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The potential of desalination plants driven by photovoltaic power generation

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Desalination is already an important option for water resources production in some climatic contexts, but it will become increasingly relevant also in other areas due to projected worsening of climate extremes (droughts). However, this source of water is highly energy-demanding. Maximizing the use of renewable energy sources to power desalination facilities is therefore a priority in order to minimize the climate impact of this strategic option.

In this work we assessed the potential and limitations of reverse osmosis (RO) desalination using photovoltaic (PV) energy in the extended Mediterranean/Black Sea region. Water production is assumed to be continuous, following a monthly modular pattern based on the seasonal variability of PV power availability. Different options are investigated to overcome the power generation intermittency to meet the water production pattern. The most obvious way to store energy is to exchange it with the electric grid; however, the grid may not be available because it can be absent (e.g. in certain islands) or insufficient. Other options include to assist the grid buffer with on-site energy storage by means of either: (a) an electric battery; (b) a water reservoir upstream of the desalination plant to "pre-pressurize" the RO feed; (c) a combination of both (a) and (b).

About 6,000 locations across the extended Mediterranean-Black Sea-Atlantic region have been considered as potential sites for plant installation by simulating the operation of the PV-RO system. Different indicators are computed for each potential plant in order to highlight the most favorable locations. In general, the adoption of a local battery buffer improves plant autonomy from (on average) 30% to 45% of time, while the reservoir alone provides negligible improvements to autonomy. The combined use of battery and reservoir, instead, greatly improves the autonomy, towards 70% (or more) of the operation time. Local energy buffer also reduces the residual amount of (average and peak) power exchanged with the grid; again, the combined use of batteries and reservoir moderates the in/out grid load. Simplified indicators of cost and environmental impact are finally defined to rank the most reliable locations and identify where it would be reasonable to deploy fully PV-assisted RO desalination within the investigated area.