

New Technologies for Lighting & Generating Power



**Solid State
Illumination**



Solar

**Marc Chason
Founding Partner
Quantum Solar Group**

**iNEMI Sustainability Summit
September 22-23, 2008
Galvin Center at Motorola, Schaumburg, IL**

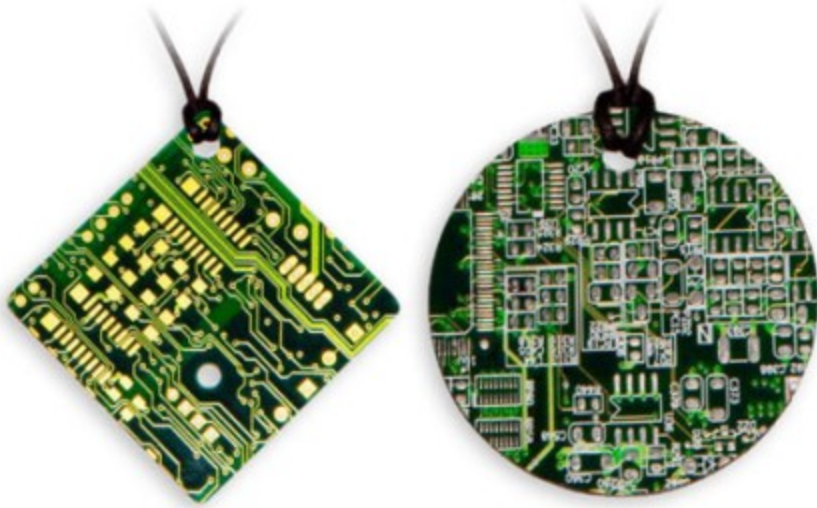


Quantum Solar Group, Inc.

...attaining a higher power

**iNEMI Sustainability Summit
September 22, 2008**

An Example of Sustainable Electronics?



Recycled circuit boards become fashionable necklace pendants

by **Doug Osborne** posted on August 27, 2008

<http://www.geek.com/recycled-circuit-boards-become-fashionable-necklace-pendants-20080827/>

You can order these circuit board necklaces now from ThinkGeek for \$19.99.

When we talk about sustainability we are referring to our ability as an industry to use our planet's resources wisely so that future generations can live their lives and enjoy the benefits of our products without concern for degrading the environment and/or depleting critical materials.

Jim McElroy, iNEMI
CircuiTree, August 28, 2008



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

The Lighting Challenge

“According to the Department of Energy (DOE), lighting accounts for 8% of all energy consumption in the United States and 22% of electricity nationwide. LEDs have the potential to reach 200 lm/W, compared to the efficacies of incandescent lamps at 15 lm/W and fluorescent tubes at 90 lm/W. If solid-state lighting replaced all existing lights, the DOE estimates customer savings of \$115 billion by 2025 and a 10% reduction in greenhouse emission gases.



<http://www.nglia.org/about.htm>

“The Solid State Illumination (SSI) chapter addresses technologies specific to inorganic and organic LED assembly (i.e., materials, assembly, packaging, manufacturing), test and measurement, devices and circuits, reliability and standards.”

2009 iNEMI SSI Roadmap

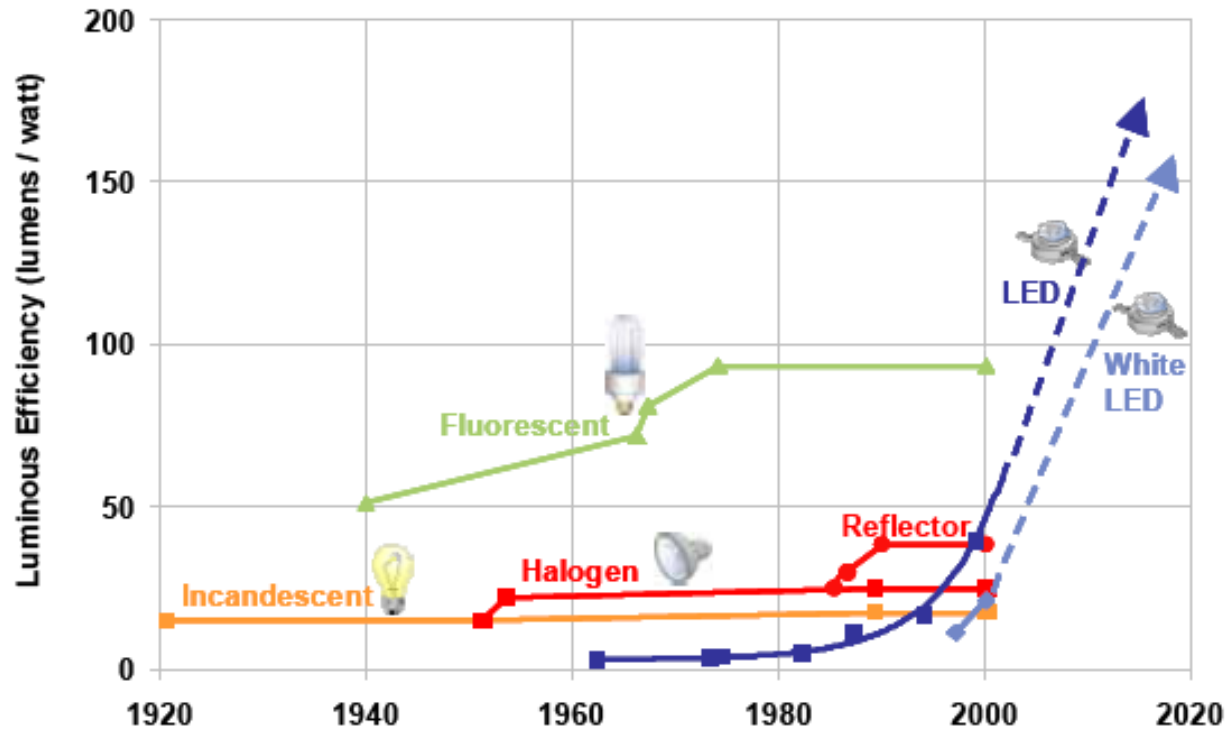


Quantum Solar Group, Inc.

...attaining a higher power

**iNEMI Sustainability Summit
September 22, 2008**

The Solid State Illumination Promise



Source: Lumileds

http://www.netl.doe.gov/ssl/PDFs/SSLMYPP2008_web.pdf

The cost per lumen produced via SSI sources is dropping, enabling new markets.

High lumens/watt reduces overall lighting carbon footprint



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

Solid State Illumination Realized

Inorganic luminaires commercially available



Ledtronics



Cree



Lighting Sciences Group

Organic luminaires beginning to appear



Osram



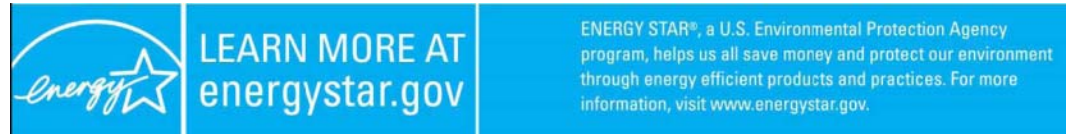
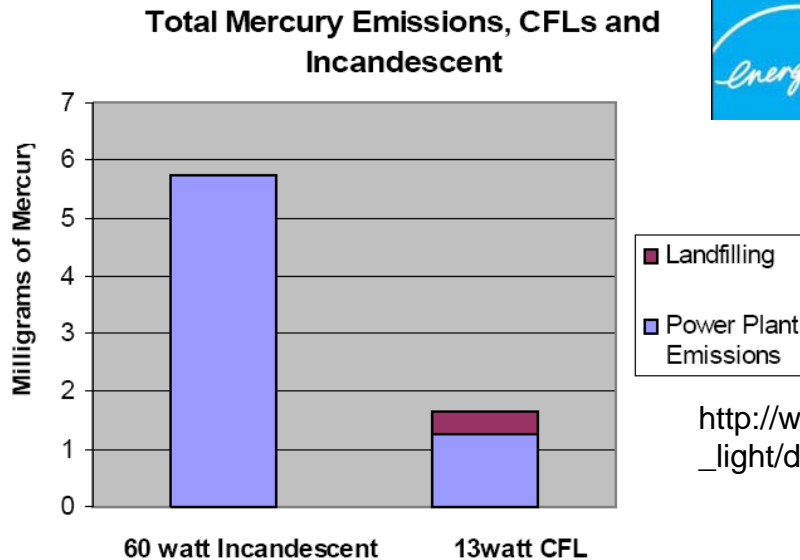
E-Lite



SSI Light Source is Environmentally Friendly

- LEDs & OLED do not present any known environmental risk, during use or after disposal.

Clearly, a consumer benefit over Compact Fluorescent Lamps (CFL)



Frequently Asked Questions Information on Compact Fluorescent Light Bulbs (CFLs) and Mercury April 2008



http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf

- Higher lumens /watt leads to lower air conditioning costs



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

Solid State Illumination Assembly Hierarchy

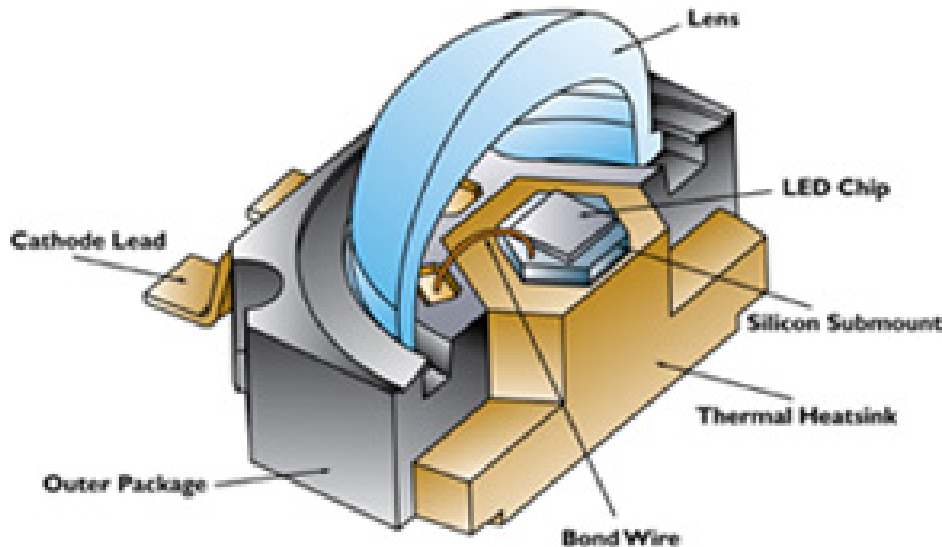
Assembly Level	Definition	Comments
3	System level assembly (Total system)	Assembly of light engine into luminaire. Product is sold to customers.
2	Second level assembly (Package on board)	Assembly typically accomplished with SMT and batch reflowed according to established processes. Suppliers generally provide design guides for proper thermal transfer and electrical operation.
1	First level assembly (LED & OLED in package)	Assembly process technologies such as solder reflow, gold wire bond, clear encapsulation and phosphor coating, lens mounting. Much of this assembly technology is held as intellectual property.
0	Device (LED & OLED)	Focuses on the fabrication of the light emitting structure, which can be from inorganic or organic materials.



SSI Assembly Challenges

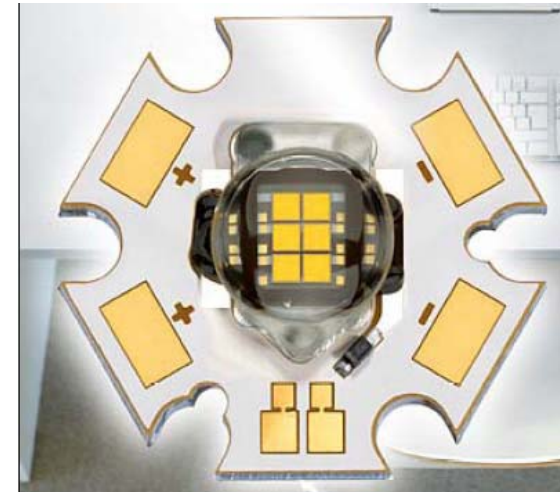
Producing higher efficiency and brighter white light centers on:

- LED and OLED Materials
- Phosphors (quantum dots?)
- Packaging



Lumileds

www.lumileds.com/technology



OSTAR® LED example
(source OSRAM)



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

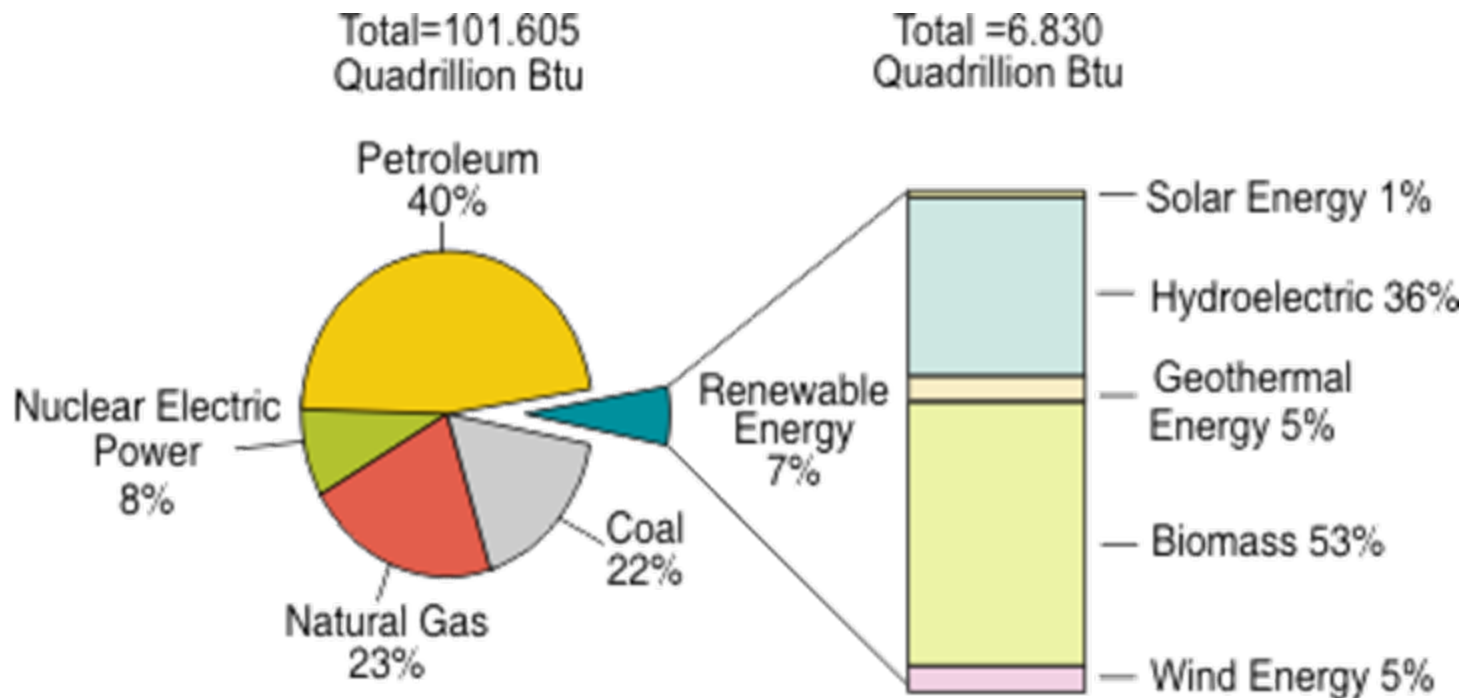
SSI Sustainability Challenges

Assembly	<ul style="list-style-type: none">• Design tools required for new assembly processes & to assess product life cycle issues• Package designs must address high thermal loads for ultra-bright LEDs• SMT assembly not readily amenable with LED structures
Materials	<ul style="list-style-type: none">• Need more efficient inorganic materials• Need functional inks to enable low cost OLEDs• Need improved phosphor materials
Standards	<ul style="list-style-type: none">• WEEE, RHoS, Energy Star, EuP, etc., need to be watched for impact on industry direction
Supply Chain	<ul style="list-style-type: none">• Need alignment of supply chains for cost reduction to drive consumer acceptance• Supply chains for distribution from non-traditional luminaire suppliers





Renewable Energy Plays a Role in the Nation's Energy Supply (2007)



Note: Sum of components may not equal 100 percent due to independent rounding.

Source: EIA, *Renewable Energy Consumption and Electricity Preliminary 2007 Statistics*, Table 1: U.S. Energy Consumption by Energy Source, 2003-2007 (May 2008).

http://tonto.eia.doe.gov/energy_in_brief/renewable_energy.cfm

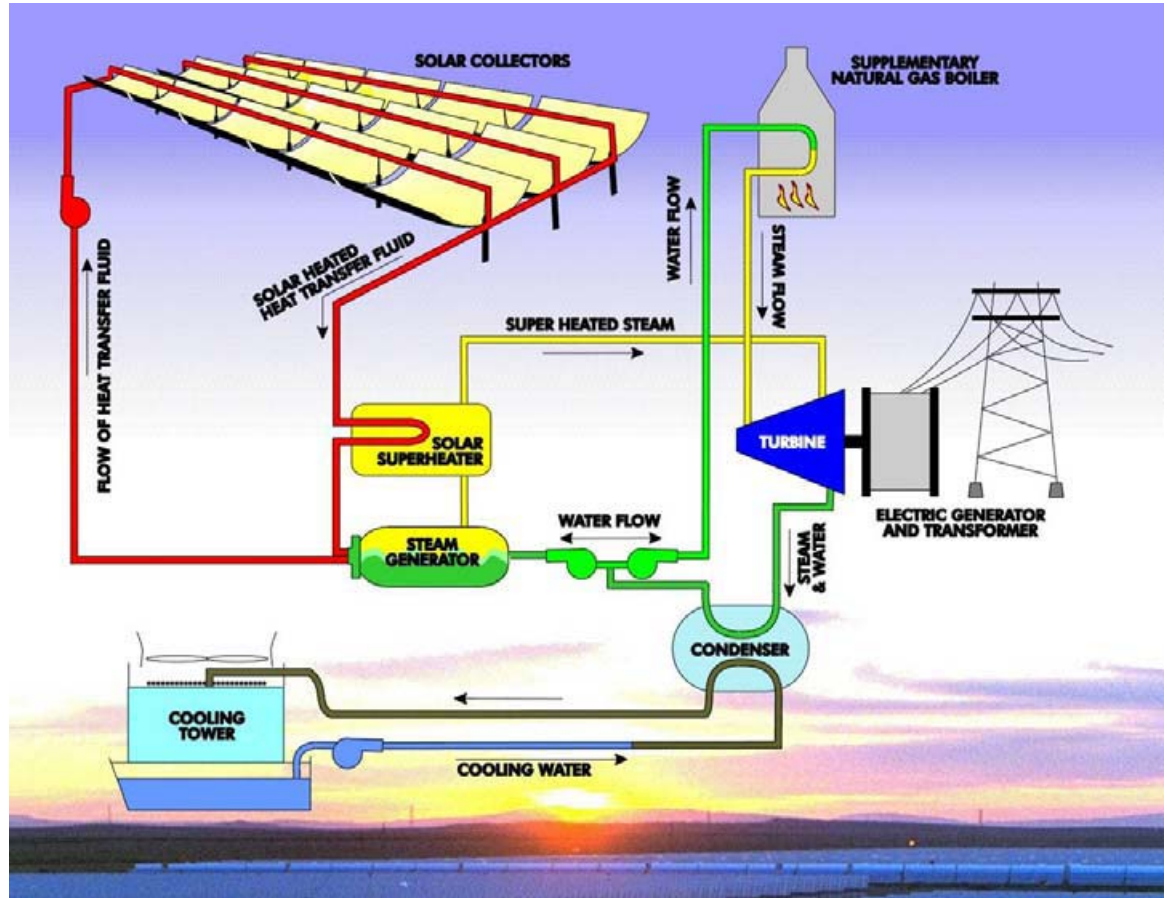


Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

Solar: Thermal



Solar Electric Generating System (SEGS)



California Plant:
Generating capability of 310 megawatts.

http://www.fplenergy.com/portfolio/pdf/solar_factsheet.pdf



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

Solar Electric: Photovoltaic



Location:	Beneixama (Spain), Province Alicante
Nominal power:	20 MWp (200 x 100 KWp)
Surface area	approx. 500.000 m ² (about 71 soccer fields)
Module area:	approx. 160,000 m ²
Electricity production:	approx. 30,000,000 kWh p.a. (needs of approx. 12,000 average German households)
CO₂-reduction:	approx. 30,000 t p.a. approx. 750,000 t during 25 years minimum operating time
Date of completion:	September 2007



<http://www.city-solar-ag.com/index.php?id=66.html>



Quantum Solar Group, Inc.

...attaining a higher power

**iNEMI Sustainability Summit
September 22, 2008**

DOE Solar Energy Program Overview

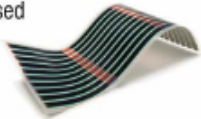
Market Trends, Strategy, R&D Pipeline, Next Steps

FY07 National Lab module research balances various materials thru joint industry R&D and long-term research



4% Organic PV

Customizing organic molecules for optimal cell efficiency in materials that can be processed without expensive vacuum chambers



1% Dye Sensitized Cells

Advancing the efficiency and stability of inexpensive dye-based solar cells with novel nanostructures



22% Wafer Silicon

Combining thin amorphous and wafer silicon to make high efficiency cells with smaller total amounts of silicon

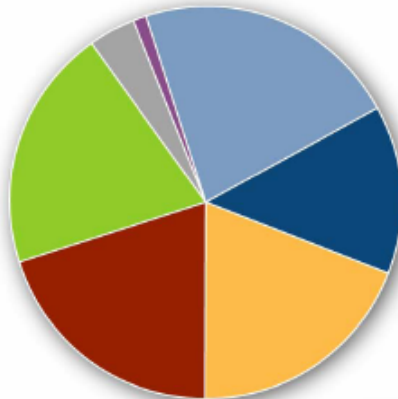
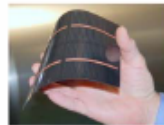


Developing new ink-jet printing methods for silicon electrical contacts

20% Thin Films (CIGS)

Supporting the novel manufacture of CIGS cells from ink-based precursors

Transferring discovery that highest performance material has nanostructured patterns into a fast and uniform manufacturing process



14% Concentrator PV

Devising strategies for making quicker, easier, less precise cells but maintaining record performance

Achieving record efficiencies (33.8%) even without concentration



20% Thin Films (CdTe)

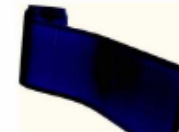


Produced thinner films with same cell performance

Discovered a more durable way to make electrical contacts

19% Thin Films (Silicon)

Developing methods of making thin silicon film solar cells on inexpensive glass and at low processing temperatures



http://www1.eere.energy.gov/solar/solar_america/pdfs/solar_energy_comp_overview_0807.pdf



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

Silicon PV Supply Chain

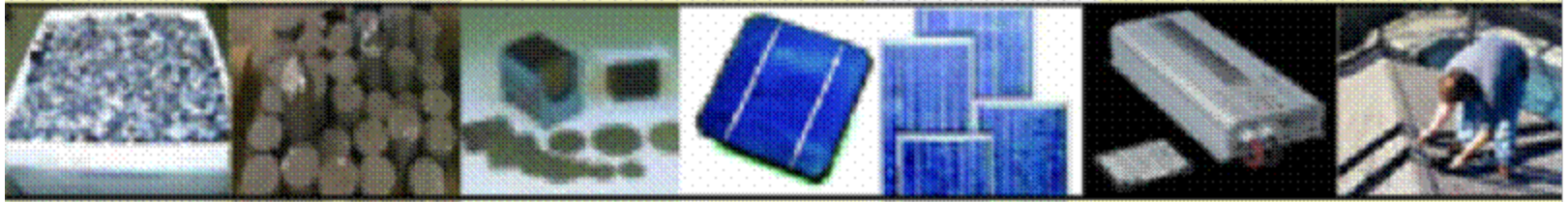
Segment:



Percent of installed system cost:



Example:



iNEMI PV Roadmap, 07SSI-Photo-Grace O'Malley



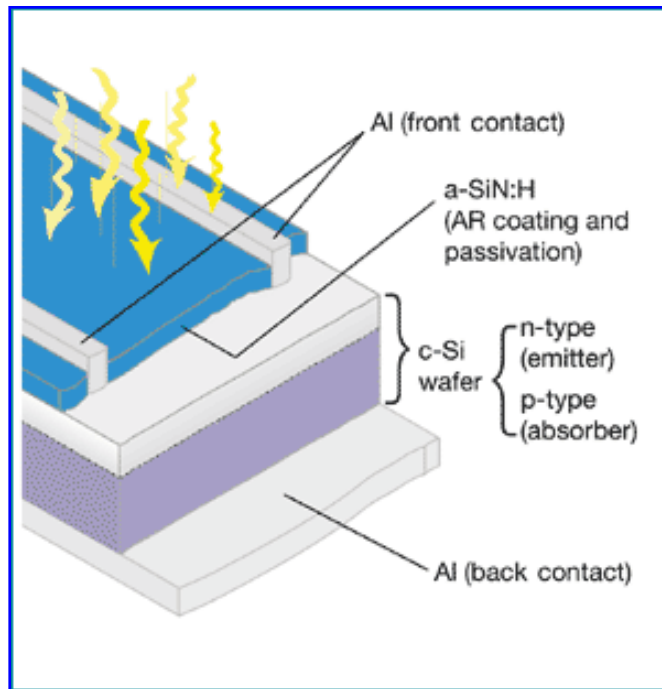
Quantum Solar Group, Inc.

...attaining a higher power

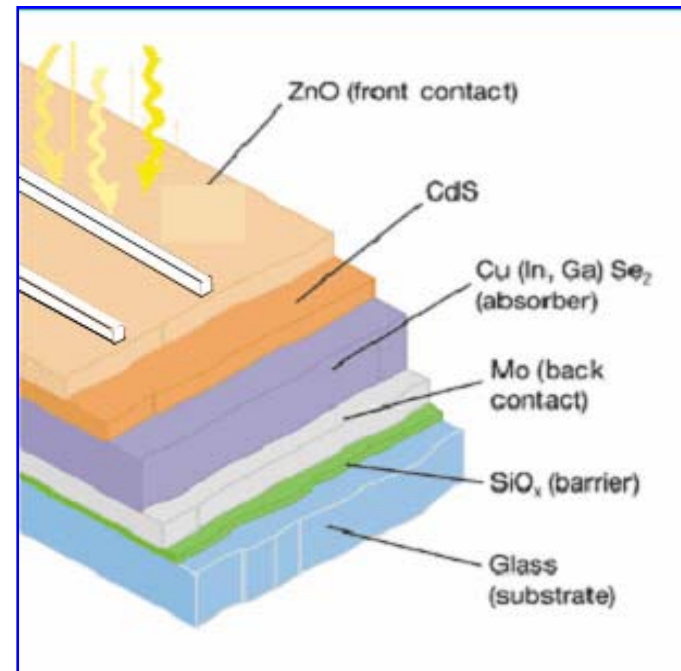
iNEMI Sustainability Summit
September 22, 2008

Materials for Silicon and Thin Film PV

Crystalline Si 250 μm



Thin Film CIGS 2 μm



iNEMI PV Roadmap, 07SSI-Photo-Grace O'Malley

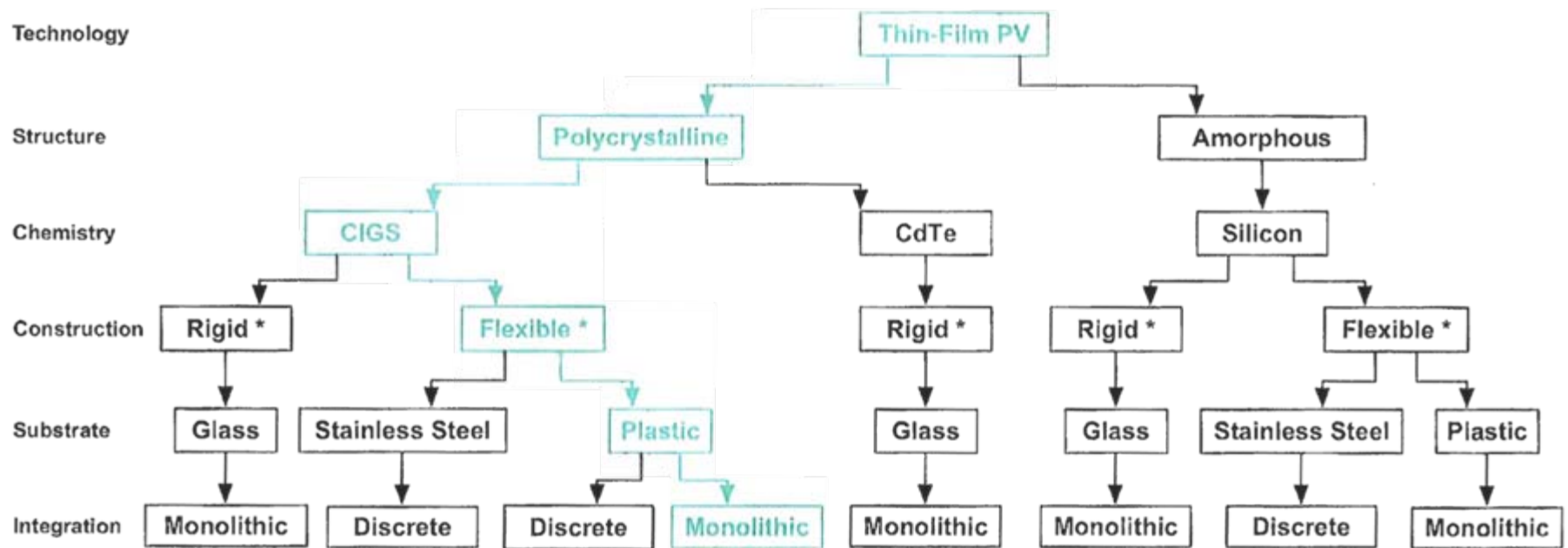


Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

Thin Film PV: one possible nomenclature



iNEMI PV Roadmap, 07SSI-Photo-Grace O'Malley



Quantum Solar Group, Inc.

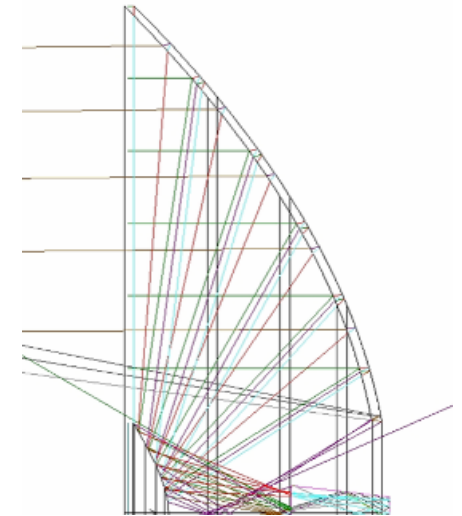
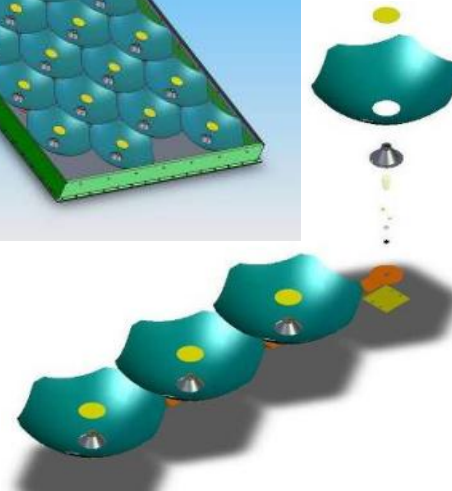
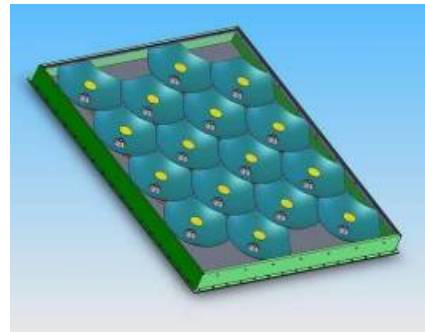
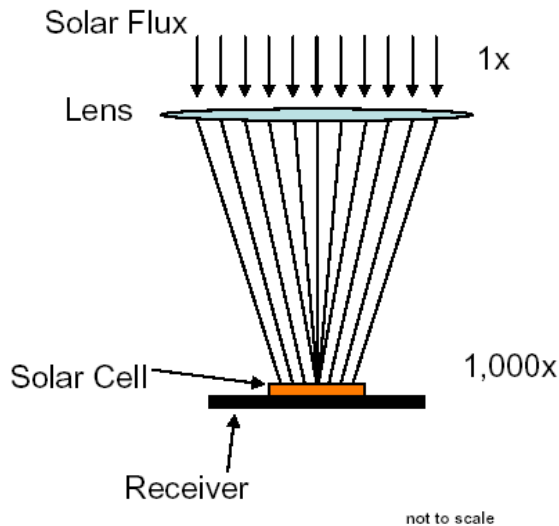
...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

Concentrator PV

Tailored Imaging Concentrator

- 500 suns on 1cm² Cells
- Passive Cooling



iNEMI PV Roadmap, 07SSI-Photo-Grace O'Malley



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008

PV Sustainability Challenges

Assembly	<ul style="list-style-type: none">• Design tools required for new assembly processes & to assess product life cycle issues
Balance of System	<ul style="list-style-type: none">• Electronics for long term reliability
Equipment	<ul style="list-style-type: none">• Need to handle larger substrates• Need to deposit unique/novel materials
Materials	<ul style="list-style-type: none">• Need materials for more efficient PV materials• Need environmentally friendly materials
Metrology	<ul style="list-style-type: none">• Need metrics for comparing “true” energy costs
Packaging	<ul style="list-style-type: none">• Need cost effective solutions at device, module & system level• Need materials for long term reliability
Standards	<ul style="list-style-type: none">• WEEE, RHoS, Energy Star, EuP, etc., need to be watched for impact on industry direction
Supply Chain	<ul style="list-style-type: none">• Need alignment of supply chains for cost reduction to drive consumer acceptance



A Sustainable Future



SSI can reduce energy use and carbon footprint

- Devices are becoming commercially available

PV technology driving towards cost effective solutions

- Large opportunity to impact grid-electricity production



Quantum Solar Group, Inc.

...attaining a higher power

iNEMI Sustainability Summit
September 22, 2008