Heliogen

A Modular AI Powered CSP System

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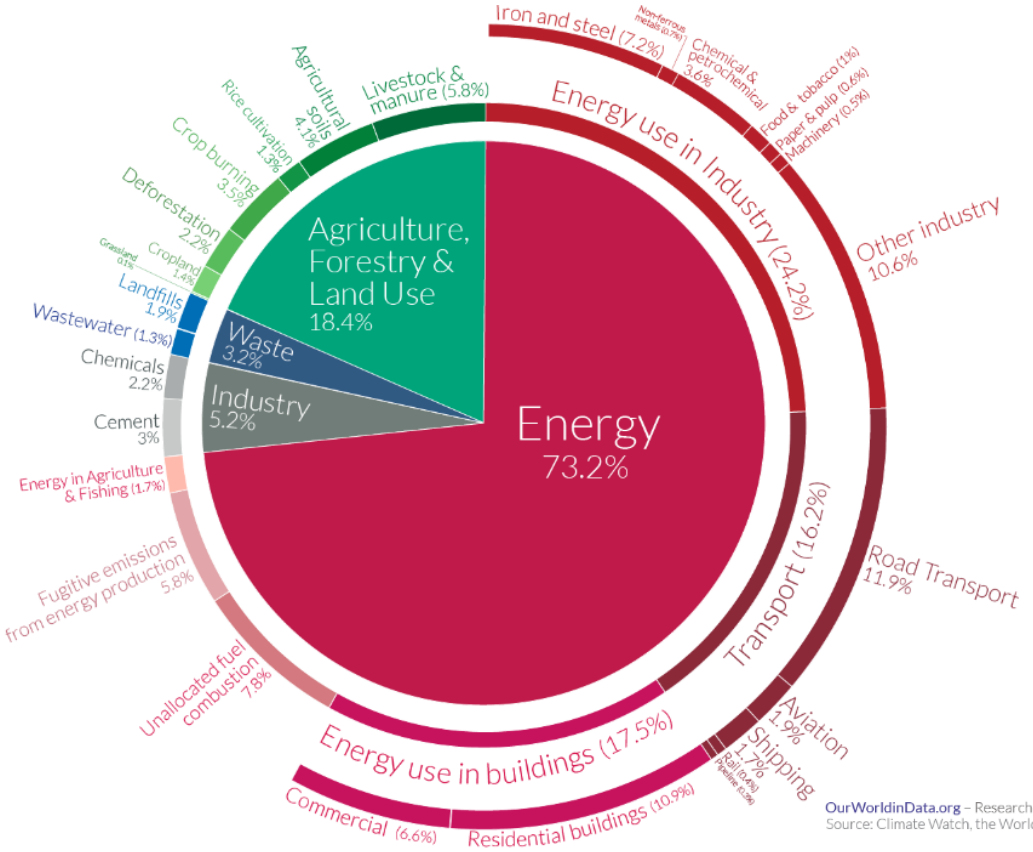
Managing Director HelioHeat Gmbh

25th Cologne Solar Colloquium
Jülich, June 22nd, 2022

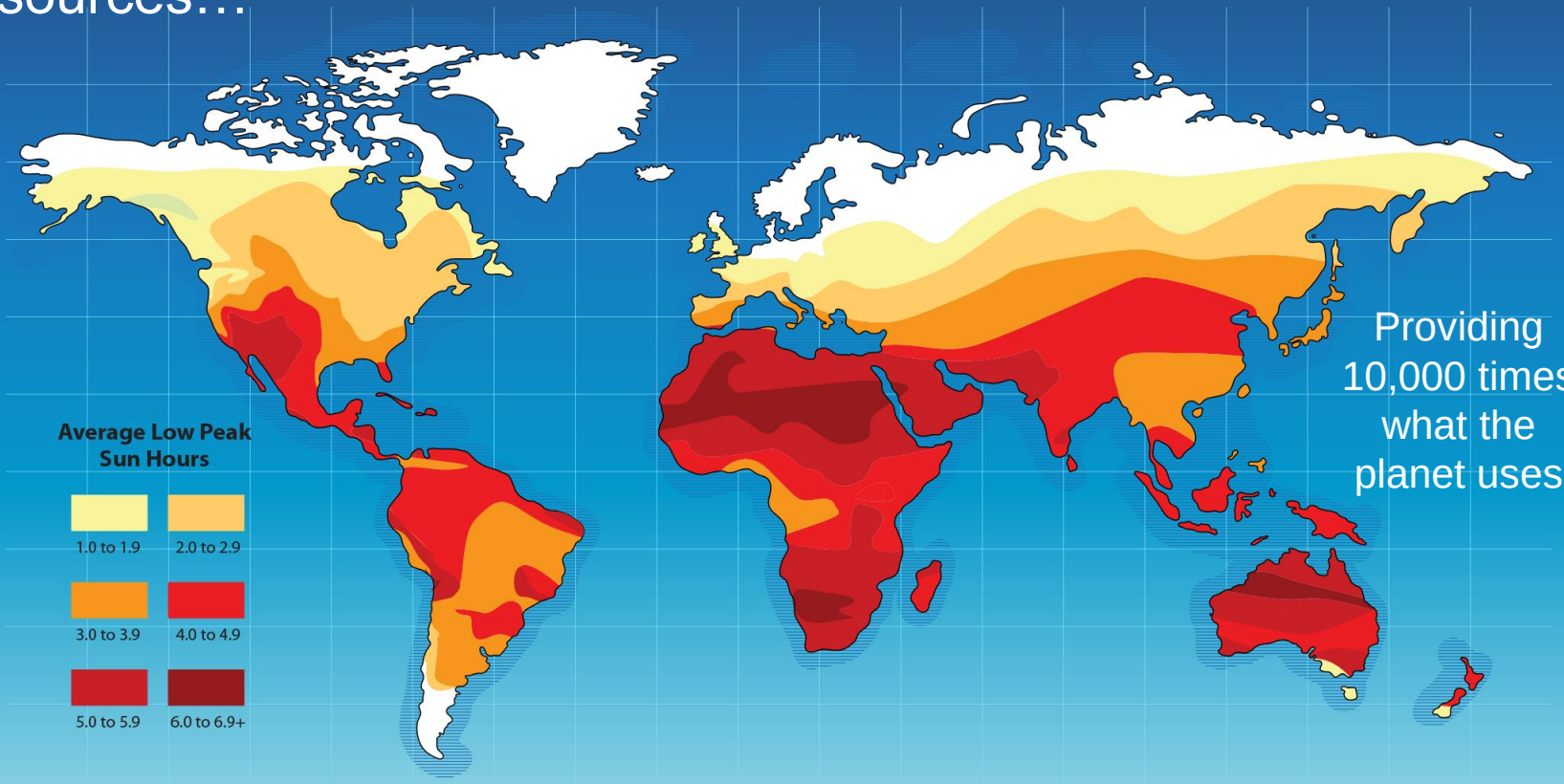
Global greenhouse gas emissions by sector (49.4 billion tonnes CO_2eq. in 2016)



OurWorldinData.org – Research and data to make progress against the world's largest problems.
Source: Climate Watch, the World Resources Institute (2020).

Industry needs a new resource to power the energy transition including heat, power, and hydrogen

Solar energy is one of the most evenly distributed natural resources…



Providing 10,000 times what the planet uses

However, there are two problems:

Solar / renewable energy is extremely intermittent

Solar / renewable energy is difficult to transport

Heliogen's Sunlight Refinery™ will solve these two fundamental problems

Heliogen aims to produce near always-available and transportable renewable energy – cost-effectively

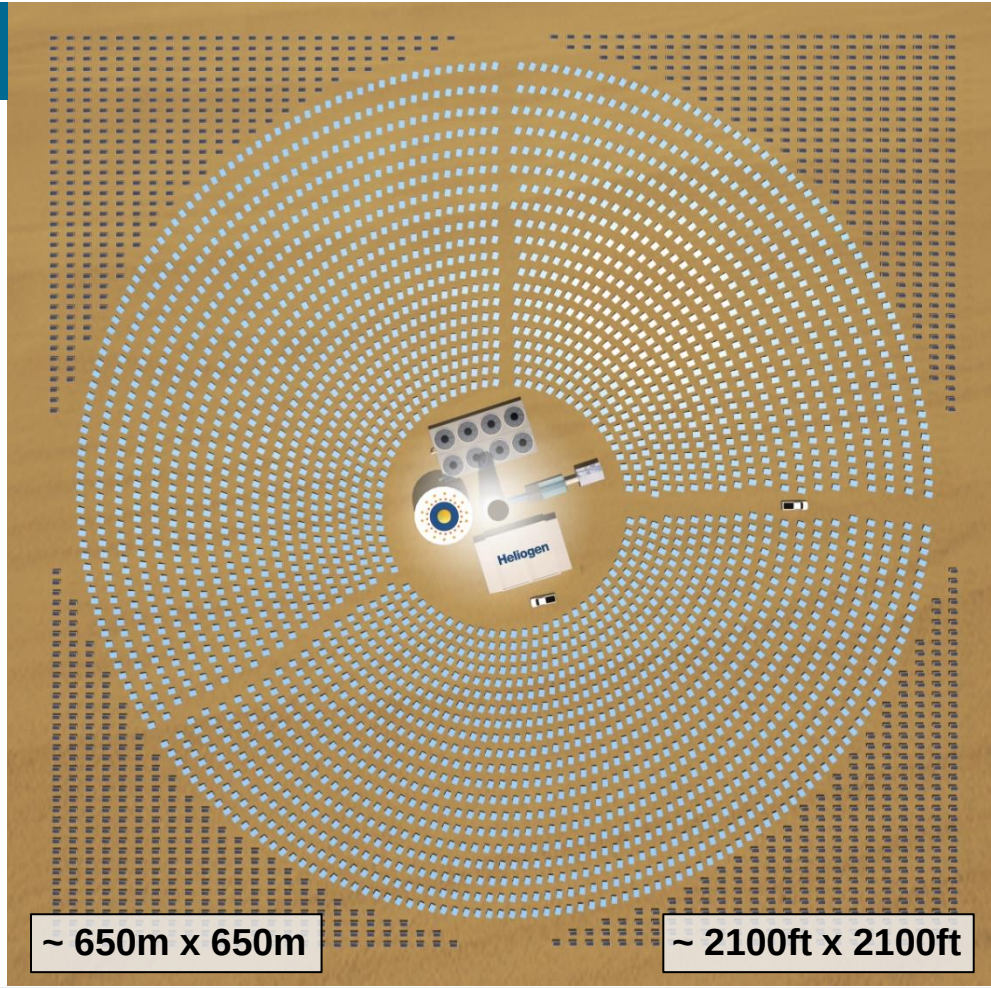
We Reinvented Concentrated Solar to be Modular & Scalable

We build ONE modular 5MW plant and replicate it to meet our customers' demand:

- ~100MW of electrical energy can be produced with ~20 modules
- Modular and easily scalable design will allow for growth to compete with large scale renewable projects

Plant estimated to produce:

- > 85% capacity factor renewable power
- < 5 cents per kW-hour power cost[1]
- < 1/6th square mile footprint (650m x 650m)
- > 850,000 kilograms of hydrogen/year



1. Heliogen estimates. Analysis assumes subsidized economics with 60% debt at 8% interest rate and 40% equity at 12% cost over 30 year projection period. Represents the estimated implied LCOE of Heliogen.

Heliogen has 4 fundamental insights that set it apart

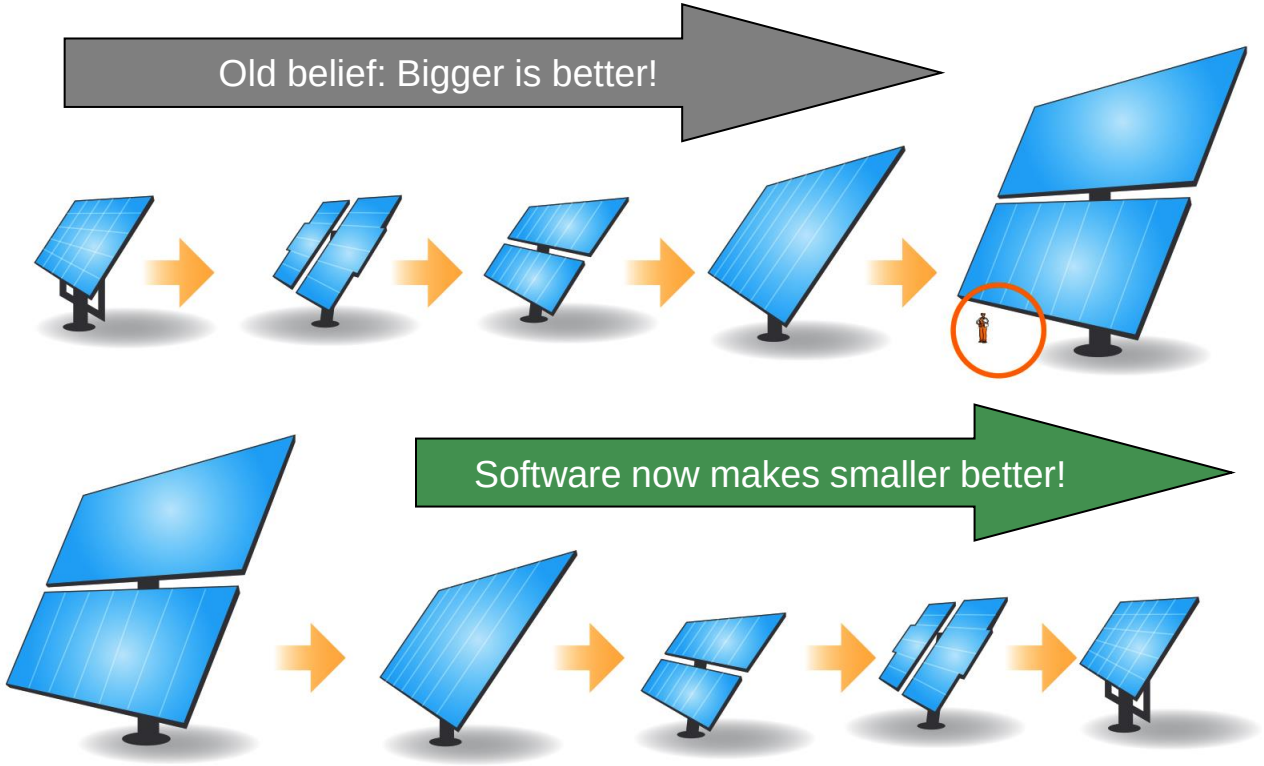
1. Heavy industry is a critical market for decarbonizing technologies and is currently underserved
2. Renewable energy for heavy industry must be near constantly available *and* cost effective
3. AI / software / computation power can simplify and reduce both hardware, installation, and maintenance cost
4. High volume manufacturing techniques enable reliability, scale, and learning curve cost-reduction

Heliogen is building on these 4 key insights to decarbonize industry, projected to create a profitable, high-growth business

We believe that Heliogen is currently the only public solar technology company poised to meaningfully address climate change for industrial customers

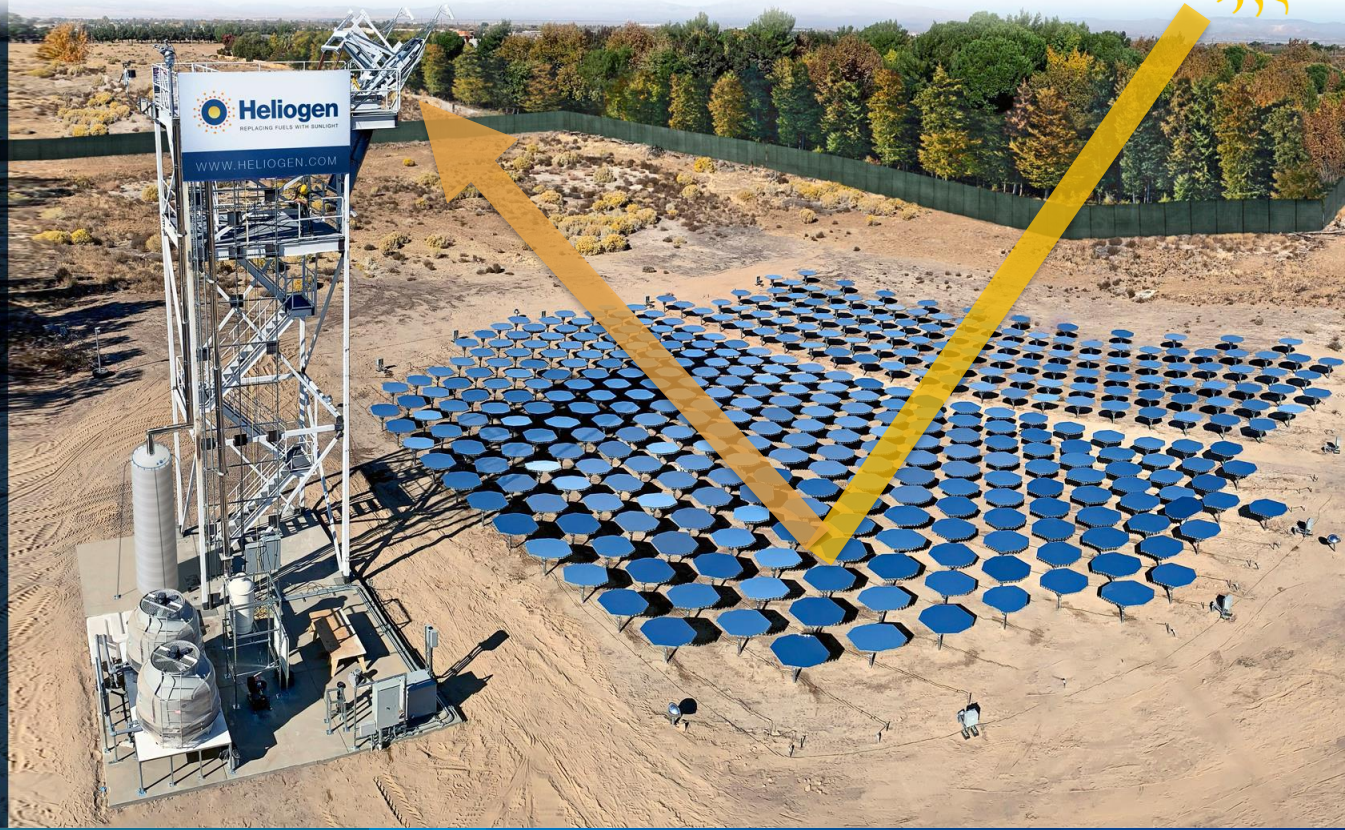
Residential/Commercial	Utility	Industrial Decarbonization
sunrun, ENPHASE, TESLA, JinKO Solar, sunnova	NEXTera ENERGY, First Solar, IBERDROLA, shoals, ARRAY TECHNOLOGIES, Canadian Solar	Heliogen

Our Fundamental Insight – More computation now makes smaller better



The Heliogen Process Heliogen's closed-loop system uses computer vision to identify the precise position of every single mirror, then make micro-adjustments in real time to achieve a perfect focus. Closed-loop means that the mirrors are pointed more accurately with optical feedback, not just mechanical stiffness

1. Reflect sun rays to top of tower
2. Generate high temperatures in solar receiver
3. Store heat in solid media
4. Heat exchanger brings heat to heat engine
5. Heat engine makes power
6. Optional electrolyzer makes Hydrogen



Heliogen's operational prototype facility in Lancaster, California

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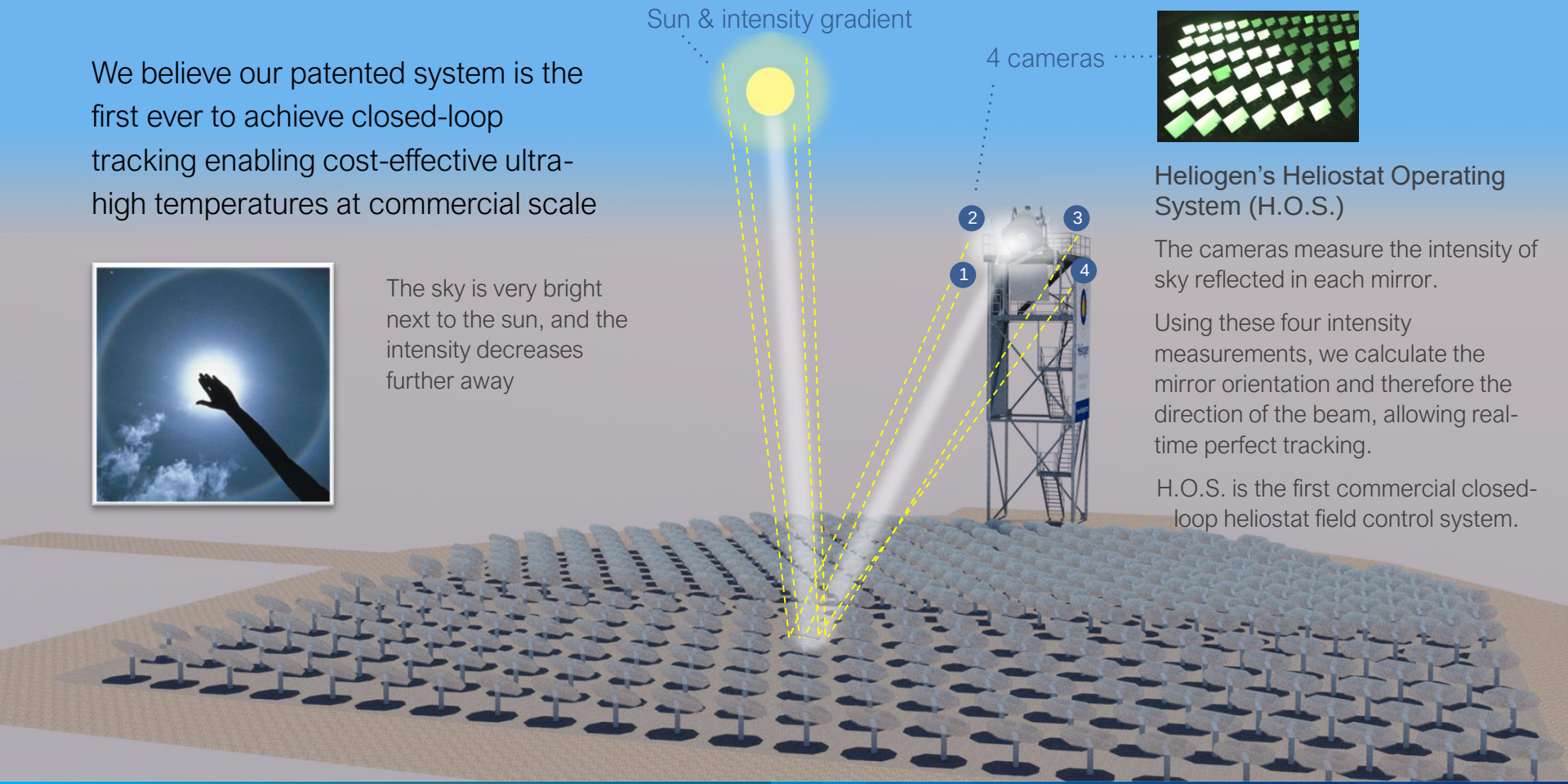
We believe our patented system is the first ever to achieve closed-loop tracking enabling cost-effective ultra-high temperatures at commercial scale

The sky is very bright next to the sun, and the intensity decreases further away



Heliogen's Heliostat Operating System (H.O.S.)

The cameras measure the intensity of sky reflected in each mirror.

Using these four intensity measurements, we calculate the mirror orientation and therefore the direction of the beam, allowing real-time perfect tracking.

H.O.S. is the first commercial closed-loop heliostat field control system.

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Heliogen's AI-driven technology is designed to capture, concentrate and refine sunlight into **cost-efficient energy on demand**.

This low-carbon energy can be available as heat, power, or hydrogen fuel in modular deployments.

HelioHeat

HelioHeat™ provides heat in excess of 1000°C to power industrial processes or mining.

~ 1 mile →

Delivery range approximately 1 mile

HelioPower

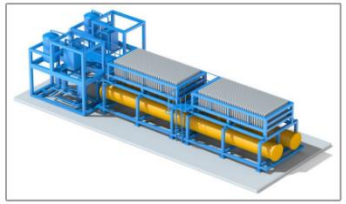
HelioPower™ delivers the HelioHeat solar thermal energy to a heat engine to produce electrical power.

~ 100 miles →

Delivery range approximately 100 miles

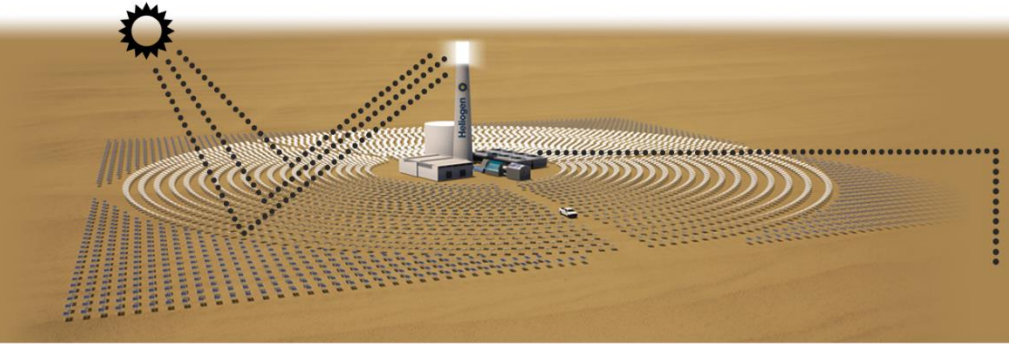
HelioFuel

HelioFuel™ systems couple a HelioPower plant with a large-scale water electrolyzer to produce green Hydrogen fuel.



> 10,000 miles →

Delivery range greater than 10,000 miles.



The collected sunlight is processed and converted to:

- HelioHeat
- HelioPower
- HelioFuel

To make green Hydrogen affordable, you need low-cost renewable energy **AND** high capacity-factor

(to leverage capex cost of electrolyzer)

20%
Capacity-Factor

Fixed Solar Panels

27.5%
Capacity-Factor

Tracked Solar Panels

46.5%
Capacity-Factor

Wind Farm

50%
Capacity-Factor

Offshore Wind Farm

~85+%
Capacity-Factor

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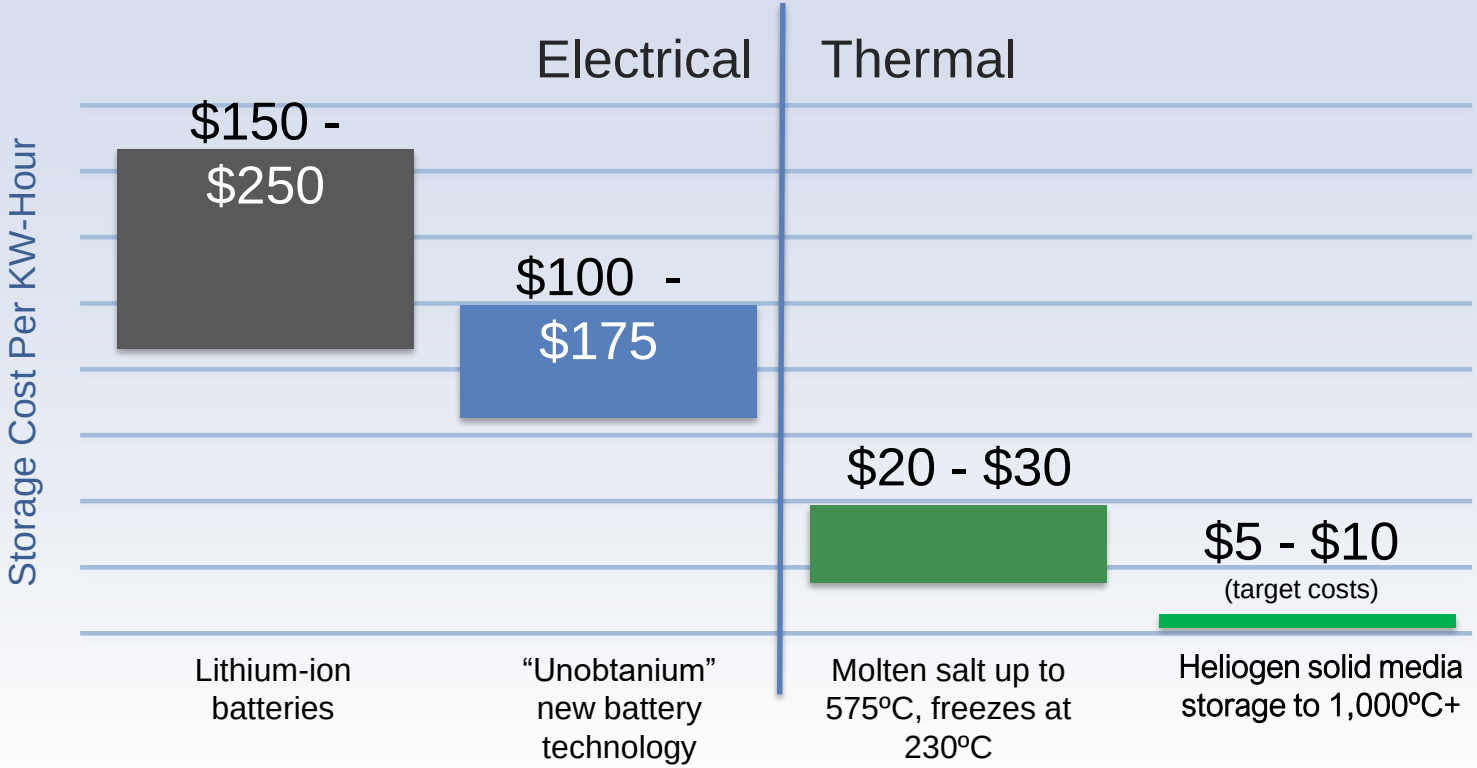
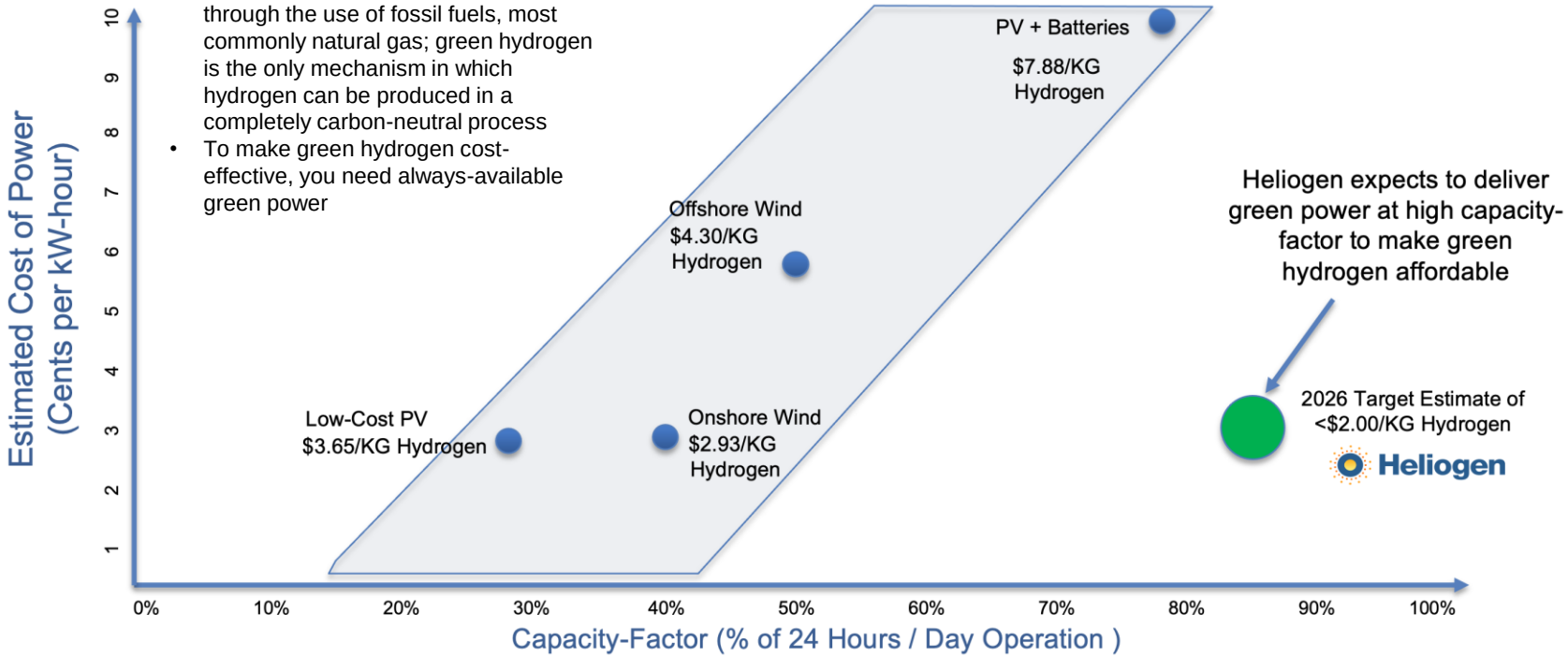
Source: Lazard 's Levelized cost of energy analysis 14.0 – Solar Panels = average of rooftop and C&I, Tracked = Utility-scale average, Wind Farm = Onshore Average, Offshore = Offshore Avg. Heliogen = estimate based on customer target

Heliogen's high-temp thermal storage enables economic near 24/7 operation



Industry and Green Hydrogen Needs Always-Available Green Power

- Grey and blue hydrogen are made through the use of fossil fuels, most commonly natural gas; green hydrogen is the only mechanism in which hydrogen can be produced in a completely carbon-neutral process
- To make green hydrogen cost-effective, you need always-available green power



Source: Heliogen estimates.
Note: Analysis assumes subsidized economics with 60% debt at 8% interest rate and 40% equity at 12% cost over 30 year projection period. Represents the estimated implied LCOE of Heliogen assuming a capital cost range of approximately $3,600–$5,000 $/kW.

Bill Gross

Founder & CEO of Heliogen

Heliogen

Founder & CEO

idealab®

Founder & Chairman

Idealab has participated in 150+ companies, with 40+ M&A exits and IPOs.
Through Idealab, Bill has started and sold multiple solar companies.

"Powering the planet renewably I believe is the biggest financial opportunity in history. I have spent most of my life inventing and refining a solution to enable solar energy to compete with fossil fuel, and Heliogen's solution is the result."

Our 1st Strategic and Commercial Relationships

ArcelorMittal

- One of the world's leading steel and mining companies
- Largest steel manufacturer in North America, South America and Europe

Department of Energy, United States of America

- Selected to negotiate $39mm[1] award to develop, build, and operate supercritical carbon dioxide power integrated with thermal energy storage supplied by heliostat field

Woodside

- Australian oil and gas company with global presence

RioTinto

- Mining and metals company operating in 35 countries around the world
- One of the largest producers of iron ore, copper, diamonds and gold

Bloomenergy®

- Leading provider of electrolyzer uniquely suited to amplify key benefits of Heliogen's technology

1. *Value of total project is expected to be ~$70mm with ~$31mm funded from private investor.*

Summary

- Heliogen is working to be the leading technology provider enabling industrial decarbonization
- There is staggering demand and trillions of dollars of spend this decade
- Heliogen’s technology is superior for meeting this customer demand
- Heliogen’s technology is patented and combines software, hardware, and know-how to realize superior expected margins
- Heliogen’s team is strong, experienced, and capable of seizing this opportunity
- We welcome you to join us in reducing climate change through industrial decarbonization

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Thanks

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