TubeMon
New online flux density and temperature measuring systems for Monitoring and optimized operation of external Tube receivers

Project duration: from 09.2019 to 08.2022
Report submitted: 10.2022

Publishable Summary

Solar power towers offer the highest cost reduction potential among all CSP technologies. Raising the receiver efficiency and extending its lifetime are suitable measures to reduce the electricity generation costs. In order to do that, the flux density and the temperature distribution have to be measured and controlled. Previous measurement methods suffer from severe disadvantages. The moving bar technique for measuring the flux density distribution is hardly feasible for large-scale receivers due to high efforts and costs. Formerly used thermography methods assume a constant emissivity and ignore the receiver's aging and spatial inhomogeneities.

The TubeMon project is a key for overcoming these limitations and boosting the enhancement of measuring systems, simulations and control for industrial-scale external tube receivers. It puts emphasis on the improvement of a promising flux density measurement technique and will lead it to application at large tubular receivers. Emissivity and thermographic temperature measurement will substantially gain

accuracy. Demonstrational tests of the newly developed flux density measurement system at a commercial power plant in Ashalim, Israel pave the way for posterior application and commercialization of the technologies. Progress in raytracing, modelling and control of flux and receiver operation supplement the project very well.

The project was carried out by a strong trinational consortium, bringing together experts of industry and science. Together, they make a significant contribution to the decrease of CSP costs.

In work package 1, a method was applied that had already been used successfully on open volumetric receivers. For the adaptation to tubular receivers, it was necessary to make some changes to the software for the evaluation of the generated images. Furthermore, the method was tested many times at the Jülich solar tower on an improvised tube receiver.

The measurement of temperature and emissivity (work package 2) is still in progress. Here, a system has been developed that is also contactless and capable of collecting temperature and emissivity data in real time.

As a highlight of the project, in work package 3 the developed system for measuring the optical flux density was tested on the solar tower of the Megalim solar power plant in Ashalim, Israel in June 2022. First results show good results, the detailed processing of the data is not yet completed, as the project ended in August 2022.

In work package 4, software was developed that uses graphics processors to calculate the distribution of the images of the heliostats on the tube receiver and thereby optimises the target point accuracy of the heliostats.

The measurement system developed in this project will be further developed and tested and eventually raised to commercialisation status.

Within this project, 3 student theses were completed, a patent was filed and a peer-reviewed publication was published.

Project consortium

Coordinator and all contact details:

Full name of organisation	Deutsches Zentrum für Luft- und Raumfahrt, Institut für Solarforschung
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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	2	623 145	623 145
Spain	1	288 861	173 316
Israel	1	357 949	178 974
Total	*4*	*1 269 955*	*975 435*

Funding agencies involved and contracts

Funding Agency	Contract N° and Title
Agencia Estatal de Investigación (AEI)	-
CDTI	Sera-20201001 Nuevos sistemas de medición online de temperatura y de densidad de flujo en receptores Externos (de tubos) para optimizar la operación de la planta termosolar
Projektträger Jülich (PtJ)	Zuwendung aus dem Bundeshaushalt, Einzelplan 09, Kapitel 03, Titel 68301, Haushaltsjahr 2019. Förderkennzeichen: 03EE5008