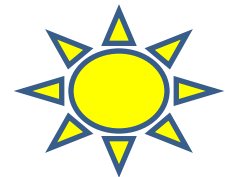


THE SOLAR ENERGY INDUSTRY: CURRENT STATUS AND FUTURE CHALLENGES

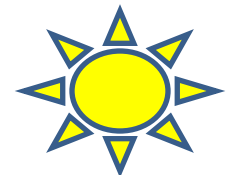
Gerald I. Susman
Smeal College of Business
Pennsylvania State University

Sustainability Conference
Washington, DC
October 13, 2009



SUPPLY/DEMAND FOR SOLAR ENERGY IN 2008

- Photovoltaic cell (PV) production grew 85%; 7.9 GW were added worldwide
- The top five PV cell producing countries in 2008 were China, Germany, Japan, Taiwan, and the U.S. Cumulative worldwide capacity was 15 GW
- Worldwide PV installations reached a record high of 5.95 GW in 2008. Spain led the world in new solar installations in 2008 (2,011 MW), then Germany (1,500 MW), United States (342 MW), Korea (274 MW), Italy (258 MW), and Japan (230 MW)
- Germany (5.3 GW) leads the world in cumulative solar installations, Spain (3.0 GW), Japan (2.2 GW), and United States (1.6 GW)
- In the United States, California had the most installations (178.6 MW), then New Jersey (22.5 MW), Colorado (21.6 MW), Nevada (14.9 MW), and Hawaii (11.6MW)



INCENTIVES

- Feed-in tariffs
 - Enacted in most EU countries. Germany was first. Enacted in Ontario, Canada and in the U.S in CA, Gainesville, FL
- Investment tax credits
 - Extended to eight years in October 2008
 - Removed \$2000 cap on residential property
 - Allowed utilities to participate
 - Allowed cash rebate in lieu of tax credit in February 2009
- Five year accelerated depreciation
- Renewable portfolio standards in 29 states; 14 have solar “carve-outs”
 - CA is 20% by 2010, NJ is 20% by 2020, NY is 25% by 2013
- Renewable energy credits (\$150-\$200 per MW)
- Rebates, tax abatements, low interest loans, etc.
 - California Solar Initiative offers \$2.20 per W or .34 per KWh for residential installations. Different rates apply to commercial or governmental installations
 - Incentives are expected to remain in place until “grid parity” is reached

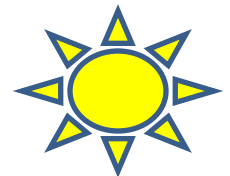


SOLAR ENERGY TECHNOLOGIES

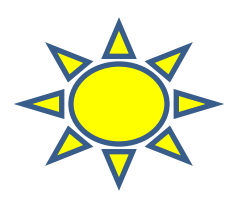
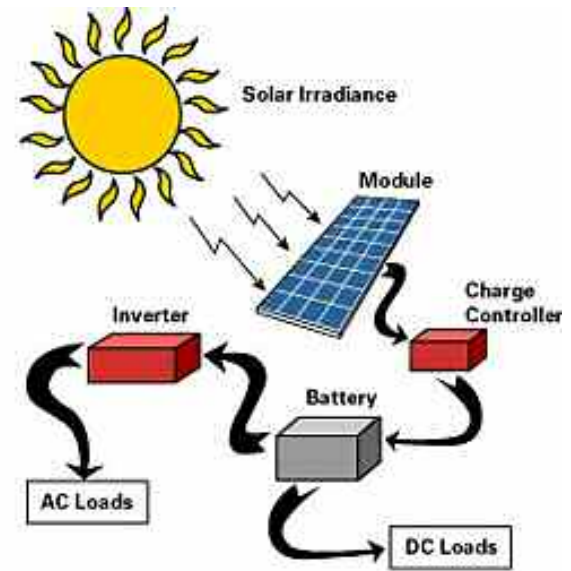
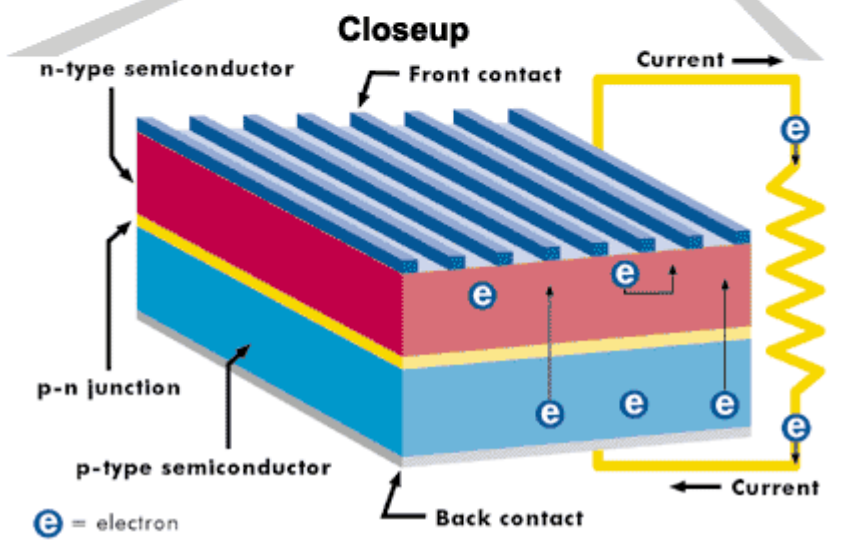
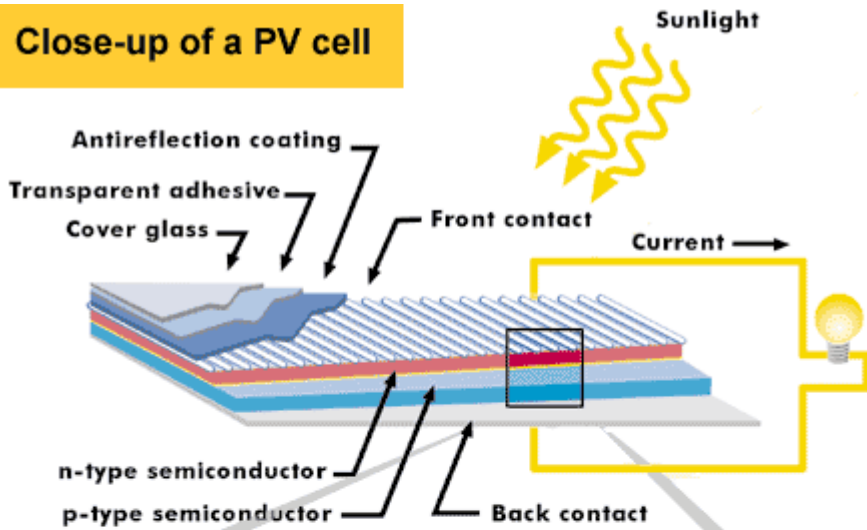
- Photovoltaic
 - Mono-crystalline and multi-crystalline
 - Thin-film (amorphous silicon, CdTe, CIGS)

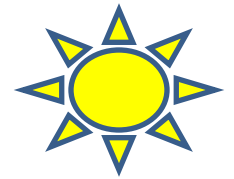
- Concentrating Solar Power
 - Parabolic trough mirrors
 - Dish-Stirling engines
 - Distributed power towers

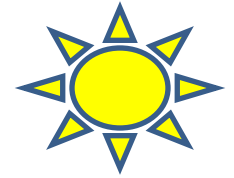
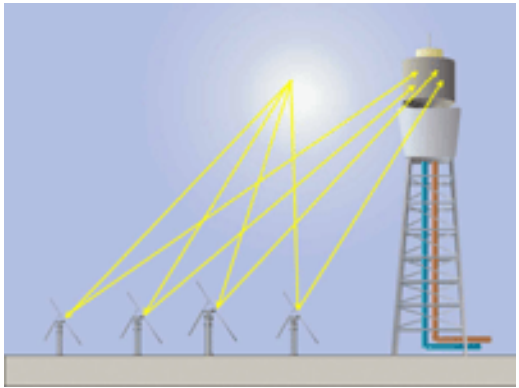
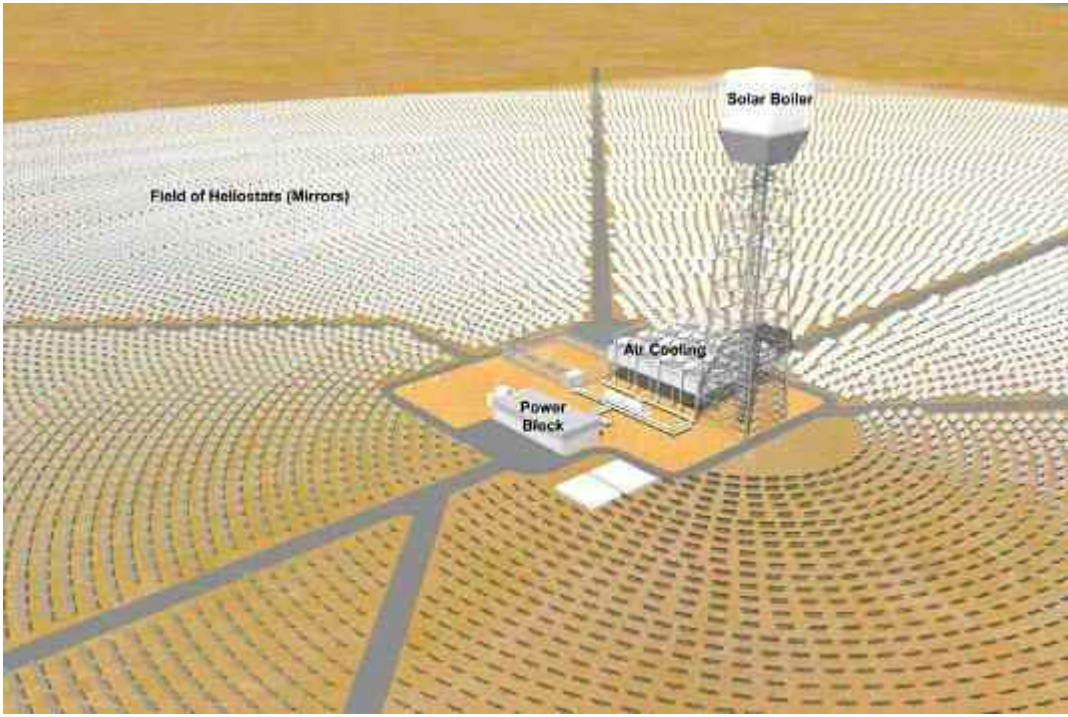
- Solar Thermal Collectors
 - Flat-plate
 - Evacuated tube collectors
 - Batch solar heaters



Close-up of a PV cell











MARKETS AND APPLICATIONS

Shipment of of PV Cells and Modules by Application (peak KW)

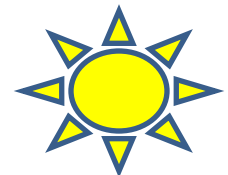
Application (end-use)	Total (2007)	Percent of Total (2007)
Electricity		
Grid Connected	253,101	.90
Off-Grid	10,867	.04
Communications	2,836	.01
Consumer Goods	589	.002
Transportation	4,018	.01
Water Pumping	3,852	.01
OEMs	4,802	.02
Health	410	.001
Total	280,475	100.00

Source: Energy Information Administration, Form EIA-63B, "Annual Module/Cell Manufacturing Survey"

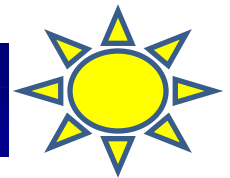
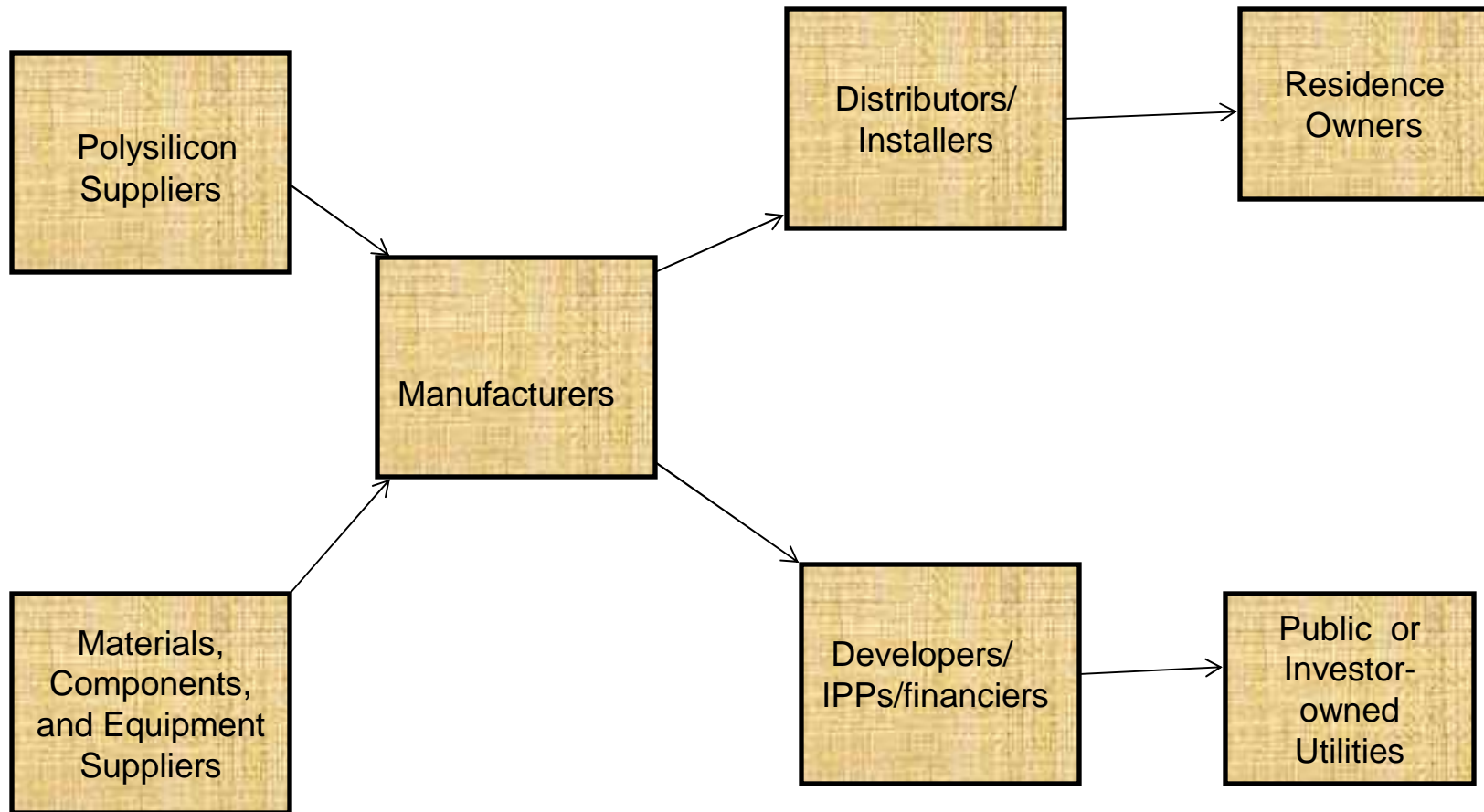
Domestic Shipments of PV Cells and Modules by Market and Type (peak KW)

Market	Crystalline Silicon	Thin-Film Silicon	Concentrator Silicon	Total (2007)	Percent of Total (2007)
Residential	54,793	13,624	--	68,417	.24
Commercial	113,780	26,404	250	140,434	.50
Industrial	22,064	10,638	--	32,702	.11
Electric Power	32,682	1,876	737	35,294	.13
Transportation	3,627	1,876	--	3,627	.02
Total	226,946	52,542	987	280,475	100.00

Source: Energy Information Administration, Form EIA-63B, "Annual Module/Cell Manufacturing Survey"



INDUSTRY PARTICIPANTS



INDUSTRY PARTICIPANTS

- Top-Fifteen Manufacturers

The top-fifteen PV cell producers in 2008 were Q-Cells (582 MW), First Solar (504 MW), Suntech (498 MW), Sharp (473 MW), JA Solar (300 MW), Kyocera (290 MW), Yingli (282 MW), Motech (272 MW), SunPower (237 MW), Sanyo (215 MW), Trina Solar (210 MW), SolarWorld (190 MW), Gintech Energy (180 MW), Ningbo Solar (175 MW), and Solarfun (160-180 MW).

- Top Seven Polysilicon Producers

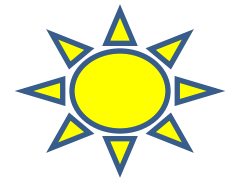
Hemlock, Wacker, Tokuyama, MEMC, REC, Mitsubishi, and Sumitomo

- Materials, Components, and Equipment Suppliers.

Solar process equipment, test equipment, solar materials, inverters, batteries, charge controllers, and solar products

- Developers/IPP/Financiers

SunEdison, MMA Renewable, Epuron, GE Energy Financial Services



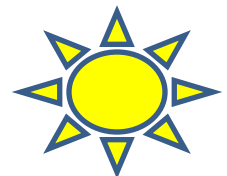
COMPETITIVE STRATEGY

- Capacity expansion
- Plant location
- Market expansion
- Acquisition, partnerships, long-term agreements
- Technological innovation
 - Efficient manufacturing processes
 - Recycling silicon
 - Reducing wafer thickness
 - Raising the conversion efficiency of cells
 - Increasing wafer size
 - Automating the assembly of solar modules and panels
 - Reducing installation costs



Plant Locations of Top Fifteen Cell Manufacturers

Company	Megawatts	Percent Growth over 2007	Plant Location (current and planned)
Q-Cells	582 MW	49%	Germany, Sweden, Malaysia
First Solar	504 MW	152%	US (Ohio), Germany, Malaysia
Suntech	498 MW	46%	China
Sharp	473MW	30%	Japan, US (Tennessee)
JA Solar	300 MW	127%	China
Kyocera	290 MW	40%	Japan, Czech Republic
Baoding Tianwei Yingli	282 MW	93%	China
Motech	272 MW	54%	Taiwan
SunPower	237 MW	137%	US (California), Philippines
Sanyo	215 MW	30%	Mexico, Hungary
Trina Solar	210 MW	624%	China
SolarWorld	190 MW	12%	Germany, US (California, Oregon), Korea
Gintech Energy	180 MW	199%	Taiwan
Ningbo Solar	175 MW	75%	China
Solarfun	160 MW	104%	China



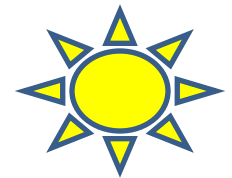
RISE OF CHINESE PRODUCERS

- Suntech became the world's largest PV crystalline cell producer in 2009.
- Trina Solar, Solarfun and Gintech became top 15 cell producers in 2008. BP Solar, Isofoton, and Mitsubishi dropped out of the top15.
- Chinese companies have 30% lower cost than Western companies.
- Average retail selling price is down significantly this year (25-35%)
- More Western companies stuck with long-term polysilicon contracts
- Western companies are building or expanding Asian plants or partnering with Asian companies, especially for module manufacturing.
- Chinese companies in general
 - Well-financed by IPOs or private equity
 - Good net margins (10-25%), low-cost labor and low tax rates
 - Buy cheap Chinese manufacturing equipment or latest American or European technology
 - Strong government incentives are stimulating domestic demand.
 - Major investments in Chinese polysilicon startups keep supply cost low



FUTURE DIRECTIONS

- Utilities will face increasing economic stress from shrinking volume, and devise defensive as well as offensive solutions
- German solar market will face risk of market saturation by 2013
- Grid-tied solar will require complementary investments in smart grid and storage technology as market penetration approaches 20%
- Solar companies will boost weak margins by vertical integration, lowering cost and differentiating their products by esthetics, ease of installation, and selling directly to distributors or end-users.
- PV systems and concentrated power systems (CSP) technologies will compete vigorously for utility-scale contracts



Thank you.

Questions?

