next-CSP

High Temperature concentrated solar thermal power plant with particle receiver and direct thermal storage

European funded project - Grant Agreement number 727762

Deliverable D7.3

WP7 – Scale-up to a 150 MW solar power plant – Preliminary design, risk analysis, cost and value assessment

Deliverable D7.3 Report on Cost Analysis: Capex, Opex, LCOE & Positioning in the Global Energy Mix

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Foreword

This report is the last one of Work Package 7 whose purpose is to study the scale-up of the concept developed in Next-CSP to a utility-scale 150 MW_e power plant. The first report outlined its preliminary design, the second one described the Risk Analysis performed for this scaling-up, and a first estimate of its LCOE was made in the Milestone Report. The purpose of this report is to refine this assessment of the LCOE and to lower its value through proper streamlining of the preliminary design performed in D7.1. Additionally, this report shows that, beside LCOE, the positioning of CSP in an electricity mix depends primarily on the additional value provided by its massive storage.

This report was written by EDF in collaboration with CNRS, EPPT, and SBP. All these partners provided crucial contribution to this study in their respective fields of expertise.

Objective of the study

As stated in the Grant Agreement [Grant], the objective of Work Package 7 of the Next-CSP project (project N. 727762 [Grant]) is to study the scale-up of the concept developed in Next-CSP to a 150 MW_e power plant. This Work Package is broken down into three tasks. The corresponding Deliverables are the following reports:

- D7.1: Preliminary design of the future utility-scale commercial plant [D7-1]
- D7.2: Scaling-up from pilot plant to commercial plant – Risk analysis [D7-2]
- D7.3: Cost analysis: Capex, Opex, LCOE – Positioning in the global energy mix

D7.1 was released on 6 November 2018 and D7.2 on 30 September 2019.

The objective of this study is twofold:

- Assessing the cost of a future utility-scale plant whose design is based on the concept developed in Next-CSP (referred to in this document as "Next-CSP plant"). As explained in D7.1, the 150 MW_e power output of the plant is generated during 5 full load equivalent hours per day (Peaker power plant). Capital and Operation Expenditures (OPEX and CAPEX) are assessed as well as the Levelized Cost of Electricity (LCOE). A rough estimate of the LCOE was made in a "Milestone Report" [Milestone] released on 17 April 2017; this study aims at refining it.
- Assessing the additional value of the power generated by Concentrating Solar Power with massive in-built storage – including the future Next-CSP utility-scale plant – compared to that of photovoltaic power generation. Various prospective scenarios are considered. The cost decrease of photovoltaic and storage (including batteries) is also part of these scenarios.

Conclusion – Global potential of CSP

In Europe:

With current electricity prices and cost construction for CSP plants, a large-scale deployment in Europe is unlikely, unless significant subsidies are granted: the LCOE of a peaker CSP plant built in Sicily should be lower than 108 €/MWh to allow competitiveness without subsidies and taxes. Achieving such a LCOE[31] with a DNI slightly below 2000 kWh/m^2.year should be feasible in the short-term future, but not at large scale: without subsidy, Sicily is the best area in Europe for CSP due to its high price levels and variability combined with a good DNI (less than 10% lower than the best DNIs in Europe).

A larger deployment in the mid/long-term future would require a strong decrease of the LCOE of CSP and/or a significant increase of the electricity prices during peak hours. This is plausible if the operating cost of fossil-fueled plants is severely affected by rising costs of fuel and carbon.

Overall, the global share of CSP plants built in Europe will remain marginal.

Outside Europe:

In this document, Arizona (USA) was studied as an example. In terms of performances and competitiveness, the results obtained in our study for a peaker CSP plant are very similar to those drawn by Hank Price from his study [Price1]. Amongst his conclusions that are relevant for us, the main ones are as follows:

- A carefully designed molten salt tower plant can operate as a peaking power plant;
- The assessed cost of the CSP plant is less than 5% higher than a similarly sized and operated natural gas plant when APS reference fuel and emissions costs are included. In this comparison, the CSP plant takes advantage of a USA-specific 30% investment tax credit but relatively low natural gas and carbon pricing assumptions were made.
- The cost of the CSP plant is likely to decrease significantly whilst the combined cost of fuel and carbon should rise.
- As an emission and carbon-free peaking power plant, the CSP plant is free of future pricing risk. It provides local jobs rather than importing fuel.

Considering that Arizona is very good area but not great for CSP (as are, for example, areas of Chile and South Africa), these conclusions foreshadow a bright future for peaker CSP plants on a global scale. Even though the deployment of CSP will remain much more limited than that of Wind or PV due to the very stringent DNI criterion[32], there is considerable room for deploying peaker CSP plant worldwide.

A general recommendation:

In order to maximize the efficiency of each Euro spent for subsidizing CSP, European stakeholders should accept to subsidize the construction of CSP plant outside Europe (where each kW_e of CSP capacity needs little subsidies to be competitive) rather than in Europe (where each Euro will subsidize a lower amount of CSP capacity). CSP can be an exporting European industry, even if few plant are built in Europe. This policy recommendation has been stated in [Siros].