Solar 2008
May 6, 2008

Concentrating Solar Power Forum
Concentrating Photovoltaics

Sarah Kurtz, Principal Scientist
National Renewable Energy Laboratory
Email: sarah_kurtz@nrel.gov
Tel: 303-384-6475
Outline

• Growing PV:
  – Use a variety of approaches to grow faster
• Comparison of three concentrator technologies
• Value of high efficiency
• Status of concentrator PV industry
Growth of photovoltaic industry

Growth of PV industry requires capital investment in Si purification
Reduce semiconductor material to reduce cost and capital investment

Front Solar cell

Back

Thin film

Low-X concentrator

Concentrator

A high efficiency cell increases value of the optics
Concentrating Photovoltaic Systems: CPV

Dish: requires active cooling

Fresnel lenses focus light on small cells: Passive cooling

Low-concentration

High-concentration system mounted close to the ground
Concentrating Solar

Solar thermal
• > 100 MW fields
• 1-axis tracked
• Requires water for steam
• Hundreds of MWs experience
• Responds slowly to sun (storage)

High-concentration PV
• > 30 kW fields
• 2-axis tracked
• May not require water
• MWs experience
• Responds quickly

Low-concentration PV
• > 1 kW applications
• Can be static
• Passively cooled
• MWs experience
• Responds quickly to changes in sun
Multijunction cells use multiple materials to match the solar spectrum.
Champion solar-cell efficiencies - Pathway to 50%

Multijunction Concentrators
- Three-junction (2-terminal, monolithic)
- Two-junction (2-terminal, monolithic)

Crystalline Si Cells
- Single crystal
- Multicrystalline
- Thin Si Film
- Thick Si Film

Thin Film Technologies
- Cu(In,Ge)Se₂
- CdTe
- Amorphous Si:H (stabilized)
- Nano-, micro-, poly- Si
- Multijunction polycrystalline

Emerging PV
- Dye cells
- Organic cells (various technologies)

40.7%
King, APL 2007
Companies with datasheets for multijunction cells

- Spectrolab
  - Minimum average efficiency: 36% @ 50 W/cm²
- EMCORE
  - Typical efficiency: 36% @ 470 suns
- Spire Semiconductor (Bandwidth)
  - Typical efficiency: 35% @ 500 suns

- About one dozen companies have some cell capability
Some concentrator system companies using multijunction cells

• North America
  – Abengoa Solar
  – Amonix
  – Boeing
  – Concentrating Technologies
  – Cool Earth Solar
  – EMCORE
  – Energy Innovations
  – EnFocus
  – ENTECH
  – GreenVolts
  – Menova
  – OPEL International
  – Pyron
  – SolFocus
  – Soliant
  – SUNRGI

• Europe
  – Concentracion Solar La Mancha
  – Concentrix
  – Guascor Foton
  – Isofoton
  – Sol3g
  – SolarTec

• Australia
  – Solar Systems
  – Green & Gold

• Asia
  – Arima Ecoenergy
  – Daido Steel
  – Sharp
Flying high with high efficiency

Cells from Mars rover may soon provide power on earth

sarah_kurtz@nrel.gov