Analysis of hybrid photovoltaic/thermal (PV/T) solar systems for small scale reverse osmosis desalination plants

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INTRODUCTION AND MOTIVATION
- A PV/T system’s major disadvantage is low fluid output temperatures (30°C to 40°C) when the photovoltaic (PV) part is to be run at high efficiency
- Nevertheless, this disadvantage can redound to its advantage using PV/T systems as power supply in reverse osmosis (RO) desalination plants
- RO membranes gain a significantly higher fresh water output at higher brine (= membrane) temperatures
- In addition to that, membrane operation temperatures are limited to 45°C
- Potential of an PV/T application in RO plants: while preheated feed water will lead to a much higher fresh water output, the cooled PV surface may result in a higher electrical efficiency

THEORY
- MS Excel based calculation model
- Input: hourly data of solar radiation and ambient temperature and salt water inlet temperature
- Output: average fresh water mass flow [l/(h m²)]

BOUNDARY CONDITIONS AND ASSUMPTIONS
- Important boundary conditions: recovery ratio (RR) of 40%, energy consumption (EC) of 7 kWh per m³ fresh water (both related to 25°C feed water temperature)
- weather data representing a standard reference year (TRY)
- Assumptions: no influence of salinity on osmotic pressure and water density, RO plants can be run at any operating point

CONCLUSIONS
- Only a small cooling effect of the fluid can be observed
- PV/T driven plants produce about 30% to 40% more potable water than PV driven plants
- Compared to a pure RO-PV system, 20% to 30% of collector area could be saved
- PV/T systems can also be an economic alternative to pressure recovery systems