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EDITORIAL
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Editorial: Advances in Solar Central Receiver Technology

Omar Behar[1], Loreto Valenzuela[2]* and Kamal Mohammedi[3]**

[1]CCRC, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia, [2]CIEMAT-Plataforma Solar de Almería, Almería, Spain, [3]MESO/URMPE, M. Bougara University, Boumerdes, Algeria

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Editorial on the Research Topic

Advances in Solar Central Receiver Technology

This editorial summarizes the contributions to the Frontiers Research Topic "Advances in Solar Central Receiver Technology" established under the Frontiers in Energy Research journal.

Concentrating solar thermal power (CSP) technologies have experienced a relevant commercial deployment with an installed capacity higher than 6 GWe worldwide. This type of renewable energy technology is based on the use of a solar field of distributed mirrors that individually track the Sun and focus the sunlight onto a receiver. In the case of line-focus solar collectors, e.g., parabolic troughs or linear Fresnel reflectors, the receiver is a tube located in the focal line of the parabola of each collector of the solar field, and in the case of a central receiver (or solar tower), solar field heliostats focus the sunlight on the surface of the receiver located on the top of the tower. Other point-focus solar systems are parabolic dishes that present the benefit of achieving high concentration and temperatures in the receiver located at the focal point of the dish. Up to date parabolic troughs utilize CSP technology with large commercial deployment, with about 4.4 GWe installed, but with parabolic troughs the conversion efficiency from thermal to electrical energy is limited by the maximum temperature achievable in the fluid circulating through the receivers in the solar field, which limits the options to integrate these systems into steam Rankine cycles. Central receiver solar thermal power plants have the potential of using different heat transfer media (steam, air, molten salts, and particles) at higher temperatures than parabolic troughs, and have proven to be technically and also commercially feasible. But central receiver solar tower technology still requires further research, innovation, and developments to achieve a more reliable and robust technology with better integration capabilities into thermodynamic power cycles.

This Frontiers Research Topic presents recent studies on modeling, experimentation, and enhancements of subsystems in central receiver solar power plants, especially on heliostat fields and solar receivers.

One of the major Research Topics for solar tower systems is the automation and control of heliostat fields to achieve an optimal performance of the whole solar power plant and to prevent damages to the receiver and extend its service life. García et al. conducted a study on the development of a dynamic aiming method suitable for working under closed-loop control strategies. The method entails an optimization procedure for two tuning parameters, one that limits how far the aiming point of a heliostat placed in the solar field can move from the equator line of the receiver installed in the tower, and a second one that represents its direction (upward or downward) from this line toward the edge of the receiver. The study considers three different sets of constrains for the optimization; the first set limits the obtained heat flux distribution; secondly, the value of the distance from the equator line is also limited within a range; and finally, the relative values of this distance are considered between subgroups. The study is conducted considering a base case scenario with a central receiver composed of 12 panels and the solar field is divided, in the same way, into 12 sections.

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Michael Folsom Toney, University of Colorado Boulder, United States

****Correspondence:***
Omar Behar
omar.behar@kaust.edu.sa
Loreto Valenzuela
loreto.valenzuela@psa.es
Kamal Mohammedi
mohammedi.kamal@univ-boumerdes.dz

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With the optimization procedure proposed, the heat flux on the receiver is improved up to 27% and good robustness and flexibility of the aiming methodology through application to a different configuration of solar field and receiver are also shown.

The importance of optimum solar flux distribution on solar tower receivers is also the scope of the article of El-Leathy et al. The advantages of considering concentrated solar thermal power plants over other renewable energy technologies lie, for example, in their ability to offer a reliable thermal energy storage solution for dispatch when needed. Besides, increasing the efficiency of CSP technology is also required to reach high temperatures compared to those currently applied on commercial solar tower power plants to allow the connection to highly efficient power cycles or innovative systems such as solar fuels or materials production. Solid particles have the advantage over other potentially applicable heat transfer media in solar tower systems as they can be directly used as the thermal storage media, which would reduce the complexity of the systems and the costs. El-Leathy et al. investigate on how to manage the solar flux distribution on a solar particles receiver, which is a direct absorption central receiver with a falling curtain of particles heated directly by a concentrated beam of sunlight from a heliostats field. In their study, El-Leathy et al. consider both single and multi-aiming point strategies to achieve uniform flux distribution on to the receiver, which is composed of five panels inside a cavity, while the solar field consists of 9,907 heliostats. For the multi-aiming points strategy analyzed, the heliostats field is divided into seven groups or clusters. The study reveals how the implementation of the single aiming point strategy may result in high flux intensity in the receiver panel but also in overheating of the particles and potential damage to the receiver, while the implementation of a multi-aiming points strategy entails a more uniform solar flux distribution even when considering only five points of aiming, one per panel, which increases the spillage.

An alternative to large concentrated solar power systems based on central receivers is small-scale CSP technologies like solar dishes coupled to consolidated and relatively cheap technology of micro-gas turbines (MGT). Agostini et al. have investigated the environmental impacts of such small-scale CSP technology. The study of an environmental life cycle assessment analysis of the production and operation of a CSP-MGT system is performed following an eco-design approach. The results, presented per unit of electricity produced, are compared to other renewable technologies with the same level of dispatchability to evaluate the strengths and weaknesses. With regards to greenhouse gas emissions, it resulted in the same range as those generated by photovoltaic systems but with a potential reduction of up to 73% with respect to the built prototype considered in the study, which reveals an interesting aspect for science-based energy policy planning given the rapid penetration of non-dispatchable energy technologies in the energy market.

Together, this special issue presents specific Research Topics on concentrated solar power systems based on point-focusing concentrators that are still open fields for investigation with the aim of increasing the performance and lifetime of the systems and reducing their environmental impact.

AUTHOR CONTRIBUTIONS

LV prepared and organised the information to be included in this editorial brief and wrote the first draft of the manuscript. OB and KM read, reviewed and approved the submitted version.

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