Next Generation Solar Products

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Outline

Solar Market Overview
PV Technology Introduction
About HelioVolt
Questions and Answers
Humanity uses 12 TW of power today

- 1 TW = 1,000 GW (Gigawatts)

World will need 15 TW by 2012

Only 5 known sources of energy are available on a TW scale*

- Fossil fuels: Coal, oil, gas
- Nuclear fuels
- Solar
  - Only inherently distributed solution
  - No fuel cost

*Prof. Nathan Lewis,
http://nsl.caltech.edu/
Global Photovoltaic Market Demand Through 2010 (MW)

Source: Solar Today, 2007
Plateau in direct manufacturing costs

Data source Luuk Beurskens, ECN Policy Studies, PHOTEX’03
Value Chain Cost Distribution

2006 US Solar System Cost Allocation by Category

- Polysilicon: 20%
- Ingot: 30%
- Wafer: 50%
- Solar Cell: 50%
- Solar Panel: 30%
- System: 20%

HelioVolt Corp © 2007
History of Light-to-Electricity

All solar cells utilize the photovoltaic (PV) effect
  • Discovered in 1839 by Becquerel

Direct cost has decreased continually
  • 1970: $150/Watt
  • 2005: $4/Watt

Three deployed technologies
  • Silicon: 90% market share
  • GaAs/III-V: space & concentrators
  • Thin film: second generation
Advantages of thin film PV

- Efficient and high performing materials
  - Direct bandgap semiconductors
  - Better energy output – kWh/KW
  - CIGS record at 19%+ conversion efficiency
- Significantly reduced costs
  - Less material usage
    - Not affected by silicon supply shortages
  - Potential for improving costs throughout value chain
- Advanced manufacturing techniques
  - Fewer processing steps
  - Monolithic integration of circuits
  - Automation
- Better aesthetics
Module Manufacturing Sequence

Crystalline Silicon Modules
- Polysilicon Sorting
- Polysilicon Type Check
- Polysilicon Etch
- Crystal Growing
- Ingot Shaping
- Ingot Sizing
- INGOT
- Mounting
- Wire Saw Cutting
- Cleaning
- WAFER
- Cleaning
- Front Print
- Rear Print
- AR Coating
- Oxidation
- Plasma Etch
- Phosphorus Diffusion
- Cleaning Etch

Thin Film Modules
- Stringing
- Circuit Assembly
- Deposit Base Electrode
- Cut Isolation Scribe
- Deposit Precursors
- Absorber Formation
- Junction Formation
- Cut Interconnect
- Deposit Window
- Cut Isolation Scribe

CIRCUIT
- Laminated Assembly
- Lamination
- Module Assembly
- IV Test
- Lamination
- Module Assembly
- IV Test

MODULE
- Cell Test
- Fire Paste
- Rear Print
- Front Print
- IV Test
- IV Test
Thin Film Product Availability

- **Amorphous Silicon**
  - Flexible and rigid

- **Cadmium Telluride**
  - First Solar capturing significant market share for central power applications

- **CIS/CIGS**
  - New commercial availability entering the market in 2008
CIGS Thin-Film Products

- Alloy of Copper, Indium, Gallium and Selenium
- CIGS is one of three known intrinsically stable PV materials (with Silicon and Gallium Arsenide)
  - Intrinsic stability required for long lived robust products
- More efficient absorber of light than any other known semiconductor
- Requires 1/100th of the material compared to silicon for comparable light absorption
Solar is a match for Buildings

- Power Buildings are expected to become a multi-$T market
  - PV as an integrated electronic component
- Huge latent demand
  - $150 billion per year US potential
- Current products unsuitable
  - Crystalline silicon unattractive
  - Amorphous silicon inefficient
- Multiple segments
  - Architectural Glass
  - Windows and skylights
  - Roofing

Electrical Demand that can be met by PV

Power Buildings will become multi-$T market

- BIPV is the fastest growing sector of PV

Efficient, durable thin-film solar cells incorporated into traditional building materials enable rapid deployment of revolutionary products

- Current products unsuitable and not cost effective
Roofing
- Most common BIPV application today

Sunshades
- Energy conservation and reduced building operating costs
- Cooling load mitigation and glare control
- Easiest retrofit for PV

Overhead glazing (canopies, skylights, atriums)

Curtain wall ~ 2M sq ft per year+
Example: Correlation between Daily PV Power Production and Energy Consumption of an Office Building in Spain

Source: RWE Energie AG and RSS GmbH
Founded: 2001
Location: Austin, TX
Employees: 40+ (70 expected by end of 2007)
Technology: Revolutionary method for manufacturing high-efficiency CIGS circuits

Building 1st production facility in the US
Expanding capacity in Europe
To develop and commercialize a new generation of efficient, safe, reliable, and attractive thin-film photovoltaic solar power products that are the first to enable energy production at **cost parity with conventional sources of electricity.**

- **Cost**
  - Lowest cost thin film circuits, less than one fourth that of silicon PV and one tenth that of current Building Integrated PV (“BIPV”) products

- **Durability**
  - Warranted Lifetime of 20 years for first products

- **Efficiency**
  - Comparable conversion efficiencies to multicrystalline silicon
HelioVolt’s technology addresses most significant PV challenges:

- CIGS thin-film technology is the most promising candidate to replace expensive silicon-based technologies
- FASST™ process technology will produce high quality CIGS photovoltaics in minutes, an 80-98% reduction over other CIGS thin-film manufacturing processes
HelioVolt's two step process enables high throughput low cost manufacturing of CIGS PVICs.

**Stage 1:**
- Precursor Deposition

**Stage 2:**
- Rapid Thermal Anneal and Separation

**FASST™ – Field Assisted Simultaneous Synthesis and Transfer**
PVIC Manufacturing Process Flow

1. **Front End**
   - Glass Clean
   - Metal Deposition
   - Metal Pattern (P1)

2. **CIGS Synthesis**
   - Precursor Deposition
   - FASST™ Synthesis
   - Buffer Deposition

3. **Buffer**

4. **Device Processing**
   - Absorber Pattern (P2)
   - TCO Deposition
   - TCO Pattern (P3)

5. **Back End**
   - PVICs
   - Product Packaging
   - Test and Ship
HelioVolt Highlights

- Solar Power is a Huge Unparalleled Growth Opportunity
- Truly Disruptive CIGS Platform
- Mass Market Opportunity Driven by Cost-per-Watt
- Award Winning Company and Technology
- Ideally Suited for Enabling BIPV Products
- Strong Intellectual Property Portfolio
- Outstanding Management Team and Advisory Board

Solar Power is a Huge Unparalleled Growth Opportunity
Thank you for your interest!

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For more information regarding HelioVolt and career opportunities, please visit: www.heliovolt.com