

## The energy demand for desalination with solar powered reverse osmosis units

J. Went\*, F. Kroemke, H. Schmoch, M. Vetter

*Fraunhofer Institute for Solar Energy Systems, Heidenhofstr. 2, 79110 Freiburg, Germany  
Tel. +49 761 45885240; Fax +49 761 4588-9217; email: joachim.went@ise.fraunhofer.de*

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### ABSTRACT

There are few energy recovery devices (ERD) available on the market for small reverse osmosis units (RO). With reference to small units, installations have been considered which could be driven easily by a photovoltaic (PV) generator with an output of 200 l up to 10 m<sup>3</sup> desalinated water per day [1–14]. In this paper, a systematic analysis for typical reverse osmosis concepts is presented which allows better understanding of the energy demand of small RO processes with energy recovery and which can be used as a decision tool. In contrast to publications already in existence which compare energy recovery devices [9,10,12,15–27], the smallest devices are considered here. These are often positive displacement devices [3,10,16,28,29]. The new method of analysis takes as a basis the same physical parameters for all RO concepts, starting with the calculation of the osmotic pressure. Assumptions by an expert for possible operating parameters (recovery ratio, the feed and the concentrate pressure), known as the hydraulic envelope (suggested by Manth and Oklejas [30]) are not required. All parameters are considered dependent on the recovery rate. The following RO concepts are analysed: without energy recovery (noER); with energy recovery via reverse running pump or turbine (ER-EC); pressure exchanger (ER-PE); intermittent operation with pressure storage (ER-BP); pressure intensifier (ER-PI). These basic concepts are compared for steady state operation. The analysis shows the ideal recovery ratio related to the specific energy consumption (SEC) for each RO concept. With this basic analysis it is possible to choose the most energy-efficient hydraulic concept for a specified RO capacity in order to combine it with a solar energy supply. In particular variable operation and frequent shutdowns and start-ups are typical requirements for small PV-RO systems without energy storage. The best performance in this calculation is achievable for the RO process with pressure exchanger.

*Keywords:* Energy efficiency; Specific energy consumption; Seawater desalination; Photovoltaic reverse osmosis system

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\* Corresponding author.