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Photovoltaics in Texas

Part Two: Strategies for Growth

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As the world turns to clean energy sources, Texas has a strategic opportunity to expand its traditional energy leadership capacity into solar power. This article is the second in a two-part series examining the photovoltaics (PV) industry in Texas. The first article, published in April 2007, focused on the potential benefits of expanded reliance on PV systems for Texas consumers and utilities and broadly outlined the state's "innovation pipeline" in the industry. This article builds on the first by examining the progress other states and nations have made in creating demand for PV power and attracting PV manufacturing and installation firms to their regions. Finally, the article identifies areas for further research and recommends actions the public, private, and academic sectors can take to develop Texas' PV industry.

The Competition: What Other Regions Are Doing to Build Their PV industries *Now*

Germany

Germany currently leads the world in photovoltaic capacity as shown in Table 1 below. The nation employs a feed-in tariff model to regulate its renewable energy industry rather than utilizing a quota system. Feed-in tariff models

Table 1
Total Installed PV Power by the End of 2005

Country	Cumulative PV Capacity (kW)			Installed in 2005 (kW)		Total per capita [kW/Capita]
	Off-Grid PV	*Grid-Tied*	*Total*	*Total*	*Grid-Tied*	
Germany	1,400,000	29,000	**1,429,000**	635,000	632,000	17.32
Japan	1,420,760	1,148	**1,421,908**	289,917	287,105	11.13
United States	379,000	100,000	**479,000**	103,000	70,000	1.62
Spain	41,600	15,800	**57,400**	20,400	18,600	1.32
Netherlands	45,857	4,919	**50,776**	1,697	1,547	3.12
Australia	41,813	8,768	**50,581**	8,280	1,980	2.97
France	19,199	13,844	**33,043**	7,020	5,900	0.54
Italy	22,200	5,300	**27,500**	6,800	6,500	0.64
Switzerland	24,120	2,930	**27,050**	3,950	3,800	3.66
Austria	21,126	2,895	**24,021**	2,961	2,711	2.93
Mexico	4,218	14,476	**18,694**	513	30	0.17
Canada	10,843	5,903	**16,746**	2,862	612	0.52
Korea	14,168	853	**15,021**	6,487	6,183	0.31
United Kingdom	10,650	227	**10,877**	2,732	2,567	0.18
Norway	452	6,800	**7,252**	362	0	1.58
Sweden	887	3,350	**4,237**	371	0	0.47
Denmark	2,580	70	**2,650**	360	320	0.49
Estimated Total	**3,494,524**	**202,276**	**3,696,800**	**1,092,851**	**1,039,917**	

Source: International Energy Agency, www.iea-pvps.org

The California Solar Initiative authorized the state to invest $3.3 billion for consumer rebates in small-scale solar electric power systems over 11 years and established a statewide goal of building a million solar electric roofs, or 3,000 megawatts (MW) of solar electric power. The investment was funded from a small surcharge on electric and gas customers within the utilities regulated by the Public Utilities Commission.

require energy supply companies to give priority to electricity generated using renewable energy sources, feed it into the grid, and pay producers a fixed price, whereas under a quota system, the regulatory authority specifies that a fixed proportion of electricity on the market must be produced by renewable energy sources.

On August 1, 2004, Germany amended the German Renewable Energy Sources Act (EEG), which regulates the input and payment of electricity from renewable resources by the utilities. The feed-in tariffs were adjusted according to changes in supporting market introduction programs. The rates are guaranteed for a period of 20 years with a built-in annual decrease of 5% percent annually for basic installed systems and a decrease of 6.5% percent for field installations.[1]

Clearly, the feed-in tariff has accelerated the development of the photovoltaic (PV) market in Germany. Although the International Energy Agency (IEA) states that Germany only generates 1% percent of its power from PV, the industry exhibits the highest growth rate of all renewable energies. In 2005, Germany led the world in both total PV installed and cumulative PV capacity, edging slightly ahead of Japan.

Additionally, Germany has invested in national research & development (R&D) programs, with the most recent (5th) Energy Research Program 2006-2008. Nationally sponsored PV R&D programs are designed to support the German PV industry to reach, maintain, and extend its industry leadership by funding projects in silicon wafer technology, thin-film development, and system technologies.

The favorable feed-in tariff program, as well as national R&D support, has sparked innovation and development within Germany's PV industry, despite the fact that Germany's natural available solar resources are far below those found in the United States. As a result of these initiatives, Germans invested nearly $5 billion in new solar photovoltaic systems in 2006 and in doing so employed nearly 35,000 workers in its solar industry.

United States

According to the U.S. Department of Energy, 20 states and the District of Columbia have adopted Renewable Portfolio Standards (RPS). The RPS requires a state's electricity providers to collectively generate a set percentage of all electricity from renewable resources. Since the RPS is a market standard, it relies almost entirely on the private market for its implementation, resulting in competition, efficiency, and innovation throughout the value chain of the renewable energy industry. Additionally, Illinois and Vermont have issued non-binding state goals for renewable energy adoption rather than a RPS.

California

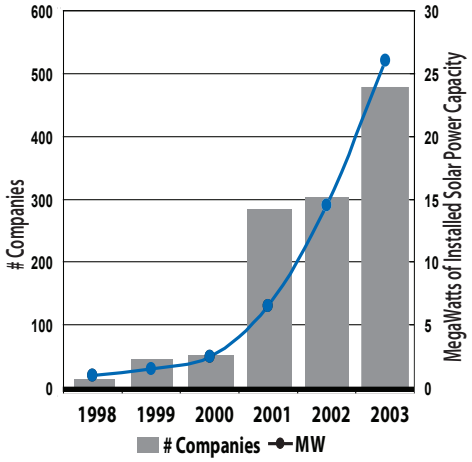
California stands out among the states in promoting renewable energy. It leads the nation in setting energy standards and in both venture and public capital investment in "clean tech." California currently leads the nation's solar energy production, and if it were a separate nation, it would rank third in the world, behind Germany and Japan.

On January 12, 2006, the California Public Utilities Commission (PUC) approved the California Solar Initiative, which authorized the state to invest $3.3 billion for consumer rebates in small-scale solar electric power systems over 11 years and established a statewide goal of building a million solar electric roofs, or 3,000 megawatts (MW) of solar electric power. The investment was funded from a small surcharge on electric and gas customers within the utilities regulated by the PUC.[2]

Eight months later, on August 21, 2006, Gov. Arnold Schwarzenegger signed SB 1 into law, establishing policies that complement the California Solar Initiative and that the PUC did not have authority to establish on its own. SB 1 expands the Million Solar Roofs plan to customers of municipal-owned utilities over which the PUC does not have jurisdiction, increases the state's net metering cap to 2.5 percent, allows approximately 500,000 new solar energy systems into the program, and

Figure 1

California PV Industry Growth Reflects Policy Changes



Source: California Energy Commission

Investments in intellectual capital will create new technologies, stimulate technology transfer, and present commercialization opportunities for entrepreneurs to launch PV-related businesses.

requires developers of more than 50 new single family homes to offer the option of a solar energy system to all customers beginning January 1, 2011. Figure 1 illustrates company growth in relation to previous supportive policy.[3]

New Jersey

In April 2006, New Jersey took steps to ensure the future growth potential of the PV industry. The New Jersey Board of Public Utilities (BPU) issued additional regulations that require the state to produce 22.5 percent of its energy through renewable resources by 2021, including 2.12 percent from solar.[4] The solar electric set-aside percentage is an interesting policy that will result in about 1,500 megawatts (MW) of solar-electric power.

As a result of the state's continued commitment to promoting solar initiatives since its Clean Energy Program was first enacted in 2001, New Jersey has become one of the nation's largest PV markets in terms of installations, second only to California, which has four times the population and energy usage. Four factors have led to robust market development within the state:

- a solar electric "set aside" within the RPS legislation that has helped create demand and investor confidence in the market;
- reliable interconnection and net metering standards that have made it much easier for systems to connect to the distribution system and be compensated for their contribution;
- a Solar Rebate Program that has helped finance over 50 percent of the cost of installation; and
- a Solar Renewable Energy Certificate Trading Program that provides energy credits and additional long-term financing for PV installation.

Solar Renewable Energy Certificates (SRECs) represent the renewable attributes of solar generation, bundled in minimum denominations of one megawatt hour of electricity production.[5] New Jersey's SREC program provides a channel for solar certificates to be created, verified, tracked, sold to and eventually retired by electric suppliers to meet their solar RPS requirement. New Jersey's online marketplace for trading SRECs was launched on June 25, 2004 and is recognized to be the first of its kind in the world.

Pennsylvania

The Pennsylvania Alternative Energy Portfolio Standard (AEPS) was enacted in November 2004 and calls for 18 percent of the state's electricity to come from qualifying renewable sources by 2021. The Pennsylvania regulations establish two tiers of renewable obligations, as well as a solar PV set-aside of 0.5 percent by April 2021.[6] This set-aside will result in the development of approximately 860 MW of solar PV over the next 15 years, which equates to enough PV capacity to power 300,000 homes within the state. Already, it is estimated that the Mid-Atlantic region will add 5,710 local jobs in installation, operation, and maintenance and 8,080 manufacturing jobs in the PV industry as a function of the favorable legislative atmosphere.[7]

The state has also established guidelines for Sustainable Energy Funds, which are designed to promote the development of sustainable and renewable energy programs and clean-air technologies throughout Pennsylvania. The funds have provided more than $20 million in loans and $1.8 million in grants to over 100 projects since their inception in 1999.[8]

Recommendations

This series of articles has outlined photovoltaic developments and initiatives in other states and in Germany and has tried to identify opportunities to pursue in developing a solar industry strategy for Texas. What follows is a set of initiatives, reforms, proposals, and recommendations that flow from material presented here.

Stimulate demand: Modest public investment in the form of rebate initiatives, system benefits charges, or other public finance programs have demonstrated an ability to stimulate commercial and residential demand for PV installations in other states and foreign countries, which in turn generates new company formation, job creation, and all the ancillary benefits of renewable energy production.

Create research pipeline: More public and private R&D spending, and more targeted spending, will leverage Texas research and educational assets already in place. Investments in intellectual capital will create new technologies, stimulate technology transfer, and present commercialization opportunities for entrepreneurs to launch PV-related businesses.

Create economic incentives: Building PV companies in, and attracting firms to, Texas should be a priority in the state's economic development strategy. The Emerging Technology Fund and the Enterprise Fund should give priority to clean energy, and specifically PV, companies.

Leverage excess semiconductor capacity: PV cells and semiconductors use silicon wafers as the basis of their products. Human capital and industry expertise developed in the state's advanced semiconductor manufacturing sector should be harnessed. Texas Instruments and

The PV industry would be an ideal entry point for a major economic development initiative to take advantage of the next wave of technological innovation in wafer design.

other major semiconductor firms are transferring R&D operations from Texas to foreign countries. Other semiconductor firms already have solar initiatives. Applied Materials, a leading developer of semiconductor manufacturing equipment, has made a significant commitment to the solar industry, developing solar manufacturing tools as well as acquiring Applied Films.

Expand silicon processing: Texas has a number of PV assets already in place, including Hemlock and a manufacturing plant for MEMC, two of the world's largest silicon processors. Worldwide silicon processing capacity is expected to expand from an average of 47,000 metric tons in 2007 to 80,000 metric tons in 2008, representing a 70 percent increase, Figure 2. Texas is presently home to approximately 11.5 percent of the world's silicon processing capacity. Given worldwide distribution of silicon processing growth, Texas is forecasted to own only 4.9 percent of the market by 2010. Texas should specifically encourage the expansion of this industry niche in its long-term solar industry goals.

Institute retail net metering: Net metering, which allows customers to receive a retail credit on their electric bill for the excess power they deliver to the grid, will make solar generation even more valuable and help reduce peak demand pressure on traditional utilities, which are forced to turn on inefficient plants to cover only peak demand.

Develop a strategy for high-surface-area electronics industry in Texas: The next stage in design and engineering of PV cells and semiconductors will be in high-surface-area manufacturing. The PV industry would be an ideal entry point for a major economic development initiative to take advantage of the next wave of technological innovation in wafer design.

Further Research

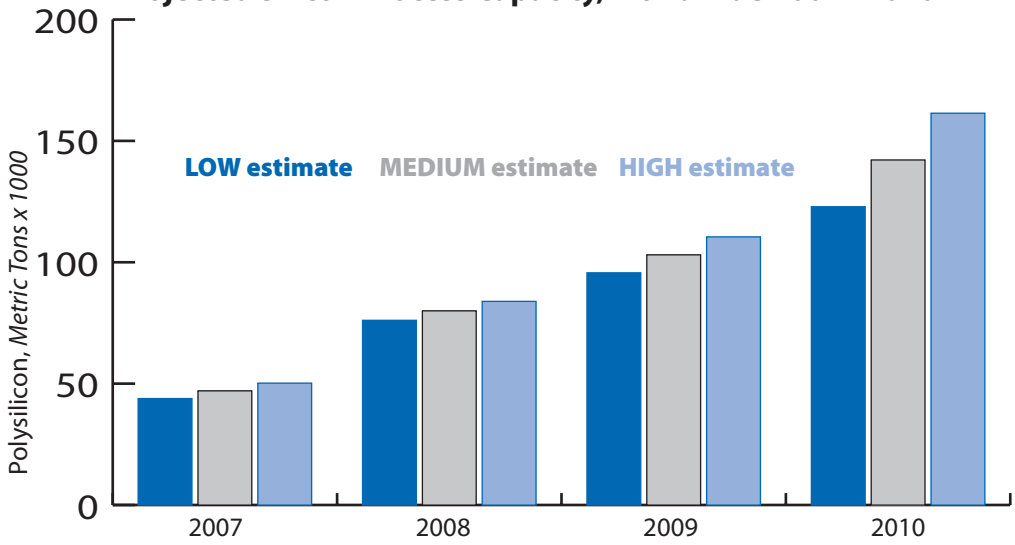
A number of issues need to be better understood to help policy makers, analysts, and industry stakeholders make informed decisions. To facilitate a more coordinated expansion of the PV industry by the state's political, academic, educational, and commercial leadership, we propose a number of research projects to assist stakeholders in understanding the needs, opportunities, and challenges of the photovoltaic industry.

Investigate the viability of PV understructure for disaster preparedness. Solar PV can have a significant value related to avoiding and mitigating economic costs of disasters and speeding disaster recovery. The value can be economically significant, i.e., in excess of $1,000/kW, in cases where solar is deployed in conjunction with appropriate amounts of energy storage. Overall, a disaster recovery benefit could increase the value of PV energy generation assets by as much as 50 percent.[9] Further research is needed to investigate the disaster recovery benefit and assess how distributed PV with distributed energy storage could be incorporated with disaster recovery services at the city and county levels for several Texas regions.

Explore the viability of neighborhood solar security clusters. Another valuable

Figure 2

Projected Silicon Process Capacity, Worldwide 2007 - 2010



Source: International Energy Agency, www.iea-pvps.org

study would be an extension of a disaster preparedness study and the role PV assets could play in disaster recovery, with specifics on how neighborhood solar security clusters could be formed. These could constitute shared solar PV generating assets and energy storage among several households for powering critical loads during grid outages. Especially valuable would be specific recommendations for the engineering design, the impact on local utility service areas, and the community collaboration issue.

Conduct PV economic impact studies unique to Texas (by city, by region). Christy Herig's "Value of Solar" study that was conducted for the City of Austin could be expanded, including verification of the 41 cents per kWh increase for the Travis County Gross Regional Product, and the provision of Gross Regional Product results possible for other Texas locations.[10]

Investigate the viability of forming a next-generation thin film PV ecosystem in Texas. There will be a significant technology substitution of thin film PV, like CIGS for c-Si PV, in the future. The United States still has a leadership position in these next-generation thin film PV technologies, but no regional cluster has been created as of yet to catalyze the growth of these emerging PV technologies in collaboration with enabling and complementary technologies.

Verify and identify leverage points with the semiconductor industry. This paper has assumed that a significant portion of manufacturing photovoltaics value chain can productively leverage state expertise and capacity in semiconductors, including silicon-production, semiconductor fabrication, semiconductor equipment, advanced manufacturing, power equipment, and services industries. However, this complex issue warrants a much clearer and precise understanding to better identify and exploit leverage points and prepare a more effective defensive strategy for maintaining PV human, intellectual, and physical capital in the state.

Conclusion

In a recent survey, Texas registered voters were asked, "Do you think the Texas Legislature should encourage investment in solar power in Texas?" Fully 84 percent responded "Yes." To the question, "Would you support having the Texas Legislature encourage solar power investment in Texas if it would cost you less than one dollar per month on your electric bill," 81 percent said they would support such an increase. Texans are ready for clean energy development in the state.[11]

Texas would absolutely benefit from the expansion of solar power generation. By stimulating demand, Texas, with its enormous consumer market, can drive down the costs of manufacturing and installation. By investing in the intellectual capital in its research centers and universities where PV research is underway and could be expanded, the state can capitalize on existing assets in R&D. Texas companies will become globally competitive, creating wealth, luring out-of state firms to Texas, expanding jobs, and providing clean energy to millions of Texans. Employment in solar module construction consists of high-wage, advanced manufacturing jobs using nanotechnology and robotics, exactly the type of position for which the state's workforce development boards are training the next generation of workers. The state's residents will have real choices in choosing electricity providers and may even elect to produce their own power. Finally, solar power's distributed generation means that solar benefits all types of communities, from urban to rural, from big cities to the most remote parts of the state.

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A PV INDUSTRY CASE STUDY
MEMC: The Sand King

MEMC Electronic Materials, Inc. (NYSE: WFR) is engaged in the design, manufacture and sale of silicon wafers. Headquartered in Missouri, this international company has manufacturing plants in both Sherman and Pasadena, Texas, as well as Japan, Taiwan, Malaysia, South Korea and Italy. The company provides wafers in three catagories: prime polished, epitaxial and test/monitor, and in sizes ranging from 100 millimeters (four inch) to 300 millimeters (12 inch). Its wafers are used as a starting material for the manufacture of various types of semiconductor devices, including microprocessors, memory, and logic and power devices. MEMC is one of four wafer suppliers having more than a 10% share of the overall market. The company also sells intermediate products, such as polysilicon, silane gas, partial ingots and scrap wafers. MEMC is a major supplier of polysilicon, the raw material required for developing solar panels. In fact, the silicon wafer industry grew at a compound annual growth rate of 9% from 1,118 million square inches in 1985 to 7,975 million square inches in 2006, according to SIA/SEMI.

Revenues: 2004: $1.02 billion
2005: $1.1 billion
2006: $1.54 billion
Market Cap: $15 billion

Announcement

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