SolFieOpt
Optimal Heliostat Fields for Solar Tower Power Plants

Project Duration: 07.2016 to 09.2019
Initital report submitted: 04.2017

Summary

A solar tower power plant (also known as central receiver system (CRS) consists of a receiver on top of a tower and a field of hundreds or thousands of heliostats. The heliostat field reflects and concentrates direct solar radiation onto a receiver placed at the top of the tower. At the receiver the light is absorbed and the resulting high-temperature thermal energy is transferred to the heat transfer fluid in order to either directly produce electricity through a conventional thermodynamic cycle or to be stored. Today four large tower plants are already operating in the US (Ivanpah 1-3 and Crescent Dunes), three in Spain (PS10, PS20 and Gemasolar) and one is under construction in South Africa (Khi Solar One). Numerous small-scale plants exist around the world for demonstration and research purposes (e.g. the Solarturm Jülich in Germany, and the facilities CESA-1 and SSTS-CRS in Spain).

Solar tower power plants technology is very well suited for converting sunlight into dispatchable electricity. Dispatchability is important as the electricity demand hardly ever matches the production of renewable energies, such as wind and photovoltaics. While for small amounts of renewable energies the effect on the electric grid is negligible, countries with high shares of solar energy (such as Italy and Germany) face a challenge. Solar tower systems operate at high temperatures, making thermal storage systems very cost-efficient. Their storage capabilities help to even out fluctuations of other renewable plants and thus help to further increase the capacity of the non-dispatchable renewable energy technologies.

The design of the heliostat field layout is a challenging task of exceptional importance. It is the sub-system with the highest cost and its optimal design highly depends on the specifications for each project. Within this project the partners will create a tool to optimize the field layout including new features and constraints as for instance tripod foundations for heliostats or multi-tower layouts. A hybrid software will be created based on preliminary works of the two university research groups (University of Seville and RWTH Aachen University). A storage system will be modelled to consider the dynamic energy charges during day and night, and it will be optimized for meeting the electricity demand. The optimizer will have the possibility to consider pattern-based and pattern-free fields. An optimized cleaning strategy will be studied and applied for any kind of field layouts, aiming to reduce the path length of the cleaning trucks or robots. The developed simulation and optimization tools will be cross-validated against commercial and in-house tools of TSK Flagsol. Real data for the cost model and a reference field will be used.

The methods developed within this project will yield more efficient and thus more competitive heliostat fields, which lead to higher market penetration of this technology, benefitting the entire industry.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	2	436’872	345’456
Spain	1	120‘000	120‘000
Total	*3*	*556’872*	*465’456*

Funding agencies involved and contracts

Funding Agency	**Contract N° and Title**
Minsterium für Innovation, Wissenschaft und Forschung des Landes Nordrhein-Westfalen	W042- “SolFieOpt- Optimal Heliostat Fields for Solar Tower Power Plants”
Ministerio De Economia y Competitvidad	PCIN-2015-108 “Optimal Heliostat Fields for Solar Tower Power Plants”
Projektträger Jülich	0324039 – „SolFieOpt- Optimale Heliostatenfelder für Solarturmkraftwerke”