National Renewable Energy Laboratory
Feature Stories

New Solar Technology Concentrates on Cost, Efficiency

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It looks like a giant funhouse mirror. But the big new dish atop South Table Mountain could be a renewable energy breakthrough that helps make concentrated solar power more affordable and appealing to utilities and their customers.

For the next several months, NREL engineers will be testing the performance of SkyTrough, an innovative parabolic trough that is coated with a gleaming reflective skin instead of mirrored glass.

NREL offers leading-edge testing and performance analysis for advanced solar technologies and other renewable energy designs.

The SkyTrough was developed by SkyFuel, an Albuquerque–based manufacturer with a research facility near NREL in Arvada, CO.

NREL senior engineer Keith Gawlik and University of Colorado graduate student Kathleen Stynes are conducting tests on the new SkyTrough parabolic trough design atop South Table Mountain for the next several months. Gawlik is holding a sample of the trough's highly reflective metal skin. The sheet metal replaces heavy glass mirrors. *Credit: Pat Corkery*

The unit's lightweight glass-free are mirrors made of sheet metal beneath ReflecTech® mirror film.

This highly-reflective, silver-metalized film is lighter and less expensive than the breakable glass mirrors that are traditionally used. The film is a joint invention of NREL and ReflecTech™ and exclusively licensed from NREL. The glossy laminate is comprised of multiple layers of polymer films with an inner layer of pure silver to provide for a highly reflective surface that also protects the silver layer from oxidation

In commercial use, a SkyTrough could measure as large as 375 feet long and 20 feet high. One SkyTrough would supply enough electricity for 125 homes. The test model is smaller, but uses the same technologies.

"It's unlike any parabolic trough design used so far," said NREL senior engineer Keith Gawlik. "Our new facility is designed to test the optical efficiency of the unit, which they can't do on their own at SkyFuel."

How Parabolic-Trough Systems Work

Parabolic-trough systems concentrate the sun's energy through long U-shaped mirrors. The mirrors are tilted toward the sun, focusing sunlight on a vacuum pipe that runs down the center of the trough.

The tube contains heat-transfer oil that absorbs the focused sunlight and reaches temperatures of 400 degrees Celsius. The hot oil then is used to boil water in a conventional steam generator to produce electricity.

As the sun moves across the horizon, the troughs follow its trajectory by rotating along their axes with the help of tracking motors. This keeps the collectors oriented towards the sun to maximize the system's performance throughout the day.

SkyTrough Testing at NREL

The SkyTrough itself is mounted on NREL's Large Payload Solar Tracker. It supports solar components that require 2-axis tracking. The tracker is capable of carrying a maximum vertical load of 9,000 pounds with a tracking accuracy of 1 milliradian.

The NREL tests will center on validating the SkyTrough's optical performance. A key step in concentrating solar power (CSP) is making sure the light collected in the parabolic trough is accurately converted and focused on the receiver tube so it can heat the transfer oil efficiently.

"Lots of things come into play when focusing light," Gawlik said. "We have to consider the reflectivity of the surface, the accuracy of the surface and then aiming all of the light into the narrow focal line of the receiver tube."

Kathleen Stynes peers at the continuous data provided by analytical instrumentation for field testing of the SkyTrough parabolic trough design. The novel design using a reflective metal coating instead of heavy glass mirrors was developed by SkyFuel with NREL's help. *Credit: Pat Corkery*

Typically, a parabolic trough operates at nearly 80 percent optical efficiency, and SkyFuel expects its design to function at least as well, while being less expensive to manufacture, transport and maintain.

The NREL test will span portions of at least three seasons to explore the unit's performance under a variety of weather conditions and sun angles.

"There is a cascade of opportunities to lose some light at every step in the process," Gawlik said. "That's why we field test the whole unit and get solid data over a number of months. It removes the uncertainty in the final efficiency result."

Future Concentrating Solar Power Plants

The NREL tests will not include actual electricity generation because that step in the process uses conventional steam turbine technology. But it is that hybrid combination of the renewable and the conventional that makes CSP appealing to utilities as a source of cleaner bulk power during peak and intermediate load periods.

Parabolic trough power plants also require relatively large tracts of nearly level open land with strong solar characteristics, as well transmission lines and other infrastructure. These factors make Southwestern states the leading candidates for additional CSP installations; in California, the Solar Energy Generating Systems plants have been operating for two decades.

A rear view of the SkyTrough being tested atop South Table Mountain in Golden. The model is attached to NREL's Large Payload Solar Tracker. It supports solar components that require 2-axis tracking of the sun. The tracker can support equipment weighing 9,000 pounds with a tracking accuracy of 1 milliradian. *Credit: Pat Corkery*

By 2015, the Western Governors' Association estimates that 4 gigawatts of new concentrating solar power plants could be built in the United States.

Learn more about NREL research into concentrating solar power.

— Joseph B. Verrengia