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## Techno-economic analysis of a stand-alone solar desalination plant at variable load conditions

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### Abstract

The operation of large-scale reverse osmosis units in combination with different solar power plants, both, Concentrating Solar Power (CSP) and Photovoltaics (PV) has been evaluated under variable load conditions. In the case of the Reverse Osmosis (RO) unit, configurations with and without an energy recovery device have been considered. In the case of the CSP plant, a thermal storage system with several capacities (8-14 h) covers the periods with low solar radiation and no storage has been taken into account for the PV plant due to the prohibitively high cost of batteries at large scale. Two scenarios and different strategies within each scenario have been proposed to adapt the operation of the RO unit at partial load in order to assure a stable operation. In the first scenario, the RO unit is represented as a whole unit with variable performance according to the power availability. In the second scenario, the RO unit is composed of 10 sub-units that are switched on/off depending on the power availability. The analysis has been done for a specific location in Algeria and the dynamic performance of the RO unit has been presented for each scenario, together with an economic analysis.

*Keywords:* reverse osmosis, partial load operation, CSP, PV, gradual capacity, economic analysis

### 1. Introduction

The development of industrial and agricultural activities together with the increasing population has led to the massive exploitation and contamination of water resources, leading to an alarming shortage of fresh water. Middle East and North Africa (MENA) is one of the regions suffering more and more from serious problems of freshwater availability [1]. Such water scarcity leads to the use of seawater desalination technologies that can alleviate this problem [2]. Algeria is one of the countries in MENA region that has included seawater desalination. The strategy of Algeria until 2030 is to have 1 billion m<sup>3</sup>/year of water produced by seawater desalination [3]. The exploitation of renewable energy sources (solar or wind) to produce electricity and fresh water is commonly considered as a very promising way to reduce the pollution and the environmental impact. Algeria has this great solar potential and the climatic conditions are favorable for the implantation of solar plants. Therefore, it seems

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