More Efficient Heliostat Fields for Solar Tower Plants: The HELIOSUN Project

Jesús Balletrín[1,*], Loreto Valenzuela[2], Jesús Fernández-Reche[2], Ramón Pujol[3], Gabriel Cardona[3], José A. Carballo[2], Javier Bonilla[2], Noelia Estremera[2], Elena Carra[2], Noelia Simal[2], Rafael Monterreal[2], Aitor Marzo[4]

[1] CIEMAT-Plataforma Solar de Almería. Point Focus Solar Thermal Technologies Unit. P.O. Box 22. E04200 Tabernas-Almería (SPAIN), +34 950 387 903, jesus.ballestrin@psa.es

[2] CIEMAT-Plataforma Solar de Almería

[3] University of Islas Baleares, Spain

[4] Department of Optics, University of Granada, Granada, Spain

*Correspondence: Jesús Ballestrín, jesus.ballestrin@psa.es

1. Introduction

Solar tower plants have the greatest potential for improvement: it presents higher conversion efficiencies due to the operation at higher temperatures, as well as greater potential of cost reduction in its deployment. Among all the components of the technology the cost reduction in the solar field would have the greatest impact on the cost reduction of a central receiver plant, since it represents up to 60% of the investment cost for those plants with more than 100MWe of nominal power.

The HELIOSUN spanish project approaches cost reduction from 3 different but complementary points of view. Firstly, an artificial vision system with object recognition based on neural networks is proposed, which allows the closed-loop tracking control of the heliostats in the solar field. This system, consisting on the installation of a low-cost camera and processor in each one of the heliostats in the solar field, will eliminate the positioning sensors and improve the tracking accuracy of heliostat, improving the concentrated solar radiation distribution on the solar receiver surface. Moreover, a correct measurement of the atmospheric attenuation suffered by the solar radiation concentrated by the heliostats on its way to the solar receiver, with distances greater than 1500m for large solar plants will allow firstly, to perform an adequate selection of those sites with the best characteristics for the deployment of solar tower plants and to optimize the routine operation of the solar plant with real-time measurements of atmospheric attenuation. For this purpose, the project aims to work on the generation of an extinction type year for the Plataforma Solar de Almería (PSA); in addition to generating and validating atmospheric extinction prediction models based on climatic variables. Finally, using the generated models and satellite data, an atmospheric extinction map for Spain will be generated, which will be very useful for those CSP promoters interested in the development of the technology. Finally, a ray-tracing simulation software, based on OTSun, is intended to be developed, including a more accurate prediction of the behaviour of a solar tower plant with central receiver considering spectral analysis, as well as including all the experimental results presented above.

2. Expected impact of the HELIOSUN project

Expected results for the HELIOSUN project (09/01/2022 – 08/31/2025) will contribute to foster the deployment of the solar tower central receiver technology both, improving

efficiency of those systems and reducing the cost of the heliostats and, in consequence, of the solar field.

The development of a complete-new artificial vision close-control loop for heliostats is in concordance with the emerging concept of SMARTHELIOSTAT in the scope of SMARTCSP [1]. The main features of SMARTCSP components are autonomous intelligent control, lean manufacturing concepts and plug-and-play approaches. At the same time the system will contribute to the development of the Autonomous heliostat, as it is also compatible with autonomous heliostats. Autonomous heliostats concept removes all the electrical wires and related components (Fig. 1). The communication is performed by radio or Wi-Fi. Autonomous heliostats are powered by batteries and PV panels. HELIOT contributes to this concept giving more autonomy to the heliostat, since the automatic control system is embedded. Wireless communications are only needed to receive supervision and to send local data. Finally, it can include internet of things capabilities, since collected data can be processed and sent to be stored in a cloud database.

Fig. 1. Smart Solar tracker prototype and selected installation in the CESA-I heliostat field (PSA)

A proper measurement of the atmospheric attenuation and the generation of a solar extinction type year for PSA will contribute to validate the already existing models, as well as, together with the SMARTHELIOSTAT development will provide insight or data for improving CSP processes [2]. In this sense, another objective of the project is to obtain an extinction map of Spain with the previously validated models that will serve as a guide for CSP promoters of solar tower thermal power plants in the correct choice of the most favourable locations in our country. Finally, a ray-tracing simulation software, based on OTSun including a more accurate prediction of the behaviour of a solar tower plant with central receiver considering spectral analysis, as well as including all the experimental results presented above [3]. The application, being of public use, will be of great interest to the entire research, academic and industrial sector, both nationally and internationally.

References

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