Thrust Area 4: Solar (Low Cost PV Manufacturing)

Florida Opportunities for PV Manufacturing and Application

(Old Title: *PV Manufacturing Data Base and Florida Applications*)

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Description: The goal of this project is to establish a photovoltaic (PV) manufacturing and applications data base and to stimulate the development of a PV manufacturing industry and related applications in Florida. This project is now in its third year and consequences from both the national and the state perspective show the dominance of the Chinese industry. However, a strong market can eventually lead to manufacturing and, thus, the Florida opportunity. The key to Florida's PV goals are to have both a magnet and a demand. Florida is positioned to be a magnet because of its winning the DOE funded PV Manufacturing Consortium (PVMC) program and high demand is proposed through the application of PV power for electric vehicles. Details follow.

Budget: $81,120
Universities: UCF/FSEC

Progress Summary

The goal of this project was to establish a photovoltaic (PV) manufacturing and applications data base in order to stimulate the development of a PV manufacturing industry and PV applications in Florida. This project's data shows both the international and national PV manufacturing and application trends which are: China has emerged as the world leader, crystalline silicon remains the top world choice at 87% and California remains as the location with the largest installed capacity with Florida ranked at 8$^{th.}$
Florida imports almost all of its energy resources. Thus, the citizens of Florida pay $27 billion for electricity and $30 billion for gasoline giving a total output of $50 billion/year. Of this total, one-half leaves the state or our citizens lose an estimated $24 billion per year. These facts lead to two challenges – How can Florida reduce its energy costs and how can Florida's electricity power plants and transportation fuel be manufactured in Florida? In other words, can we design an energy future which allows Florida to keep this money and in return allow us to make the profits and increase jobs. We believe that there is a Florida future which allows for the vision described as follows.

First let's present data on jobs produced by the energy industries. Data shows that PV produces 23 jobs/MW, wind is 8 jobs/MW, nuclear is 4 jobs/MW, natural gas is 3 jobs/MW and coal is 0.5 jobs/MW. Since Florida can produce very little to no manufacturing in wind, nuclear or coal, the only possible manufacturing for Florida is PV. The key to manufacturing is to have both a magnet and a demand. How does Florida create both of these?

Starting with the magnet, Florida is positioned to be a magnet because of it winning the DOE funded PV Manufacturing Consortium (PVMC) program. Florida is teamed with SEMATECH of New York who is the prime and who won the DOE program (PVMC is a $50 million effort). For the SEMATECH program, Florida's task is crystalline silicon R&D which, as mentioned above, is the dominate cell material at 87%. In the Florida PVMC program, an existing 100,000 ft^2 semi-conductor facility has been dedicated to PVMC. However, the facility needs to be re-furbished with the installation of crystalline silicon pilot manufacturing assembly line. Once the pilot facility is established, the probability is very high for national PV manufacturing firms to become pilot facility users and then to follow with plants in a nearby location. This is the magnet.

The second need is demand. Demand is supplied by a concept that we have called a "game changer" or simply put, what can we do about gasoline prices? The answer is electric vehicles for our future. At this time, 26% of all Florida vehicles are small cars. And, the new electric motor drive cars, like the Nissan Leaf or plug-ins like the Chevy Volt, give us a whole new option to consider. How does electricity compare to gasoline in costs? Using the efficiency of a 33 mpg car, one kWh of electricity will produce 3 car miles for an equivalent electric car. Changing these numbers into cost values, a gasoline powered car cost 10.6 cents per mile to drive while the electric car costs 5.6 cents per mile. These numbers are for gasoline at $3.50 per gallon and for PV electricity at 16.8 cents per kWh. Thus, the cost to drive the PV powered electric car is less than half that of the gasoline car. This supplies the demand.

2011 Annual Report

In order to set the background for PV manufacturing in Florida and a PV demand, a data base of PV in the world and then the U.S. was established. Florida's opportunities and prospects are then evaluated.

World PV Manufacturing Statistics

The following Table 1 presents the world's PV manufacturing output (from Reference 1) for the years 2008, 2009 and 2010 (2010 is the latest available data).

Table 1 - World PV Output by Country/Region
All values are in megawatts (MW)

Worldwide Cell Data					
	2008	**2009**	**2010**	**10-09 Change**	**2010 Market Share**
China	2139	4077	10228	151%	43%
Taiwan	712	1553	3965	155%	17%
Europe	1996	2096	3127	49%	13%
Japan	1268	1503	2182	45%	9%
U.S.	401	580	1116	92%	5%
ROW	610	1506	3280	118%	14%
Total	7126	11315	23898	111%	100.0%
% C-Si	86%	83%	87%		

With world production established, let's next examine the individual companies that are the world's largest manufacturers. Although actual data is not presented, the results from Reference 1 show again the denomination of the Chinese and Taiwanese in the top spots. Only one U. S. company, First Solar is in the list and it is ranked at number 3. It is noted that the majority of the cells produced by First Solar are not made in the U. S.

U.S. PV Manufacturing Statistics

Now let's examine the U.S. manufacturers in more detail. The following Table 2 presents the top nine U.S. manufacturers for 2007, 2008, 2009 and 2010 (Reference 1).

Table 2 - U.S. Cell Production (Mega watts = MW)

		2007	2008	2009	2010	% Change
Solarworld	CA	35	33	72	251	249%
First Solar	AZ	120	147	153	222	45%
Suniva	GA	0	0	16	170	963%
Evergreen Solar	MA	16	27	105	158	50%
United Solar	MI	47	112	120	120	0%
Solyndra	CA	0	2	30	67	123%
BP Solar	MD	28	28	-	-	-
Schott Solar	NM	9	11	-	-	-
Global Solar	AZ	4	7	-	-	-
Other		10	77	84	128	-
Total		269	444	580	1116	92%

Next the PV installations in the U.S. by state for 2008, 2009, and 2010 are presented in Table 3 (Reference 2).

Table 3 – Top 10 States of PV Installations (MW)

State	2008	2009	2010	10-09 Change	2010 Market Share
CA	178.7	212.1	258.9	22%	29%
NJ	22.5	57.3	137.1	139%	16%
NV	14.9	3	61.4	1947%	7%
AR	6.4	21.1	54	156%	6%
CO	21.7	23.4	53.6	129%	6%
PA		3.4	46.8	1276%	5%
NM		1	42.8	4180%	5%
FL	0.5	35.7	35.2	-1%	4%
NC	4	7.8	30.7	294%	3%
TX		4	22.6	465%	3%
Others	38.6	34.7	135.2	290%	15%
Total	287.3	403.5	878.3	18%	100.0%

The above Tables show the international and national PV manufacturing and application trends. The data is summarized as follows:

- China has emerged as the world leader in both cell and module manufacturing with a production of 10,228 MW or 43% of the world share. The U.S. is ranked 5th with 1116 MW or 5% of the world total, a ranking that has remained the same for the past 4 years.

- Crystalline silicon remains the top world choice at 87% (up from 77% in 2009).

- There is only one U.S. PV company, First Solar, at #3 in the top 15 of the world production companies.

- In 2010, California remains as the location with the largest installed capacity at 258.9 MW or 30% of the U.S. market share. New Jersey is second at 137.1 MW. Florida ranks 8th at 35.2 MW following from 3rd in 2009.

Over the past three years, Florida has had numerous announcements of proposed PV manufacturing facilities, but no large scale plant has transpired. As reported above, applications have slightly dropped with the three FPL solar plants being put in production about two years ago. In addition, there have been publicized announcements concerning major PV projects in central and north Florida, but these announcements have not led to ground breaking and many PV experts question the economics of the proposed installations.

With these comments made, how does Florida become a player in this arena? History has shown a strong market can eventually lead to manufacturing and ,thus, the Florida opportunity.

Florida Options

Florida imports almost all of its energy resources. Thus, the citizens of Florida pay $27 billion for electricity and $30 billion for gasoline giving a total output of $50 billion/year. Of this total, one-half leaves the state or Florida consumers lose an estimated $24 billion per year. These facts lead to two challenges – How can Florida reduce its energy costs and how can Florida's electricity power plants and transportation fuel be manufactured in Florida? In other words, can we design an energy future which allows Florida to keep this money and in return allow us to make the profits and increase jobs. We believe that Florida's future can evolve which allows for this vision.

First let's talk about jobs produced by the energy industries. Data shows that PV produces 23 jobs/MW, wind is 8 jobs/MW, nuclear is 4 jobs/MW, natural gas is 3 jobs/MW and coal is 0.5 jobs/MW. Since Florida can produce very little to no manufacturing in wind, nuclear or coal, the only possible manufacturing for Florida is PV. The key to manufacturing is to have both a magnet and a demand. How does Florida create both of these?

Starting with the magnet, Florida is positioned to be a magnet because of it winning the DOE funded PV Manufacturing Consortium (PVMC) program. Florida is teamed with SEMATECH of New York who is the prime and who won the DOE program (PVMC is a $50 million effort) (see Figures 1 and 2). For the SEMATECH program, Florida's task is crystalline silicon R&D which, as mentioned above, is the dominate cell material at 87%. In the Florida PVMC program, a existing 100,000 ft2 semi-conductor facility has been dedicated to PVMC (see Figure 3). However, the facility needs to be re-furbished and to have a crystalline silicon pilot manufacturing assembly line installed. Once the pilot facility is established, the probability is very high for national PV manufacturing firms to become pilot facility users and then to follow with plants in a nearby location. This is the magnet.

Figure 1: PVMC Program

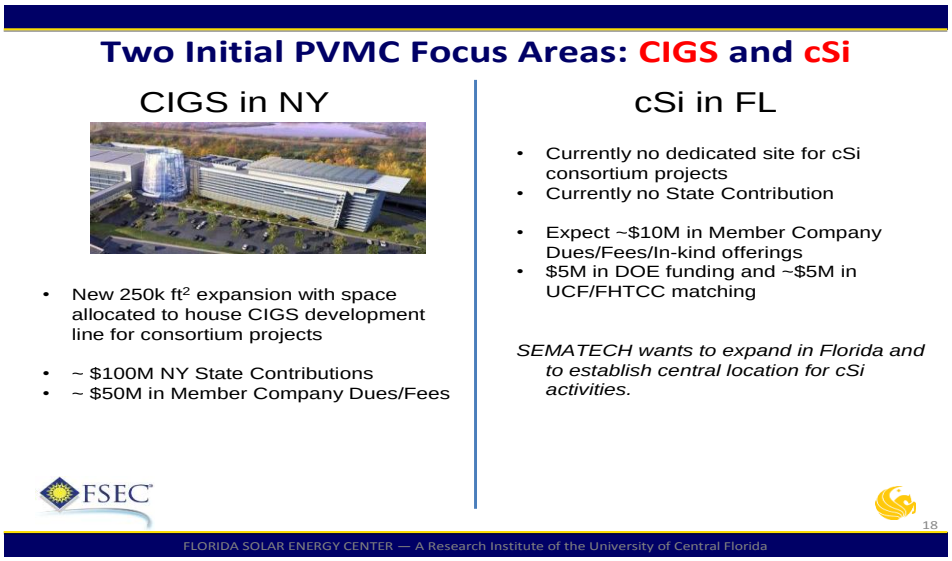

Figure 2: PVMC Focus Areas

Unique Opportunity for Florida….

- SEMATECH *must* establish a PVMC Center for cSi Consortium Projects.
  - 30 MW cSi cell and module *manufacturing*-scale lines
  - Critical value-added element of PVMC for industry, houses consortium and member company projects.
- Florida strategically positioned to establish the PVMC Center in our state.
- 100,000 ft^2 site already available in Palm Bay, FL

- With state/local funding, Florida can establish itself as *the U.S. Hub for cSi manufacturing*.
- Aside from job creation, this will put Florida on short list of relocation sites for all PV manufacturers.

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FLORIDA SOLAR ENERGY CENTER — A Research Institute of the University of Central Florida

Figure 3: UCF Facility at Palm Bay

The second need is demand. To create a demand a concept is proposed that we have called a "game changer". This concept is based on electric vehicles for our future. At this time, 26% of all Florida vehicles are small cars. And, the new electric motor drive cars, like the Nissan Leaf or plug-ins like the Chevy Volt, give us a whole new option to consider. How does electricity compare to gasoline in cost? Using the efficiency of a 33 mpg car, one kWh of electricity will produce 3 car miles for an equivalent electric car. Changing these numbers into cost values, an internal combustion vehicle cost 10.6 cents per mile to drive while the electric car costs 5.6 cents per mile. These numbers are for gasoline at $3.50 per gallon and for PV electricity at 16.8 cents per kWh (see Figures 4 and 5). Thus, the cost to drive the PV powered electric car is less than half that of the gasoline car. This supplies the demand.

If Florida was to change all its small cars to electric or hybrid cars, we could save 1.8 billion gallons of gasoline. We will have to pay for small car's electricity, but this change will still save $3.2 billion in fuel costs per year. This change will also give the need for 15 billion more KWh (15 TWH) or 4 more electric power plants.

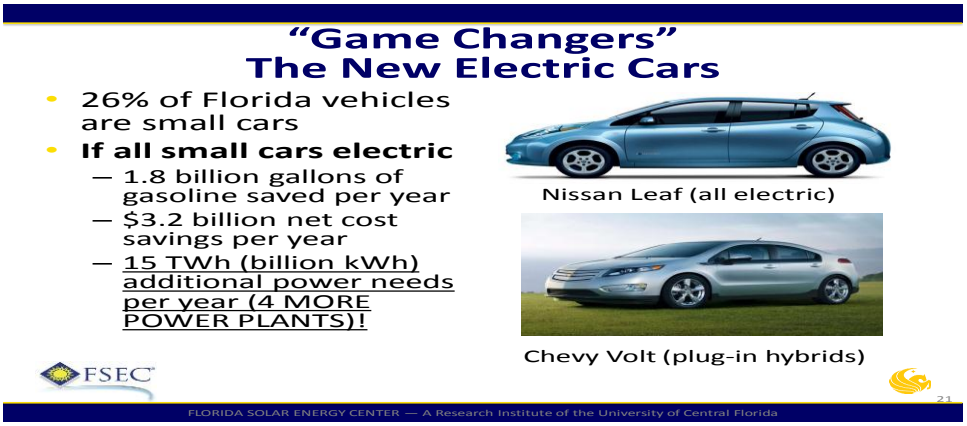

Figure 4: Electric Vehicles

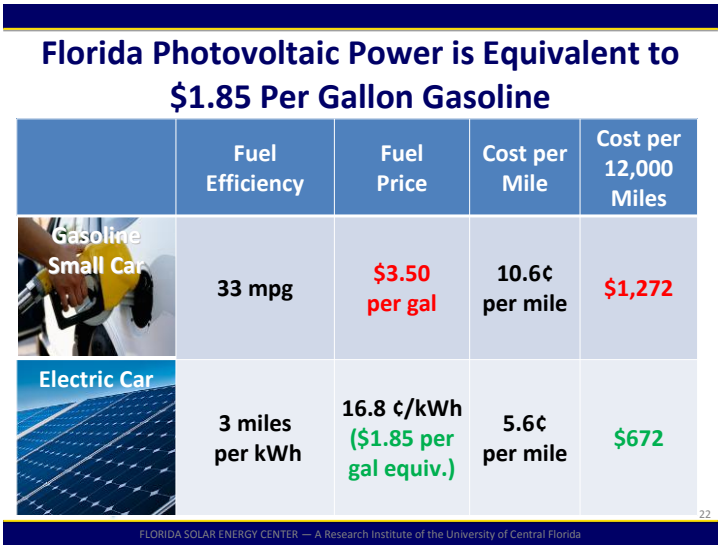

Figure 5: Electric Costs

References:

1. The Solar Industries Monthly Market Monitor, PV News, Vol. 30, No. 5, May 2011.

2. U. S. Solar Market Insight, 1st Quarter 2011, Solar Energy Industry Association, April 2011.