Title: Methodology for sizing the solar field for parabolic trough technology with thermal storage and hybridization

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Abstract: A detailed methodology to design the size of solar field for a parabolic trough plant is not explicitly available in open literature, particularly if thermal storage and hybridization are also considered, as most of the papers present a gross overview. This paper gives a procedure to determine the annual electricity generated for a parabolic trough based solar plant of a given rated capacity (1-50 MWe), at a chosen location & given hourly annual solar input, specified hours of thermal energy storage using a two-tank molten salt system and specified fraction of hybridization using natural gas. In this methodology losses due to shut down or cloud cover are also covered. The size of the solar field is optimized for the maximum annual solar to electric conversion efficiency using the concept of solar multiple (ratio of actual aperture area to the reference aperture area needed to get rated power output at maximum solar input). This procedure is validated with the existing parabolic trough plants (Solar Energy Generating Systems VI and Solana Generating Station) and it was found that the annual electrical energy generated by the plant matches reasonably well.

Jodhpur, in India, was considered as a location for the case study and the results are presented to understand the influence of thermal storage and hybridization for a given capacity of the plant. The results for various combinations of thermal storage hours and fraction of hybridization used with respect to plant capacity, solar multiple, annual plant efficiency etc. have been discussed in detail. It is observed from the results that, under design conditions, the reference aperture area per MW decreases as plant capacity increases and reaches a limiting value asymptotically at a capacity of 50 MW. The optimized size of the solar field, with respect to annual efficiency, is found to be 1.4 and 2.3 times the size under design conditions for zero and six hours thermal storage respectively. The benefit of hybridization is high for lower solar multiples.