On the environmental footprint of solar electricity production including storage

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Summary

The massive deployment of renewable electricity production plants is a sine-qua-non condition for limiting the impact of global warming in the decades to come. The increasing integration of energy storage systems, with the aim of promoting a better match between solar demand and production, will lead to specific energy losses that are likely to affect the technical, economic and environmental indicators of the next generations of solar power plants. The aim of this work is to assess how the increasing integration of energy storage systems is likely to affect both the technical and economical indicators of the plants, as well as the carbon footprint of the electricity produced. The performance of two solar electricity generation technologies is being assessed and compared:
1) Photovoltaic (PV) conversion systems, which are based on the direct conversion of solar energy into electricity using the photovoltaic effect.
2) Thermodynamic conversion systems (CSP), which use heat as an energy carrier. CSP technologies are based on the use of solar concentrators to heat a transfer fluid circulated at the receiver at the heart of the system.
Three different energy storage technologies are also considered in this study: 1) electrochemical energy storage, 2) thermal energy storage and 3) thermophotovoltaic energy storage.

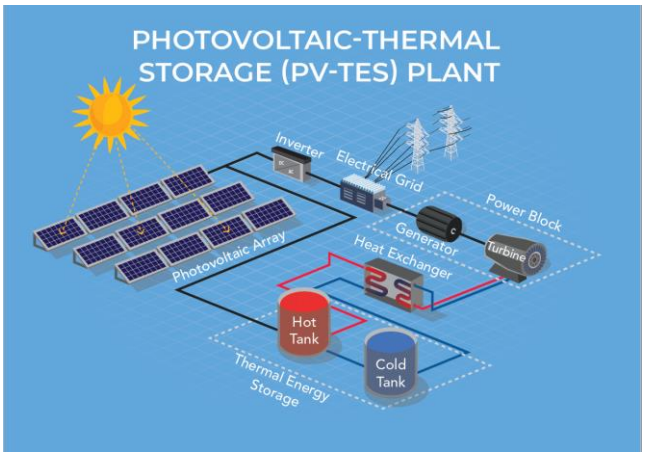

Fig. 1: PV plant integrating thermal energy storage

To this end, a numerical model was developed to determine the energy output of the various power plant technologies studied as a function of the electricity grid demand profile. Secondly, the carbon footprint associated with these means of electricity production is being assessed. By combining these two tools, it is possible to estimate how the increased dispatchability of solar power plants, combined with the growing integration of storage, will lead to an increase in the carbon footprint of solar electricity injected into the grid. By comparing the technical and environmental indicators of the various technologies studied, we will then be able to identify 1) which technologies are best able to meet growing electricity demand with minimal environmental impact 2) which are the 'key' components of the various conversion and storage technologies that need to be developed in order to improve the environmental footprint of the electricity produced.
In this presentation, we will discuss the technical and economic conclusions and provide some preliminary information on the carbon footprint of electricity including storage.