Concentrated solar power tower

The ST technology offers theoretically higher efficiency because of higher temperature. However, the technology is also more demanding from economic and technical view-points. While ST plants are certainly less widespread than PT plants [6], there is an open debate in the literature about which CSP technology may have the better perspectives.

The global market of CSP is dominated by PT plants, about 90% of all the CSP plants [6]. As per [6], back in 2010 the ST component of CSP was overshadowed by the PT component, accounting for more than 90% of the total CSP installed capacity. The situation has not drastically changed since then [7]. The majority of the larger CSP plant projects under development/under construction are based on the solar tower configuration.

The CSP technologies presently do not compete on price with photovoltaics (PV) solar panels that have progressed massively in recent years because of the decreasing prices of the PV panels and the much smaller operating costs. While the uptake of solar energy is still minimal, the CSP component is largely overshadowed by the PV component [9]. While CSP may have the potential to play a key role in balancing renewable energy production, the technology is presently living in the shadow of PV [9].

As explained in Ref. [8], the installed capacity (power) is particularly misleading in case of solar if used to indicate the actual annual production of electricity (energy) by these systems, as the capacity factors (electricity produced divided by the product of the installed capacity by the number of hours in a year) of recent CSP plants, for example ISEGS [12, 13, 14, 15], are only about 20%, even conceding the benefit of a production boost by combustion of NG.

This scenario is expected to drastically change in the next few years, and there is a clear need to develop new CSP ST technologies to match the significant demand. However, this requires significant technology updates that is unclear could be delivered.

Aims of this paper are to provide an objective assessment of the current costs and performances of CSP ST plants, and then to survey the proposed technologies the many issues that strongly limit the current outlook of CSP ST. As the present costs and performances differ considerably from the planned values, this negatively impacts on the reliability of the figures circulated in the surveyed peer review works.

The specific renewable energy technology assessment is performed based on actual costs and electricity production data of existing power plants delivering electricity to the grid and having a nameplate capacity exceeding a threshold value.

The survey of development trends is then performed based on a review of the latest literature that propose advances vs. the current design. These literature claims may not translate in actual technology improvements

as asserted in the papers.

Concentrating solar power (CSP) has been so far mostly proposed and implemented in the parabolic through (PT) technology. 90% of the CSP plants are indeed PT. Hence, we start this state-of-the-art paragraph with a reference to the PT technology to move then to the ST technology. Incidents and accidents are not considered in the present analysis, similarly to the environmental impacts. The substantial land requirements for CSP are also not included in the analysis.

The number of existing CSP ST plants of significant size is very limited, and the time they have been operational is also minimal. Additionally, not all the data needed are publicly available. Hence, the full potential of the ST technology is not shown by the surveys of plants.

In the list of the ST plants of [18], here reproduced as Table 1, there are only 34 CSP ST plants worldwide. Only 3 above 20 MW of capacity are operational, ISEGS of 377 MW capacity since 2014, Crescent Dunes Solar Energy Project (Tonopah) of 110 MW capacity since 2015, and Khi Solar One of 50 MW capacity since 2016. The 377 MW ISEGS plant only producing 703,039 MWh/year (2016), the output of a medium to small scale CCGT plant, has the best data set covering 3 years.