

Revisiting the history books

China's solar story: Charting the birth of the Chinese PV industry is a transparent task, yet misinformation regarding the state's role in supporting the sector persists. Australian expertise, U.S. investment, German foresight and Chinese boldness were all more pivotal in giving China's PV manufacturing base a headstart, argues UNSW's Martin Green.

"Forget the 'dumping-subsidizing-copy-catting' story." This is the advice of Christian Binz from Lund University, one of several researchers currently exploring PV industry development in China. The shift of PV manufacturing to China over the 2005-2010 period (See Chart top p. 98), despite its casualties, undeniably has been the game-changer in bringing PV to international attention as an immediate option for large-scale, low-carbon electricity supply, years earlier than expected.

Another global benefit is PV's positioning for maximum impact in meeting China's increasing energy needs, replacing fossil fuels. There are encouraging signs that internationally competitive PV manufacturing is also possible in India and Southeast Asia, where energy needs are growing the next most rapidly.

The actual story behind the transition illustrated in the chart on the top of page 98 is more interesting. In addition to China, it involves Germany, through the transformational German feed-in tariff (FIT) program, as well as the U.S. where it was investors, not the Chinese government, that largely financed this transi-

tion. Australia also played a key role by providing the expertise that seeded Chinese growth.

Wei Zhang and Steven White at Tsinghua University are also researching this transition. They identify the Chinese-Australian joint venture Suntech as the "root firm" from which the industry grew, critical to it in the same way as Fairchild was to the growth of Silicon Valley.

Prior to Suntech's formation in 2001, PV prospects in China were bleak. The Tsinghua researchers note that China was "lacking all the factors representing necessary resources and opportunity," the PV ecosystem was "rudimentary" and technological levels within existing state-owned enterprises (SOEs) fabricating PV in small quantities during the 1990s were "far below international standards."

Echoing this bleakness, the 2000 IEA World Energy Outlook predicted total Chinese installed PV capacity of less than 0.1 GW (sic!) by 2020. The Chinese government was also largely unaware of the PV industry's potential until well past the critical stages of development, suggesting in late 2007 a slightly more upbeat 2020

target of 1.8 GW (the present target is 150 GW).

Australian seeding

Zhengrong Shi, an Australian citizen, was the driving force behind Suntech, and key to this transition. Zhengrong obtained his training and PhD in PV from the University of New South Wales (UNSW) and subsequent management experience as Deputy Research Director of UNSW spin-off, Pacific Solar. Suntech co-founders were Zhengrong's colleagues from Pacific Solar, Ted Szpitalak and Fengming Zhang, as well as Huaijin Yang, all Australians, and Chengrong Xu. After rejection by the Shanghai, Dalian and Hangzhou governments, the Wuxi government overcame initial hesitation and organized a combined \$6 million contribution from seven local enterprises. Zhengrong contributed \$400,000 of his savings plus know-how, earning 25% ownership.

Despite this limited budget, Suntech's first 10 MW cell production line was successful, producing sellable cells in August 2002, in time for its gala opening, generating profits by year-end. These financed the installation of a second 15 MW line during 2003, likewise on a minimal budget, with Suntech reporting capital expenditures of \$2.5 million in 2002 and 2003 "primarily to purchase manufacturing equipment to expand manufacturing lines for production of PV cells and modules."

Meanwhile, SolarWorld in Europe, opening its first cell line a week after Suntech, reported €40 million expenditure for a 30 MW turnkey capability. Apart from Zhengrong, two other Australians were key to this success: Stuart Wenham and Ted Szpitalak.

Szpitalak had been responsible for procuring largely secondhand equipment and its subsequent commissioning for the

Photo: UNSW/Martin Green



Martin Green at the opening of Suntech's original 10 MW line in 2002.

UNSW solar labs since the 1980s. He was then seconded to Pacific Solar as Acquisitions Manager. Szpitalak's acquisition and commissioning experience had a big impact on the Chinese industry, at Suntech and at Sunergy and JA Solar, then finally Sunrise Global (See Chart bottom p. 98).

As soon as Suntech's first line was operational, Wenham, who had set up Australia's first screen-printing line, then made several one to two week visits, in order to fine-tune the processing, and train Suntech engineers in this and quality control. The UNSW "Virtual Production Line" software, developed for UNSW courses by Stuart Wenham and PhD student Anna Bruce, facilitated communication and thoroughly grounded the Suntech engineers in a host of processing intricacies.

The four pioneers

Although Suntech was the first private company producing cells in China, both Trina and Yingli have longer histories (See Chart p. 100), with Canadian Solar (CSI) only slightly younger. The Tsing-

hua research group notes that the motivation for founding all was not immediate business opportunities but interest in PV's social and environmental benefits. However, only Suntech initially had the technical expertise to capitalize on this interest.

Trina produced its first modules in late 2004 and its first cells in 2007. Yingli sold its first module in early 2003 and began cell production on a small 3 MW line in March 2004, 18 months after Suntech, although dependent on others for cells until a full-sized line was commissioned in mid-2006. These pioneering companies were positioned to quickly exploit opportunities provided by Suntech's success. Sunergy, Solarfun and JA Solar, the three remaining companies earning "top 10" positions via cell manufacturing (See Chart p. 100) were Suntech "spin-offs."

Other pioneering roles

The Tsinghua researchers have documented Zhengrong's additional role in developing local supply chains in polysilicon, ingots, wafers, pastes and processing equipment. Although all of Suntech's

2002 sales were in China, he realized that success depended upon competing internationally and that lower local costs would offer competitive advantages.

Zhengrong gained ISO certification of Suntech's production in 2002 and IEC61215 module certification in 2003. Suntech exhibited in Europe in late 2002, with 19% of 2003 sales to Germany, growing to 72% in 2004. In its 2004 Annual Report, SolarWorld reported concluding "a license agreement with Chinese solar manufacturer Suntech Power Inc. for the production of SolarWorld modules in China in the first quarter of 2005," mentioning volumes of "around €100 million over the next two years." Suntech filings suggest actual volumes of more than \$200 million. Given the different costs, Suntech could sell modules profitably to SolarWorld, with SolarWorld then profitably onselling. This endorsement of Chinese product quality undoubtedly contributed to its international acceptance.

Suntech then pioneered capital raising on U.S. markets. In an interview with Christian Binz, Zhengrong reports an approach by Goldman Sachs and Mor-

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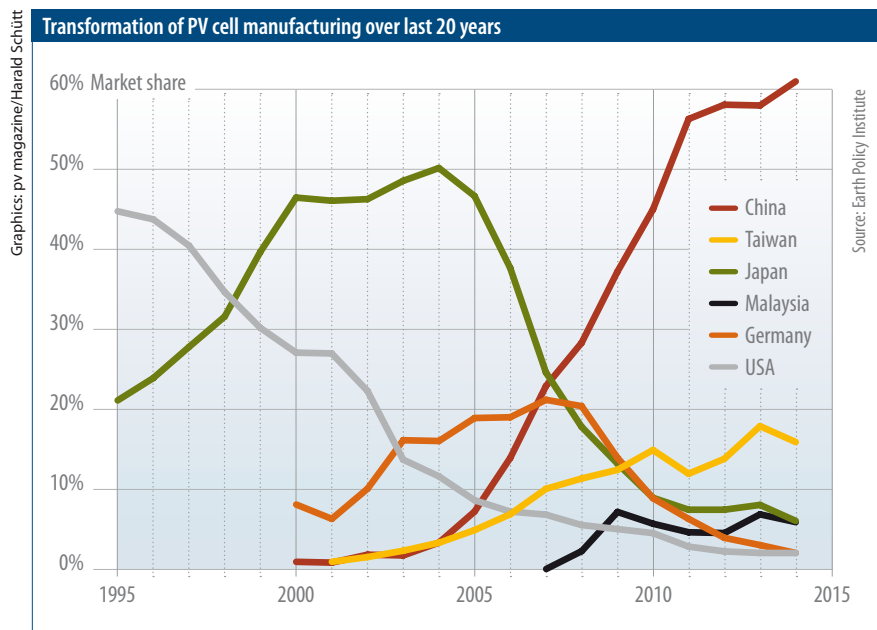
Neo Solar Power Corporation

www.nsp.com

7, Li-Hsin 3rd Rd, Hsinchu Science Park, Hsinchu, Taiwan 30078

Tel: +886-3-578-0011

Fax: +886-3-578-1255



gan Stanley in 2004 with U.S. listing suggested, triggering an effective “management buy-out.” Zhengrong emerged with majority shareholding in the reorganized company, subsequently incorporated in the Cayman Islands. From the Chinese perspective, as for the other “top 10” companies, Suntech is a “wholly foreign-owned enterprise” (WFOE).

Cayman Island registration provides a path for foreign companies to operate on U.S. stock exchanges. Zhengrong chose

the New York Stock Exchange (NYSE) for listing, the first private company based in China to do so, raising \$396.5 million in reportedly the largest technology float of 2005. The other pioneers, Yingli, Trina and CSI, followed largely independent paths, although all appointed Australian-trained staff to senior positions. All benefited from Suntech’s pioneering role in developing local supply chains, opening up international markets and pioneering U.S.-investor funding, with

all listing within 18 months of Suntech (See Chart p. 100).

“Second wave” spin-offs

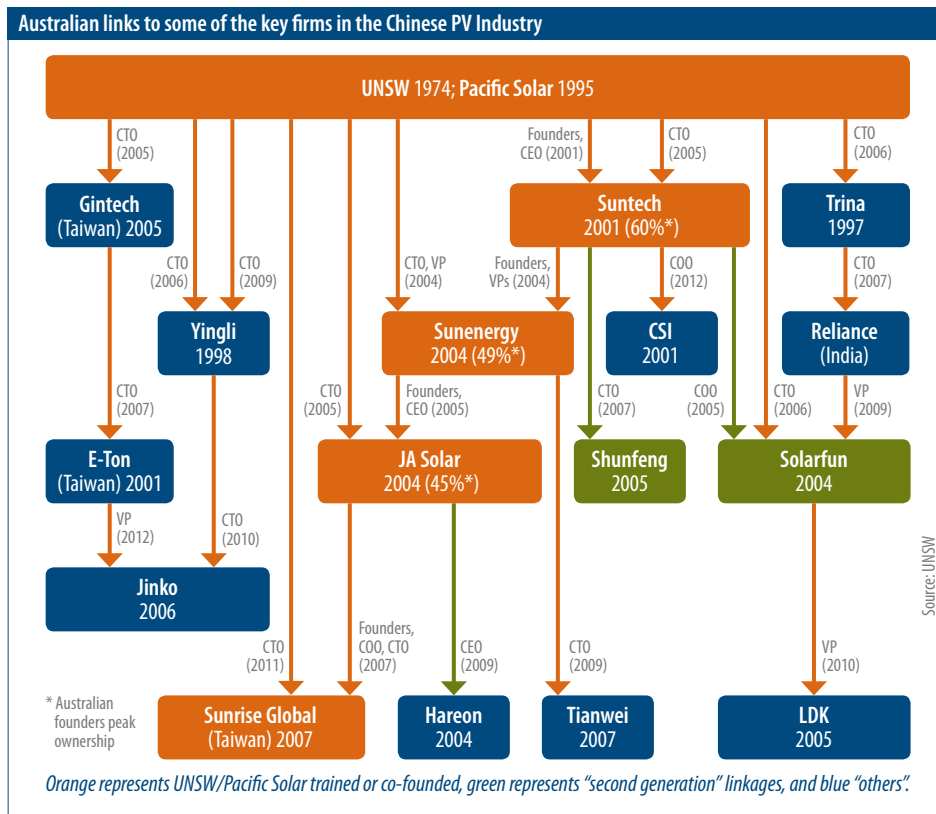
Suntech’s initial European success in 2003 and 2004 was probably not widely known outside these pioneers and others with Suntech links. The three other cell manufacturers making the “top 10” had such links, namely China Sunergy and Solarfun, both formed in August 2004, and JA Solar, founded in May 2005.

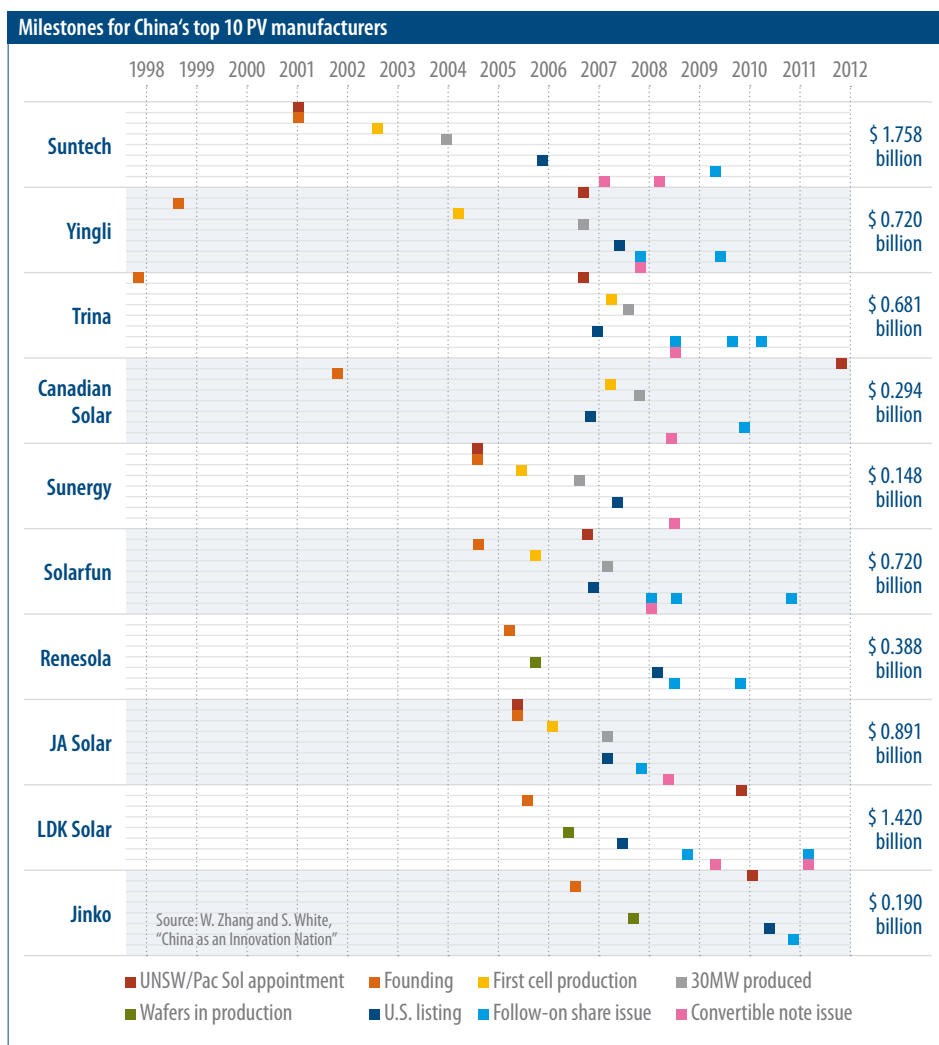
After Suntech, the next internationally competitive line was commissioned at Sunergy with the first cells produced in June 2005. Suntech’s founding team, minus Zhengrong, had moved en masse to help two other UNSW researchers, Jianhua Zhao and Aihua Wang, cofound Sunergy, together owning 49% of Nanjing PV, Sunergy’s precursor.

After establishing Sunergy’s production, Ted Szpitalak and Huaijin Yang formed another team with Bruce Beilby and Ximing Dai (both UNSW PhDs) to establish yet another line in China at JA Solar, founded in May 2005 as a joint venture with the Jinglong Group, with 45% Australian equity. Market-ready cells were produced in April 2006, around the same time Yingli started full-scale production. Yang and Dai became CEO and CTO of JA Solar respectively. Szpitalak, Beilby and Dai moved on to set up yet another production line at Global Sunrise in Taiwan, a pioneer in commercializing UNSW PERC cell technology. Huaijin later became President, CEO and Chair of Hareon Solar.

Founded shortly after Sunergy was Solarfun, which is now Hanwha Q Cells. While Sunergy and JA Solar were direct Suntech spin-offs, the Tsinghua group describe Solarfun as a “second-generation” spin-off. Wang Hanfei, the first professional manager hired by Suntech, moved to Solarfun, with the company producing its first cells in November 2005.

Another notable “second-generation” spin-off was Shunfeng, with Hui Qu and Caixia Tong leaving Suntech in 2006, becoming responsible at Shunfeng for “production quality and technological management” and “technology and research and development,” respectively. Shunfeng was founded in late 2005, producing its first cells in 2007.





Follow the dots: Fund-raising patterns and the route to manufacturing are evident in the various companies' paths to market. As is a correlations between UNSW appointments and U.S. market listing.

U.S. financing

Suntech listed in late 2005, with both Suntech and supporting U.S. venture capitalists doing well. Goldman Sachs' shares increased in value by \$200 million beyond their purchase price in the first week. This not only encouraged other PV companies in China to follow suit, but similarly encouraged U.S. venture capitalists to target and groom these to repeat Suntech's success. For firms not already having a senior UNSW appointee, grooming apparently included encouraging this, explaining why multiple companies (Trina, Solarfun, Yingli and Jinko) appointed UNSW CTOs.

By lowering entry barriers through its success, Suntech opened the floodgates for massive U.S. investments in the Chinese PV industry. All but one of the remaining "top 10" companies listed in a 14 month window between December 2006 and January 2008, before the Lehman Brothers' bankruptcy in Sep-

tember when PV share prices fell sharply. Jinko and Daqo, listing in 2010, did not fare as well as hoped, with subsequent low market valuations encouraging both Trina and JA Solar recently to consider delisting.

Capital raisings by the "top 10" over the 2005-2010 period through share and convertible note issues on U.S. exchanges total \$7 billion, growing to \$10 billion including personnel shares and options. This investment, boosted by profits from European sales, underpinned the 100-fold increase in cell manufacturing capacity in China from less than 300 MW in 2005 to more than 30 GW in 2010.

The third wave

Suntech's listing attracted widespread attention since Zhengrong's shareholding immediately shot above \$1 billion in value, attracting international coverage of the "first solar billionaire" during 2006-2007. In particular, companies and

local governments within China took note. In a University of Texas Masters thesis, Yu Xia explains how the resulting "uncoordinated, irrational exuberance" led to distorted local government incentives and massive overinvestment.

Fiscal reform in China in 1994 gave local governments increased autonomy in local economic development, thereafter retaining all local and some shared taxes. This gave strong incentives to increase revenue by supporting local industrial development, such as by seed funding, low electricity rates and by establishing industrial parks to provide cheap land. The promotion system for local officials also contributes, since it is based on local economic growth. PV companies had been effective in increasing growth, and advancing the careers of multiple government officials.

Also entering the fray were subsidiaries of large SOEs, Fortune 500 companies, with access to ready capital and ambitious plans for rapid expansion. Tianwei New Energy, formed in mid-2007, invested \$1.5 billion to establish 500 MW capacity in wafers, cells and modules by 2010, with plans to expand to 1.5 GW by 2012. Guodian Solar, established in September 2009 as a subsidiary of one of China's "big five" power companies, had similarly ambitious plans, investing \$1.2 billion. This third wave pushed PV equipment expenditure to a peak in 2011 (See Chart p. 101). As shown in the insets, there was a major imbalance between geographical origins and use of this equipment.

Massive oversupply created problems for manufacturers inside and outside of China. It benefited users and prospects for PV impact, by driving down prices as companies struggled to maintain cash flows. Only the strongest were able to reduce manufacturing costs to below the new price levels and much of the third wave, including Tianwei and Guodian, withdrew after massive losses.

Dumping-subsidizing-copycatting

Dumping, in the usual sense of selling less expensively in foreign markets than in the home market, certainly does not apply to Chinese PV produce. The local market has long been the market of last resort due to higher prices on foreign markets. World Trade Organization (WTO) rules are based on "normal value" allowing, in some cases, replacement of actual prices by "calculation based on the

combination of the exporter's production costs, other expenses and normal profit margins." This would produce sensible determinations if China were not, until December 2016 at least, classed as a "non-market" economy. This has allowed questionable practices to be used in recent dumping determinations.

Government subsidies have benefited most PV manufacturers globally. PV manufacturing subsidies in former East Germany were probably the most generous, involving cash grants of 35% of capital costs (reported in SolarWorld's 2002 Annual Report), partially offsetting the cost differential between German and Chinese production. Subsidies in China have come in various, normally uncoordinated, forms, with local governments, motivated by subsequent economic benefits outweighing costs.

Commonly the view is that China has hijacked the PV industry through large, low-interest government loans. However, as documented by the Tsinghua researchers: "Not until after 2007... did local governments begin to support the industry through... targeted subsidies and incentives and by establishing solar PV industrial parks... the central government did not provide direct financial or political support to the private solar PV sector before 2009."

U.S. investors largely financed the transformation of the PV manufacturing industry. Debt financing through convertible note issues on U.S. exchanges was clearly more attractive than local loans. Interest rates associated with other



Suntech's 2005 NYSE listing paved the way for Chinese PV manufacturers to raise capital in the U.S.

debt were not particularly low and, for key players, are explicitly documented in company Form 20F filings.

After the event, in 2010, lines of credit totaling over \$40 billion were made available to Chinese PV companies, when the Chinese government embraced PV. However, these were not particularly attractive, as documented by low uptake. Recent Chinese market development programs have had a far more significant impact.

Copycatting does not accurately describe how the PV industry took root in China. Early lines at Suntech were not turnkey, but were patched together using

the accumulated Australian experience of the founders. Moreover, the Chinese industry has shown a confidence in embracing, developing and commercializing new technology rare in earlier phases of the industry.

The birth of the Chinese PV industry arose from a convergence of key precedents. Among these were the emerging free market in China, the German FITs, an appetite for Chinese stocks on U.S. markets prior to the global financial crisis, and fortunate timing by a team of technically astute researchers driven by the desire to make a difference. ♦

Martin A. Green

