Desalination and Water Treatment
www.deswater.com

41 (2012) 9–25
March

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doi: 10.1080/19443994.2012.664674

Taylor & Francis
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Techno-economic analysis of combined concentrating solar power and desalination plant configurations in Israel and Jordan

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Received 23 August 2010; Accepted 22 March 2011

ABSTRACT

Combined concentrating solar power (CSP) and desalination plants represent a realistic future option for the production of electricity and fresh water for countries of the world's sunbelt. In this paper, parabolic trough power plants for electricity production have been analysed in combination with multi-effect distillation (MED) and ultrafiltration/reverse osmosis (RO) desalination plants for two sites in Israel (Ashdod) and Jordan (Aqaba). Both RO and MED desalination plants were designed for a fresh water production capacity of 24,000 m^3/d. The power block of the CSP plant was selected to meet the steam consumption of the MED plant at the design point, which led to a gross electrical power generation capacity of the power block of 42 $MW_{el,gross}$. Due to the low availability and generally high cost of coastal land, the CSP + RO plant consists of two separate units. It was assumed that the CSP plant is located at an inland location where there is land available. The RO plant is located at the sea, while the MED plant is located at the CSP site. The pumping of the seawater and the water transmission system add about 0.2 $/$m^3$ to the levelized water costs of the CSP + MED plant compared with a plant located at the sea. Three different sizes of high temperature heat storages (0 h, 6 h and 12 h of additional full load operation of the steam turbine) were applied to find the most economic setup. At current prices for heat storage units, systems with huge heat storage capacities become economic only at high feed-in tariffs for electricity and thus high revenues. The price of the electricity generated by the CSP plant was varied to show the influence of the feed-in tariff on the water generating costs. The levelized costs of water (LCOW) strongly depend on the electricity price. Water costs in Ashdod are higher than those in Aqaba due to the lower solar irradiance. For Aqaba, LCOW of about 1 $/$m^3$ can be realized if a feed-in tariff of about 0.24 $/kWh for electricity from renewable energy sources is established.

Keywords: Desalination; Solar energy; Reverse osmosis; Multi-effect distillation; Concentrating solar power; Costs of water

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