Deployment of Parabolic Trough Concentrated Solar Power Plants in North Africa – a Case Study for Libya

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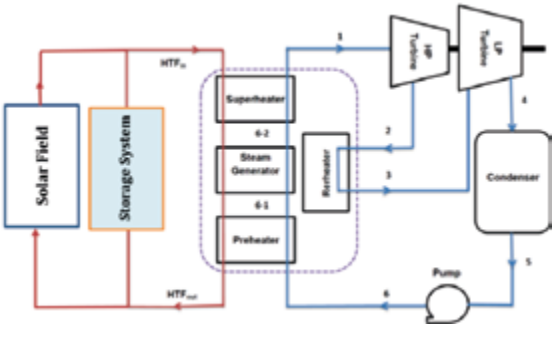
The study addresses the potential of using the parabolic trough concentrated solar power plant (CSP) as an alternative for clean energy generation in the Libyan Mediterranean coast. Impact of project financing and incentives were taken into consideration on the cost of energy. The primary finding of the study is that the CSP plant located in Tripoli (Libya) region, which was selected due to its high direct normal irradiation (DNI) and the absence of sandstorms, presents superior performance and potentially lower levelized cost of electricity ($0.18/kWh versus $0.22/kWh), as compared to that in Almeria (Spain). Also, the Tripoli plant takes a slight edge (2-3%) in terms of overall efficiency.

The dual-purpose of implementing CSP technology in Libya is: 1) sales to Europe of the produced electricity supplied through subsea transmission lines; and 2) regional economic and social development resulting from: a) construction work and locally manufactured components; b) operation and maintenance using regional workforce; and c) partial use of the power generated for local projects leading to diversification of the economy.

FIGURE 1
Schematic of the present study CSP.

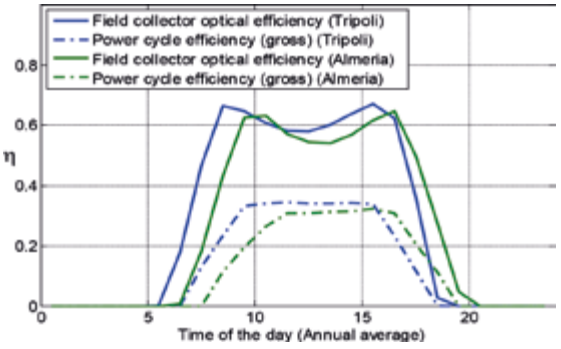


The CSP [1] located in Tripoli has the same configuration and size (50 MWe) of that in Almeria; it consists of an array of mirrors that tracks sun irradiation and reflects it into a receiver, where the concentrated energy is used to heat up the heat transfer fluid (HTF) that enters the steam generator (Fig. 1).

The study is supported by two main models: 1) mathematical model to determine the HTF energy and exergy balance for each plant component, and 2) model, based on SAM [2], to analyze the behavior and performance of the components through an hourly analysis on an annual basis. The first model also has the capability of conducting a detailed thermoeconomic analysis to determine the cost rate of exergy destruction. Figure 2 reports the annual efficiency profile of the collector field and power cycle for the two sites. The CSP at the Tripoli location presents higher efficiency than that in Almeria mainly due to its higher DNI.

The combined models provide a powerful tool for preliminary design, evaluation of performance and feasibility of CSPs.

FIGURE 2
Annual solar field and power cycle efficiency for the Tripoli and Almeria sites.



References

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[2] National Renewable Energy Laboratory. 2015. System Advisor Model (SAM 2015.6.30). https://sam.nrel.gov/download.