Renewable and Sustainable Energy Reviews 81 (2018) 1019–1029

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

# An overview of drivers and barriers to concentrated solar power in the European Union

Pablo del Río[a,*], Cristina Peñasco[a], Pere Mir-Artigues[b]

[a] Consejo Superior de Investigaciones Científicas (IPP-CSIC), C/Albasanz 26-28, 28037 Madrid, Spain
[b] Energy Sustainability Research Group (University of Barcelona)/UdL, John Maynard Keynes, 1-11, 08034 Barcelona, Spain

ARTICLE INFO

*Keywords:*
Renewable electricity
Concentrated solar power
Drivers
Barriers

ABSTRACT

The aim of this article is to identify the most relevant drivers and barriers for the deployment of concentrated solar power (CSP) in the EU in a 2030 horizon, based on a thorough literature review and interviews with key stakeholders in the sector. The results of our interviews show that the higher "value" of CSP compared to other renewable energy sources (RES) is regarded as the most relevant driver, followed by the policy drivers (innovation and deployment support) and the significant cost reductions expected for the technology. The most relevant barrier is the high cost of the technology in comparison with conventional power plants and other renewable energy technologies, closely followed by uncertain and retroactive policies.

## 1. Introduction

In Solar Thermal Electricity (STE) technology, also called Concentrated Solar Power (CSP), mirrors concentrate solar energy onto a heat medium, which is then used to drive a conventional turbine. Designs either concentrate to a few hundred degrees (Parabolic/Fresnel designs) or to a maximum temperature for steam power cycles in power tower designs (around 600 degrees Celsius) [1]. There are four CSP plant variants, namely: Parabolic Trough (PT), Fresnel Reflector (FR), Solar Tower (ST) and Solar Dish (SD), which differ depending on the design, configuration of mirrors and receivers, heat transfer fluid used and whether or not heat storage is involved. The first three types are used mostly for power plants in centralised electricity generation, with the parabolic trough system being the most commercially mature technology.

As a still maturing technology, CSP is at an early deployment stage. It has experienced a substantial increase in deployment in the last years worldwide, although starting from a very low base. According to REN21 [2], total installed capacity in STE at the end of 2016 amounted to 4.81 GW, up from 600 MW at the end of 2009. Deployment has mostly taken place in two countries (Spain with 2300 MW and the U.S. with 1738 MW), although the technology has also been deployed elsewhere, including India, Morocco, South Africa, the United Arab Emirates, Algeria, Egypt, Australia , China and Thailand. However, only 110 MW were added in 2016 (100 MW in South Africa and 10 MW in China. The CSP market is dominated by the parabolic trough technology, both in terms of number of projects and total installed capacity (around 85% of capacity) [3].

The increase in deployment in the EU has been significant. From the 10 MW being installed in 2007, the current capacity deployed is 2311 MW [4]. The total installed CSP capacity to date in Spain represents 99.7% of the total installed capacity in the EU [4]. However, this is likely to change in the future, since only 50 MW are under construction or at an advanced stage of development and Italy seems to have taken over, with many projects under development.

The future deployment of CSP around the world looks bright according to different publications, which focus on the 2030 and 2050 timeframes. According to IRENA [5], CSP would reach between 52 GW (reference scenario) and 83 GW (Remap 2030 scenario). However, in its new Remap report [6], CSP deployment would only reach 44 GW in the reference scenario. The IEA [7] expected a much lower amount of CSP capacity being installed (110 GW in the 450 scenario). According to [8], STE could represent as much as 11% of electricity generation in 2050 under a high renewable energy scenario, with 954 GW of installed capacity. In its STE technology roadmap [9], the IEA updates those figures upwards, expecting 982 GW in 2050, with only 28 GW of those being deployed in the EU. These numbers are in line with the STE European industry association (ESTELA), which expects a worldwide diffusion of 1080 GW in 2050, 90 GW of which will be in Southern Europe [10].

According to the National Renewable Energy Action Plans (NREAPs), that each Member State had to submit to comply with the Renewable Energy Directive (Directive 28/2009/EC), installed capacity in the EU would reach 6765 MW by 2020 (4800 MW in Spain, 600 MW in Italy, 540 MW in France, 500 MW in Portugal, 250 MW in Greece

* Corresponding author.
*E-mail addresses:* pablo.delrio@csic.es (P. del Río), cristina.penasco@csic.es (C. Peñasco), peremirartigues@gmail.com (P. Mir-Artigues).

http://dx.doi.org/10.1016/j.rser.2017.06.038
Received 12 June 2016; Received in revised form 26 November 2016; Accepted 16 June 2017
1364-0321/ 