

The Opportunities and Challenges of the Pennsylvania RPS— A Solar Cell Manufacturer's Perspective

**Richard Rosey
Vice President Marketing & Sales
Solar Power Industries, Inc.**

**Penn State University--Sixth Goddard Forum
January 30-31, 2006**

SPI's Perspective

- The Opportunity
- The Challenges
- PV Market Overview
- PV Module Supply Chain Issues
- Solar Power Industries Background
- Addressing the Challenges

The Opportunity

- The AEPS will result in 400-600 MW of solar generating capacity in PA by 2020
 - Support 14,000 jobs, with one-third in PA
 - Significant environmental benefits
- SPI can be a major supplier of PV modules to enable successful implementation of the AEPS

The Challenges

- Competitive market is outpacing supply
 - Strong market growth in Europe
 - Germany feed in tariff created strong market
 - Other countries following the Germany model--Spain, Italy
 - Asian market is awakening
 - China incentives put in place January 2006; 8,000 MW by 2020
 - South Korea 15 yr feed in tariff of 0.58 euro
 - Domestic market—other states very lucrative incentives
 - California Solar Initiative—
 - 3,000 MW, 11 yr, \$3.2 B incentive program
 - Massachusetts, New Jersey, et al
- Silicon supply is not keeping pace with market growth
 - Long term supply contracts with significant “upfront \$\$\$”
 - Shortage + Increasing Prices = Increased PV module cost

PV Market Overview

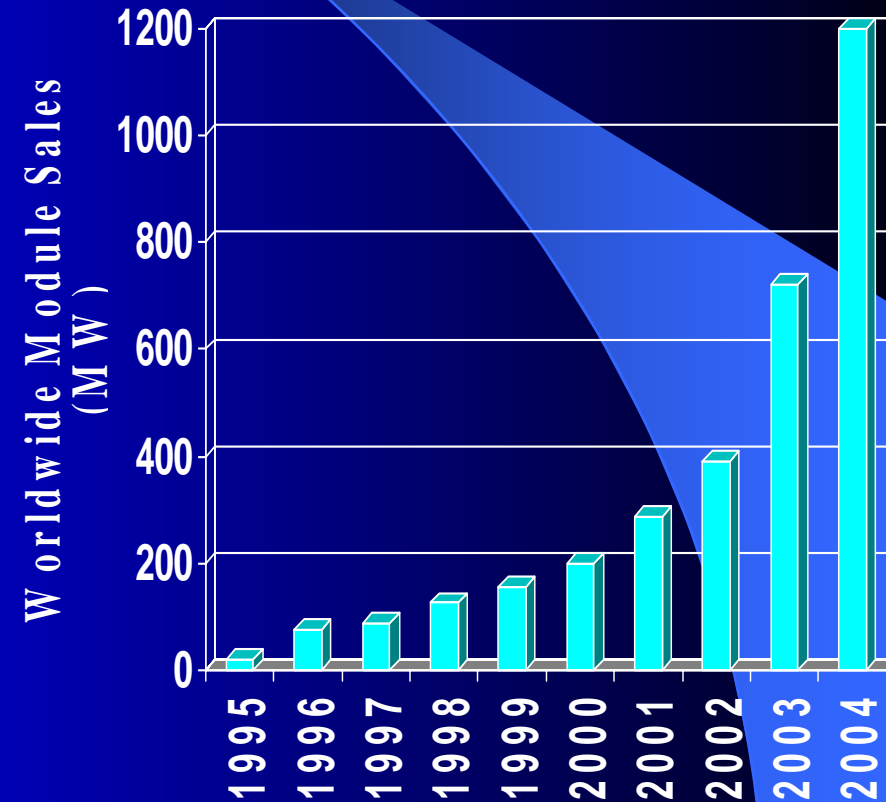
- 25-30% CAGR forecast through 2010 (\$19 B sales)
 - PV production 1,200 MW in 2004 (\$6.5 B sales)
 - 60% growth over 2003
 - 34% CAGR for past 10 years
 - PV production est. at 1,700 MW in 2005 (*PV News)
 - > 40 % growth over 2005
 - Maintained despite silicon shortages and higher prices
- 40+ solar cell manufacturers
 - 50 % of market supplied by top 4 producers
 - Most manufacturers have excess capacity
 - Production limited by silicon/wafer supply
- 94% of the market is silicon based solar cells

3 Countries Account For 85% of Global Installed PV Capacity

- Japan
 - 1,100 MW installed through 2004
 - 4,800 MW goal for 2010
 - 3 of top 5 cell manufacturers located in Japan
- Germany
 - 800 MW installed through 2004
 - Annual rate of installations overtook Japan in 2004
- United States
 - 300 MW installed through 2004—predominantly California

Top 10 Solar Cell Producers Captured 80% of the 1.2 MW 2004 Market

Rank	Company	2003	2004
1	Sharp	197.9	324.0
2	Kyocera	72.0	105.0
3	BP Solar Group	70.2	85.8
4	Mitsubishi Electric	40.0	75.0
5	Q-Cells	28.0	75.0
6	Shell Group	77.0	72.0
7	Sanyo Electric	35.0	65.0
8	RWE Group	44.0	65.0
9	Isophoton	35.2	53.3
10	Motech	17.0	35.0



Major Solar Cell Manufacturers Executed Significant Expansions in 2005

- 84 companies with 111 factories in 30 countries
- Cell production capacity does not restrict market growth
- Installed capacity of twenty largest cell producers exceeds 2,500 MW
- PV Industry largest growth sector is in China
- Similar capacity expansions planned for 2006

Major Polysilicon Suppliers Production-Metric Tons

Supplier	Country	2004	2005(E)	2006(E)
Hemlock	US	7,000	7,700	10,000
Wacker Polysilicon	Germany	5,000	5,000	5,500
Tokuyama	Japan	4,800	5,200	5,400
REC (ASIMI,SGS)	US	4,800	5,400	6,000
MEMC	US & Italy	3,700	3,700	5,180
Mitsubishi Material	Japan	1,600	1,600	1,600
Mitsubishi Polysilicon	US	1,200	1,200	1,200
Sumitomo Titanium	Japan	700	700	700

Silicon Ingot/Wafer Production Is Dominated By A Few Companies

- “Independent” sources of wafers is limited
 - 4 companies—42% of 2004 PV market
 - 185 MW PV Crystalox (Germany/UK)
 - 130 MW ScanWafer (Norway)
 - 120 MW Deutsche Solar (Germany)
 - 80 MW M.Setek (Japan)
 - Marketing/Sales now via long term (10 yr) contracts
 - Well established links to major independent cell producers
- Vertically integrated companies
 - In-house production for own use—26% of 2004 PV market
 - 105 Mw Kyocera
 - 80 MW BP-Solar
 - 72 MW Shell Solar
 - 53 MW Isophoton

Polysilicon Supply Will Not Keep Pace With PV Solar Cell Demand Through 2006

- Supply fell short of demand by 30% in 2005
 - Supply shortage initiated in mid-2004
 - 2005 Production increase 4.2% vs Demand growth of 11.1%
 - Primary forecast demand increase due to PV use (up 25%)
 - Will continue to worsen in 2007
- Major silicon suppliers are slow in expansion commitments
 - 18-24 month lead time for major plant expansions
 - \$250-500 M for 5,000 Ton capacity increase
- Continued silicon price increases threaten PV economic benefits
 - Silicon wafer represents 30-35% of PV module cost
 - Spot market prices have quadrupled since 2004 (\$25/T to \$100/T)
 - Prices will continue to rise through 2006

Polysilicon Supply To Solar Industry Is Forecast To Be In Balance By 2010

- Typical silicon feedstock utilization: 11-14 T / MW
 - 2004 solar consumed 45% of silicon sold
- 2005 silicon production estimated at 31,000 T
 - 16,000 T usage by the solar industry
 - 1,330 MW @ 12 T/MW
 - Approx. 4,800 T shortfall to meet solar demand
- 2010 forecast production estimated at 50,000 T
 - Assumes new sources will supplement plant expansions
 - 36,000 T available for the solar industry
 - 4,000 MW @ 9 T/MW (30% CGR)

China's Role In The Solar Market Is Still Not Clear

- Strong potential as a silicon feedstock supplier
 - Projected production of 5,000 to 10,000 Tons by 2010
 - Concerns regarding quality
- Significant buildup of ingot and wafer capacity
 - LDK Solar: 200 MW 2006, expand to 400 MW by 2008
 - Major buyers of available silicon feedstock
- Diverging views of end-customer market growth
 - Estimate of 2005 installations—range from 10 MW to 115 MW
 - Expected market of 300-700 MW by 2010
- Attracting significant levels of private equity
 - Suntech IPO on NYSE raised \$400M, market cap of \$3B

Solar Power Industries--Background

- Incorporated October 2003, Investment from *King of Fans*
- Located SW of Pittsburgh—Belle Vernon
- Utilized the assets of former Ebara Solar
- Management/Engineering team average 20+ years PV experience
- Currently 80+ employees
- Integrated photovoltaic manufacturing from silicon to modules
 - 26 MW Silicon Ingot Production Capacity
 - 15 MW Silicon Wafer Production Capacity
 - 25 MW Solar Cell Production Capacity
 - 3 MW Module Production Capacity
- Potential Expansion to 50-60 MW Annual Capacity

SPI Facility



SPI Manufacturing Operations

Wafer Production

- Ingot casting
- Ingot bricking
- Wafer sawing
- Wafer cleaning

Cell Production

- Etching
- Diffusion
- Plasma Etching
- SiN Coating
- Metal printing/ firing
- Testing

Module Assembly

- Interconnect
- Lamination
- Framing
- Testing

SPI Major Countermeasures to Offset Silicon Supply/Price Situation “New Silicon”

- Develop ingot/wafering processes to utilize non-traditional sources
 - Lower silicon purity levels: 5N vs 9N feedstock
 - Cleaned scrap silicon—broken semiconductor wafers, pot scrap, etc
 - New suppliers/processes for polysilicon materials

SPI Major Countermeasures to Offset Silicon Supply/Price Situation “Utilization”

- Increase the utilization of silicon –watts/gm
 - Thinner wafer substrates
 - 320 micron (2004) > 270 micron (2005) > 240 micron (2006 goal)
 - Improve cell performance (Average efficiency)
 - 13% (2004) > 14% (2005) > 15% (2006 goal)
 - Maximize usable wafer size from standard ingots
 - 150 mm square (2005) to 156 mm square (2006) (8% increased area)

SPI Major Countermeasures to Offset Silicon Supply/Price Situation “Collaboration”

- Collaborate with other PV industry companies
 - Utilize customer silicon supply for dedicated wafer/cell production
 - Contract out wafering to offset present ingot casting imbalance
 - Contract out module assembly to maintain competitive pricing