The State of the PV Industry - An Association Perspective

Karen Savala President, SEMI Americas





Outline

- About SEMI & PV Group
- Semiconductor & PV
- Global Energy Market & Renewables
- Global PV Market
- U.S. PV Market
- The Importance of Standards
- Call for Action



About SEMI

- Global industry association w/ offices in US, Belgium, Germany, France, China, Taiwan, Singapore, Korea, Japan, Russia, and India
- 1900+ member companies (480+ PV)
- Established 1970 to serve the semiconductor supply chain
- Today serves members in:
 - Semiconductor, Photovoltaic, Flat Panel Display, Emerging Markets – MEMS, LED/SSL, Printed Electronics, and Nanotechnology
- Governed by Board of Directors with extensive advisory committee and Special Interest Group (SIG) structure





SEMI PV Group

Formed to represent SEMI member companies involved in the solar/PV manufacturing supply chain.





Our Focus is PV Manufacturing

- Leverage semiconductor's existing core competencies in order to create a long-term sustainable market through:
 - Supply chain collaboration & roadmapping activities (ITRS model)
 - International standards development
 - Global public policy and advocacy
- Expand the market while continuing to drive down costs
- Achieve the carbon reduction goals proposed by many nations





PV Group's Global Scope



- More than **480 global companies** form PV Group, many of them with history and expertise in semiconductor manufacturing
- More than 160 SEMI PV Group member companies reside in the United States
- Advisory Committees established in Europe, North America, China, India, Taiwan and Korea; Japan in formation
- Our member companies cover the PV manufacturing supply chain from feedstock to module assembly and balance of systems



SEMI is Governed by an International Board of Directors

Energy/PV Solar Standing Committee

- M. Splinter, President & CEO, **Applied Materials** Committee Chair
- T. Higashi, Chairman & CEO, **Tokyo Electron Ltd.**
- S. Kohyama, President & CEO, **Covalent Materials Corporation**
- G. Rauter, COO, **Q-Cells**
- Z. Shi, Founder, Chairman & CEO, **Suntech Power Holdings**
- E. Weber, Director, Fraunhofer-Institute for Solar Energy Systems



And by Regional Advisory Committee Members...





Semiconductor & PV: Leveraging Similarities, Understanding Differences



Leveraging Similarities Between Semiconductor & PV

- PV is a semiconductor technology that will benefit from chip industry experience because of similarities in:
 - Materials
 - Processes
 - Process Integration
 - Equipment
 - Yield
 - Productivity
 - Innovation
 - Learning Curve Acceleration





Cost Reduction: Chips vs. PV



Opportunities for Collaboration



SEMI PV Standards in the PV Manufacturing Supply Chain



crystalline silicon example

Why Standards?

- Define interfaces (hardware and software)
- Clearly characterize materials
- Improve supply chain communication
- Optimize environment, health and safety

Enabling these Benefits

- Cost reduction
- Focus on product differentiation
- Acceleration of product development
- Accepted verification procedures



Global Energy Market Renewables and PV



Solar Today: 0.08% of Our Energy



Note: Sum of components may not equal 100% due to independent rounding. Source: U.S. Energy Information Administration, *Annual Energy Review 2009*, Table 1.3, Primary Energy Consumption by Energy Source, 1949-2009 (August 2010).



Solar in the Future: A Major Energy Source



The Global PV Market



The Global PV Climate

In Crystalline Silicon

- China and Taiwan C-si manufacturers gained a huge market share
- 2009: 6 of top 10 silicon cell manufacturers are Chinese
- European, American, Japanese companies lost market share as a result of extremely competitive pricing
- European/American firms outsource production to Asia to cut costs

In Thin Film

- Polysilicon price drops make c-Si a lot more competitive
- Cheap, abundant and mature c-Si modules cause:
 - Pricing pressure, margin squeezes, low utilization
- Manufacturers still finding it tough to commercialize high-throughput processes



Source: GTM Research

Global PV Demand Markets (GW)



Major PV Country Markets 2010 (GW)

Global PV Installations





World cumulative PV

Europe leads the way with

~16 GW (70%)

Japan (2.6 GW)

US (1.6 GW)

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power installed

Cumulative Global PV Installations



Figure 1 - Historical development of World cumulative PV power installed in main geographies

China makes its entry into the top 10 as a major contender in manufacturing



Supply and Demand



PV Manufacturing Growth



Source: Prometheus Institute

Production Growth 2005 to 2010







Source: Prometheus Institute

Regional Market Growth - Driven by Policy

Japan - grid-connected applications stimulated by market incentive programs and reintroduction of feed-intariffs (2009)

> Germany - The largest on-grid market demand stimulated by feed-in tariffs. (Reduced in 2010)





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Drivers in the Market

- Renewable energy policy aimed at reducing CO₂ emissions may help solar deployment and job creation.
 - China = Golden Sun policy
 - India = National Solar Mission
 - Japan = revived residential feed in tariff program
 - Korea = Green Korea plan
 - U.S. DoE has recently unveiled "SunShot" program
- And, demand is driven by:
 - Consumer support for renewable energy
 - Highly dependent on either "being green" or educated about RE or both
 - Increasing electricity rates encourage alternative sources of energy.
 - A Trained Workforce
 - Availability of qualified installers, financial experts, system integrators, project managers, and other high tech workers



Module Price Index 2006-2010



Key Drivers for Cost Reduction -Materials Consumption



- Material cost account, depending on the technology, for 50–70 % of the total cost. In addition to location factors, biggest influence on cost reduction!
- Material costs per Watt can be influenced directly by reducing the consumption of material and indirectly by increasing the conversion efficiency.



Source: Manz Automation AG

The U.S. PV Market



U.S. PV Manufacturing



Source: Greentech Media Research and The Prometheus Institute

3TM PESEARCH SEPTEMBER 2009



Top States for Utility-Scale PV Development in the U.S.



Every state constitutes its own unique PV market with its own set of incentives, solar generation requirements, electricity prices, and regulatory traits.

Source: Greentech Media Research



The U.S. Market

• U.S. government policies still need lots of work

- The large number of state created policy initiatives fragmented regulations and incentive environment but states are stimulating their own local markets
- Federal incentives will play a larger role in stimulating demand

• U.S. Share of Renewable Electricity Is Expected to Grow

- The U.S. Energy Information Administration (EIA) projects that renewablegenerated electricity will account for 17% of total U.S. electricity generation in 2035, up from 9% in 2008.
 - Growth driven by the extension of Federal tax credits and the loan guarantee program in the American Recovery and Reinvestment Act (ARRA).



U.S. Policy Overview

• Solar Manufacturing Tax Incentives

- American Recovery and Reinvestment Act (ARRA) included a competitive tax credit capped at \$2.3 billion in total tax expenditures for advanced energy manufacturing projects (new code Section 48C). This program encouraged domestic manufacturing and helped to create jobs.
- Solar Manufacturing Jobs Creation Act Legislation to include equipment used to manufacture solar energy equipment under Section 48 of the commercial Investment Tax Credit (ITC). The bill would allow a 30% credit for investments in equipment placed in service in U.S. manufacturing facilities before January 1, 2017.

• **PV** Group advocates in the US for extending:

- Advanced Energy Manufacturing Tax Credit (MTC)
- Section 1603 Grants in lieu of credit program
- And for enacting:
 - Renewable Energy Standard (RES) of 20% by 2020
 - Establishment of a "Green Bank"



PV Group Efforts in the U.S.

- We work through a network of supply chain stakeholders Advisory Committee, subcommittees and partnering organizations to
 - Identify and tackle manufacturing cost drivers
 - Lend a strong industry voice on key issues on Capitol Hill
 - Define best practices in EHS and sustainability
 - Forge strategic alliances with other organizations
 - Share current, credible market information
 - Strive to maintain free and open trade environments
- Advisory companies include: SunPower, First Solar, Oerlikon Solar, SolarWorld USA, BP Solar, Applied Materials, Matheson, DuPont, Dow Corning, KLA-Tencor, and many others



The Importance of Standards



Standardization...

- Enables repeatability, scalability
- Helps achieve cost reductions and process efficiency goals
- Reduces hidden & soft costs behind every PV transaction as fixed costs become less of a factor (modules, inverters, BoS)
- Standardization enables scalability (Customization limits it)
 - Find a way to strike a balance between standardization and differentiation





Source: SolarTech

The Need for PV Standards

- The PV industry has few standards to support the manufacturing process
- The PV market is growing rapidly, with many new companies entering the manufacturing supply chain
- Different applications and processes lead to diverse manufacturing challenges –this is where industry standards can play a critical role by:
 - Bringing the global supplier and customer communities together
 - Collectively streamlining the number of options in a given process
 - Agreeing on common parameters and terminology





Companies Involved in Developing SEMI PV Standards

6N Silicon Inc a2peak power Co...Ltd. Accademia Europea Bolzano acp-IT AG Adema Technologies Inc advanced clean production Information Tech Air Liquide **Air Products** Air Products and Chemicals. Inc. AIS Automation Dresden GmbH AIST **Applied Materials Applied Spectra, INC** Asahi/America, Inc. Ascari Limited Atelier Ishikawa ATMI BayTech Group BEIJING SEVENSTAR ELECTRONICS CO.LT Bosch Solar Energy AG **BP Solar Brewer Science Bruce Technologies Inc BT** Imaging CA Solar camLine **Canon ANELVA Corporation** centrotherm photovoltaics Asia Centrotherm Thermal Solutions GmbH + Co. C-Gerhards GmbH i.G **CH2M Hill**

Chroma ATE INC CI Industrial Safety Consulting, LLC CiS Forschungsinstitut für Mikrosensorik un CMS/ITRI **Conexant Systems** Cook Engineering, Inc. **Covalent Materials Corporation** Daewon SPIC **Daihen Corporation** Dainichi Shoji K.K. DAINIPPON Delsolar **Despatch Industries** Deutsche Solar AG **Dow Corning DuPont De Nemours International S.A. DuPont Teijin Films ECN Solar Energy Energy Innovation Associates** ENspring Entegris, Inc. **Evans Analytical Group** Ever Energy Co. Ltd. **Evergreen Engineering** Exponent Inc. Fraunhofer Freibera Fuji Electric Advanced Technology Co., Ltd. **GEASOL** Itd **Gintech Energy Cooperation Gnostic Systems**

Gnostic Systems GTsolar **Haas Training Solutions** Hager + Elsässer Heltina AG Hemlock Semiconductor Corporation Hirata Corporation Hitachi Kokusai Electric Inc. Hong Ming Technology Co., Ltd. Hvnix Semiconductor Inc. IAPMO ICL Performance Products LLC IE&S GmbH IIT Roorkee Industrial Technology Research Institute InnoLas Semiconductor GmbH InReCon AG Institut für Solarenergieforschung Instituto Tecnologico Superior de Irapuato ITRI Japan Radio Co.,Ltd. Japan Solar Silicon JC's Chunson Limited Jonas&Redmann Automationstechnik GmbH **KANEKA CORPORATION** KesslerConsult **KEYENCE** King Design Industrial Co., Ltd. **KLA-Tencor**





Companies Involved in Developing SEMI PV Standards

Korea Institute of Lighting Technology Lanco Solar Pvt Ltd Lewis Bass International Inc LG Electronics, Inc. LG. Display Linde LLC M+W Zander FE GmbH Malema Engineering Manz Automation AG Materials & Metrology Matheson Tri-Gas **MEMC Electronic Materials, Inc. Meyer Burger AG** Micronit **Mitsubishi Electric Corporation** Mitsubishi Heavy Industries,LTD Mitsuishi Bussan Corporation Limited Mizuho Information & Research Institute, Inc MOSERBAER PHOTOVOLTAIC LIMITED Motech (Solar Division) Nippon Steel Corp. Nisshinbo Mechatronics Inc. NIST **Nokia Siemens Networks** NREL NS Solar Material Co., Ltd. NSN **OC Oerlikon Balzers AG** OCI

Omron **Op-tection GmbH** OptiSolar **Orient Service Corporation** Pall Corporation Parker Hannifin PEER Group GmbH Polar Star Research, LLC Prediktor AS **PVTC/ITRI** Q-Cells SE QSES Inc. **R.A.Smythe, Management Consultants RAPT Industries. Inc. Raytex Corporation REC Silicon RENA GmbH** Roth & Rau - Ortner GmbH **RTS** Corporation Safe Techno Limited Salmon Leap Associates India (p) Ltd Salus Schott Solar AG Semilab Semisol SEMITRAC Sentech Instruments GmbH Sigma-Aldrich Silicon Solar Siliken Chemicals SINTEF Materials and Chemistry Sinton Instruments

SITEX 45 SRL Sixtron Advanced Materials Solar World SolarTech Solland Solar Cells GmbH SPIL SUMCO Sunicon AG Suntech Power Holdings Co., Ltd. Swagelok Tainergy Tech Co., Ltd TAIYO NIPPON SANSO CORPORATION The Scatter Works. Inc. **TNO Industrie en Techniek Tokuyama corporation** Tokyo Electron Ltd. Toray Research Center, Inc. **Tronic International Pte Ltd** TUV ULVAC Underwriters Laboratories Taiwan UNI3 Ssytem Co., Ltd. Universidad Carlos III de Madrid University of Oxford Voltaix, LLC VOC Wacker Chemie AG Yaskawa Electric Corporation sem

PV Standards Developing Organizations

Application of International Standards in the Photovoltaic Industry



SEMI PV Standards Organization



Next PV Standards Committee and Task Force Meetings 2011

- Europe
 - March 22-23, PV Fab Managers Forum, Berlin, Germany
- North America
 - March 29-30, SEMI HQ office, San Jose, California
- Japan
 - April 12, SEMI Japan office,
 - Tokyo
- Taiwan
 - 2nd week of April, ITRI in Hsinchu





Get Involved with SEMI PV Group!

How to Get Involved

Become a Member!

- Join a PV Standards Committee
 - More than 500 Standards Committee Members active in Europe, North America, Taiwan, and Japan
- Support PV Public Policy
 - Support through SEMI Washington, D.C. and other regional offices
 - PV market is policy driven, members need information on how to navigate available funding, tax credits, etc.
 - Work with other PV associations to align positions wherever possible
- Join in Industry Collaboration & Roadmapping Efforts
 - Roadmapping efforts continue in Europe and the U.S.
 - Working with US Department of Energy, European cell makers, labs and universities to determine what "collaboration platform" should look like

• Advocate for PV EH&S/Sustainability

- Monitor legislation on RoHS, REACH
- Monitor key issues such as Conflict Minerals and Rare Earth Minerals
- Participate in PV Equipment Book to Bill Data Collection Program
- Attend a PV Group Event
 - May II PV Industry Luncheon
 - July 2011 Intersolar North America, NA PV Fab Managers Forum

Thank you!

For more information visit: www.pvgroup.org