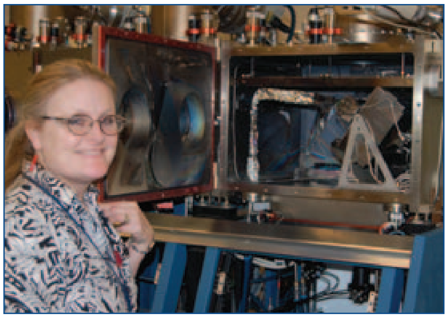
Concentrating Solar Power

Concentrating solar power (CSP) is positioned to become a major source of renewable electricity generation in the United States. Researchers in the Thermal Systems Group at the National Renewable Energy Laboratory (NREL) provide scientific, engineering, and analytical expertise to help advance the state of the art in CSP. As part of NREL's Electricity, Resources, and Building Systems Integration Center, our R&D capabilities span the entire electricity system—from generation to transmission and distribution to the end user—and offer assistance in four major areas of concentrating solar power and solar thermal technologies.

Collector/Receiver Characterization

We use a variety of in-house techniques and tools to test the performance of systems, pinpoint areas of weakness, and help identify the most cost-effective design of CSP components.

- Through Parabolic Trough Collector Testing, we can measure the optical performance of parabolic trough modules.
- At the Receiver Test Laboratory, we can measure heat loss as a function of temperature to establish the thermal performance of receiver tubes in parabolic trough systems.
- The Receiver Infrared Imaging System uses a vehicle-mounted infrared camera and global positioning system that helps us identify which heat collection elements in an operating CSP parabolic trough plant are losing heat and require maintenance.
- At the Concentrator Optical Measurements Laboratory, we use VSHOT (Video Scanning Hartmann Optical Test) and other state-of-the-art techniques to characterize the optical performance of point- and line-focus optical concentrators.
- NREL's High-Flux Solar Furnace consists of a tracking heliostat and 25 hexagonal mirrors in parabolic configuration to concentrate sunlight to an intensity of up to ≈ 30,000 suns. We use the furnace to test and evaluate CSP components, such as reflector and absorber materials and receivers. The furnace is also used for investigating thermochemical hydrogen and advanced material processes.


PIX 16740

In the Thin Film Deposition Laboratory, we develop advanced solar reflectors and absorbers using magnetron sputtering, electron-beam evaporation, and ion-beam-assisted deposition equipment.


PIX 16739

NREL's VSHOT laser scanning system determines the accuracy of concentrator mirror structures and is used in both a laboratory setting and in the field. It has proven critical in the design of new reflector structures.

Advanced Reflector and Absorber Materials

Our researchers use NREL's facilities and capabilities to test new CSP optical materials—with industry partners—to determine if the materials meet the optical requirements of CSP solar field components. Improvements in solar field performance can significantly boost system-wide efficiency.

- Optical characterization involves measuring the reflectance and transmission of CSP mirrors, glazing, lenses, glass, and coatings. In material characterization, we study the properties of materials, such as permeability, adhesion, reflectivity, absorption, and more.
- Accelerated exposure testing replicates the long-term effects of outdoor exposure in a short period of time. Thus, we can assess the durability of CSP reflectors and absorbers in a timeframe that supports more rapid deployment of these advanced materials.
- In our Thin Film Deposition Laboratory, we determine characteristics and effectiveness of thin-film coating on CSP mirrors and receivers.

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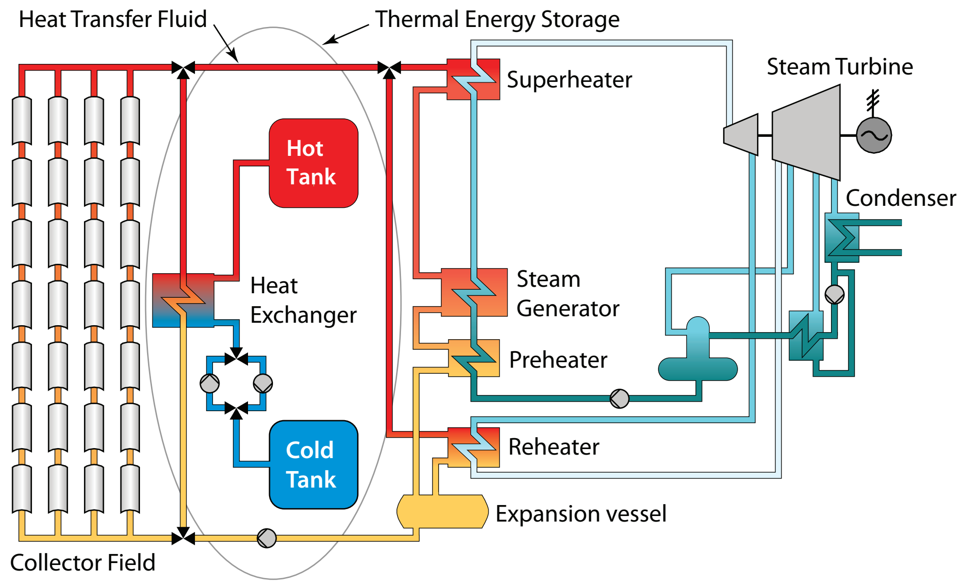
Thermal Storage and Advanced Heat Transfer Fluids

We can measure and evaluate the properties of fluids that transfer and store heat in CSP systems and predict the overall performance of a thermal-storage system.

- We use the Thermal Storage Materials Laboratory to evaluate the thermal properties of storage materials and to characterize fluids for both heat transfer and storage.
- The Thermal Storage Process and Components Laboratory, when completed, will have the equipment and accessories to determine the overall performance of a complete thermal-storage system before it is tested at full scale.
- With Thermal Storage Heat Transfer and Fluid-Flow Modeling, we use computer simulation software to model the flow of thermal energy and fluid over time and to predict the performance of complex heat-transfer and flow systems.

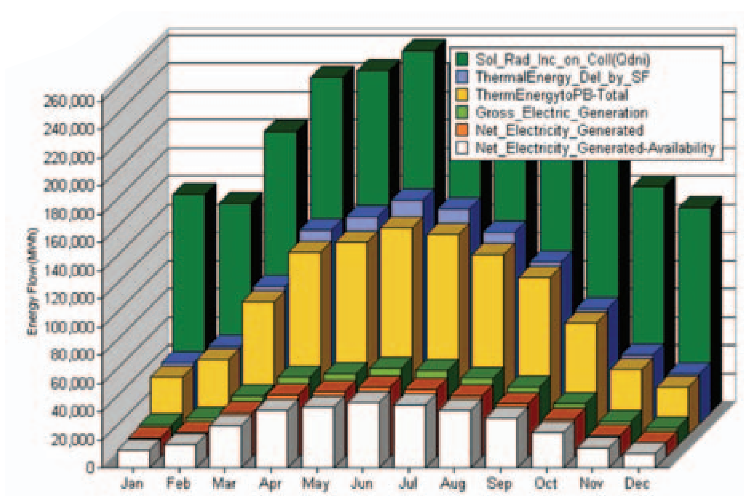


Major components of a parabolic trough power plant are shown. Heat transfer fluid from the collector field may generate electricity directly or be sent to thermal energy storage for later electricity generation.

CSP Modeling and Analysis

We employ advanced modeling techniques and data collection methods to help determine the best locations for CSP plants, based on solar irradiance, as well as economic, social, and environmental factors.

- We use models and analytical techniques to evaluate the potential for large-scale deployment of CSP under various scenarios and to estimate the resulting impact in terms of energy delivery, jobs, and the environment. Example include the Solar Advisor Model (SAM), used to calculate the levelized cost of CSP system designs; the Regional Energy Deployment System (ReEDS), used to determine energy and environmental impacts; and Job and Economic Development Impact (JEDI), used to quantify potential employment and financial outcomes.
- Our Resource Information and Forecasting group provides us with the necessary solar data, including satellite imagery, to help stakeholders better understand the feasibility of locating a CSP plant in a particular area.



This monthly energy flow diagram for a parabolic trough power plant shows the conversion of energy from incident sunlight (green) to net electricity delivered to the grid (white).

Helpful Websites

NREL Concentrating Power Research
www.nrel.gov/csp

TroughNet Parabolic Trough Solar Power Network
www.nrel.gov/csp/troughnet

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