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

Teaching students about solar energy

Providing a voice for the solar industry

Public Policy
White Papers
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...

(Partial List)
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

**PV's Unique Challenges:**
- Policy driven
- Industry structure (vertically integrated, turn-key systems, etc.)
- Deployment bottlenecks
Cost Reduction: Chips vs. PV

- Productivity Improvement → 10-30% Reduction Yearly
- Improved Yield → 10-15% Yearly

Future Cost Reductions Will Come from:

- Process Cost Reductions
  - Economies of Scale
  - Materials
  - Automation
- Improved Cell Efficiency
  - Cell Structure
  - Process and Materials Innovation

Module Cost ($/W)

Cost $/W
- $6.07/W
- $4.9/W
- $3.89/W
- $2.7/W

Average Transistor Price by Year

Source: Int'l WSTS, August 2007

Together, we can change the world.
Opportunities for Collaboration

Efficiency Drivers
- New Module Materials
- Precision Alignment
- Materials Systems Integration

2007-2008
Standard Cells
16 – 17 %

2009-2012
Advanced Cells
17 – 21 %
- Multiple printing
- Selective emitter
- Advanced passivation
- Enhanced texturing
- New Tedlar® backsheet
- Improved encapsulant
- Low cost installation

2012-beyond
Next Generation Cells
22+% - 25%
- Customized metallization
- EWT/ MWT metallization
- Tedlar® sheet
- Integrated Tedlar® backsheet
- Novel encapsulation

Source: Applied Materials, DuPont (ISS US)

Together, we can change the world.
SEMI PV Standards in the PV Manufacturing Supply Chain

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

crystalline silicon example
Global Energy Market
Renewables and PV
Solar Today: 0.08% of Our Energy

U.S. Energy Consumption by Energy Source, 2009

Total = 94.578 Quadrillion Btu

- Petroleum 37%
- Natural Gas 25%
- Coal 21%
- Nuclear Electric Power 9%

Renewable Energy 8%

- Solar 1%
- Geothermal 5%
- Biomass waste 6%
- Wind 9%
- Biofuels 20%
- Wood 24%
- Hydropower 35%

Total = 7.744 Quadrillion Btu

Note: Sum of components may not equal 100% due to independent rounding.
Solar in the Future: A Major Energy Source

Forecast of the German Scientific Advisory Board

Yearly use of primary energy [EJ/a]

- Other Renewable
- Solar Thermal
- Solar Power (PV and Solar Thermal Power)
- Wind
- Biomass
- Water
- Nuclear
- Gas
- Coal
- Oil

Source: solarwirtschaft.de
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)

Germany: 6.60
Italy: 1.30
USA: 0.97
Japan: 0.62
Czech...: 0.40
Belgium: 0.33
China: 0.48
France: 0.62
Spain: 0.103
S Korea: 0.117

Leading European PV Markets

Source: Solarbuzz
Global PV Installations

Market Share of New PV Installations by Region

Source: IMS Research - Global PV Demand Database Q4’10 www.pvmarketresearch.com
Cumulative Global PV Installations

World cumulative PV power installed

- Europe leads the way with ~16 GW (70%)
- Japan (2.6 GW)
- US (1.6 GW)
- China makes its entry into the top 10 as a major contender in manufacturing

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

2009 Shipments (not including 2008 inventory)
- Rest of World (primarily China): 51%
- Europe: 25%
- Japan: 17%
- North America: 7%

2009 Demand (based on Sales to first point of sale)
- Europe: 76%, (primarily Germany)
- North America: 10%
- Rest of the World: 9%
- Japan: 5%

Source: Navigant (ISS US)
PV Manufacturing Growth

Source: Prometheus Institute

Number of Active Manufacturing Facilities - 2005 vs. 2010

- Crystalline Si
- CdTe
- CIGS
- Amorphous Si
Production Growth 2005 to 2010

Top 5 Cell Manufacturers - 2005

- Sharp: 428
- Q-Cells: 166
- Kyocera: 142
- Sanyo: 125
- Mitsubishi Electric: 100

Top 5 Cell Manufacturers - 2010

- First Solar: 1,011
- Suntech Power: 704
- Sharp: 595
- Q-Cells: 581
- Yingli Solar: 525

Source: Prometheus Institute
Regional Market Growth - Driven by Policy

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

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

Source: EuPD Research
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.
The U.S. PV Market
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 renewable-generated 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., Ltd.
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
Dupon de Nemours International S.A.
Dupon Teijin Films
ECN Solar Energy
Energy Innovation Associates
Enspring
Entegris, Inc.
Evans Analytical Group
Ever Energy Co. Ltd.
Evergreen Engineering
Exponent Inc.
Fraunhofer
Freiberg
Fuji Electric Advanced Technology Co., Ltd.
Geasol ltd
Gintech Energy Cooperation
Gnostic Systems
Gnsotia Systems
GtSolar
Haas Training Solutions
Hager + Elsässer
Heltina AG
Hemlock Semiconductor Corporation
Hirata Corporation
Hitachi Kokusai Electric Inc.
Hong Ming Technology Co., Ltd.
Hynix semiconductor Inc.
Iapmo
Icl Performance Products LLC
Ie&S Gmbh
II T 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 automationtechnik 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
Mitsubishi 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 Ssytet Co., Ltd.
Universidad Carlos III de Madrid
University of Oxford
Voltaix. LLC
VQC
Wacker Chemie AG
Yaskawa Electric Corporation
PV Standards Developing Organizations

Application of International Standards in the Photovoltaic Industry

- Equipment
- Parts
- Material
- Cell Manufacturer
- Module Manufacturer
- PV System Manufacturer
- Market & End-User

SEMI
IEEE
DIN
ASTM
Cenelec
IEC
ISO
UL

Together, we can change the world.
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 11 PV Industry Luncheon
  • July 2011 – Intersolar North America, NA PV Fab Managers Forum
Thank you!

For more information visit: www.pvgroup.org