

Heating up Decarbonization: Solar Thermal Assessment

May 19, 2021



TODAY'S SPEAKERS



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THE CHALLENGE OF DECARBONIZING THERMAL

Renewable Thermal: Beyond Electricity



50% OF GLOBAL
final energy is comprised
of energy used for heating
and cooling



\$270 BILLION
amount heating and
cooling cost in the
United States annually.



39% OF GHG
emissions from energy-
related sources can be
attributed to heating
and cooling.



The world already has
great renewable electricity
solutions but if we are to
keep the warming of the
planet below 2 degrees
then we also need great
renewable thermal
solutions.

Barry Parkin, Chief Sustainability and
Health & Wellbeing Officer, Mars

Facilitated by:





RENEWABLE THERMAL COLLABORATIVE

Members:



Sponsors:



Update

July 6:

Event site goes live and
registration opens



First Summit Sponsors:



Blue Delta Energy



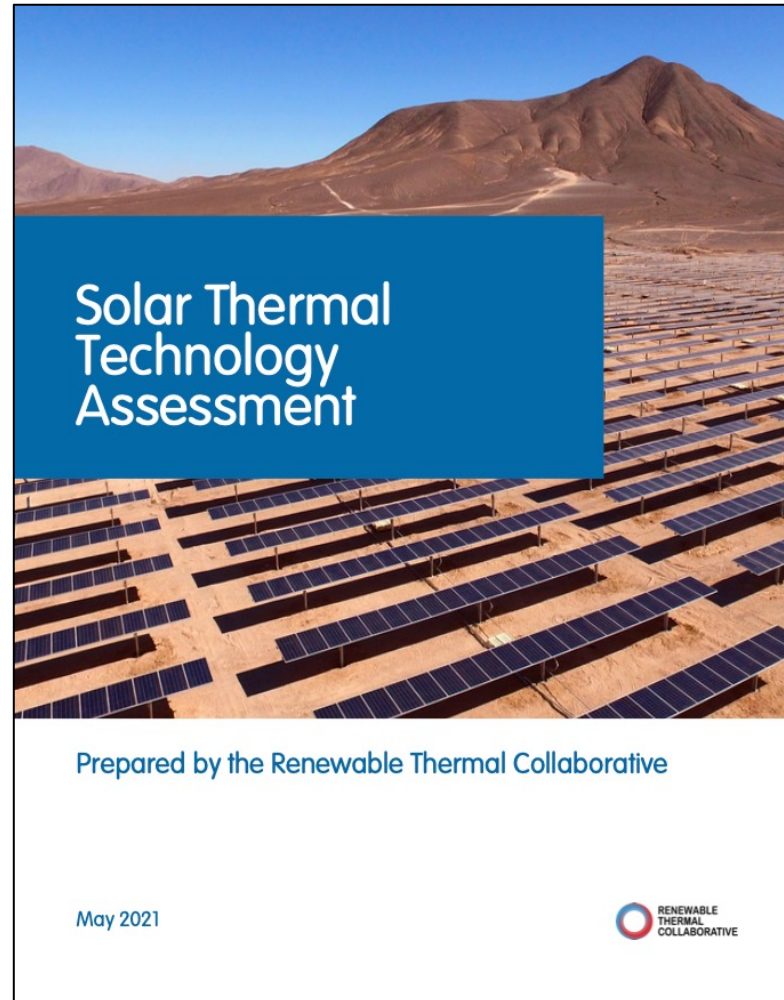
Wrap-up and Next Steps

Upcoming RTC dates:

- May 20: RNG Working Group meeting
- May 25-6: VERGE Electrify
- May 26: Policy Working Group meeting
- June 8: Projects Working Group meeting
- June TBD: RNG webinar
- July 6: RTC Summit site goes live
- July 13: Community Call
- Sept. 29-30: RTC Summit

SOLAR THERMAL ASSESSMENT

Introduction



SOLAR THERMAL ASSESSMENT

Introduction

What is solar thermal's technical and market potential in the near (2030) and long (2050) terms?

What are the primary barriers to accelerated industrial deployment of solar thermal technologies?

What solutions could be effective in addressing those barriers?

What can large energy users do to accelerate their decarbonization efforts using solar thermal?

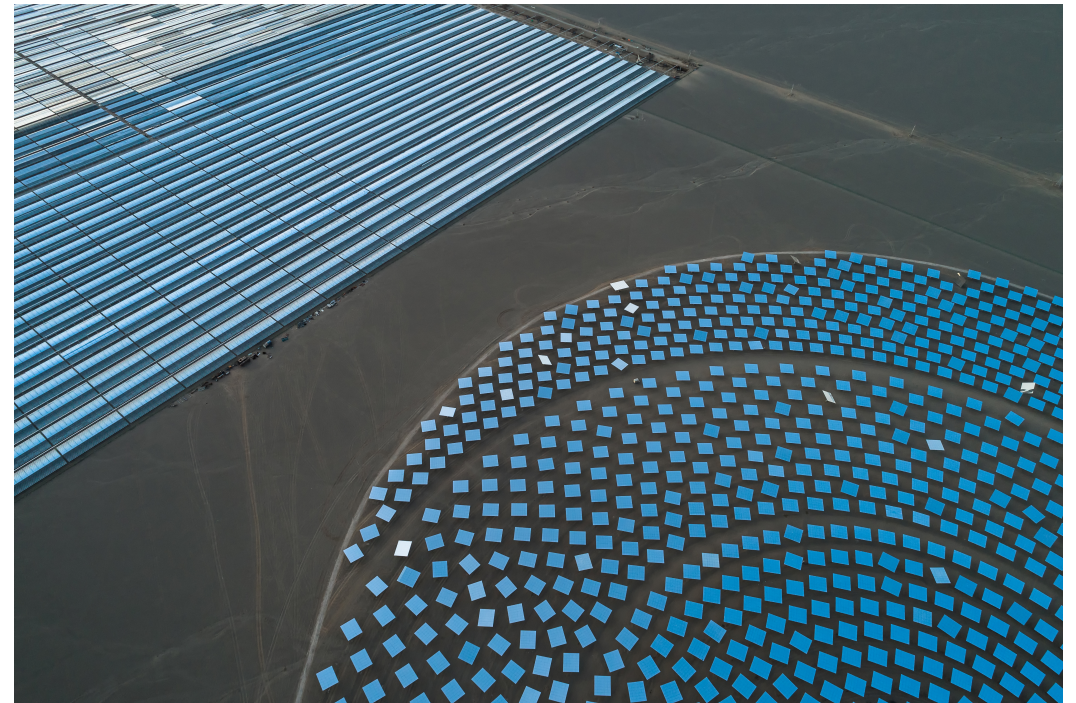


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Potential

Where is solar thermal today?

- 1% of industrial energy use
- Non-Concentrated Solar Power
 - Up to 100°C
- Concentrated Solar Power (CSP)
 - Up to 1000°C



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Potential

Technology	Year	Year	Technical or Market Potential
Non-Concentrated Solar Thermal	2030		Technical potential to supply 30-40% of global low-medium temperature process heat demand; 14,000 PJ
Non-Concentrated Solar Thermal		2050	Predicted, using combined technical and market potentials, 6.3% of industrial global energy use; 8,000 PJ
CSP	2030		Cost is predicted to remain too large a barrier before 2030
CSP		2050	Predicted, using combined technical and market potentials, 1% of U.S. industrial energy use; 135 GWh

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Barriers

What are the primary barriers to accelerated industrial deployment of solar thermal technologies?

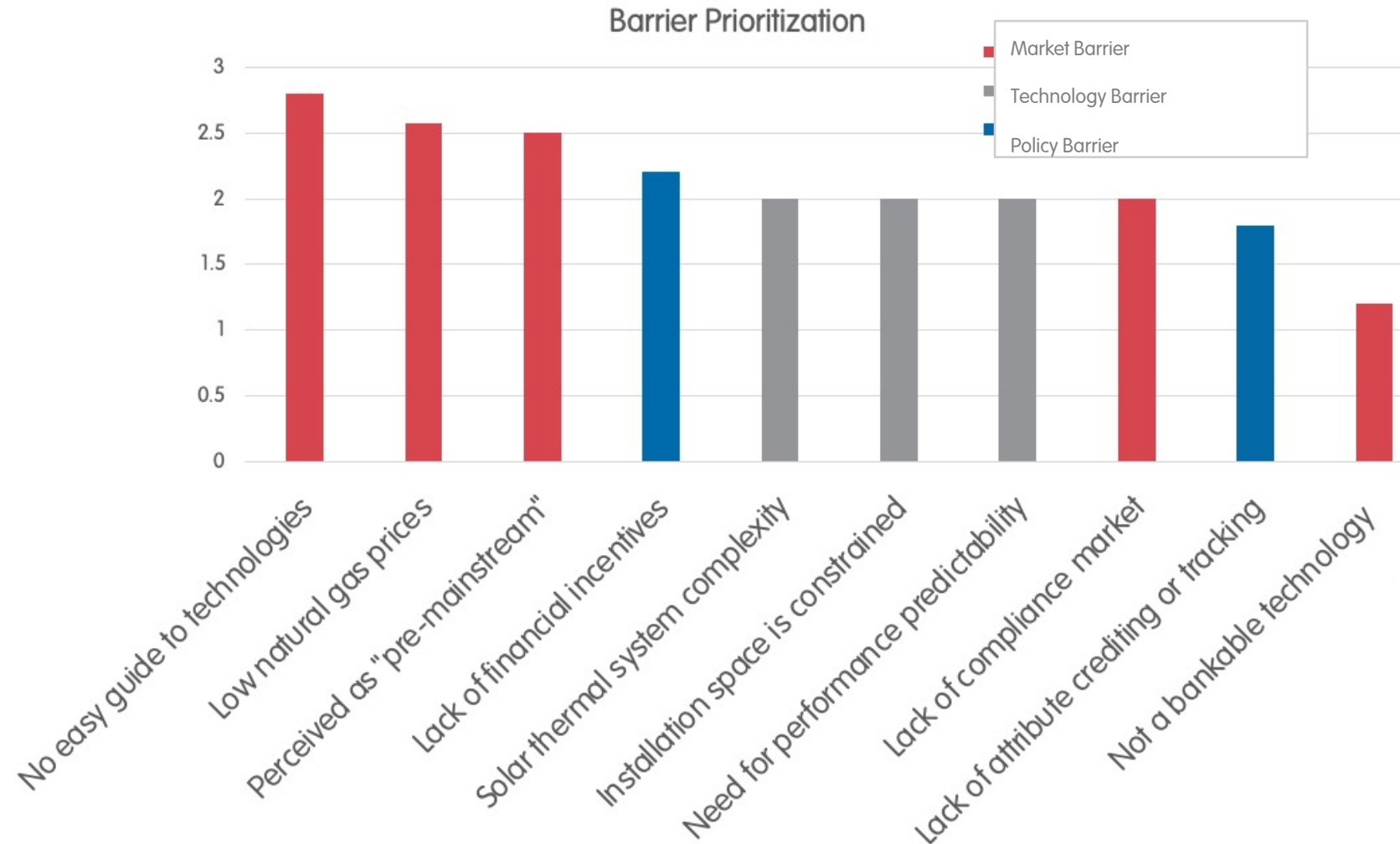
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Barrier	Category
Solar thermal system complexity	Technology
Installation space is constrained	Technology
Solar thermal is not a bankable technology	Technology
Low natural gas prices	Market
No easy guide to solar thermal technologies	Market
Solar thermal perceived as “pre-mainstream”	Market
Lack of attribute crediting or tracking	Market
Need for performance predictability	Market
Lack of financial incentives	Policy
Lack of a solar thermal compliance market	Policy

Barriers

Live Polling: Barriers

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Barriers

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Solutions

What solutions could be effective in addressing those barriers?

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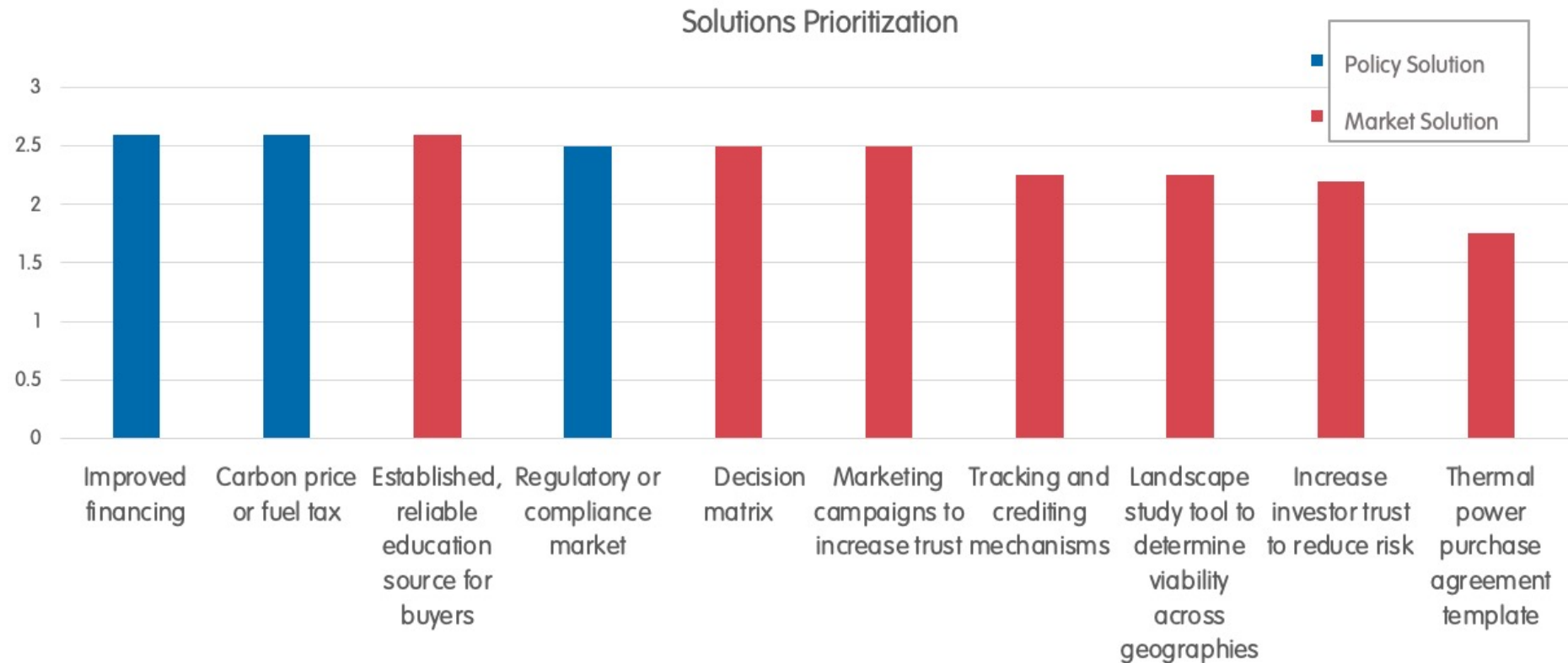
Solution	Category
Increase financial incentives	Policy
Increase regulatory or compliance market support	Policy
Create a carbon price or fuel tax	Policy
Increase tracking and crediting mechanisms	Market
Create a thermal power purchase agreement template	Market
Increase investor trust to expand financing options	Market
Create a decision matrix for energy users	Market
Create educational resources for buyers	Market
Develop a landscape study tool to assess viability across geographies	Market
Deploy marketing campaigns to increase trust in solar thermal	Market

Solutions

Live Polling: Solutions

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Solutions



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Actions

What can large energy users do to accelerate their decarbonization efforts using solar thermal?

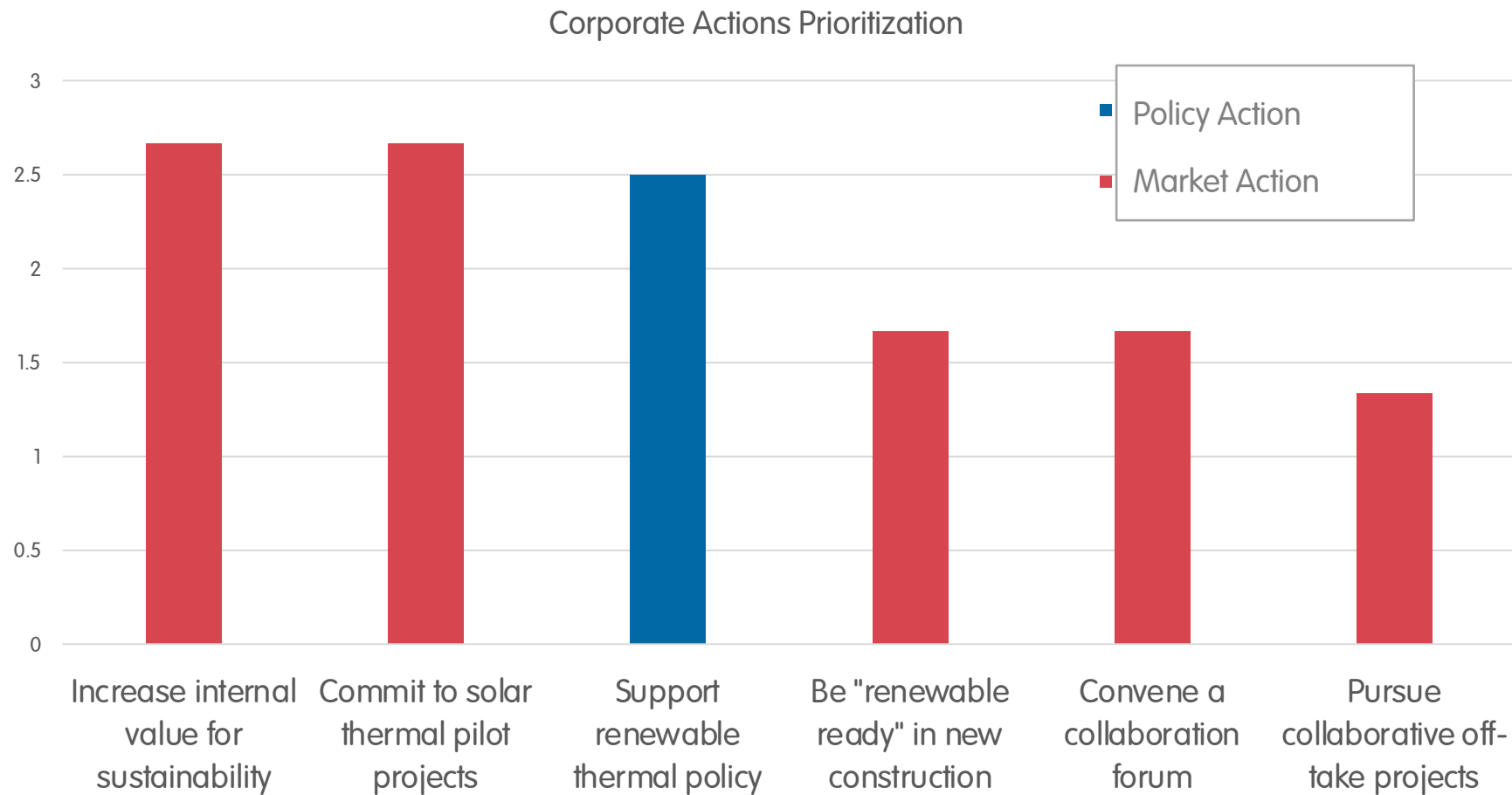
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Actions

Action	Category
Support renewable thermal policy	Policy
Increase internal value for sustainability	Market
Be "renewable ready" in new construction	Market
Commit to solar thermal pilot projects	Market
Pursue collaborative off-take projects	Market
Convene a collaboration forum	Market

Live Polling: Actions

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Actions

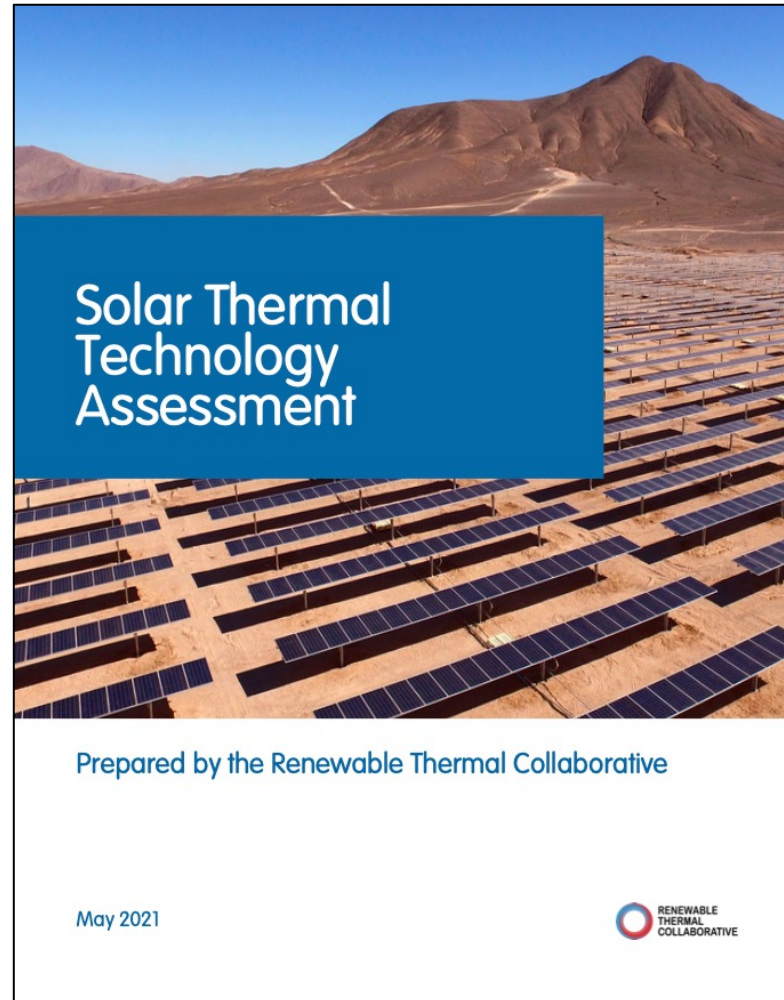
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Next Steps

- Technology Action Plan
- Policy engagement
- Take first step towards overcoming barriers

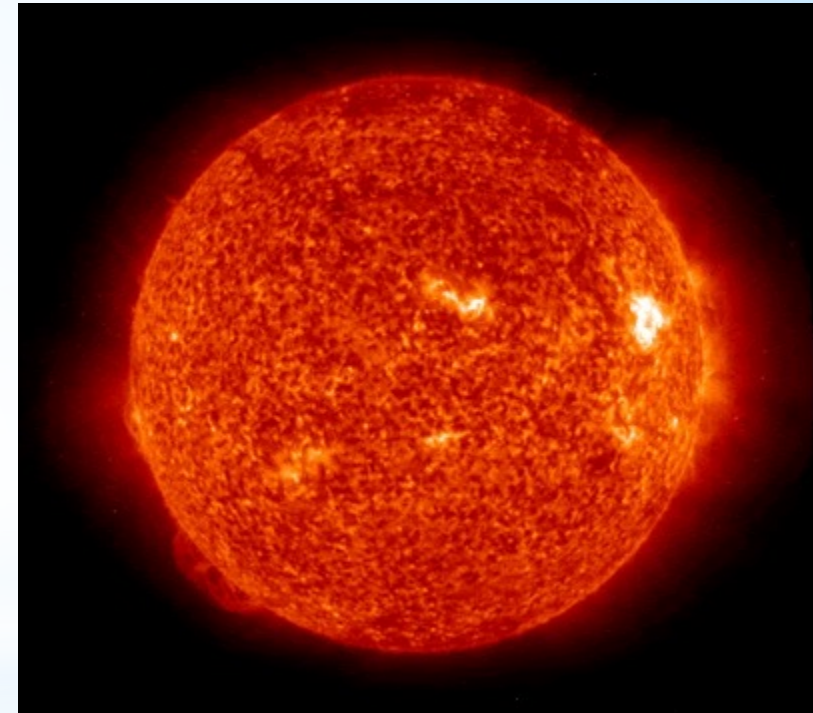
SOLAR THERMAL ASSESSMENT

Introduction



Solar UV Solutions

The *OTHER*
Side of Solar



www.SolarUVSolutions.com

About - Solar America Solutions



- Headquartered in Indianapolis, IN
- Focused on bringing world class solar thermal products to market.
- Marketing and selling solar technology that's been 20 years in development.
- Over 200 installations – now selling our 3rd generation.
- See www.SolarUVSolutions.com
- **Solar UV Solutions, LLC** is an exclusive SunQuest 250 Distributor for Solar America Solutions.

What is (is not) Solar Thermal Heat

- Solar Thermal Heat is heat produced from low-energy solar Infrared PLUS high-energy Ultraviolet (UV) energy. UV is 3-4 orders of magnitude more energetic than IR (about 4000 times more energy on average).
- Solar Thermal Heat is **NOT Electricity** (Photovoltaic, or PV).
- Solar UV energy is harvestable, limitless, and free.
- Solar UV energy is present from sun rise to sun set.
- Solar UV energy is present on cloudy days – that's how you can get sunburned on cloudy days.

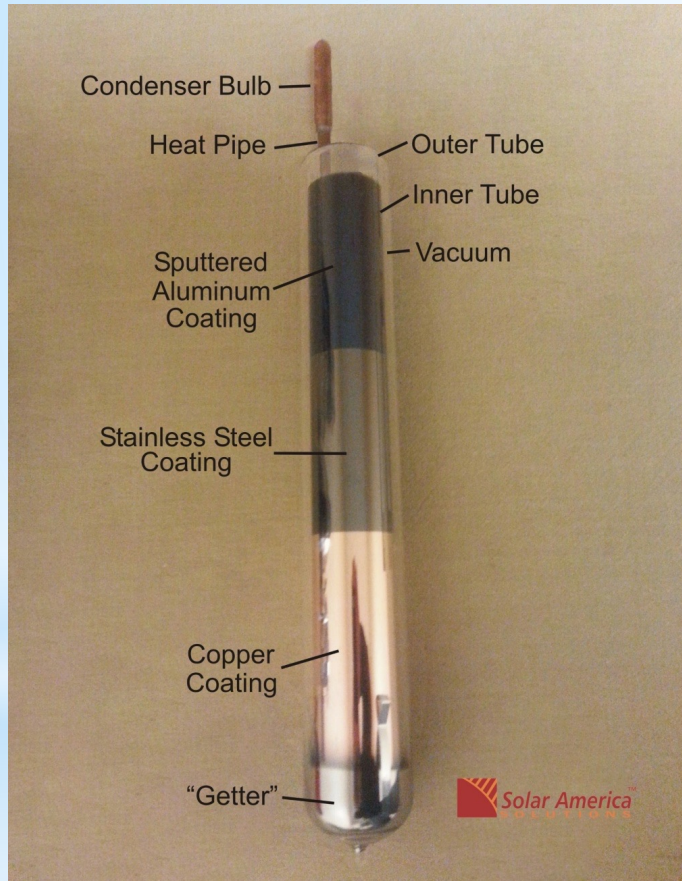
SunQuest 250

- United States Patent Protected Technology that vastly increases thermal energy output.
- SRCC and OG-100 Certified – Made in USA
- The SunQuest® 250 system is *scalable* and adaptable to supplement installed heating and hot water systems.
- SunQuest® 250 solar collector panel (25 evacuated tubes) average daily output is up to 300,000 BTUs/87.92 kWh.
Competitor output is 10,000 – 40,000 BTUs per day or 2.93 kWh – 11.72 kWh.

Bottom Line Items

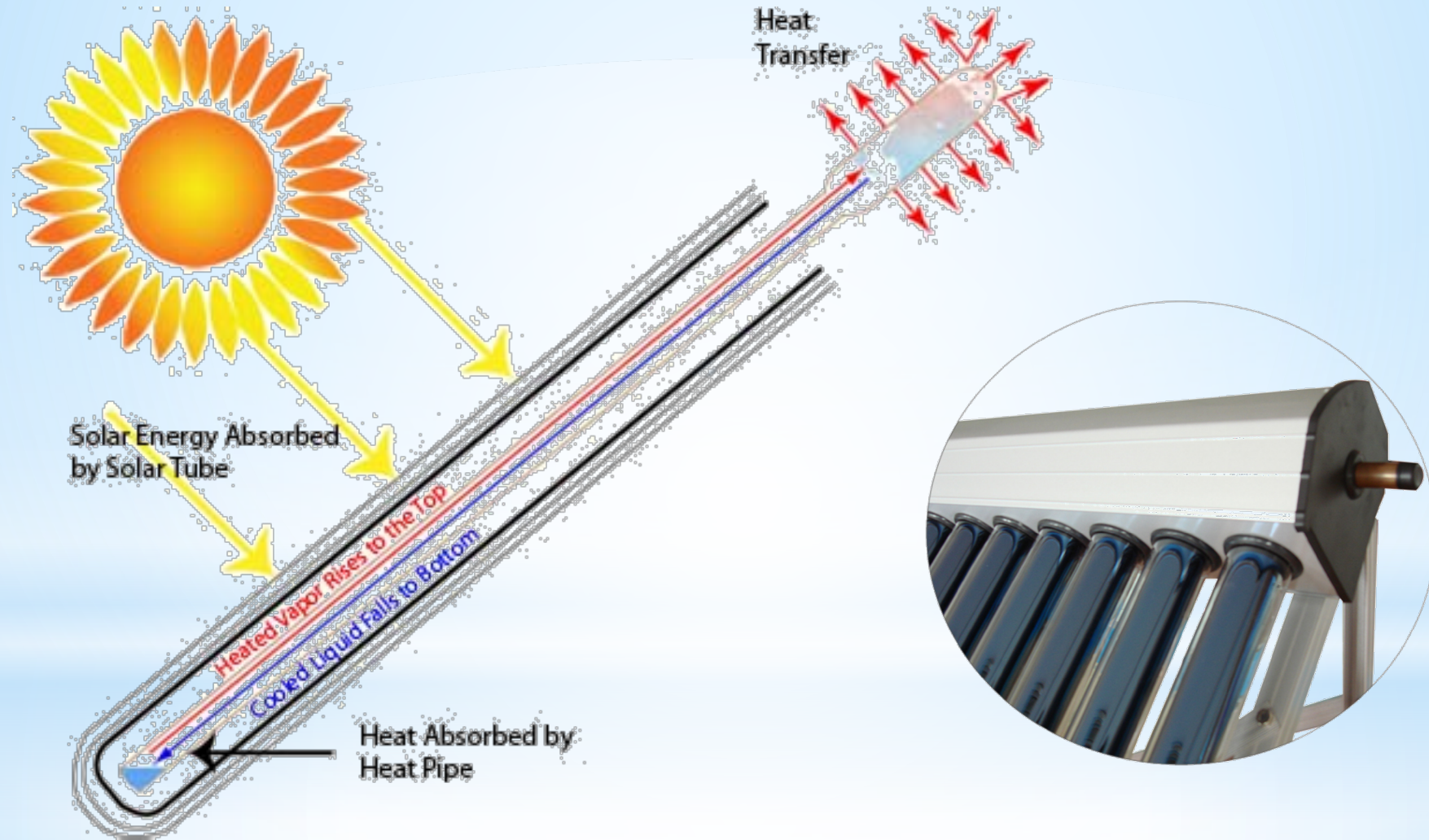
- What our nearest competitor makes in heat during a full day, we do in one hour.
- Nominal Return on Investment (ROI) energy savings for the SunQuest® 250 system – around 5 years.
- Reduce energy costs by up to 50% in private, commercial, and government installations.
- Output water temperatures > 300°F or 148.89 ° C
- Green renewable energy that significantly reduces fossil fuel consumption and CO₂ emissions.
- Great product to **Help Save our World!**

The Science Behind the *SunQuest 250TM*

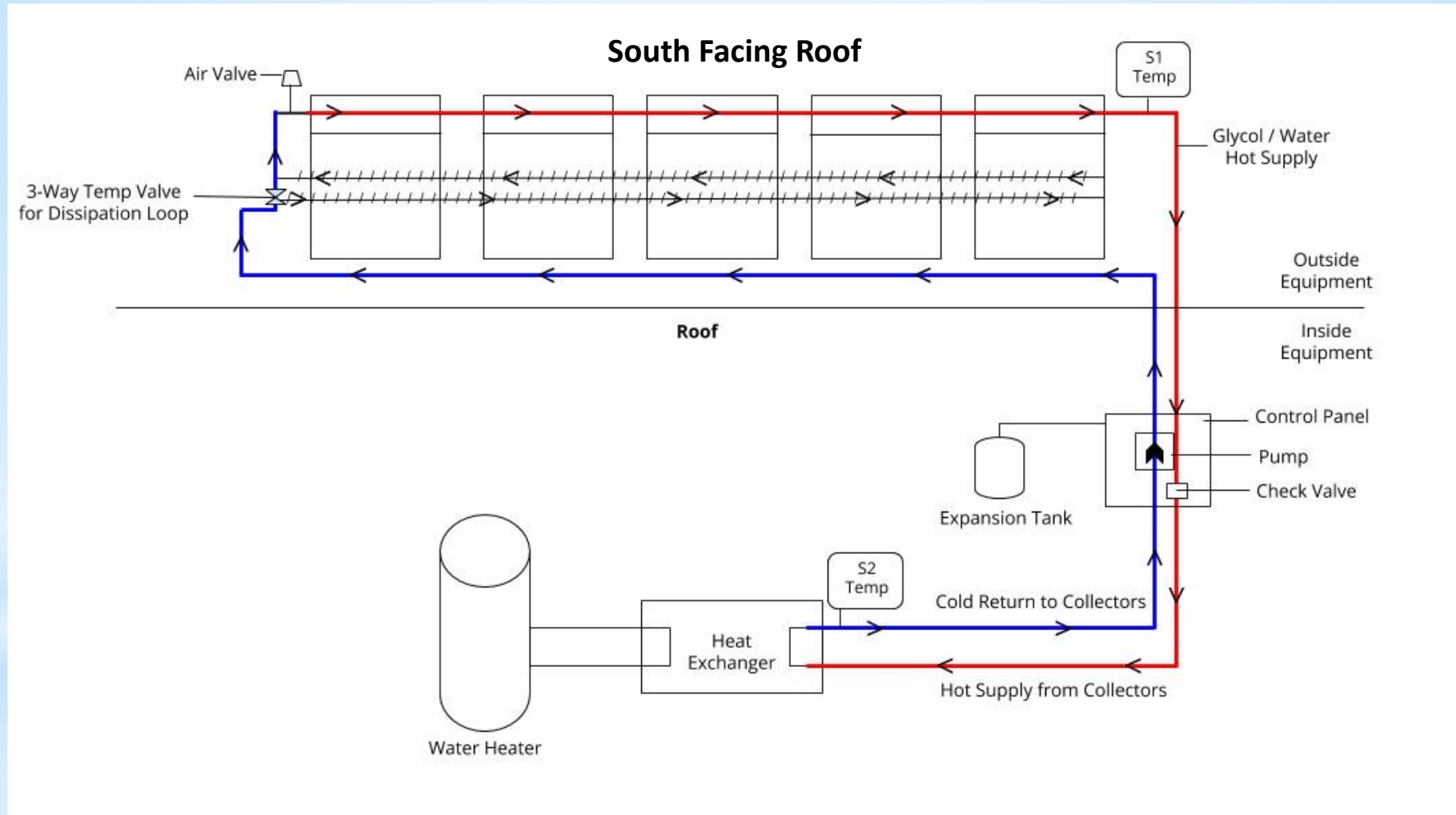


- Blue sputtered coating attracts UV rays; friction creates heat.
- Tube within a tube; 9 torr vacuum between prevents heat loss.
- Stainless steel coating spreads heat evenly; copper coating transfers heat quickly.
- Heat pipes move heat to header and delivered to the use point as free BTUs.

The Science Behind Solar Thermal



SunQuest 250 System Diagram





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System Controller



- The system “brain.”
- Controls target temperature and flow rate.
- Circulates 50/50 purified water and food-grade glycol mixture through panel header and heat exchanger.
- Contains 1/25 hp. circulation pump – the only moving part.

Utilizing the Federal ITC With New Construction

- Any “for-profit” business or residential solar thermal installation can claim the ITC.
- The total dollar amount includes the delivery system that is connected to the solar thermal application. The delivery system has to be installed in the same tax year and the solar energy provided must be at least 50%.
- Delivery Systems include;
 - Radiant Floor Cost that includes all concrete, aggregate, pex tubes, manifolds & labor.
 - Water heaters, boilers, including plumbing & installation.
- The ITC normally pays for the complete solar thermal application, leaving you with a building that has “free space heat” for the next 30 years. Provides over a 50% savings in energy cost to heat the building.
- In most cases the total construction cost is greatly reduced.

Investment Tax Credit (ITC)

- The application must be under construction during the given tax year that you wish to claim the ITC.
- Through the end of 2022, you can claim 26%.
- Through the end of 2025, you can claim 22%.
- Future years, you can claim 10%.

Now, is the time to take full advantage of this tax credit!

Solar Thermal Applications

Anything & Everything to do with hot water. Larger the better:

- Domestic Hot Water (DHW) – Bathrooms, showers, kitchens, pool heat.
- Wash down – sterilization
- Metal die coating – hot water vats/tanks
- Most agricultural and food processing from the farm to packaging

Space Conditioning Applications:

- Radiant Flooring
- Radiant heat and thermal reheat.
- Hydronic Space Heating
- Temper cold air chillers
- Coils in front of cold air returns for fresh air
- Solar cooling with Thermax Inc. chillers that require heat to make cold air.

Steam Applications:

- Preheat make-up water from the ground or city before the boiler.
- Apply solar heat to the return steam loop before it enters the boiler.

Warranty

- Solar UV Solutions will size, engineer, price, and help you calculate the ROI free of charge.
- SunQuest® 250 solar thermal collectors are fully warranted for 10 years (longer than system ROI).
- Collector glass tubes are warranted to withstand 1.0-inch hail and 150 mph wind.

Questions?



www.SolarUVSolutions.com

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Don@SolarUVSolutions.com



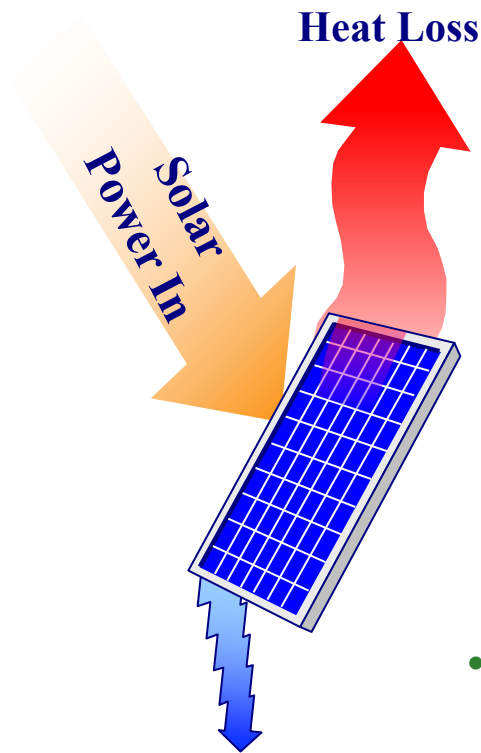
*Hybrid (Photovoltaic/Thermal) innovations
in heating and cooling*



Michael Intrieri

SunDrum® Solar Advantages

Conventional PV Panel

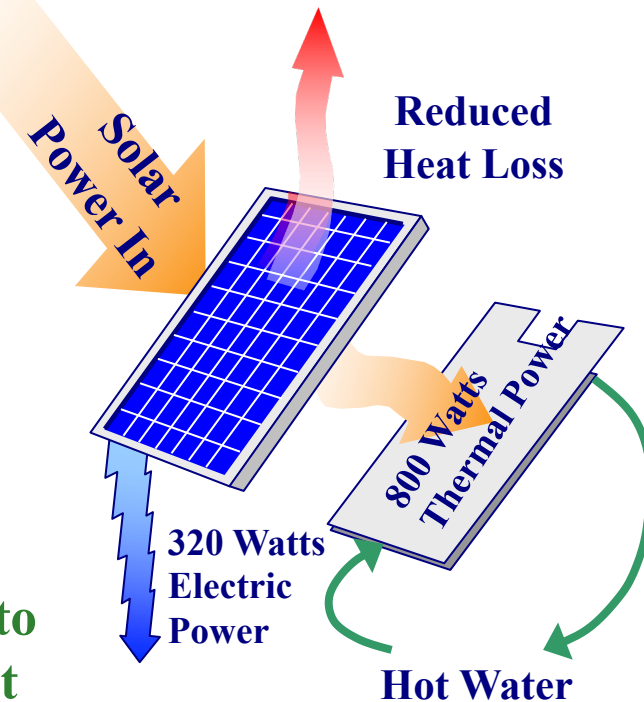


300 Watts Total Power

The SunDrum® collector field attached underneath the PV panel to absorb the PV panel's waste heat

- Increased electrical power
- Significant thermal power
- 3X power improvement
- 8X energy improvement
- Heating System delivery up to 185F with reliable storage at 160F
- Environmentally friendly cooling

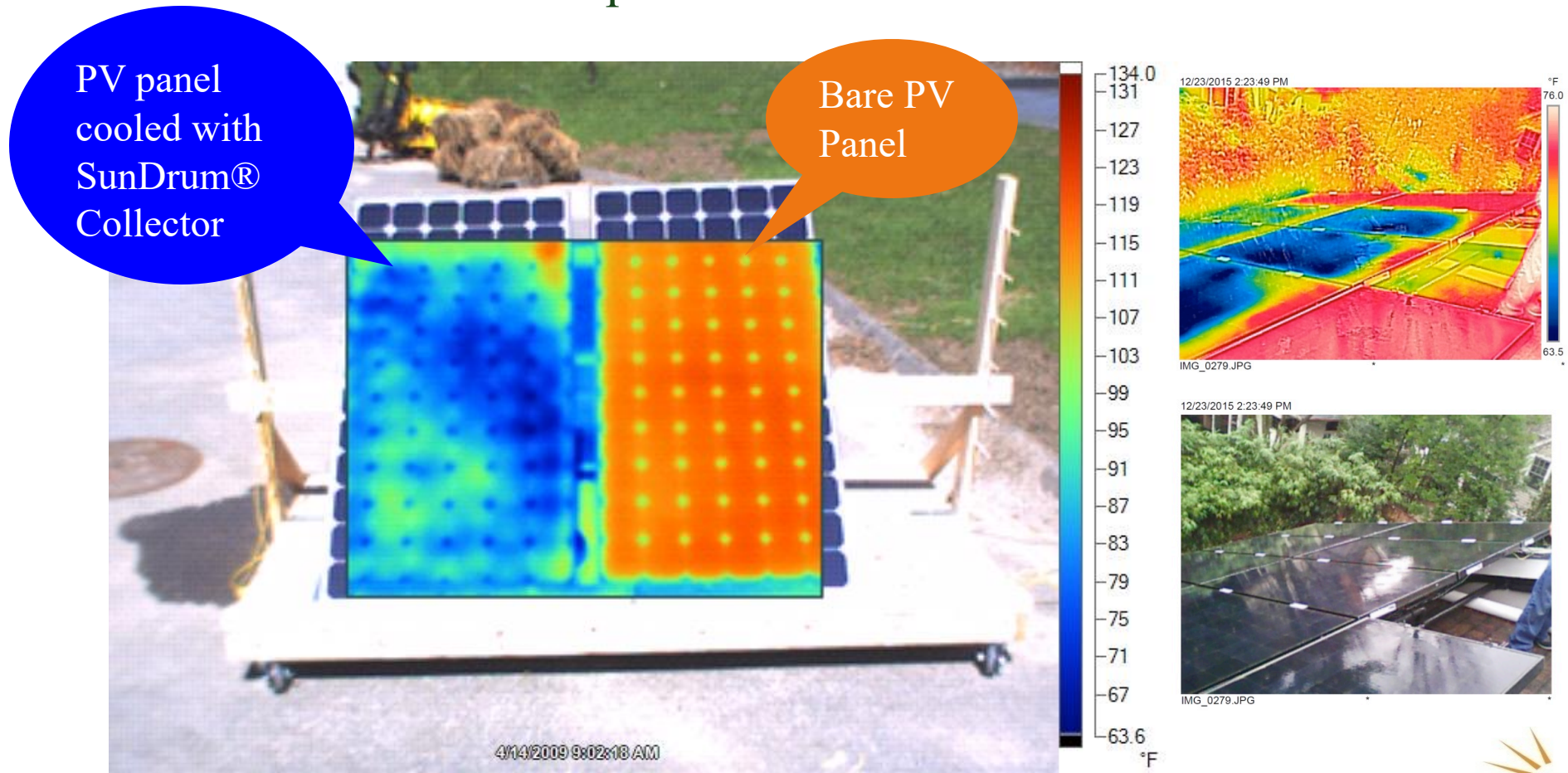
SunDrum Hybrid PV Panel



1120 Watts Total Power

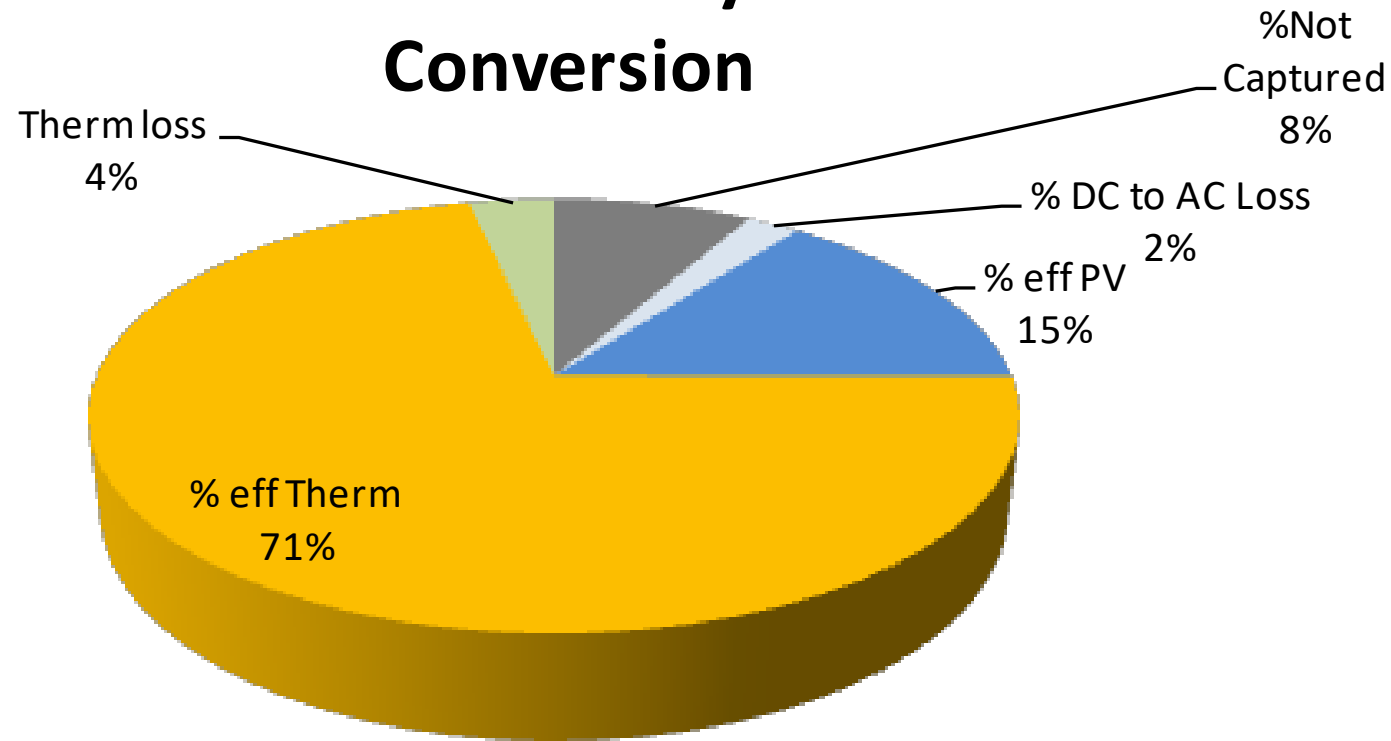
Thermal Imaging Demonstrates SunDrum® Collector Cooling

SunDrum collectors can improve the PV array
performance 4-10%



Establishing Record Solar Efficiency

86% SunDrum Solar Hybrid Record Conversion



12 Million Lbs. of CO₂ avoidance and counting!

Since 2011 Commercial Installations



TP O'Neill Federal Office Building



Retirement Home

Customer Quote:
“SunDrum Solar was very Responsive to any concerns raised and work diligently through one of our worst winters (2010) in the area to install the system. We are exceptionally satisfied with system Performance.” JS 6/12

References available upon Request



Assisted Living



Brown University Aquatics

SunDrum® Solar HarvestHP™

The HarvestHP system combines the most efficient solar collectors in the world with heat pump technology to become a **Solar Boiler**



When the sun is shining, the system in active mode captures thermal energy and electrical energy from the sun.



When the sun's direct rays are not available, "Harvest mode" allow our collectors to absorb energy from the air and use a heat pump to increase its useable temperature. In addition, cooling can be provided.

Our systems can provide energy 24/7

Maui Brewing Co



- System provides 160F preheat water to hot liquor tank saving over 20,000 gal propane annually.
- Higher efficiency cooling provides <40F chilled water to cold liquor tank saving over 71MWh electricity annually.
- Automated controls interface with BAS with remote capability.

- 176kWt Hybrid array with 30 ton heat pump capacity.
 - 220 hybrid modules.
- 300kbtuh heating, 175kbtuh cooling
- Capable of offsetting over 200,000 lbs CO2 annually.



Residential HarvestHP™ wins AEE 2017 International Innovation award

- 27kW hybrid array
 - 15.5kW thermal
 - 11.5kW electric
 - 2100/600ft²
home/pool
- Annual energy
 - 100% pool heating
 - >95% space cooling
 - 86.1% space heating
 - 84.3% DWH
 - 75.3% electric



Net Zero Meter



Listed in the Top 10 2019 Renewable Energy Companies

- <https://renewable-energy.energycioinsights.com/vendor/sundrumsup-sup-solar-redefining-the-solar-energy-efficiency-paradigm-cid-619-mid-63.html>

Ground mount array, 80kWt collectors 10 ton, commercial laundry and 2.2MW field array



Large Dormitory (DHW)



Location: Illinois

Application: Electric and Domestic Hot Water

Rated Power Output: 243kW (86.7kW elect, 156.8kW Thermal)

Yearly Energy Output: 46.8MWh, 11,872 therms

Year CO2 reduction: 198,000 lbs

Thermal Storage: 4000 gal

Energize Date: July 2018

Experience's -28F winter temperatures

System has provided over 11,000 dekatherm's of savings

Capable of 100% hot water heating

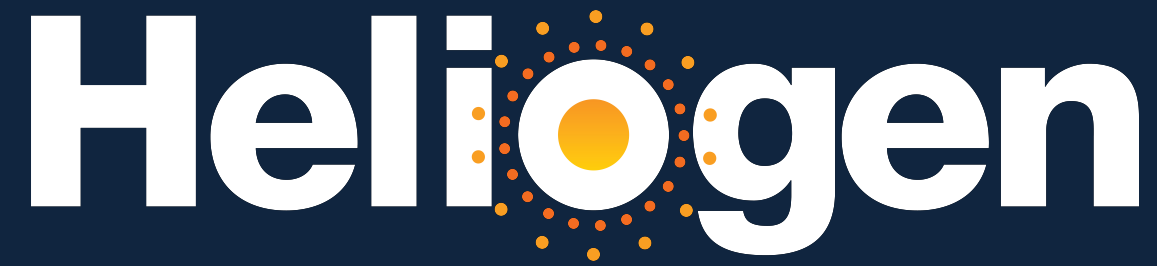
- In Mild Climate Zones
- Able to scale to any size and provide reliable commercial DHW heating.

Contact

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Replacing Fossil Fuels with Sunlight

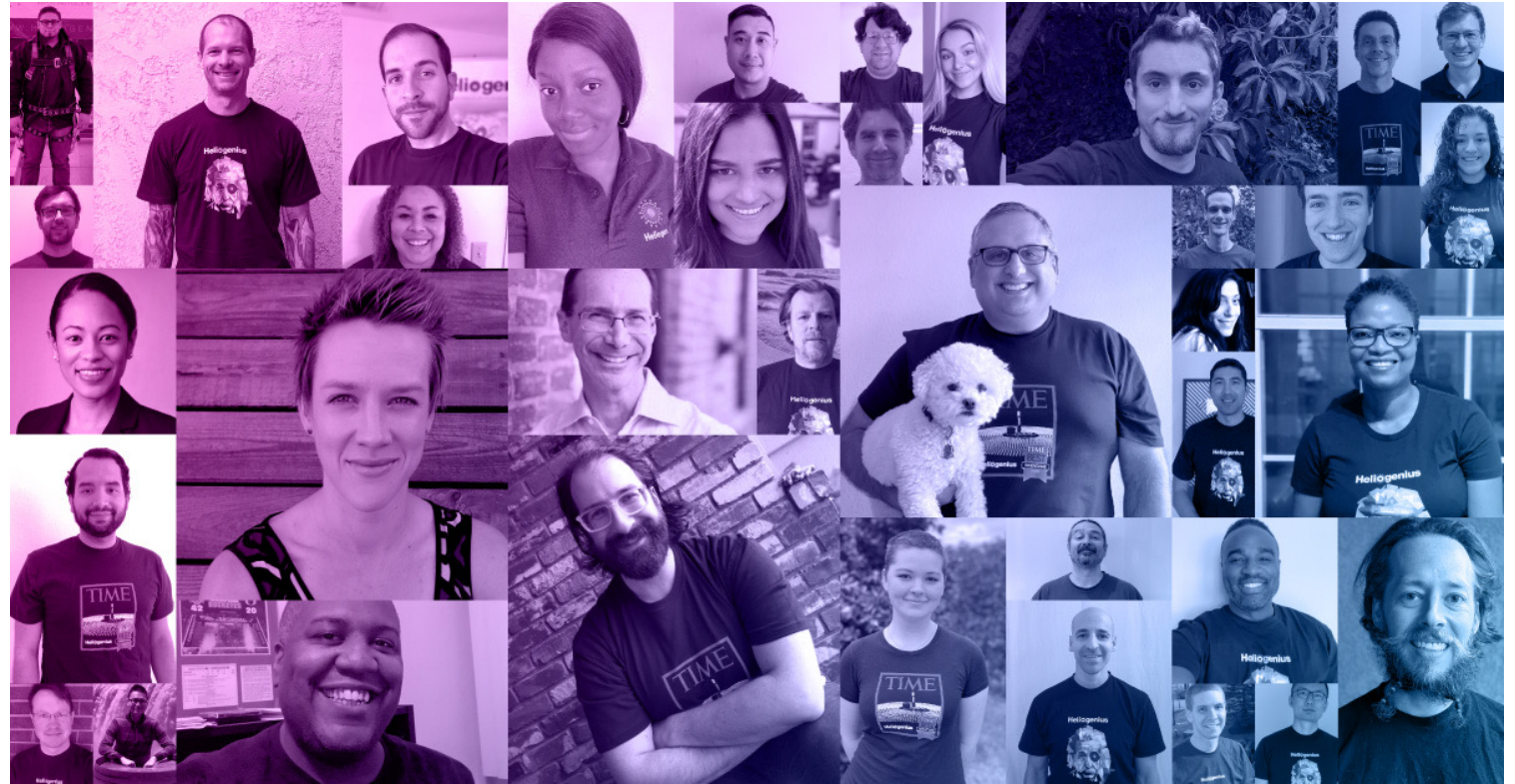
Nate Thomas, PhD

Lead Simulation Engineer

May 19, 2021

Introducing Heliogen, a Renewable Energy Technology Company

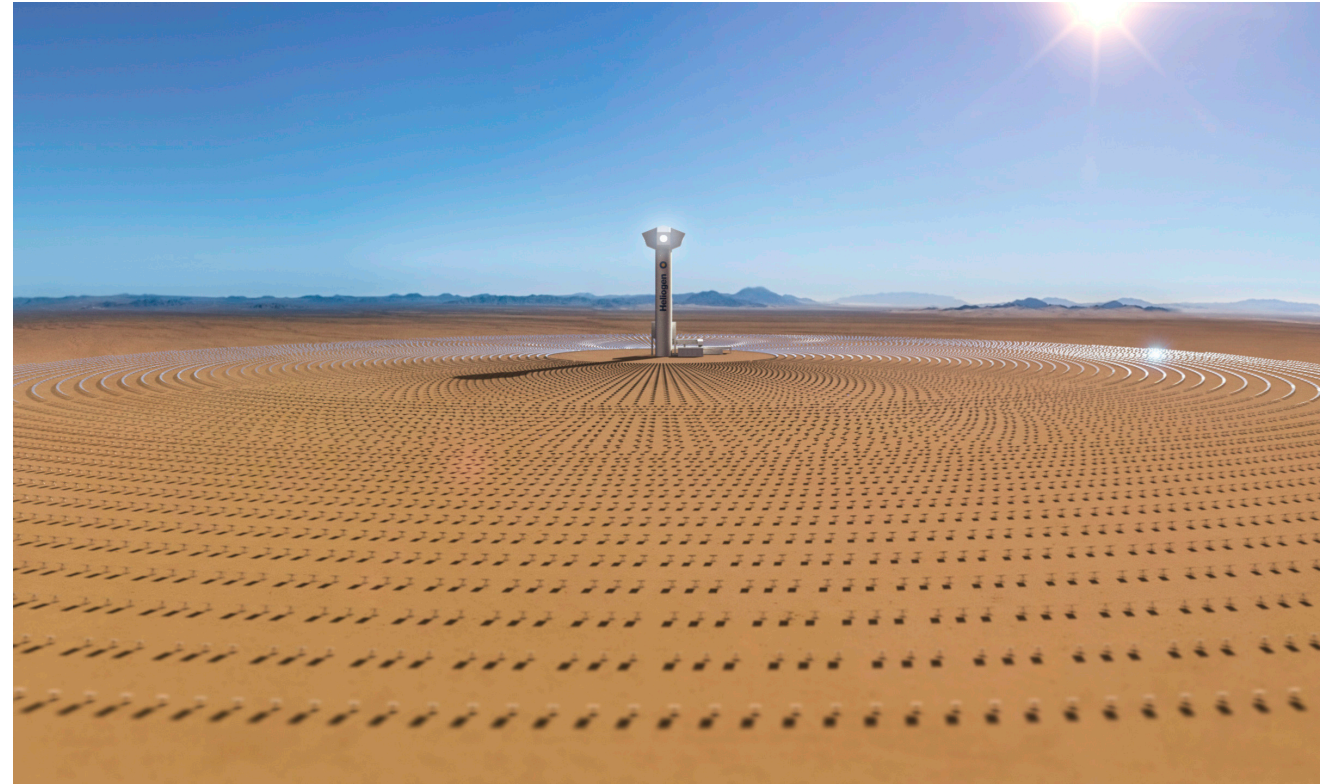
- Heliogen is focused on finding alternatives to fossil fuels in all sectors of the economy
- Heliogen's advanced Concentrated Solar Power (CSP) technology can cost-effectively supply round-the-clock **thermal** or **electrical** power, and use that power to produce **green hydrogen**
- Heliogen was created at Idealab, the leading technology incubator, by visionary entrepreneur Bill Gross



The Heliogen Team

The Refinery of the Future, Heliogen's Sunlight Refinery™

- *Sunlight Refineries* capture, concentrate, and refine sunlight into cost-effective, renewable energy on demand
- *Sunlight Refineries* utilize Heliogen's unique advanced computer vision software to precisely align an array of mirrors (heliostats), reflecting sunlight to a single target with unprecedented accuracy
- *Sunlight Refineries* are modular and can be easily deployed in proximity to industrial operations or in remote areas



Photorealistic rendering of Heliogen's Sunlight Refinery

Heliogen's Always-Available Renewable Energy Solutions



HelioHeat™

- Carbon-free, ultra-high temperature heat
- Energy is stored thermally as heat in rocks; most cost-effective energy storage available
- Target cost: < delivered natural gas



HelioPower™

- On demand, low carbon electricity made from concentrated sunlight
- Target cost: < 5¢/kWh



HelioFuel™

- Clean, renewable fuels like green hydrogen
- Around the clock electricity enables near 100% electrolyzer utilization for hydrogen production
- Target cost: < \$2/kg

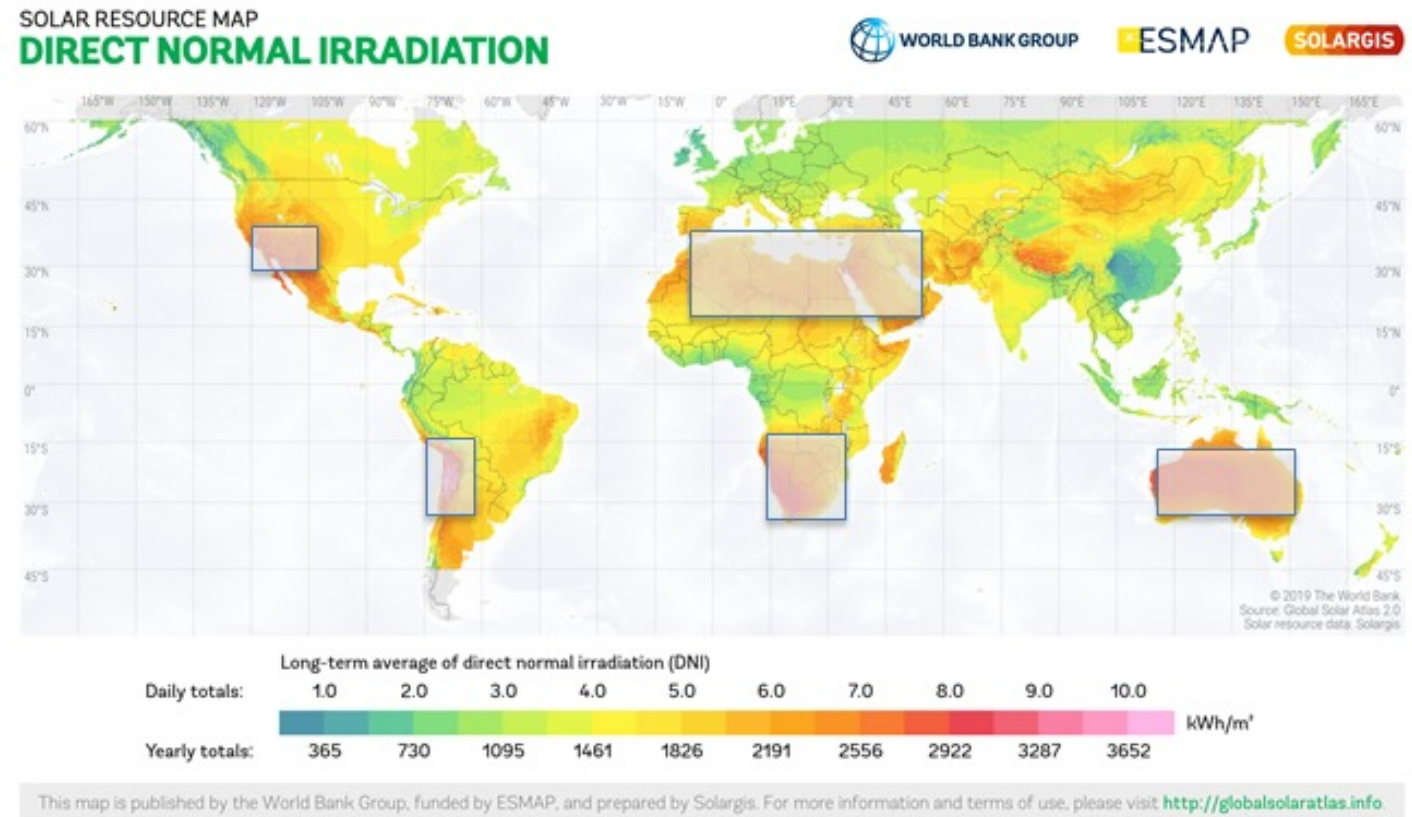
How it Works – Transforming Sunlight Into 24/7 Energy on Demand

1. Sunlight is reflected towards an inlet at the top of a tower using a field of computer-controlled mirrors (heliostats)
2. The concentrated sunlight is converted to high-temp heat/air at the receiver and stored in rocks (thermal energy storage)
3. The collected heat drives a heat exchanger / sCO₂ engine (power block), producing renewable electricity around the clock



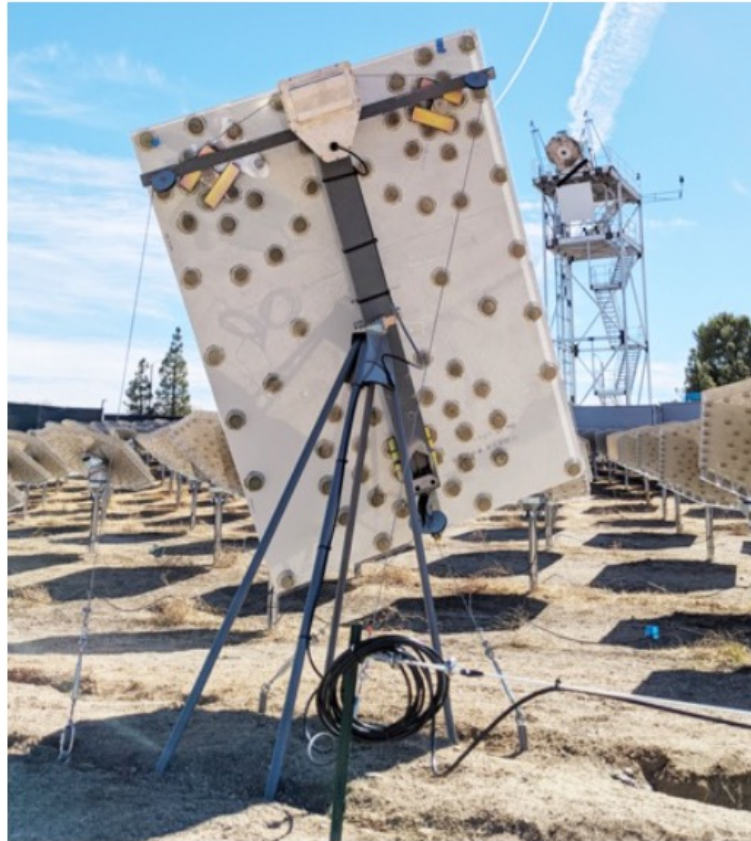
Decarbonizing with Sunlight

- Direct Normal Irradiation (DNI) is a measure of annual solar resource available per m²
- The greater the DNI, the better the economics
- South America is well known for having the best sunshine on the planet, followed closely by Australia, Africa, and the Southwestern United States
- Many industrial facilities are already located in these regions



Source: Solargis

Leveraging Breakthrough Technology



Heliogen's next-generation heliostat

Moore's Law (Software vs. Hardware)

Heliogen uses software and computer vision to precisely control thousands of small mirrors to create ultra-high temperatures, **unlocking low-cost thermal energy storage**

Reduced Installed Costs

Heliogen's heliostats are **mass-produced**, easy to deploy, **requiring little in-field assembly**

Faster Installation

Heliogen's patented closed-loop control system **eliminates the need for months-long manual calibration**



Technology Maturation

2018 – Heliogen develops the world's first commercially viable closed-loop heliostat tracking control system

2019 – Heliogen deploys first-generation heliostats to test facility, successfully demonstrating performance targets

2020 – DOE selects Heliogen for \$39 million award to deploy 5 MWe baseload CSP plant

2021 – Heliostat manufacturing facility developed, receiver-scale tests ongoing

2021 – Rio Tinto selects Heliogen's breakthrough solar technology to provide carbon-free energy to Boron mine

2023 – First commercial projects online

2025 – Manufacturing capacity for many modules per year

A Natural Fit for Industry

- Heliogen's concentrated solar technology is the only commercially-available solution today that can cost-effectively provide renewable energy around the clock.
- Our modular Sunlight Refineries are distributed energy assets that require less than half the cost and take half the time to deploy, compared to traditional CSP.
- We are exploring deployments all over the world and welcome the opportunity to green your operations cost-effectively as well.



Heliogen's demonstration facility in Lancaster, California

Thank You

Nate Thomas, PhD

Lead Simulation Engineer

nate@heliogen.com



Questions?

Thank you for attending.

Sign up for our newsletter at renewablethermal.org

To learn more about the RTC, contact Blaine Collison at blaine@dgardiner.com