Design optimization of large SWRO plants utilizing time-of-use (TOU) energy prices

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ABSTRACT

The Israeli electricity pricing system is characterized by a sophisticated TOU (time-of-use) tariff. Different prices apply to different hours of the day and different seasons of the year following the electricity system management considerations. Current pricing system defines three yearly seasons, each having peak, shoulder and off-peak prices. This obviously can significantly affect design optimization of large SWRO desalination plants by shifting the Capex/Opex tradeoff. The effect of utilizing TOU differential prices to reduce energy and consequently unit water cost is demonstrated and parametrically analyzed. Two design options satisfying the same water demand are compared: (a) a plant having constant hourly production capacity; (b) a larger plant designed to avoid operation at electricity peak loads. Unit water cost savings demonstrated are in the range of (–1.8)–9.1 US cents/m³ depending strongly on prevailing average electricity price and economy of scale factor. A TOU utilization optimization model is proposed, composed of two steps: (i) optimizing plant design to achieve the lowest possible specific energy consumption, especially while operating at high energy prices; (ii) maximizing water production while operating at off-peak energy prices. Energy cost savings of approximately 18% are achieved given a peak to off-peak price ratio of 2.8:1.

Keywords: SWRO design optimization; TOU energy price; Desalination energy cost reduction