Techno-economic assessment of the main PV/CSP compact hybrid technologies

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Compact hybrid PV/CSP systems, which basically consist in the amalgamation of PV and Concentrated Solar Power (CSP) technology into one single plant, are currently perceived as a promising option toward providing both low cost and affordable solar electricity.

To date, several studies tried to quantify the added value of these systems based on their ability to efficiently convert sunlight into electricity [1][2]. However, the rigorous evaluation of these technologies is inherently constrained by their hybrid nature : 1) the operating conditions (in terms of solar ressource available, operating temperature, or illumination) may differ substantially from one subsystem to the other 2) the imbalance between PV and CSP electricity production, stemming from the use of two different converters, may affect both the dispatchability of the electricity generated and its cost. 3) the extra-electricity generated should be analyzed in the light of the overcost necessarily associated with the integration of two different technologies into one single-plant. In addition to the metrics commonly used to evaluate the performance of solar energy converters (i.e. conversion efficiency, energy yield), hybrid systems must be assessed considering additional quality criteria reflecting the technical and economical specificities of these two different converters when they are combined.

In this work, we assess and discuss the ability of two hybrid PV/CSP technologies to fulfill three performance criteria translating their capacity to simultaneously provide affordable and disptachable, solar electricity. To do so, we evaluate and compare the key performance indicators of hybrid PV/CSP systems based on three concentrating technologies (namely Linear Fresnel Reflectors, Parabolic Troughs, and Solar Tower) with their conventional CSP counterpart. Both the PV topping approach (involving PV cells also acting as thermal receivers) and the PV Mirror approach (involving PV cells acting as reflectors) are assessed.

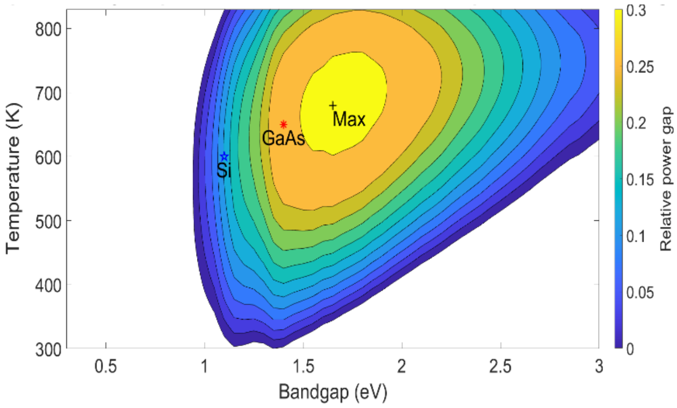

Fig. 1 : Relative improvement in the electrical power of a PV Mirror Hybrid system in comparison with a conventional CSP converter, assuming the parabolic trough geometry.

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[2] Vossier, A., Zeitouny, J., Katz, E. A., Dollet, A., Flamant, G., & Gordon, J. M. (2018). Performance bounds and perspective for hybrid solar photovoltaic/thermal electricity-generation strategies. Sustainable Energy & Fuels, 2(9), 2060-2067.