

PV Technology For Global Village Power

Village Power '98
Off-Grid PV Systems Workshop
World Bank, Washington, D.C.
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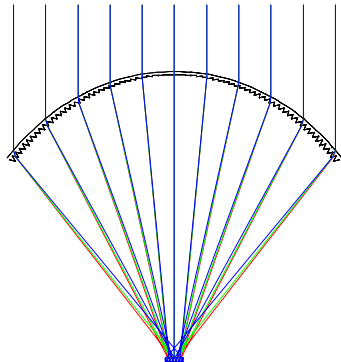
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ENTECH'S Terrestrial Photovoltaic Products For Global Village Power



◆ **SunLine**

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

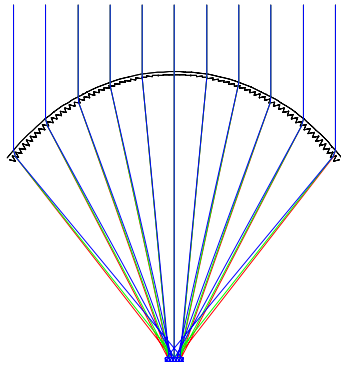
◆ **SolarRow**

- 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

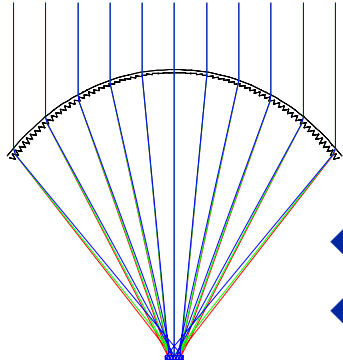
SunLine PV Product



- ◆ 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



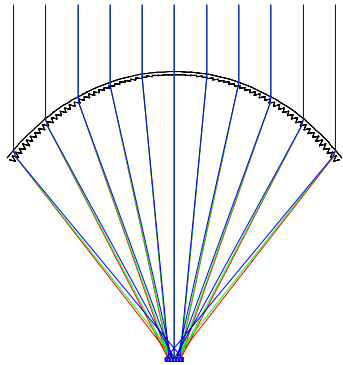
* CSW - Central and South West Company - Major Electrical Utility In USA



ENTECH's Technology Licensing Program Outside U.S.

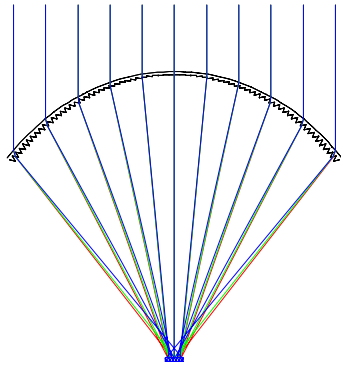
- ◆ License Agreement Gives In-Country Company (Licensee) Right To Manufacture & Sell *SunLine* & *SolarRow* Products For Village Power And Other Sustainable Power Markets
- ◆ License Program:
 - ENTECH
 - Receives Up Front Fee To Cover Technology Transfer & Training
 - Ships Fresnel Lenses, Solar Cell 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

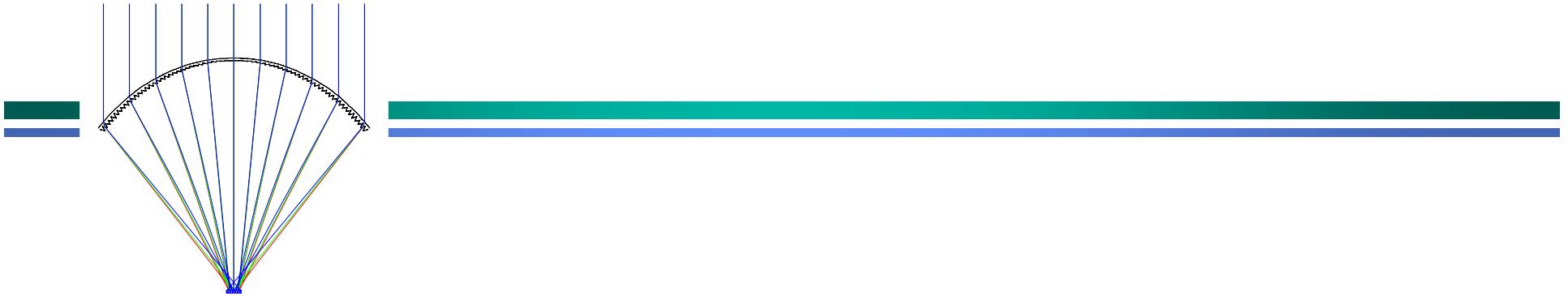


- ◆ **Can Achieve Lower Product Cost Than Competition With**
 - **Moderate Production Volume**
 - **Minimal Technical Risks**
- ◆ **Ideal For International Licensing**
 - **Creates In-Country Jobs & Local Economic Development Through Manufacturing, Assembly, Installation, Operation & Maintenance**
 - **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)

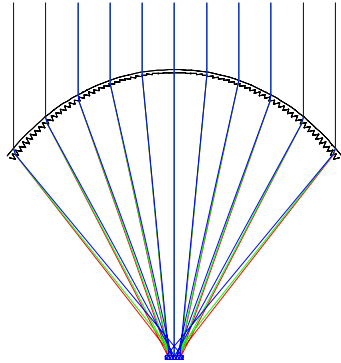


- ◆ **Long Term Performance & Reliability Verified By Numerous Third-Parties**
- ◆ **Technology Protected Internationally Through Key Patents**
- ◆ **ENTECH's Solar Power Systems Can Provide:**
 - **Electricity, Hot Water And/Or Distilled Water For Villages, Homes, Hospitals, Schools, Apartments, And 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**



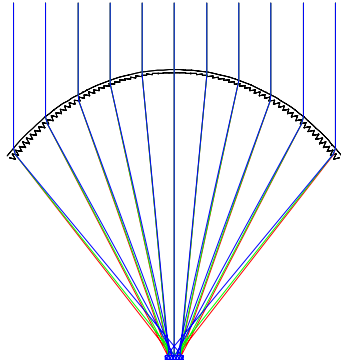
Experience
High-Performance & Reliability

ENTECH Experience

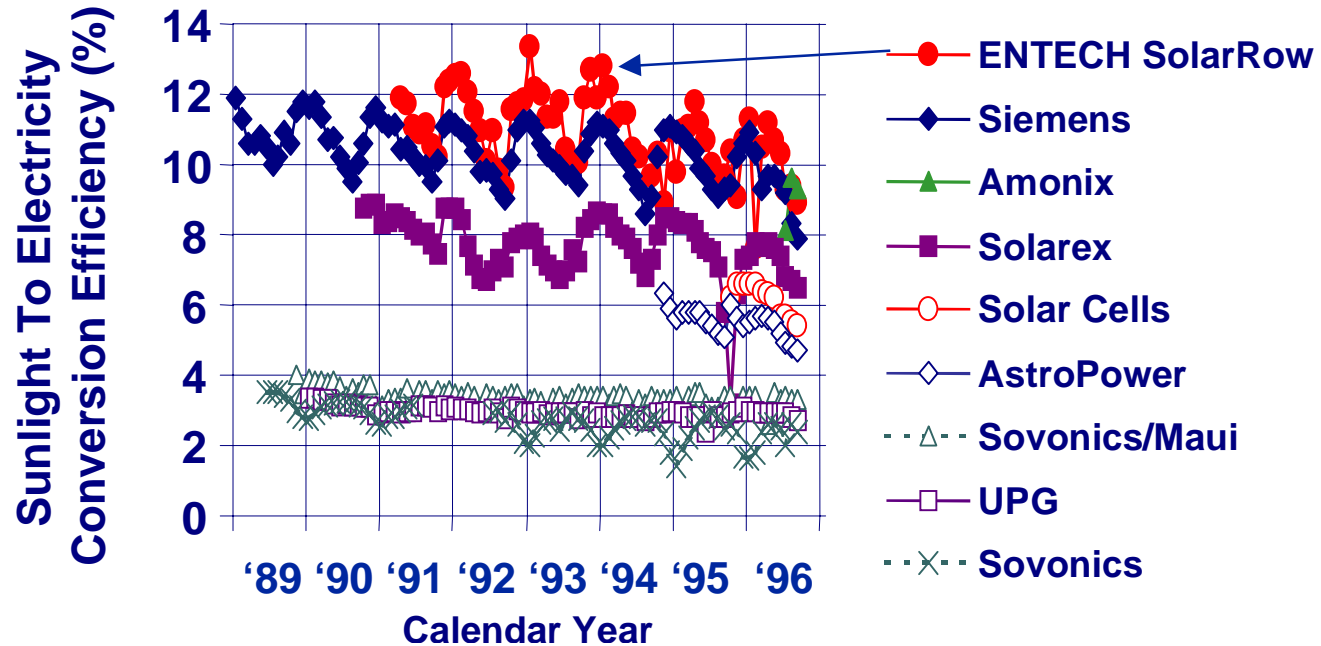


- ◆ **Technical and Management Team Together Since 1977**
- ◆ **Four Generations of Terrestrial Concentrator PV Technology**
- ◆ **More than \$30 Million of R&D Investment to Date**
- ◆ **Prior Successful Contracts:**
 - **Government - U.S. Dept. of Energy, Sandia National Laboratories, National Renewable 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*

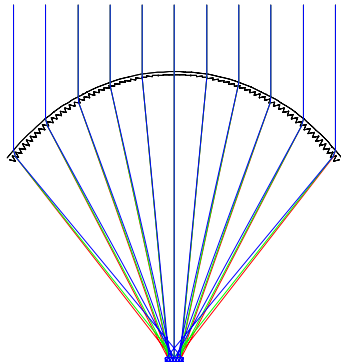


* PVUSA - PhotoVoltaic for Utility-Scale Applications Program (Davis, CA USA)

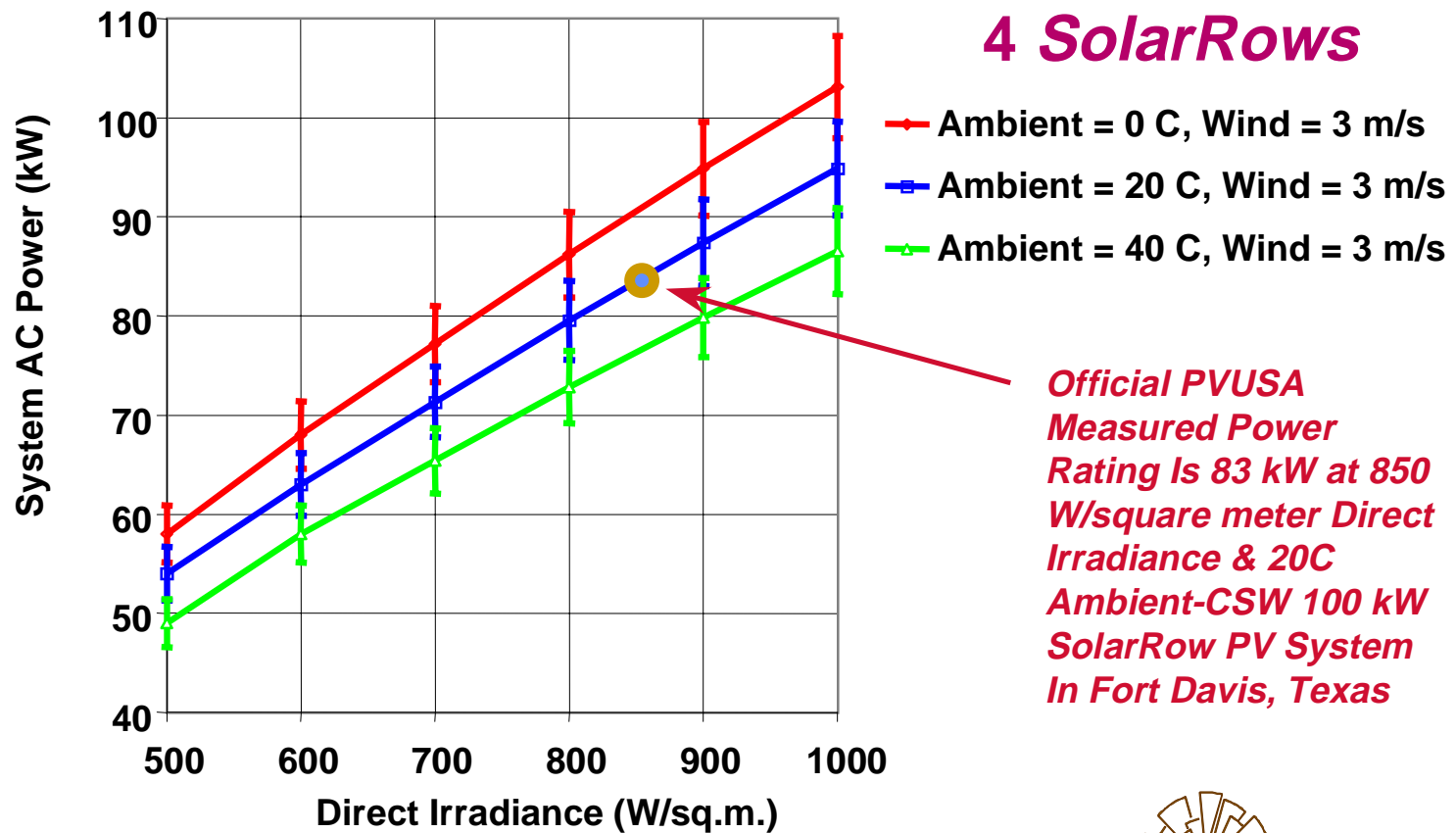
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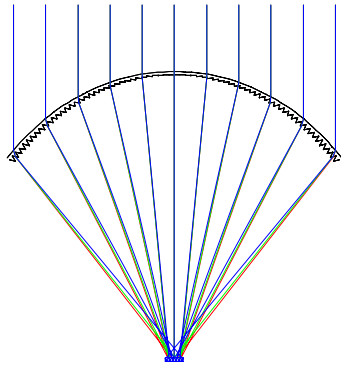
High Performance & Reliability Predictable PV System Power



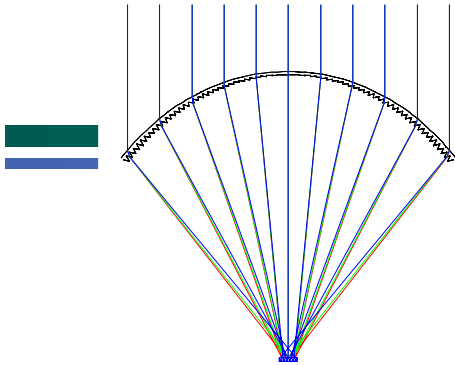
Curves Are Predicted Based on Sandia Module Test Data Correlations with 95% Wiring/Mismatch Loss and 94% Inverter Efficiency



High-Performance & Reliability SunLine PV System In Minnesota

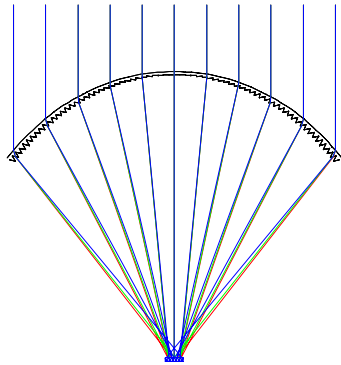


- ◆ **Customer: Northern States Power Company**
- ◆ **Location: 3M Center, St. Paul, MN**
- ◆ **Operational Since July 1995**
- ◆ **Survived 3 Minnesota Winters**
 - **Ice Storms**
 - **Snowstorms**
 - **Minus 35C Ambient**
 - **Many Meters of Total Snowfall**
- ◆ **Survived Severe Wind Storm**
 - **>30 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:**

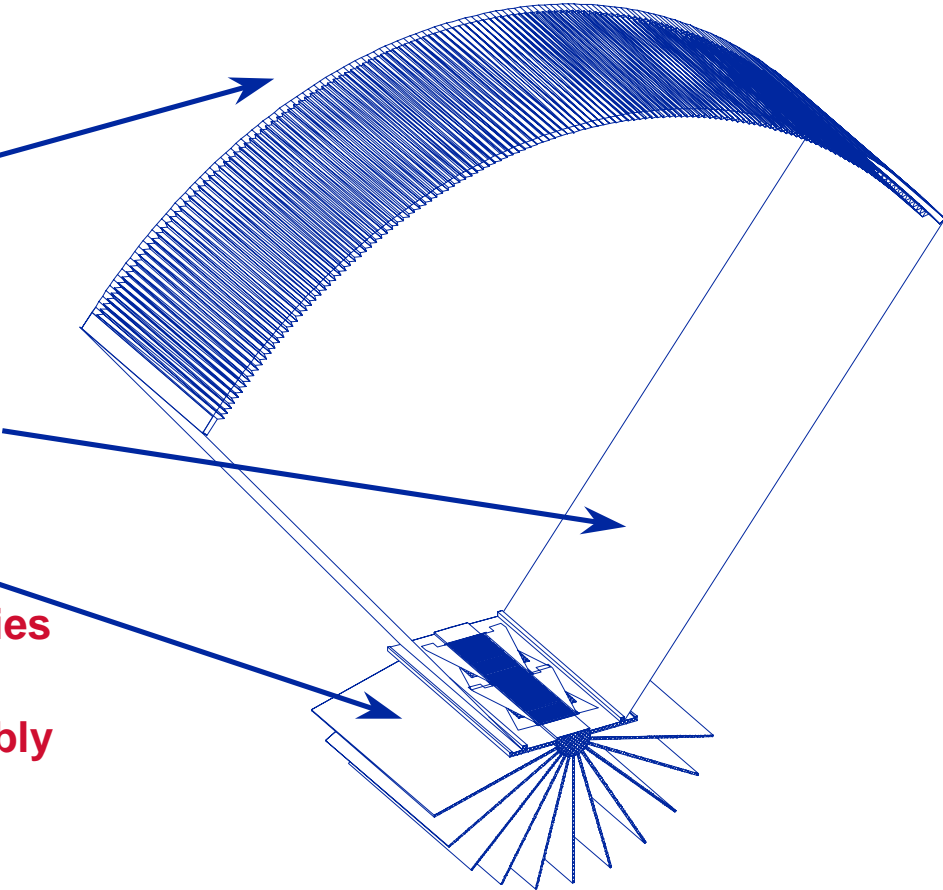
- ENTECH Supplied/3M-Produced Acrylic Lens

◆ **Marine Aluminum Housing**

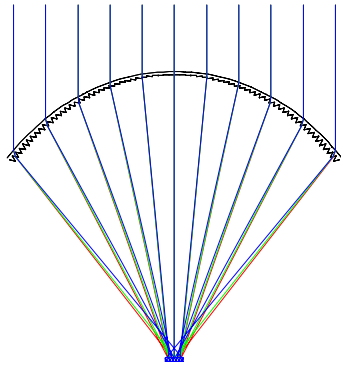
- Licensee Supplied

◆ **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***

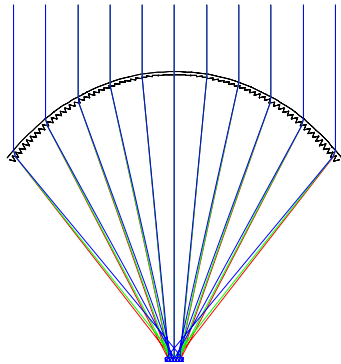


- 37 Cell Assemblies
- 1 Extruded Heat Sink
- Dielectric Tapes/Films
- 430-480 W Output

***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

