A Chinese Solar Company's Fleeting Run in the Arizona Sun

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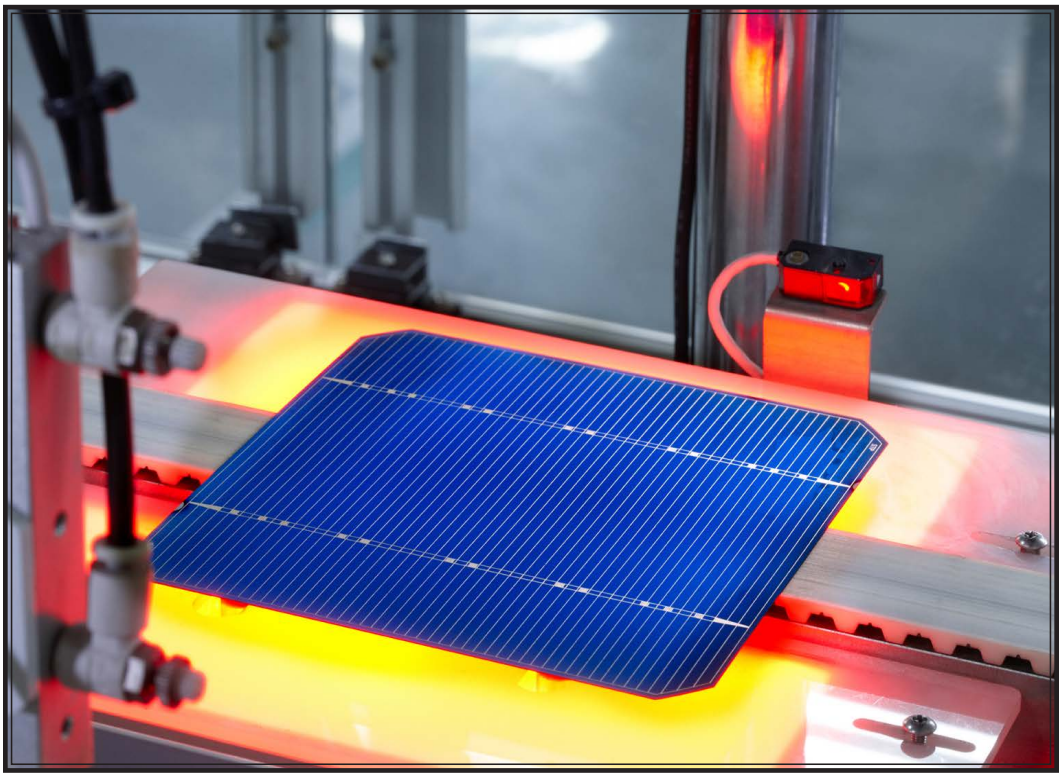

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Preface

For decades, bilateral investment has flowed predominantly from the United States to China. But Chinese investments in the United States have expanded considerably in recent years, and this proliferation of direct investments has, in turn, sparked new debates about the future of US-China economic relations.

Unlike bond holdings, which can be bought or sold through a quick paper transaction, direct investments involve people, plants, and other assets. They are a vote of confidence in another country's economic system since they take time both to establish and unwind.

The Paulson Papers on Investment aim to look at the underlying economics—and politics—of these cross-border investments between the United States and China.

Many observers debate the economic, political, and national security implications of such investments. But the debates are, too often, generic or take place at 100,000 feet. Investment opportunities are much discussed by Americans and Chinese in the abstract but these discussions are not always anchored in the underlying economics or a realistic investment case.

The goal of the Paulson Papers on Investment is to dive deep into various sectors, such as agribusiness or manufacturing—to identify tangible opportunities, examine constraints and obstacles, and ultimately fashion sensible investment models.

Most of the papers in this Investment series look ahead. For example, our agribusiness papers examine trends in the global food system and specific US and Chinese comparative advantages. They propose prospective investment models.

But even as we look ahead, we also aim to look backward, drawing lessons from past successes and failures. And that is the purpose of the case studies, as distinct from the other papers in this series. Some Chinese investments in the United States have succeeded. They created or saved jobs, or have proved beneficial in other ways. Other Chinese investments have failed: revenue sank, companies shed jobs, and, in some cases, businesses closed. In this sense, past investments offer a rich set of lessons to learn.

Damien Ma, Fellow of The Paulson Institute, directs the case study project.

For this case study of Wuxi Suntech Power, we are extremely grateful to James Harter, a talented University of Chicago undergraduate, for his

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extraordinary research and enthusiasm for the project.

Case studies are reconstructed on the basis of the public record, personal interviews with participants, and journalistic accounts. They aim to reflect a best reconstruction of the case. But they may have gaps and other inadequacies where the record is incomplete, facts are murky, or players chose not to share their views.

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Glossary of Terms[1]

Polycrystalline Silicon ("polysilicon"): A material consisting of small silicon crystals and a central component of solar panel construction.

Photovoltaic ("PV") effect: A process by which sunlight is converted into electricity.

PV Cell ("solar battery cell" or "solar cell"): A semiconductor device made from a silicon wafer that converts sunlight into electricity by the PV effect. Suntech produces a variety of monocrystalline and mulitcrystalline silicon PV cells.

Photovoltaic Module ("PV module"): An assembly of PV cells that have been electrically interconnected and encapsulated via a lamination process into a durable and weather-proof package. Suntech produces a variety of PV modules.

PV System ("solar panel"): A package of one or more PV modules that are physically mounted and electrically interconnected, with system components such as batteries and power electronics, to produce and reserve electricity.

Conversion efficiency: The ability of PV products to convert sunlight into electricity. "Conversion efficiency rate" is commonly used in the PV industry to measure the percentage of light energy from the sun that is actually converted into electricity.

Cost per watt/price per watt: The method by which the cost and price, respectively, of PV products, is commonly measured in the PV industry. A PV product is priced based on the number of watts of electricity it can generate.

Kilowatt/Megawatt/Gigawatt: Equal to one thousand, one million, and one billion watts, respectively.

Timeline

2000 Germany passes generous solar incentives to encourage utilities to buy electricity generated from private green power generators.

2001 Dr. Shi Zhengrong returns to China from Australia to found Suntech Power Holdings, with a $6 million initial investment from the Wuxi City government.

2002 Suntech's first 10 megawatt (MW) photovoltaic cell production line begins operation in Wuxi.

2004 Shi ousts a Wuxi government appointed chairman and assumes dual position of Chief Executive Officer (CEO) and Chairman of the Board.

2005 *April:* At Shi's urging, local government funds and state enterprises sell their stakes in Suntech to private investors.

December: Suntech succeeds in its initial public offering and raises $400 million, as its shares close at $20.35 on the first day of trading on the New York Stock Exchange.

2006 *January:* The US federal Energy Policy Act of 2005, signed into law by President George W. Bush, takes effect. Among its provisions is a 30 percent investment tax credit for commercial and residential solar energy systems.

July: Suntech America is incorporated in San Francisco, California.

November: Arizona adopts a Renewable Energy Standard and Tariff, mandating that regulated utilities in Arizona generate 15 percent of all electricity from renewable sources by 2025.

December: Representatives from Arizona State University meet with Suntech's CEO and Chief Operating Officer at its headquarters in Wuxi.

2007 Shi travels to Arizona and meets with then-Governor Janet Napolitano and Bill Harris, CEO of the Arizona Science Foundation. Shi is the guest of honor at a dinner attended by a number of industry leaders.

2008 Lehman Brothers collapses, triggering a series of events that leads to the worst financial crisis since the Great Depression. Weak consumer confidence, diminished consumer and business spending, and tight credit contribute to a marked slowdown in demand for products that require large initial capital expenditures, including solar. Government incentive cuts in Europe also contribute to weakening solar demand.

2009 *February:* US Congress passes the American Recovery and Reinvestment Act, setting aside $6 billion for Department of Energy loan guarantees for solar companies and projects. A "Buy American" mandate is included in the bill.

May: Suntech announces its intention to open a manufacturing facility in the United States and begins a site selection process.

September: Suntech announces that it has selected Arizona as the site of its North American manufacturing facility.

2010 *April:* Department of Commerce (DOC) opens an investigation into a complaint brought by the United Steelworkers union against Chinese aluminum extrusion exporters.

September: US government announces its preliminary decision that China unfairly subsidizes factories that produce aluminum extrusion products, also used in solar panels, and proposes countervailing (CVD) and antidumping (AD) duties.

October: Suntech America opens plant in Goodyear, Arizona with 25 MW of annual production capacity and 75 new American employees.

2011 A coalition of US solar manufacturers brings trade case against China, alleging that the Chinese government is unfairly subsidizing Chinese solar manufacturers, thus inflicting material harm on US industry.

2012 *May:* DOC finds that the Chinese government is unfairly subsidizing solar manufacturers to support exports and imposes AD and CVD duties on Chinese solar exports.

July: Suntech announces that it is the victim of a $690 million fraud related to a joint venture agreement in Europe.

2013 Suntech closes its Arizona factory at the beginning of March. By the end of the month, the company defaults on a bond payment and is declared bankrupt.

Key Players

United States:

ASU
Arizona State University, a public metropolitan research university located on several campuses across the Phoenix Metropolitan Area.

City of Goodyear, Arizona
Suburb of Phoenix.

Department of Commerce
US federal agency whose mission is, in part, to support job creation and economic growth through promoting a dynamic business community and global trade.

Department of Energy
US federal agency whose mandate is, in part, to advance energy technology and promote related innovation in the United States.

GPEC
Greater Phoenix Economic Council, a public-private partnership tasked with attracting businesses to relocate and expand in the Phoenix Metropolitan Area.

SEIA
Solar Energy Industries Association, the US trade association for solar energy and related businesses.

China:

Suntech Power Holdings ("Suntech" or "Company")
One of the leading solar energy companies in the world based in Wuxi, Jiangsu province.

Wuxi, Jiangsu
A city of over six million people located on the Yangtze River Delta, about 87 miles from Shanghai, and the headquarters of Wuxi Suntech Power.

Introduction

On October 8, 2010, several hundred American and Chinese businessmen, lobbyists, workers, and politicians gathered in the town of Goodyear to celebrate the opening of a new solar factory in Arizona. The opening, by Suntech, a Chinese industry giant, marked the first investment by a Chinese company in "green tech" manufacturing in the United States.

With hefty capital expenditures and the promise of jobs for American workers, the plant opened to great fanfare and drew wide praise from Arizona politicians. Speaking to the crowd, Arizona Governor Jan Brewer heralded the event, proclaiming, "Today, we celebrate a cornerstone in advancing Arizona's competitive position in the global solar marketplace." Turning to face Suntech's Chief Executive Officer (CEO) Shi Zhengrong, who was seated behind her, Brewer added, "This is indeed, Dr. Shi, a fabulous day!"

Photo: Flickr/Suntech Power

And Brewer was not alone in her praise. From the podium, Rhone Resch, President of the Solar Energy Industries Association (SEIA), confidently declared that "this plant is not only state of the art and high tech, but it shows you the future of the economy in the United States."[2]

Local media joined the chorus. *The Arizona Republic*, the state's major newspaper, gushed on its editorial page that Suntech's decision to locate in Arizona "is a major national coup."[3]

And this was certainly true for the working men and women who won jobs at the new plant. The new factory employed 75 Arizona workers, who expected to earn an annual salary between $32,000 and $35,000 with health benefits.[4] Suntech's initial $10 million investment and the plant's 25 megawatt (MW) annual capacity of solar panels represented just a fraction of the Chinese company's $2.9 billion in revenues, 1.5 gigawatt (GW) in sales, and over 20,000 employees worldwide in 2010.[5] The plant had the potential to grow.

Indeed, despite the factory's initial modest scale, the event attracted significant media attention and spurred optimism in the United States for future growth—in Arizona and in the

solar industry generally. Roger Efird, President of Suntech's North American sales division, speculated that if the US solar market kept growing at the rate Suntech predicted, the company could be poised to hire around 1,000 American factory workers within a few years.[6]

Suntech argued that the Goodyear facility might eventually ramp up to 200 MW of annual capacity and employ 200 to 250 employees. And that was not all: Suntech's investment coincided with similar announcements from two other major Chinese solar players, Yingli Green Energy and UpSolar, that they too intended to open US factories. Yingli was awarded $4.5 million from the US Department of Energy (DOE) to open a 100 MW factory, either in Arizona or Texas, four times the initial output of Suntech's new plant.[7] For the time being, it seemed that Chinese solar companies, armed with vast amounts of investment capital, were rushing to set up shop in the United States.

But that was only the beginning of the story. In the end, neither Yingli nor UpSolar followed Suntech to the United States. Both companies canceled their plans because soon after the 2008 financial crisis, solar panel prices began to drop precipitously around the world. Meanwhile, trade conflict in solar erupted between Washington and Beijing, with the United States in October 2012 imposing antidumping (AD) and countervailing (CVD) duties on Chinese imports.

Nor did Suntech ever reach its goals of 200 MW of production and 1,000 factory workers in Arizona. Its new Goodyear plant peaked at about 100 employees, just 25 more than the initial 2010 hire, and 50 MW of annual output.

In short, the euphoria surrounding Suntech's presence, and Chinese investment in US solar, turned out to be ephemeral. What had once been hailed as a potentially transformative Chinese investment in Arizona fizzled. And by November 2012, Suntech cut production to 15 MW. Just four months later, in early March 2013, Suntech announced that it would close the plant, laying off the 43 workers who remained. Bankruptcy filing of the parent company followed later that month. No similar US investment by a Chinese solar company has occurred since.

This case study tells the story of Suntech's failure, which has deservedly attracted wide interest from constituencies ranging from investors to politicians to environmental advocates around the world. Not surprisingly, controversy has followed the company, and the solar industry it represents, particularly as the entire sector has become part of significant trade frictions between the United States and China.

But with hindsight, it is possible to view Suntech's failed ambition as a

consequence of a complex set of factors. The most significant was the boom and bust of the global solar industry, from which Suntech simply could not extricate itself. The company's rapid rise from its first 10 MW photovoltaic (PV) cell production line in Wuxi, China in 2002 to its newfound status as the world's largest supplier of PV modules, and its equally rapid descent into insolvency, is a window into a young and challenging industry in China.

This is a Chinese sector whose major players—and the government, for that matter—have had significant ambitions to establish a global brand and footprint. Solar has also become caught up in the ebb and flow of US-China trade tensions and market dynamics.

This study focuses primarily on Suntech's decision to manufacture in the United States, and its subsequent experience opening and then shutting down a facility in Arizona. It provides an analysis of Suntech's motives for investing in US manufacturing, explains why the venture failed, and suggests some potential lessons that can be drawn from its failure. In addition to available public sources, this reconstruction of Suntech's story is the result of numerous interviews over a period of several months with former Suntech employees, solar industry association representatives, and state and municipal leaders in Arizona.

The case illustrates:

- How US federal policy on renewable energy development has been inconsistent and contradictory. Sometimes, as the case shows, this has hurt efforts by state governments to develop solar energy locally.
- The risks and challenges states and municipalities face when seeking to attract investment in industries that depend heavily on long-term government incentive policies at the local, state, and federal levels.
- How professional economic development organizations and entrepreneurial research universities, backed by favorable state and local incentive policies, shape foreign firms' choices. Suntech, like other firms, weighed these factors carefully as it decided whether and where to make its US investment, as various states competed vigorously for the investment.
- The potential for in-sourcing into the United States of even low-skilled manufacturing for devices like solar modules. This is, in fact, possible from countries, such as China and Germany, if US states choose to enact the right incentive, tax, and credit policies.
- How the proximity to production facilities of manufacturing infrastructure and an efficient supply chain affects costs, which in turn influences a firm's decision to invest in fixed manufacturing assets.

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Icarus on the Yangtze

American corporate history is replete with larger-than-life personalities, companies founded by adventurous men and women who drove risky ventures to celebrated success, and, sometimes, to spectacular failure. Suntech's is one such story.

Like many Chinese entrepreneurs of his generation, Shi Zhengrong was not born into privilege but into a family of peasant farmers on an island in the Yangtze River in 1963. Chinese families traditionally celebrate the arrival of boys as an auspicious event, but Shi's life was hard from the start. Already struggling to feed their two older children, Shi's biological parents decided to give Zhengrong to the neighboring family, surnamed "Shi," who coincidentally had given birth to a stillborn daughter that same day.

In his hometown of Yangzhong, Jiangsu province, Shi was regarded as an exceptionally hardworking and promising student, excelling in school and learning English. At just 16 years old, he won a scholarship to attend the Changchun University of Science and Technology, and went on to pursue a master's degree in laser physics at the Shanghai Institute of Optics and Fine Mechanics.[8]

In Shanghai, Shi was selected to pursue a graduate degree abroad. He hoped to study in the United States, even going as far as trying to perfect an American accent. But he ended up instead at the University of New South Wales (UNSW) in Sydney, Australia, to pursue a doctorate in electrical engineering. He earned the degree in two and a half years. In Sydney, Shi studied under prominent solar scientist Martin Green, considered by some to be the "father of photovoltaics,"[9] who was in the process of developing the world's highest efficiency silicon solar cells.

Between 1983 and 2004, Green's lab increased the amount of sunlight energy that can be converted into electricity from 18 percent to 24 percent.[10] In 1995, Green co-founded a company called Pacific Solar, which specialized in developing a new and lower cost PV technology called thin-film solar cells. The firm extended a job offer to Shi. Seizing the opportunity, Shi stayed in Australia to work for Pacific Solar and became a naturalized Australian citizen.

But after five years working for Pacific Solar, Shi "needed a new goal," as he later recounted to *Fortune*.[11] He had grown weary of the firm's heavy emphasis on research, and, instead, believed that a historical point had arrived to shift toward large-scale commercialization of existing solar technologies.

On a trip to Sydney, a Chinese businessman from Shi's hometown of Yangzhong reached out and convinced Shi to consider returning to China to start a solar company. In the 12 years since Shi had left China in 1988, the country had undergone rapid economic development and attracted billions of dollars in foreign investment. Local governments and businesses had begun aggressively recruiting highly skilled overseas Chinese to return, in the hope that they would create and/or manage companies. Shi traveled back to China in April 2000 to explore this possibility.

The trip proved life changing. He returned to Australia with new ideas to start a China-based solar company and drafted a 200-page business plan. In it, Shi estimated that he could slash solar panel prices from $5/watt to $3/watt. He prophesized that a Chinese solar company, targeting the heavily subsidized European and Japanese markets, could create a major export industry for China.[12]

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Shi returned to China soon after and approached various local officials with his proposal to establish a solar panel manufacturer in China. At the time, venture capitalists and companies offering growth equity were still relatively rare in China, so Shi appealed to local governments in various provinces for startup capital.

Shi saw that China's labor and regulatory environment, where wages, land, and general and administrative expenses are much lower than in developed countries, offered the opportunity to drive down production costs. He spent ten months establishing relationships and pitching his idea, while his family, including two children, lived off his accumulated life savings.[13]

Ultimately, Shi found a partner in officials from Wuxi, a city of around six million located in Jiangsu, 70 miles from Shanghai and about an hour's drive from where Shi grew up. They agreed to invest in his effort to create a solar company in the Wuxi New District, a high-tech industrial park. In exchange for a 25 percent initial stake and the potential for an additional 5 percent based on good performance and rights to run the company, Shi agreed to contribute $1.6 million of the technology he owned and to invest $400,000 of his own money. The remaining 75 percent stake in the new company was disbursed to government funds and state companies in exchange for $6 million in start-up money.

The founders registered the company on January 21, 2001 under the name "Wuxi Suntech Power Corporation"—the Chinese name "*shangde*" for "Suntech" is a reference to a widely known classical phrase meaning "upholding virtue."[14] Shi

assumed the position of CEO in the new company, and a local Chinese politician named Li Yaren became Chairman of the Board of Directors. Shi recruited an international leadership team, comprised of Australian and Chinese businessmen and scientists, to manage Suntech.

In 2005, for example, Shi brought on Stuart Wenham, a prominent solar scientist and his former colleague from UNSW and Pacific Solar, as Suntech's Chief Technology Officer (CTO), and Graham Artes, a 30-year industry veteran in service, production, and sales in the United Kingdom, to be COO.

Photo: Flickr/Suntech Power

Suntech commenced business operations in 2002, at a time when large companies, with relatively high-cost production bases such as Sharp, Siemens, and BP, dominated the nascent solar market. Wenham assisted in arranging the production line and plans. The company opened its first factory in 2002, with a production capacity of 10 MW per year. It used imported turnkey equipment, which enabled Suntech to immediately start producing panels with 14.5 percent average efficiency. This was not far from its Western and Japanese competitors, which were averaging around 15.5 percent.[15]

By April 2003, Suntech had sold its entire initial inventory. The company's original 10 MW assembly line relied heavily on imported, expensive robots and machinery, and was too expensive for the young company to replicate. So Shi and Suntech's leadership now faced the challenge of expanding production on a tight budget.

How did Shi and Suntech's management team expand production lines while limiting capital expenditures and other costs? They devised a two-pronged method to reorganize the assembly line. First, they sought to reduce automation wherever possible. Second, they aimed to rely more extensively on manual labor, or what Suntech described as a "semi-automated" process.[16]

Thus began a period when Suntech furiously scoured the world for bargain prices on used equipment. For instance, Suntech bought equipment from an Italian laboratory and paid $0.50 on the dollar to AstroSolar, a US solar company in liquidation, for its machinery. In exchange for a discount, Shi also helped a Japanese startup firm design assembly line equipment for its solar production.

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Adopting a more labor-intensive assembly model also had its benefits: it reduced the breakage rate of panels, since machines can destroy a portion of delicate solar cells and modules by exerting too much force.[17] With a new manufacturing process and the necessary equipment in place, Suntech began operation of its second 15 MW PV cell line in December 2003.

Suntech rode this combination to success. One piece was the shift to the semi-automated manufacturing process. Another was close relationships with Chinese and international suppliers. A third was economies of scale. Together, this trio of factors proved effective in making the capital cost of Suntech's new production lines extremely low relative to its competitors. In 2006, Suntech estimated that a new 30 MW production line would cost it approximately $8 to $10 million, while the equivalent line would cost a Western or Japanese firm as much as $30 to $75 million.[18]

Shi's timing in founding Suntech proved fortuitous: the decade from 2000 to 2010 saw an exponential increase in global demand for solar panels.

In short, Shi's prediction that a China-based solar company could drive down prices proved to be true. The new company developed a significant price advantage over its international competitors from the beginning. In 2003, just one year after production began, Suntech sold panels at $2.80/watt, much lower than the $4.50/watt industry average.[19] And Shi's timing in founding Suntech proved fortuitous: the decade from 2000 to 2010 saw an exponential increase in global demand for solar panels.

The Global Solar Boom

Germany led this explosion in global solar demand, albeit from a very low base.

In 2000, the German government began providing generous subsidies to encourage utilities to buy electricity generated from private green power generators. These subsidies were subsequently increased in 2004. German regulations mandated utilities to sign long-term contracts, some as long as 20 years, to pay premium prices for renewable electricity that was as much as $0.60/Kilowatt-hour (Kwh) for solar. This was about five times the market price for electricity generated by coal and nuclear energy ($0.12/Kwh).[20] And so the subsidies had a dramatic impact: Germany became the single largest solar market in the world—and Suntech's largest export destination.

Throughout most of the 2000s, Europe accounted for about 80 percent of global demand for solar panels. European countries, such as Italy and Spain, followed Germany's example by passing their own price incentives for solar installations. Spain enacted

especially aggressive solar incentives and accounted for about half of total global solar installations by watts in 2008.[21]

These years were marked by industrial policy and "green" politics, which taken together significantly influenced global markets. European incentives and subsidies led to an era of rapid expansion for the global solar industry. In the years after Shi founded Suntech in 2001, the total amount of watts produced by the global solar industry doubled roughly every two years. Between 2000 and 2005, the global PV market grew at a compound annual growth rate (CAGR) of 43 percent, from roughly $2 billion to $9.8 billion.[22]

Suntech Rises

Shi was determined to turn Suntech into the largest solar cell and panel company in the world, not just China.

And Suntech expanded even faster, doubling its own output every year until 2009. Between 2003 and 2007, Suntech's revenues leapt from $13.9 million to $1.35 billion, and they more than doubled again to over $2.9 billion in 2010. Suntech achieved a staggering CAGR of 250 percent from 2003 to 2006. Total PV cell and module sales skyrocketed 60 times, from 6.4 MW in 2003 to 363.3 MW in 2007, and again to 1.54 GW in 2010.[23]

Dozens and dozens of solar startups in China opened their doors during these years, and rapidly began expanding production. Other provincial governments in China tried to replicate Suntech's success in Jiangsu. As some have argued, the Chinese solar industry entered a period of irrational exuberance in the decade of the 2000s.

But Shi was determined to turn Suntech into the largest solar cell and panel company in the world, not just in China. He strongly believed that expansion would allow the company to create beneficial economies of scale. The problem was that at this time, many solar companies were struggling to meet demand because of a global shortage of polysilicon, a key input in solar cell production.

One of Suntech's early strengths was its ability to secure polysilicon at a time when the solar industry was suffering from tight supply. Because Suntech was able to achieve the lowest cost of production in the industry, it could effectively pay proportionately more for polysilicon, without compromising relative profitability.[24]

Still, explosive expansion meant that Suntech had to rely on outside financing. And the pace of Suntech's output growth and debt accumulation created a rift between Shi and Suntech's government-appointed chairman Li. The latter objected to the speed of expansion, and to the company's spending on new equipment. As Shi later told *Fortune*, "That's when I realized that [having a]

controlling position in the company was critical. I didn't want this kind of complexity again."[25]

Shi approached other board members in 2004 and persuaded them to vote Li out and give Shi the dual positions of CEO and chairman. Later, in April 2005, Shi successfully bought out the remaining stakes held by government investors for $80 million, using a combination of borrowed money and funds from private investors, including Goldman Sachs, Actis Capital, Jiangsu Little Swan, and Wuxi High Tech Venture Capital.

Photo: Flickr/Suntech Power

Before raising equity capital from foreign investors, Suntech had established a holding company in the British Virgin Islands in early January 2005. On August 8, 2005, Suntech then incorporated Suntech Power Holdings Co, or Suntech, in the Cayman Islands as a listing vehicle for a potential initial public offering (IPO).[26]

Encouraged by the tremendously successful IPO of Q-Cells, a German solar cell producer, Credit Suisse First Boston and Morgan Stanley in December 2005 took Suntech public in New York at a valuation of $5.5 billion.[27] These VCs' investments in the company paid off handsomely by any standard. The Suntech IPO was estimated to be one of the highest returning foreign investments in a Chinese company ever.

By virtue of the IPO, Suntech also gained the distinction of being the first private Chinese company listed on the New York Stock Exchange (NYSE). The firm raised a total of $743 million from Wall Street in its two separate public stock offerings in 2005 and 2009, respectively.

In addition to issuing equity, the company took on large amounts of debt. In February 2007, Suntech raised $500 million through a convertible senior note offering, and an additional $575 million through a second convertible senior note offering in March 2008.[28] In 2010, the Chinese government also stepped in and made Suntech eligible for $7.3 billion in loans through the China Development Bank to fund additional expansion.[29]

By 2007, Suntech had become the top PV module supplier to Spain, the second-largest supplier to Germany, and third-largest supplier to the United States.[30] In 2010, Suntech shipped around 1.5 GW of solar products, thus making the company the leading supplier of solar panels globally and achieving Shi's objective of becoming the biggest solar supplier in the world.[31]

Suntech, although it was a private firm, naturally became a national champion, widely viewed in China as the country's equivalent to famous private firms like Google or IBM in the United States. Its stock price soared from $20.35 per share at closing on its first day of trading in December 2005 to $90 in early January 2008.[32] In April 2006, Beijing designated Suntech as the exclusive supplier of a 130 KW solar system for the "Bird's Nest," the main stadium for the 2008 Beijing Olympic Games. Suntech also supplied the panels for the 2010 Shanghai World Expo. Clearly, Shi's startup company had arrived in a big way.

Anointing the "Sun King"

But Suntech did not simply rest on its laurels. Although it committed a smaller portion of revenue to research and development (R&D) than some of its competitors, Suntech had nonetheless built up a sizable R&D team that focused intensely on reducing solar product prices to "grid parity," meaning lowering of the cost of solar power generation to a price point where it would be competitive with traditional energy sources in the absence of generous subsidies.

Led by the company's CTO, Wenham, Suntech had 202 R&D employees by 2006, which included 120 PV technology experts. The team increased to 450 R&D employees and 264 PV technology experts by 2012.[33]

Suntech also collaborated with universities, including UNSW and the Swinburne University of Technology in Australia, and Zhongshan University, Shanghai Jiaotong University, Zhengzhou University, Nanjing Aeronautic University, and Jiangnan University in China.

In addition to driving down costs, Suntech and other Chinese manufacturers changed the global solar market in other ways. For years, PV modules had relatively high variance in terms of their conversion efficiency from sunlight into electricity. For example, a 250-watt module could have a variance of +/- 5 percent.

"Chinese producers were really instrumental in changing module makers' practices," notes Mark Holohan, president of the Arizona branch of the SEIA and a Solar Division Manager at Wilson Electric.

Yet Chinese solar companies were some of the first to sell modules without any negative variance. Their improvement allowed solar installers to give buyers a projection on future electricity bill savings from a newly installed panel with more certainty and accuracy. "Chinese producers were really instrumental in changing module makers' practices," notes Mark Holohan, president of the Arizona branch of the SEIA and a Solar Division Manager at Wilson Electric.[34]

In 2008, Suntech began the commercialization of a new technology, developed in collaboration with UNSW, called "Pluto," which reached conversion efficiency rates in the range of 18 to 19 percent on PV cells manufactured with higher quality monocrystalline silicon wafers and 16.5 to 17.5 percent on PV cells manufactured with lower quality multicrystalline silicon wafers.

This technology innovation represented a significant efficiency improvement over Suntech's conversion efficiency of its standard monocrystalline and multicrystalline silicon PV cells, which were 17.2 percent and 15.2 percent, respectively. The firm's products were also competitive with the industry average for high-performing monocrystalline and multicrystalline silicon PV cells, which were around 18 percent and 14 percent, respectively.[35]

Suntech had become an internationally recognized brand, and its founder a world-renowned entrepreneur and industry titan. The *Wall Street Journal* explained Suntech's combination of high quality and low prices as, "first world technology and developing world prices." Indeed, investors and environmentalists celebrated Suntech as an anomaly among Chinese companies, distinguishing itself by its focus on quality and innovation, as well as by the personality of its idealistic and passionate founder, who was anointed in the global media as "China's New King of Solar" and "Sun King."[36]

For a few years, Shi held the mantle of the richest man in mainland China, with an estimated net worth of $2.9 billion in 2008, ranking him 396th on *Forbes*' "World's Billionaires List."[37] In a glowing 2006 profile of Shi, *New York Times* columnist Thomas Friedman dubbed Suntech "China's Sunshine Boys," and warned his American readers that "China's emerging green power entrepreneurs could clean our clock in the clean power business" if US policymakers and businesses do not "start doing everything we can to develop our own clean power."[38]

Solar Eclipse

All good things must come to an end. And the golden era of solar would not last forever, either. The global financial crisis of 2008 badly burned Suntech and the entire solar industry. European governments, from the United Kingdom and France to Germany and Spain, reduced solar feed-in-tariffs (FiTs) as part of austerity measures, causing demand to contract. Turmoil in the credit markets also made it difficult for customers to secure financing for capital-intensive projects, leading to the cancellation or postponement of many solar initiatives.

The solar boom and bust was perhaps most dramatic in Spain, which saw its share of newly installed capacity fall from 41 percent of the world's solar infrastructure in 2008 to just 6 percent in 2009.[39] Unfortunately for Suntech, the company had enormous exposure to Spain, an export market that made up 37.4 percent of Suntech's revenues, or $718.7 million, in 2008. In the wake of the collapse, Spain comprised just 3.6 percent of Suntech's revenues, or $61.1 million, in 2009.

As supply vastly outstripped demand, the average price of solar panels around the world plummeted. As a result, Suntech's average selling price fell from $3.89/watt in 2008 to $2.40/watt in 2009, and again to $1.82/watt in 2010.[40]

To make matters worse, the global polysilicon supply bottleneck reversed and turned into a supply glut. That was because the period from the mid to late 2000s saw big investments in new polysilicon production in response to the global shortage, especially in China. Much of the new production capacity came online right around the time of the financial crisis and precisely as subsequent solar demand was squeezed. Suntech had already poured money into hedged polysilicon contracts when market prices were at their peak. It had also directly invested in joint ventures (JVs) with polysilicon manufacturers.

Instead, the price of polysilicon wafers used to make solar cells dropped 73 percent between 2010 and 2012. Polysilicon prices peaked at $450/kg to $475/kg in 2008, and fell to under $30/kg by December 2011 and again to $16/kg shortly thereafter (see Figure 1).[41]

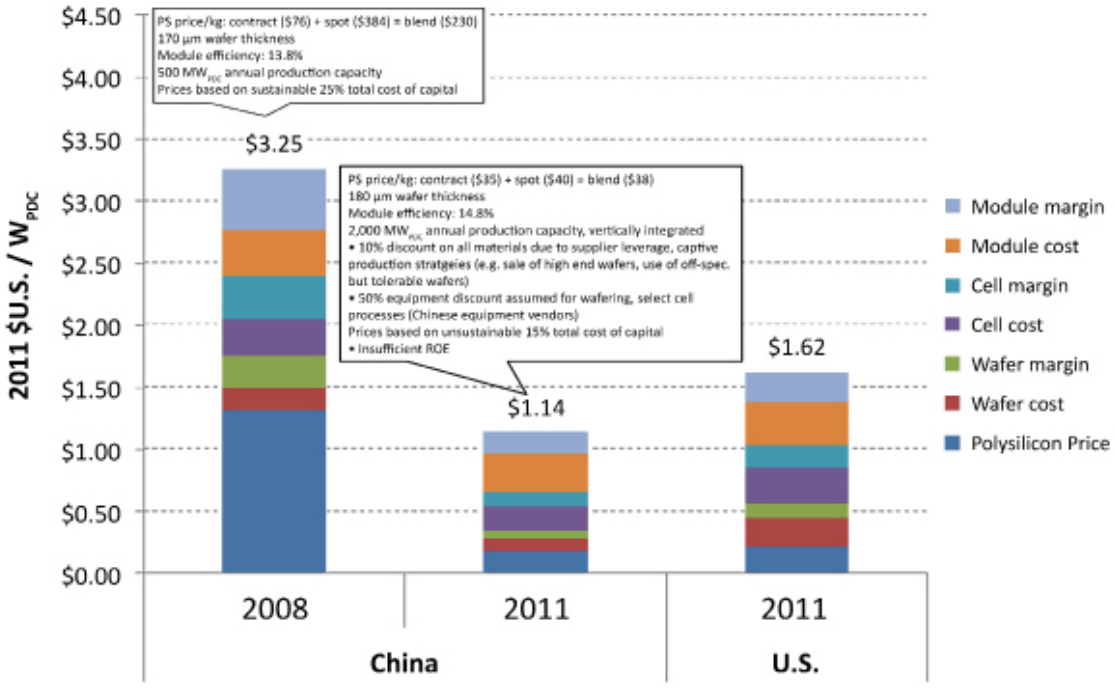
Suntech had made six large investments in upstream suppliers of polysilicon. These investments and contracts included a 10-year, $6 billion polysilicon supply contract with MEMC Electronic Materials, a California-based manufacturer of silicon wafers now known as Sun Edison, secured in July 2006 when global prices were high. Suntech invested another $678 million with Hoku Materials to build a new

polysilicon plant with annual volumes of 2,000 metric tons in Pocatello, Idaho. Hoku, a Hawaiian company with a Chinese investor base, subsequently collapsed and the plant never became operational. In 2013, Hoku's nearly $700 million factory was sold at auction for just $8.3 million.[42]

These losses suffered from JV agreements were made worse by the fact that Suntech was also forced to buy itself out of expensive contracts. Many of these contracts were difficult or impossible to renegotiate because Suntech had reached "take or pay" arrangements with its various suppliers. In effect, this meant a supplier would invoice the company for the full purchase price of the polysilicon or silicon wafers that Suntech was obligated to purchase each year, whether or not Suntech ordered the volume.[43]

By the end of 2008, Suntech was in dire straits. It fired 800 employees in China to cut cost and reduce overcapacity.[44] To prevent further job losses, the Wuxi tax bureau refunded 800 million yuan ($115 million based on 2008 USD/RMB exchange rate) to Suntech in December 2008, citing a three-year "accounting error" by the company.[45] From its peak

Figure 1. Polysilicon's Decline as a Percentage of Total Solar Panel Cost



Source: National Renewable Energy Laboratory.

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in early 2008, the firm's stock on the NYSE quickly crashed to $5.34 per share by early 2009.[46]

Adapting to New Realities

Obviously, Shi and Suntech management realized that a new strategy would be needed to adapt to this tougher set of market conditions. The rapid ascendancy of other Chinese firms meant that Suntech was no longer the only low-cost solar panel maker in China. Up until 2008, the company had little need to do marketing, in part because it faced few viable low-cost and high-quality competitors.

Consider, for example, the biggest hurdle Suntech had to overcome in Europe during the period of its ascendancy. Then, Suntech simply needed to establish itself as a "bankable" brand. And that meant convincing distributors and project financiers that Suntech sold high-quality products—and that the company would survive long enough to honor its warranties and contracts. Suntech lured top sales talent from its established competitors, many of whom were well practiced in actually bashing Chinese products, but now had to pitch Suntech's quality and scale.

But after the financial crisis, Suntech suddenly found itself in a crowded field of worthy competitors. So Suntech brought on a team of marketing professionals, who decided to brand its products as being of very high quality but not necessarily the *most* technologically advanced, and as being affordable but not necessarily the cheapest in the market. Wei-Tai Kwok, who joined Suntech in early 2009 as vice president for strategic marketing (later global vice president of marketing) called Suntech a "Toyota," as opposed to a BMW. It was essentially a Target- or IKEA-like positioning strategy—that is, dependable and affordable products with mass market appeal.

Like other solar companies, Suntech used business-to-business advertising, which relied heavily on a sales team to build relationships with solar installers and distributors, rather than marketing directly to consumers. "No one picks out the hot-water heater in their house. You trust a contractor or installer to pick one out in your price range," explained Kwok in an interview, "Solar panel installations are the same way."[47]

Suntech also needed to find new opportunities to diversify away from European markets, which at the time of the global crisis accounted for 80 percent of the company's revenues. The US and Chinese markets flickered as bright spots on the horizon. In fact, just as government policy in Europe was withdrawing from generous solar subsidies, policy in the United States, at least in certain states, was moving in precisely the opposite direction as new subsidies and incentives were on the horizon.

Beyond Europe … America Beckons

The United States had briefly flirted with solar energy incentives in the 1970s as a result of the Arab Oil Embargo and Iran Hostage Crisis. In November 1978, the United States adopted the Energy Tax Act, which created a federal energy tax credit of up to $2,000 for residential solar installations.

In a symbolic move, President Jimmy Carter ordered the installation of 36 solar panels on the White House roof in 1979. The Reagan Administration subsequently decided to phase out these incentives in the mid-1980s, leaving energy decisions to the market.[48] Upon taking office, President Ronald Reagan abruptly removed the solar panels from the White House roof.[49]


Photo: Flickr/Suntech Power

It was not until the late 1990s and in California that policy moved significantly to favor solar. The California Energy Commission created the Emerging Renewable Program, and the California Public Utilities Commission enacted a Self-Generation Incentive Program. In 2002, California increased its state-level incentives with the adoption of a Renewable Portfolio Standard (RPS), which required that 20 percent of California's electricity be generated from renewable resources by 2010.[50]

In 2004, then-California Governor Arnold Schwarzenegger announced a new solar initiative called the "Million Roofs Program." In 2007, the state launched Go Solar California, an initiative that provided incentives for new energy efficient home construction and rebates for investor-owned utilities. Schwarzenegger also increased the RPS to 33 percent by 2025. Although California failed to reach the 20 percent target in 2010, the state still became the largest solar market in the United States (see Figure 2).[51]

At the federal level, energy-related politics during the mid-2000s were heavily influenced by record oil prices and the growing unpopularity of the Iraq War. The idea of "energy independence" in the United States, meaning that the country would no longer have to rely on imported oil, gained momentum.

In 2005, President George W. Bush signed the Energy Policy Act. Among its many provisions was to restore a

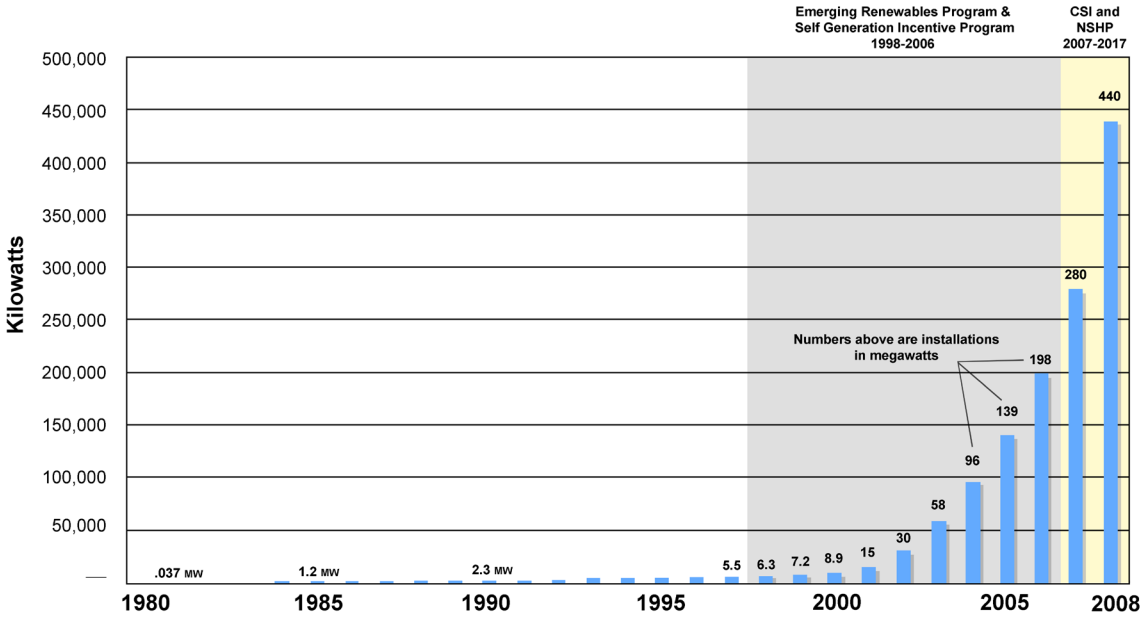
Federal Solar Tax Credit that allowed the purchaser of a solar panel to recoup up to 30 percent of the project's cost. In 2006 and 2007, 22 states either enacted or made upward revisions to their RPS. By 2010, major utilities in 30 states were required to purchase renewable energy, sometimes to include specific percentages of solar energy.[53]

Energy Politics

The mounting unpopularity of US involvement in the Middle East in the mid-2000s became joined to a debate about the role of clean energy in countering climate change. Politicians in many states were influenced by polls that showed that moving away from fossil fuels to non-carbon emitting "clean energy" seemed to be gaining wider public support in the United States. Sixty-six percent of respondents in the 2008 Gallup Public Opinion Polls answered that they "personally worry a great deal or a fair amount" about climate change, up from 51 percent in 2004.[54] During the 2008 presidential race, both the Democratic and Republican nominees, Senators Barack Obama and John McCain, ran on platforms that included strong actions to address climate change and reducing US dependence on foreign oil.

The turn to solar was in part influenced by developments with other energy technologies. Take nuclear power.

Figure 2. Grid Connected PV Installed Capacity in California, 1981-2008



Source: California Energy Commission.[52]

Enthusiasm had emerged in some quarters for a nuclear renaissance in the United States, but the hope was somewhat dampened by actions Senator Harry Reid (D-NV), the US Senate majority leader, took. Congress had approved the Yucca Mountain Nuclear Waste Repository in Reid's home state of Nevada in 2002—a facility intended to be a deep geological repository for storage of spent nuclear reactor fuel and other highly radioactive waste. But the plan was very unpopular in Nevada, and in 2005 Reid blocked Bush nominees for dozens of positions to force the president to appoint Greg Jaczko, a Reid policy advisor, to the Nuclear Regulatory Commission (NRC).

In 2009, President Obama elevated Jaczko to chairman of the NRC. In May of that year, Obama's Secretary of Energy Steven Chu said flatly, "Yucca Mountain as a repository is off the table."[55] Jaczko resigned in 2012 amid the release of a bipartisan report by the NRC inspector general that alleged Jaczko had "strategically" withheld information from his colleagues to stop work on Yucca Mountain and cruelly treated the NRC staff.[56] But Senate Democrats were also blocking efforts for enhanced domestic conventional oil and gas drilling. In late 2005, they led a successful filibuster of an Arctic Refuge drilling amendment to the annual House appropriations bill proposed by Senator Ted Stevens (R-AK).

As prospects for domestic nuclear energy dimmed, and with alternatives such as clean coal still in the experimental phase, advocates of alternative energy turned toward solar, wind, natural gas, and biofuels. And initiatives in these areas gained bipartisan support, whether presented as a means to tackle climate change or as a path to achieve energy independence.

At the end of the 2000s, in stark contrast to an embattled Europe, dynamics in the United States appeared to be moving to favor renewable energy.

That is where government incentives began to enter the mix in the United States. Because the price of solar power is uncompetitive with the price of fossil fuels, Suntech and all solar companies tend to make strategic bets, in large part, on the basis of where they believe government support policies around the world are heading. At the end of the 2000s, in stark contrast to an embattled Europe, dynamics in the United States appeared to be moving to favor renewable energy.

In this context, Suntech decided to make a bet on the US market.

Sunnier in America?

Suntech had already incorporated a subsidiary, Suntech America, in July 2006. Based in San Francisco, the new company was formed a short while after Suntech's China-based parent had begun exporting a small portion of its inventory to the US market—less than

20 MW of panels in 2006—serving just a handful of American customers. By way of comparison, some of Suntech's European customers imported more than its entire US shipment, including a single German distributor that bought over 100 MW of Suntech's solar panels.[57]

In 2006, however, many of Suntech's Chinese competitors were still ignoring the US market. Demand had yet to peak in Europe, and Chinese panels could command a higher price there than in the United States on account of the more generous government incentives and robust demand.

Within Suntech, however, internal debates began to emerge over how to allocate limited module supplies across different geographies. Suntech eventually made the strategic decision to invest in lower priced regions where the company could see long-term potential. One such region was the United States, a small solar market, to be sure, but one with a favorably evolving political climate around renewable energy.[58]

Still, the US market presented new challenges to the company. For one, the structure of the American market was very different from the European market. In Europe, solar companies' major customers were large distributors, who acted as middlemen between panel producers and installers. Before winning business from distributors, module companies had to be approved by banks, which in turn wanted to feel comfortable that a company was financially sound enough to live up to its warranty with products that would prove technically sound.

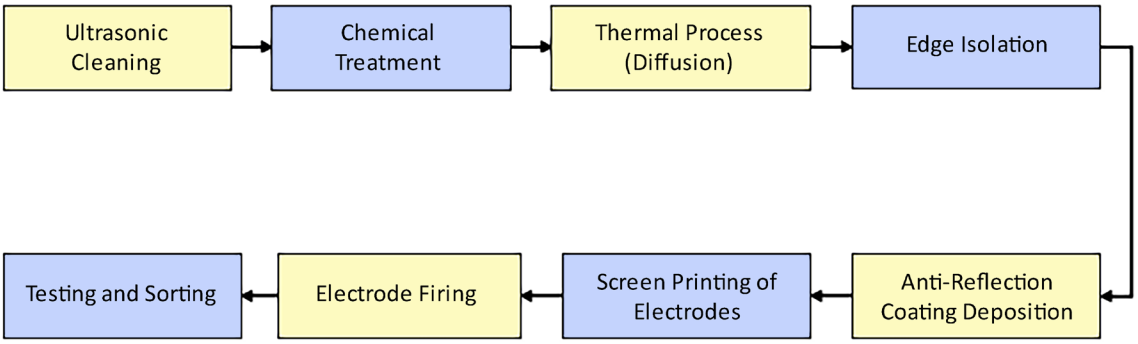
At this time, Suntech had little trouble meeting the European banks' conditions. The company was well capitalized, had a large module capacity, and possessed the ability to scale up production quickly. These factors proved sufficient to turn initially skeptical Europeans into enthusiastic Suntech customers.

But the US market was more immature, and existing incentives were not lucrative enough to support the extra 10 percent price margin that European distributors typically took. The sheer size of the United States also meant that its markets were fragmented, with meaningful state variations. Solar companies had to cut out distributors, marketing their products directly to the installers.

Operating amid these uncertainties, Suntech decided to jointly invest with developers in order to gain development expertise in the US market. In 2008, Suntech created two JVs, Gemini Solar and the Gemini Fund, to develop, finance, own, and operate large-scale PV projects in the United States of 10 MW or greater in size.

The company also acquired a small installation company called EI Solutions

Figure 3. PV Cell Manufacturing Process



Source: Suntech 2008 Annual Report 20-F.

in September 2008, aiming to win contracts for utility projects. EI Solutions had designed and implemented solar projects for leading US companies, including Google, Walt Disney, North Face, and Sony Pictures.[59] And some utility companies found Suntech to be an attractive supplier because they wanted to source from established and reliable partners. By 2009, Suntech America had grown to over 60 employees.

By 2007, Shi began to contemplate splitting up a portion of Suntech's module production from its cell production. As Suntech grew in size, gained easier access to credit, and capital and equipment prices fell, the company began to increasingly automate its production process to raise its efficiency.

In 2008, Suntech acquired KSL-Kuttler Automation Systems GmbH, a Germany-based producer of solar automation systems, to bring the design and production of a portion of its equipment in-house. According to Suntech, by 2011, labor comprised only 3-4 percent of the total cost of producing its solar panels. In 2008, Suntech needed an average of four workers to produce one MW each year. By 2010, it had lowered the worker/MW ratio to 1.49.[60]

At that point, Shi and management had not considered moving solar cell production outside of China. Solar cells are small and compact and are therefore economical to ship long distances. Splitting production is expensive and solar cells can break easily during transport. Shi also wanted to keep the company's solar cell manufacturing concentrated and tightly monitored to protect intellectual property, the most important component of which was its solar cell technology and manufacturing process (see Figure 3).

Moreover, solar cell production is also labor-intensive, so it made little sense

to move production to a region like the United States that actually had higher labor costs than China.

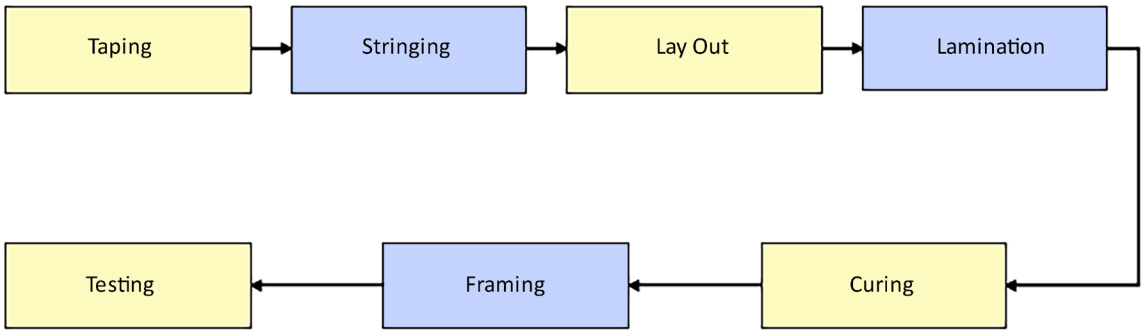
But Shi thought that module production could become economical if located near large end markets (see Figure 4). Module production, the process by which solar cells are soldered and assembled into grids mounted on metal frames to create a finished solar panel, does not require the most skilled labor and allows for more automation. Completed solar panels are also large and more fragile, so they are relatively inefficient to ship long distances (see Box).

In addition, Shi emphasized corporate social responsibility at Suntech, especially relating to the company's carbon footprint. International attention was already mounting on the dirty and pollution-intensive polysilicon industry in China. A widely circulated 2008 *Washington Post* article chronicled the story of a Chinese village located next to a polysilicon factory, where acrid air stung villagers' eyes every night and fields of green grass had turned "white as snow."[61] This was a blemish on what was supposed to be clean energy, even though most of China's polysilicon was imported. Shi believed that moving module plants nearer to target markets could offset at least some of the carbon

What is Soldering?

It is the process by which individual solar cells are joined together in preparation for building a complete solar panel. Solar cells have metallic gridlines, which must be connected on bust bars so that electrons captured in the cells can jump on metal fingers. The top of one cell is soldered onto the bottom of the next cell, just like a AAA battery with a positive and negative end. Soldering is the most labor-intensive part of the module assembly process.

Figure 4. PV Module Manufacturing Process



Source: Suntech 2008 Annual Report 20-F.

emissions produced by vessel and freight shipping and thus improve a firm's reputation.

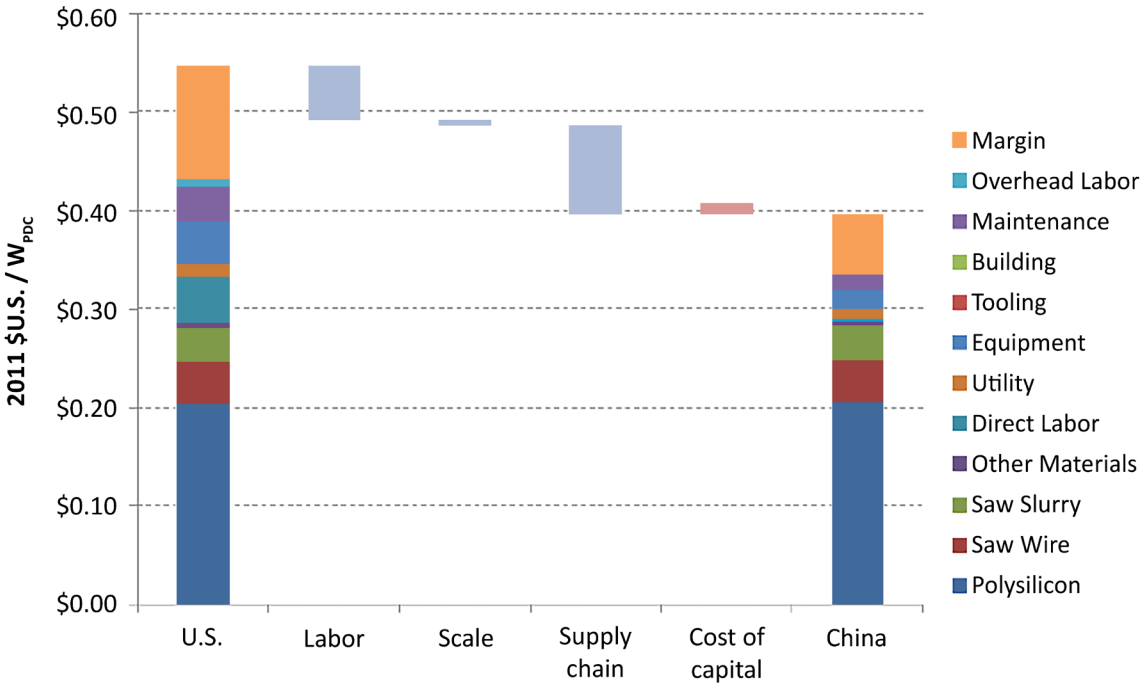
Then there were the numbers: Shipping a panel from China to the United States takes around three weeks. In an industry where prices, technologies, and demand change drastically on a quarterly basis, three weeks can feel like an eternity. Suntech believed that by moving some module production capacity into growing markets, it could become more agile and responsive to changing demand and prices, and so better serve the immediate needs of its local customers.

Put differently, if the cost of production in the United States could be made comparable to the cost of a panel manufactured in China that would be advantageous. And Shi believed that setting up production in a target market, such as the United States, could also distinguish the Suntech brand in an increasingly crowded and indistinguishable solar market.

US Solar Gets a Boost

Even as these internal debates erupted within Suntech about the merits of moving some module production, it did not expect to actually decide anything

Figure 5. Impact of Supply Chain on Solar Cell Production Costs in the US and China



Source: National Renewable Energy Laboratory.

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soon. Throughout 2007 and 2008, the firm still believed that solar module production in the United States would end up eroding its price advantage.

The reason went beyond simple wage differentials: the United States did not have as developed or efficient a solar manufacturing supply network as the one that had blossomed in China.

China's solar industry had become so large that it had developed a formidable production infrastructure and supply chain in close proximity to production facilities. This is what economists refer to as "agglomeration," a concept proposed by the economist and Nobel Prize winner Paul Krugman as it relates to his theory of the new economic geography (see Figure 5).[62]

Another catalyst to Suntech's new thinking came in February 2009, when President Obama signed the American Recovery and Reinvestment Act (ARRA).

Such a localized, dense network of suppliers, distributors, and labor pool can generate economies of scale and significantly reduce overall production costs. In Suntech's case, Shi thought it might be wise to wait a few years to see if a solar manufacturing network and supply chain became robust enough in the United States to make production there cost competitive.

But Suntech was not the only, or even the first, solar firm to contemplate splitting up parts of its panel production process. To be closer to target markets, two German companies, SolarWorld and Schott Solar, were adopting the same strategy. SolarWorld owned and operated a module-making facility in Camarillo, California, purchased from Shell Solar in 2006, a firm whose earliest incarnation dated to 1975. The facility employed 180 workers and had 150 MW of annual capacity.

In October 2008, SolarWorld announced that it would create the largest solar cell factory in North America. It subsequently purchased from Japan's Komatsu Group a $40 million, 480,000 square feet facility in Hillsboro, Oregon that spanned a quarter mile.

This facility would have a capacity of 350 MW on two production lines at a price tag of $600 million—and operate without any federal subsidies. At its peak employment in 2011, the facility employed over 1,000 Oregonians. The company announced that it expected the factory to have an initial production capacity of 150 MW during its first year of operation, and the potential to grow that capacity to 500 MW by 2011.[63]

For its part, Schott Solar, which had manufacturing facilities in Germany, the Czech Republic, Spain, and Boston, announced plans to open its own 200,000 square feet plant in

"Buy American" Explained

"Buy American" is different from "Made in the USA" and is less restrictive. For a product to be considered "Made in the USA," the product must be "all or virtually all" made in the United States, with "all or virtually all" meaning that all significant parts and processes that go into the product must be of US origin. The product's final assembly or processing must take place in the United States. Other factors, such as the portion of manufacturing cost assigned to US parts and processing, and how far removed any foreign content is from the finished product, are taken into consideration.[70]

"Buy American" has different requirements. Goods produced outside the United States can earn the "Buy American" designation if the United States has a trade agreement with the country of origin, or if the country of origin has signed the World Trade Organization (WTO) Government Procurement Agreement. China is the largest trading partner of the United States that does not meet either of these two requirements.

The DOE's ARRA website defines the "Buy American" provision as: "none of the funds appropriated or otherwise made available by this Act may be used for a project for the construction, alteration, maintenance, or repair of a public building or public work unless all of the iron, steel, and manufactured goods used in the project are produced in the United States" (manufactured good was defined as a "good brought to the construction site for incorporation into the building or work that has been processed into a specific form and shape; or combined with other raw materials to create a material that has different properties than the properties of the individual raw materials.")[71]

Albuquerque, New Mexico. To lure the German firm, New Mexico had given Schott a whopping $130 million incentive package. To streamline its North American production, Schott Solar closed a smaller Boston factory on July 31, 2009, laying off 180 full-time workers. Schott Solar's New Mexico factory opened on May 11, 2009 and was intended to achieve annual production capacity of 85 MW.[64]

As a number of solar companies announced plans to open manufacturing facilities across the United States in 2008 and 2009, Suntech began to think that the development of an efficient supply and distribution network for solar production might follow sooner than planned.

Yet another catalyst to Suntech's new thinking came in February 2009, when President Obama signed the American Recovery and Reinvestment Act (ARRA). Among the provisions in this stimulus bill was the Advanced Energy Manufacturing Tax Credit, which provided $2.3 billion in tax credits. The credit was equal to 30 percent of the total investment cost of a renewable energy project that, according to DOE, "establishes, re-equips or expands a manufacturing facility."[65]

In addition, the law gave DOE $6 billion to distribute in loan guarantees for renewable energy projects. The law also included several measures intended to spur solar installation, including a cash

grant in lieu of the 30 percent federal investment tax credit (FITC) for solar installations placed into service during 2009 or 2010 and for projects that began construction prior to the end of 2010. It also included a 50 percent bonus depreciation for installations put into service during 2009.[66]

With the law's manufacturing subsidies, loan program, and extension of the federal tax credit, the US market for solar now showed new promise, prompting Suntech to accelerate its plan to experiment with module production outside of China.

Steven Chan, president and Chief Strategy Officer (CSO) for Suntech America, said in 2009, "The US market is on the cusp of greatness…It's a toss-up as to whether the US or China will be the largest market in the world next year (2010)."[67] His statement marked an attitudinal shift from even a year earlier, when approximately 80 percent of global demand for solar energy products came from Europe.

Indeed, Suntech shipped more than 250 MW of solar products to North America in 2010 and ranked as the top supplier of solar panels to the region, with a net market share of around 20 percent.[68] In an interview for this case study, Chan noted that "the stimulus bill was a catalyst that accelerated the discussions Suntech was having about our long-term manufacturing strategy."[69]

But access to some of the law's funds and credits was contingent because Congress had inserted a "Buy American" clause (see Box). This meant that Americans who bought imported Suntech panels for their homes and businesses would be eligible for the FITC, but Suntech itself would be locked out of government, military, and some utility projects that used the law's funds unless the company manufactured those products in the United States.

Whether Buy American was a big driver of solar installations in general is hard to determine. But it seemed to have factored into Suntech's decision to manufacture in the United States.

Investing in America

With these attractive manufacturing subsidies suddenly in place, and a long-term state and federal policy outlook that seemed favorable for solar, Suntech decided it would establish a small portion of its module production in the United States earlier than anticipated.

Internal company research showed that US military and government solar installations could grow to between 200 MW and 300 MW per year.[72] "We thought that outlook made higher costs justifiable," said John Lefebvre, former President of Suntech America. "We knew that the stimulus money would run out and the 'Buy American' market would largely go away in a few years," said Kwok, "But we thought it provided us time to experiment with driving down the cost of module production outside of China and give time for the US supply chains to develop."[73]

Solar cells, manufactured in Suntech's Chinese factories, would be imported and assembled by American factory workers into grids mounted on metal frames.

At a board meeting in Shanghai in February 2009, Shi and his management team decided to green light the US project.[74] Later in June that year, Efird said at a conference, "In this time of downturn in the [US] economy, the politically correct thing to do, if you are a buyer, is to promote 'Buying American'."[75] Suntech's calculations said that modules produced in America could come to within 5 to 10 percent of the cost of those made in Suntech's Chinese factories.[76]

In May, during the same week that Schott Solar celebrated the opening of its New Mexico factory, Suntech announced it would open a US plant and would select a location within six months.

Suntech intended the jobs in the United States to be associated with assembling panels from finished subcomponents that were not cost effective to ship from Asia. This meant that the manufacturing of Suntech's solar cells would still be done in Wuxi. But the least-skilled portion of the manufacturing process would now occur at the US facility. Solar cells, manufactured in Suntech's Chinese factories, would be imported and assembled by American factory workers into grids mounted on metal frames. Once cells were soldered together, the assembly would laminate durable layers of glass and sealants before the finished panels were shipped and installed.

The announcement attracted significant media attention in the United States. "It created buzz in the press for a while," remembers Steve Chadima, Suntech

America's former Vice President of External Affairs. "Mostly, we dealt with calls and inquiries from financial analysts who wanted to know how it would change our cost structure. We explained that we would only do this if it did not increase the cost structure, and that the factory's output was not going to be big relative to the total amount of modules Suntech sold, even in North America." He continued, "It wasn't going to be a game changer. Generally, people were very positive about the idea."[77]

Chan adds that Suntech understood that the cost differential between the United States and China would not be bridged on Day One. Still, the company wanted to invest in the United States to demonstrate Suntech's long-term commitment, differentiate its brand, and demonstrate social responsibility.[78]

Location Scouting

Polly Shaw, Suntech's Head of Policy and Government Affairs, and Jason Somers, Head of New Business (and its attorney), were part of the site selection team. Suntech devised a checklist of roughly 50 criteria—including favorable state solar policy, supply networks, price and skill level of the labor force, proximity to key markets, and economic incentive packages, among others.

The team started out with a 17-state matrix, but the final determination was primarily based on economic incentives offered by the states. "We are asking for the best economic packages now," Efird said in a speech at the Edison Electric Institute's annual convention in San Francisco. "Then, we will narrow the list down."[79]

But Suntech interviewees also recall other factors: for one, they faced external political pressure to have the factory employ union labor; for another, some constituencies argued that they should locate in a state with a Democratic governor. Most notably, Suntech responded to media inquiries about one bold tactic coming out of California. A California labor union leader sought a media outlet to publish his claim that he had "traveled to Wuxi to meet personally with Shi," who supposedly had "assured him that Suntech would both locate in California and hire union workers." The story turned out to be false, and failed to gain traction in the press.[80]

In a number of states, local state economic development organizations competed vigorously and intensely to win the Suntech factory. "I remember when the site selection team went to visit Austin, Texas," recalled a former Suntech America employee involved with the selection process, "The economic development organization from New Mexico heard we were there, flew out to Austin, and took us out to dinner. They stalked us. It was brilliant!"

In some cases, governors made personal appeals to get Suntech to set up shop in

their states. For instance, Pennsylvania Governor Ed Rendell and Michigan Governor Jennifer Granholm called Shi at home to express their hope that Suntech would choose their respective states to open the factory. Shi was flattered.[81]

But Suntech examined sites across the country, ranging from one on the Sacramento River Delta outside of San Francisco to another on the St. Lawrence River in upstate New York. Other states Suntech considered included Idaho, Oregon, California, New Mexico, Texas, New York, New Jersey, Pennsylvania, Ohio, Michigan, and, of course, Arizona. The final four states on the company's criteria matrix were New York, Arizona, Texas, and Oregon, which then further narrowed to two finalists: Arizona (Phoenix) and Texas (Austin).[82]

The Suntech team was at ease with states that had aggressive and professional economic development organizations.

The Suntech team was at ease with states that had aggressive and professional economic development organizations. One former Suntech employee involved in the selection process recounted, "States such as Oregon, Texas, New Mexico, and Arizona all had some form of economic development organizations that created materials to clearly communicate the various incentive packages we could receive from locating there. They also suggested possible factory sites and explained the permitting process. In general, they were eager to answer our questions."[83]

"GPEC [in Phoenix, Arizona] did spectacularly well compared to the rest," a person involved in the deal recounted. "They would call our leads every two or three days to ask us what we still needed to know, and whom we still needed to talk with to choose Arizona. They are an exceptionally service oriented one-stop shop."[84]

At the other end of the spectrum, a member of the Suntech team recalls that California was somewhat dysfunctional. "It was hard to get basic questions answered in California. We had to go out and search for them ourselves. The California officials did not see the situation from our business perspective, which was based on economics."[85]

While the site selection process progressed, Suntech received a lucky break from Washington, DC—one that seemed to validate its decision to open a factory in the United States. In November 2009, a new bilateral controversy sprouted around a Texas wind farm applying for the federal tax credit that intended to use wind turbines manufactured in China.

Senator Charles Schumer (D-NY) and three other senators introduced legislation that would apply a Buy

American provision to all renewable energy projects seeking stimulus funds, extending it past military and government projects, and thereby requiring them to rely on US manufactured parts. This was a tough break for the Texas wind farm but an opportunity for Suntech, which planned to ride the coattails of Buy American with its US operation.

And The Winner Is? … Arizona

On November 16, 2009, Suntech announced that it would locate its factory in Goodyear, Arizona, a Phoenix suburb with a population of 65,000. Shi heralded the decision, saying, "Bringing manufacturing jobs to the United States is part of Suntech's vision to grow the solar market in every corner of the world. We are eagerly watching growing markets and see the potential [to] bring manufacturing capabilities to other markets where we see the combination of rapid local market growth and manufacturing cost competitiveness."[86]

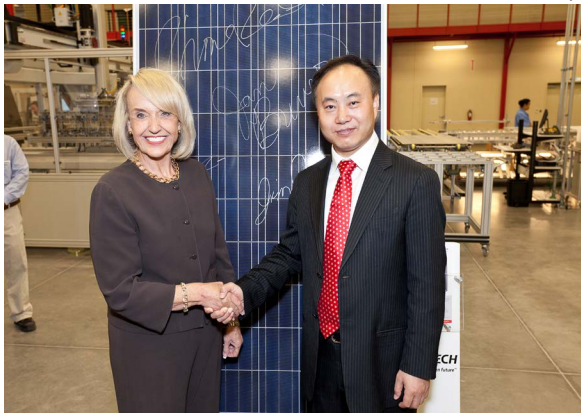


Photo: Suntech Power

For the plant's initial $10 million capitalization, Suntech secured $3 million in incentives to offset its own investment: this comprised $2 million in federal stimulus, $500,000 from the state of Arizona, and $500,000 from the City of Goodyear.

But the economic incentive package was not the whole story. In its press kit, Suntech described its decision as being influenced by Arizona demonstrating leadership on solar technology research and the state's pro-solar policies. The location gave Suntech easy access and lower transportation costs to the California market, which was and is the largest solar market in the country. In Arizona, Suntech gained proximity to California but avoided the problems its site selection committee had discovered there.

Indeed, solar policy in Arizona had progressed over the previous 15 years. The Arizona Corporate Commission's (ACC) original 1996 solar portfolio standard set a goal of having just 0.2 percent of state regulated utility power be generated from solar by 1999 and 1 percent by 2003. The ACC then created an Environmental Portfolio Standard (EPS) in 2001, which mandated that 1.1 percent of state-regulated utilities' energy must be generated from renewable energy sources by 2007, with 60 percent of that coming from solar power.[87]

In pushing for solar, the ACC cited potential economic development benefits, positive environmental impacts, the need to diversify global energy supply, reliability issues, and post-9/11 security concerns affecting traditional energy sources, such as oil markets.[88]

By 2004, the ACC had begun to consider amendments to its EPS. In 2006, the ACC approved a new Renewable Energy Standard and Tariff (REST), requiring regulated utilities to generate 15 percent of their energy from renewable resources by 2025.[89] These rules took effect on August 14, 2007, after certification by the Arizona Attorney General.

Simply put, the ACC hoped that REST would encourage Arizona utilities to use solar, wind, biomass, biogas, geothermal, and similar technologies to generate clean energy. And state regulations favored so-called distributed generation, where power is generated locally at residences or businesses from solar panels or other renewable sources.

Suntech liked this Arizona emphasis on creating a solar production hub in the state. And there were other companies who had blazed a trail. FirstSolar, one of the largest solar companies in the world, was located in Arizona. Moreover, rhetoric and policy suggested that Arizona officials wanted to attract more such companies, going so far as to pitch itself as the "Solar Capital of America."

Suntech hoped that an integrated solar production ecosystem would evolve in Arizona—much like the agglomeration effect it had seen in China. This would include glass-makers, junction box producers, and frame makers, among others.

"We wanted to locate in a state where we thought solar manufacturing would grow [and] attract a supply chain and support infrastructure, which would lower our production costs," recalled Kwok, "We really liked that in Arizona the governor and state [officials] regularly articulated a vision to be the 'Solar Capital of America.' GPEC was very aggressive about pursuing Suntech and other Chinese companies to locate in Phoenix. We would go to a trade show in Germany and see GPEC there; we would go to a trade show in China and bump into them there. The organization's commitment to attract solar to the state was obvious."[90]

For Arizona, the announcement of Suntech's new investment provided positive publicity at a time when the state was weathering harsh economic conditions. When the housing bubble burst in 2008, Arizona, Florida, Nevada, and other sunbelt states were among the hardest hit. Arizona's unemployment rate skyrocketed from 3.5 percent in July 2007 to 10.8 percent in January 2010, just as Suntech entered into its lease.

Indeed, as the unemployment rate shot up, Arizona construction jobs vanished,

declining by a whopping 53 percent from 244,300 in June 2006 to 114,300 in January 2010. The Phoenix metropolitan area suffered an even sharper drop in construction jobs, falling 56 percent over the same period.[91]

Former Governor Napolitano, a Democrat who later entered the Obama cabinet, had sought to devise a strategy to diversify the state's economy from construction and housing by seeking to develop growth industries, such as solar. During her tenure, Napolitano ordered the Arizona Department of Commerce to draft an "Arizona Solar Electric Roadmap Study," published at the beginning of 2007.[92]

Photo: Suntech Power

Her successor, Governor Brewer, a Republican, continued the state's bipartisan support for solar, but also identified aerospace, defense, electronics, semiconductors, healthcare, and biotechnology, as key industries that her administration would aim to attract and promote. In September 2010, Brewer put the point bluntly: "Arizona's economy has been based so much on the construction industry. When it goes down, the state goes down…You can't beat 320 days of sunshine and it certainly makes a lot of sense to develop the solar industry here."[93]

Brewer followed with additional actions, signing Arizona Senate Bill 1403 in July 2009 to create renewable energy tax breaks for solar manufacturers, with a new incentive focusing on solar generation projects. This helped make Arizona the US leader for solar manufacturing. More than 100 solar companies already operated in the state, and Brewer vowed to "continue to compete, not only nationally, but globally, for solar companies to come here."[94]

But it was not just political leaders from Arizona who aggressively courted solar companies to locate in Arizona. So did Arizona State University (ASU), whose activism Suntech cited as another reason for choosing Arizona. For years, administrators and researchers from ASU had been active in trying to attract Suntech and other solar companies to the Greater Phoenix area. In 2007, well before Suntech publicly announced its US intentions, Jonathan Fink and Rob Melnick, two administrators from ASU, traveled to Wuxi to meet with Shi and Artes.

ASU's interest in Suntech was not arbitrary. The university's president Michael Crowe had made it a priority to help attract industry to Phoenix, and administrators and researchers at ASU

pressed him to make solar a top priority. Moreover, ASU had one of America's first solar research programs and the only Photovoltaic Testing Lab (PTL) accredited for PV design qualification and type approval in North America. This PTL provides ASU with access to companies who use its facilities to test their products. The PTL also trains technicians who end up joining the solar industry.[95]

In fact, in 2007 alone, ASU administrators met with executives from eight solar companies in Germany and China, but Suntech was the only Chinese solar firm they ultimately pursued. ASU targeted Suntech in part because of the firm's R&D collaboration with universities like UNSW in Australia. Using the PTL as lure to secure an initial meeting with Shi in 2007, Fink and Melnick then visited Suntech's management team several times in China and California.

ASU subsequently co-hosted a visit by Suntech's senior management to Phoenix in July 2008. This included meetings with Napolitano and officials at the Arizona commerce department. Fink also recruited two of Shi's former UNSW graduate students from the University of Delaware to join the ASU faculty.[96]

Arizona's favorable solar policies and dedicated effort to attract companies to the state clearly paid dividends. According to AriSEIA, the Arizona branch of SEIA, residential solar installation in the state began to pick up in 2008, and commercial market demand rose in 2009.[97] Large state incentive programs made the financing of solar projects feasible and buoyed the market. And employment got a boost as these solar installations increased, with solar-related jobs in the state jumping from 2,105 in 2010 to 4,786 in 2011. That job figure more than doubled in 2012, exceeding 10,000 and making Arizona the second-largest solar employment state in the nation, behind only California.[98]

Done Deal

With the Goodyear investment, Suntech became the first major Chinese renewable energy player to bring factory jobs to the United States. The investment also marked the first time Arizona had beaten Texas in attracting any project, and the first time it had beaten New Mexico for a solar project. Barry Broome, CEO of GPEC and a key player in bringing Suntech to Arizona, touted the investment, viewing it as a harbinger of future Chinese investment in the state. During a November 2009 interview on local television, Broome proclaimed, "All the industrial leadership of China is watching this move. I do think that China will become an aggressive inward investor in the United States."[99]

In January 2010, Suntech entered into a lease for an 118,000 square feet building, which made the facility the third smallest of the firm's ten manufacturing plants. By way of

comparison, Suntech's corporate headquarters and PV module manufacturing base in Wuxi is a 2.5 million square feet facility, and its Pluto cell and module manufacturing factory in Shanghai is 1.7 million square feet.

Suntech announced that the Goodyear facility would initially focus on producing Suntech's 280 watts Vd-series modules, which are used primarily for commercial and utility-scale electricity generation. The firm also announced that the new facility would open with the capacity to make 30 MW of solar panels annually—the equivalent of outfitting around 7,500 homes, with the flexibility to boost output to 200 MW. When the facility first opened, it had 25 MW of annual capacity, which was ramped up to 35 MW and 50 MW.[100] Because solar panels made at the Arizona facility underwent "substantial transformation" the products were "Buy American Act compliant," even though the cells were imported from China.

With the Goodyear investment, Suntech became the first major Chinese renewable energy player to bring factory jobs to the United States.

In its 2009 Annual Report, Suntech emphasized the importance of gaining access to ARRA projects, stating that, "In addition to our China-based production, which we believe gives us a cost competitive advantage, we have announced our intention to open a 30 MW facility in Goodyear, Arizona, with a target of completion of mid-2010. The addition of this production facility will enable us to compete for US-only projects not open to strictly foreign manufacturers."[101]

Lefebvre told *Industry Week*, "The 'Made in America' [sic] label is essential to some of our customers including utility companies."[102]

Kwok was given responsibility and a 10-month timeline to bring the factory together for a grand opening in October 2010. Instead of in-sourcing a portion of the equipment, Suntech purchased a new state-of-the-art turnkey production line from 3S Swiss Solar. Ultimately, the factory opened on time and on budget. "The Arizona factory had Suntech's most modern and advanced line," Kwok noted in interviews. "We deployed our best equipment there." The labor force in Goodyear started at 40, and quickly grew to around 100. At its peak the factory ran three shifts, each shift with 30 workers, and the plant had around 10 office and administrative staff. Before the announcement, Suntech employed around 60 people in the United States and had a network of over 200 solar dealers and integrators for its products.

"The Arizona workforce was excellent," recalled Kwok. "They were extremely hardworking and grateful for the jobs. Turnover was miniscule."[103] The facility paid a salary of $32,000-$33,000 with healthcare, above the 120 percent of

the state wage requirement to qualify for some SB 1403 subsidies.[104]

The SB 1403 subsidies offered a corporate income tax credit benefit, which is calculated based on the economic benefits a project brings to the state. It also created a property tax reclassification and reduction for projects investing $25 million or more[105] (the Arizona factory's initial $10 million investment was not enough to qualify for the property reclassification, although GPEC expected it would if Suntech were to expand).[106]

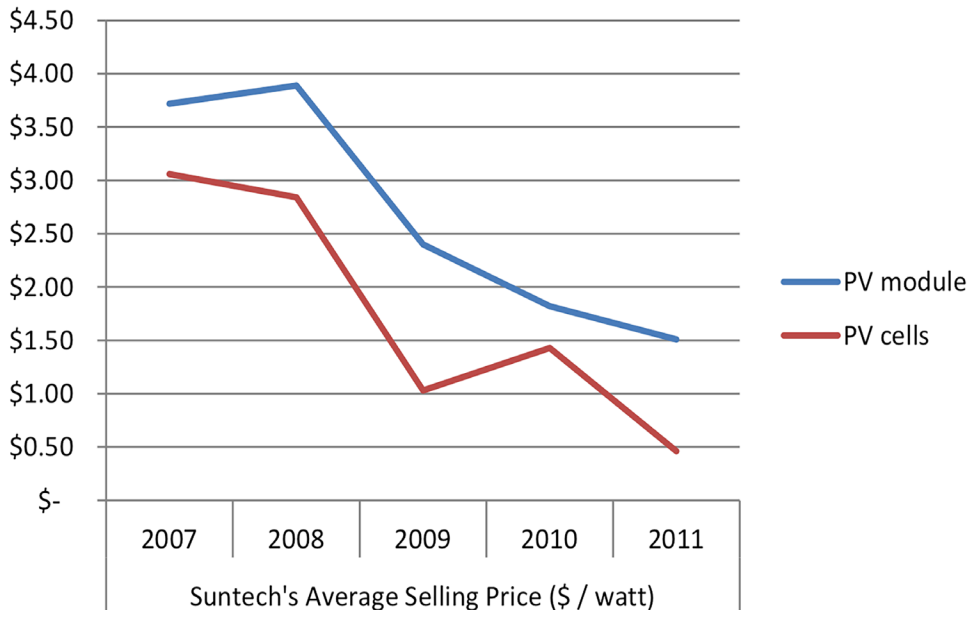
Efrid had urged Suntech to do the "politically correct thing" by ensuring that it is Buy American Act compliant. But more than that, Suntech hired ex-US military personnel for the facility. "Approximately 5 to 6 percent of our workforce is former military personnel," Lefebvre said in 2011. "They have the training, discipline, and ethics that create an excellent workforce."[107]

Stormy Skies

From here, the Suntech story turns downhill. The Arizona factory opened in October 2010, but in the year and a half between Suntech's decision to open a US factory and the plant actually becoming operational, the global solar market rapidly deteriorated. Panel production, especially by Chinese firms, far outpaced demand. And increased production and plummeting polysilicon prices coincided with further scaling back of incentive programs in Germany and Italy in 2011, which pushed more exports into the US market. Suntech's reported average selling price for its PV modules and PV cells continued to decline (see Figure 6).

These market conditions posed a much greater challenge to the Arizona factory from its very inception than Suntech had anticipated. The enormous price drop placed additional pressure on Suntech to reduce production costs in Arizona—indeed, to cut them even faster than what it had projected. Although the firm had some success in this regard, it proved to be not enough, according to Kwok. Suntech officials recounted in interviews that the premium price modules produced at the Arizona facility soon proved too expensive to compete in the marketplace, costing about an extra $0.20/watt.

Figure 6. Suntech's Average PV Module and Cell Price, 2007-2011[108]



Source: Suntech 2011 Annual Report 20-F.

But Suntech did display some political skill with an aggressive lobbying effort against a bill moving through the Arizona legislature at this time. During the late summer and fall of 2011, Republicans in the Arizona legislature pushed to amend the state's REST to broaden the 15 percent renewable energy requirement to include hydroelectric and nuclear power. Suntech's Shaw testified to the legislature that the proposal would "gut" the REST, and "obliterate the demand for solar." Suntech threatened to reconsider the Arizona project if the bill passed, arguing that it "would eliminate the reason we selected Arizona."[109]

Governor Brewer, who had touted the Suntech factory in her "State of the State" speech the previous month, pressed legislators to drop the bill, according to local press coverage. The proposal was indeed dropped in October, and Brewer released a statement commending the legislature's "wise and thoughtful actions."[110]

US-China Trade Tensions Rise

What was more, US policy, which at this point had seemed to be heading in a pro-solar direction, abruptly turned against the sector. In April 2010, while the Arizona factory was still under construction, the US Department of Commerce (DOC) opened an investigation into a complaint brought by the United Steelworkers Union against Chinese aluminum extrusion exporters. (Aluminum extrusion products are used in solar modules, construction, window frames, door-frames, car parts, and gutters.[111])

In August, DOC announced its preliminary decision that China had improperly subsidized domestic aluminum companies, and proposed countervailing (CVD) and antidumping (AD) duties amounting to more than $500 million per year.[112] The decision was a blow to Suntech, which relied on aluminum frames imported from China to build the modules at the Arizona plant. The United States did not produce a competitive alternative at that time.

Friction now began to rise within Suntech over the viability of the Arizona factory amid increasingly difficult and unpredictable market conditions.

Friction now began to rise within Suntech over the viability of the Arizona factory amid increasingly difficult and unpredictable market conditions. Already struggling, Suntech America in May 2011 replaced its Chief Financial Officer (CFO) Amy Zhang with David King, the former CFO of California-based Tetra Tech and Vice President of Finance and Operations at Walt Disney Corporation.

King began to raise concerns about the Arizona facility, in light of its high production costs. "He wanted to close it immediately when he saw the cost difference," recalled Lefebvre.[113] The Suntech America team pushed back, arguing that the US manufacturing base needed more time to develop an efficient supply network, which would then reduce production costs. The US-based team

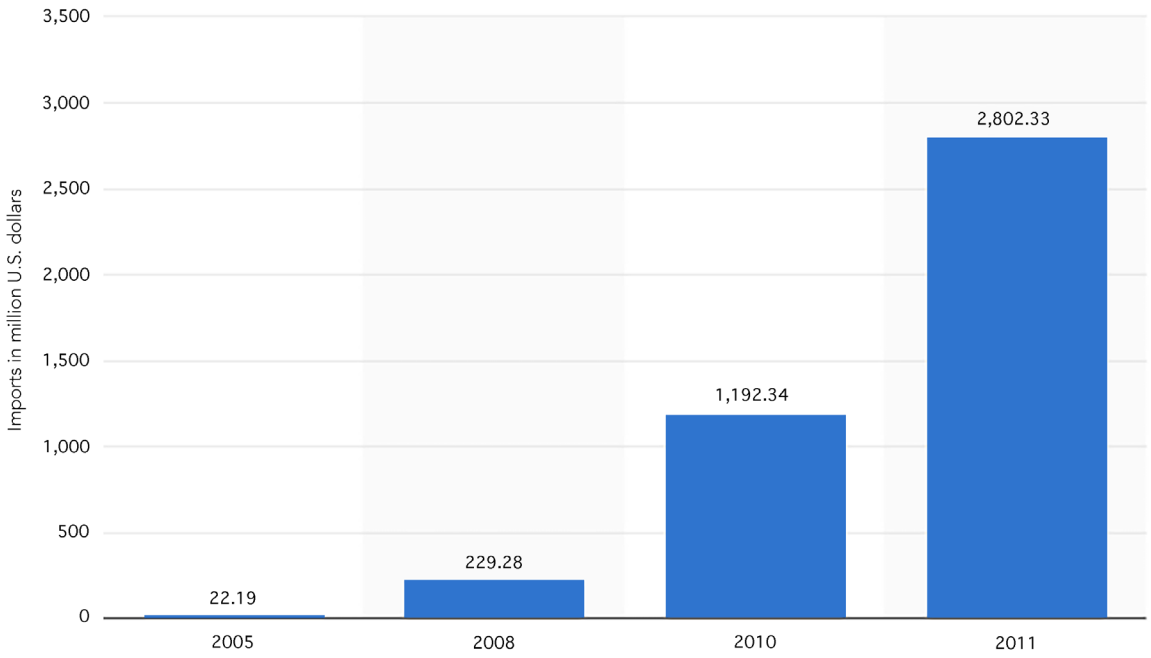
also argued that the Arizona product was differentiated to serve growing military and government markets, and thus could offer some cushion for the company against potential future bilateral trade cases.

And new trade cases did arrive. On October 19, 2011, the US subsidiary of Germany-based SolarWorld, along with seven other US solar manufacturers, filed a petition with DOC and the US International Trade Commission (ITC) alleging that China granted anti-competitive subsidies that allowed Chinese solar manufacturers to dump solar panels into the US market, thus injuring US industry.

As with numerous other manufactured products, China has had a successful record of rapidly driving down prices—a pattern that has been seen again and again, from mobile phones to solar panels. This so-called "China price" makes it very difficult for US, European, and Japanese manufacturers to compete. For example, even as total PV installations in the United States grew by 300 percent from 2009-2011, solar companies saw a drastic decline in profitability as prices plummeted. Hundreds of firms around the world went bankrupt.

Since Suntech's founding, Chinese solar exports into foreign markets have surged exponentially (see Figure 7). In 2011,

Figure 7: US Imports of Solar Cells and Panels from China, 2005-2011



Source: Statista.

China exported 95 percent of its solar panels, which accounted for around 60 percent of global supply.[114] Suntech was certainly part of that story: 95 percent of its revenue came from outside of China because there was simply no domestic market for solar at the time, despite haphazard attempts from the Chinese government to boost demand for solar products.

The surge in Chinese exports led to rapid reversal of market share gains in the United States. For instance, in 2007, US manufacturers supplied 43 percent of panels for the California Solar Rebate Program, while Chinese companies supplied just 2 percent, with the remaining portion supplied by Japanese and European firms. Three years later, however, Chinese solar firms had captured 42 percent market share while that of US firms fell to just 15 percent.[115]

The surge in Chinese exports led to rapid reversal of market share gains in the United States.

Trouble further roiled the solar industry with three high-profile failures that dominated headlines: the cases of Solyndra, Sharp, and Q-Cells.

US-based Solyndra had received a $536 million federal DOE loan guarantee and a $25.1 million tax break from California's Alternative Energy and Advanced Transportation Financing Authority. But the company filed for Chapter 11 bankruptcy in September 2011 and fired all of its 1,000 workers. Solyndra's collapse was spectacular. It soon became caught up in US presidential politics, with Republican nominee Mitt Romney touting it as a symbol of wasteful and inefficient stimulus spending.

In Japan, meanwhile, Sharp Solar withdrew from solar manufacturing almost entirely after being bailed out by the Japanese government in 2012. Sharp was the world's largest solar company by revenue in 2009, but by the end of 2011, it was no longer even in the top five. The firm's production costs were 30 to 40 percent higher than its cheapest Chinese and Taiwanese competitors. Faced with collapsing market share and a high-cost structure, Sharp sold three of its four Japanese solar factories and closed its marketing operations in the United States and Europe.[116]

In Europe, the German manufacturer Q-Cells went bankrupt in 2012, even though it had been for years the largest global maker of solar cells and an investor favorite that had consistently met or exceeded Wall Street's quarterly earnings estimates. At the end of 2007, the company was valued at $10.7 billion. By 2011, Q-Cells posted losses of $1.1 billion and, in the following year, its stock was trading at $0.09 per share. Q-Cells laid off more than 2,000 workers in Germany when it filed for bankruptcy.[117]

Amid all this turmoil, SolarWorld and its coaltion appealed to the ITC and DOC to impose tariffs of up to 250 percent on PV

imports from China. In an unusual move, SolarWorld was the only manufacturer to bring the petition publicly, as the seven other participants chose to remain anonymous. John Smirnow, Vice President of Trade and Competitiveness at SEIA speculated that the reason the seven US companies chose to remain anonymous was due to supply chain considerations.

"My best guess," he recalled, "is that those companies were sourcing parts from China, but at the same time wanted to be able to use SolarWorld or other non-Chinese company's solar cells for their modules. They likely feared that China would have terminated their contracts right away."[118]

Trade Rules

According to WTO rules, just because a government is providing support does not constitute a trade violation. Violations arise when government support is used to give domestic producers an advantage in a foreign market or markets. If it's determined that (1) government subsidies targeted toward exports are giving an unfair advantage to foreign companies, and (2) these unfair practices hurt domestic industry. In this event, CVDs are applied. The SolarWorld complaint against China listed 40 different programs it deemed as unfairly helping Chinese exporters, ranging from providing land, electricity, material inputs, and financing at below market rates, to direct financial support and other preferential policies.

In December 2011, the ITC issued a preliminary determination, ruling that Chinese government subsidies and dumping practices were harming US industry. In May 2012, DOC issued its preliminary finding and began to impose duties on Chinese products. Later that year, in October, DOC announced its final determination and recommended a continuation of these AD and CVD duties against Chinese manufacturers. DOC stated that it had found that Chinese producers and exports "have sold cells in the United States at dumping margins ranging from 18.32 to 249.96 percent and Chinese producers have received counter available subsidies of 14.78 to 15.97 percent."[119]

Both types of tariffs would apply to Suntech's panels exported from China, and to those produced at the Arizona facility. DOC ruled that the solar cell's origin, not the module's origin, was to be the determining factor, so the modules produced by the Arizona facility would be hit with the tariff because they used cells imported from China.

This solar trade case disrupted Suntech's global supply chain shipping cells to the United States. In 2011, the US market had surpassed Germany as Suntech's largest revenue source, accounting for around 23 percent of the firm's sales.[120]

Losing Control

As troubles mounted, Suntech faced even greater problems than the Arizona plant

or the trade tariffs. The firm, which posted $237 million in profits in 2010, lost over $1 billion in 2011.[121] A confluence of factors, including tariffs, debt, expensive raw material contracts, poor investment choices, and a global supply glut, weighed heavily on the company.

The debt Suntech accumulated to finance its expansion spiraled to $2.2 billion by the end of March 2012, and its market capitalization collapsed to just $195 million.[122] Many of China's other large solar manufacturers, which by then made up nine of the top ten solar panel makers in the world, were in similarly dire financial straits. China's ten largest solar companies had a combined debt of $17.5 billion at the end of March 2012. Pavel Molchanov, an equity analyst at Raymond James & Associates, told *Bloomberg BusinessWeek* in November 2012 that Suntech had a balance sheet "so egregious" it would be an "imminent bankruptcy candidate if they were American or European."[123]

Photo: Flickr/Suntech Power

Suntech had a looming $541 million offshore convertible bond payment due in March 2013. To piece together money to cover the bond payment, Suntech decided it would look to sell its stake in a JV called Global Solar Fund (GSF), a company set up to invest in European PV projects. Suntech owned an 80 percent stake ($318 million) in GSF, and Chairman Shi himself owned a 10 percent stake. The remaining 10 percent was held by an entity called GSF Capital, which was controlled and owned by Javier Romero, a former Suntech salesman.

In the agreement, Suntech guaranteed a $683 million credit line from the China Development Bank for GSF portfolio companies. For collateral, Romero's GSF Capital pledged $690 million in German government bonds. In July 2012, however, Suntech said it had discovered that the bonds did not exist and the company was thus the victim of a $690 million fraud.[124]

When Romero first pitched the GSF JV, Shi enthusiastically backed it over the objections and skepticism of others in the Suntech management team.[125] The massive fraud revelation turned out to be the final straw that ended Shi's tenure as CEO. He was already under intense criticism for Suntech's deteriorating financial position. By August, Shi had decided to step down, but retained roles as CSO and non-executive chairman. King took over as CEO.

In a press release, Shi defended his tenure—and his focus on aggressive growth. He argued that the earth, which

suffered from climate change, could not have waited. "We had to accomplish in a decade what many told me would take a century. Some believe that we grew too fast; and certainly, you can't achieve what Suntech has achieved without some growing pains. But the world couldn't afford to wait a hundred years to solve our planet's energy and environmental crisis."[126]

Even so, the company's financial position continued to falter through 2012 as the solar supply glut proved enduring and government policy turned increasingly unfavorable. In September, Suntech cut or reassigned 1,500 workers at its PV cell factory in Wuxi, and accepted a $32 million loan from local authorities to prevent more job losses. In November, job cuts made their way across the Pacific as Suntech announced it would lay off 50 employees in Arizona, around half of the plant's workforce.

When Suntech's problems grew increasingly urgent in 2011, management started to experience considerable turnover. Chan and Chadima both departed the Suntech America team in 2011. Lefebvre followed shortly thereafter in October 2012.

Many customers and business partners interpreted this instability as an indication that the firm was in huge trouble and might not be around long enough to honor warranties and contracts. This hurt sales in the US market.[127]

Back in China, infighting continued on Suntech's board. Shi was removed as chairman of the board in early 2013, a move he called "misconceived and unlawful." He told the *Wall Street Journal* that he was being excluded from negotiations with Suntech's bondholders and issues relating to restructuring of the company. It became evident to those within the company and to outside observers that a bailout from either the government in Beijing or the local Wuxi government would be needed to prevent a default.

But no bailout came in time, and Suntech announced it would close the Arizona plant on March 12, 2013. It also missed the $541 million payment on convertible bonds due three days later on March 15. Shortly thereafter, a Chinese court declared the firm bankrupt.

Thus ended Suntech's fleeting run in the Arizona sun.

Conclusion

At the time Suntech opened its Goodyear facility in 2010, GPEC was in serious discussion with ten other Chinese solar companies as solar jobs flowed into Arizona. GPEC says these discussions ended abruptly during the fall of 2011, when the SolarWorld case was brought before the DOC and ITC.[128] Great expectations deflated, and very suddenly indeed.

But it took much more than a trade case to derail Suntech's Arizona venture. A perfect storm of factors converged simultaneously to bring it to an end and force Suntech into bankruptcy. For one, the large and efficient supply network never materialized in Arizona, as Suntech had hoped. This kept the cost of some input prices as much as 20 percent higher than those paid by Suntech's Chinese factories.

A perfect storm of factors converged simultaneously to bring it to an end and force Suntech into bankruptcy.

From its failure in Arizona, however, Suntech learned that the solar market has no tolerance from the purchaser for a difference of just a penny per watt. It also learned that government and military demand for "Buy American" products is smaller than Suntech's analysts had predicted.

"We faced two big challenges with the Arizona factory," summarizes Chan. "First, could we get the cost delta versus producing in China as tight as possible? Second, could we convince customers to pay an increment to recover that premium? It turned out no; we failed on both counts."[129]

Another former Suntech employee recalls, "The situation at the Arizona factory was tough even before the trade case, but we were trying hard to keep it open. The import tariffs on aluminum frames and cells were the last straw. No way could we ship in our own cells and have a tariff on top of that when [the plant] was struggling already. The costs went through the roof."[130]

The trade cases and collapsing market prices were strong headwinds working against Suntech. But poor decisions made in Wuxi were also major factors in bankrupting the company. "The trade cases didn't play a huge role in Suntech's bankruptcy," says Andrew Beebe, Suntech's former Chief Commercial Officer.[131] The irony is that the very factors that facilitated Suntech's rise from a blip into the world's largest solar energy company over a short period were the same ones that doomed it.

In a letter to shareholders in 2006, Shi wrote: "One of Suntech's key strengths has been our ability to secure silicon wafers at a time when the industry

is suffering from tight supply and can effectively pay proportionately more for silicon without compromising profitability. In fact, we see this period of limited silicon as an opportunity to expand our output and capacity more rapidly than our competition. This expansion will allow us to create beneficial economies of scale."[132]

Yet when polysilicon prices began to drop in 2008, Suntech was burdened with a higher cost structure than its more cautious competitors.

"Being the largest player meant a lot to Suntech. The company was driven by the belief that scale mattered. If you are the 'Wal-Mart' of that category, you have all the purchasing power, which is extremely important when you are locked in a game to sell a commodity like a solar panel," says Kwok. "Sales and market share come down to who can sell for pennies cheaper. If you could gain a 1 percent or 2 percent price advantage, that is hugely significant."[133]

Unfortunately, scale amounting to lower cost is *not* an iron-clad law. Nor does it always hold up when the market is choppy, inefficient, and difficult to predict from year to year. Keeping a huge company staffed, supplied, and financed requires long-term contracts, commitments, and leverage. And this leaves limited room to maneuver during periods of market tumult.

In its quest to become the world's number one in the solar business, Suntech sacrificed precisely this flexibility and adaptability needed to navigate against rapidly shifting winds. "There was a sense with some within the company that we were mortgaging the future to pay for the present," said Chan. On top of that, the negligent due diligence of the GSF JV in Europe left Suntech unable to pull together the necessary financing to meet its massive debt obligation.

In the United States, a tilt toward more protectionist solar trade policy curtailed future Chinese investment in module manufacturing, while competition and higher prices bankrupted many US producers of solar cells and modules at the same time. This reduced the size and efficiency of an already small and inefficient supply chain.

Even if the DOC tariffs had stopped the flood of Chinese solar imports, it is unlikely that such tariffs will ever be shown to have a net positive effect on job creation in the US solar sector because the vast majority of solar jobs are related to installation, service, and sales, and not to manufacturing. According to the Solar Foundation, even when US solar manufacturing was at its peak during 2011, this segment only amounted to around 36 percent of the total solar industry labor force.[134]

As public policy has shifted against solar, Arizona is experiencing a steep decline in solar jobs far beyond the Suntech factory's closing. The state's experience

in solar reflects the risks that come with investing heavily in industries, especially young industries, dependent on government action.

"Over the course of two years, federal and state policy shifted one way, then 180 degrees the other way," says Chris Camacho, Executive Vice President of Business Development at GPEC. "It shows how policy can impact job creation and investment. Many people went back and got retrained for solar installations and services after the housing crash. Now they're losing their jobs again."[135]

Looking to the future of solar production in the United States, Lefebvre says, "Cell production is too expensive but module production can develop in the US if we implement the right public policy and companies have access to affordable credit. That would allow enough production to develop to create a supply chain to make costs competitive. But given the political climate, I am skeptical that will happen."[136]

Epilogue

Shunfeng Photovoltaic International, a solar cell maker and solar power station operator, bought Suntech's Chinese assets in the fall of 2013. Shunfeng agreed to pay 30 percent of the $1.75 billion Suntech owed to its Chinese creditors (Suntech also owes $541 million to overseas bondholders). The deal kept solar factories in China running under the Suntech name (but owned by a Cayman Islands holding company) as it moved through bankruptcy proceedings. The Chinese central government has identified reducing overcapacity in industries, not least solar, as one of its top priorities, so the Wuxi city government's arrangement of this deal surprised some international observers.

The combined company is expected to be the third-largest PV panel maker in the world in 2014.[137] In July 2014, Suntech surprisingly announced that it may return to the US market.[138] Beebe says the company is now reconsidering opening the Arizona facility, which is still owned by the Cayman Islands holding company, in light of new AD and CVD imposed on Chinese imports in June 2014.[139] DOC again ruled that Chinese companies were circumventing the tariffs it had imposed by sourcing cells from Taiwan.

Solar installations have continued to grow strongly in the United States, but now China and Japan have largely replaced the United States as the growth markets in 2013 and 2014 due to strong new government incentives. The "green energy economy," articulated during the 2008 presidential campaign, has yet to take hold in a major way in the United States. During his 2011 State of the Union speech, President Obama called for 80 percent of US energy to be derived from clean sources by 2035. How the United States will get there remains unclear.

Factoring in climate change's costs into the price of fossil fuels through equitable and well designed price incentives would help the United States reach President Obama's clean energy goal by making non-carbon emitting energy sources like solar cost competitive.

But future of solar in the United States is uncertain, in part because of the impending FITC reduction from 30 percent to 10 percent in 2016 if Congress does not act to extend it. Moreover, the economics of solar is likely to remain challenging in the near term because it requires large immediate capital investment with the expectation of future savings, which are spread across a long period of time. High FiTs also drive up electricity prices for the people who cannot afford solar energy, as utilities are forced to raise electricity prices.

In yet another turn of events, the WTO in July 2014 released the ruling from its nearly two-year long investigation into US CV and AD duties on Chinese solar products. It found that US trade tariffs against Chinese solar products were in violation of WTO rules. If this initial WTO ruling holds, Suntech may be back in business.

Suntech may emerge out of bankruptcy relatively intact, but whether it will again rise in the Arizona desert, or anywhere else in the United States, to manufacture modules, seems most unlikely.

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The Paulson Institute's Program on Cross-Border Investment

There are compelling incentives for the United States and China to increase direct investment in both directions. US FDI stock in China was roughly $60 billion in 2010, yet a variety of obstacles and barriers to further American investment remain. Meanwhile, Chinese FDI stock in the United States has hovered at around just $5 billion. For China, investing in the United States offers the opportunity to diversify risk from domestic markets while moving up the value-chain into higher-margin industries. And for the United States, leveraging Chinese capital could, in some sectors, help to create and sustain American jobs.

As a nonprofit institution, The Paulson Institute does not participate in any investments. But by taking a sector-by-sector look at opportunities and constraints, the Institute has begun to highlight commercially promising opportunities—and to convene relevant players from industry, the capital markets, government, and academia around economically rational and politically realistic investment ideas.

The Institute's goal is to focus on specific and promising sectors rather than treating the question of investment abstractly. We currently have two such sectoral efforts—on agribusiness and manufacturing.

The Institute's aim is to help develop sensible investment models that reflect economic and political realities in both countries.

The Paulson Institute currently has four investment-related programs:

US-China Agribusiness Program

The Institute's agribusiness programs aim to support America's dynamic agriculture sector, which needs new sources of investment to spur innovation and create jobs. These programs include:

- A US-China Agricultural Investment Experts Group comprised of some of the leading names in American agribusiness. The group brainstorms ideas and helps in the Institute's effort to develop innovative investment models that reflect economic and technological changes in global agriculture.
- Periodic agribusiness-related investment workshops, bringing key players and companies together. The Institute held the first workshop in Beijing in December 2012, whose attendees included numerous CEOs and experts. It has since held smaller, sessions in the United States focused on specific technologies or aspects of agribusiness.

- Commissioned studies that propose specific investment models, including for commodities, such as pork, or value chain opportunities, such as collaborative research and development (R&D).

US-China Manufacturing Program

In June 2013, the Institute launched a program on trends that will determine the future of global manufacturing and manufacturing-related capital flows. We aim to identify mutually beneficial manufacturing partnerships that would help support job growth in the United States. The Institute's principal manufacturing programs include:

- Investment papers that the Institute is co-developing with private sector and academic partners.
- Periodic workshops in Beijing and Chicago with Chinese, American and global CEOs and executives, focused on technological change, sectoral trends, and investment opportunities.

Case Study Program

The Institute publishes in-depth historical case studies of past Chinese direct investments in the United States, examining investment structures and economic, political, and business rationales. These detailed studies are based on public sources but also first-hand interviews with deal participants on all sides. They aim to reconstruct motivations and actions, and then to draw lessons learned.

State-Level Competitiveness Program

The Institute works closely with several US governors to help them hone their teams' approach to attracting job-creating foreign direct investment. Our core competitiveness program is a partnership with states in the Great Lakes region, but we work with other governors as around the United States as well.

- Paulson Institute-Great Lakes Governors Partnership: Working closely with the Council of Great Lakes Governors, the Institute is honing pilot strategies to help match the "right" investors and recipients to the "right" sectoral opportunities. Work is also focusing on how to connect Great Lakes/St. Lawrence-based R&D and innovation to foreign deployment opportunities while opening markets in China. The Council includes the governors of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin, as well as the Canadian premiers of Ontario and Quebec.

- American Competitiveness Dialogues: The Institute convenes an ongoing series of competitiveness forums around the United States. These aim to address the implications of the changing global economy for US competitiveness, opportunities and challenges associated with foreign direct investment.

- R&D+Deployment ("R&D+D"): Working with partners, including McKinsey & Company and a small number of universities, the Institute is exploring new models that would link Chinese investors to the US innovation engine, especially in areas linked to demand-side needs in the China market. The aim is to design fresh models that capture value in both countries but do not sacrifice America's innovation edge or intellectual property protection. Our dialogue in this area aims, ultimately, to lead to a pilot initiative.

About The Paulson Institute

The Paulson Institute, an independent center located at the University of Chicago, is a non-partisan institution that promotes sustainable economic growth and a cleaner environment around the world. Established in 2011 by Henry M. Paulson, Jr., former US Secretary of the Treasury and chairman and chief executive of Goldman Sachs, the Institute is committed to the principle that today's most pressing economic and environmental challenges can be solved only if leading countries work in complementary ways.

For this reason, the Institute's initial focus is the United States and China—the world's largest economies, energy consumers, and carbon emitters. Major economic and environmental challenges can be dealt with more efficiently and effectively if the United States and China work in tandem.

Our Objectives

Specifically, The Paulson Institute fosters international engagement to achieve three objectives:

- To increase economic activity—including Chinese investment in the United States—that leads to the creation of jobs.
- To support urban growth, including the promotion of better environmental policies.
- To encourage responsible executive leadership and best business practices on issues of international concern.

Our Programs

The Institute's programs foster engagement among government policymakers, corporate executives, and leading international experts on economics, business, energy, and the environment. We are both a think and "do" tank that facilitates the sharing of real-world experiences and the implementation of practical solutions.

Institute programs and initiatives are focused in five areas: sustainable urbanization, cross-border investment, climate change and air quality, conservation, and economic policy research and outreach. The Institute also provides fellowships for students at the University of Chicago and works with the university to provide a platform for distinguished thinkers from around the world to convey their ideas.

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