

# PV Technology For Global Village Power

**Village Power '98**  
**Off-Grid PV Systems Workshop**  
**World Bank, Washington, D.C.**  
**October 5, 1998**

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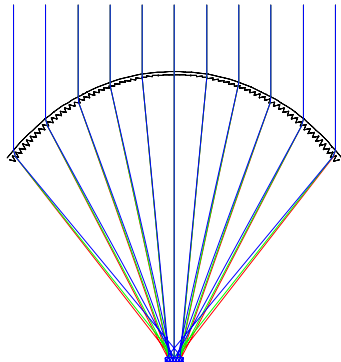
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# ENTECH'S Terrestrial Photovoltaic Products For Global Village Power



## ◆ **SunLine**

- Solar PV System That Produces 800 Watts Of Power For Small And/Or Remote Applications (DC or AC)

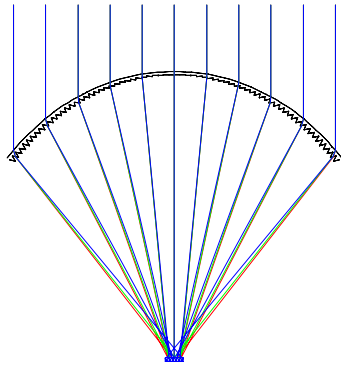
## ◆ **SolarRow**

- Solar Photovoltaic System That Uses Sunlight To Produce Power For Multi-kW To Multi- MW Users (DC or AC), For Villages to Utilities

## ◆ **Licenses**

- ENTECH Is Developing Local Industry and Jobs by Licensing Companies In-Country to Manufacture and Sell These Products To Provide Local Village Power, As Well As for Other Independent and Sustainable Power Applications

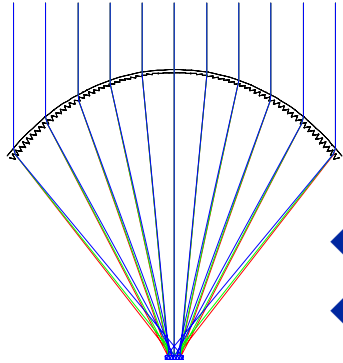
## SunLine PV Product



- ◆ Power Output: 800 Watts (DC)
- ◆ Two 4th-Generation Concentrator PV Modules
- ◆ Solar-Charged 12 VDC Battery Powers the Micro-processor Controller and the Sun-Tracking Drives for Both Tilt and Roll Axes
- ◆ All-Galvanized Structure Can Be Fabricated In-Country And Fully Assembled in Local Factory for Easy Field Installation



## **SolarRow PV System Product**



- ◆ **Four *SolarRows* at CSW\* Solar Park, Fort Davis, Texas**
- ◆ **Power Output: 25 kW Per *SolarRow*, 100 kW For 4 Rows**



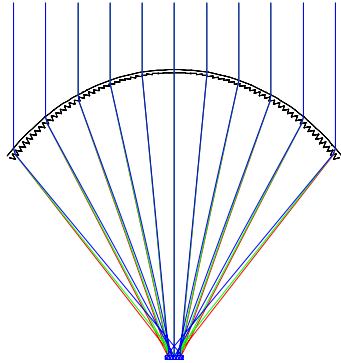
\* CSW - Central and South West Company - Major Electrical Utility In USA



## ENTECH's Technology Licensing Program Outside U.S.

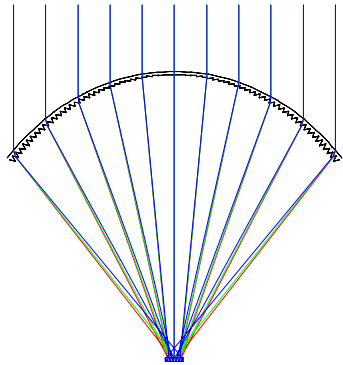
- ◆ License Agreement Gives In-Country Company (Licensee) Right To Manufacture & Sell *SunLine* & *SolarRow* Products For Village Power And Other Sustainable Power Markets
- ◆ License Program:
  - ENTECH
    - Receives Up Front Fee To Cover Technology Transfer & Training
    - Ships Fresnel Lenses, Solar Cell Assemblies & Other Specialty Components To Licensee For Life Of Agreement
    - Makes Available To Licensee On-Going Tech. Support & Consultation
  - Licensee
    - Builds Aluminum & Steel Components In-Country
    - Assembles Modules, Structures, Controls, Drives & Inverters In-Country
    - Sells, Installs, Maintains, And Operates Systems As Desired

## ENTECH PV Product Advantages



- ◆ **Can Achieve Lower Product Cost Than Competition With**
  - **Moderate Production Volume**
  - **Minimal Technical Risks**
- ◆ **Ideal For International Licensing**
  - **Creates In-Country Jobs & Local Economic Development Through Manufacturing, Assembly, Installation, Operation & Maintenance**
  - **Creates U.S. Jobs - Manufacture Specialty Components In USA**
  - **Allows For Rapid Market Expansion**
- ◆ **Provides Predictable Energy Costs For 30 Years Or More**

## ENTECH PV Product Advantages (Continued)



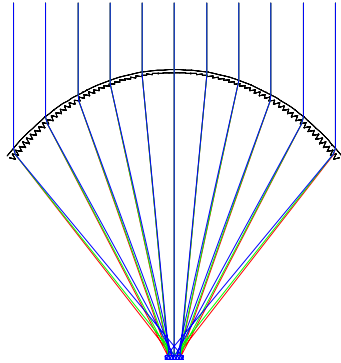
- ◆ **Long Term Performance & Reliability Verified By Numerous Third-Parties**
- ◆ **Technology Protected Internationally Through Key Patents**
- ◆ **ENTECH's Solar Power Systems Can Provide:**
  - **Electricity, Hot Water And/Or Distilled Water For Villages, Homes, Hospitals, Schools, Apartments, And Businesses**
  - **Electricity For Remote Water Pumping**
  - **Electricity And/Or Process Heat For Local Industries**
  - **Electricity For On-Grid or Off-Grid, DC or AC Applications**
- ◆ **Can Rapidly Expand Production To 100's of Megawatts Per Year**



Experience  
High-Performance & Reliability

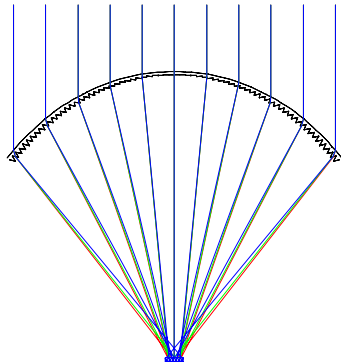


## ENTECH Experience

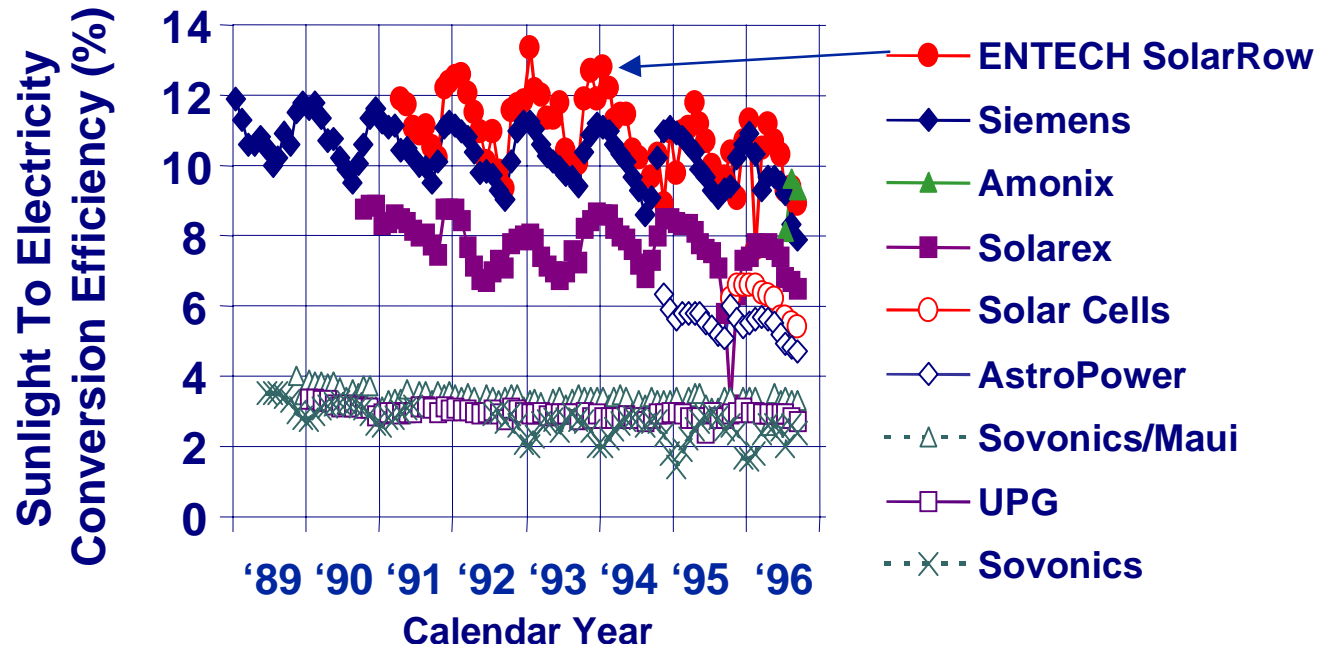


- ◆ **Technical and Management Team Together Since 1977**
- ◆ **Four Generations of Terrestrial Concentrator PV Technology**
- ◆ **More than \$30 Million of R&D Investment to Date**
- ◆ **Prior Successful Contracts:**
  - **Government - U.S. Dept. of Energy, Sandia National Laboratories, National Renewable Energy Laboratory, Jet Propulsion Laboratory, NASA**
  - **Utilities - Bechtel/Pacific Gas & Electric Company, Texas Utilities Company, Central and South West Company, Northern States Power, City of Austin Municipal Electric Department, Tennessee Valley Authority**
  - **Companies - 3M and Overseas Customers**
- ◆ **ENTECH Has Received Over 11 Patents On This Solar Technology**
- ◆ **Recognized as the Leader in Concentrating Photovoltaic Technology for Terrestrial and Space Applications**

## High Performance & Reliability



**ENTECH Is the Long-Term Leader In Independent PV Tests Of U.S. Manufacturers' Photovoltaic Systems At PVUSA\***

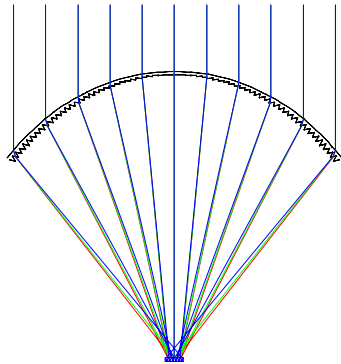


\* PVUSA - PhotoVoltaic for Utility-Scale Applications Program (Davis, CA USA)

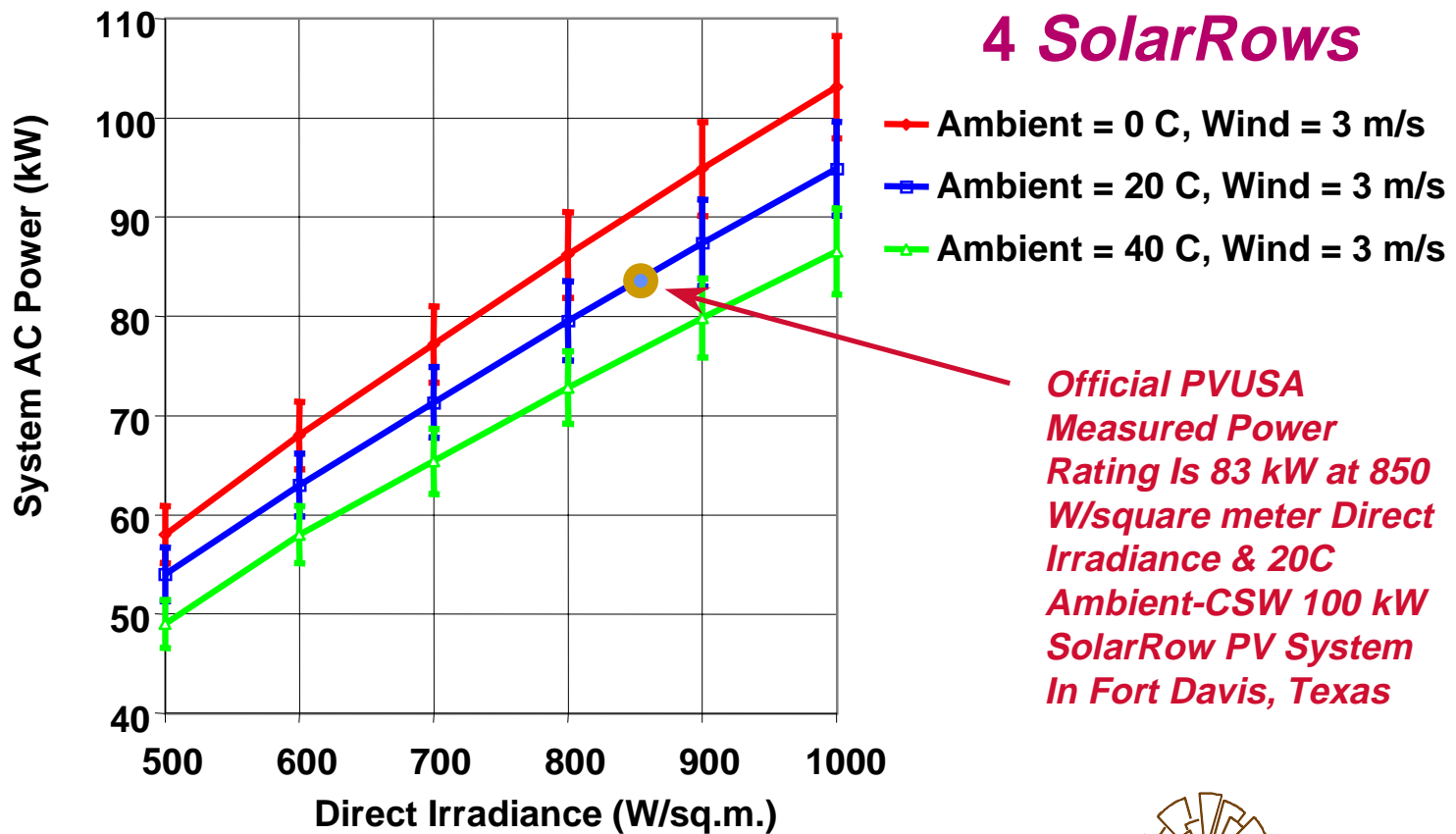
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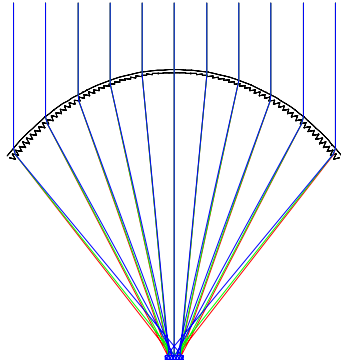
# High Performance & Reliability Predictable PV System Power



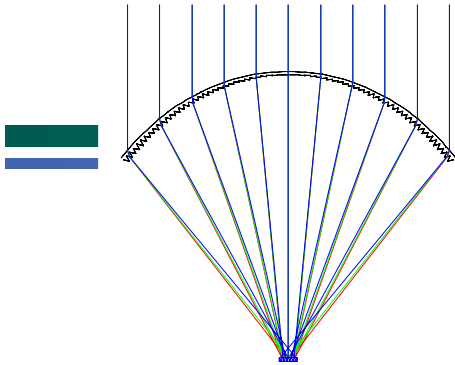
*Curves Are Predicted Based on Sandia Module Test Data Correlations with 95% Wiring/Mismatch Loss and 94% Inverter Efficiency*



## High-Performance & Reliability SunLine PV System In Minnesota

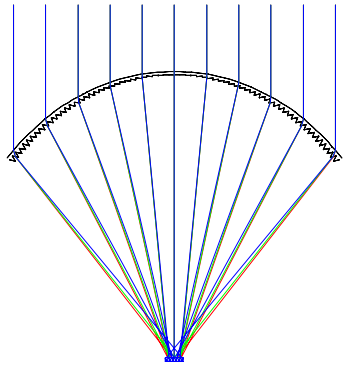


- ◆ **Customer: Northern States Power Company**
- ◆ **Location: 3M Center, St. Paul, MN**
- ◆ **Operational Since July 1995**
- ◆ **Survived 3 Minnesota Winters**
  - **Ice Storms**
  - **Snowstorms**
  - **Minus 35C Ambient**
  - **Many Meters of Total Snowfall**
- ◆ **Survived Severe Wind Storm**
  - **>30 meters/second Speed**
  - **Over 250 Mature Trees Blown Down at 3M Center**
- ◆ **Lenses Never Cleaned**
- ◆ **Negligible Degradation**
- ◆ **Automatic, Unattended Operation**



## PV Technology Designed For In-Country Jobs & Industry

## 4th-Generation Concentrator PV Module



*One-Foot Cross Section*

### ◆ Fresnel Lens:

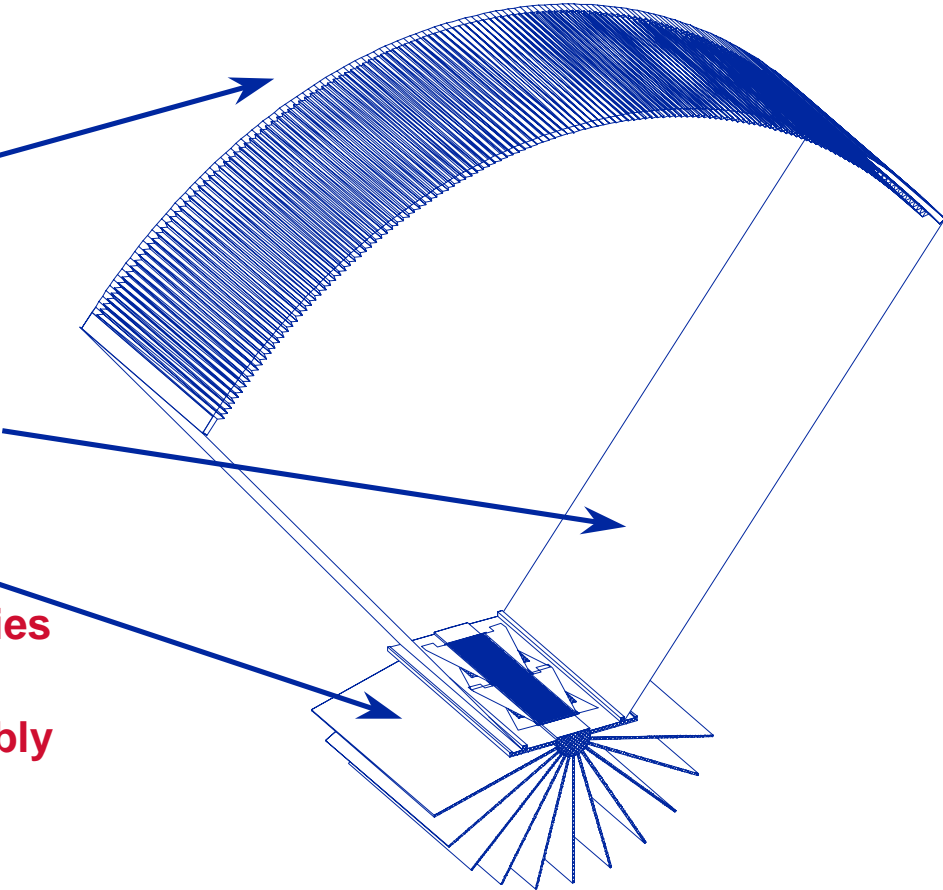
- ENTECH Supplied/3M-Produced Acrylic Lens

### ◆ Marine Aluminum Housing

- Licensee Supplied

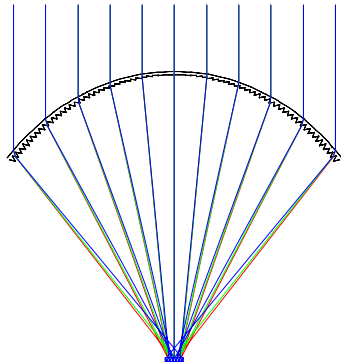
### ◆ Photovoltaic Receiver:

- ENTECH - PV Cell Assemblies (U.S. Patent 4,711,972)
- Licensee - Receiver Assembly (US Patent 5,498,297)
- Licensee - Extruded Aluminum Heat Sink



# Photovoltaic Receiver Assembly

*Assembled In-Country Under License Agreement*



***U.S. Patent 5,498,297 for New, Streamlined, Dry Tape & Film Receiver Assembly Approach***

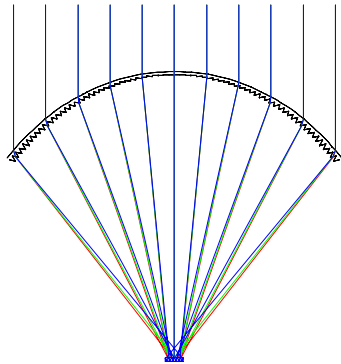


- 37 Cell Assemblies
- 1 Extruded Heat Sink
- Dielectric Tapes/Films
- 430-480 W Output

***Heat Sink Fin Area Is 4X Larger Than Lens Aperture Area***

***Result: Cells Operate As Cool As Cells In Flat Plate PV Modules***

## SolarRow Hardware



*Aluminum & Steel For SunLine & SolarRow Fabricated & Assembled, Along With Other Components, In-Country Under License Agreement*



\* CSW Solar Park, Fort Davis, Texas USA

### ◆ SolarRow Comprises:

- 14 Concrete Piers
- 13 Galvanized Posts
- One Galvanized Bolt-Together Frame
- 72 ENTECH PV Modules
- 12 VDC Roll/Tilt Drives, Controls, & Batteries
- DC Combiner Box with Fused Disconnect, MOV's, and Blocking Diodes
- Two Wires Carry 63 Amps at 400 VDC to the DC/AC Inverter

