Nanotechnology and Power Buildings: Solar Power's Surprising Future

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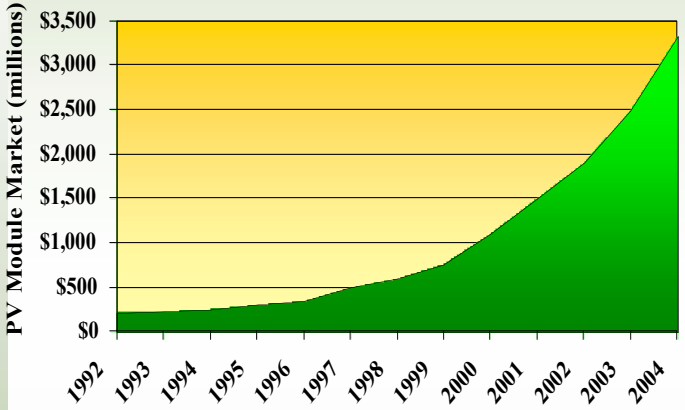
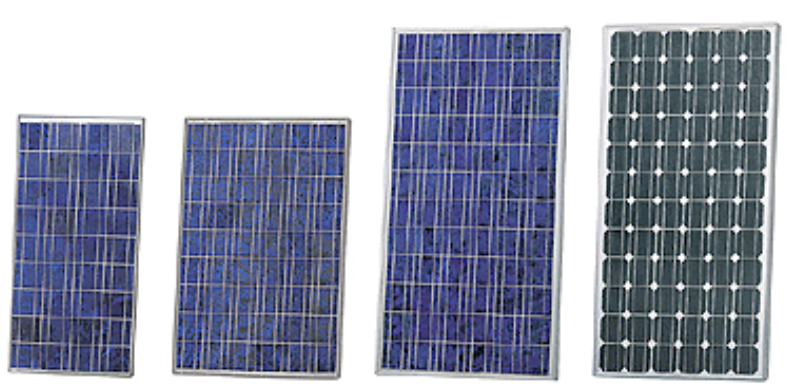
Will Solar Become a Significant Power Source for the World?

- **Solar's role in the world's energy future depends on political choices**
  - **Will coal's use be limited by**
    - **CO_2 generation?**
  - **Will nuclear's use be limited by**
    - **waste disposal costs and proliferation risk?**
- **Solar's growth is inevitable**
  - **Breadth of adoption dependent on**
    - **New technologies for reduced cost**
    - **New application paradigm: Power Buildings**

Solar Power Today

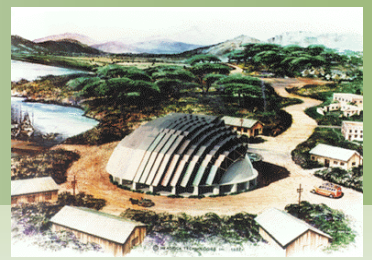
- **Silicon Photovoltaic (PV) modules for retrofit**

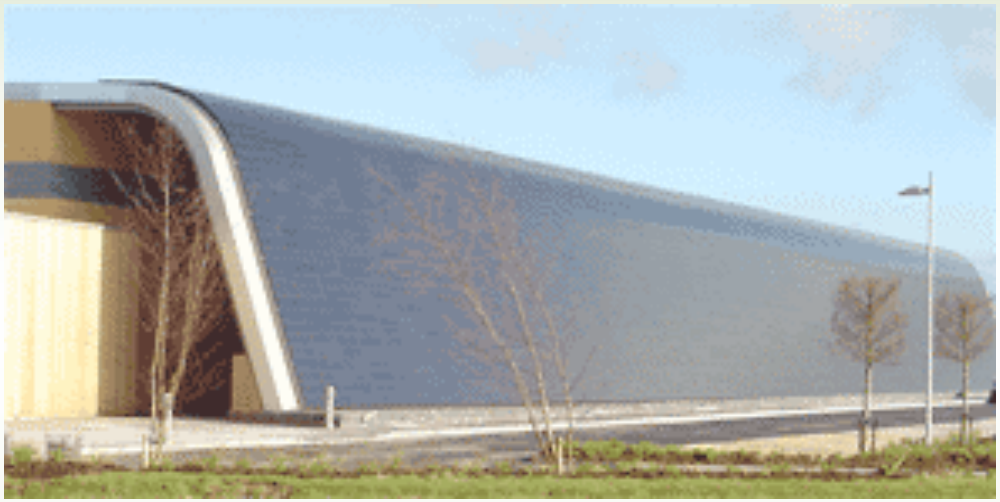




- **PV module sales $3.3B (2004 estimate)**
  - **PV market 30+% CAGR**
- **Sales <½% total annual global CapEx for electrical power generation**
- **Current market limited by price**
  - **$3.50/Wp modules + $3 installation**

Solar Power Tomorrow

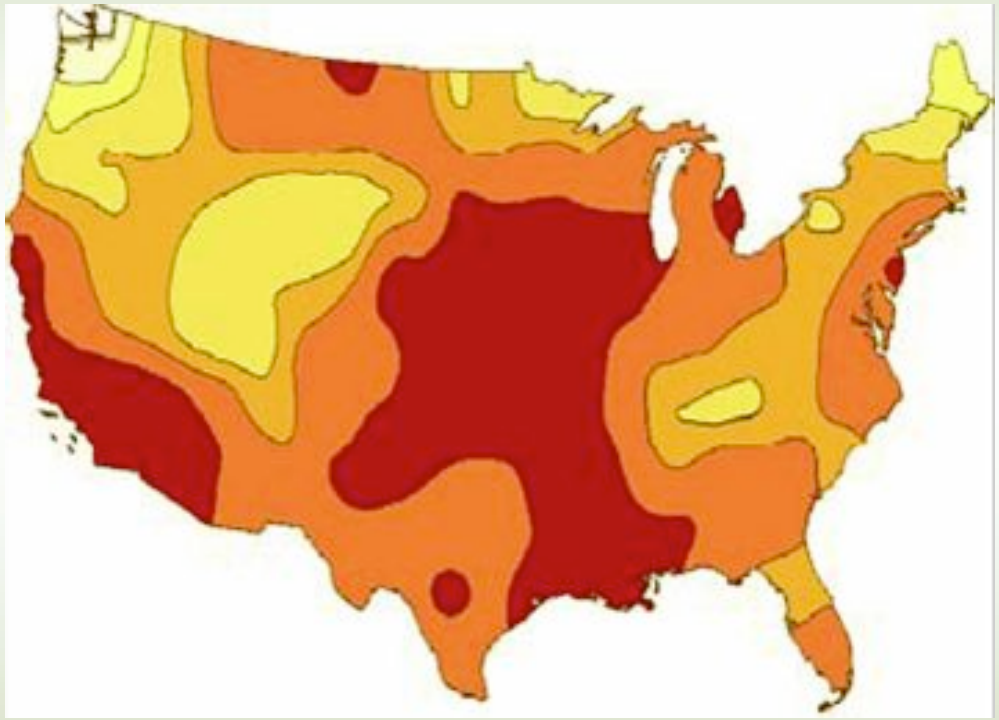




- **Power Buildings will become multi-$T market**
  - **PV as an integrated electronic component**
- **Efficient, durable thin-film solar cells incorporated into traditional building materials**
- **Current products unsuitable**

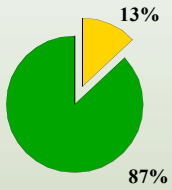
Power Buildings Market

- **Huge latent demand**
- **USA potential: $150B/yr**
  - **60% share**
- **Multiple segments**
  - **Architectural glass**
  - **Windows & skylights**
  - **Roofing**



Electrical Demand met by PV

Competitors for the Mass Power Market?



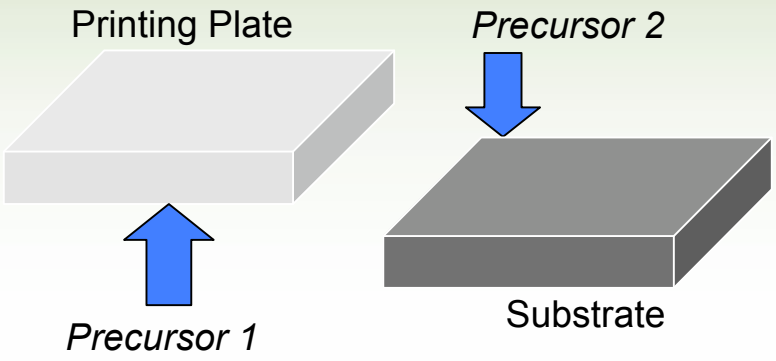
- **Silicon PV cannot meet needs**
  - **Durable & efficient**
  - **Expensive mature technology**
  - **Low margins**
- **Organic PV unlikely to meet needs**
  - **Efficiency & lifetime issues**
- **Conventional semiconductor thin film currently too expensive**

Heliovolt Breakthrough CIGS Platform Technology

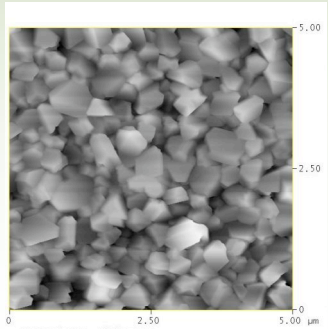
- **Highest Performance and Durability**
  - **Copper Indium Gallium Selenide (CIGS): Highest Thin Film Efficiency**
  - **Currently used for most-demanding applications**
- **Lowest Cost**
  - **Less than one third the cost of Silicon PV Cells**
- **Widest Range of Form Factors**
  - **Durable and inexpensive coating for glass, metals and polymeric materials**
- **Unique Patented *FASST*™ Process**
  - **Field-Assisted Simultaneous Synthesis and Transfer**
  - **Replaces costly slow processing unsuited to mass production**

HelioVolt

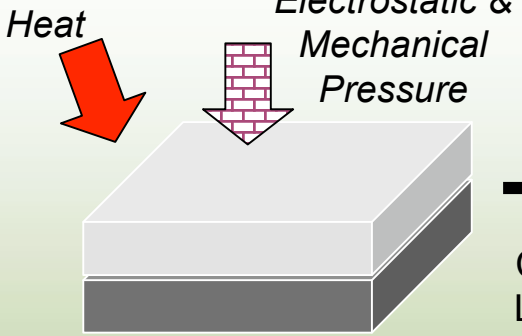
Nanotechnology in HelioVolt's *FASST*™ CIGS Process: Precursors

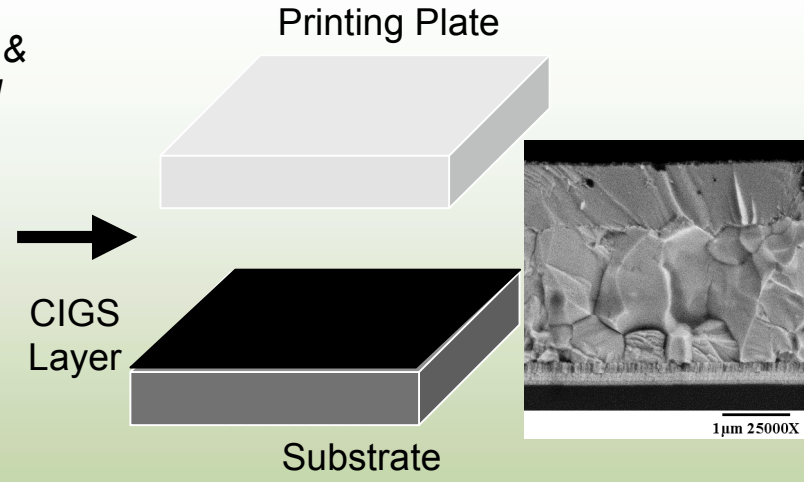


Stage 1: Precursor Deposition



Stage 2: Rapid Thermal Processing and Separation





Unique Nanoscience of CIGS

- **Inherent to CIGS PV semiconductor**
  - **Spontaneous nanostructuring**
    - **Driven by phase segregation**
  - **Forms internal nano-scale junctions**
    - **Two phases form different interpenetrating percolation networks for each carrier type**
    - **Explains CIGS performance & robustness**
- **New scientific insight**
  - **Suggests novel pathways for cost & performance improvement**

Nanotechnology and Buildings: Changes for the Electrical Industry

- **Generation**
  - **Integration of CIGS PV as Coatings on Building Construction Materials**
- **Conservation**
  - **Nanotechnology application to improved insulation, lower cost low-E windows**
- **Transmission**
  - **Need reduced by distributed generation:**
    - **Power produced at the point of consumption**
    - **Inherent benefit of PV Power Buildings**

HelioVolt Corporation

World's Highest Performance, Lowest Cost, & Most Versatile Solar Power Platform