# Demonstration of the SOLARSCO2OL sCO2 power cycle for future hybrid CSP-PV plants at the Évora Molten Salt Platform

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## 1. Introduction

SOLARSCO2OL [1] is an EU funded project that started in October 2020 with the following main objectives: to demonstrate a MW-scale recuperated supercritical $CO_2$ (s $CO_2$) power cycle operating from molten salts; to demonstrate a MW-scale molten salt electric heater to enable active hybridization of CSP and PV; and to investigate novel hybrid PV and CSP plants using $sCO_2$ power blocks. The design of the key components and sub-systems of the cycle, namely the primary heater, the recuperator, the turbine, the compressor and the cooler and other balance of plant sub-systems, has advanced according to plan. The original demonstration plans, however, faced difficulties due to unforeseen market conditions, which in turn led to delays and to re-planning of the demo-site. Initially the demonstration campaign was targeted to be realized at the premises of La Africana power plant in Southern Spain, for which a completely new purposely-built facility for testing would have been erected. Instead, to overcome this challenge it is proposed to build upon existing facilities using molten salts.

For this purpose, the Évora Molten Salt Platform (EMSP) has been identified as the most suitable industrial-scale facility in EU able to accommodate the plant, allowing to build upon existing molten salt systems and related expertise (Fig 1). The EMSP is a top stat-of-the-art recently inaugurated facility that hosts a first-of-its-kind molten salt parabolic trough collector system and a high temperature molten salt thermal energy storage (TES) system [2]. It is owened by the University of Évora, and jointly managed and operated with the German Aerospace Center (DLR). Pre-existence of these systems would enable the SOLARSCO2OL consortium to save costs, while at the same time the demonstration of the technology at the premises of the EMSP would further enhance the visbility of the site and guarantee continuation in the operation of the facility while being extended to accommodate innovative components, thereby making the EMSP even more unique and positioning it as the first installation in EU and worldwide to host a MW-scale hybrid PV-CSP-$sCO_2$ system. Through this integration, the SOLARSCO2OL consortium also welcomes University of Évora and DLR as project partners, whom bring on board additional skills and expertise in the field of CSP, complementary to the project.

The successful operation of this demonstration will largely advance the maturity and readiness level of molten salts based $sCO_2$ CSP plants enabling future large scale and commercial applications. This paper presents a preliminary description of demo plant and up-scaled molten salt hybrid PV-CSP-$sCO_2$ systems.

Fig. 1: Side view of the molten salt parabolic trough collector and storage system at Évora Molten Salt Platform. (Credit: University of Évora / Hugo Faria).

## 2. Suggested integration of the SOLARSCO2OL technologies at the EMSP

The successful demonstration of the main enabling components of the $sCO_2$ power block and molten salts loop at MW scale, as well as the full system integration, represents a crucial step toward more cost-competitive and efficient CSP plants in the near term, leveraging from already commercial molten salt CSP plants. The system proposed for integration at the EMSP consists of a 2 MW gross power cycle with heat provided both from the already existing parabolic trough loop and complemented by a booster electric heater. In doing so, the SOLARSCO2OL consortium will leverage upon the existing molten salt systems and focus on the integration aspects concerning the novel technologies proposed and their control. Fig. 2 shows a simplified representative schematic of the pilot plant including the existing EMSP facility and all main components developed and installed within the context of SOLARSCO2OL - namely the high-pressure turbine (HPT), the main compressor (MC1), the cooler, the recuperator (HTR), the main primary heater (MH), and the electric heater - with black lines denoting electricity, green $CO_2$ and red molten salts, respectively.

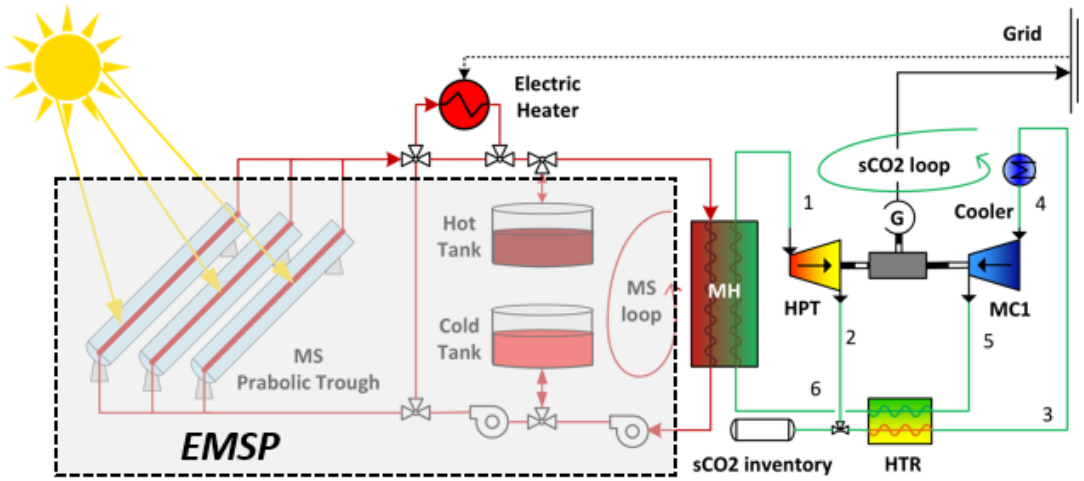


Fig. 2: Schematic of the analyzed hybrid PV+CSP power plant.

The pilot is designed to fully demonstrate and mimic the typical behavior, operational strategies and flexibility of a CSP plant. The EMSP solar field includes four parabolic trough collectors connected in series, for a total length of 700 m and equipped with innovative heat collecting elements, reaching a total thermal power output of 3.5 MW and a molten salts temperature up to 560 °C. In the proposed integration, the collector field is placed in series with an electric heater, which is found downstream. In this way it is suggested to use the field to increase the temperature of the standard Solar Salt up to approximately 465 °C, to then be boosted to 565 °C by the electric heater. This would be one of the firsts electric heating systems at MW scale purposely designed for molten salt applications and demonstrated in a research facility in EU, enabling first hand performance data to the scientific and industrial power-to-heat and CSP communities. Specifically, a 3 MW electric heater will be exploited. The system will be operated on-sun and the electricity is planned to be withdrawn from the grid. PV production profiles will be investigated and emulated as input to the heater to investigate possible operating modes of the pilot in a hypothetical hybrid CSP-PV scenario. Infrastructure on-site including grid-connection points and utilities will be upgraded to accommodate the pilot.

## References


[1] "SOLARSCO2OL," 2020. https://www.solarsco2ol.eu/.

[2] https://www.dlr.de/content/en/articles/news/2022/02/20220428_salt-makes-solar-thermal-power-more-cost-effective.html.