Market Dynamics That May Have Contributed to Solyndra's Bankruptcy

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On September 6, 2011, Solyndra, a solar system manufacturing company, filed for Chapter 11 bankruptcy protection. In September 2009, Solyndra received a loan guarantee commitment from the Department of Energy valued at $535 million, of which $527 million had reportedly been drawn down at the time of the bankruptcy announcement. Financial stress that leads to corporate bankruptcy can be caused by a number of factors, including changing market/competitive conditions, corporate and financial management decisions, financial markets, global policy changes, among others. This report evaluates how changes in the solar market, since Solyndra's founding in 2005, might have contributed to corporate financial stress and the company's bankruptcy filing.

Background

Solyndra manufactures solar photovoltaic (PV) electricity generation systems that can be installed on flat commercial rooftops. The company sells its products to value-added resellers that resell Solyndra systems to end-users such as businesses and utility companies. Unlike the majority of solar modules manufactured for electricity generation, which use flat panel silicon technology, Solyndra's proprietary PV technology is based on a cylindrical design that uses copper indium gallium diselenide (CIGS) material to convert solar energy into electricity. Solyndra claims that its unique solar system design is differentiated in the solar marketplace based on several factors that include (1) increased light collection by capturing direct, diffuse, and reflected light, (2) more electricity generation per rooftop area, (3) lower levelized cost of electricity, (4) simple, low-cost, and non-intrusive installation, and (5) reduced wind loads.

Since its founding in 2005, Solyndra has reportedly raised more than $1.5 billion: $1 billion in private investment and a $535 million loan facility, from the Federal Financing Bank, that is guaranteed by the U.S. Department of Energy. Proceeds from the DOE-guaranteed loan were used to construct Phase I of a manufacturing plant, known as Fab 2, that would be capable of manufacturing 250 megawatts per year of Solyndra solar modules.[1] Construction of Fab 2 began in September 2009 and first module shipments from the new production plant were scheduled to occur the first quarter of 2011.[2] Total cost of Fab 2 Phase I is estimated to be $733 million.[3] As of July 2011, Solyndra reportedly had sold approximately 750,000 modules throughout the world totaling roughly 100 megawatts of installed capacity.[4]

The solar PV market has experienced a number of changes since Solyndra started business operations in 2005. Around 2005, solar grade polysilicon prices began to rapidly escalate, thereby creating a strong economic value proposition for the alternative Solyndra technology. However, the market responded by adding more polysilicon production capacity and prices for the material decreased significantly. New solar module manufacturing companies also entered the solar PV marketplace, which resulted in increased competition and price pressure for firms such as Solyndra. Solar PV module prices have declined from over $3.50 per watt in 2007 to around $1.15 per watt today. And, finally, in response to rapid solar PV price declines, European

[1] Solyndra S-1 SEC filing, available at http://www.sec.gov/Archives/edgar/data/1443115/000119312510058567/ds1a.htm#toc15203_8.

[2] Ibid.

[3] Solyndra S-1 SEC filing, available at http://www.sec.gov/Archives/edgar/data/1443115/000119312510058567/ds1a.htm#toc15203_8.

[4] Kanellos, Michael, "Stat of the Week: 0.2 percent," Greentech Media, July 15, 2011.

countries, Solyndra's target markets, have reduced or capped financial incentives for future solar PV projects.

In summary, the solar PV market has essentially become commoditized. Solar PV firms that have proven technology, can warranty their products, and have enough operational performance to satisfy financial risk concerns of debt and equity finance providers will be acceptable solutions for solar PV projects. Competition, therefore, will likely be based on either module prices or electricity costs. Solyndra's technology is relatively new with limited operational performance history. Furthermore, the company's announced price targets for its PV modules are higher than current market prices for competing technologies. Whether or not scaling up manufacturing would have allowed Solyndra to compete on cost is unknown. Furthermore, Solyndra's business model was narrowly focused on a niche market for which there are other possible, and potentially lower cost, solutions. With the solar PV market becoming commoditized, along with Solyndra's higher cost niche market approach, it is possible that market dynamics created a pricing environment in which Solyndra had a difficult time competing. Since Solyndra reportedly had more than $783 million of debt at the time of filing for bankruptcy,[5] the company may not have been able to profitably sell enough modules to service its debt obligations.

Following is a discussion of solar market conditions that may have contributed to Solyndra's bankruptcy filing.

Polysilicon Price Fluctuations

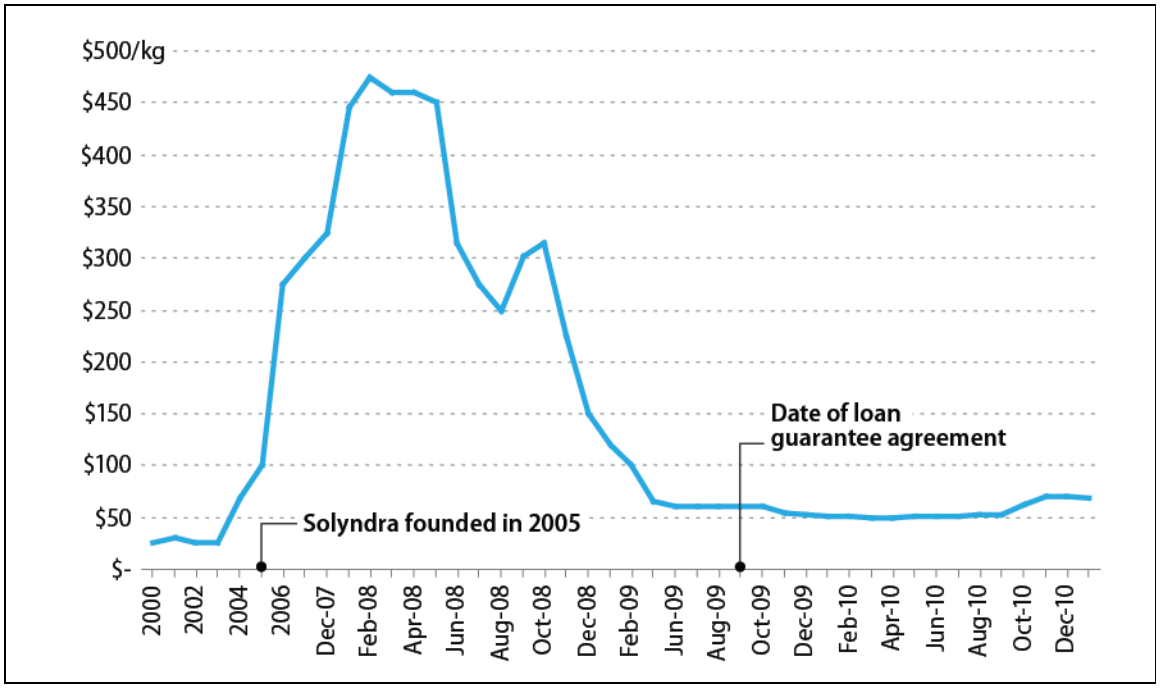
In 2010, crystalline silicon (c-Si) solar modules made up approximately 74% of global solar module market share.[6] Solar grade polysilicon is a critical material for c-Si solar module manufacturing and an estimated 6.5 grams of polysilicon is needed per watt of wafer used to manufacture a module.[7] Polysilicon used for solar module manufacturing is typically priced in terms of dollars per kilogram ($/kg). The spot price of solar grade polysilicon experienced a high degree of fluctuation between 2003 and mid-2009 as prices ranged from as low as approximately $25/kg to as high as approximately $460/kg (see **Figure 1**).

[5] "Solyndra files for bankruptcy, looks for buyer," Associated Press, September 6, 2011.

[6] Mehta, Shyam, "PV Technology, Production and Cost Outlook: 2010 –2015," Greentech Media, January 5, 2011.

[7] Kim, Anthony, "Analyst Reaction – Solar Price Surveys, January 2011," Bloomberg New Energy Finance, January 17, 2011.

Figure 1. Solar Grade Polysilicon Historical Spot Prices



Source: Bloomberg New Energy Finance, Solyndra website, DOE loan guarantee program website.

Notes: This chart reflects historical solar "spot" prices, which may be different than "contracted" prices for solar grade polysilicon. Polysilicon suppliers may enter into long-term supply contracts for polysilicon material.

The dramatic rise in solar grade polysilicon prices has been attributed to increased demand for solar PV modules in Germany and Spain starting in 2005, as a result of feed-in tariff policies and solar installation targets that incentivize installation of solar PV projects. As polysilicon prices started to escalate in 2005/2006, polysilicon suppliers responded by adding additional production capacity. As the additional polysilicon production capacity came on line in 2008, prices started declining as supply and demand became more balanced. Since early 2009, solar grade polysilicon prices have remained relatively stable, with prices ranging from $50/kg to approximately $70/kg. On August 31, 2011, polysilicon spot prices were approximately $51.50 per kg.[8]

As indicated in **Figure 1**, Solyndra was founded in 2005, just as the PV market was experiencing a polysilicon shortage and polysilicon spot prices were rising. Solyndra's technology does not require polysilicon material. Rather, the company's approach uses copper indium gallium diselenide (CIGS) material for its PV modules. By using CIGS material for its PV technology, Solyndra is insulated from solar grade polysilicon price fluctuations. As polysilicon prices rose to as much as $460/kg in early 2008, Solyndra likely had a strong economic value proposition compared to c-Si PV modules and systems that were being challenged by high polysilicon prices.[9] As additional solar grade polysilicon production started coming on line in 2008, polysilicon prices began dropping and the economic value offered by Solyndra's alternative PV module approach was eroded to some degree.

[8] http://pvinsights.com/.

[9] According to Bloomberg New Energy Finance, approximately 6.5 grams of polysilicon is needed per watt of solar wafer. At $460/kg, polysilicon raw material would cost nearly $3.00 on a per-watt basis. At $50/kg, polysilicon raw material would cost approximately $0.33 on a per-watt basis.

Whether polysilicon price declines completely eliminated Solyndra's cost competitiveness is unknown and is beyond the scope of this analysis. In fact, it is important to note that polysilicon prices only impact the cost of c-Si PV modules and not a complete solar PV system. The cost of an entire solar PV system includes other cost variables such as balance-of-system costs and financing costs. Neither of these variables is impacted directly by the cost of polysilicon. Nevertheless, solar grade polysilicon price declines did reduce the economic value proposition offered by the Solyndra PV solution.

Additional PV Market Participants

Rising global demand for PV systems attracted new market participants looking to establish and solidify a position in a rapidly growing marketplace. Rising PV demand also provided an incentive for existing companies to expand production capacity. In 2008, approximately 6.2 gigawatts of solar PV systems were installed throughout the world. In 2010, 16.6 gigawatts of solar PV systems were installed, a nearly three-fold increase in two years.[10] Most of this global market growth resulted from feed-in tariff policies in Germany, Italy, and the Czech Republic.[11]

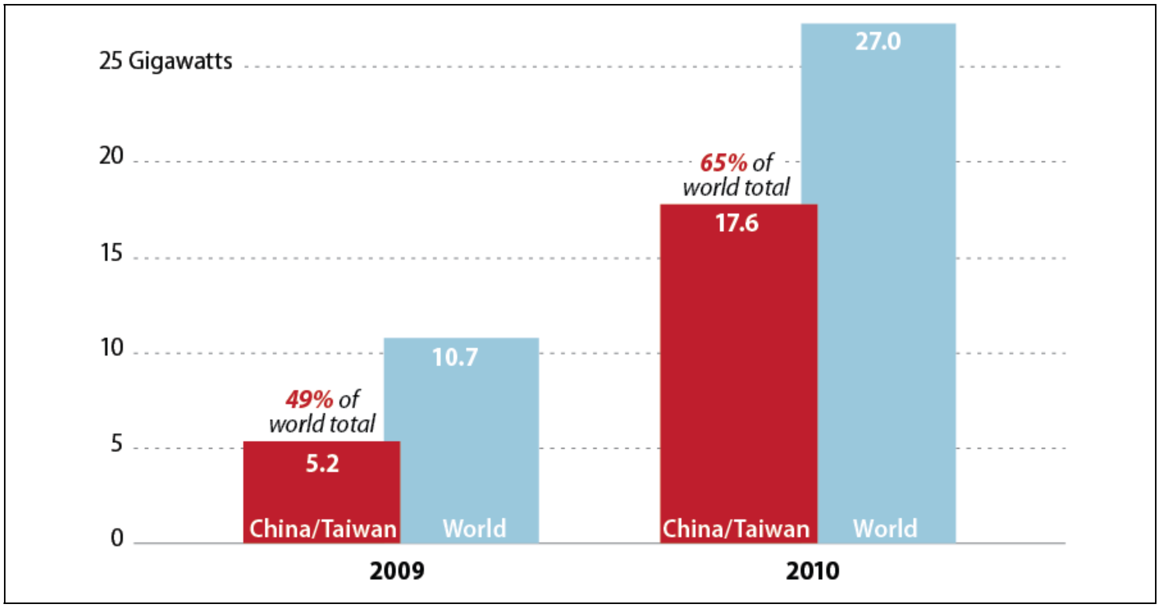
In response to this rapid market growth, additional manufacturing capacity was added to satisfy market demand. In 2009 10.5 gigawatts of PV cells were manufactured globally and in 2010, global PV cell manufacturing capacity had reached 27 gigawatts.[12] A large portion of PV cell manufacturing capacity additions were from companies located in China and Taiwan (see **Figure 2**).

[10] REN21. 2011. *Renewables 2011 Global Status Report* (Paris: REN21 Secretariat).

[11] Ibid.

[12] Ibid. It is important to note that cells and modules are different products. PV cells are typically assembled, electrically connected, and integrated onto a substrate material to form a solar module. Module manufacturing capacity may be different than PV cell manufacturing capacity.

Figure 2. Global Solar PV Manufacturing Capacity



Source: REN21. 2011. *Renewables 2011 Global Status Report* (Paris: REN21 Secretariat).

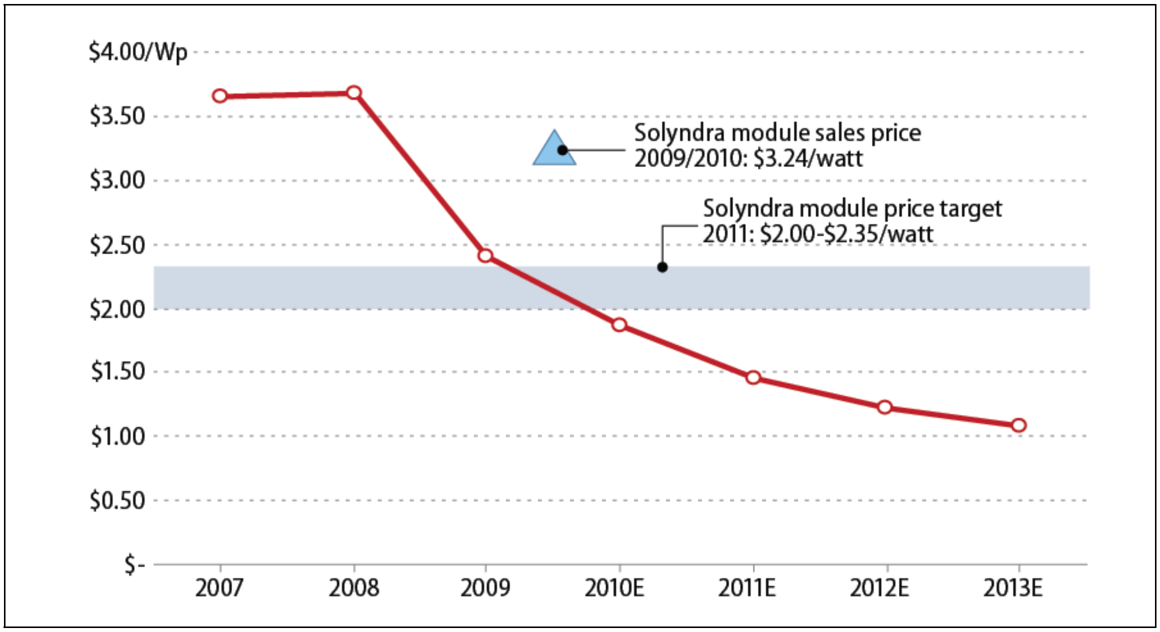
Additional firms in the PV marketplace may have created a much more competitive environment in which Solyndra was required to operate. The majority of the PV manufacturing capacity added in recent years has been for c-Si PV technology and the market share for this type of solar electricity generation remains above 70%. As a result, PV system integrators and purchasers may be developing a higher degree of comfort and acceptance for c-Si technology, thus resulting in market acceptance pressure on the Solyndra technology and system.

Rapidly Decreasing PV Prices

As a result of decreasing solar grade polysilicon prices and additional companies entering the solar PV market, prices for PV modules have experienced steep price declines since 2007 (see **Figure 3**).

Figure 3. Global Blended PV Module Average Selling Price

(2007-2013E)



Source: Greentech Media.

Notes: Wp = watt peak. Blended average selling prices include prices for all types of solar module technologies: c-Si, cadmium telluride, CIGS, amorphous silicon, etc. E = estimated.

As indicated in **Figure 3**, PV module prices declined from over $3.50/watt in 2008 to approximately $1.75/watt in 2010.[13] Analysts from Greentech Media report that spot prices for solar modules were between $1.15 and $1.20 per watt in August 2011.[14] Compare this to reported statements from Solyndra management that Solyndra modules were selling for $3.24/watt in the 2009/2010 timeframe and the price target for modules was between $2.00 and $2.35 per watt.[15] Based on the forecast of global solar module prices and Solyndra's module price projections, the ability of Solyndra to profitably sustain business operations might be difficult.

Whether Solyndra's cost structure would have allowed the company to adequately respond to these forecasted market conditions, and therefore remain competitive, is unknown and beyond the analytical scope of this report. However, independent analysis of Solyndra's S-1 Securities and Exchange Commission (SEC) filing indicates that while Solyndra was selling modules for $3.24/watt, manufacturing costs were more than $6 per watt.[16] Solyndra's negative operating margin is, arguably, somewhat common for new companies that manufacture new technologies. The business challenge for Solyndra was to scale-up manufacturing, achieve production economies of scale, and reduce costs to a level that would result in a profitable and sustainable

[13] Mehta, Shyam, "PV Technology, Production and Cost Outlook: 2010 –2015," Greentech Media, January 5, 2011.

[14] Kanellos, Michael, "Will Solyndra, or Part of It, Get Bought?," Greentech Media, August 31, 2011.

[15] Kanellos, Michael, "Solyndra to Dop by 50% in Price by 2012, Says CEO," Greentech Media, November 3, 2010.

[16] Mehta, Shyam, "Solyndra: 1.9 MW Project Installed, But Story Remains Fraught With Uncertainty," Greentech Media, February 1, 2010.

business. However, auditor PricewaterhouseCoopers noted in Solyndra's 2010 S-1 SEC filing that "the company has suffered recurring losses from operations, negative cash flows since inception and has a net stockholders' deficit that, among other factors, raise substantial doubt about its ability to continue as a going concern."[17]

Commercial Rooftop Niche Market

Solyndra's business model was solely focused on addressing potential demand for solar electricity generation on commercial building rooftops. The Solyndra technology design provided this niche market with some unique characteristics: more rooftop area covered with solar modules, reduced wind loads, and simple, non-intrusive, and low cost installation, among others.

According to Solyndra's 2010 S-1 SEC filing, approximately 11 billion square meters of commercial building rooftop area exists throughout the world.[18] This rooftop area represents, perhaps, the entire theoretical market potential for Solyndra systems. However, what is not clear is how much of this rooftop area is an addressable market. Many commercial buildings are located in areas that have poor solar resources and, therefore, would not justify investment in a rooftop solar PV system. Furthermore, economic, policy, and other market conditions may eliminate some portion of commercial building rooftops from the addressable market. Exactly how much global rooftop area is actually addressable is not known at this time.

To date, many solar PV installations have been on residential rooftops and a growing solar PV market segment is classified as "utility scale." While there is no formal definition of this market segment, utility scale solar PV projects might be 10 megawatts or larger and consist of ground-mounted PV systems. The Solyndra technology is not ideally suited for residential or utility scale types of projects and, as a result, the company was limited in its options to diversify into other solar PV markets if necessary.

Finally, Solyndra's technology is not the only solution available for commercial rooftop PV projects. Flat-panel silicon and thin-film technologies can also be installed on commercial rooftops. Solyndra was positioning its technology as one that can provide the lowest levelized cost of electricity, as its configuration allows for more rooftop area to be covered with electricity generating photovoltaics. However, the current operational efficiency of Solyndra's CIGS technology is approximately 11% to 12% compared to c-Si efficiencies of approximately 14.3%, which is 20% higher relative to CIGS.[19] Therefore, for a given commercial rooftop, higher efficiency silicon PV could potentially generate as much electricity as the Solyndra CIGS approach even though Solyndra's technology would cover a larger portion of the commercial rooftop area. This efficiency differential combined with consistent silicon PV cost and price reductions may have resulted in Solyndra losing its position within the commercial rooftop niche market.

[17] Solyndra S-1 SEC filing, available at http://www.sec.gov/Archives/edgar/data/1443115/000119312510058567/ds1a.htm#toc15203_8.

[18] Ibid.

[19] Mehta, Shyam, "PV Technology, Production and Cost Outlook: 2010 –2015," Greentech Media, January 5, 2011.

Incentive Declines in European Markets

According to Emerging Energy Research, Solyndra was emphasizing European commercial rooftop markets. This is evidenced by framework supply agreements with six European developers with a potential value of $1.57 billion, and that represents 71% of its announced supply agreements as of December 2009.[20] European solar markets are typically incentivized through feed-in tariff policies that essentially provide guaranteed rates for electricity generated from solar or other renewable technologies over a period of 10 to 25 years.[21] Feed-in tariff rates and qualification criteria differ from country to country. However, feed-in tariffs are typically generous enough to provide project developers with investment rates of return high enough to incentivize solar project installations. The most notable European countries with feed-in tariff incentives include Germany, Spain, France, Italy, and Czech Republic. **Table 1** summarizes the amount of solar PV capacity added in these countries, and the U.S., which does not have a federal feed-in tariff policy, since 2006.

Table 1. Solar PV Additions: 2006-2010

(in megawatts)

	2006	2007	2008	2009	2010
Germany	845	1,270	1,950	3,795	7,405
Spain	90	560	2,600	145	370
Italy	10	70	340	715	2,320
Czech Republic	—	3	60	400	1,490
France	10	10	45	220	720
United States	145	205	340	475	880

Source: REN21. 2011. *Renewables 2011 Global Status Report* (Paris: REN21 Secretariat).

As indicated in **Table 1**, Spain experienced a solar market boom and bust between 2008 and 2009. The large amount of solar PV additions in 2008 can be attributed to a feed-in tariff policy that was extremely generous and did not have caps or other mechanisms to control explosive growth. As a result, project developers rushed into the Spanish market to take advantage of lucrative incentives. However, in 2008 the Spanish government revised payment levels down and capped its feed-in tariff incentive policy. The market for solar PV in Spain declined dramatically in 2009.[22]

Germany has experienced consistent solar market growth since 2006 and had record solar PV additions of 7,405 megawatts in 2010, nearly double the additions in 2009. Germany's feed-in

[20] T. Maslin and C. Deline, "US-Based Solyndra Specializes on EU Rooftops," Emerging Energy Research, December 30, 2009.

[21] For more information regarding feed-in tariffs see T. Couture, K. Cory, C. Kreyik, and E. Williams, "A Policymaker's Guide to Feed-in Tariff Policy Design," National Renewable Energy Laboratory, July 2010.

[22] Karlynn Cory, "Stops and Starts in the Spanish Solar Market," National Renewable Energy Laboratory, November 30, 2009, available at http://financere.nrel.gov/finance/content/stops-and-starts-spanish-solar-market.

tariff policy incorporates responsive degression, which includes a base feed-in tariff reduction every year as well as additional adjustments, either up or down, based on the amount of capacity installed each year.[23] Germany's degression approach is structured to be responsive to the rapid price and performance changes occurring in the global solar marketplace. As a result of large solar additions during 2010, Germany's feed-in tariff will be further reduced, based on the defined degression schedule, therefore reducing the rate-of-return premiums that might otherwise be available. Germany's feed-in tariff reductions also result in a challenging economic environment for higher priced, niche market products such as those sold by Solyndra.

Incentive changes and modifications in European countries, one of Solyndra's target markets, may have limited the company's ability to sell products into the respective markets.

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[23] For more information regarding Germany's solar feed-in tariff degression approach, see "EEG Amendment 2012 – What will change as of 1 January 2012," BSW Solar, available at http://en.solarwirtschaft.de/fileadmin/content_files/EEG-Novelle2012_EN.pdf.