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Guest Editorial

Special Issue on Heliostat Technologies for Concentrating Solar-Thermal Power

Concentrating solar-thermal power (CSP), naturally coupled with thermal energy storage, can offer competitive renewable energy generation for (1) dispatchable electricity to the grid, compared with PV, wind, and batteries; (2) industrial process heat, particularly with a temperature higher than 200 °C, in a wide range of industrial applications; and (3) renewable fuel generation through high-temperature heat above 1000 °C. Currently, CSP has a global installed capacity of over 7 GW_e for electricity and has also been initiated for process heat and renewable fuels. Thus, it presents a golden opportunity for researchers to tackle critical research and development (R&D) issues for CSP's broader deployment in the upcoming decade. The heliostat field is a critical component of next-generation CSP technologies, as it represents 40–60% of the total system cost. There exists a great potential to improve its performance and reduce its cost for CSP commercial competitivity.

The Special Issue on Heliostat Technologies for CSP calls for papers on new, emerging applications, and/or applying heliostat technologies to enable the manufacture of new products by a collection of scholarly articles within the scope of the ASME *Journal of Solar Energy Engineering*. It intends to collect original theoretical and applied research from the global CSP community, which would cover topics such as heliostat design, metrology, heliostat optics, and solar field-related aspects (operation, control, maintenance, wind load, techno-economic analysis).

Highlights of the research papers selected for publication include innovative metrology development by the University of Arizona, Quantum Optics Applied Research, and the German Aerospace Center (DLR) (with CSP services). They proposed new techniques to measure in situ opto-mechanical performance of heliostats. In the paper led by Dr. Brandon D. Chalifoux, titled "Laboratory Demonstration of Grating Embedded Mirrors for Single-Shot Heliostat Optical Metrology," a compact, accurate, and high-speed heliostat slope error metrology system is proposed, designed, and tested in a laboratory environment. The original work established a solid foundation for further development to be applied to a commercial-scale field with more than 10,000 heliostats. The paper titled "Closed-Loop Pointing Feedback for Heliostats in Concentrating Solar Power," by Dr. Bernhard W. Adams, not only proposed a novel heliostat point error measurement metrology tool but also a closed-loop tracking control system based on the metrology. The underlying principles were elaborated, followed by experimental verification. In addition, the "open access" paper "HelioPoint—A Fast Airborne Calibration Method for Heliostat Fields," led by Dr. Julian J. Krauth and Dr. Christoph Happich, introduces a drone-based heliostat field calibration technique for a commercial-scale field.

For readers less familiar with heliostat technologies, the selected paper in the special issue titled "Review on Carousel Heliostat Designs" by Dr. Andreas Pfahl, provides a systematic introduction on heliostat technology by focusing on one type of a particular design—carousel design.

A majority of research papers in this special issue derive from HelioCon, an international heliostat consortium funded by the U.S. Department of Energy Solar Energy Technologies Office (SETO) started in 2021. HelioCon is designed to advance U.S. heliostat technologies by engaging industry, subject matter experts, and general stakeholders for direct project-level collaboration, external consulting, and mission-specific panels and workshops. HelioCon is led by the National Renewable Energy Laboratory and Sandia National Laboratories, in partnership with the Australian Solar Thermal Research Institute. Right now, HelioCon has been expanded to include 16 consortium members and 19 partners across the world, including top research institutes and leading industrial developers. The special issue collects the findings from the roadmap study conducted by over 20 researchers from HelioCon in 2022. The papers include gap analysis on top-priority RD focus areas critical to heliostat technology development over a variety of topics such as wind load, field deployment, components & controls, techno-economic analysis and resources, training, and education. Original research performed under HelioCon such as non-intrusive optical metrology tool and evaluation of composite structural materials for heliostat are also included in the special issue.

We hope the collection in this special issue will inspire more exciting works across the mechanical engineering community in the domain of CSP and heliostats for years to come. A special thanks goes to the Editor-in-Chief, Professor S. A. Sherif for making this special issue possible and for his valuable and patient guidance in improving the quality and spectrum of the selected papers. We also wish to thank the reviewers for providing critical peer reviews for submissions under this special issue. Lastly, and most importantly, we wish to thank all the authors to conduct original research work and submit their work to the Special Issue of the prestigious ASME *Journal of Solar Energy Engineering*.

We are excited to see the special issue published!

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