17-181
September 13, 2017

MIT MANAGEMENT SLOAN SCHOOL

# First Solar

*Neil Thompson and Jennifer Ballen*

Tymen deJong, First Solar's senior vice president of module manufacturing,[1] fixated yet again on the company's latest 10-K. DeJong had joined the company in January of 2010, at a time when First Solar's future appeared bright. Now, just two years later, First Solar's cost advantage was eroding and deJong was facing challenges that would require tough decisions.

In 2009, First Solar broke cost records by becoming the first photovoltaic (PV) manufacturer to produce panels that generated a megawatt of power at a manufacturing cost of less than $1.00 per watt.[2] The company's proprietary thin-film cadmium telluride technology had made it the largest and lowest-cost producer for nearly a decade. However, the 2011 Form 10-K on deJong's desk revealed a net operating loss of $39 million, the company's first year-end net operating loss in the past seven years. Although revenues were $2.7 billion, revenue growth had slowed from 66% in FY 2009, to 24% in FY 2010, and then to a meager 8% in FY 2011.[3] Much of this slowed growth was attributable to broader trends affecting the entire PV industry. Chinese manufacturers, subsidized by their government, were flooding the market with low-price crystalline-silicon (c-Si) solar panels. Market demand for PV panels was also weakening. The 2008–2009 global financial crisis had squeezed government budgets and weakened the financial positions of many banks. As a result, the once-heavy European solar subsidies were shrinking and the willingness of banks to finance solar projects had virtually disappeared. Silicon raw material

[1] As of July 2015, Tymen deJong became the chief operating officer (COO) of First Solar.

[2] Watt: a unit of power is defined as 1 joule per second; it measures the rate of energy flow.

[3] First Solar Inc., Form 10 K, 2007.

This case was prepared by Jennifer Ballen, MBA 2017, and Professor Neil Thompson.

prices were also falling. This helped First Solar's competitors, which produced silicon-based panels, but not First Solar, which produced cadmium telluride-based ones.

As deJong reflected on the company's recent financial slump, he wondered if First Solar's competitive edge had eroded permanently. How should First Solar respond to the threat from the Chinese manufacturers? What could the company do to maintain its cost advantage? Were First Solar's recent acquisitions of down-stream solar panel installers a strategic benefit or a distraction? DeJong knew that to answer these questions, he first needed to better understand the sources of First Solar's competitive advantage and whether these sources were sustainable.

## PV Solar Manufacturing and Distribution

### Solar Industry History and Evolution

In 1839, nineteen-year old French scientist Edmond Becquerel discovered the *photovoltaic effect*: that shining light on the junction of two dissimilar materials, such as a metal and a semiconductor, creates electric current. This led to Bell Lab's 1954 creation of the first functional solar cell. Early solar cells were inefficient and costly to manufacture, so their use was limited to high-value applications, such as space satellites.[4] By the early 1980s, PV solar cell use had broadened to consumer applications, such as calculators and watches, and by the mid-1990s utility companies had begun using PV solar plants, although costs continued to be higher than nonrenewable energy sources.

At the turn of the 21st century, two major types of solar technologies had emerged: solar thermal and photovoltaic. Solar thermal power plants used sunlight to generate heat that was used to boil water, with the resulting steam driving a turbine to create electricity. But, the fastest growing solar market was photovoltaics: the conversion of sunlight directly into electricity. First Solar produced exclusively photovoltaic panels

### Overview of Photovoltaics

By early 2012, there were two dominant technologies used to produce PV solar power: (i) thin-film and (ii) crystalline silicon (c-Si) (**Exhibit 1**). The PV supply chains typically involved the following steps (**Figure 1**).

[4] "Solar Explained: Photovoltaics and Electricity," *U.S. Energy Information Administration,* October 25, 2015.

***Figure 1 Steps in the PV Supply Chains***

| Production Stage | Process for Crystalline Silicon | Process For Thin Film |
|---|---|---|
| i) Raw material preparation | Raw silica, often in the form of sand, is purchased and purified. | A substrate (e.g. glass) and semiconductor (e.g. cadmium telluride, CdTe) are prepared by 3rd parties. |
| ii) Solar wafer production | Silicon is formed into thin circular wafers. | N/A |
| iii) Solar cell production[5] | Solar wafers are layered to generate electric current when hit by sunlight. | A thin layer of semiconductor is layered on top of the substrate, coated, and then defined with a laser. |
| iv) Module array production | Solar cells are electrically wired together into solar modules and weatherproofed. | |
| v) System integration and development | System integrators install completed modules and arrays. For utility customers, integrators also provide financing, engineering, construction, and ongoing maintenance. | |

*Source: Case writers.*

Crystalline silicon was the dominant technology in the market, accounting for nearly 85% of manufactured solar panels over the last decade. Crystalline silicon was used for semiconductors in both electronics and solar cells. In 2001, 20% of total silicon use was allocated towards solar cell production, and 80% towards electronics. By 2010, this had reversed: 80% of total silicon use was for the manufacturing of solar cells. The rapid growth in demand from solar manufacturers increased silicon prices from $50/kg in 2001 to a peak of $475/kg in 2008.[6] In response, crystalline silicon manufacturers raced to improve cell efficiency and reduce the thickness of the silicon wafer, which decreased silicon use in solar cells from approximately 15 grams per watt in 2001 to 5 grams per watt by EOY 2011.[7] From 2008–2011, supply of silicon ramped up, causing prices to plunge from $475/kg back to $65/kg (**Exhibit 2**). Industry experts predicted that silicon prices would continue to decline further in the near future, benefiting First Solar's competitors.

An alternative to crystalline silicon was thin film technology, first commercialized in the early 2000s by First Solar and a small number of other manufacturers. True to its name, thin film technology involved the placement of thin layers of semiconductor material, such as cadmium telluride, on top of inexpensive substrates, such as glass or aluminum. Panels using thin film were typically lower cost and required 98% less semiconductor material than traditional c-Si panels. In 2011, cadmium telluride use in thin film solar panels was approximately 0.1 grams per watt. The price of cadmium telluride varied

[5] "The Difference Between Solar Cells and Solar Panels," *RGSEnergy.com.*

[6] "Mineral Commodity Summaries," *U.S. Geological Survey*, January 2012.

[7] Shyam Mehta, "The Shifting Relationship Between Solar and Silicon in Charts," *Greentech Media*, 2011.

over time, from $48/kg in 2006 to $192/kg in 2011 (**Exhibit 2**). Offsetting thin-film's cost advantage was its historically lower efficiency in converting sunlight into power for most applications (**Exhibit 3**).

The cost of nonrenewable fossil fuel power had historically been lower than that of renewable power. By the end of 2010, ignoring subsidies, it cost utilities approximately $0.15-$0.35/kWh to produce electricity from solar power, $0.08-$0.10/kWh to generate electricity from wind, and $0.06-$0.08/kWh for natural gas.[8] Coal cost only $0.04/kWh, but was the dirtiest form of power. Indeed, many coal plants with remaining useful life were being decommissioned to avoid the environmental and health damage they caused. Natural gas was becoming cost-competitive with coal due to the reduced cost of extracting natural gas through hydraulic fracking,[9] a technique that had increased in use substantially over the past decade. However, natural gas, while cleaner than coal, still produced carbon emissions and posed environmental risks. Historically, the cost of solar was much higher than other forms of power. In 1976, the cost of solar was approximately $2.00/kWh, but this cost was falling substantially as producers learned-by-doing and took advantage of economies of scale (**Exhibit 4**).

## Global Market

Over the last decade, PV solar energy had become the fastest-growing power generation technology in the world. Much of this growth was driven by regulatory policies, as solar was still more expensive than traditional fossil fuels. Government incentives typically enhanced the returns for solar providers in two ways: either providing higher prices for solar power suppliers or requiring utilities to purchase a specific amount of solar power.[10] For example, Feed-in Tariffs (FiTs) were widely used, particularly in Europe, and offered solar producers long-term contracts at above-market, government-mandated rates. Another incentive, termed renewable portfolio standards, mandated that certain percentages of the energy produced by utilities be sourced from renewables, such as solar, wind, geothermal, or hydroelectric power. Renewable portfolio standards were used by many states in the United States, most significantly California that had been increasing renewable percentage requirements since 2002.

From 2002–2008, global PV demand increased at an average annual rate of 48%. However, in early 2009 the global financial crisis impacted the solar market, tightening the wallets of financial institutions and decreasing government spending. Existing subsidies allowed demand to continue increasing, but at a slower rate, after 2009. By early 2012, many governments had significantly reduced incentive programs. This was particularly evident in Europe, whose share of overall demand fell, albeit from a

[8] "Electricity Generation Estimates," *U.S. Energy Information Administration and Michigan State University*, April 2011.

[9] Hydraulic fracking is an extraction technique for oil and gas wells in which pressurized liquid is injected into the cracks in rock formations. Once the hydraulic pressure is removed from the well, the remnants of the fracking fluid ease the extraction of oil and gas.

[10] Government incentives came in many different forms including, but not exclusive to: feed-in-tariffs, renewable portfolio standards, quotas, tax credits, tendering systems, net metering, rebates, loans, and production incentives.

high level (**Exhibit 5**). Despite this, the total global PV installed base at EOY 2011 was 65 gigawatts and experts predicted that this would grow by 400-600 gigawatts by 2020.[11]

The biggest change in solar production was the large-scale entry of Chinese producers. In 2001, China comprised less than 1% of overall solar production, but by 2012 Chinese producers were manufacturing nearly 60% of the entire world's supply of PV panels[12] (**Exhibit 6**).

## Market Segments

There were three broad markets for solar power: residential homeowners, commercial businesses, and utilities. The residential segment represented 29% of the total market and was predicted to grow to 35% by 2020. Commercial businesses comprised 40% of the market; this segment was expected to shrink to 25% by 2020. The utility market was predicted to be the fastest growing segment, with an expected increase in market share from 31% in 2011 to 40% by 2020. In all three markets there were numerous systems integrators.

**The Residential Market** In the residential market, PV solar manufacturers sold panels to third-party system integrators, installers, and distributors, who would physically position the panel on a homeowner's roof and connect the panel to the regional electric grid. Residential users were encouraged to adopt solar through investment tax credits and net metering incentives (which encouraged solar operators to sell unused electricity back to utilities).

Residential customers typically did not focus on the technology or maker of their solar panels, but instead on the overall costs and benefits of the installed system. The key criteria for a residential customer purchasing from a panel manufacturer were (in descending order): the levelized cost of electricity (an average cost measure per kWh across the lifetime of the system),[13] installation and distribution costs (expenses that were paid by the homeowner), watts per unit area, and sometimes even aesthetics, as some residential homeowners were concerned about the appearance of highly visible rooftop panels.

**The Commercial Market** Commercial and industrial businesses seeking to lower their operating expenses and carbon footprints also purchased solar power systems through third party system integrators and distributors. As commercial projects were typically larger in scope and required greater wattage per panel, the primary purchase consideration for commercial businesses was the levelized cost of electricity. When purchasing panels, commercial customers also focused on watts per unit area, installation and distribution costs, and reliability of the technology.

[11] Krister Aanesen, Stefan Heck, and Dickon Pinner, "Solar Power: Darkest Before Dawn," *McKinsey & Company*, May 2012.

[12] Robert Castellano, "China's EV Battery Industry Could Be A Repeat of Solar and Rare Earth Dominance," *Seeking Alpha,* October 25, 2016.

[13] See Glossary for more details.

The commercial and utility markets both financed solar projects with solar leases and power purchase agreements (PPAs), financial contracts between buyers and providers of electricity. With a PPA, the developer was responsible for the design, financing, and installation of the solar system at little to no cost for the customer. The developer also operated and maintained the system over the duration of the contract, typically 10-25 years. In return, the customer purchased the generated energy at a fixed rate from the developer. At contract termination, the customer would either extend the PPA, remove the system, or purchase the system from the developer. PPAs provided an assurance of both volume (all the kWh were sold) and price (as set by the PPA contract).

**The Utility Market** In contrast to the residential and commercial markets, the utility market encompassed a smaller number of larger-scale projects. For example, in the United States, there were approximately 60 new utility-scale solar projects in 2011, as compared to hundreds of thousands of projects in residential and commercial markets.[14] Some utilities purchased panels directly from PV manufacturers, while others purchased from system integrators and installers. System developers provided a variety of services to utility customers, including:

i. **Project Development:** obtaining land permits, negotiating purchase agreements, transmission interconnection, major engineering, and construction.
ii. **Operations and Maintenance:** subsequent to development, signing long-term contracts to provide on-site operations and maintenance, such as performance analysis, forecasting, contractual and regulatory advice, performance reporting, and inventory management.
iii. **Project Finance:** negotiating and executing power plant sales, raising capital from debt and equity markets, and structuring non-recourse project-level debt financing.
iv. **Engineering, Procurement and Construction:** engineering and designing power plants, developing grid integration, construction management, and procuring component parts from third parties.

The primary purchase consideration for the utility market depended on the placement. In space-constrained areas, the most important factor was typically watts-per-square meter, so that as much power as possible could be generated in small spaces. Utilities that were not space constrained were willing to purchase less efficient panels if the panels had a lower cost per kilowatt-hour. Many utility installations were not space constrained.

A vendor track record of successful and timely installation was typically the next purchase consideration for utilities. PV manufacturers that wanted to sell products to utilities in a certain location would often first establish a relationship with integrators that had a favorable track record in order to better reach that market. Finally, utilities purchased panels based on proven technology and anticipated

[14] "An Analysis of New Electric Generation Projects Constructed in 2011," *Electric Market Reform Initiative and American Public Power Association*, March 2012.

reliability of the system. Feed-in-tariffs were implemented by many governments to encourage demand and required utilities to buy renewable energy at above-market rates. Utilities often passed this incremental financial burden to their customers through a small extra fee on monthly electric bills.

## First Solar

### Brief Company History

First Solar originated as a glass company in 1984 under the name Glasstech Solar, founded by glass entrepreneur Harold McMaster. In 1990, the company was renamed to Solar Cells, Inc., and then once again in 1999 to First Solar, LLC, after True North Partners purchased a controlling interest in the company and the firm was recapitalized. John Walton, the son of Walmart's founder Sam Walton, and Mike Ahearn (who later became co-founder, Chairman, and the first CEO of First Solar) founded True North Partners. Walton and Ahearn both believed in the power of technology to accelerate sustainability.

On November 17, 2006, First Solar became a publicly-traded company (FSLR), raising $450 million at an initial offering price of $20 per share.[15] First Solar's business model focused solely on component manufacturing at first: designing and producing PV solar cells and modules to sell to project developers, system integrators, and operators of clean energy projects. Beginning in 2007 with a series of acquisitions, First Solar vertically integrated, buying system integrators primarily in the United States. Through its systems business, First Solar controlled the engineering, procurement, construction, operations, maintenance, and development of solar power plants, and at times, project finance.

### Manufacturing and Costs

First Solar manufactured PV solar cells and modules using an advanced thin-film cadmium telluride (CdTe) technology, controlling all stages of production entirely in-house which, according to First Solar's 10-K, "…eliminated the multiple supply chain operators and expensive and time consuming batch processing steps that are used to produce crystalline silicon solar modules."

In 2005, First Solar produced its first commercial solar module. First Solar used a proprietary vapor deposition technology to coat glass panels with two thin layers of semiconductor material: first cadmium sulfide, then cadmium telluride. High speed lasers then divided the semiconductor into cells, the fundamental units for absorbing light and converting it into electricity. Solar cells were combined to form solar modules and solar modules were combined to form solar panels to scale up the amount of electricity provided.

Tymen deJong commented on First Solar's use of thin-film:

[15] Nasdaq, First Solar Inc. IPO priced November 17, 2006.

> Most of the early work in photovoltaic generation was done on crystalline silicon, so that's where the R&D investments went. While there was an awareness of thin-film and cadmium telluride, there simply was not that much money being invested in it. There are significant technical challenges in applying cadmium telluride. We figured it out early and, to this day, we have a tremendous amount of IP around how to do that. The barriers to entry to figure this all out are years of R&D and hundreds of millions of dollars in capital expenditures. And, to be fair, all of the early efficiency records were based on c-Si…it looked like a better technology to new entrants. But, if you want to look at thin-film, you have to do all that work yourself. Our company leaders had this vision around CdTe and what we could do.

Historically, First Solar produced all of its modules at its manufacturing plant in Perrysburg, Ohio, which later evolved to also become the company's primary research and development (R&D) center. In April of 2007, First Solar expanded production internationally and began to produce modules at its Frankfurt/Oder Germany plant.

As of 2011, First Solar operated 36 production lines in Perrysburg, Ohio; Frankfurt, Germany; and, Kulim, Malaysia. Of these, the Malaysian plants had the lowest production costs, but the other plants had advantages in terms of R&D or serving particular markets. The company's newest plant was built in Frankfurt, Germany in November of 2011. This was First Solar's second plant in Frankfurt, adding a capacity of 250 megawatts per year to the region. The plant had taken First Solar one year to construct and cost roughly 170 million euros (US $230 million).[16] First Solar also had two plants under construction in Mesa, Arizona and Ho Chi Minh City, Vietnam.[17]

Traditionally, First Solar had operated its plants very close to 100% capacity in order to maximize use of the expensive fixed capital required to produce PV panels. By 2011, however, the increasing market share of Chinese competitors led to First Solar producing only 1.7 gigawatts of panels (approximately 21 million solar modules) despite having the capacity to produce 2.5 gigawatts.

The manufacturing cost per watt for First Solar and its competitors is shown in **Exhibit 7**.

## Customer and Market Strategy

The majority of First Solar's early customers were system integrators, developers, and operators, primarily located in subsidy-rich Europe. In 2008, approximately 74% of the company's net sales resulted from Germany alone.[18] In order to diversify, First Solar expanded into direct sales in high-sunshine, non-subsidy reliant markets, primarily selling systems to utilities in Africa, the Middle East, and the Americas.

[16] Jonathan Gifford, "First Solar Inaugurates Second German Plant," *PV Magazine,* November 3, 2011.

[17] First Solar Inc., Form 10-K, 2011.

[18] First Solar Inc., Form 10-K, 2010.

The company first ventured into the systems business in late 2007 with a $34.4 million acquisition of system integrator, Turner Renewable Energy. Further acquisitions of Mission Edison's project pipeline, OptiSolar (a power plant contractor), NextLight Renewable Power (a solar panel developer), and Ray Tracker (a component parts firm), expanded First Solar's presence in the systems market.[19] While First Solar became closer to the customer, these acquisitions also brought with them higher SG&A expenses. From 2009 to 2011, First Solar grew its utility-scale systems business from 5% to 25% of overall sales, narrowing the gap between itself and systems leader, SunPower, which derived 53% of its business from systems in 2010 and 46% in 2011. Chinese manufacturers were largely absent from the systems business. **Exhibit 8** provides additional details.

## Financial Strategy

First Solar pursued a conservative financial strategy, borrowing less than its competitors. From 2007–2011, First Solar had an average annual debt of $276 million, whereas SunPower had $687 million, Suntech had $1.7 billion, and Yingli Solar had $1.1 billion. First Solar also consistently kept more cash on hand than competitors, for use in financing promising solar projects. Capacity expansions were typically funded with 50% cash and 50% equity. Bruce Sohn, former President and Board member (2003–2011), commented on First Solar's financial approach:

> The reason we pursued a low leverage strategy was because we wanted a strong balance sheet. This served to both lower borrowing costs [for First Solar customers] and provide confidence to buyers that we would be able to sustain our business for the long-term. We did it by design for those reasons. In contrast, our competitors during this time were levering up and borrowing to expand, and thus had weak balance sheets. People didn't trust those companies. First Solar took the opposite approach.

**Exhibit 9** shows both the income statements and balance sheets for First Solar and its main competitors.

## Vertical Integration

All PV manufacturers produced solar modules, with several outsourcing various aspects of semiconductor production. Few forward-integrated into systems, so First Solar was unusual in this respect. The company divided its business into two interrelated segments: components and systems. The components business manufactured cadmium telluride solar cells and modules, while the systems business developed those components into complete solar systems. The components segment had historically achieved higher profitability and generated more cash than systems, but the systems business had less margin variability because the provision of ongoing maintenance, engineering, and construction was less dependent on materials prices.

[19] First Solar Inc., Form 10 K, 2007.

Sohn commented on the vertical integration:

> We realized that we could scale our production faster than our customers [the systems integrators] were able to scale their business. Our customers were the constraint and we determined that if we could vertically integrate, especially in places where our customers did not operate, then we could grow significantly faster. This effectively doubled our shipment rate and enabled steep volume growth even during a period of heightened competition.
>
> Having our own utility scale solar business also provided us with the opportunity to optimize overall system design…For several years, First Solar was able to deliver systems that yielded up to 5% better performance than competitors because of our intimate knowledge about the [First Solar] panels.

## Competition

### United States

Although U.S. customers were initially slower to adopt PV solar power than their European and Asian counterparts, by 2011 U.S. solar installations had grown enormously, doubling from 2009 to 2011. In 2011, the U.S. market share of total global PV installations increased from 5% to 7%. U.S. market share was anticipated to outpace the growth of other nations over the next five years. Reported installed solar capacity from 2010–2011 in the United States was a total of 1,855 megawatts, comprised of 16% residential, 43% commercial, and 41% utility. The utility market had only recently grown in size, while the commercial market had long accounted for over 50% of solar energy growth.[20] As in the rest of the world, the majority of modules produced in the United States used crystalline silicon technology.

In 2011, First Solar controlled approximately 41% of the U.S. market. SunPower was the second largest PV manufacturer, controlling 38.5%, while the remaining 20.5% of the market went to smaller players including Solyndra, SunEdison, SunRun, Evergreen Solar, and Spectrawatt, Inc.[21] SunPower manufactured highly efficient (18.1%–20.1%) and more expensive, solar panels and modules. In 2011, SunPower was suffering a similar fate to First Solar, also recording its first year-end net operating loss since 2007. SunPower's gross margin over the past five years had decreased from 19% in 2007 to 10% at EOY 2011. In April 2011, SunPower sold a 60% controlling interest to the oil company Total for $1.38 billion. Total offered SunPower up to $1 billion of credit over the ensuing five years.[22]

Solyndra, a California-based solar panel manufacturer, also competed in the thin-film market, using a copper indium gallium (di)selenide (CIGS) technology to design and manufacture panels, primarily for

[20] "U.S. Solar Market Insight Report 2011 Year-In-Review," *Solar Energy Industries Association,* 2011.

[21] First Solar, Inc., Form 10K, 2011; SunPower Corporation, Form 10K, 2011.

[22] "Total to Begin Friendly Tender for Up to 60% of SunPower Shares," *Bloomberg*, March 28, 2011.

commercial customers. Although Solyndra had increased production from 30 MW in 2009 to 67 MW in 2010,[23] the company was ultimately forced to declare bankruptcy in September of 2011. Analysts speculated the bankruptcy was due to an over-leveraged balance sheet and tightening credit conditions.

## China

In 2009, the Chinese government declared leadership in PV solar production a national priority, ratifying a multitude of solar subsidy programs that transformed China into the world's largest producer of solar panels in just a few short years. Crystalline silicon manufacturers from China began producing quickly, cheaply, and in mass quantities, exporting over 90% of their panels abroad.[24] Chinese manufacturers also had much lower R&D expenditures, typically a third to a half as much as First Solar. Major players in the Chinese market included Suntech, Yingli, and Trina Solar.

The Chinese government subsidized both the demand and supply of PV solar panels. Domestically, the government subsidized demand through a series of initiatives. In March of 2009, China released its first national solar subsidy initiative called "building-integrated photovoltaics," a government subsidy providing up to 20 RMB (US$3) per watt for such systems and 15 RMB per watt for rooftop systems.[25] By July, the program had offered $1.2 billion in subsidies. That same year, China launched its second national solar subsidy program: Golden Sun. This program sought to accelerate the development of utility-scale solar projects, offering a 50% subsidy for building, transmission, and distribution costs. The subsidy increased to 70% for PV projects in remote areas lacking connection to the grid. The government's stated intent was to install over 500 megawatts of solar power in two to three years.[26] A variety of similar subsidies were implemented in the following years. Collectively, the yearly installation of PV panels in China grew more than 1000% from 2009 to 2011.[27]

Chinese subsidization of suppliers is harder to quantify. One 2011 U.S. Department of Energy and Stanford University study attempted to quantify the scale of the advantages of producing in China, including subsidies, low-cost equipment, cheaper labor, and regional supply chain advantages (**Exhibit 10**). This study found that the Chinese cost advantage due to subsidies for PV manufacturers was approximately 18-20% of costs, when compared with a 60 MW crystalline silicon U.S. plant. In 2011, the World Trade Organization (WTO) began an investigation of Chinese subsidies, ultimately concluding that of the 18-20% cost advantage, 1/5 was due to subsidies, most of which manifested in the form of lower depreciation. In other words, the Chinese government was primarily subsidizing the building of new plants rather than ongoing operations.[28]

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[23] "2010 Solar Technologies Market Report," *U.S. Department of Energy*, November 2011.

[24] "Why Millions of Chinese-Made Solar Panels Sat Unused in Southern California Warehouses for Years," *Pacific Standard*, June 30, 2015.

[25] It is important to note that this number applies to the entire solar system, not just the panel, and therefore is not comparable to values in Exhibit 2.

[26] Lin Jones, "China's National Solar Subsidy Programs," *China Policy in Focus*, 2012.

[27] Greentech Media Research, PV Pulse, 2008-2011.

[28] Mark Clayton, "China Subsidized Solar Panels, U.S. Finds…" *Csmonitor.com*, March 2012.

Chinese manufacturers produced so many panels over this period that they had to store millions of panels in warehouses in California. Many of these panels sat unused until they became obsolete for the U.S. market.[29] In October 2011, Solarworld, along with six anonymous PV manufacturers, filed an anti-dumping[30] lawsuit with the Department of Commerce and the International Trade Commission, contending that crystalline-silicon Chinese manufacturers were benefiting from illegal subsidies and dumping their modules into the U.S. market. Industry experts had given credence to this anti-dumping lawsuit by accusing Chinese suppliers of selling modules below their bill of materials and contending that the Chinese government was giving free equipment, gifts of land, deferred taxes and other benefits to its domestic manufacturers. The severity of this for First Solar was captured in the company's 2011 10-K Filing:

> In 2011, industry average module pricing declined significantly as competitors reduced prices to sell-through inventories in Europe and elsewhere. If competitors reduce module pricing to levels near or below their manufacturing costs, or are able to operate at minimal or negative operating margins for sustained periods of time, our results of operations could be adversely affected. At December 31, 2011, the global PV industry consisted of more than 150 manufacturers of solar modules and cells. In the aggregate, these (global PV) manufacturers have installed production capacity that significantly exceeded global demand in 2011. We believe this structural imbalance between supply and demand (i.e., where production capacity significantly exceeds current global demand) will continue for the foreseeable future, and we expect that it will continue to put pressure on pricing, which could adversely affect our results of operations.

## Bankruptcies

The combination of the flood of inexpensive panels from China and the drop in subsidies in Europe drove down solar prices worldwide, forcing the closure of numerous manufacturing plants, particularly in the United States. On August 15, 2011, U.S manufacturer Evergreen Solar, Inc. filed for bankruptcy, closing at $0.18 on the NASDAQ, a dramatic end to a stock that in 2007 had a price of $113.10 and a promising future. The price of solar wafers, Evergreen Solar's main product, had dropped 35% in the last 12 months.[31] Just one week later, SpectraWatt Inc., backed by Intel Corp. and Goldman Sachs Group, also filed for Chapter 11 bankruptcy.[32] The U.S. solar industry was suffering, and higher-cost producers were being hit the hardest.

[29] "Why Millions of Chinese-Made Solar Panels Sat Unused in Southern California Warehouses for Years," *Pacific Standard*, June 30, 2015.

[30] Dumping: when a foreign producer sells goods or services in domestic country for a price lower than production costs and/or the domestic producer's selling price. The price difference is referred to as the dumping margin.

[31] Nichola Groom, "Solar Company Evergreen Files for Bankruptcy," *Reuters,* August 15, 2011.

[32] Andrew Herndon and Michael Bathon, "Intel-Backed Solar Company Files for Bankruptcy as Prices Slide," *Bloomberg,* August 24, 2011.

In September of 2011, U.S. CIGS[33] manufacturer Solyndra filed for bankruptcy after just six years of operation, resulting in the loss of thousands of jobs. Solyndra's insolvency was also politically charged because just two years earlier the company had received a $535 million loan guarantee from the U.S. Department of Energy, the first-ever loan recipient under the 2009 American Recovery and Reinvestment Act. At the time, U.S. President Barack Obama had publicly praised Solyndra for setting a positive example for the "future" of American energy businesses.[34] Solyndra had also received over $700 million in venture capital funding during its time of operation.[35] Although Solyndra was not considered a major player in the global solar market, its default on a federal loan guarantee carried higher implications than other bankruptcies: Solyndra became a proof of concept for those seeking to diminish loan-guarantees and other incentives for clean energy.

## First Solar's Response

### Protagonist Prepares for Upcoming Meeting

DeJong was concerned. The quarterly Board meeting was just around the corner and he knew that the company's recent financial underperformance meant he would have to field intense questions from employees and investors. The $413 million loss in 4Q 2011 amounted to a per-share loss of $4.78. Just one year ago, during 4Q 2010, First Solar had earned a $155.9 million ($1.80 per share) quarterly profit.

Could First Solar still be profitable if silicon prices continued to fall? Was the systems business a competitive advantage or a distraction? What changes did First Solar need to make to counter the threat of Chinese entrants? If First Solar was forced to retrench, which market should the company focus on, and would it be able to prevail in that market? Could the company maintain its competitive advantage or would it follow other American solar manufacturers into bankruptcy in the face of these difficult challenges?

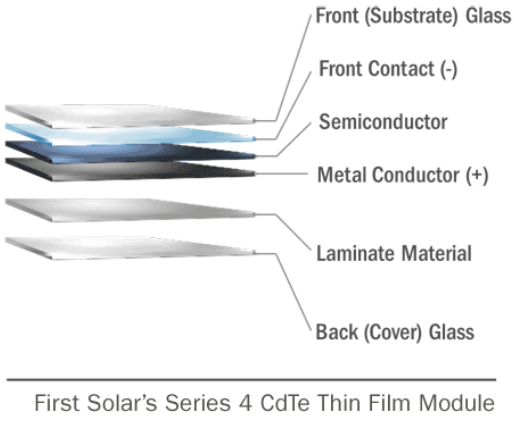
[33] CIGS: short for Copper-Indium-Gallium-Selenide, a technology used to manufacture thin-film solar cells and modules.

[34] Joe Stephens and Carol D. Leonnig, "Solyndra Solar Company Fails after Getting Federal Loan Guarantees," *Washington Post,* August 31, 2011.

[35] Tom Hals, "U.S. Solar Frm Solyndra Files for Bankruptcy," *Reuters,* September 6, 2011.

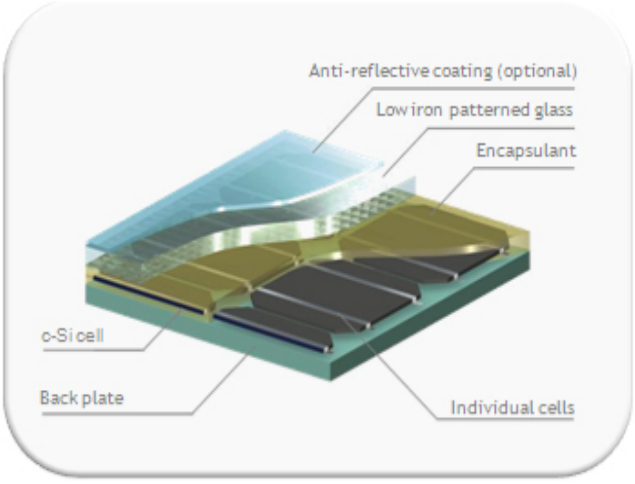
### *Exhibit 1 Thin-Film and Crystalline Silicon Solar Cells*

*Thin film*



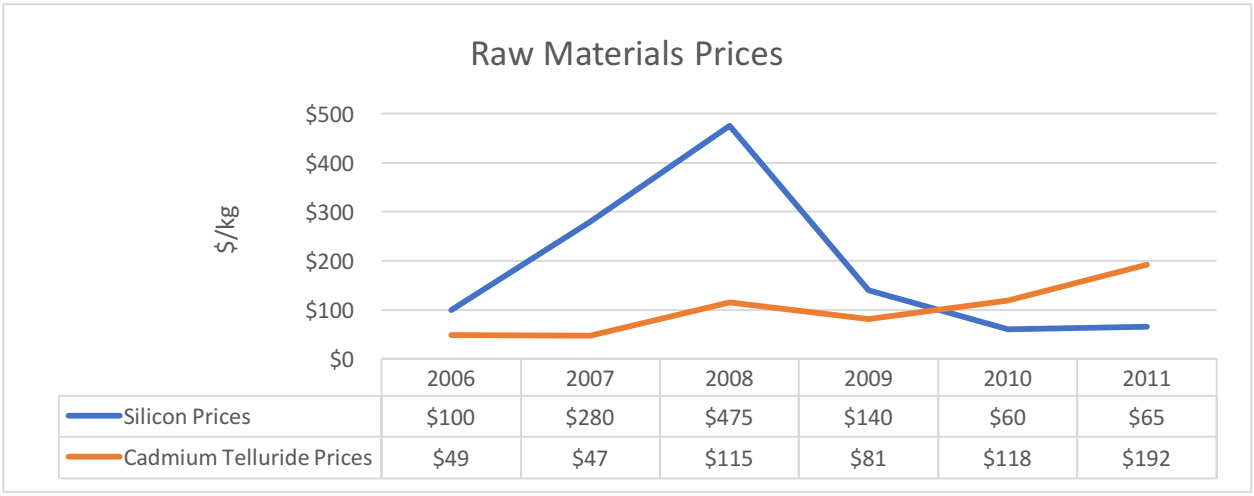

First Solar's Series 4 CdTe Thin Film Module

*Crystalline Silicon*




*Source: First Solar.*

### *Exhibit 2 Raw Materials Prices*[36]




| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Silicon Prices | $100 | $280 | $475 | $140 | $60 | $65 |
| Cadmium Telluride Prices | $49 | $47 | $115 | $81 | $118 | $192 |

*Sources: U.S. Geological Survey, Mineral Commodity Summaries, January 2012; PV Insights.*

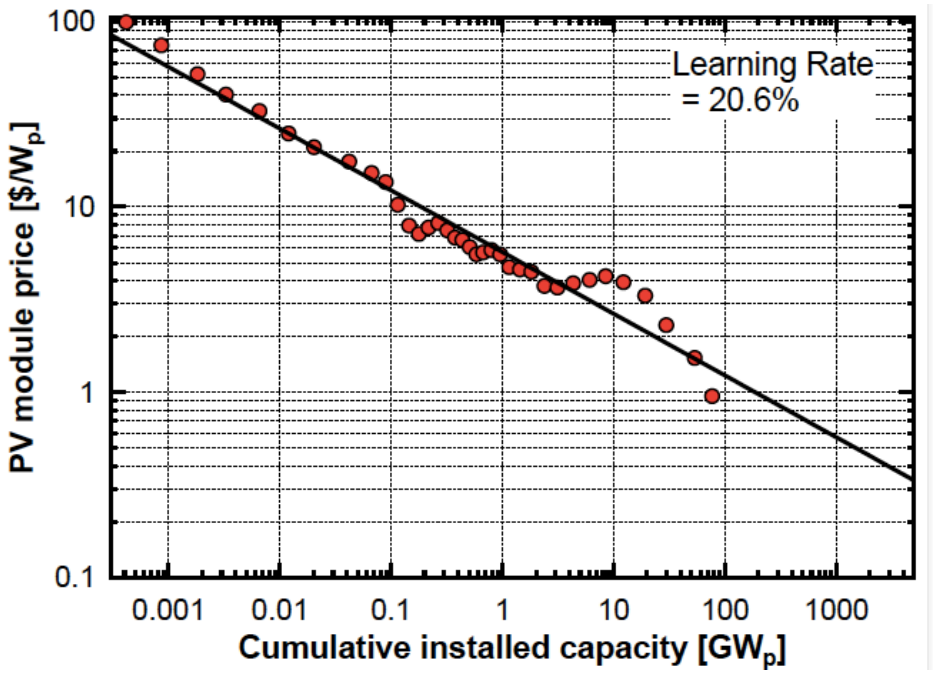
[36] Cadmium telluride prices calculated based on the cost of the two input materials: cadmium and telluride.

### *Exhibit 3 Module Size and Wattage*[37]

| Company | Area of Solar Module | Watts per Module |
|---|---|---|
| First Solar | 8 $ft^2$ | 80 |
| SunPower | 23.3 $ft^2$ | 435 |
| Suntech | 13.8 $ft^2$ | 190 |
| Yingli | 10.76 $ft^2$ | 130 |

*Source: Company SEC Form 10-Ks and Annual Reports.*

### *Exhibit 4 Learning Rates*[38]

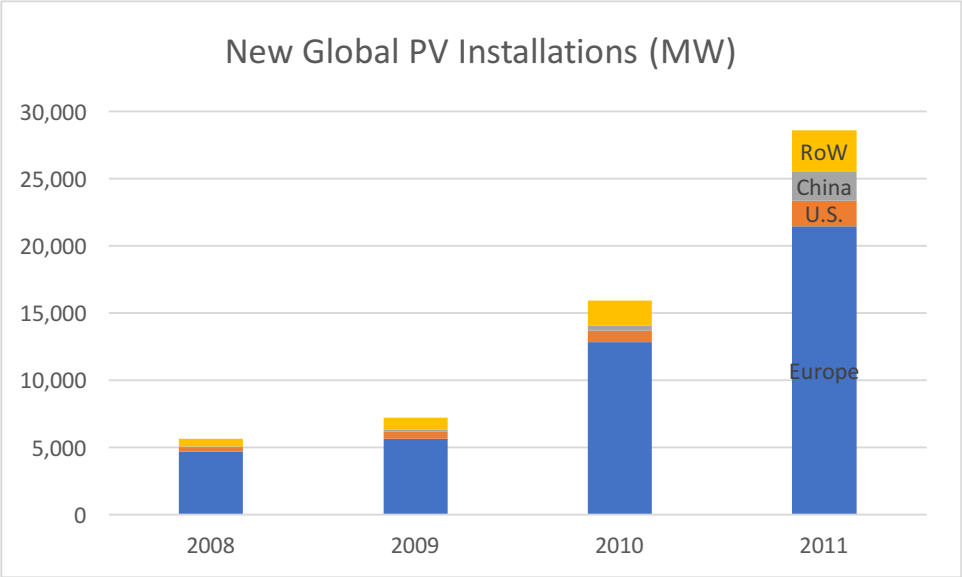



*Source: Trancik, Jessika E., Patrick R. Brown, et al. "Technology Improvement and Emissions Reductions as Mutually Reinforcing Efforts: Observations from the Global Development of Solar and Wind Energy." Cambridge, MA: Institute for Data, Systems and Society, Massachusetts Institute of Technology, November 13, 2015. URL: http://hdl.handle.net/1721.1/102237.*

[37] "Yingli-Panel Specifications", First Solar 10K, "SunPower_PanelSpecs", "Suntech_Panel Specs"

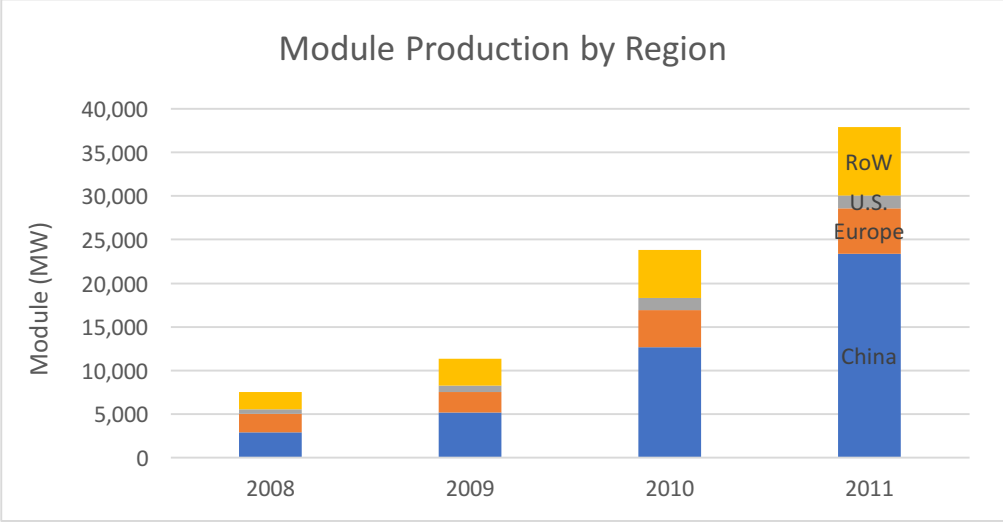
[38] Learning rate: percentage decrease in costs, given a doubling of production.

***Exhibit 5 New Global PV Installations***




*Source: Greentech Media Research, PV Pulse, 2008-2011.*

***Exhibit 6 Module Production by Region***




*Source: Greentech Media Research, PV Pulse, 2008-2011.*

### *Exhibit 7 Manufacturing Cost per Watt*

| FIRST SOLAR | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|
| **Watts (thousands)**[39] | 1,700,581 | 1,400,696 | 1,066,711 | 525,841 | 205,344 |
| **Manufacturing Cost Per Watt** | $0.75 | $0.77 | $0.87 | $1.08 | $1.23 |

| SUNPOWER | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|
| **Watts (thousands)** | 1,408,304 | 999,612 | 649,509 | 563,717 | 234,846 |
| **Manufacturing Cost Per Watt** | $1.48 | $1.71 | $1.91 | $1.93 | $2.67 |

| SUNTECH | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|
| **Watts (thousands)** | 2,083,841 | 1,594,451 | 705,542 | 677,289 | 440,621 |
| **Manufacturing Cost Per Watt** | $1.26 | $1.41 | $1.78 | $2.14 | $2.40 |

| YINGLI | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|
| **Watts (thousands)** | 1,630,835 | 1,082,250 | 531,422 | 285,328 | 144,167 |
| **Manufacturing Cost Per Watt** | $1.16 | $1.14 | $1.50 | $3.01 | $2.91 |

*Source: Company SEC Form 10-Ks and Annual Reports.*

[39] Total Capacity Watts

### *Exhibit 8 Share of Sales in Components and Systems (US$)*

| First Solar | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2011 | | 2010 | | 2009 | | 2008 | | 2007 | |
| Components | Systems | Components | Systems | Components | Systems | Components | Systems | Components | Systems |
| 74.8% | 25.2% | 85.2% | 14.8% | 95.1% | 4.9% | 95.9% | 4.1% | 99.3% | 0.7% |
| | | | | | | | | | |
| **SunPower** | | | | | | | | | |
| 2011 | | 2010 | | 2009 | | 2008 | | 2007 | |
| Components | Systems | Components | Systems | Components | Systems | Components | Systems | Components | Systems |
| 54.0% | 46.0% | 46.6% | 53.4% | 57.1% | 42.9% | 42.7% | 57.3% | 40.1% | 59.9% |
| | | | | | | | | | |
| **SunTech** | | | | | | | | | |
| 2011 | | 2010 | | 2009 | | 2008 | | 2007 | |
| Components | Systems | Components | Systems | Components | Systems | Components | Systems | Components | Systems |
| 95.8% | 4.2% | 95.3% | 4.7% | 94.9% | 5.1% | 92.8% | 7.2% | 98.8% | 1.2% |
| | | | | | | | | | |
| **Yingli** | | | | | | | | | |
| 2011 | | 2010 | | 2009 | | 2008 | | 2007 | |
| Components | Systems | Components | Systems | Components | Systems | Components | Systems | Components | Systems |
| 99.6% | 0.4% | 99.5% | 0.5% | 99.3% | 0.7% | 99.6% | 0.4% | 99.9% | 0.1% |

*Source: Company SEC Form 10-Ks and Annual Reports.*

***Exhibit 9 Consolidated Financial Statements for First Solar, SunPower, Suntech, and Yingli Green Energy***

| **FIRST SOLAR: INCOME STATEMENT** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **31-Dec-11** | **31-Dec-10** | **26-Dec-09** | **27-Dec-08** | **29-Dec-07** |
| Net Sales | 2,766,207 | 2,563,515 | 2,066,200 | 1,246,301 | 503,976 |
| Cost of Sales | 1,794,456 | 1,378,669 | 1,021,618 | 567,908 | 252,573 |
| **Gross Profit** | **971,751** | **1,184,846** | **1,044,582** | **678,393** | **251,403** |
| *Operating expenses* | | | | | |
| Research and Development | 140,523 | 94,797 | 78,161 | 33,517 | 15,107 |
| Selling, general, and administrative | 412,541 | 321,704 | 272,898 | 174,039 | 82,248 |
| Production start-up | 33,620 | 19,442 | 13,908 | 32,498 | 16,867 |
| Goodwill impairment[40] | 393,365 | - | - | - | - |
| Restructuring | 60,366 | - | - | - | - |
| *Total Operating Expenses* | 1,040,415 | 435,943 | 364,967 | 240,054 | 114,222 |
| **Operating (loss) Income** | **(68,664)** | **748,903** | **679,615** | **438,339** | **137,181** |
| **EBIT Margin (%)** | -2.48% | 29.21% | 32.89% | 35.17% | 27.22% |
| Foreign currency gain (loss) | 995 | (3,468) | 5,207 | 5,722 | 1,881 |
| Interest income | 13,391 | 14,375 | 9,735 | 21,158 | 20,413 |
| Interest expense, net | (100) | (6) | (5,258) | (509) | (2,294) |
| Other income (expense), net | 665 | 2,273 | (2,985) | (934) | (1,219) |
| Income (loss) before income taxes | (53,713) | 762,077 | 686,314 | 463,776 | 155,962 |
| Income tax (benefit) expense | (14,220) | 97,876 | 46,176 | 115,446 | (2,392) |
| **NET INCOME (LOSS)** | **($39,493)** | **$664,201** | **$640,138** | **$348,330** | **$158,354** |
| **Net Margin (%)** | -1.43% | 25.91% | 30.98% | 27.95% | 31.42% |

*Source: First Solar Inc., SEC Form 10K, 2007-2011.*

[40] As stated on First Solar's 2011 10K, Goodwill represents the excess of the purchase price of acquired business over the estimated fair value assigned to the individual assets acquired and liabilities assumed. First Solar does not amortize goodwill, rather tests for impairment at least annually. First Solar recorded a goodwill impairment of $393.4 million during the 4th quarter of 2011 related to its components reporting unit, specifically related to the goodwill that had been allocated to the company's acquisitions of OptiSolar in 2009 and NextLight in 2010.

| **SUNPOWER CORPORATION: INCOME STATEMENT** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **1-Jan-12** | **2-Jan-11** | **3-Jan-10** | **28-Dec-08** | **30-Dec-07** |
| *Revenue* | | | | | |
| Utility and power plants | 1,064,144 | 1,186,054 | 653,531 | 823,307 | 464,178 |
| Residential and commercial | 1,248,350 | 1,033,176 | 870,752 | 614,287 | 310,612 |
| **Total Revenue** | **2,312,494** | **2,219,230** | **1,524,283** | **1,437,594** | **774,790** |
| *Cost of Revenue* | | | | | |
| Utility and power plants | 967,076 | 908,326 | 526,850 | 659,752 | 386,532 |
| Residential and commercial | 1,117,214 | 801,011 | 713,713 | 428,221 | 240,507 |
| **Total Cost of Revenue** | **2,084,290** | **1,709,337** | **1,240,563** | **1,087,973** | **627,039** |
| **Gross Margin** | **228,204** | **509,893** | **283,720** | **349,621** | **147,751** |
| *Operating expenses* | | | | | |
| Research and development | 57,775 | 49,090 | 31,642 | 21,474 | 23,138 |
| Sales, general, and administrative | 319,719 | 321,936 | 190,244 | 173,740 | 108,256 |
| Goodwill impairment | 309,457 | - | - | - | - |
| Other intangible asset impairment | 40,301 | - | - | - | 14,068 |
| Restructuring charges | 21,403 | - | - | - | - |
| Total operating expenses | **748,655** | **371,026** | **221,886** | 195,214 | 145,462 |
| **Operating Income (loss)** | **(520,451)** | **138,867** | **61,834** | **154,407** | **2,289** |
| **EBIT Margin (%)** | -22.51% | 6.26% | 4.06% | 10.74% | 0.30% |
| *Other income (expense) net* | | | | | |
| Interest Income | 2,054 | 1,541 | 2,109 | 10,789 | 13,882 |
| Interest expense | (67,022) | (55,276) | (36,287) | (22,814) | (12,036) |
| Other, net | (2,344) | 98,281 | 15,964 | (26,313) | 2,377 |
| **Other Income Expense, net** | **(67,312)** | **44,546** | **(18,214)** | **(38,338)** | **4,223** |
| Income (loss) before income taxes and equity in earnings of unconsolidated investees | (587,763) | 183,413 | 43,620 | 116,069 | 6,512 |
| Provision for income taxes | (22,099) | (23,375) | (21,028) | (40,618) | 22,084 |
| Equity in earnings of unconsolidated investees | 6,003 | 6,845 | 9,929 | 14,077 | (278) |
| Income (loss) from continuing operations | (603,859) | 166,883 | 32,521 | 89,528 | 28,318 |
| Income from disctd. ops., net of tax | - | 11,841 | - | - | - |
| **NET INCOME (LOSS)** | **($603,859)** | **$178,724** | **$32,521** | **$89,528** | **$28,318** |
| **Net Margin (%)** | -26.11% | 8.05% | 2.13% | 6.23% | 3.65% |

*Source: SunPower SEC Form 10K Filing, 2007-2011.*

| **SUNTECH POWER HOLDINGS CO, LTD: INCOME STATEMENT** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **31-Dec-11** | **31-Dec-10** | **26-Dec-09** | **27-Dec-08** | **29-Dec-07** |
| *Net Revenues* | | | | | |
| PV modules | 3,014,000 | 2,766,300 | 1,606,300 | 1,785,800 | 1,331,700 |
| Others | 132,600 | 135,600 | 87,000 | 137,700 | 16,600 |
| Total Net Revenues | **3,146,600** | **2,901,900** | **1,693,300** | **1,923,500** | **1,348,300** |
| *Cost of Revenues* | | | | | |
| PV modules | 2,626,200 | 2,211,900 | 1,235,600 | 1,448,200 | 1,057,600 |
| Others | 133,800 | 146,900 | 95,700 | 132,400 | 16,600 |
| Total Cost of Revenues | 2,760,000 | 2,358,800 | 1,331,300 | 1,580,600 | 1,074,200 |
| **Gross Profit** | **386,600** | **543,100** | **362,000** | **342,900** | **274,100** |
| Selling expenses | 162,600 | 118,000 | 82,100 | 59,300 | 30,600 |
| General & Administrative expenses | 248,800 | 125,100 | 76,900 | 85,800 | 44,500 |
| Research & Development expenses | 38,600 | 40,200 | 29,000 | 15,300 | 15,000 |
| Provision for prepayment to affiliates | 120,000 | 8,000 | - | - | - |
| Impairment of goodwill | 281,500 | - | - | - | - |
| Impairment of long-lived assets | 180,300 | 54,600 | - | - | - |
| Total operating expenses | 1,031,800 | 345,900 | 188,000 | 160,400 | 90,100 |
| **Income from operations** | **(645,200)** | **197,200** | **174,000** | **182,500** | **184,000** |
| **EBIT Margin (%)** | -20.50% | 6.80% | 10.28% | 9.49% | 13.65% |
| Interest expense | (143,300) | (99,500) | (103,300) | (106,100) | (49,400) |
| Interest income | 7,400 | 7,600 | 9,600 | 32,600 | 31,200 |
| Other (expense) income, net | (171,300) | (94,400) | 11,200 | (76,700) | (8,700) |
| Earnings before income taxes, non-controlling interest and equity in net earnings (loss) of affiliates | (952,400) | 10,900 | 91,500 | 32,300 | 157,100 |
| Equity in net earnings (loss) of affiliates | (98,700) | 250,800 | (3,300) | 300 | (700) |
| Income (loss) from continuing operations before tax | (1,051,100) | 261,700 | 88,200 | 32,600 | 156,400 |
| Tax expense (benefit) | 47,200 | (23,800) | (2,500) | (1,600) | (13,200) |
| Income (loss) from continuing operations before tax | (1,003,900) | 237,900 | 85,700 | 31,000 | 143,200 |
| Loss from disctd ops., net of tax | (14,100) | - | - | - | - |
| **NET INCOME (LOSS)** | **($1,018,000)** | **$237,900** | **$85,700** | **$31,000** | **$143,200** |
| **Net Margin (%)** | -32.35% | 8.20% | 5.06% | 1.61% | 10.62% |

*Source: Suntech SEC Form 10K Filing, 2007-2011.*

| **YINGLI GREEN ENERGY HOLDING CO, LTD: INCOME STATEMENT** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **31-Dec-11** | **31-Dec-10** | **31-Dec-09** | **31-Dec-08** | **31-Dec-07** |
| *Net revenues* | | | | | |
| Sales of PV modules | 2,287,467 | 1,860,129 | 1,048,717 | 1,091,358 | 550,515 |
| Sales of PV systems | 8,537 | 8,585 | 7,354 | 4,043 | 268 |
| Other revenues | 36,090 | 25,223 | 6,773 | 11,673 | 5,700 |
| Total net revenues | **2,332,094** | **1,893,937** | **1,062,844** | **1,107,074** | **556,483** |
| Cost of PV modules sales | 1,891,594 | 1,232,002 | 799,643 | 857,634 | 418,868 |
| Cost of PV systems sales | 6,876 | 7,453 | 5,838 | 2,820 | 205 |
| Cost of other revenues | 44,409 | 25,272 | 6,206 | 7,762 | 6,240 |
| Total cost of revenues | 1,942,879 | 1,264,727 | 811,687 | 868,216 | 425,312 |
| **Gross Profit** | **389,215** | **629,210** | **251,157** | **238,858** | **131,171** |
| Selling expenses | 129,971 | 118,219 | 50,916 | 23,054 | 15,071 |
| General & administrative expenses | 95,763 | 70,836 | 60,080 | 38,369 | 20,538 |
| R&D expenses | 45,267 | 20,837 | 27,005 | 8,391 | 2,405 |
| Provision for (recovery of) doubtful accounts receivable | 6,195 | (1,985) | 47,271 | - | - |
| Impairment of intangible asset | 361,465 | - | 19,217 | - | - |
| Impairment of goodwill | 43,436 | - | - | - | - |
| Provision for inventory commitments | 135,321 | - | - | - | - |
| Total operating expenses | 817,418 | 207,907 | 204,489 | 69,814 | 38,014 |
| **Income from operations** | **(428,203)** | **421,303** | **46,668** | **169,044** | **93,157** |
| **EBIT Margin** | **-18.36%** | **22.24%** | **4.39%** | **15.27%** | **16.74%** |
| *Other income (expense)* | | | | | |
| Equity in loss of affiliates, net | (1,518) | (95) | (406) | (319) | (152) |
| Interest expense | (99,578) | (66,365) | (55,133) | (21,868) | (8,888) |
| Interest income | 4,584 | 2,423 | 926 | 1,867 | 1,867 |
| Foreign currency gains (losses) | (30,264) | (51,245) | 5,624 | (9,716) | (4,478) |
| Loss on debt extinguishment | - | - | (35,855) | - | - |
| Loss from revaluation of derivative | - | - | (33,892) | - | - |
| Other income | 14,902 | 1,782 | 1,079 | 893 | - |
| Earnings (loss) before income taxes | **(540,077)** | **307,803** | **(70,989)** | **139,901** | **81,507** |
| Income tax benefit (expense) | 21,197 | (50,524) | 4,663 | 819 | (1,772) |
| **NET INCOME (LOSS)** | **($518,880)** | **$257,279** | **($66,326)** | **$140,720** | **$79,735** |
| **Net Margin** | -22.25% | 13.58% | -6.24% | 12.71% | 14.33% |

*Source: Yingli SEC Form 10K Filing, 2007-2011.*

| **FIRST SOLAR: BALANCE SHEET** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **31-Dec-11** | **31-Dec-10** | **26-Dec-09** | **27-Dec-08** | **29-Dec-07** |
| Cash and Cash Equivalents | 605,619 | 765,689 | 664,499 | 716,218 | 404,264 |
| Marketable Securities | 66,146 | 167,889 | 120,236 | 76,042 | 232,686 |
| Accounts Receivable, net | 310,568 | 305,537 | 226,826 | 61,703 | 18,165 |
| Inventories | 475,867 | 195,863 | 152,821 | 121,554 | 40,204 |
| Deferred tax assets, net | 41,144 | 388 | 21,679 | 9,922 | 3,890 |
| Prepaid expenses and other current assets | 1,113,917 | 149,094 | 165,210 | 91,962 | 103,300 |
| **TOTAL CURRENT ASSETS** | **2,613,261** | **1,584,460** | **1,351,271** | **1,077,401** | **802,509** |
| Property, plant, and equipment, net | 1,815,958 | 1,430,789 | 988,782 | 842,622 | 430,104 |
| Non-current project assets | 374,881 | 320,140 | 131,415 | - | - |
| Deferred tax asset, net | 340,274 | 259,236 | 130,515 | 61,325 | 51,811 |
| Marketable securities | 116,192 | 180,271 | 329,608 | 29,559 | 32,713 |
| Restricted cash and investments | 200,550 | 86,003 | 36,494 | 30,059 | 14,695 |
| Investment in related party | - | - | 25,000 | 25,000 | - |
| Goodwill | 65,444 | 433,288 | 286,515 | 33,829 | 33,449 |
| Inventories | 60,751 | 42,728 | 21,695 | - | - |
| Other assets | 190,303 | 43,488 | 48,217 | 14,707 | 6,031 |
| **TOTAL ASSETS** | **$5,777,614** | **$4,380,403** | **$3,349,512** | **$2,114,502** | **$1,371,312** |
| *Current Liabilities:* | | | | | |
| Accounts Payable | 176,448 | 82,312 | 75,744 | 46,251 | 26,441 |
| Income taxes payable | 9,541 | 16,831 | 8,740 | 99,938 | 24,487 |
| Accrued expenses | 406,659 | 244,271 | 186,682 | 140,899 | 76,256 |
| Current portion of long-term debt | 44,505 | 26,587 | 28,559 | 34,951 | 39,309 |
| Other current liabilities | 336,571 | 99,676 | 95,202 | 59,738 | 14,803 |
| **TOTAL CURRENT LIABILITIES** | **973,724** | **469,677** | **394,927** | **381,777** | **181,296** |

| | | | | | |
|---|---|---|---|---|---|
| Accrued solar module collection and recycling liability | 167,378 | 132,951 | 92,799 | 35,238 | 13,079 |
| Long-term debt | 619,143 | 210,804 | 146,399 | 163,519 | 68,856 |
| Other liabilities | 373,506 | 112,026 | 62,600 | 20,926 | 10,814 |
| **TOTAL LIABILITIES** | **$2,133,751** | **$925,458** | **$696,725** | **$601,460** | **$274,045** |
| *Stockholders' Equity* | | | | | |
| Common stock | 86 | 86 | 85 | 82 | 79 |
| Additional paid-in capital | 2,022,743 | 1,815,420 | 1,658,091 | 1,176,156 | 1,079,775 |
| Contingent consideration | - | 1,118 | 2,844 | - | - |
| Accumulated earnings | 1,626,071 | 1,665,564 | 1,001,363 | 361,225 | 12,895 |
| Accumulated other comprehensive loss | (5,037) | (27,243) | (9,596) | (24,421) | 4,518 |
| **TOTAL STOCKHOLDERS' EQUITY** | **$3,643,863** | **$3,454,945** | **$2,652,787** | **$1,513,042** | **$1,097,267** |
| **Total Liabilities & Stockholders' Equity** | **$5,777,614** | **$4,380,403** | **$3,349,512** | **$2,114,502** | **$1,371,312** |

*Source: First Solar SEC Form 10K Filing, 2007-2011.*

| **SUNPOWER CORPORATION: BALANCE SHEET** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **1-Jan-12** | **2-Jan-11** | **3-Jan-10** | **28-Dec-08** | **30-Dec-07** |
| Cash and cash equivalents | 657,934 | 605,420 | 615,879 | 202,331 | 285,214 |
| Restricted cash & equivalents, current | 52,279 | 117,462 | 61,868 | 13,240 | - |
| Short-term investments | - | 38,720 | 172 | 17,179 | 105,453 |
| Accounts receivable, net | 390,262 | 381,200 | 248,833 | 194,222 | 138,250 |
| Estimated earnings in excess of billings | 54,854 | 89,190 | 26,062 | 29,750 | 39,136 |
| Inventories | 397,262 | 313,398 | 202,301 | 248,255 | 148,820 |
| Advances to suppliers, current portion | 43,143 | 31,657 | 22,785 | 43,190 | 52,277 |
| Project assets - plants & land, current | 24,243 | 23,868 | - | - | - |
| Prepaid expenses & other current assets | 482,691 | 192,934 | 104,442 | 101,735 | 33,110 |
| **TOTAL CURRENT ASSETS** | **2,102,668** | **1,793,849** | **1,282,342** | **849,902** | **802,260** |
| Restricted cash/ equivalents, noncurrent | 27,276 | 138,837 | 248,790 | 162,037 | 67,887 |
| Property, plant, and equipment, net | 607,456 | 578,620 | 682,344 | 622,484 | 377,994 |
| Project assets - plant & land, noncurrent | 34,614 | 22,238 | - | - | - |
| Goodwill | 35,990 | 345,270 | 198,163 | 196,720 | 184,684 |
| Other intangible assets, net | 4,848 | 66,788 | 24,974 | 39,490 | 50,946 |
| Advances to suppliers, net of current | 278,996 | 255,435 | 167,843 | 119,420 | 108,943 |
| Other long-term assets | 183,349 | 178,294 | 91,580 | 92,693 | 61,024 |
| **TOTAL ASSETS** | **$3,275,197** | **$3,379,331** | **$2,696,036** | **$2,082,746** | **$1,653,738** |
| Accounts payable | 416,615 | 382,884 | 234,692 | 259,429 | 124,723 |
| Accrued liabilities | 234,688 | 137,704 | 114,008 | 136,116 | 79,434 |
| Billings in excess of estimated earnings | 170,828 | 48,715 | 17,346 | 15,634 | 69,900 |
| Short-term debt | - | 198,010 | 11,250 | - | - |
| Convertible debt, current portion | 196,710 | - | 137,968 | - | 425,000 |
| Customer advances, current portion | 46,139 | 21,044 | 19,832 | 19,035 | 9,250 |
| **TOTAL CURRENT LIABILITIES** | **1,064,980** | **788,357** | **535,096** | **430,214** | **708,307** |

| | | | | | |
|---|---|---|---|---|---|
| Long-term debt | 355,000 | 50,000 | 237,703 | 54,598 | - |
| Convertible debt, net of current portion | 423,268 | 591,923 | 398,606 | 357,173 | - |
| Customer advances, net of current | 181,947 | 160,485 | 72,288 | 91,359 | 60,153 |
| Other long-term liabilities | 152,492 | 131,132 | 76,822 | 50,715 | 21,188 |
| **TOTAL LIABILITIES** | **$2,177,687** | **$1,721,897** | **$1,320,515** | **$984,059** | **$789,648** |
| Common stock | 100 | 98 | 97 | 86 | 85 |
| Additional paid-in capital | 1,657,474 | 1,606,697 | 1,305,032 | 1,064,916 | 883,033 |
| Retained earnings (accumulated deficit) | (540,187) | 63,672 | 100,733 | 67,953 | (22,815) |
| Accumulated Other Compr. Income | 8,540 | 3,640 | (17,357) | (25,611) | 5,762 |
| Treasury stock | (28,417) | (16,673) | (12,984) | (8,657) | (1,975) |
| **TOTAL STOCKHOLDERS' EQUITY** | **$1,097,510** | **$1,657,434** | **$1,375,521** | **$1,098,687** | **$864,090** |
| **Total Liabilities & Stockholders' Equity** | **$3,275,197** | **$3,379,331** | **$2,696,036** | **$2,082,746** | **$1,653,738** |

*Source: Sunpower SEC Form 10K Filing, 2007-2011.*

| **SUNTECH POWER HOLDINGS CO, LTD: BALANCE SHEET** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **31-Dec-11** | **31-Dec-10** | **26-Dec-09** | **27-Dec-08** | **29-Dec-07** |
| Cash and cash equivalents | 492,400 | 872,500 | 833,200 | 507,800 | 521,000 |
| Restricted cash | 216,600 | 142,500 | 124,900 | 70,700 | 94,700 |
| Inventories | 516,500 | 558,200 | 280,100 | 231,900 | 176,200 |
| Accounts receivable, net of ADA | 466,600 | 515,900 | 384,400 | 213,100 | 237,600 |
| Other receivables, net of ADA | 14,300 | 19,000 | 39,300 | 46,800 | 30,700 |
| Advances to suppliers | 84,400 | 84,400 | 48,800 | 56,900 | 61,400 |
| Deferred tax assets, net | 21,400 | 22,600 | 10,800 | 7,200 | 1,700 |
| Amounts due from related partners | 67,700 | 55,100 | 185,500 | 101,000 | - |
| Other current assets | 206,100 | 142,200 | 249,00 | 86,500 | 134,200 |
| **TOTAL CURRENT ASSETS** | **2,086,000** | **2,412,400** | **2,156,000** | **1,321,900** | **1,257,500** |
| Property plant and equipment, net | 1,569,200 | 1,236,200 | 777,600 | 684,500 | 293,000 |
| Intangible assets, net | 23,000 | 156,000 | 140,800 | 176,700 | 86,000 |
| Goodwill | - | 278,000 | 86,100 | 87,600 | 29,800 |
| Investments in affiliates | 454,200 | 545,900 | 251,400 | 221,100 | 1,000 |
| Long-term prepayments | 185,100 | 213,800 | 188,100 | 248,800 | 161,700 |
| Long-term loans to supplier | - | 53,000 | 54,700 | 84,000 | 103,300 |
| Amounts due from related parties | 67,600 | 94,100 | 193,600 | 278,000 | - |
| Other noncurrent assets | 152,200 | 137,700 | 135,400 | 121,200 | 24,700 |
| **TOTAL ASSETS** | **$4,537,300** | **$5,127,100** | **$3,983,700** | **$3,223,800** | **$1,957,000** |
| Short-term borrowings | 1,573,400 | 1,400,800 | 800,400 | 638,500 | 321,200 |
| Accounts payable | 555,300 | 457,000 | 264,200 | 117,500 | 58,900 |
| Other payables | 207,200 | 170,300 | 126,700 | 137,600 | 57,400 |
| Income tax payable | - | 66,700 | 4,300 | 12,800 | 7,300 |
| Other current liabilities | 273,000 | 275,200 | 322,500 | 70,300 | 33,300 |
| **TOTAL CURRENT LIABILITIES** | **2,608,900** | **2,370,000** | **1,518,100** | **976,700** | **478,100** |

| | | | | | |
|---|---|---|---|---|---|
| Long-term bank borrowings | 133,300 | 163,300 | 138,000 | 5,900 | 20,700 |
| Convertible notes | 580,900 | 551,200 | 516,900 | 981,200 | 500,000 |
| Accrued warranty costs | 94,100 | 81,000 | 55,200 | 41,400 | 22,500 |
| Deferred tax liabilities | - | 15,600 | 33,100 | 38,800 | 22,100 |
| Other long-term liabilities | 167,300 | 155,800 | 109,600 | 96,900 | 7,700 |
| **TOTAL LIABILITIES** | **$3,584,500** | **$3,336,900** | **$2,370,900** | **$2,140,900** | **$1,051,100** |
| Ordinary shares | 1,800 | 1,800 | 1,800 | 1,600 | 1,500 |
| Additional paid in capital | 1,148,000 | 1,134,800 | 1,114,700 | 597,100 | 530,800 |
| Retained earnings | (365,000) | 653,600 | 416,700 | 412,300 | 324,100 |
| Accumulated other comprehensive income | 161,600 | 77,500 | 64,900 | 63,400 | 31,600 |
| Suntech Power Holdings Co. Ltd Equity | 946,400 | 1,867,700 | 1,598,100 | 1,074,400 | 888,000 |
| Non-controlling interest | 6,400 | 12,500 | 14,700 | 8,500 | 17,900 |
| **TOTAL STOCKHOLDERS' EQUITY** | **$952,800** | **$1,880,200** | **$1,612,800** | **$1,082,900** | **$905,900** |
| **Total Liabilities & Stockholders' Equity** | **$4,537,300** | **$5,217,100** | **$3,983,700** | **$3,223,800** | **$1,957,000** |
| **TOTAL LIABILITIES** | **$3,584,500** | **$3,336,900** | **$2,370,900** | **$2,140,900** | **$1,051,100** |
| Ordinary shares | 1,800 | 1,800 | 1,800 | 1,600 | 1,500 |
| Additional paid in capital | 1,148,000 | 1,134,800 | 1,114,700 | 597,100 | 530,800 |
| Retained earnings | (365,000) | 653,600 | 416,700 | 412,300 | 324,100 |
| Accumulated other comprehensive income | 161,600 | 77,500 | 64,900 | 63,400 | 31,600 |
| Suntech Power Holdings Co. Ltd Equity | 946,400 | 1,867,700 | 1,598,100 | 1,074,400 | 888,000 |
| Non-controlling interest | 6,400 | 12,500 | 14,700 | 8,500 | 17,900 |
| **TOTAL STOCKHOLDERS' EQUITY** | **$952,800** | **$1,880,200** | **$1,612,800** | **$1,082,900** | **$905,900** |
| **Total Liabilities & Stockholders' Equity** | **$4,537,300** | **$5,217,100** | **$3,983,700** | **$3,223,800** | **$1,957,000** |

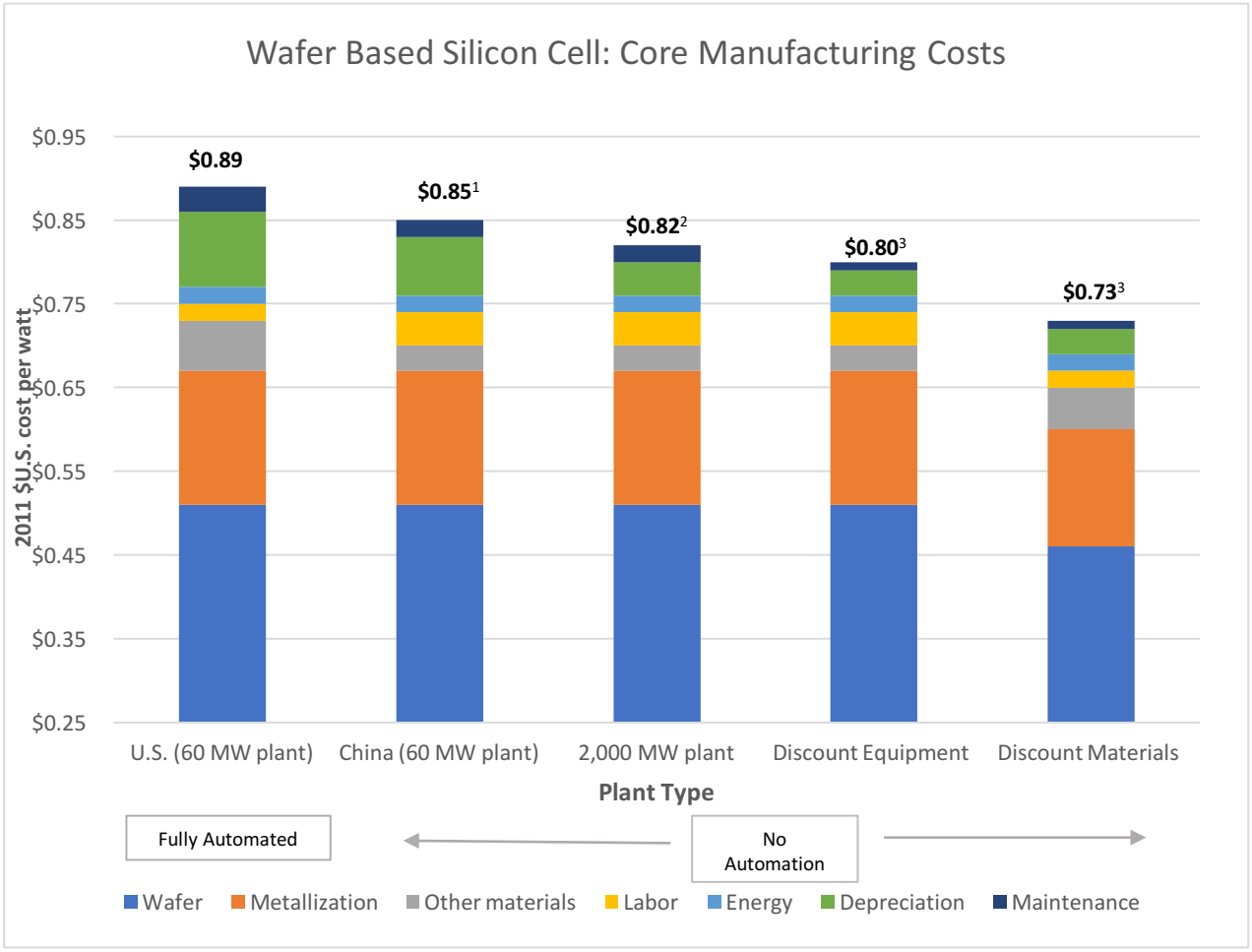
*Source: Suntech SEC Form 10K Filing, 2007-2011.*

| **YINGLI GREEN ENERGY HOLDING CO, LTD: BALANCE SHEET** *('000s of USD)* | | | | | |
|---|---|---|---|---|---|
| | **31-Dec-11** | **31-Dec-10** | **31-Dec-09** | **31-Dec-08** | **29-Dec-07** |
| Cash | 664,300 | 887,293 | 475,847 | 162,538 | 131,752 |
| Restricted Cash | 227,567 | 97,716 | 31,526 | 16,011 | 982 |
| Accounts receivable, net | 338,483 | 289,291 | 256,508 | 214,727 | 170,656 |
| Inventories | 424,366 | 382,569 | 243,927 | 299,118 | 172,896 |
| Prepayments to suppliers | 61,478 | 86,960 | 48,266 | 120,797 | 144,871 |
| Value-added tax recoverable | 150,778 | 141,187 | 44,028 | 67,656 | - |
| Amounts due from & prepayments to related parties | 88,268 | 44,176 | 44,496 | 595 | 51,836 |
| Prepaid expenses & other current assets | 68,671 | 26,423 | 21,033 | 7,092 | 24,691 |
| **TOTAL CURRENT ASSETS** | **2,023,911** | **1,955,615** | **1,165,631** | **888,534** | **697,684** |
| Restricted Cash, non-current | - | - | 24,579 | - | - |
| Long-term prepayments to suppliers | 210,158 | 76,413 | 99,373 | 98,815 | 87,362 |
| Property, plant, and equipment, net | 1,968,443 | 1,505,145 | 963,075 | 496,252 | 202,866 |
| Land use rights | 83,131 | 54,369 | 51,943 | 9,237 | 7,536 |
| Intangible assets, net | 17,539 | 24,318 | 30,447 | 57,569 | 45,421 |
| Goodwill | - | 41,464 | 40,092 | 40,112 | 3,819 |
| Other assets | 63,492 | 7,600 | 6,540 | 31,861 | 7,323 |
| **TOTAL ASSETS** | **$4,366,674** | **$3,664,924** | **$2,381,680** | **$1,622,380** | **$1,052,011** |
| *Current liabilities:* | | | | | |
| Short-term debt + current portion of Long-term debt | 1,306,833 | 887,557 | 512,903 | 299,626 | 172,905 |
| Accounts payable | 473,034 | 375,063 | 271,351 | 92,181 | 21,670 |
| Advances from customers | 142,045 | 151,711 | - | 7,612 | 3,036 |
| Amounts due to related parties | 38,541 | 12,800 | 4,562 | 1,299 | 836 |
| Convertible senior notes | 22,140 | - | 189,256 | - | - |
| Other current liabilities | 74,893 | 55,138 | 38,554 | 14,001 | 17,618 |
| **TOTAL CURRENT LIABILITIES** | **2,057,486** | **1,482,269** | **1,016,626** | **414,719** | **216,065** |

| | | | | | |
|---|---|---|---|---|---|
| Convertible senior notes | - | 13,838 | 14,670 | 182,031 | 173,105 |
| Medium-term notes | 382,337 | 151,686 | - | - | - |
| Long-term debt, excluding current | 548,451 | 378,255 | 110,287 | 97,172 | - |
| Other liabilities | 257,686 | 82,266 | 40,861 | 27,606 | 10,766 |
| **TOTAL LIABILITIES** | **$3,245,960** | **$2,108,314** | **$1,182,444** | **$721,528** | **$399,936** |
| *Stockholders' Equity:* | | | | | |
| Ordinary shares | 1,908 | 1,800 | 1,665 | 1,454 | 1,355 |
| Additional paid-in capital | 1,028,952 | 971,666 | 898,180 | 539,588 | 496,371 |
| Treasury stock | (19,675) | - | - | - | - |
| Accumulated OCI | 22,085 | 8,967 | 1,873 | 4,979 | 1,672 |
| Retained earnings | (213,238) | 282,852 | 70,327 | 150,338 | 49,203 |
| Total equity attributable to Yingli Energy | 820,032 | 1,265,285 | 972,045 | 696,359 | 548,601 |
| Non-controlling interests | 300,682 | 291,325 | 227,191 | 204,493 | 103,474 |
| **TOTAL SHAREHOLDERS' EQUITY** | **$1,120,714** | **$1,556,610** | **$1,199,236** | **$900,852** | **$652,075** |
| **Total Liabilities & Stockholders' Equity** | **$4,366,674** | **$3,664,924** | **$2,381,680** | **$1,622,380** | **$1,052,011** |

*Source: Yingli SEC Form 10K Filing, 2007-2011.*

***Exhibit 10 Core Manufacturing Costs***




[1] On level playing field, China advantage < 4%

[2] Government supported export industry, scale is a significant factor

[3] Industry scale has reduced regional supply chain benefits: purchasing power, regional supply chain benefits

*Source: "Solar PV Manufacturing Cost Analysis: U.S. Competitiveness in a Global Industry," Stanford University and National Renewable Laboratory, October 10, 2011.*

## Glossary

**Balance of Systems (BOS) costs:** the additional component costs of a solar system beyond the modules, such as the costs of installation labor, mounting hardware, wiring, and inverters, which generally comprised over half of the total costs of a utility-scale system.

**Grid Parity:** occurs when the cost to generate power through solar energy or other alternative source of energy is less than or equal to the cost of purchasing electricity directly from the electrical grid.

**Hydraulic fracking** is an extraction technique for oil and gas wells in which pressurized liquid is injected into the cracks in rock formations. Once the hydraulic pressure is removed from the well, the remnants of the fracking fluid enable ease of extracting oil and gas, increasing the rate of extraction (source: Investopedia).

**Levelized Cost of Electricity (LCOE):** the present value of the per-kilowatt hour cost (in real dollars) of building and operating a generating plant over an assumed financial life and duty cycle. LCOE takes into account capital costs, fuel costs, fixed and variable operations and maintenance (O&M) costs, financing costs, and an assumed utilization rate for each plant type (source: U.S. Energy Information Administration).

**Manufacturing throughput**: the amount of time required for a product to pass through a manufacturing process, thereby being converted from raw materials into finished goods. The concept also applies to the processing of raw materials into a component or sub-assembly.

**Net Debt:** short-term debt plus long-term debt less cash and cash equivalents.

**Net Metering**: a system that credits residential and commercial owners of solar systems for excess electricity fed back to the grid. For example, a residential homeowner with a solar panel on his/her roof might generate more energy than required by his/her house. Any excess energy supplied back to the power grid is credited, usually in the form of a reduction from the monthly electrical payment.

**Photovoltaic capacity:** the maximum power output a solar module is capable of generating.

**Photovoltaic effect:** the phenomenon in which the incidence of light or other electromagnetic radiation upon the junction of two dissimilar materials, as metal and a semiconductor, induces the generation of an electromotive force.

**Photovoltaic efficiency:** the amount of sunlight that can be converted into electricity; the conductivity of solar energy.

**Physical vapor deposition (PVD):** describes a variety of vacuum deposition methods, which can be used to produce thin films. PVD uses physical process (such as heating or sputtering) to produce a vapor of material, which is then deposited on the object, which requires coating.

**Power Purchase Agreement (PPA):** a financial contract between a buyer and provider of electricity that eliminates up-front installation costs. Developer installs solar system on customer's land for free and the customer purchases electricity from the developer at a fixed rate, typically below the rate provided from the utility, for the duration of the contract.

**PPE:** Property, plant, and equipment (PP&E) is an account on the balance sheet that represents the sum of a company's purchases of property, manufacturing plants, and equipment to that point in time, less any amortization.

**Pure Play:** a publicly traded company focused on only one industry or product.

**SG&A:** an acronym used to refer to Selling, General, and Administrative Expenses, which is a major non-production cost presented in an income statement.

**Watt:** a unit of power defined as 1 joule per second.