Photovoltaics: Technology Trends and Future Perspectives

Adam Shor
Innovation Scout for Photovoltaics

Presentation to SPREE / UNSW
Sydney, Australia
July 26, 2012
Key Takeaways

• Industry growth around conventional photovoltaics will make it difficult to unseat incumbent technologies in traditional markets
  – Crystalline Silicon PV will remain the dominant technology while other products are developed for specific markets

• Power electronics will be smarter, module integrated, higher efficiency, and enable improved grid support and functionality
  – This will lead to higher efficiency systems combined with easier installation, ultimately yielding improved system economics.

• Improvements across the value chain will result in continuous downward system pricing trends
Historic and Current PV Industry Pricing

Cost Drivers:
- Efficiency Improvement
- Manufacturing Economies of Scale
- Supply / Demand Imbalance
- Subsidized Manufacturing

First tier modules are available for
~$0.85/Wp

Source: Paula Mints – Navigant PV Services Program
Global PV Market Forecast

RECESSION, CONSERVATIVE, ACCELERATED FORECAST
2006-2016 (MWp)

0.0 5000.0 10000.0 15000.0 20000.0 25000.0 30000.0 35000.0 40000.0 45000.0 50000.0

GWp


History/Reduced Incentives 1984.2 3073.0 5491.8 7913.3 17402.7 23579.3 21269.5 18770.0 17863.7 19629.9 21586.3
Conservative 24528.4 25759.0 26798.1 28145.9 29562.5
Accelerated 31518.4 42151.3 42181.7 42633.0 46894.8

Source: Paula Mints – Navigant PV Services Program
Module Production in 2011

• By Technology

- Crystalline Silicon: 30,213, 87%
- CdTe: 2,062, 6%
- CIGS: 866, 2%
- Thin Film Silicon: 1,647, 5%

• By Region

- China: 21,265, 61%
- Rest of Asia: 5,399, 15%
- U.S.: 1,333, 4%
- Europe: 4,815, 14%
- Japan: 1,590, 5%
- RoW: 386, 1%

Source: GTM, PV News, May 2012
Production Costs are Coming Down

MANUFACTURING COST STRUCTURE - TIER 1 CHINESE WAFER/CELL/ MODULE PRODUCER, Q3 2011-Q4 2012E

Source: GTM, PV News, May 2012
Thinner Wafers = Reduced Material Cost

• Twin Creeks Technologies unveils the Hyperion “Ion Cannon” to create thinner silicon wafers.
• Wire saw technology transitioning from traditional wire / abrasive slurry mix to diamond wire cutting, reducing “kerf” losses while improving wafer yield.
Thinner Wafers = Reduced Material Cost

- Twin Creeks Technologies unveils the Hyperion “Ion Cannon” to create thinner silicon wafers.
- Wire saw technology transitioning from traditional wire / abrasive slurry mix to diamond wire cutting, reducing “kerf” losses while improving wafer yield.
Rooftop Specific Technologies for Weight Constrained Projects
AC Modules Will Be Here Shortly

- Streamlined design will lead to inverters on the module, leading to higher efficiency, faster Installation, and improved economics.
The Onset of the Smart Inverter

• Improving Grid Reliability
  – Inverter able to ride through momentary interruptions

• Providing VAR Support
  – Finer steps and faster response compared to capacitor banks

• Power Curtailment
  – Faster Response for power curtailment
Distributed PV Ownership Also Growing

- Third-party owned PV gaining market share in multiple markets
- Distributed PV economics depend on incentives, retail rates and rate design, e.g., net metering
- Third party residential PV markets growing rapidly, > 60% market share in CA in 2012
- PV leasing products appear to be enticing new demographics to adopt PV in LA
- Third-party adoption trends likely to extend to other states

Source: Drury et al. 2012 (NREL)
Performance Improvements and Market Enablers for Conventional PV

• Transition to rear contact cells (reduced front shading)
• Copper metallization in lieu of silver
• Cheap tandem cell architecture based on crystalline – Silicon cell foundation
• Selective emitters (improved blue response, better able to absorb high energy photons)
• Gen 110 (*Startup designed to identify high rate customers for third party installations*)
• Third Party leasing via no upfront costs
• Breakthrough technologies exist… but constrained to lab development through 2020
Low Concentration PV
Third Generation PV

- Third Generation (High Efficiency, Multi-junction, Multi-exciton, Hot Carrier Cells)
  - More involved cell architecture, primarily research based currently with the exception of multi-junction (MJ), significantly higher efficiencies
Key Takeaways

• Industry growth around conventional photovoltaics will make it difficult to unseat incumbent technologies in traditional markets
  – Crystalline Silicon PV will remain the dominant technology while other products are developed for specific markets

• Power electronics will be module integrated, smaller, higher efficiency, and enable improved grid support and functionality
  – This will lead to higher efficiency systems combined with easier installation, ultimately yielding improved system economics.

• Improvements across the value chain will result in continuous downward system pricing trends
Together…Shaping the Future of Electricity