



Economic evaluation of MW scale particle hybrid CSP-PV plant

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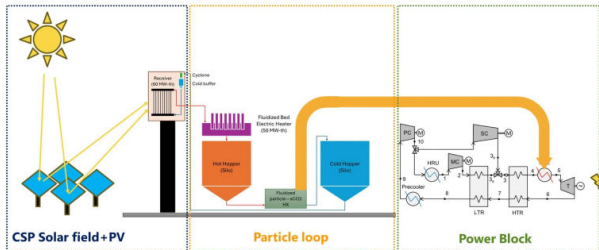
CONTEXT & OBJECTIVES

In the context of the energy transition, concentrating solar power (CSP) plants represent a promising solution for producing low-carbon, dispatchable electricity. The Horizon Europe - Powder2Power (P2P) project aims to demonstrate the operation of an original high performance and cheap particle-driven CSP-PV technology that can be applied for both power and industrial heat production at the MW-scale. The current study provides preliminary configurations of a large-scale P2P plant for peak hour electricity production. The work aims to provide some economic results on this innovative particle-based hybrid CSP-PV plant.

SYSTEM DESCRIPTION

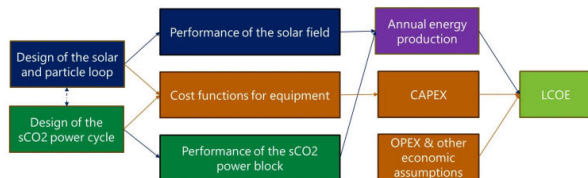
Both 50 MWe single tower and 100 MWe double tower configurations installed in Seville have been investigated in the present study.

- The CSP receiver, a multi-tube fluidized bed cavity receiver, is designed at 60 MW-th.
- An electric heating system feed by onsite PV is integrated to the particle loop in order to guarantee the temperature of hot particles at 750 ° C.
- The storage duration is defined at 7h.
- A supercritical CO₂ cycle is used to convert heat into electricity during the discharge phase.



METHODOLOGY

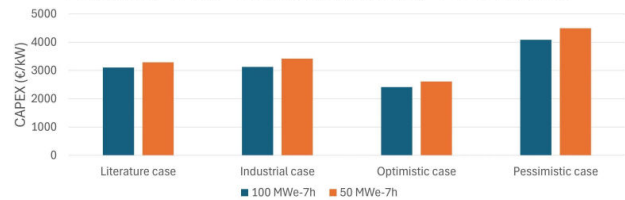
Detailed solar field and power block simulations have been carried out. The work provides the necessary information for the CAPEX estimate, the off-design performances evaluations of thermal collection and electricity production, as well as the estimation of LCOE (Levelized Cost Of Electricity) of the P2P CSP plant.



MAIN RESULTS

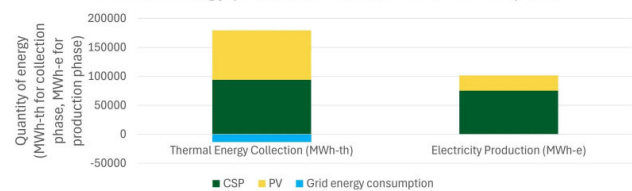
For a 50 MWe single tower configuration, the heliostat field surface is around 120000 m² and the tower height is 126 m for achieving a photo-thermal efficiency ~ 56% with particle temperatures of 650 ° C at the outlet of the cavity receiver. The sCO₂ cycle has been sized and shows a nominal efficiency around 47 %.

Preliminary CAPEX estimates, considering 4 cost scenarios



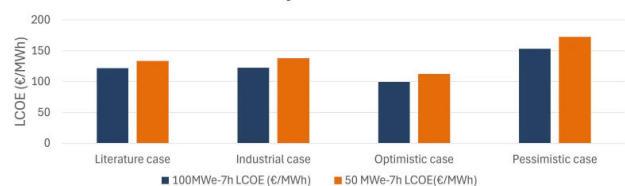
- The literature case is based on correlations from the literature [1][2].
- The other cases are based on EDF's industrial experiences.

Annual energy production for 50 MWe-7h P2P plant



- The energy stored during the daytime operation mainly comes from the CSP solar field 57 %; The PV field provides 35% of the thermal energy required; the remaining 8 % comes from the grid.
- The flexible CSP production represents 74 % of electricity produced during one typical year; 26 % of production stays variable, which corresponds to the surplus of PV production (storage fully charged or CSP part not operating)
- The production of 100 MW – 7h plant is considered roughly doubled, without considering the thermal loss in particle transport.

Preliminary LCOE estimates



- The LCOE of the 50 MWe – 7h P2P peaker plant is around 137€/MWh in the industrial case scenario. Larger plant at 100 MWe -7h would result in a reduction of LCOE by about 10%.
- Higher DNI site would potentially further lower the overall project cost. If low price of electricity is recurrent on the market, it is possible to charge the storage using electricity from the grid instead of onsite PV (in PV production-heavy region). This scenario represents a good synergy case between PV and CSP.

FUTURE WORKS

Several assumptions can be refined in the upcoming studies, such as the cost of particles loop or more detail on the thermal loss [3], particularly for the multitower configuration plant (above 50 MW-e). The configurations of the industrial scale P2P CSP plants and dispatch strategy can be optimized according to the chosen site and the electricity market. Other plant configurations can also be evaluated using similar methodology.