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Components Makeover Gives Concentrating Solar Power a Boost

Parabolic trough technology is the most mature of the various concentrating solar power (CSP) options. But scientists at the National Renewable Energy Laboratory (NREL) continue to make advances on trough systems through innovative research on various components in industrial partnerships with Acciona Solar Power, SkyFuel, Schott Solar, and others. The results are leading to improved system efficiencies and lower costs for CSP plants.

Space Frames for Lower Costs

To maximize the overall efficiency of the conventional glass-mirror trough system, NREL worked with Acciona Solar Power—then known as Solargenix Energy—to improve various system components. A key focus was the structural framework that holds the mirrors and receiver tubes within each solar collector assembly. This big-ticket item within the CSP system was redesigned so that the structure could be assembled in the field, saving both manufacturing and transportation costs. Through tests in the laboratory, in a wind tunnel, and at actual field locations, scientists identified components that could be eliminated and also fine-tuned the optics of the trough. The result was a structure produced by Gossamer Space Frames that was substantially stronger and lighter than previous models, as well as easier and faster to assemble in the field.

The overall SGX-1 trough system, with its innovative improvements to all facets of the earlier technology, was deployed at Acciona's 64-megawatt Nevada Solar One plant near Las Vegas, Nevada, which began commercial operation in 2007. The innovations are also included in Acciona's design for parabolic trough plants in Spain.

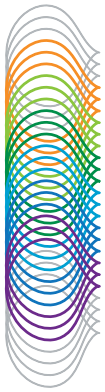
Reflective Films for Lighter Loads

NREL has been a leader in developing lightweight, more cost-effective reflective films that can replace heavier, more expensive glass mirrors. For example, collaborating with

PIX 18201

Aerial photo of Acciona's Nevada Solar One plant, with its rows of parabolic troughs.
Courtesy of Acciona Energy

The Spectrum of Clean Energy Innovation



Fundamental Science

Market-Relevant Research

Systems Integration

Testing and Validation

Commercialization

Deployment

Through deep technical expertise and an unmatched breadth of capabilities, NREL leads an integrated approach across the spectrum of renewable energy innovation. From scientific discovery to accelerating market deployment, NREL works in partnership with private industry to drive the transformation of our nation's energy systems.

This case study illustrates NREL's innovations and contributions in Market-Relevant Research through Commercialization.

NREL
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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

PIX 16604

ReflecTech Mirror Film, with a thickness of 3.7 mils (just 0.0037 inch), is deployed as the reflector in this parabolic trough. Courtesy of SkyFuel, Inc.

ReflecTech, Inc., NREL developed the ReflecTech Mirror Film, constructed of multiple polymer layers, with an inner layer of pure silver that provides high reflectance over the full solar spectrum. The design protects the silver layer from oxidation and other harmful effects. Accelerated outdoor weathering tests in Arizona showed no significant loss in solar reflectance after the equivalent of 10 years of ultraviolet light exposure.

SkyFuel, Inc. has used ReflecTech in its SkyTrough parabolic trough system, where wide strips of the film are slid into position on the support frame to form a parabolic reflective surface, in lieu of using more expensive slumped-glass mirrors. The system is easy to transport to and assemble in the field, and the lighter reflective surface also allows the space-frame support structure to be lighter, and hence, less expensive. In 2009, NREL and SkyFuel won an R&D 100 Award for the SkyTrough system, along with its associated ReflecTech technology.

NREL's ongoing partnership with SkyFuel has included further developments of the ReflecTech film, optical efficiency testing of the parabolic units to improve the optics, and thermal testing to measure the efficiency of the system. NREL's results for the SkyTrough show a thermal efficiency at 350°C of more than 73%—performance comparable to or exceeding that of a conventional utility-grade trough system at a cost well below industry standards. This system was deployed within one of the Solar Electric Generating System (SEGS) plants in California in 2009 and is being considered for other commercial applications.

Special Coatings for More Heat

A key driver in the overall efficiency of a parabolic trough system is the heat absorption and retention of the heat-collection element (HCE)—the component that absorbs the sun's thermal energy to heat the fluid within the receiver tube. Innovations in the solar-selective coating applied to the HCE can significantly improve these qualities.

Through extensive research, NREL scientists have created a high-temperature, oxidation-resistant, multilayer solar-selective coating with absorption characteristics comparable to current HCE technology, while re-emitting less energy. The coating is also able to withstand higher operating temperatures than conventional coatings, making it a potentially more robust design solution for higher-temperature applications such as central receivers.

In a cooperative research and development agreement with NREL, Schott Solar is developing NREL's advanced coating into a commercial product for HCEs for parabolic trough systems. NREL continues to optimize the coating, test stabilities at temperatures greater than 500°C, and assist Schott with scaling up the coating process to pilot-scale production.

Partnering for Better Films

NREL is investigating reflective-film alternatives to glass mirrors through the following partnerships:

- Alcoa and NREL are testing a collector designed to use any reflective film, offering greater design flexibility than commercial, thick, silvered glass mirrors. The design allows for high-volume manufacturing, and the monolithic structure enables a simple "drop-in-place," easy-to-install solar collector that lowers installation costs.
- NREL supports Abengoa Solar's development of a front-surface mirror that protects its silvered polymer substrate with an aluminum oxide coating that is dense, amorphous, strongly adhering, and anti-abrasive.
- NREL and 3M collaboratively developed a silvered acrylic reflector film. 3M, through funding from the U.S. Department of Energy, is formulating a hard coat that should significantly boost the abrasion resistance of the film.

PIX 18227

The large-scale parabolic trough SkyTrough, 6 meters across from edge to edge, uses innovative ReflecTech Mirror Film as a reflector. Courtesy of SkyFuel, Inc.

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