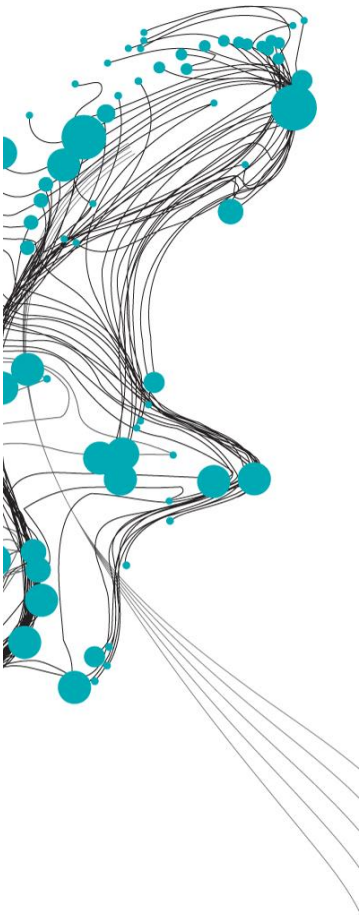
ENERGY FOOTPRINT OF WATER DESALINATION



Demand for the freshwater is growing due to the growth of world population that entails more and more of freshwater for agricultural and industrial purposes. However, the fresh water availability on Earth is limited and many countries face severe water shortages. Water desalination could be a possible solution for this problem. Among the variety of existing water desalination technologies, three are practically widely applied, these are: reverse osmosis (RO), multi stage flash (MSF), multi effect distillation (MED). Energy consumption of desalination processes is determined by factors like capacity of desalination plant (small, medium, large), the energy source (electricity and/or thermal), type of feed water (brackish (BW) or seawater (SW)), desalination method (thermal or membrane), use of renewable energy sources (solar, wind, geothermal), and necessity of feed pretreatment (mechanical and/or chemical). This research compares the total energy consumption of different methods considering each influential factor and categorizing the existing desalination techniques. Results suggest that the membrane-based technologies are the least energy intensive (Figure 1). BW RO of medium and large scales require 1.9 kW h/m3. Then comes SW RO of medium size and SW RO of large scale with 4.3 and 4.4 kW h/m3 energy consumption. The thermal desalination techniques, primarily MSF and MED have much higher energy footprint, than the membrane ones. They consume 17.1 and 11.9 kW h/m3 respectively, however, thermal technologies are more efficient for desalination of very salty waters. Nevertheless, membrane-based desalination methods due to their less energy-intensive nature and small footprint became more popular than the thermal technologies and substantial efforts have been observed in integrating RO with renewable energy sources, mainly wind and solar. Energy footprint of this type of desalination techniques is in between the membrane and thermal routes. The energy consumption of renewable powered desalination plants ranges from 1.5 to 21.1 kW h/m3. Their main drawback is small capacity, which makes them non-competitive with conventionally powered plants. We could say that globally humanity spent 7 kW h energy for desalination of 1 m3 of water.

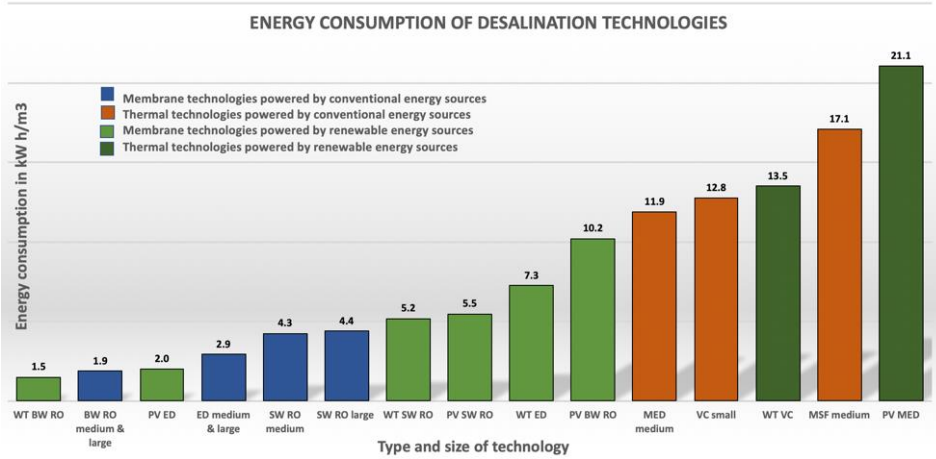


Figure 1 - Energy consumption of different type of desalination technologies

From capital cost of energy point, the desalination plants powered by renewable energy sources are shifted more to the right, which make them more expensive, than the conventional thermal ones (Figure 2). Conventional membrane technologies both economically efficient and less energy consumptive, they are again located in the left side of the graph, which means that they are most energy efficient and economically beneficial desalination techniques.

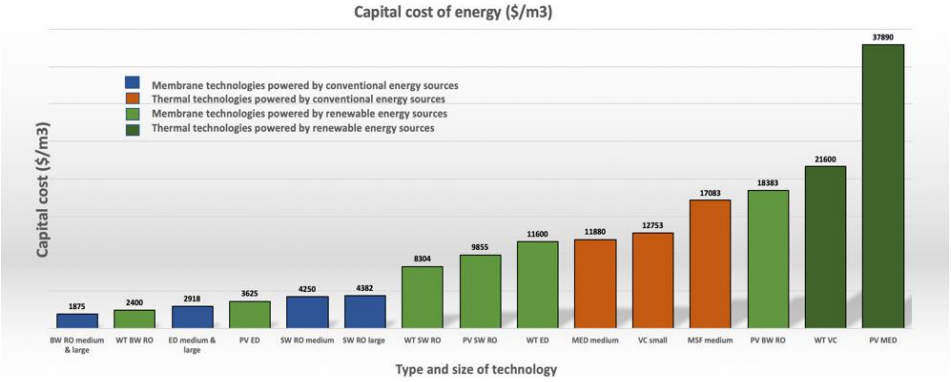


Figure 2 - Capital costs of energy for different desalination technologies

Martun Antonyan

Graduation Date:
26 June 2019

Graduation committee:
University of Twente
Prof.dr.ir A.Y. Hoekstra
PHD candidate B. Holmatov

UNIVERSITY OF TWENTE.