Heating up Decarbonization: Solar Thermal Assessment

May 19, 2021
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:

C2ES

DG/A

WWF
July 6:
Event site goes live and registration opens

First Summit Sponsors:
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

Solar Thermal Technology Assessment

Prepared by the Renewable Thermal Collaborative

May 2021

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?

RenewableThermal.org / info@renewablethermal.org / @Rethermal
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
## Solar Thermal Assessment

<table>
<thead>
<tr>
<th>Technology</th>
<th>Year</th>
<th>Year</th>
<th>Technical or Market Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Concentrated Solar Thermal</strong></td>
<td>2030</td>
<td></td>
<td>Technical potential to supply 30-40% of global low-medium temperature process heat demand; 14,000 PJ</td>
</tr>
<tr>
<td><strong>Non-Concentrated Solar Thermal</strong></td>
<td>2050</td>
<td></td>
<td>Predicted, using combined technical and market potentials, 6.3% of industrial global energy use; 8,000 PJ</td>
</tr>
<tr>
<td><strong>CSP</strong></td>
<td>2030</td>
<td></td>
<td>Cost is predicted to remain too large a barrier before 2030</td>
</tr>
<tr>
<td><strong>CSP</strong></td>
<td>2050</td>
<td></td>
<td>Predicted, using combined technical and market potentials, 1% of U.S. industrial energy use; 135 GWh</td>
</tr>
</tbody>
</table>
What are the primary barriers to accelerated industrial deployment of solar thermal technologies?
### Solar Thermal Assessment

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar thermal system complexity</td>
<td>Technology</td>
</tr>
<tr>
<td>Installation space is constrained</td>
<td>Technology</td>
</tr>
<tr>
<td>Solar thermal is not a bankable technology</td>
<td>Technology</td>
</tr>
<tr>
<td>Low natural gas prices</td>
<td>Market</td>
</tr>
<tr>
<td>No easy guide to solar thermal technologies</td>
<td>Market</td>
</tr>
<tr>
<td>Solar thermal perceived as “pre-mainstream”</td>
<td>Market</td>
</tr>
<tr>
<td>Lack of attribute crediting or tracking</td>
<td>Market</td>
</tr>
<tr>
<td>Need for performance predictability</td>
<td>Market</td>
</tr>
<tr>
<td>Lack of financial incentives</td>
<td>Policy</td>
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<tr>
<td>Lack of a solar thermal compliance market</td>
<td>Policy</td>
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</table>
Live Polling: Barriers
SOLAR THERMAL ASSESSMENT

Barrier Prioritization

- Market Barrier
- Technology Barrier
- Policy Barrier

Barriers

- No easy guide to technologies
- Low natural gas prices
- Perceived as "pre-mainstream"
- Lack of financial incentives
- Solar thermal system complexity
- Installation space is constrained
- Need for performance predictability
- Lack of compliance market
- Lack of attribute crediting or tracking
- Not a bankable technology
What solutions could be effective in addressing those barriers?
<table>
<thead>
<tr>
<th>Solution</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase financial incentives</td>
<td>Policy</td>
</tr>
<tr>
<td>Increase regulatory or compliance market support</td>
<td>Policy</td>
</tr>
<tr>
<td>Create a carbon price or fuel tax</td>
<td>Policy</td>
</tr>
<tr>
<td>Increase tracking and crediting mechanisms</td>
<td>Market</td>
</tr>
<tr>
<td>Create a thermal power purchase agreement template</td>
<td>Market</td>
</tr>
<tr>
<td>Increase investor trust to expand financing options</td>
<td>Market</td>
</tr>
<tr>
<td>Create a decision matrix for energy users</td>
<td>Market</td>
</tr>
<tr>
<td>Create educational resources for buyers</td>
<td>Market</td>
</tr>
<tr>
<td>Develop a landscape study tool to assess viability across geographies</td>
<td>Market</td>
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<tr>
<td>Deploy marketing campaigns to increase trust in solar thermal</td>
<td>Market</td>
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Live Polling: Solutions
SOLAR THERMAL ASSESSMENT

Solutions Prioritization

- Improved financing
- Carbon price tax
- Established, reliable education source for buyers
- Regulatory or compliance market
- Decision matrix
- Marketing campaigns to increase trust
- Tracking and crediting mechanisms
- Landscape study tool to determine viability across geographies
- Increase investor trust to reduce risk
- Thermal power purchase agreement template

Policy Solution
Markets Solution
What can large energy users do to accelerate their decarbonization efforts using solar thermal?
<table>
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<th>Action</th>
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<td>Support renewable thermal policy</td>
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<tr>
<td>Increase internal value for sustainability</td>
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<td>Be “renewable ready” in new construction</td>
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<td>Commit to solar thermal pilot projects</td>
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<td>Pursue collaborative off-take projects</td>
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<td>Convene a collaboration forum</td>
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Live Polling: Actions
Corporate Actions Prioritization

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

Policy Action
Market Action
• 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 250™

- 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
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;
  o Radiant Floor Cost that includes all concrete, aggregate, pex tubes, manifolds & labor.
  o 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?

Don Frank
(317) 418-0059
Don@SolarUVSolutions.com

www.SolarUVSolutions.com
Hybrid (Photovoltaic/Thermal) innovations in heating and cooling

Michael Intrieri
**SunDrum® Solar Advantages**

**Conventional PV Panel**
- Heat Loss
- Solar Power In
- 300 Watts Total Power

**SunDrum Hybrid PV Panel**
- Reduced Heat Loss
- Solar Power In
- 800 Watts Thermal Power
- 320 Watts Electric Power
- Hot Water
- 1120 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
Thermal Imaging Demonstrates SunDrum® Collector Cooling

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

PV panel cooled with SunDrum® Collector

Bare PV Panel
Establishing Record Solar Efficiency

86% SunDrum Solar Hybrid Record Conversion

- % eff Therm: 71%
- Therm loss: 4%
- % eff PV: 15%
- % DC to AC Loss: 2%
- % Not Captured: 8%

12 Million Lbs. of CO₂ avoidance and counting!
Since 2011 Commercial Installations

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
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 increases its useable temperature. In addition, cooling can be provided.

Our systems can provide energy 24/7.
Maui Brewing Co

- 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.

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

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

EMAIL: mintrieri@sundrumsolar.com
WEB: www.sundrumsolar.com
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
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

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.
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