Future sustainable concentrating solar power for MENA Region: analysis to inform decision making

Abstract:
Concentrating solar thermal power is a renewable energy technology which converts solar irradiation into heat energy at high temperature and in a successive step into electricity. The core part is a number of mirrors which reflects direct normal irradiance (DNI) to a focal line or point, called a receiver. Temperatures up to 1000 ^{o}C can be achieved. The bulk of this new CSP capacity is expected to be seen in the MENA region, where it has abundant solar radiation, cheap land and high electricity demand.

The first part of this paper is directed to provide a comprehensive review of CSP technologies that are sustainable for applications in MENA region. More focus was directed to the performance data with emphasis on technologies, economics and costs.

while in the second part of this paper, a techno-economical study of using large scale CSP plant for electricity generation in Riyadh, KSA is investigated. Two cases are proposed for present and future applications. The first case (Case-1) is using parabolic trough (PT) solar field coupled with steam turbo-generator rated at capacity of 100MWe.The second case (Case-2) is using Solar tower/heliostats solar field coupled with gas turbo-generator at rated capacity of 100MWe system which is proposed for future application in desert areas. Then a parametric study was done to investigate the best economic TES hours for both cases. Finally the optimum condition of both cases is compared. The results showed that the estimated average annual electricity is 363,892 MWhe, 341,456MWhe for case-1 and case-2 respectively. Thus achieving a conversion efficiency of 18.67%, 14.87% for case-1 and case-2 respectively. The financial results showed that: for case-1, $LCOE_{nominal}$ is 16.97, 21.8Cent/KWhe at interest rate of 3%, 6% respectively. While for cas-2: the $LCOE_{nominal}$ is 15.54, 19.68 Cent/KWhe at interest rate of 3%, 6% respectively, which is still high comparing to the current electricity cost in KSA. Also, the minimum LCOE was obtained at 6hrs thermal energy storage for both cases. Finally, when carrying out feasibility studies for CSP plants, attention must be paid to fund at low interest rate, and local manufacturing for some items of the solar field. This can achieve a significant reduction in the LCOE.

Amin Al-Ghonemy