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NATIONAL RENEWABLE ENERGY LABORATORY

Distant Observer Tool Quickly Identifies Costly Flaws in CSP Fields

Highlights in Research & Development

Remote control digital photography and metrology are combined to accurately define optical efficiency problems in concentrating solar power (CSP) plants.

In a typical 100-megawatt (MW) CSP plant, an optical efficiency gain or loss of a mere 1% is worth about $600,000 in annual revenue. Hence, optimizing optical efficiency is key to the plant's economic viability.

The Distant Observer (DO) tool, developed by the National Renewable Energy Laboratory (NREL), quickly and accurately measures the efficiency of the complete optical system in a parabolic trough collector. DO typically involves a digital camera mounted on a high-performance radio-controlled helicopter. The device finds two types of optical efficiency problems in a parabolic trough: reflector slope errors and misalignment of the receiver absorber with the focal line of the parabola.

Reflector slope errors can occur for many reasons, including imperfections in structural frame design, manufacturing, and assembly. Moreover, the systems may respond dynamically to gravity as they track the sun. Receiver absorber misalignment can be caused by poor structural design, poor installation, sag from the weight of the heat transfer fluid and the tube itself, or change in the structure over time, caused by wind loading or other effects.

Data collected from DO can be used for at least two purposes. One is to assist in the design of parabolic troughs that can maintain the best absorber alignment and lowest slope error. Also, this method is easily scalable to measure full solar fields at CSP plants. So by using DO, plant operators can spot errors and swiftly rectify them to keep the plant operating at maximum efficiency.

Technical Contact: Benjamin Ihas, *benjamin.ihas@nrel.gov*

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A high-performance radio-controlled helicopter, holding a specialized camera, is part of the Distant Observer photogrammetric data acquisition system. Here, the helicopter hovers over a trough in the Nevada Solar One CSP plant outside of Las Vegas. Photo by NREL Distant Observer Team, NREL/PIX 23115

Key Research Results

Achievement

NREL created the first CSP field metrology tool that rapidly and accurately measures the efficiency of a parabolic trough collectors' complete optical system.

Key Result

This tool measures the position of the receiver and the metrology of the reflectors for both prototype and deployed parabolic trough collectors.

Potential Impact

This tool is critical to the optimization of the optical efficiency of complete parabolic trough collector systems, thereby ensuring optimal performance of newly developed systems. Optimal performance reduces the cost of delivered energy, which is vital to attracting investors and increasing deployment of CSP throughout the nation.

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15013 Denver West Parkway
Golden, CO 80401
303-275-3000 | www.nrel.gov

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