



Heliogen

Clean Energy on Demand:

The Power of a Hybrid PV + CSP System



Clean Energy and the Push to Decarbonize

In the US, over 75%¹ of greenhouse gas emissions come from industry, electric power, and transportation. The industrial sector and municipalities need a better source of clean energy — a reliable, cost-effective, scalable replacement for fossil fuels that offers sufficient capacity and dispatchability.

Solar energy, when combined with storage, can be a highly effective substitute for fossil fuels. In addition to traditional photovoltaic (PV) solar power, concentrating solar power (CSP) with thermal energy storage (TES) has the potential to supply more than 2,900,000 Twh/yr globally. It's also a giant step towards mitigating 2.1 GtCO₂ of greenhouse gas emissions in support of the Sustainable Development Goals set by the United Nations. For industry, it provides a promising path to sustainable power.

Heliogen is dedicated to providing industrial customers with the necessary access to solar energy technology. Heliogen's hybrid approach combines AI-controlled concentrating solar thermal technology and long-duration thermal energy storage with cost-effective photovoltaics.

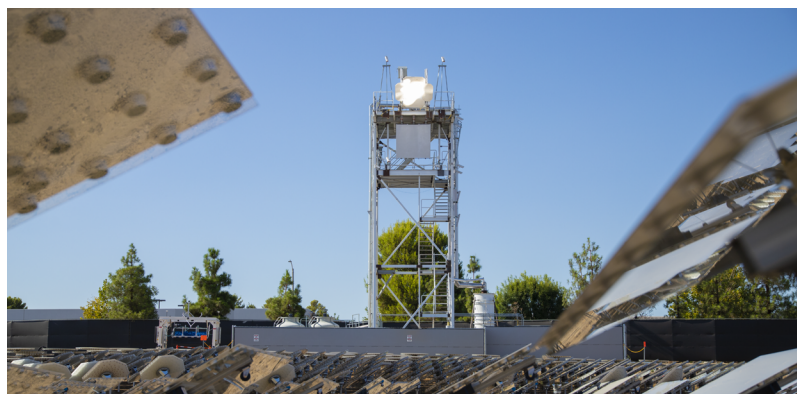
Heliogen and Its Mission

Heliogen is a California-based renewable energy technology company. Its mission is to decarbonize industry by providing green energy built for scale and flexibility, and to make clean energy more economical than fossil fuels.

Our concentrating solar energy system uses AI and thermal storage to deliver steam, heat, or power to support round-the-clock operations.

Our hybrid power system combines concentrated sunlight and thermal energy storage with traditional PV solar. It's designed to deliver efficient, carbon-free power to support 24/7 operations. It overcomes the challenges of intermittency — as posed by other renewable alternatives — to provide dispatchable clean energy. Its closed-loop AI and computer-vision calibration and positioning system radically improves efficiency.

A broad range of industries and sectors that are high users of power can benefit from this hybrid technology, including mining, chemicals facilities, data centers, oil & gas, green hydrogen, utilities, and municipalities.



Heliogen's Hybrid Power System

New iterations of clean energy systems are breaking ground and advancing industrial sustainability. Heliogen's hybrid power system is at the forefront, combining established, proven technologies with next-generation design and AI/computer vision applications — with industrial uses in mind.

Concentrating Solar Power: CSP

Heliogen's concentrating solar power system is the next-gen solution to harnessing sun and heat.

It utilizes small, factory-built mirrors arrayed in front of receiver towers. The heat generated is more than enough for long-duration thermal energy storage for dispatchable power that can support industrial processes.

The system is precisely controlled by Heliogen's proprietary closed-loop AI and computer vision technology.

1) <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#t1fn3>



CSP systems have been used with increasing frequency for some time. But Heliogen has optimized CSP performance with distinct innovations.

Modularization

Heliogen's CSP system is designed in modules — a marked departure from the traditional heliostat array fields surrounding a massive (250–260 m) receiver tower. Instead, each module is self-contained: a smaller grouping of heliostats with a smaller-sized (approximately 100 m) receiver tower. Far simpler and faster to construct, the modular system reduces installation and maintenance expenses substantially.

The smaller design means organizations can easily scale the system to meet their needs. The modular design ensures the system is producing energy whenever there are favorable weather conditions, prioritizing uptime and reliability.



AI/Computer Vision

Recent third-party testing at Sandia National Laboratories found that Heliogen's proprietary closed-loop AI/computer vision can calibrate and correct the position of each heliostat with 3x more accuracy.

The testing also showed that the AI-powered heliostat guiding and tracking software is far more effective than manual setup when it comes to monitoring and correcting heliostat position.

Able to make constant, autonomous corrections and continually guide the heliostats into their optimum position, the software

reduces the need for human intervention when it comes to calibration and repositioning, greatly reducing maintenance and operational costs. Without the need to manually calibrate heliostats to precise degrees during initial setup, construction time is reduced as well.

This new way to optimize CSP elements — with AI-guided heliostats, a receiver tower, and a long-duration thermal storage — provides a highly viable green alternative to fossil-fuel-generated steam, and can store thermal energy without interruption. Modularity makes it far more reliable — minimizing any need for overall systemic maintenance. In this instance, redundancy works to industry's advantage.

PV Technologies

The partner to Heliogen's modular CSP system is well-established PV technology — a traditional and certainly proven source of solar energy.

PV and CSP play different roles. PV is a highly effective source of power during the daytime, while CSP stores sunlight in thermal energy storage for dispatch, providing the heat to power long-duration energy storage for nighttime energy.

The Power of Synergy: The CSP + PV Hybrid System

Heliogen's hybrid system can provide energy and heat for consecutive 24-hour periods with improved reliability, and lower maintenance and construction requirements overall. As a result, industries achieve a level of cost-effectiveness that makes green solutions not only feasible, but desirable from a long-term and business standpoint.

By providing dispatchable power from sunlight using complementary technologies, the hybrid system is not only reliable and cost-effective, but flexible and scalable for varying needs.

- **Overcomes intermittency**
- **Provides energy for power as well as heat**
- **Can be configured for different uses, needs, and energy requirements**
- **Optimal, efficient, 24-hour output**
- **Up to 85% capacity factor**
- **For industries, maximum returns on Opex and Capex**



Concentrating Solar Technology in Action

Lancaster Demonstration and Testing Facility is a municipal collaboration between the city of Lancaster, California and Heliogen. Located in the Mojave, it's a successful proving ground for Heliogen's hybrid power system that shows the system's efficacy for industrial applications as well.

Heliogen's Brenda Green Hydrogen Project is aimed at the transportation & distribution sector. This will be a commercial-scale fuel cell electric vehicle (FCEV) grade (based on SAE-J2719) liquid hydrogen production facility in Brenda, Arizona, a federal Solar Energy Zone in La Paz County. It's anticipated to produce approximately 20,000 metric tons per year, with the opportunity to optimize FCEV-grade green liquid hydrogen. This output could significantly increase the supply of zero-emissions fuel in Southern California.

Working with Heliogen

There's no question that concentrating solar will play a major role in reducing climate change. Heliogen's cost-effective, proven technology is key to achieving true sustainability across industrial and utility sectors.

To truly eliminate the need for fossil fuels, industries need solutions that are efficient, cost-effective, and can be configured to the needs of each user. Solutions also need to be reliable, durable, and easy to maintain. Heliogen provides its customers with a system that does just that — so they can meet their sustainability goals and help mitigate climate change without hurting their bottom line.

Interested in a Heliogen hybrid system?

Ideal candidates for a Heliogen hybrid system have three factors in common:

- **Located in a geographical area with good DNI (direct normal irradiation)** for maximum solar potential, with enough acreage to support sufficient modular CSP arrays and PV. (The hybrid power system can support off-grid remote operations with efficient, dispatchable power and heat.)
- **Aiming for a low-carbon or zero-carbon solution** to reduce their reliance on fossil fuel for power.
- **Committed to making an investment in transforming to green energy** and being at the forefront of innovation in their industry.

To learn more, contact us at:
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