damaged China's PV panel export revenues, China remained the leading manufacturing of PV panels in 2012 with roughly two-thirds of total global production. Moreover, China's PV manufacturers continue to pursue moving their production to other counties. For example, in January 2016, Yingli, one of the largest Chinese PV module producers, announced plans to partner with Demeter Power to produce multi-crystalline PV panels in Thailand.

China's Solar Energy Policy

According to Bloomberg, the Chinese government's investment in clean energy was $110.5 billion in 2015. According to International Energy Agency (IEA), in the past 20 years, starting with the Brightness Program in 1996, China has introduced 50 energy policies, half of which are directly related to solar production, and the other half to multiple renewable energy sources in general. These policies can be categorized into five major types: government policy support, economic instruments, regulatory instruments, research development and deployment, and information and education. The largest category is policy support and it includes three subcategories: strategic planning, institutional creation and general policy support. Regulatory instruments (such as codes and standards) were introduced frequently after 2013 when China's solar PV industry faced another round of challenges, including antidumping investigation and overcapacity. But there has been very little detectable activity in the areas of research, development and deployment, or information and education.

> In 2002, [China] initiated a "Power Supply Plan for Rural Areas without Electricity in the Western Provinces and Regions," which promoted PV application in remote areas.

As the second largest category, economic instrument policies consist of fiscal/financial incentives such as taxes, feed-in tariffs, grants and subsidies.

Three policies in particular mark the government's commitment to the solar PV industry. In 2002, it initiated a "Power Supply Plan for Rural Areas without Electricity in the Western Provinces and Regions," which promoted PV application in remote areas. Incentive-based policies led to the installation of a 4.3GW solar power station (2009-12) in northwestern China; in the same period, another policy, "Golden-Sun," provided incentives to more than 700 solar power plants, each with 5.8GW capacity. Like most Western countries, China also adopted Feed-in-Tariffs (FiT)—long-term contracts provided to renewable energy producers, with variable rates per kilowatt hour of energy produced (i.e. in areas with the highest solar radiation, the FiT is lower because the generating cost is also lower). Through these efforts, the government's incentivizing has changed from "pushing" the supply side to "pulling" the demand side.

PV in the Domestic Market

On one hand, China's demand for energy, especially electricity, continues to increase. Even with the slowest rate of growth since 1998, the electricity demand in China reached 5500 terawatt hours (TWh) in 2015. On the other hand, the deteriorating environment due to the pollution emissions from coal-fired power plants makes a switch to renewable energy sources, especially solar energy, critical to improving living conditions. In 2014, air pollution led to more than 200 unhealthy days due to poor air quality in Beijing (G. Gao, "As Smog Hangs Over Beijing," www.pewresearch.org [2015]). The smog in China is a severe problem. About 60% of the country's power is generated from coal and solar power is an obvious, safer alternative. Solar power generates electricity through semiconductors and its application can be categorized into two types: centralized systems or distributed systems.

Centralized solar applications are large-scale systems run by utility companies, while decentralized applications are photovoltaic systems installed on the rooftops of residential buildings, business buildings – such as warehouses and shopping malls, and in other public areas – such as those at schools and airports. In 2015, the cumulative capacity of centralized systems accounted for 84% of total installed capacity, while distributed accounted for only 16%. Both sorts of applications face significant challenges to potential expansion.

…China remained the leading manufacturing of PV panels in 2012 with roughly two-thirds of total global production.

For centralized solar applications, there are three major obstacles. First, land use is a serious problem; to build a solar PV plant, large areas are needed. Regulations within China's different government departments vary, and getting permission for land use is very challenging. Also, taxes related to land use have significantly increased the cost of solar PV electricity generation. Second, China's vast geography is an obstacle to efficient solar generation and use. The provinces in northwestern China have sufficient solar resources, such as long hours of sunshine and large spare landscapes, and a great potential to generate solar power. But transmitting it to the populous and industrial East is the challenge. In 2015, Chinese solar PV producers abandoned 4.65 billion KWh, or 12.62% of the country's solar PV installed capacity. Gangsu, Qinghai, Xinjiang and Ningxia provinces abandoned the largest percentage of solar electricity. The uneven geographic distribution of solar resources and economic development is a serious issue and the significant power loss during the transmission process renders this business model unsustainable.

The third major obstacle for further developing large-scale solar-powered systems involves long waiting periods for permission from local governments, power-supply companies and the other administrative departments. Numerous projects did not receive government subsidies on time as promised; in one case, a group of projects experienced a two-year delay, which increased the generation cost and reduced the returns on investment. These delays have had a chilling effect for householders, who hesitate to submit their rooftop PV system adoption applications. The adoption of solar PV systems by households is slow. The complicated application process, lack of knowledge of solar PV systems, and large initial investments are prohibitive reasons. Some cultural reasons—such as fear of breaking away from centralized energy systems—may also be delaying the adoption process.

PV Supply Chain

A full understanding of China's PV industry requires a thorough

Distributed PV System on the Roof of an Industrial Plant, Changzhou. Author's photo.

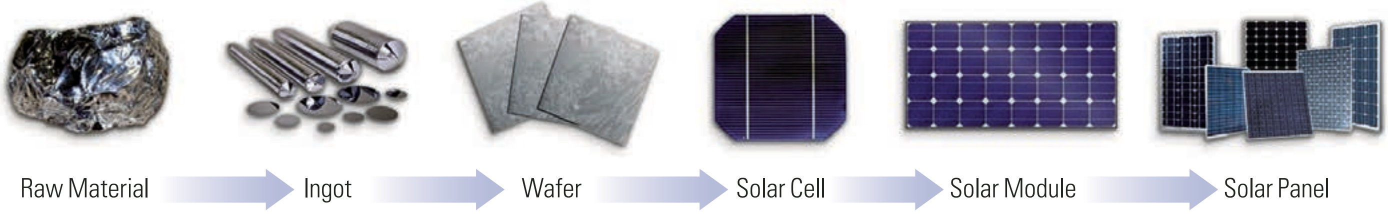

Figure 2. PV Supply Chain Structure
Sources: www.microchemicals.com/products/wafers/from_the_ingot_to_finished_silicon_wafers.html; www.utech-solar.com/en/index.html; kemiwafers.com/cells.php; solardo.eu/photovoltaik/solarmodule/.

investigation of its supply chain structure. Figure 2 illustrates the PV panel production process. Raw materials such as crystalline, or multicrystalline silicon, both of which have high purity levels of silicon, are cast into ingot and then cut into pieces, or wafers, which can be used to produce solar cells. Multiple solar cells are then strung together to make a solar module. A solar panel includes a solar module and a balance of systems including wiring, invertors for transforming AC to DC, batteries and other electronic parts. Finally, an installer takes the solar panel and installs it at a selected site.

The development of the Chinese solar PV industry has faced different challenges in different periods. In 2005, high-purity silicon and wafers were in short supply due to the rapidly increasing production of solar PV panels. As a result, producers sought to secure silicon supply through long-term contracts with silicon/wafer suppliers using common strategies of supply-chain management. But this led to other problems.

Soon, the pendulum had swung too far the other way. Over production led to a glut of silicon, wafers and PV panels causing a sharp drop in prices at all the stages of production, sometime after 2008. For example, in 2015, China's multicrystalline production was more than 165 thousand tons, double the amount of 2013. Overcapacity caused a reduction in the average price to 124 thousand renminbi (RMB)/ton, a decrease of 22.6% from 2014. Because of the low (almost zero) profit margin, only 15 multicrystalline manufacturers survived, but the largest six of them together have an annual capacity more than 10 thousand tons—more than half of the Chinese solar power market. Overcapacity led to the price reduction of solar modules from 36 RMB/Watt peak capacity (Wp) ($6 USD/ Wp) in 2007 to an average of 4.04 RMB/Wp ($0.66 USD/Wp) in 2015.

With the pressure of declining rates and the anti-dumping investigations in the global market, many Chinese PV panel producers and their suppliers went out of business between 2012 and 2014 because they did not anticipate these dramatic changes. In this field, vertical integration may potentially lead to business failure, especially if a company does not have sufficient resources or the competitive advantages to operate in the new field. Similarly, long-term contracts can introduce inflexibility into supply-chain management, which increases the risk of supply-chain interruption when the market changes. For example, SunTech, the largest producer of PV panels in China, was founded in 2001 and reached its peak in 2008. In July 2006, SunTech signed a 10-year contract (with pre-determined pricing) with U.S.-based Monsanto Electronic Materials Company (MEMC) to ensure a supply of solar wafers. With the drop of wafer prices in 2011 and the over-production of solar panels, SunTech had to terminate its contract with MEMC and pay a penalty of $120 million. One wrong purchasing decision led directly to SunTech's bankruptcy in 2012.

Within the last 10 years, the rapid growth of China's solar PV industry has been phenomenal. The future of solar PV industry in China is very promising; however, developing its solar PV sector in a healthy way still has a long way to go. With increasing competition and regulation in the global market and strong pressure domestically due to over capacity and continuous price reduction, the Chinese government and Chinese PV panel producers have steeper hills to climb than they did 10 years ago. But even in the changed and changing circumstances, solar PV remains a good solution for China, not only to meet the increasing demand for electricity, but also to reduce the pollution emissions from coal-fired power plants.

Xiangrong Liu is Assistant Professor and Internship Coordinator in the Management Department.