The Social and Economic Impacts of Clean Energy Technology Exportation

IFRI Energy Center, Summer 2012

Mariel Rodriguez

ABSTRACT

Clean energy technology is a rapidly expanding field that has changed dramatically over the past decade. While great advances in technology have made the production of clean energy on a wide scale possible, economic developments on the global scale have significantly development and production. This paper examines several cases in which the production of clean energy technology in the West was exported to the East, and specifically to China, for economic reasons. In all of these cases, the exportation of such technology resulted in the loss of jobs and taxpayer dollars locally. Nonetheless, the exportation of clean energy technology to the East provides an interesting conundrum for governments in the West. China and other Asian nations have proved to be able to manufacture clean energy technology cheaply and more efficiently than most western nations, which makes such technology cheaper for consumers. Nonetheless, the lower cost of production comes at the cost of jobs at a time when unemployment is high throughout many areas of the world. The current global dependence on fossil fuels is unsustainable in the long term, but governments must decide the role they wish renewables to play in their nations. Renewables can be a source of jobs, or an economically feasible source of energy, but currently, it has proved difficult for renewables to provide both to western nations.

Table of Contents

INTRODUCTION AND CONTEXT 4

CASE STUDIES : HIGHLIGHTS OF THE UNITED STATES AND EUROPE 6

EVERGREEN SOLAR 6

SOLON SOLAR SE 10

BEACON POWER CORP. 14

GAMESA 17

SOLYNDRA 19

IMPACT AND SIGNIFICANCE 22

SOCIAL IMPACTS 22

ECONOMIC IMPACTS 24

SIGNIFICANCE FOR GOVERNMENTS 28

CONCLUSIONS TO BE DRAWN 30

BIBLIOGRAPHY 31

List of Charts and Graphs

FIGURE 1: % REVENUES GENERATES OUTSIDE GERMANY, 2005-2010 11

FIGURE 2: DEPARTMENT OF ENERGY LOAN GUARANTEE PROGRAM RECIPIENTS, SECTIONS 1073 AND 1075 19

FIGURE 3: 1998 SOLAR SHIPMENTS BY GEOGRAPHIC REGION 24

FIGURE 4: GEOGRAPHIC DISTRIBUTION OF SOLAR CELL PRODUCTION IN 2011, BY COUNTRY 25

Introduction and Context

Clean energy technology is a rapidly-expanding field that has changed dramatically over the past decade. The changes experienced by this field are the result of many factors which have both harmed and benefitted the development of clean energy technology. The world economy is dramatically different than it was a decade ago. Clean energy technology has been developed at a pace much quicker than some analysts had predicted, due in part to support for such research and development from national governments. International communities such as the European Union have placed further stress on the development of clean energy in order to decrease dependence on fossil fuels and other energy sources that can negatively impact the environment. International relations have changed since the late 1990s, when the push for clean energy technology began in earnest.

In particular, changing economic relations between nations have impacted the development of clean energy technology. This is especially apparent when the relationships between China and the United States and China and European nations are considered. In the late 1990s, China was a minor player in the development of clean energy technology on the global scale, while Europe and the United States were two of the world's four largest producers of clean energy, and in particular, solar power.[1] By 2011, China had come to dominate the world in the production of clean energy technology.

This increased dominance for China has had drawbacks for the west. Jobs and subsidies have been lost, government loans have been defaulted upon, and local economies have been negatively impacted. In this paper, I will consider the cases of five clean energy companies in the United States and in Europe that have been negatively impacted by China's increasing dominance in the production of clean energy technology. All five of the companies considered received monetary support from their national governments. Four of the five companies considered, Evergreen Solar, Solon Solar SE, Beacon Power Corp, and Solyndra, went bankrupt. One of those companies, Evergreen Solar, in the United States, shifted the entirety of its production to China, in spite of the fact that it was founded and originally operated exclusively in the United States. Another, Solyndra, also in the United States, cost the economy over a thousand jobs when it was shuttered permanently. Solon Solar SE, in Germany, and Beacon Power Corp, in the United States, were both able to restructure following their bankruptcy filings and maintain production locally, although not without some loss of jobs and great expense to taxpayers. Gamesa, a wind company based in Spain, has seen its market shares and workforce

[1] See Figure 3 below.

negatively impacted by the growing dominance of Chinese wind turbine manufacturers and the regulations put in place by the Chinese government to favor local companies over foreign competitors.

The companies considered below did not all have business models that guaranteed success. Evergreen Solar, Beacon Power Corp (an energy storage company), and Solyndra (a solar company), took risks on unconventional products that ultimately did not pay off for a variety of reasons not limited to foreign competition, including their own production costs. Although the CEO of Evergreen Solar placed the blame for his company's failure on foreign competition in his deposition for the company's bankruptcy filing, none of the five companies considered can say that their failings are due entirely to foreign competition.

Nonetheless, foreign competition, specifically from China, did impact all five companies. In some cases, this impact was indirect. Many clean energy companies have relied heavily on government loans and subsidies, but the regulations of some countries have allowed foreign competitors to receive the same benefits from subsidies as local companies. This can be seen in the case of Solon Solar SE, in which subsidies from the German government were provided to all solar manufacturers, not only to German companies. Such subsidies, meant to encourage consumers as well as benefit the local economy, cannot be entirely effective when they are granted to all manufacturers doing business in the area. Additionally, subsidies, while they seem to have a positive effect on consumers, can ultimately have a negative effect for producers, because they mask market signals and prevent customers from realizing the true cost of goods. Subsidies are not sustainable in the long term, and ending subsidies can make consumers less likely to purchase goods, particularly in the energy sector, where renewable energy sources are more expensive than fossil fuels. Additionally, fossil fuels have long proven themselves to be reliable sources of energy, while the renewable energy field continues to develop and poses new questions about energy production and storage.

Renewable and clean energy technologies are necessary for the world energy mix of the future. However, in order to meet clean energy objectives, nations and international communities must evaluate how they will prioritize the development of clean energy resources. There are serious social and economic impacts for such decisions. The five case studies below attempt to highlight the ways in which the exportation of clean energy technology has impacted the western world, and the ensuing examination of social and economic impacts, as well as governmental implications, attempts to demonstrate the way in which a cooperative global effort is necessary if the development of clean energy technology is to be successful.

From Evergreen Solar, Inc. to Evergreen Solar (China) Co., Ltd.

Evergreen Solar, Inc. was incorporated in the United States in 1994 as a manufacturer of solar panels. They began selling solar panels in 1997. Evergreen manufactured all of its parts within the United States, although much of its market was overseas, particularly in Germany and Japan. According to Michael El-Hillow, the CEO of Evergreen at the time of its bankruptcy, Evergreen sold the majority of its products in Europe "as European countries… have historically provided subsidies to consumers for using solar technology."[2] Evergreen innovated the technology to produce solar panels using much less silicon than was traditional, which benefited the company as the price of refined silicon proved to be extremely volatile during the time that Evergreen was manufacturing solar panels. In 1997, when Evergreen began selling solar panels, the price of silicon was $75 per kilogram, which marked a peak price to that point.[3]

Evergreen initially began manufacturing solar panels in a factory in Waltham, Massachusetts, where they maintained their corporate headquarters. They began selling solar panels on a large scale in 2001 from an expanded factory in Marlborough, Massachusetts, and they were the company behind the first installation of solar panels at the White House, in 2003. In 2007, Evergreen began construction on an even larger facility in Devens, Massachusetts. They received $58 million in aid from the state of Massachusetts, which amounted to just over 8% of the $450 million total cost of the factory.[4] In 2008, when silicon prices were at their peak of $450 per kilogram, production began at the Devens facility, which employed around eight hundred workers. The Marlborough factory was closed once production moved to Devens.

From their 2008 high of $450 per kilogram, solar-grade silicon prices plummeted, reaching $52 per kilogram in 2010.[5] In that same year, in an effort to reduce costs and respond to increasing competition, Evergreen entered into partnerships with Jiawei Solarchina Co., Ltd. and Hubei Science and Technology Investment Co., Ltd. and began manufacturing in Wuhan, China. Prior to this, Evergreen had manufactured its panels exclusively within the United States, a fact that had drawn the attention of the press in the past. In 2008, Evergreen's CEO Richard Feldt presented a possible expansion to Asia as a way to "dramatically boost capacity," rather than explicitly as a cost-saving measure.[6] As early as 2000, in statements made before their initial public offering on the New York Stock Exchange, Evergreen

[2] *Declaration of Michael El-Hillow*. United States Bankruptcy Court for the District of Delaware, August 15, 2011.
[3] David Lynch, "Winning the Global Race for Solar Silicon," *JOM* 61, no. 11 (November 2009): 41.
[4] Information on aid from Steven Greenhouse, "Elusive Goal of Greening U.S. Technology," *New York Times*, December 2, 2009.
[5] "Silicon Prices Climb Higher," *Renewable Energy World*, August 25, 2010.
[6] Reuters, "Evergreen Solar might expand to Asia," *Boston Globe*, May 28, 2008.

stated that they "intend[ed] to selectively pursue opportunities to establish local manufacturing arrangement on a worldwide basis."[7] Again, at this time, the measure was discussed as a way to expand the company, rather than as an attempt to control costs.

From 2008 to 2011, the price of solar panels fell worldwide, which corresponded with the drop in prices of silicon, but this made it difficult for Evergreen to compete. Its process, which had been effective when silicon prices were high, was expensive in comparison to traditional methods when silicon prices were low. Additionally, from the company's inception in 1994 to 2011, the face of the solar industry changed dramatically. In 1999, the world's six largest solar panel manufacturers, which accounted for 71% of the world's solar panel shipments, were based in Europe, the United States, and Japan, but none were located in China.[8] In 2011, three of the six biggest solar manufacturers in the world were Chinese, and the four companies that rounded out the top ten were all based in China as well.[9] By 2011, China accounted for almost 60% of the world's solar panel production, a dramatic increase in slightly over a decade.[10]

As a result of the changing face of the solar industry and the precipitous drop in silicon prices, Evergreen announced that it was closing its Devens facility in January 2011 and shifting production to their facility in China. They were forced to declare bankruptcy seven months later, in August 2011. At the time of its bankruptcy, it was the third-largest solar panel maker in the United States. In his declaration, Michael El-Hillow, the CEO of Evergreen, was frank about the reasons of for the bankruptcy, stating "solar manufacturers in China continue to receive considerable government and financial support and, together with China's low manufacturing costs, have become price leaders within the industry."[11] Furthermore, El-Hillow blamed the United States government for the failure of his company to remain viable, stating, "the failure of the U.S. to adopt significant 'clean energy policies' is a reason for the precipitous decline in solar panel costs in 2010 and 2011."[12] The bankruptcy forced Evergreen to shutter all of its production facilities in the United States, but the company retained and expanded their facilities in China. Evergreen Solar(China), which was founded in 2009 in anticipation of the outsourcing of production, "is the successor to the assets, the trademarks, the patents and the name of Evergreen

---

[7] International Energy Agency, *World Energy Outlook 2010,* 38.
[8] Ibid., 40.
[9] "Top 10 World's Biggest Solar Producers (Estimated Module Production Capacity 2011)," Solar Plaza, accessed June 19, 2012, last modified December 31, 2011, http://www.solarplaza.com/top10-estimated-module-production-capacity-2011/.
[10] Keith Bradsher, "China Benefits as U.S. Solar Industry Withers," *New York Times*, September 1, 2011.
[11] *Declaration* 12.
[12] Ibid., 13.

Solar, Inc.," according to their website.[13] Although Evergreen originally looked for buyers which would maintain the business operations, when no buyers were found, Evergreen's "core wafer assets" were sold to Max Era Properties, Ltd., a Hong Kong company, for $9.2 million.[14] Evergreen was $485.6 million in debt at the time of their bankruptcy filing. Additionally, the company was forced to walk away from its government-subsidized Devens facility, as they were unable to find a buyer.

In March 2011, two months after Evergreen announced that it was closing its Devens plant, CEO Michael El-Hillow told the Massachusetts state senate that the company had "earned 85% of the taxpayer benefits it received because of the jobs it originally created," in spite of the fact that all of those jobs were subsequently lost.[15] Nonetheless, the announcement of the company's bankruptcy and ensuing closure created something of a political controversy within the state. A *Boston Globe* editorial claimed that up to $40 million of the subsidy the state had given to Evergreen would be "lost."[16] The Massachusetts Republican Party called the subsidies to Evergreen a "waste," in light of the fact that they had been received under a Democratic governor.[17] Evergreen, however, never claimed to be a safe bet for investors. In a 2000 SEC filing, Evergreen cautioned potential investors, stating, "We have a history of losses, expect to incur substantial further losses and may not achieve or maintain profitability in the future, which may decrease the market value of our stock."[18] In April 2011, the company warned its investors that it was "burning through cash because of slow sales, falling solar-panel prices, and weak proceeds from the sale of Devens factory assets."[19]

Evergreen's financial troubles were the result of a variety of local and global factors, some of which were ultimately out of the control of the company. It backed the wrong manufacturing techniques with its "String Ribbon" wafers which used less silicon, although at the time of the company's inception, it seemed to be a better development than the traditional methods, based on the price of silicon. Additionally, the state of the world's solar industry changed drastically in the fifteen years during which the company was operational. China went from a minor player in the solar industry to the leading producer of solar panels, backed by hundreds of millions of dollars in subsidies from their government. The United States has lagged noticeably in awarding subsidies to the development of clean

---

[13] "About Us," Evergreen Solar, accessed June 19, 2012, last modified 2011, http://evergreensolar.com/en/lxwm.html.
[14] Michael Bathon, "Bankruptcy judge approves asset sales by Evergreen Solar," *Boston Globe*, November 11, 2011.
[15] Greg Turner and Jerry Kronenberg, "Evergreen Solar files for bankruptcy, plans asset sale," *Boston Herald*, August 15, 2011.
[16] "Evergreen Solar's failure shows US weakness in clean energy," editorial, *Boston Globe*, August 18, 2011.
[17] Turner and Kronenberg.
[18] *Declaration,* 6.
[19] Turner and Kronenberg.

energy. Although Evergreen did receive aid from the state of Massachusetts, they did not apply for aid from the federal government, stating that they had been lead to believe that they would not receive any substantial subsidies from the Department of Energy. Phyllis Cuttino, the director of the Pew Charitable Trusts' Clean Energy Program has stated, "The U.S. has a rich manufacturing base, a well educated workforce, and we are an innovation center. But if we don't have the policies in place to make investment here a sure thing, then we could potentially lose to other countries… They have policies to take a lot of projects to scale, and that's what's missing in the United States."[20]

Evergreen Solar's bankruptcy cost the state of Massachusetts close to nine hundred jobs and tens of millions of dollars in unreturned subsidies. Hundreds of millions of dollars in defaulted debts were lost to the economy of the state as well. Additionally, the subsidy allowed Evergreen to grow and develop its technologies and procedures, all of which were migrated to China when the company closed its doors in the United States. Evergreen's situation is not unique, however. Since the latter half of the 2000s, the Chinese have been rapidly erasing any advantages American and European solar companies may have had, forcing them into bankruptcy and insolvency with low production costs and high government subsidies. Many other companies, with traditional means of production and a larger manufacturing base, have been forced to close their doors as well.

[20] Greenhouse.

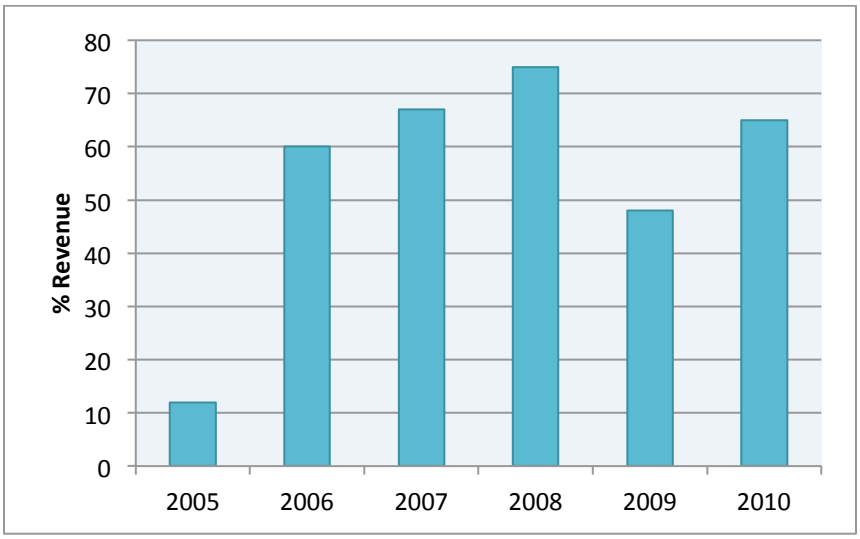
The Rescue of Solon Solar SE

The solar panel manufacturer Solon AG für Solartechnik (Solon AG for Solar Technology) was founded in 1997 in Berlin, Germany. It was the first solar company to be listed on the German stock exchange when it went public in 1998. At their peak, they employed nearly a thousand people in subsidiaries in Europe and the United States, although the majority of employees were concentrated at various plants in Germany. Much of Solon's success was connected to the generous feed-in tariffs which the German government employed to encourage the use of clean energy. The tariffs subsidized consumers and encouraged them to install solar panels. In 2004, Germany overtook Japan to become the leading producer of electricity from solar energy, amounting to 69% of the world's photovoltaic (PV) production.[21]

In December 2008, Solon AG was converted to a European company and changed their name to Solon Solar SE (Societas Europaea).[22] CEO Thomas Krupke believed the move would allow the company to flourish, saying, "As a European Company, we will be able to operate as a single legal entity within the EU together with our subsidiaries in Germany, Austria, and Italy. This will facilitate cross-border transactions and strengthen our position in the European market." In the latter half of the 2000s, Solon increasingly relied on exports as a source of revenue. While exports accounted for 12% of the company's revenue in 2005, by 2006, that figure had jumped to 60%.[23] Solon exported mainly to other European countries and to the United States. Figure 1 shows the percentage of total revenue earned outside Germany by Solon from 2005 to 2010.

[21] Michael Woodhead, "Germany loses its place in the solar power industry," *The Sunday Times*, January 8, 2012.
[22] "Solon AG Becomes European Company (SE)," Solon Solar SE. Press release, December 8, 2008.
[23] "SOLON AG continues to expand its international business," SOLON AG für Solartechnik. Press release, April 25, 2007.

Figure 1: % Revenues Generated Outside Germany, 2005-2010[24]



Sales slowed in the first nine months of 2011, however, with revenue declining by 11%. The company operated with a net loss of €208.3 million during this time. Additionally, 83% of sales occurred outside Germany.[25] From 2009 onward, the feed-in tariffs which had driven much of the demand for solar energy in Germany were ended or downsized, which caused a decline in demand for new solar panel units within the country. By December 2011, Solon was €400 million in debt, with €275 million due by the end of the year. The State of Berlin had acted as a guarantor of €37.4 million of that debt, while the state of Mecklenburg-Vorpommern and the federal government together guaranteed €80 million of that debt.[26] As a result of its debt load, Solon filed for insolvency on December 13, 2011.

Almost immediately, there were discussions that the State of Berlin might intervene in Solon's financial situation. One Berlin senate spokesperson commented that the state had "a great interest that the site remains in Berlin and that Solon quickly becomes competitive again."[27] There was also some criticism of the role the government played in the insolvency of Solon and other German solar companies. The *Sunday Times* of London called the feed-in tariff "the most attractive reason for Asian rivals to sell cheaper panels into the German market at the expense of home-based companies."[28] Although the tariff was key to the growth of the solar industry within Germany, it was not limited to German-manufactured products, providing foreign companies with an incentive to export products that were cheaper than panels made within Germany. Norbert Röttgen, the German environment minister,

[24] SOLON AG für Solartechnik and Solon Solar SE financial reports, fiscal years 2005-2010.
[25] Becky Stuart, "Solon's financials hit by solar slowdown," *PV Magazine*, November 15, 2011.
[26] Sandra Endhardt and Becky Stuart. "State of Berlin to save Solon?" *PV Magazine*, December 16, 2011.
[27] Ibid.
[28] Woodhead.

accused foreign companies, and in particular the Chinese, of pursuing a "pricing policy designed to displace German companies" by taking advantage of the tariff.[29]

Some in the media were critical of Solon's insolvency, placing blame on the company, rather than outside factors. In an editorial in *PV Magazine*, Karl-Heinz Remmers praised Solon for their innovation, but was critical of the company's business model, writing, "in its day-to-day work throughout all the years, Solon was not able to optimize costs and processes in a measure sufficient enough to keep pace with a market marked by rapid development and stiff competition."[30] Other analysts viewed Solon's insolvency as a positive event. One analyst at the Bank Sarasin stated, "overall, [Solon's bankruptcy] will have an ultimately positive impact on the global solar industry, despite the fact that some companies are 'bound to fail.'"[31] Analysts have contended that the solar market is currently composed of an unsustainable amount of producers, and it would benefit the industry as a whole to have the number of companies reduced.

In February 2012, it was reported that Solon had two possible buyers, and on March 1, Solon announced that it had found a buyer in Microsol, a solar company based in the United Arab Emirates, under Indian management. Of the nearly one thousand employees that Solon had at its peak, Microsol announced it was retaining just over four hundred. Solon Nord GmbH, which was based in Greifswald, in eastern Germany, was not included in the sale, and the factory there, which had ceased production in the fall of 2011, was closed completely, and all remaining employees were let go. Eastern Germany has struggled to reintegrate into the German economy as a whole since the collapse of the Soviet Union in the early 1990s, and the presence of several solar plants there was seen as an important step in that process. The departure of companies such as Solon Nord GmbH has damaged those prospects. Nonetheless, Microsol announced its intention of taking over Solon's business from its Berlin headquarters, and Solon's American and Italian subsidiaries were acquired as well. Sabine Lutze, the chairman Solon's works council, stated, "We are pleased with the preservation of many jobs," in regards to the acquisition.[32] Fears that the Emerati company would announce further layoffs have thus far been unfounded.

During the acquisition process, Solon continued to develop products, take orders, and expand international solar plants, even winning the Intersolar Award 2012 in the PV category in Tucson, Arizona

---

[29] Alexander Neubacher, "Germany Created Their Own Threat with Chinese Solar Aid," *Der Spiegel*, February 27, 2012.
[30] Karl-Heinz Remmers, "Solon is bankrupt- again?" editorial, *PV Magazine*, December 14, 2011.
[31] Becky Stuart, "Solon files for insolvency," *PV Magazine*, December 14, 2011.
[32] Becky Stuart, "Microsol forms Solon Energy GmbH," *PV Magazine*, March 6, 2012.

in June 2012.[33] Nonetheless, the argument has been made that companies such as Solon "have failed to understand the competitive forces within solar and as a result have wrongly positioned themselves."[34] As in the United States and other western countries, the argument has been made that while it is important for German companies to retain the rights to their intellectual property, there is less of a need for solar products to be manufactured within the country. The argument has been made that the cost of German labor makes it effectively impossible for companies to compete on the international level. The debate between the importance of local employment and low prices continues to be relevant, even as Solon continues to maintain operations in Germany.

[33] "SOLON SOLquick Commercial Rooftop System Wins Intersolar Award 2012," Solon Energy GmbH. Press Release, June 13, 2012.
[34] Becky Stuart, "PV price shifts and painful consolidation," *PV Magazine*, November 24, 2011.

Experiments in Energy Storage: Beacon Power Corp.

In 2009, Rich Kalisch, a senior director of technology initiatives as Midwest Independent Transmission System Operator said, "There's a natural affinity between storage and renewables."[35] Beacon Power Corp., an energy storage developer based in Tyngsboro, Massachusetts, attempted to capitalize on this natural affinity by developing a system of flywheel energy storage. The company was founded in 1997 as a spin-off of SatCon Technology Corp's Energy Systems Division, and between 1997 and 2009, the company invested over $200 million into the research and development of its flywheel design.[36] The flywheels are rotating wheels or cylinders whose inertia is used to store power or deliver it quickly. Such storage can help in power grid regulation by helping to balance the constant discord between electrical supply and demand.[37] Solar and wind plants, which can only produce electricity under the right conditions, have made energy storage and grid regulation more important.

Beacon originally planned to use its technology as a source for telecommunications relay stations between power outages and the amount of time it took to switch on their back-up generators, but this industry crashed and the development was unable to proceed. Instead, Beacon adjusted their technology to meet the demands of the new development of renewable energy sources. They introduced this new technology just as the global economic recession hit, however. Nonetheless, it was one of the first companies to qualify for a loan from the United States Department of Energy in August 2010. Under the 2009 Recovery Act, the Department of Energy's Loan Guarantee Program was "designed to jump-start innovative and clean energy projects," as well as to create jobs for the American economy.[38] Beacon received $43 million to partially finance a new $69 million flywheel storage facility in Stephenstown, New York. The facility was expected to create twenty new jobs at the site, as well as forty new jobs at the company's headquarters in Massachusetts.[39] The energy storage plant in Stephenstown was the first flywheel regulation system in the nation. Beacon's flywheels used composite carbon fiber, which was a different material than was traditional in flywheel design. Beacon's flywheel's were 85% efficient in returning energy from storage, which made their design particularly

[35] Phil Taylor, "Companies Race to Develop Utility-Scale Power Storage," *The New York Times,* September 28, 2009.
[36] Dawn McCarty, "Beacon Power, Backed by US Loan Guarantees, Files Bankruptcy." *Bloomberg Businessweek*. October 31, 2011.
[37] Matthew L. Wald, "Advancing the Flywheel for Energy Storage and Grid Regulation." *The New York Times.* January 25, 2010.
[38] Steven Mufson and Juliet Eilperin, "Beacon Power declares bankruptcy; second loan guarantee recipient to falter." *The Washington Post*. October 31, 2011.
[39] "DOE Charges Up Flywheels with $43 Million Loan." *The New York Times.* August 10, 2010.

efficient, and the company's CEO, F. William Capp, claimed that Beacon would be able to provide grid regulation "at a lower cost than a traditional generator."[40]

The company also received loans for several other projects and from other sources, including a $29 million loan from the state of Pennsylvania for a new storage facility, and $5 million from the state of Massachusetts. Privately, Group Robinson, LLC raised over $53 million for the Pennsylvania project and was looking for foreign customers that would allow Beacon to expand their business. The company produced and delivered its flywheel storage system in Stephenstown, but between 2010 and 2011, the price of frequency regulation that it was able to charge grid operators fell by around 70% because of market swings and the ongoing economic recession. As a result, Beacon filed for bankruptcy in October 2011. At that time, they held $72 million in assets, and had an outstanding debt of $47 million.[41] The company had lost 80% of its market value on the stock exchange in 2011, and was worth only $12.8 million on October 28.[42] On October 31, as the bankruptcy was reported, the company's shares closed at $0.107, leaving the company valued at $3 million.[43]

F. William Capp, the company's CEO, did not hesitate to place the blame for Beacon's bankruptcy outside the company, saying, "The current economic and political climate, the financing terms mandated by DOE, and Beacon's recent delisting notice from Nasdaq have together severely restricted Beacon's access to additional investments through the equity market."[44] The company claimed that it was a "technological success," its financial troubles notwithstanding.[45] Gene Hunt, a company spokesman, said the company was a "victim of the recession, which has hurt demand for electricity among industries."[46] Others pointed to problems within the company. A *Washington Post* article stated that the company was unable to attract investors, and mechanical issues at the Stephenstown storage facility "fanned investor concerns about maintenance costs."[47] One analyst with Ardour Capital acknowledged the merit of Beacon's flywheel systems, but questioned whether the storage technology was something an entire business could be based around.[48] The renewable energy magazine *Energy Boom* cited an unnamed source in claiming that the Department of Energy had forced

[40] Wald, "Advancing the Flywheel."
[41] McCarty, "Beacon Power, Backed by US Loan Guarantee, Files Bankruptcy."
[42] Ibid.
[43] Mufson and Eilperin.
[44] McCarty, "Beacon Power, Backed by US Loan Guarantees, Files Bankruptcy."
[45] Matthew L. Wald, "Solyndra Has a Cousin in the Poorhouse." *The New York Times*, November 17, 2011.
[46] Ibid.
[47] Mufson and Eilperin.
[48] Ibid.

Beacon to charge low rates to utilities for use of its storage system. It also claimed the recent rise in the prevalence of natural gas influenced the demand for storage facilities such as Beacon's.[49]

Much was made of the fact that Beacon Power was the second company that had been given a loan by the Department of Energy to declare bankruptcy, following Solyndra, which had defaulted on nearly $535 million loaned by the Loan Guarantee Program. Nonetheless, the $43 million loaned to Beacon represented less than 1% of the Department of Energy's $37.6 billion loan portfolio.[50] Additionally, the department set aside up to $10 billion for potential losses in the loan program.[51]

In spite of the bankruptcy declaration, Beacon Power continued to operate as it searched for a buyer. Many workers agreed to a 20% pay cut and remained on the job. In February 2012, the private equity firm Rockland Capital announced it was buying Beacon for $30.5 million and creating two new private companies, Beacon Power, LLC and Spindle Grid Regulation, LLC. In exchange for a $3.7 million cash payment, the Department of Energy reduced Beacon's debt to $25 million. The total to be recovered by the Department of Energy amounted to around 72% of the original loan. Rockland was hopeful for the success of the company, in light of a new rule change by the Federal Energy Regulatory Commission which would increase revenues for energy storage providers with a pay-for-performance scheme. The equity firm said that it intended to rehire most of the current Beacon employees and go forward with building the storage facility in Pennsylvania for which Beacon had received additional funding from the state and federal governments.[52] It has even been suggested that the bankruptcy, which has raised the company's profile nationally, could help attract investors and ensure its survival after the reorganization undertaken by Rockland.

[49] Jeanne Roberts, "Another DOE Favorite, Beacon Power, Files for Chapter 11." *Emerging Energy,* November 1, 2011.
[50] "The Solyndra Mess." *The New York Times,* November 24, 2011.
[51] John M. Broder, "Energy Loan Oversight is Needed, Audit Finds." *The New York Times*, February 10, 2012.
[52] Aamer Madhani, "Energy Department to recoup most of Beacon loan." *USA Today*, February 6, 2012.

The Case of Gamesa: Beaten at Its Own Game

Gamesa, a Spanish wind company, established a presence in China as early as 2000, long before renewable energy technology came to the forefront of the global political conscious. The company was founded in the 1970s, in the early years of renewable energy development, and by the early 2000s, the company had a significant global presence. It was one of the most successful Spanish wind companies, and its early entry into the Chinese market occurred at a time when the Chinese had not yet seriously entered the renewables market. By 2005, Gamesa controlled over a third of the Chinese wind market.[53] They opened their first turbine factory in Tianjin in that same year, and arranged a €1.2 billion loan from banks across Europe.[54]

In the 1990s, Gamesa was able to manufacture more of its products for wind power in Spain, where labor was relatively inexpensive, and export its goods around the world. This policy became more difficult in the early 2000s as China, which was one of Gamesa's greatest importers, began placing increasing regulations on renewable energy technology, mandating that more technology for wind power be produced in China, rather than imported from abroad. In a key decision in 2005, the Chinese government announced that 70% of the value of equipment in wind farms in the nation had to come from products which had been locally manufactured.[55] Gamesa trained over five hundred local manufacturers to meet this requirement, and because of the cheap cost of production in China, the balance of exportation has shifted, and some essential parts for Gamesa's wind turbines are now being shipped from China to Gamesa's assembly plants around the world.[56] Throughout the 2000s, the company's workforce in Spain suffered as manufacturing jobs were increasingly sent overseas. In 2008, the company laid off around 140 employees in As Somozas in northwestern Spain.[57] Although several of these employees seem to have been temporary workers whose contracts were not renewed, the layoffs were not a positive sign for one of the largest wind manufacturers in the world. Further layoffs have continued in several of Gamesa's locations, including Spain and the United States, as the global economic recession and increasing foreign competition has threatened Gamesa's global viability.

In 2008, Gamesa divested itself of its solar division, leaving the company free to concentrate exclusively on wind power. When the company was founded in the 1970s, it focused on a wide variety of renewable technology, but over the years, it disposed of its other divisions, and its 2008 decision left

[53] Keith Bradsher, "To Conquer Wind Power, China Writes the Rules." *The New York Times*, December 14, 2010.
[54] "RLPC-Gamesa seeks 930-mln euro forward-start loan- bankers." *Reuters*, September 16, 2009.
[55] Bradsher, "To Conquer Wind Power."
[56] Ibid.
[57] Lorena Bustad, "CC OO denuncia despidos masivos en Gamesa." *El Pais*, November 1, 2008.

it focused on wind power. By 2009, it had a presence in over twenty European, American, and Asian markets.[58] In that year, it began development of its first wind farm in China in an attempt to solidify its presence beyond manufacturing. The company benefited from the generous subsidies from the Chinese government, even while the company struggled in other areas around the world. The company was forced to lay off several hundred employees in the United States in 2009 as they continued to expand in China.

The market for renewable technology evolved rapidly in China while Gamesa continued to grow, however. Although the company controlled a third of the wind market in 2005, by 2010, the Chinese had reclaimed 85% of the market for local companies.[59] In 2010, Gamesa held only three percent of the wind power market. The Chinese took a distinctly more ambitious approach to their development of wind turbines than the major western companies did. Gamesa, Vestas, a leading Danish wind company, and other wind turbine manufacturers in the west spent many years developing 100-kilowatt turbines before they began producing more efficient 1.5-megawatt turbines, while many of Chinese companies began producing the larger turbines immediately.[60] In spite of the Gamesa's shrinking share of the Chinese market, they in fact produced over twice as many turbines in 2010 as they had in 2005.

While the Chinese have focused on production rather than consumption of many renewables, by 2009, China was the world's fastest-growing market for wind energy.[61] Additionally, the government has significantly increased the controls and regulations extended over the development of renewable energy technology, making it more difficult for foreign companies to compete in the country. This has significantly impacted Gamesa, in spite of the fact that the company has a long-established presence in the nation. The government has also extended subsidies and low-interest loans to Chinese companies, and made cheap land available to native companies, to the disadvantage of foreign companies. In spite of the fact that these policies may run afoul of international trade agreements, companies such as Gamesa have been reluctant to launch complaints because they continue to reap benefits from their presence in China, in spite of the fact that their positions in the country are becoming increasingly endangered.

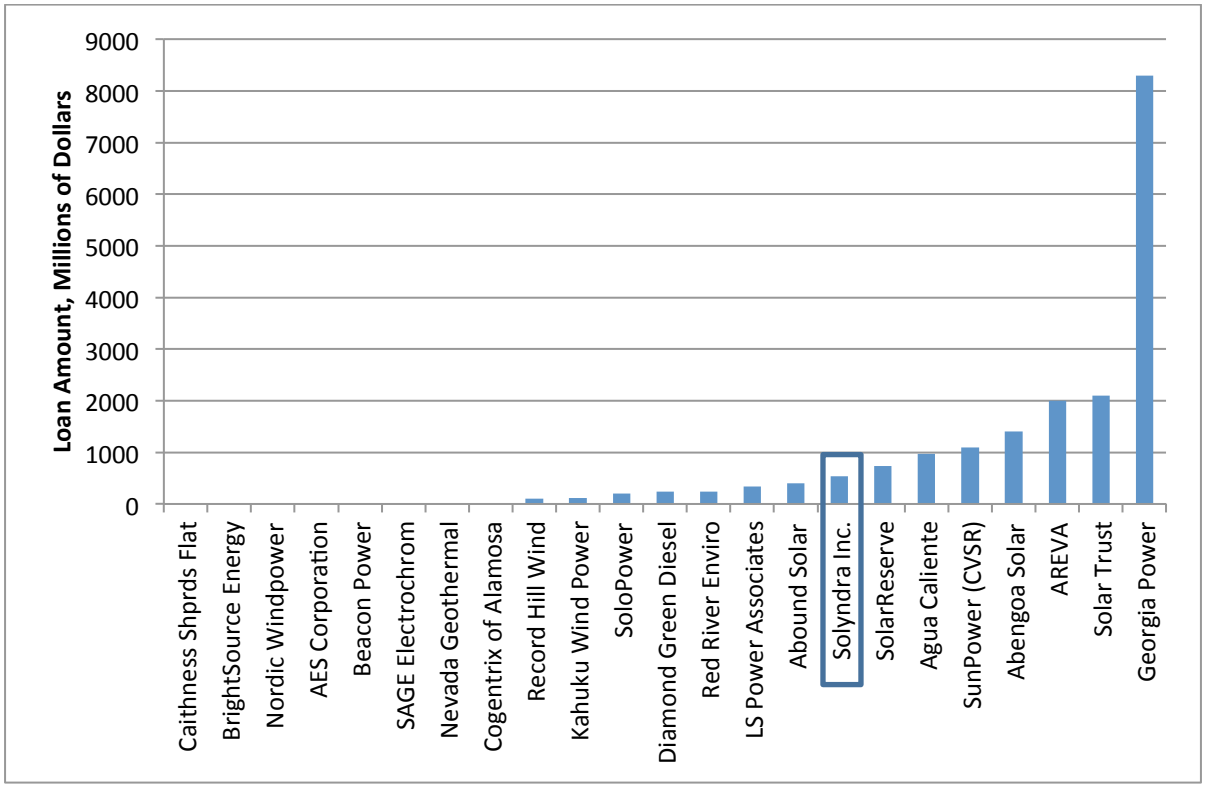
---

[58] "Global consolidation," Gamesa, <http://www.gamesacorp.com/en/global-consolidation-2000-2009.html>
[59] Bradsher, "To Conquer Wind Power."
[60] China joins wind turbine business
[61] "Gamesa expands in presence in China by building fifth manufacturing plant," Gamesa Corp. Press release, May 10, 2010.

Government Loans and the Failure of Solyndra

Solyndra was a solar company founded in 2005 by Christian Gronet in Fremont, California. The company began producing solar panels in 2007. Commercial shipments of the panels began in 2008, and in 2009, the company received a $535 million loan from the United States Department of Energy through the department's Loan Guarantee Program to begin manufacturing a new type of solar panel.[62] This was one of the larger loans given out by the program, which gave money to programs in across many energy sectors.

Figure 2: Department of Energy Loan Guarantee Program Recipients, Sections 1073 and 1075[63]



The company was a high-profile recipient of the Department of Energy's loan program. When the company broke ground for its new factory upon receiving the loan, Vice President Joe Biden, Energy Secretary Steven Chu, and California governor Arnold Schwarzenegger were in attendance. In 2010, President Barack Obama visited the factory in Fremont to highlight the Department of Energy's loan program.

---

[62] About Us, Timeline, Solyndra, June 8, 2010, < http://www.solyndra.com/about-us/timeline/>.

[63] Section 1073 of the Loan Guarantee Program finances clean technology innovation, and Section 1075 finances renewable energy, electric power transmissions, and biofuels as a temporary measure to address the economic conditions of the nation. The third component of the program, the Advanced Technology Vehicles Manufacturing, financed automotive production. Solyndra received its loan under Section 1075. Table information from Eric Wesoff, "Are DOE Loan Guarantees an Energy Policy Mistake?" *Greentech Media,* June 2, 2011.

However, even before the company received the $535 million dollar loan, its financial situation was being called into question. Solyndra produced non-traditional solar panels, which were cylindrical and used copper indium gallium diselenide thin-film technology, which avoided the expense of silicon but had limited use. The cylinders could absorb light from any angle, which was an uncommon innovation, but they were nearly twice as expensive as traditional panels to produce.[64]

Solyndra was one of the first loans to be granted under the Loan Guarantee Program, and as such, its success was assigned much political importance. Nonetheless, the loan did not solve the company's financial difficulties. Seven weeks after Solyndra opened the new $733 million dollar factory that had been financed by the Department of Energy loan, the company announced that it was closing its old plant, immediately delaying the planned expansion of the new plant, and abandoning plans for a stock offering. Forty permanent employees and 150 temporary workers were laid off in the factory closure, but the move was expected to save Solyndra $60 million in capital expenditures.[65] Gronet was also made chairman of the board and a new CEO, Brian Harrison, was hired.[66] In spite of the fact that the company earned over $100 million in revenue in 2009 and completed installations around the world between 2009 and 2010, the company was still forced to restructure its repayment plan due to financial difficulties. Even with the loan restructuring and the additional funds raised, Solyndra declared bankruptcy in September 2011, suspending all of its operations and laying off 1100 employees. Additionally, it was forced to default on the government loan, the first and thus far the largest failure of the program.

The bankruptcy of Solyndra was caused by a variety of factors. Solar panel prices had been driven down steeply by competition, especially from foreign entities, which cut heavily into company revenues. Rhone Resch, the president and CEO of the Solar Energy Industries Association, has stated that the bankruptcy of Solyndra and the difficulties of other solar companies "happens in every industry that is maturing and growing more competitive" and that "winners emerge who find innovative ways to offer consumers the most competitively priced products."[67] Solyndra likely misjudged the marketplace when it made the decision to manufacture its unconventional panels.

Following the bankruptcy, however, the FBI began investigating the company, seeking evidence of fraud. The company had spent $1.8 million on lobbyists during the loan vetting process, apparently

---

[64] David R. Baker, "Feds probe Solyndra's upbeat July report." *San Francisco Chronicle*, September 13, 2011.
[65] Todd Woody, "Solar Panel Maker to Close a Factory and Delay Expansion." *New York Times*, November 3, 2010.
[66] Roberta Rampton, "Solyndra staff saw "mutiny" before Obama visit." *Reuters*, December 1, 2011.
[67] Anne C. Mulkern, "Solyndra Bankruptcy Reveals Dark Clouds in Solar Power Industry." *New York Times,* September 6, 2011.

to keep government officials from understanding the risks of investment. A government accountability office found that preliminary loan approvals were occasionally granted by the Department of Energy "before officials had completed mandatory evaluations of the financial and engineering viability of the projects." No other company which received a Department of Energy loan similarly employed a lobbying firm during the process.

Additionally, six weeks before the company declared bankruptcy and their factory was closed, Solyndra assured members of Congress that they were in no danger. Simultaneously, it told investors and the Department of Energy that it was going to have to cut its revenue forecasts. When the company could not find enough backers to meet its restructured agreements, the Department of Energy informed Solyndra that it would not be able to restructure the loan a second time. The very next day, Solyndra closed the doors to its factory.[68]

In the loan restructuring which took place in the fall of 2010, the Department of Energy had agreed that in case Solyndra went bankrupt, its obligation would be to private investors, not to the department and taxpayers. This meant that when Solyndra declared bankruptcy, the government lost the $535 million it had invested in the company. Although this quickly became a major political issue, the loss represented only 1.3% of the total loan portfolio of the Loan Guarantee Program and fell well within the amount the department had set aside for potential losses.

In the press release given before when Solyndra shut its Fremont factory, the company was quick to place the blame for its failure on outside factors, stating,

> Solyndra could not achieve full-scale operations rapidly enough to compete in the near term with the resources of larger foreign manufacturers. This competitive challenge was exacerbated by a global oversupply of solar panels and a severe compression of prices that in part resulted from uncertainty in governmental incentives in Europe and the decline in credit markets that finance solar systems.[69]

Discussions of Solyndra's failure in the press were frequently coupled with discussions of China's rising dominance in the solar market. This gives rise to a debate over the social and economic impacts of the exportation of renewable energy technology in a modern global context.

[68] Baker.
[69] "Solyndra Suspends Operations to Evaluate Reorganization Options," Solyndra. Press release, August 31, 2011.

Social Impacts of Renewable Energy Technology Exportation

The bankruptcy of many renewable energy companies, the outsourcing of renewable energy jobs, and the loss of taxpayer dollars to defaulted companies has created a significant debate in the western world. Many pundits feel that the Chinese have unfairly taken advantage of subsidization policies in the west to build their own renewable energy industry, but an important question has arisen in this debate: is it necessary for renewable energy technology to be manufactured in the western world? At this point in time, China has a clear advantage in manufacturing. This has some drawbacks for the western world, but it also has definite benefits. Because the Chinese have been able to mass-produce renewable energy technology more efficiently and more cheaply than western companies, prices have dropped much more quickly than industry analysts predicted, especially in the solar industry. This makes solar technology more affordable to a broader base of people, but it also makes it difficult for western manufacturers to compete.

The inability of western manufacturers to compete efficiently with Chinese manufacturers has cost thousands of jobs as companies are forced to close or outsource their production. Foreign competition has not been the only reason that Western companies have been forced to shut their doors, however. Many companies bet on the wrong types of technology, which ultimately resulted in expensive production costs or unpopular products.

The reliance of many companies and consumers on subsidies in the West has negatively impacted the market for renewables as well. Many governments have heavily subsidized their renewables industries, which masks market signals and makes it difficult for consumers to adjust to price differentiations. Renewables are often much more expensive than conventional fossil fuels, but subsidies have disguised the true prices of energy generated by renewables. Upcoming and ongoing cuts to subsidies have driven up energy costs for consumers, particularly in Europe, which has been more receptive to the introduction of renewables than the United States.

In their article "Misguided Policy? Following Venture Capital into Clean Technology," Andrew Hargadon and Martin Kenney stated, "The current global energy system resists change as it is the outcome of a technological trajectory now more than a century old, thoroughly integrated into our everyday lives, and literally at the core of all political economies."[70] A certain sense of complacency is prevalent, especially in the United States, but also throughout the West, where fossil fuels are proven and cost-effective means through which to produce electricity. The transition to renewable energy will

[70] Andrew Hargadon and Martin Kenney, "Misguided Policy? Following Venture Capital into Clean Technology," *California Management Review*, vol. 54, no. 2 (Winter 2012): 119.

undoubtedly be beneficial in the long term, but establishing manufacturing factories and generation plants is costly in the short term.

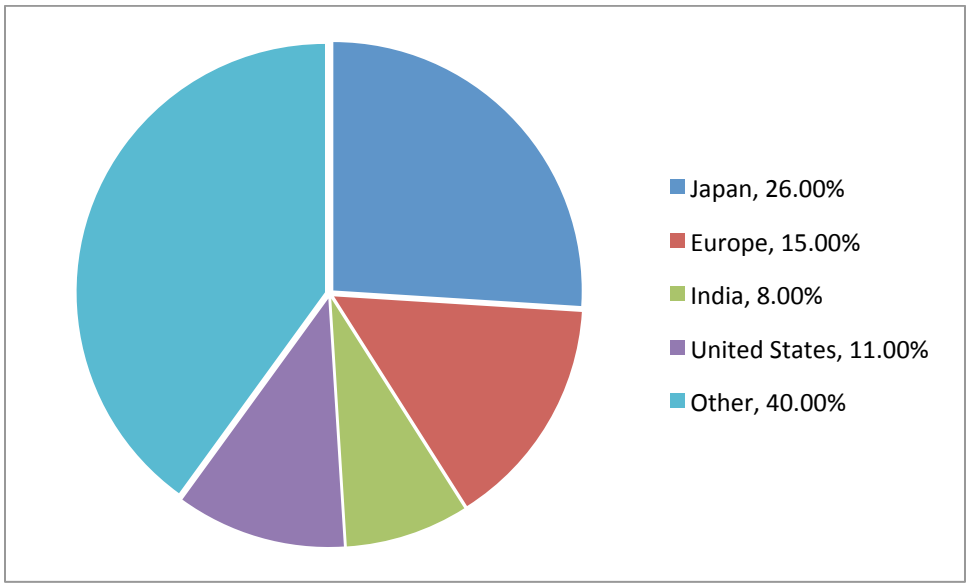
In order for the transition to renewable energy to be truly effective, greater complicity from the general public is needed. The public needs to take an active interest in the ongoing debates over what the role of renewable energy manufacturing should be in their countries. In the long term, increased usage of renewable technology will benefit not only the environment, but the national economy as well, as dependence on foreign energy sources is minimized. The public should take this into account as politicians debate the exact role renewables should play in national energy mixes.

Economic Impacts of Renewable Energy Technology Exportation

The United States Department of Energy has stated that the mission of their Federal Loan Guarantee program is "to accelerate the domestic commercial deployment of innovative and advanced clean energy technologies at a scale sufficient to contribute meaningfully to the achievement of our national clean energy objectives- including job creation" as well as "enhancing American competitiveness in the global economy of the 21st century."[71] The global economy has in fact changed drastically since a greater significance was placed on the development of renewable energy technology by the global community in the 2000s. While energy generation from renewable sources has increased dramatically, a global recession has hurt the development of clean energy, and the face of the global market has changed markedly.

The solar industry provides as a good example of the way the global market has changed. In 1998, the leading solar producers were Japan, the United States, and the European continent. As the chart below demonstrates, China produced less than 8% of the world's solar power.

Figure 3: 1998 Solar Shipments by Geographic Region[72]

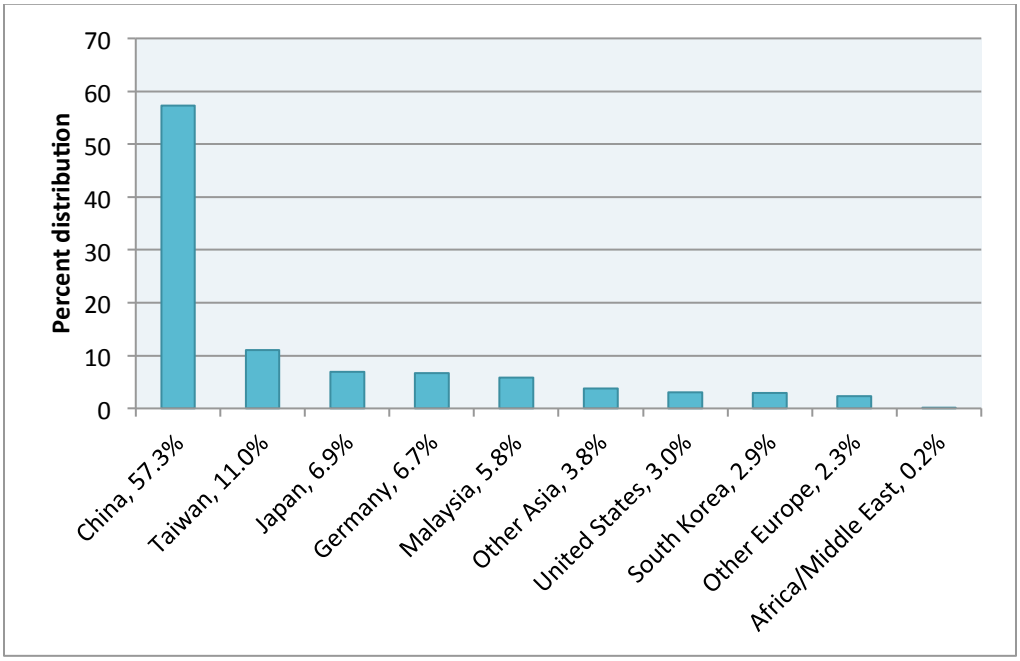


By 2011, however, the global distribution of solar production had shifted greatly. Only Japan retained its position as one of the largest solar producers in the world, although it was no longer the top producer, having been passed by China and Taiwan. Germany had managed to distinguish itself as a major producer, but the United States and the rest of Europe produced a very small amount of the

[71] U.S. Department of Energy Loan Programs Office, "Our Mission." Last accessed July 23, 2012. <https://lpo.energy.gov/?page_id=17>
[72] Source : PV Energy Systems

world's solar panels, just over 5% combined. With the contribution of Germany, the 12% contribution of Europe and the United States in 2011 still represented a loss of over half of their share of the world market 1998.

Figure 4: Geographic Distribution of Solar Cell Production in 2011, by Country[73]



There have been many economic issues which have led to the difficulties in continuing the original western dominance of the renewables market on a global scale. While Europeans, and in particular the Germans, have been generous in their subsidization of renewable energy technology development, their support levels do not approach the levels of support the Chinese government has shown to its renewables industry, and the United States has supported the development of renewables at a level below even that of Europe. Although renewables have been touted as a way to reduce dependence on imported fuels, especially oil and gas, when the technology needed to produce renewable energy is manufactured abroad, the economic significance of such a desire is blunted.[74]

While socially, it may be ultimately beneficial to import renewable technology from the most affordable sources, from an economic standpoint, this position is more difficult to defend. The inability of European and American companies to compete with Chinese prices has forced several of these companies to restructure or close entirely, resulting in a loss of jobs. The loss of jobs has a definite impact on local economies. The closure of companies with sizeable workforces, such as Solyndra in California and Evergreen Solar in Massachusetts, can have a dramatic effect that is compounded even

[73] Source : Photon and Statista
[74] World Energy Outlook 2010, 297.

more when a factory is located in a small town, as was the case with Evergreen Solar's factory in Fort Devens, Massachusetts.

Employment figures are also made more complicated when jobs in the west are lost to outsourcing. Evergreen Solar, which began as an American company, gradually expanded to China until it transferred all of its operations there in 2011. Gamesa, the Spanish wind company, built a large workforce in China when it was required to do so in order to meet government regulations, at a cost to the workforce in Spain and other subsidiary locations, such as the United States.

The economic recession is also beginning to have a greater impact on China than it had in previous years. All of China's major solar firms posted losses in 2011. Suntech, the largest solar photovoltaic firm in the world, told Reuters in May 2012 that "China's PV sector might not survive if the EU follows the US's example and imposes import duties."[75] Currently, global production capacity outstrips demand. However, global demand is concentrated in regions such as China and eastern Asia. Europe has done well to increase its own demand through the years, mainly through government measures, but the United States continues to lag behind in its demand for renewable energy sources.

The situation is not entirely bleak, however. Both the United States and European nations such as Germany sell production equipment to China. The United States is currently a net exporter of solar products to China because of this fact, and analysts consider that this sector is likely to remain in the west, because it is a high-tech industry, unlike the assembly of panels.[76] This, combined with the installation of renewable technology such as windmills and solar panels, means that many renewable technology jobs are likely to remain in the west, even as production jobs shift increasingly overseas. This provides the dual economic benefits of providing jobs in the west as well as lowering the cost of renewable technology for western markets.

The debate over renewable energy subsidies also has an important role in the economic impact of renewable energy. The *World Energy Outlook* has suggested that "exposing consumers to market-driven price signals would strengthen and accelerate the demand response, which in turn would contribute to reducing volatility in global markets."[77] While the subsidies were designed to help encourage local production of renewables technology, subsidies from western countries have played a major role in the Chinese development of their renewable technology production capabilities, because in many countries, including Germany, foreign companies were allowed to receive the same benefits as

[75] Craig Morris, "German solar bubble? Look again!" *European Energy Review,* July 5, 2012.
[76] Craig Lacey, "Are the Chinese Using Predatory Pricing to Knock America Out of Solar Manufacturing?", *Think Progress*, September 9, 2011, and Morris.
[77] World Energy Outlook 2010, 584.

national companies. Ending this practice would strengthen local producers as well as prevent a drain of resources from the national economy.

The **Significance of Renewable Energy Technology Exportation for Governments**

Conflicting and controversial information about green energy technology has been released in recent years. While the American government tied loans for clean energy companies to the 2009 Recovery Act as a measure meant to create jobs within the United States, academics in Spain have suggested that the creation of renewable energy jobs actually results in a net loss of jobs for a region.[78] Although this study has been largely discredited, renewables are not the safest bet for job creation, especially in the current global economic climate. Much of the world is still heavily dependent on fossil fuels for their electricity generation. In the United States, the recent utilization of hydrofracking to access vast reserves of natural gas has changed the forecast for the future energy mix and downplayed the importance of renewables. Venture capitalists in the United States and in Europe have been hesitant to invest in renewable energy, which is costly to produce and uneven in its availability, meaning that conventional plants are still required to fill the gaps in energy production that wind and solar plants experience. Energy storage is becoming more important to this equation and makes renewables more viable as a primary source of energy, but storage can be more expensive than reliance on traditional sources.

Governments in Europe and the United States have attempted to downplay the difficulties in establishing the competitiveness of renewables through subsidies and loans, but this creates an interesting conundrum and exposes those governments to many risks. By funding corporations private investors have been reluctant to support, governments attempt to prop up local firms and ensure their survival, which is in no way guaranteed, as can be seen by the case studies above. All five companies received government support, and four declared bankruptcy, while the fifth, Gamesa, is relying increasingly on foreign bases, denying jobs in Spain at a time when unemployment is at record levels.[79] While only two companies, Evergreen Solar and Solyndra, permanently ceased production, jobs were lost in every case as the companies went through bankruptcy proceedings.

One important factor for venture capitalists is the viability of projects, discussed in Hargadon and Kenney's article on clean technology investment: "new ventures must be able to provision a rapidly growing market without a correspondingly growing need for capital investment."[80] In nearly every case study done above, the companies needed a continuing influx of cash or restructuring of loan repayment programs as they were unable to generate adequate revenue on their own, in some cases even after years of production. This is due in part to the government subsidies which are meant to encourage

[78] Craig Morris, "Are renewables job killers?" *PV Magazine,* (June 2009): 20-21,
[79] In July 2012, the Spanish unemployment level reached a record high of 24.6%. Raphael Minder and Jack Ewig, "24.6% Unemployment Rate in Spain." *New York Times*, July 27, 2012.
[80] Hardgadon and Kenney, 125.

clean energy technology use. By heavily subsidizing this industry, governments render clean energy production independent of market signals.[81] This has proven to be especially dangerous in the current economic recession, and even when production is subsidized, when consumers do not demand renewable energy on par with levels of production, companies are ultimately unable to sustain themselves. Likewise, the recession has made cuts to subsidies logical, but consumers have become used to the prices paid in a subsidized market, and the end to such measures would raise prices to levels that might be considered unacceptable to consumers. Ongoing subsidies are unfeasible for governments in the long run, but in the current economic climate, it is difficult to end them and difficult to keep them.

Renewable energy technology has been supported by government policies, and these policies have been key to the success of such technology in the west.[82] The development of renewable energy technology is closely related to government objectives to reduce carbon dioxide (CO_2) emissions. The differences in policy support also demonstrate why renewables have taken a stronger hold in Europe than they have in the United States, where lawmakers have been more reluctant to support renewables over the traditional energy sources which have been so influential in American politics. The United States has subsidized the production of renewable energy mainly through tax credits and bonds, while in Europe, many countries subsidize consumers directly through feed-in tariffs.[83] The *World Energy Outlook 2010* suggested that "eradicating subsidies to fossil fuels would enhance security, reduce emissions of greenhouse gasses and air pollution, and bring economic benefits," and that "fossil fuel subsidies undermine the development and commercialization of renewable energy and other technologies that could become more economically attractive."[84] It also suggested that "the existence of government programs to make renewables attractive to investors and create markets for them is the most important factor affecting the expansion of renewable energy."[85] While this is true, governments must be careful to find a balance between such programs and allowing renewable technology to respond adequately to market conditions, which will ensure the stability of the technology for the long term.

---

[81] Carlo Stagnaro, "How solar subsibsidies can distort the power market: the case of Italy." *European Energy Review*, July 5, 2012.
[82] International Energy Agency, *Clean Energy Progress Report.* 2011, 13.
[83] Ibid, 314.
[84] International Energy Agency, *World Energy Outlook 2010*. 55 and 574.
[85] Ibid., 277.

Conclusions to be Drawn

The exportation of clean energy technology has both positive and negative effects. Exportation of clean energy technology can make it possible for renewables to be made more cheaply, making them more affordable to consumers around the world, including in the countries from which the production of such technology was originally exported. However, the exportation of clean energy technology also comes at the cost of jobs and at the expense of taxpayer dollars, as demonstrated in the five case studies above. The costs and benefits of clean energy technology exportation must be carefully weighed, and the exact benefits nations are seeking from clean energy technology must be discussed.

Some nations, such as the United States, have highlighted the development of clean energy technology as a job-creating endeavor, as demonstrated by the fact that the United States Department of Energy's Federal Loan Guarantee Program was created by the 2009 Recovery Act, which was meant to stimulate the economy through job creation.[86] However, the long-term implementation of clean energy technology can have great benefits for nations as well, making them less dependent on foreign energy sources, and currently, nations outside the west have shown themselves better able to mass-produce clean energy technology relatively cheaply, which benefits the west by making renewables more affordable for consumers. This furthers the goals for energy self-sufficiency many nations possess. Clean energy technology exportation also brings continuing trade benefits, especially as currently, the west still produces and exports the majority of the equipment needed for the production of renewables.

Nonetheless, governments must carefully evaluate their priorities for clean energy technology. While many companies in the west have suffered because of foreign competition, current government policies, even those designed to help local companies, have not always done so. Subsidies that are made available to foreign companies undermine efforts to encourage local production. Subsidies can also mask market signals, with ultimately negative consequences. Especially in the current world economic situation, subsidies for clean energy technology are an unsustainable practice.

Renewables are a vital component of the global energy mix as energy usage continues to grow and expand around the world. Without the use of such alternative energy sources, the global consumption of fossil fuels will grow to unsustainable levels. Governments must actively work to prioritize renewables in order to ensure continued supply for the growing demands of their citizens, and to ensure that increasing energy demands do not negatively impact the environment.

[86] Mufson and Eilpern.

Bibliography

"About Us." Evergreen Solar. Accessed June 19, 2012. Last modified 2011. http://evergreensolar.com/en/lxwm.html.

About Us, Timeline, Solyndra, June 8, 2010, Accessed July 23, 2012. http://www.solyndra.com/about-us/timeline/.

Ailworth, Erin. "As federal funds dry up, Beacon Power still has reason for hope." *Boston Globe*, November 27, 2011.

———"Evergreen Solar fires chief executive." *Boston Globe*, November 26, 2011.

———"Patrick pushes for support of clean energy firms, despite failure." *Boston Globe*, May 30, 2012.

Baker, David R. "Feds probe Solyndra's upbeat July report." *San Francisco Chronicle*, September 13, 2011.

Bathon, Michael. "Bankruptcy judge approves asset sales by Evergreen Solar." *Boston Globe*, November 11, 2011.

Boston Globe. "Evergreen Solar's failure shows US weakness in clean energy." Editorial, August 18, 2011.

Bradsher, Keith. "China Benefits as U.S. Solar Industry Withers." *New York Times*, September 1, 2011.

———"Solar Panel Maker Moves Work to China." *New York Times*, January 14, 2011.

——— "To Conquer Wind Power, China Writes the Rules." *New York Times*, December 14, 2010.

Brickley, Peg. "Evergreen Solar to Abandon Massachusetts Factory." *Wall Street Journal*, March 12, 2012.

Broder, John M. "Energy Loan Oversight Is Needed, Audit Finds." *New York Times*, February 10, 2012.

Burnham, Michael. "Company Breaks Ground on 'Flywheel' Energy-Storage Plant." *New York Times*, November 19, 2009.

Bustad, Lorena. "CC OO denuncia despidos masivos en Gamesa." *El Pais*, November 1, 2008.

Clean Energy Progress Report: IEA Input to the Clean Energy Ministerial. International Energy Agency, 2011.

Climate Progress (blog). http://thinkprogress.org/climate.

Dealbook. "D.O.E. Charges Up Flywheels with $43 Million Loan." *New York Times*, August 10, 2010.

Declaration of Michael El-Hillow. United States Bankruptcy Court for the District of Delaware, August 15, 2011.

Der Spiegel. "German Solar Firms Eclipsed by Chinese Rivals." September 7, 2011.

"DOE Charges Up Flywheels with $43 Million Loan." *New York Times.* August 10, 2010.

Endhardt, Sandra, and Becky Stuart. "State of Berlin to save Solon?" *PV Magazine*, December 16, 2011.

Enkhardt, Sandra. "Microsol will take Solon over." *PV Magazine*, February 29, 2012.

———"Solon: Further takeover details emerge." *PV Magazine*, February 13, 2012.

———"Solon receives 2 concrete takeover bids." *PV Magazine*, February 1, 2012.

Enkhardt, Sandra, and Becky Stuart. "Plans to resue Solon failed." *PV Magazine*, December 15, 2011.

Galbraith, Kate. "Solar Manufacturing: Not So Sunny." *New York Times*, January 14, 2009.

"Gamesa expands in presence in China by building fifth manufacturing plant," Gamesa Corp. Press release, May 10, 2010.

Gold, Russell. "Overrun by Chinese Rivals, U.S. Solar Company Falters." *Wall Street Journal*, August 17, 2011.

"Global consolidation," Gamesa, <http://www.gamesacorp.com/en/global-consolidation-2000-2009.html>.

Greenhouse, Steven. "Elusive Goal of Greening U.S. Technology." *New York Times*, December 2, 2009.

Groom, Nichola. "Solar company Evergreen files for bankruptcy." *Reuters*, August 15, 2011. Accessed June 6, 2012. http://www.reuters.com/article/2011/08/15/us-evergreensolar-idUSTRE77E49320110815.

Guernsey, Lisa. "HOW IT WORKS; From a White House Roof, Solar Power Proclaims Gains." *New York Times*, February 27, 2003.

Hals, Tom, and Rebecca Rampton. "Beacon Power bankrupt; had US backing like Solyndra." *Reuters*, October 31, 2011.

Hargadon, Andrew and Martin Kenney. "Misguided Policy? Following Venture Capital into Clean Technology," *California Management Review*, vol. 54, no. 2, Winter 2012.

Kho, Jennifer. "Should Renewable Be 'Made in the U.S.A.'?" *New York Times*, August 20, 2009.

Lacey, Craig. "Are the Chinese Using Predatory Pricing to Knock America Out of Solar Manufacturing?", *Think Progress*, September 9, 2011

Lipton, Eric, and John M. Broder. "In Rush to Assist a Solar Company, U.S. Missed Signs." *New York Times*, September 20, 2011.

Lynch, David. “Winning the Global Race for Solar Silicon.” *JOM* 61, no. 11 (November 2009): 41-48.

Madhani, Aamer. “Energy Department to recoup most of Beacon loan.” *USA Today*, February 7, 2012.

McCarty, Dawn. “Beacon Power, Backed by U.S. Loan Guarantees, Files Bankruptcy.” *Bloomberg News*, October 31, 2011.

Michaelson, Ruth. “Taking the temperature at Forum Solarpraxis: day one.” *PV Magazine*, November 18, 2011.

Morris, Craig. “Are renewables job killers?” *PV Magazine,* June 2009, pgs. 20-23.

——— “German solar bubble? Look again!” *European Energy Review*, July 5, 2012.

Mufson, Steven, and Juliet Eilperin. “Beacon Power declares bankruptcy; second loan guarantee recipient to falter.” *Washington Post*, November 1, 2011.

Mulkern, Anne C. “Solyndra Bankruptcy Reveals Dark Clouds in Solar Power Industry.” *New York Times*, September 6, 2011.

Neubacher, Alexander. “Germany Created Their Own Threat with Chinese Solar Aid.” *Der Spiegel*, February 27, 2012.

———“Re-Evaluating Germany’s Blind Faith in the Sun.” *Der Spiegel*, January 18, 2012.

New York Times. “The Solyndra Mess.” Editorial, November 24, 2011.

New York Times. “The Solyndra Panic.” Editorial, September 25, 2011.

O’Brian, Heather. “’We have shifted our investments to places where demand is growing.’” *European Energy Review*, June 28, 2012.

Plumer, Brad. “Five myths about the Solyndra collapse.” Editorial, *Washington Post*, September 14, 2011.

Rampton, Roberta. “Solyndra staff saw “mutiny” before Obama visit.” *Reuters*, December 1, 2011.

Remmers, Karl-Heinz. “Solon is bankrupt- again?” Editorial, *PV Magazine*, December 14, 2011.

Renewable Energy World. “Evergreen Solar Has Successful IPO.” November 8, 2000.

Reuters. “Evergreen Solar might expand to Asia.” *Boston Globe*, May 28, 2008.

Roberts, Jeanne. “Another DOE Favorite, Beacon Power, Files for Chapter 11.” *Energy Boom*, November 1, 2011.

Roney, J. Matthew. “Solar PV Breaks Records in 2010.” *Earth Policy Institute*, October 27, 2011.

Schultz, Stefan. “Bankruptcies Have German Solar on the Ropes.” *Der Spiegel*, April 3, 2012.

“Silicon Prices Climb Higher,” *Renewable Energy World*, August 25, 2010.

“Solon AG Becomes European Company (SE),” Solon Solar SE. Press release, December 8, 2008.

“SOLON AG continues to expand its international business,” SOLON AG für Solartechnik. Press release, April 25, 2007.

SOLON AG für Solartechnik and Solon Solar SE financial reports, fiscal years 2005-2010.

“Solyndra Suspends Operations to Evaluate Reorganization Options,” Solyndra. Press release, August 31, 2011.

Stagnaro, Carlo. “How solar subsidies can distort the power market: the case of Italy.” *European Energy Review*, January 5, 2012.

Stech, Katy. “DOJ Slams Beacon Power Legal Tab, Bonuses.” *Wall Street Journal*, March 21, 2012.

Stephens, Joe, and Carol D. Leonnig. “Solyndra loan: White House pressed on review of solar company now under investigation.” *Washington Post*, September 14, 2011.

Stuart, Becky. “Microsol forms Solon Energy GmbH.” *PV Magazine*, March 6, 2012.

———“PV price shifts and painful consolidation.” *PV Magazine*, November 24, 2011.

———“Solon files for insolvency.” *PV Magazine*, December 14, 2011.

———“Solon officially saved.” *PV Magazine*, March 1, 2012.

———“Solon’s financials hit by solar slowdown.” *PV Magazine*, November 15, 2011.

Taylor, Phil. “Companies Race to Develop Utility-Scale Power Storage.” *New York Times*, September 28, 2009.

“Top 10 World’s Biggest Solar Producers (Estimated Module Production Capacity 2011).” Solar Plaza. Accessed June 19, 2012. Last modified December 31, 2011. http://www.solarplaza.com/top10-estimated-module-production-capacity-2011/.

Turner, Greg, and Jerry Kronenberg. “Evergreen Solar files for bankruptcy, plans asset sale.” *Boston Herald*, August 15, 2011.

U.S. Department of Energy Loan Programs Office, “Our Mission.” Last accessed July 23, 2012. https://lpo.energy.gov/?page_id=17.

Wald, Matthew L. “Advancing the Flywheel for Energy Storage and Grid Redulation.” *New York Times*, January 25, 2010.

———"Solar Firm Aided By Federal Loans Shuts Doors." *New York Times*, August 31, 2011.

———"Solyndra Has a Cousin in the Poorhouse." *New York Times*, November 17, 2011.

Wesoff, Eric. "Solon, Bankrupt German Solar Vendor, Acquired b UAE's Microsol." *Green Tech Media*, March 6, 2012. Accessed June 20, 2012. http://www.greentechmedia.com/articles/read/Solon-Bankrupt-German-Solar-Vendor-Acquired-by-UAEs-Microsol/.

——— "Are DOE Loan Guarantees an Energy Policy Mistake?" *Greentech Media,* June 2, 2011.

Woodhead, Michael. "Germany loses its place in the solar power industry." *The Sunday Times*, January 8, 2012.

———"Germany loses its place in the solar power industry." *The Sunday Times*, January 8, 2012.

Woody, Todd. "Solar Panel Maker to Close a Factory and Delay Expansion." *New York Times*, November 3, 2010.

World Energy Outlook 2010. International Energy Agency, 2010.