Low-Cost 20X Silicon-Cell-Based Linear Fresnel Lens Concentrator Panel

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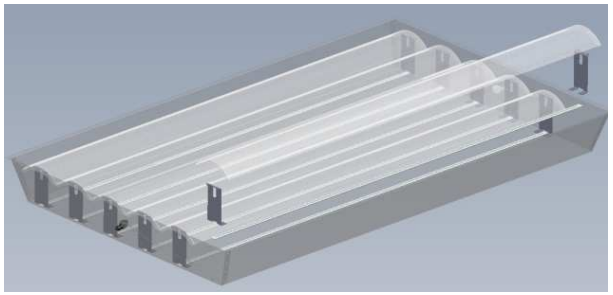
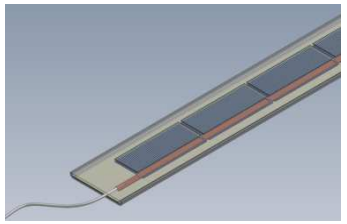
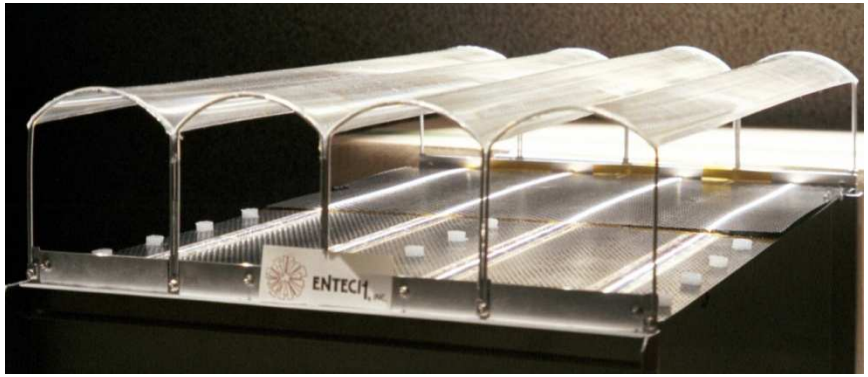


SolarVolt™



Entech's Latest SolarVolt™ Module Borrows Heavily from Our Space Technology

- Entech Has Worked with NASA and DOD on Space CPV Arrays for 25 Years, and the Synergy Between Our Space Stretched Lens Array (Left Photo) and Our Latest CPV Module (Right Photo) Is Obvious
- In Space We Need to Minimize Weight, On the Ground We Need to Minimize Cost, and Material Efficiency Is Critical to Both



Space Stretched Lens Array (SLA) Above and SolarVolt™ Panel at Right

Entech Solar Background: 30 Years of Field-Proven Concentrating PhotoVoltaic (CPV) Technology

NASA/Boeing Company
1.3 kW CPV System
(First kW-Scale CPV System Ever Installed Using Multi-Junction Cells)

PG&E Company
(PVUSA)
20 kW CPV System

Northern States Power Company
800 W CPV System

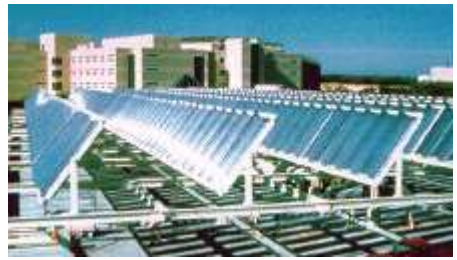
Central and South West Company
100 kW CPV System

Sandia National Labs
10 kW and 22 kW
CPV & CPVT Systems

TU Electric
(Texas Utilities Company)
100 kW CPV System

DFW Int'l Airport
CPVT System, U.S. DOE
24 kW_e / 140 kW_t

3M, City of Austin, State of Texas, U.S. DOE
300 kW CPV System

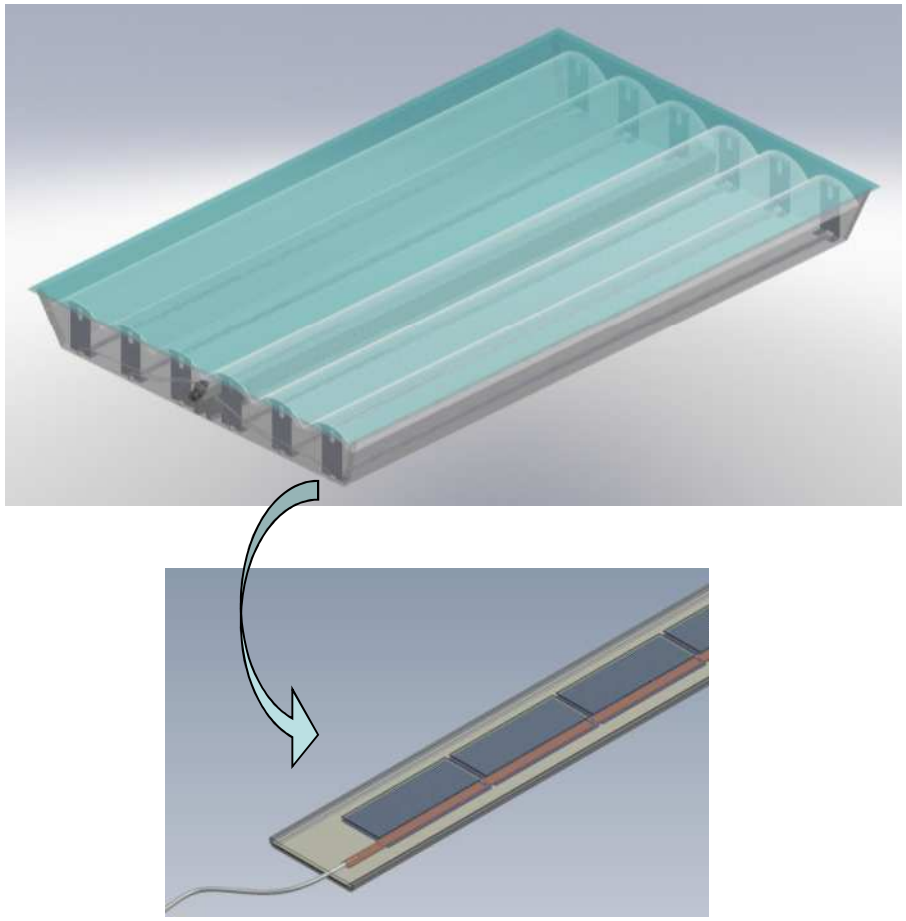


Previous Generation CPV Modules

- 20X linear Fresnel lens concentrators focusing onto one-sun-type silicon cells
- Commercial, industrial and utility applications
- 30 years of field-proven performance and durability with many customers at various locations (from Hawaii to Ohio, from Minnesota to Texas)
- Over 500 kW of installed systems
- Basis of our new SolarVolt™ Design

SolarVolt™ Concentrating PhotoVoltaic (CPV) Module

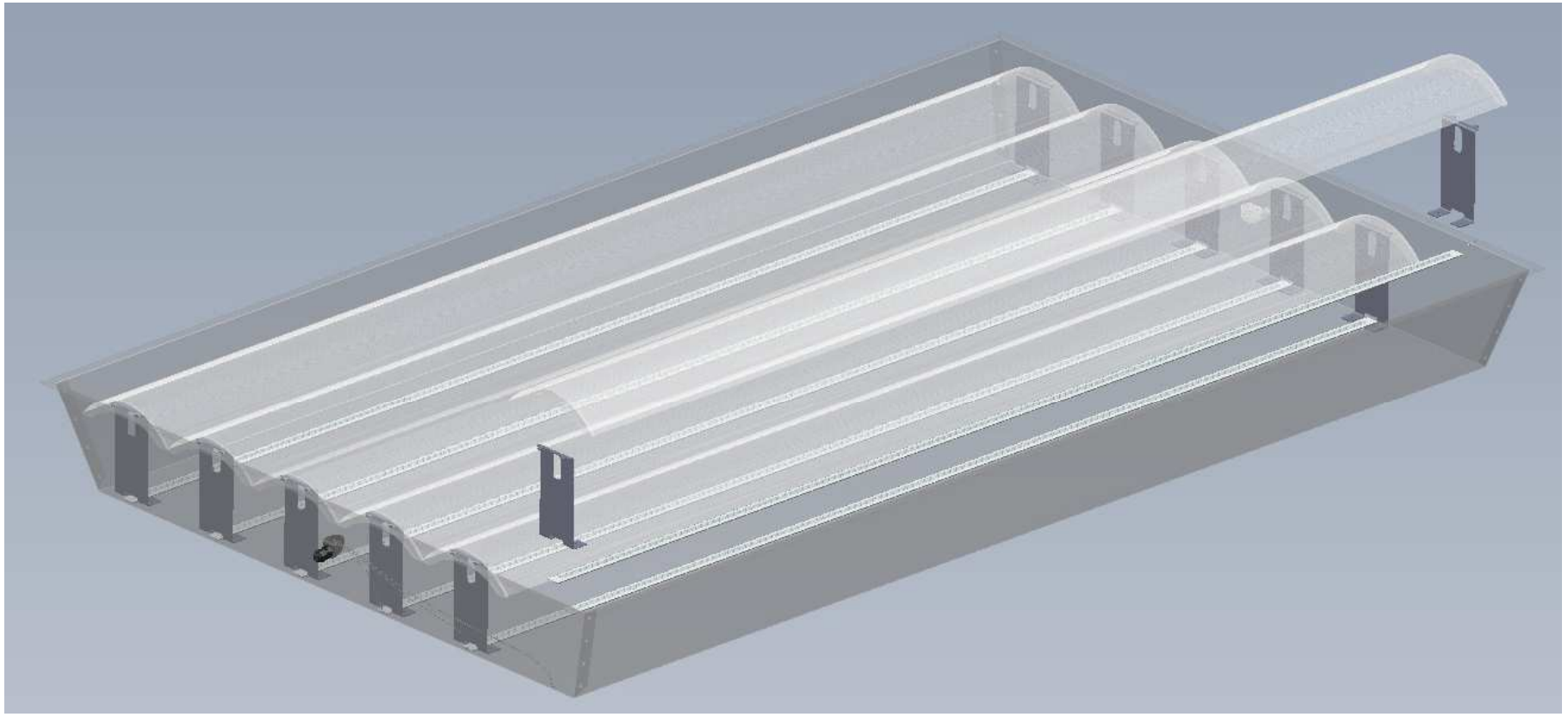
Concentrating Photovoltaic (CPV) Product for Large-Scale Solar Power Plants



Key Features of the State-of-the-Art SolarVolt™ Product

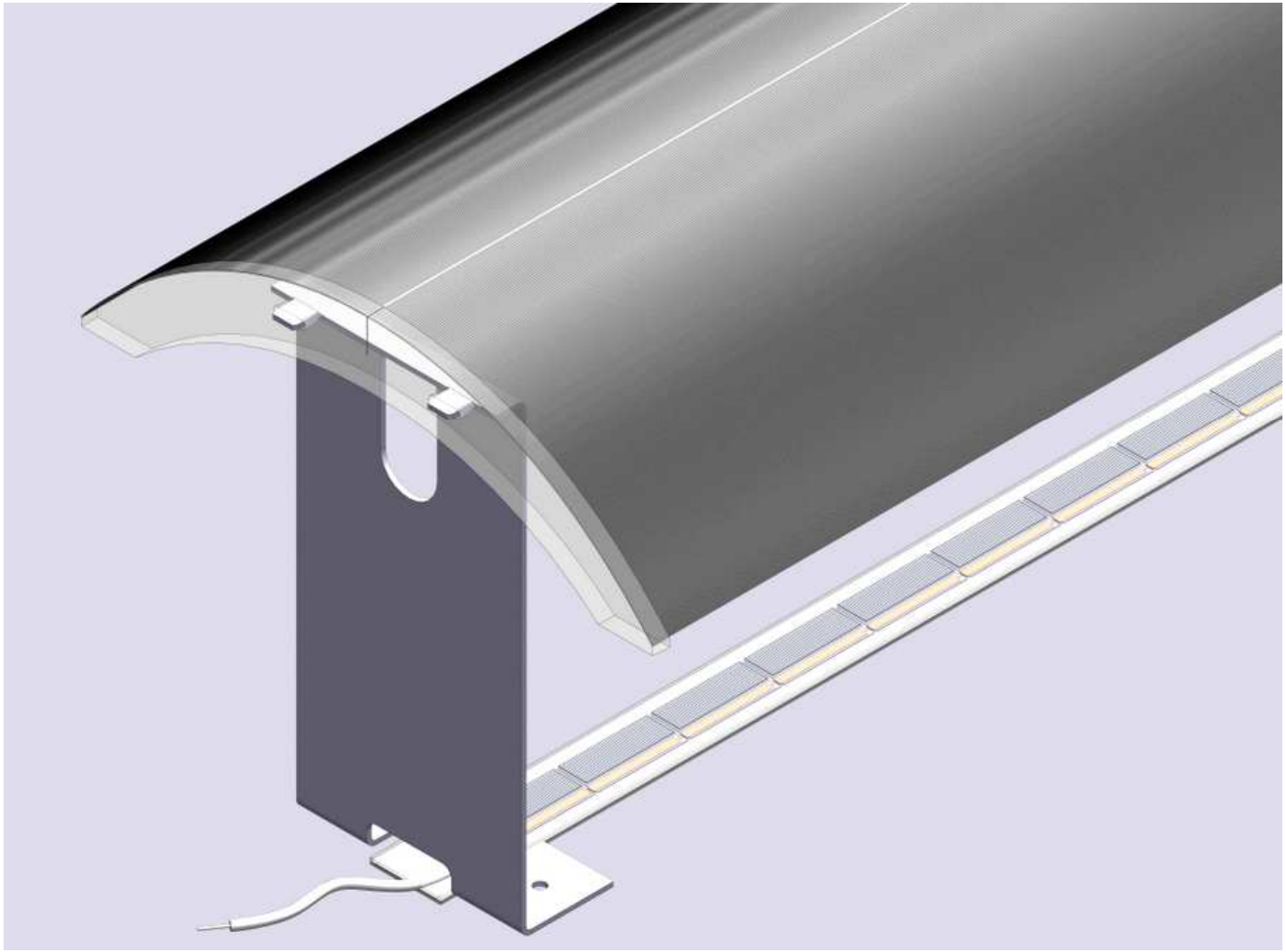
- Durable AR-Coated Tempered Glass Front
- Thin High-Efficiency Acrylic Fresnel Lenses
- Long-Life High-Performance Silicon Cells
- Fully Encapsulated Solar Cell String
- Robust Aluminum Housing
- Six Lenses Collect and Focus the Sunlight Onto Six Narrow Solar Cell Circuits
- 20X Concentration Saves More than 90% of the Silicon Cell Area per Watt Compared to Conventional One-Sun PV Panels
- Manufacturing Cost of SolarVolt™ Is Lower than for One-Sun Silicon PV Panels Which Currently Dominate the Marketplace
- SolarVolt™ Is Protected by Multiple Issued and Pending Patents

SolarVolt™ CPV Panel Schematic Blow-Up

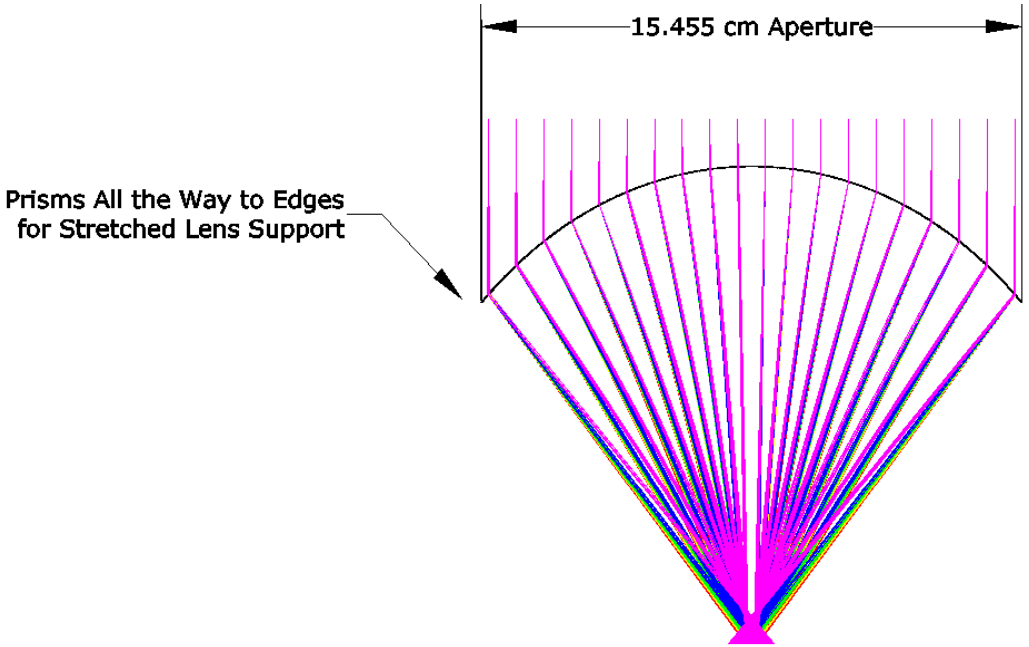


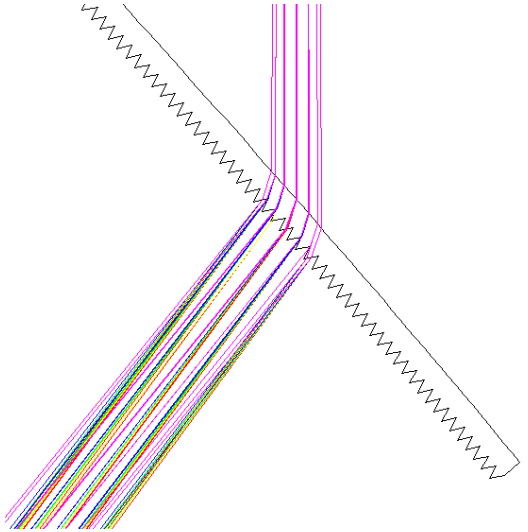
Each Lens Is Supported Using Entech's Patented Stretched Lens Approach
Originally Developed for Space Applications

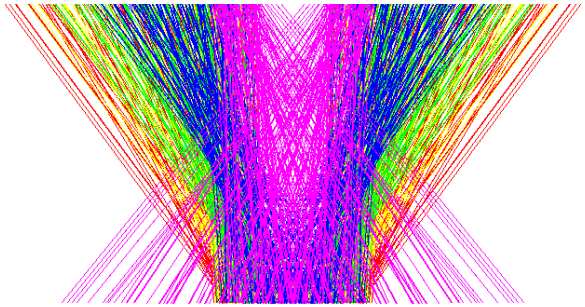
CPV Lens-Receiver Schematic



Thin Lensfilm (250 microns) Design Uses Entech's Symmetrical Refraction Approach





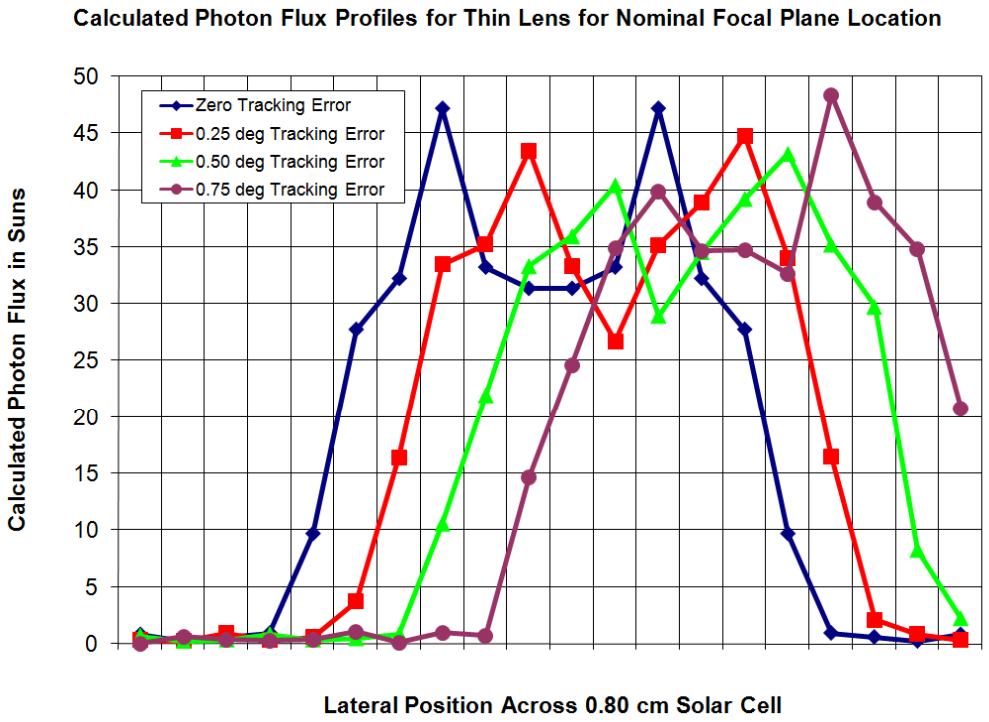


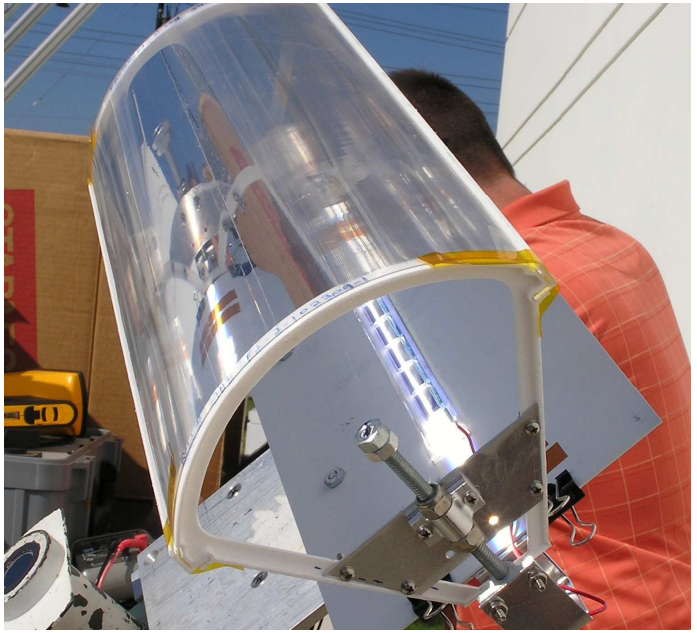
Edge Blow-Up Shown Above and Focal Region Blow-Up Shown on the Left

Our Symmetrical-Refraction Lens Offers:

- Minimum Reflection Loss, Maximum Transmittance
- Sharper Focusing
- Shorter F/#
- Exceptional Shape Error Tolerance
  - >200X Better than for Reflective Concentrators
  - >100X Better than for Flat Lenses

Thin Lensfilm Irradiance over the Cell



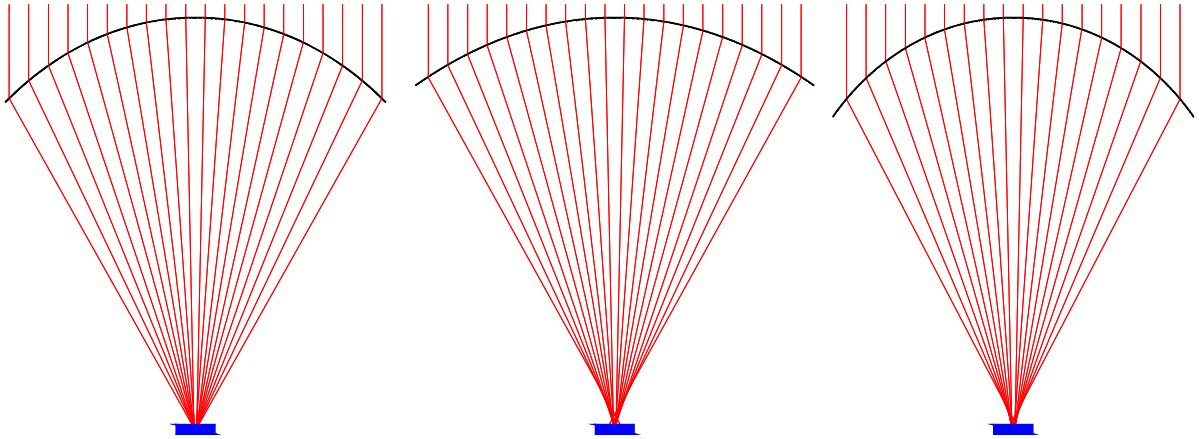


Prisms Are Optimized for 20X Concentration and ±0.75 Degree Sun-Pointing Tolerance

Outdoor Measurements Confirm 90% Net Optical Efficiency at 20X

Direct Ray-Trace Comparison of Shape Error Tolerance of Entech Solar's Lens Versus a Reflective Concentrator

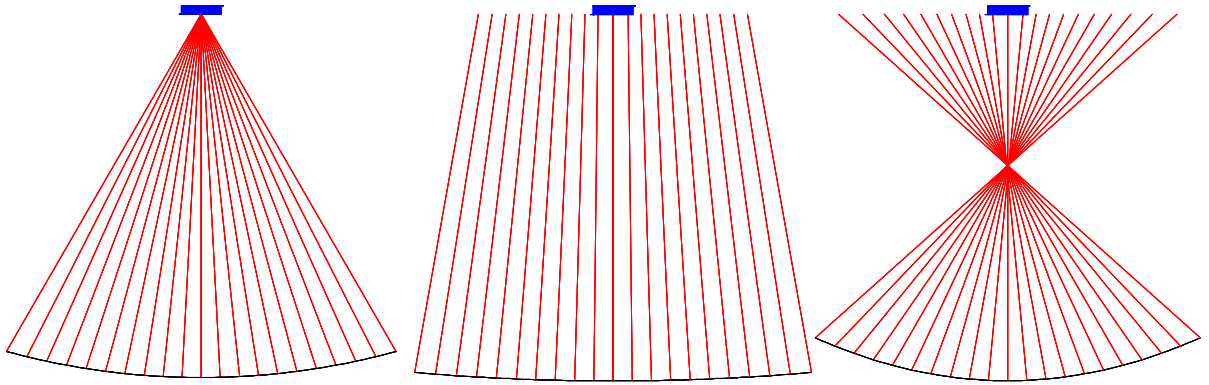
- Results Are Equally Applicable to Line-Focus or Point-Focus Concentrators
- Lens and Reflector Both Have 30 degree Rim Angles
- Red Lines Are Ray Traces
- Identical Slope Error Distributions for Lens and Reflector
- The Same Slope Error Causes >200X More Defocusing for a Reflector of Any Kind than for Entech Solar's Lens
- While Not Shown Here, a Similar Ray Trace Analysis Shows the Entech Solar Lens to Have >100X Shape Error Tolerance Advantage Over Flat Fresnel Lenses



Lens with Perfect Shape

Lens with Flattened Shape with -10 degree Slope Errors at Both Edges

Lens with Overbent Shape with +10 degree Slope Errors at Both Edges

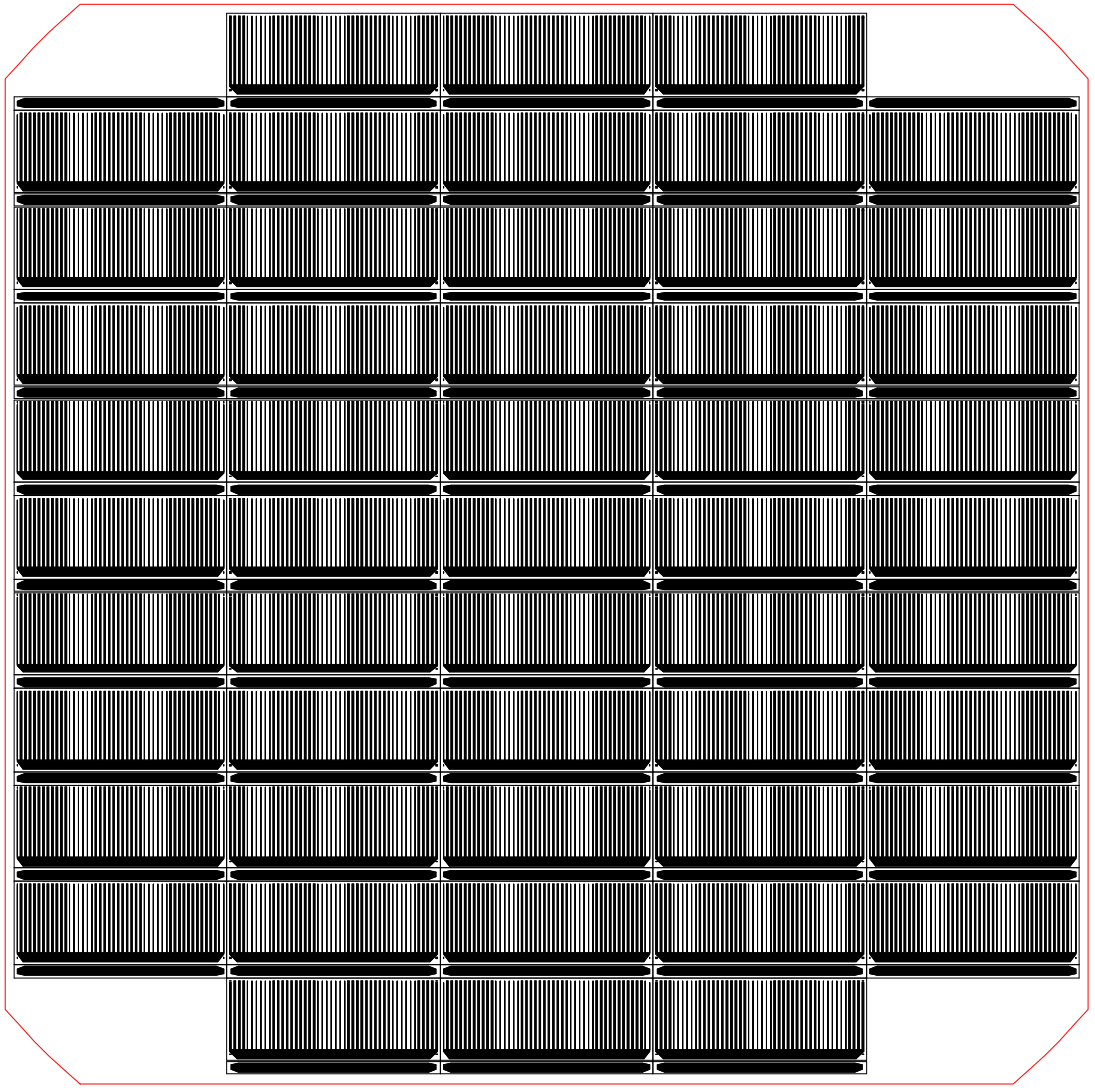


Parabola with Perfect Shape

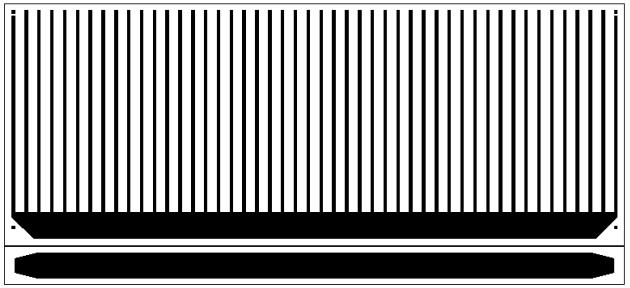
Parabola with Flattened Shape with -10 degree Slope Errors at Both Edges

Parabola with Overbent Shape with +10 degree Slope Errors at Both Edges

51 Pairs of Cells and Bypass Diodes per 125 mm Pseudo-Square Wafer



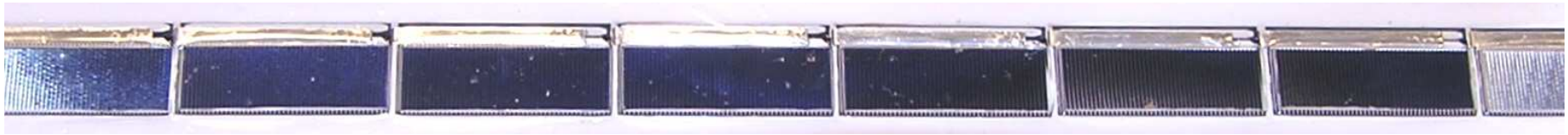
When Used in SolarVolt™, Each 125 mm Wafer Produces 31-33 Watts



One Pair: 1 Cell and 1 Diode

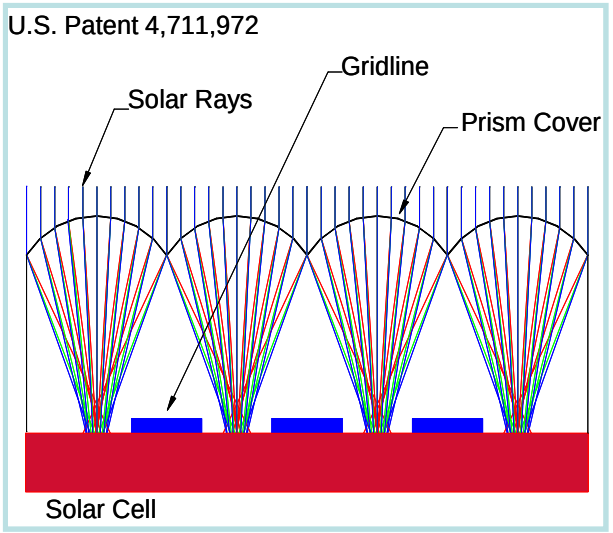
Each SolarVolt™ CPV Panel Has Six Receivers, Each with 60 Pairs of Cells and Diodes, for a Total of 360 Pairs, Equivalent to About 7 Wafers of the 125 mm Size Shown

Photovoltaic Receiver in SolarVolt™



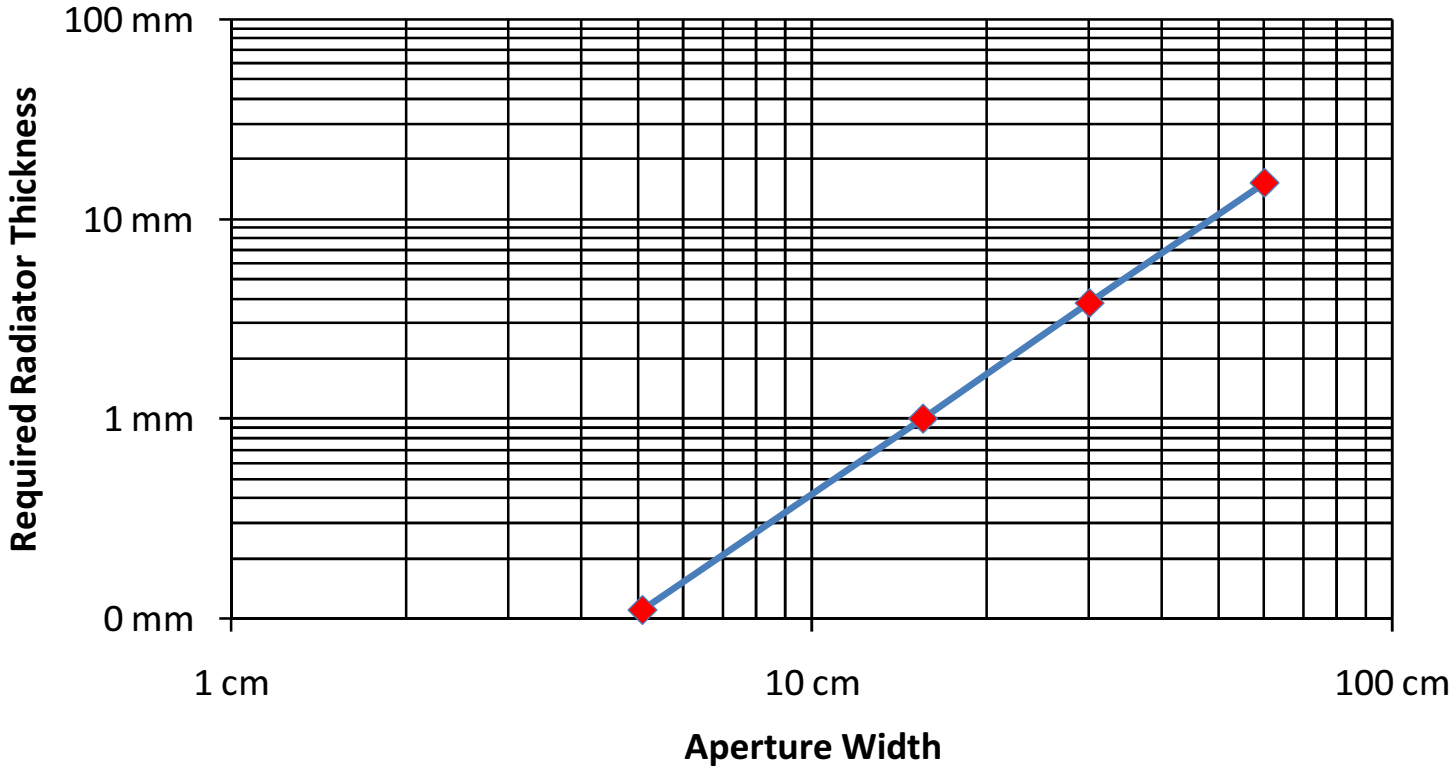
Cells Are Typically 30-40% Metallized with Gridlines But Suffer No Shadowing Loss After Prism Covering, Yielding About 20%-Efficient Concentrator Cells from Standard Screen-Printed 17%-Efficient One-Sun Cell Technology

New Patents Pending for New Approaches to Prism Cover Manufacturing and Alignment



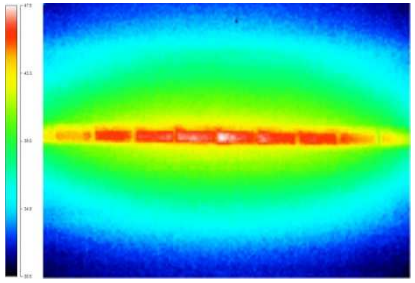
Back-Plane "Radiator" Thickness Versus Lens Aperture Width – Small Is Good, Large Is Bad

Required Aluminum Backplane Radiator Thickness for Line-Focus CPV Module to Maintain Cell Temperature at 50°C on 20°C Ambient Day with 1,000 W/m^2 Direct Normal Irradiance, for Overall Heat Transfer Coefficient from Both Sides of Radiator = 28 W/m^2-°C



SolarVolt™ Thermal Performance

- We've Run a Number of Thermal Tests to Measure the Three Components of Cell-to-Ambient Temperature Differential
  - Cell-to-Radiator Differential
  - Radiator Heat Spreading Temperature Gradient
  - Radiator-to-Environment Convection/Radiation Differential

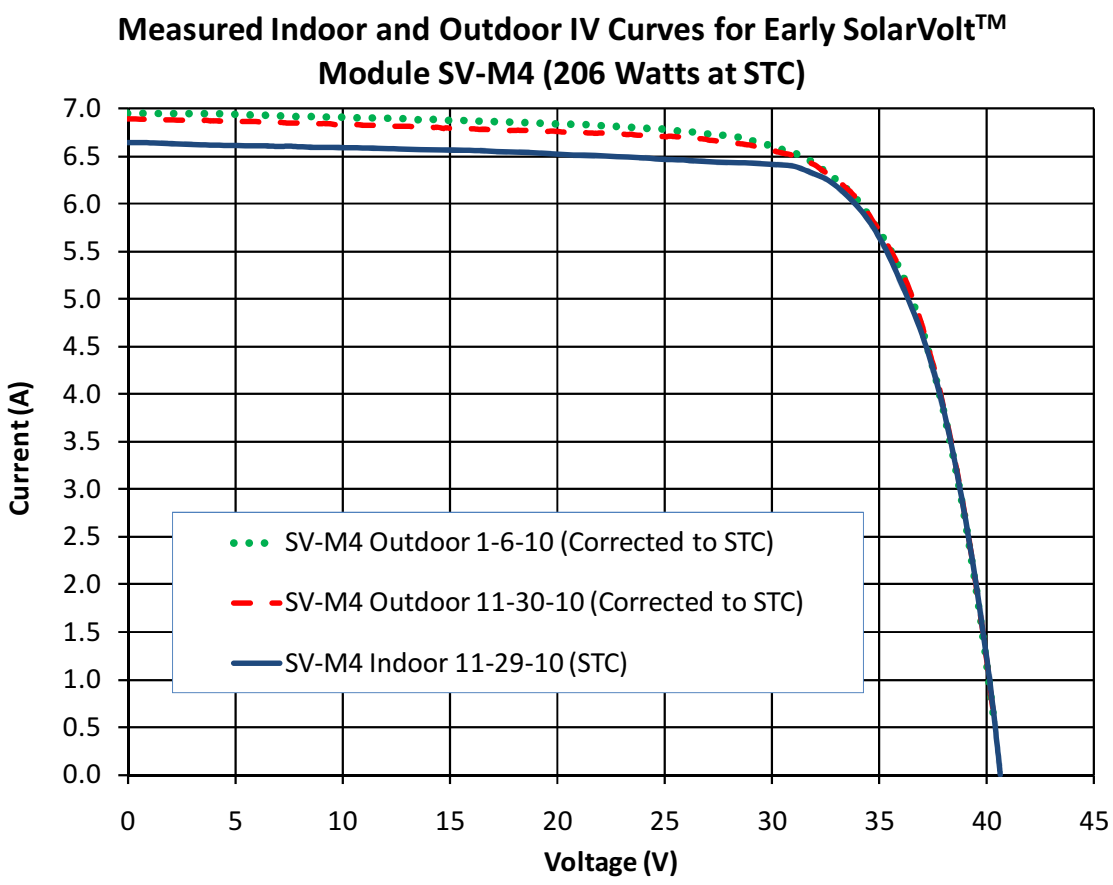


- For Peak Direct Irradiance Conditions (1,000 W/m^2) and a Still-Air 20^{o}C Ambient, the Overall Cell-to-Ambient Temperature Differential Is About 30^{o}C.
- For the Measured Power/Temperature Coefficient of - 0.36%/^{o}C, the Power Will Be ~9% Lower at 50^{o}C Operating Temperature than at 25^{o}C Standard Test Conditions (STC)
- For Comparison, a 500X Multi-Junction Cell Concentrator with Its Lower Power-Temperature Coefficient of ~ - 0.2%/^{o}C (*Kurtz et al., "Considerations for How to Rate CPV," CPV-6*) Would Also Have ~9% Lower Power at 70^{o}C Operating Temperature. Higher Concentration and Radial Heat Flow Imply Higher Cell Operating Temperatures at 500X than for Our Modest 20X for SolarVolt™.

SolarVolt™ CPV Panel Elements

- Glass Top: AR-Coated Tempered 3.2 mm Solar Glass
- Clear Anodized Aluminum Pan: Single-Piece 1 mm Thick Enclosure and Waste Heat Rejection Surface
- Six Stretched Lenses: Thin (0.25 mm) Acrylic Fresnel Lenses of Symmetrical-Refraction, High-Performance, Error-Tolerant Configuration
- Six Photovoltaic Receivers:
  - 60 Series-Connected Silicon Cells Using Conventional One-Sun Solder-Coated Copper Ribbon Stringing
  - Special High-Voltage-Endurance Dielectric
  - Prism Covers to Eliminate Cell Gridline Shadowing Losses
  - Robust Fully Encapsulated Package

Indoor "Sun Tunnel" Simulator Measurements Versus Outdoor On-Sun Measurements

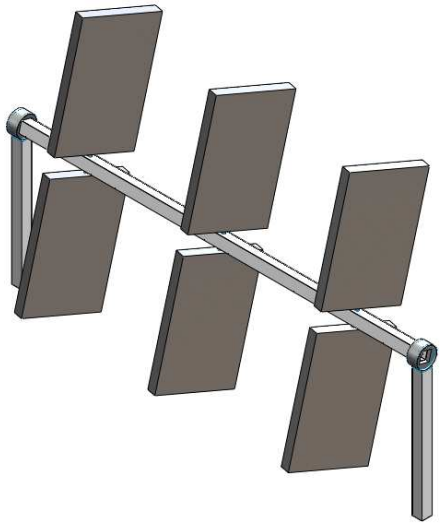


We've Developed a 33-meter-long "Sun-Tunnel" Flash Simulator with a Collimated Beam ($\pm 0.9^{o}$) to Test SolarVolt™ with Good Correlation to Outdoor Testing

New Tracker Development for New SolarVolt™ Panel

- We're presently developing a new version of our SolarRow™ roll-tilt tracker for the new smaller and lighter SolarVolt™ panels.
- The tracker design will be firmly based on the lessons we've learned over the past 30 years for making reliable, robust trackers, and new wind tunnel test results.

Four SolarRow™ Trackers for Previous Generation of Entech CPV Modules



Schematic of Small Section of New SolarRow™ Tracker for SolarVolt™

The New (SolarVolt™) and the Old

- The New SolarVolt™ Panel Is Much Smaller (~50% of Area, ~8% of Volume) and Lighter (~25% of Weight) than the Old Module
- By Using Smaller Lenses, the Aluminum Housing Provides All Waste Heat Rejection, Eliminating the Need for a Heavy (55 kg) and Expensive Heat Sink
- By Using a Glass Window to Protect the Stretched Lenses from the Elements, 0.25 mm Thick Acrylic Lensfilm Replaces 3.5 mm Thick Laminated Acrylic Lenses
- The 25 kg 15-cm Deep SolarVolt™ Provides Half the Power of the 100 kg 90-cm Deep Old Module

Conclusion and Future Plans

- **Firmly Based on Our Heritage of Field-Proven CPV Technology, SolarVolt™ Represents Our Smallest, Lightest, and Lowest Cost CPV Product to Date:**
  - Small, Thin Stretched Lenses from Our Space CPV Technology
  - Silicon Cell Material Usage Reduced by More than 90% Compared to One-Sun Modules
  - Thin Aluminum Pan Provides Support and Heat Rejection
  - Tempered AR-Coated Glass Window Protects Lensfilm and Receivers from Elements
- **We Plan to Commercialize SolarVolt™ in 2012, After We Complete the Following Activities this Year (2011):**
  - New SolarRow™ Tracker Development and Array Field Testing
  - Manufacturing Scale-Up, Both In-House and at Key Suppliers
  - IEC 62108 Certification, Which Began Last Fall (2010)

Backup

Why We Currently Use Multi-Junction Cells for Our Space CPV and Silicon Cells for Our Terrestrial CPV Products

- With Our Partners at Boeing, NASA, and DOD, We Flew Our First Mini-Dome Fresnel Lens/Dual-Junction Cell CPV Array in Space in 1994 (PASP+), and It Worked Exceptionally Well
- With Our Partners at ABLE Engineering (Now ATK), NASA, and DOD, We Flew Our First Color-Mixing Arched Fresnel Lens/Triple-Junction Cell CPV Array in Space in 1998 (Deep Space 1), and this Award-Winning Array Performed as Predicted Over the Full 38-Month Mission, the First Space Mission to Be Powered by Triple-Junction Cells
- Using Our Space Stretched Lens Array with Triple-Junction Cells in Outdoor Testing in 2001, We Demonstrated Over 30% Net Module Efficiency at Operating Temperature
- In Space, Watts/kg Is King, and Multi-Junction Cells Beat Silicon Cells Hands-Down in Both One-Sun and Concentrator Arrays
- On Earth, Watts/Dollar Is King, and Our Cost Model Shows that Simple Line-Focus Lens Modules Using Low-Cost One-Sun-Type Silicon Cells Are Still More Cost-Effective than More Complex Point-Focus Lens Modules Using Currently 300 Times More Expensive Multi-Junction Cells
- Silicon Cells Also Enjoy a Very Long Term (> 30 Years) Successful Heritage While Multi-Junction Cells Represent a New Technology for Terrestrial Applications (About 8 Years)
- Line-Focus Modules Are Simpler than Point-Focus Modules, Using Continuous Strips of Lens and Photovoltaic Receiver Materials, Rather than Individual Optical and Receiver Elements
- We Obviously Use and Appreciate Both Cell Technologies, and We Will Continue to Perform R&D in Both Areas for Terrestrial Applications