



# SkyTrough®

Parabolic Trough Concentrator

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## ATTRIBUTES

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- Low Capital Cost
- High Efficiency
- Unbreakable Mirrors
- Rapid Field Assembly
- Compact Transportation
- Low Maintenance
- Proven & Reliable

## Next Generation Solar Parabolic Trough Technology

SkyTrough® is a high performance parabolic trough collector for use in solar thermal power plants or industrial process heat applications. Its breakthrough design is patterned after the best of previous generation parabolic troughs with important innovations that improve performance and reduce cost. SkyTrough makes concentrating solar power the affordable, dispatchable choice for today's clean power markets.

SkyTrough has undergone rigorous testing and validation over the course of the last ten years. It has been successfully deployed in some of the harshest environments on earth, including extreme heat, cold, sand, wind and hail, making it a proven and reliable choice for any project.

## HOW SKYTROUGH® WORKS

SkyTrough concentrates sunlight onto an evacuated thermal receiver, held with precision along the full length of the collector's focal line. A heat transfer fluid flows through the receiver to absorb the sun's energy and then delivers the thermal energy to a heat exchanger, where it generates steam for power generation or industrial processes.



CONTROL AND DRIVE: At the center of each SkyTrough is OnSun, an integrated control and drive system.

## ADVANTAGES

SkyTrough collectors deliver the proven reliability of traditional glass mirror parabolic trough systems, but with several performance and economic advantages resulting from significant design and material innovations.

Use of ReflecTech® mirror film results in light monolithic mirror panels that are easy and quick to install, requiring no optical adjustment. Each ReflecTech mirror panel is one third the weight of its sagged glass mirror equivalent.

The lightweight aluminum space frame uses less material, is easier to transport, and requires less time and labor to assemble in the field than welded steel torque tube or torsion box designs.

The rugged OnSun™ integrated control and drive system provides highly accurate position using a helical, hydraulic rotary actuator and the SkyTrakker™ control board for precision tracking. An integrated SCADA platform allows for complete plant and system control with data collection from one interface.

## CONSTRUCTION

The highly reflective surface of SkyTrough is a glass-free, silvered polymer called ReflecTech mirror film. This proprietary reflector technology is low cost, easy to maintain, lightweight, abrasion resistant, and commercially proven. When laminated to an aluminum sheet and integrated into the SkyTrough frame, ReflecTech mirror film forms the most optically accurate parabolic surface in existence. The space frame is made of extruded aluminum struts and is self-aligning when joined together with fasteners, requiring no welding. The entire assembly is mounted on pylons and attached to a self-locking rotary hydraulic drive enabling the SkyTrough to pivot and track the sun. This approach creates the ability for rapid field assembly using minimal labor and equipment. The complete assembly process is completed on site without the need for a dedicated building or precision jigs or fixtures, dramatically reducing construction time and cost.

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## REFERENCE PROJECTS

ENEL Stillwater Geothermal Boost	Nevada, USA
Medicine Hat ISCC	Alberta, Canada
WaterFX Desalination	California, USA
Gümüşköy Geothermal Hybrid	Turkey
SEGS II Loop	California, USA
SkyTroughDSP	Colorado, USA
Molten Salt Test Platform	Colorado, USA



MEDICINE HAT ISCC: CSP and Natural Gas Hybrid Power Generation, Canada



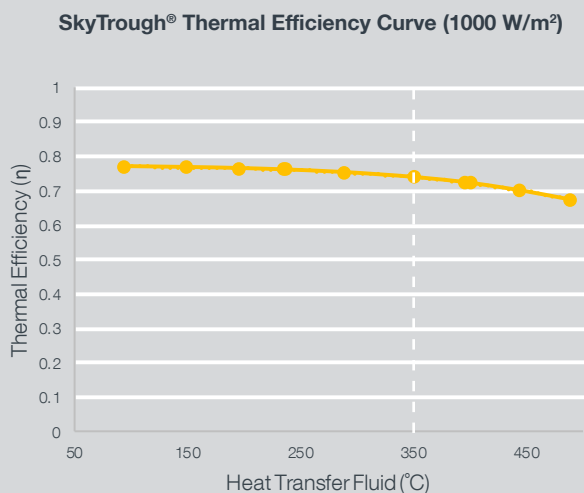


NOVEL RIB AND PANEL STRUCTURE: SkyTrough features an innovative space frame design and introduces a rib and panel mirror structure – a first for parabolic trough technology

## PROVEN PERFORMANCE

A SkyTrough collector loop, with ReflecTech mirror film and OnSun tracking system, began operation at SEGS II in Daggett, California since February 2010. Performance data collected from the operating loop confirms the 73 % thermal efficiency predicted by testing at the U.S. National Renewable Energy Lab (NREL). ReflecTech mirror film has demonstrated optical durability of over 30 years in NREL's Ultra Accelerated Weathering System.

## SKYTROUGH EFFICIENCY

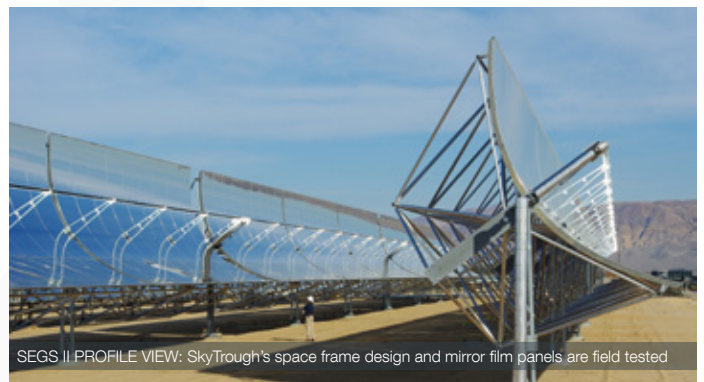


The orange line is the thermal efficiency of SkyTrough based on optical efficiency and receiver heat loss measurements from NREL.

At an operating temperature of 350 °C a parabolic trough solar collector used for utility-scale power generation has an efficiency (η) = 0.73.

## CONCLUSION

The innovations found within SkyTrough enable significant performance and cost improvements over other commercially available parabolic trough collectors, making SkyTrough the most cost-effective parabolic trough solution available today. Choosing SkyTrough for your project will minimize the cost of thermal energy production and ensure reliable operation for decades.



SEGS II PROFILE VIEW: SkyTrough's space frame design and mirror film panels are field tested

## SkyTrough® Specifications

### GEOMETRY

Total Solar Collector Assembly <sup>(1)</sup> Length	115 m	377 ft
Net Aperture Area	656 m <sup>2</sup>	7,061 ft <sup>2</sup>
Number of Modules <sup>(2)</sup>	8 per Solar Collector Assembly <sup>(1)</sup>	
Module Aperture Length	13.9 m	45.6 ft
Module Aperture Width	6.0 m	19.7 ft
Receiver Type	Evacuated	
Receiver Length	4.722 m	15.5 ft
Absorber Tube Diameter	80 mm	3.15 in

(1) The Solar Collector Assembly ("SCA") length comprises the modules, pylons, control and drive, and ball joints (one at each end).  
(2) A module is the parabolic mirror and receiver unit supported by a pair of pylons.

### PERFORMANCE

Optical Efficiency	76 %		
Thermal Efficiency <sup>(3)</sup>	72 %		
Design Point Thermal Output <sup>(3)</sup>	480 kW-th <sup>(*)</sup>		
Maximum Temperature (Thermal Oil)	400 °C	750 °F	
Maximum Temperature (Molten Salt)	565 °C	1,050 °F	
Indicative Annual Energy Generation	1,000 MWh-th <sup>(*)</sup>		
Indicative Design Point Gross Electric Output <sup>(4)</sup>	180 kW-e <sup>(*)</sup>		
Typical Land Use	2 ha/MW-e	5 acre/MW-e	
Maximum Installed Slope	4 % gradient		
Maximum Wind Speed (Stow)	37.5 m/s	84 mph	3 second gust
Maximum Wind Speed (Operation)	18 m/s	40 mph	3 second gust
	13 m/s	30 mph	Sustained

(3) Defined as (Gross Thermal Power) / (Solar Power) at 1000 W/m<sup>2</sup> of direct normal incident solar radiation and 350 °C heat transfer fluid temperature.

(4) At 37.5 % steam turbine efficiency

(\*) kW-th = Kilowatt Thermal; MWh-th = Megawatt-Hour Thermal; kW-e = Kilowatt Electric

### MIRRORS

Structural Backing	Aluminum Sheet
Reflective Surface	ReflecTech® Mirror Film
Specular Reflectance <sup>(5)</sup>	94 %
Mirror Service Life	30+ Years

(5) At 1.4° acceptance angle measured with a Device & Services Specular Reflectometer

### ONSUN™ DRIVE AND CONTROLLER

Controller Communication	Network	RS485 Wired
Control System Architecture	SCADA + PLC + Embedded Board @ Drive	

For more information, contact:

[info@SkyFuel.com](mailto:info@SkyFuel.com)

SkyFuel, Inc.

200 Union Blvd Suite 590, Lakewood, CO 80228, USA

+1 303.330.0276

[www.SkyFuel.com](http://www.SkyFuel.com)

