Solar Desalination in Island States

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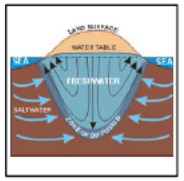
30-04-2019

Contents

- Island Context
- Desalination Technologies and Characteristics
- Renewable Desalination Market
- Economics of RE Desalination
- Outlook and Take aways

Island Context



Limited natural freshwater resources (lenses, lakes)

Isolation from larger inhabited areas

Limited surface area for water collection or retention possibilities

Sensitive to natural disasters (cyclones, erosion, climate change)

Supply demand mismatches (dry or tourist seasons)

- Main Drivers for Renewable Energy Based Desalination
  - ✓Expensive Water Imports
  - ✓Fossil Fuel Imports for Water Desalination

Island Context

Benefits of Renewable Energy Based Desalination

Fuel costs: reducing the cost burden of a clean and reliable water supply

Economic Development: facilitates the growth and deployment of economic activities

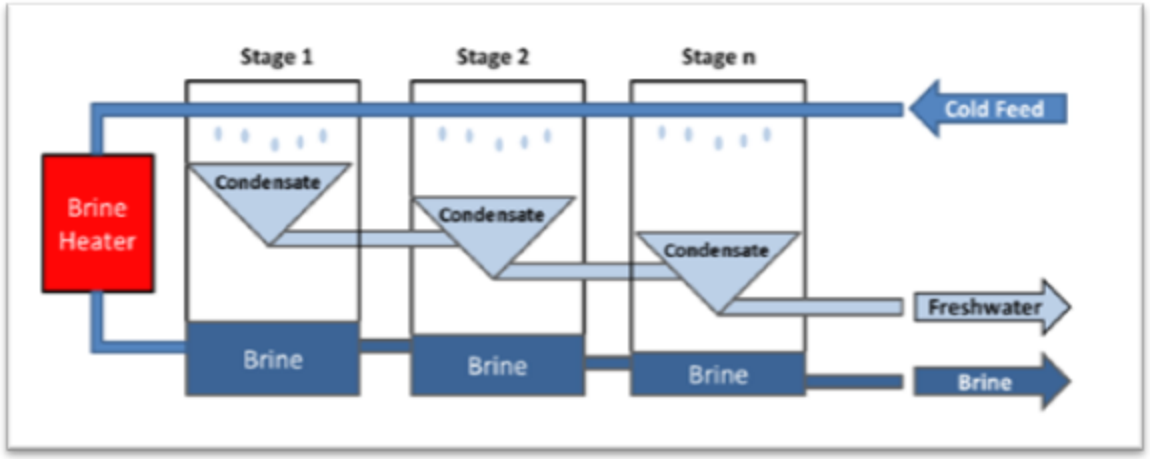
Reduced imports: reduces the need for fuel or water imports

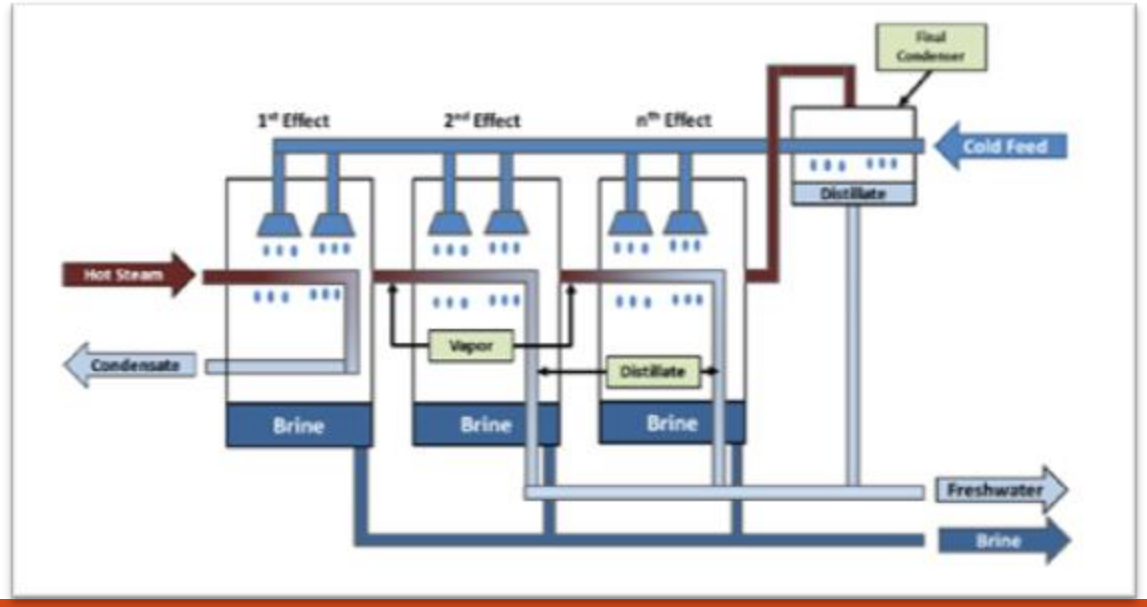
Security of Supply: increases independence

Desalination Technologies and Characteristics

Thermal Driven

- **Multi Stage Flash (MSF)**
  - ✓Motive Steam for Brine Heater
  - ✓Top brine temperature around 112°C
  - ✓Qualifies for CSP steam feed
- **Multi Effect Desalination (MED)**
  - ✓Motive steam for evaporator tube
  - ✓Requires medium operating temperatures of around 70 °C
  - ✓Qualifies for low grade waste heat from CSP

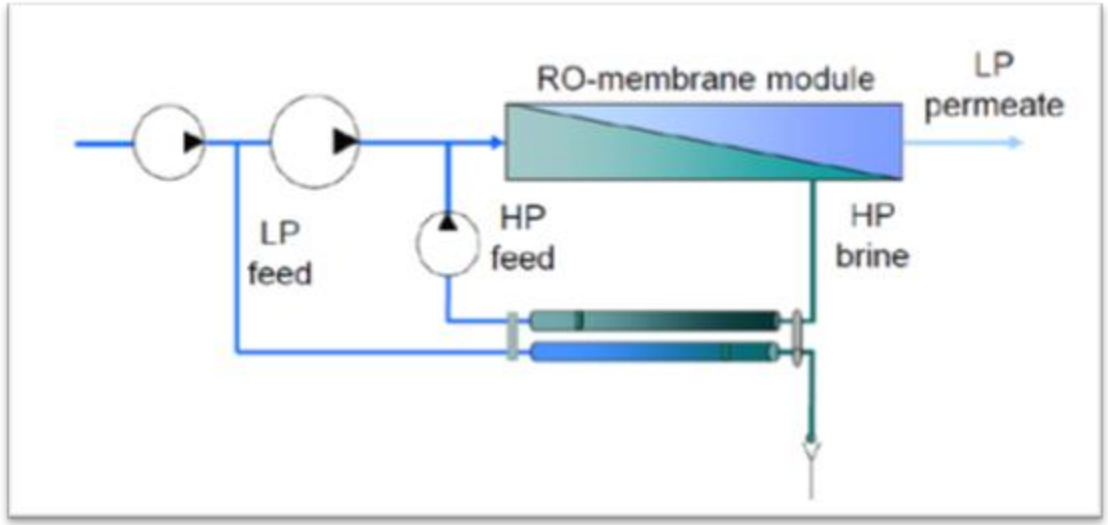




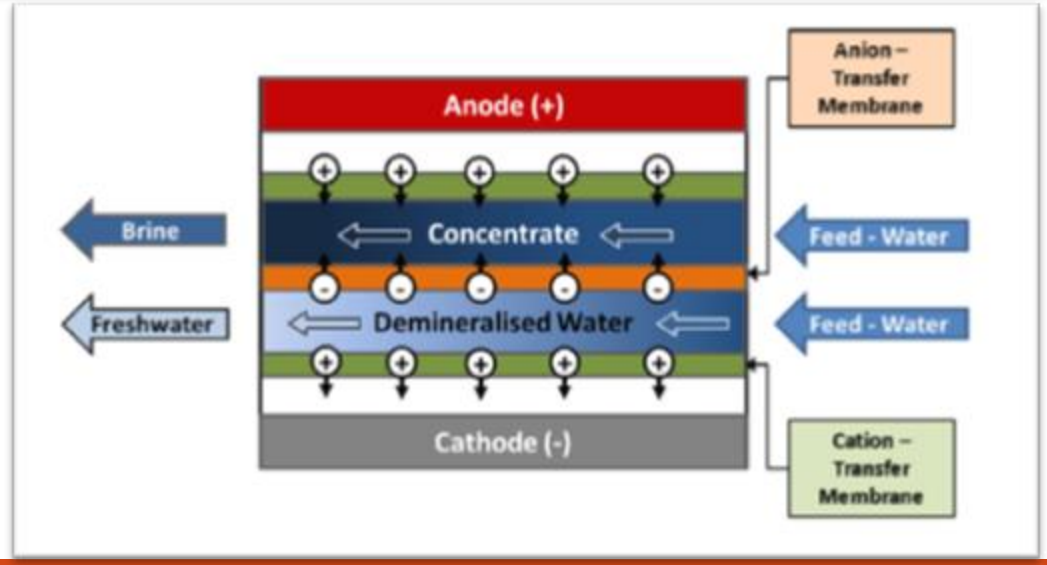
Desalination Technologies and Characteristics

Electricity Driven

- **Reverse Osmosis (RO)**
  - ✓80% electricity consumed for pumping
  - ✓Pressure requirements proportional to water salinity
  - ✓Sensitive to fluctuations



- **Electrodialysis (ED)**
  - ✓Operates on DC supply
  - ✓Limited to small scale brackish water applications



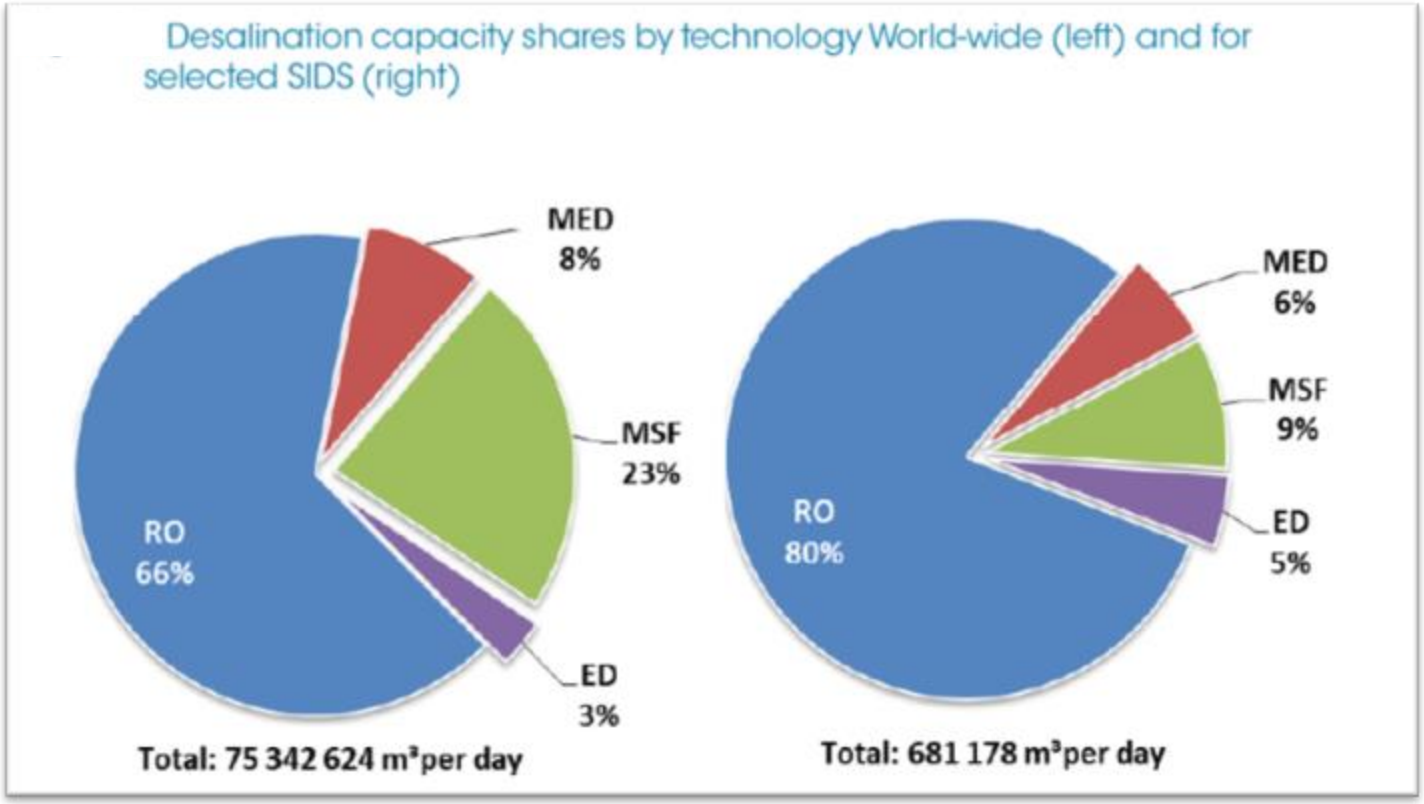
Desalination Technologies and Characteristics

Other Solutions

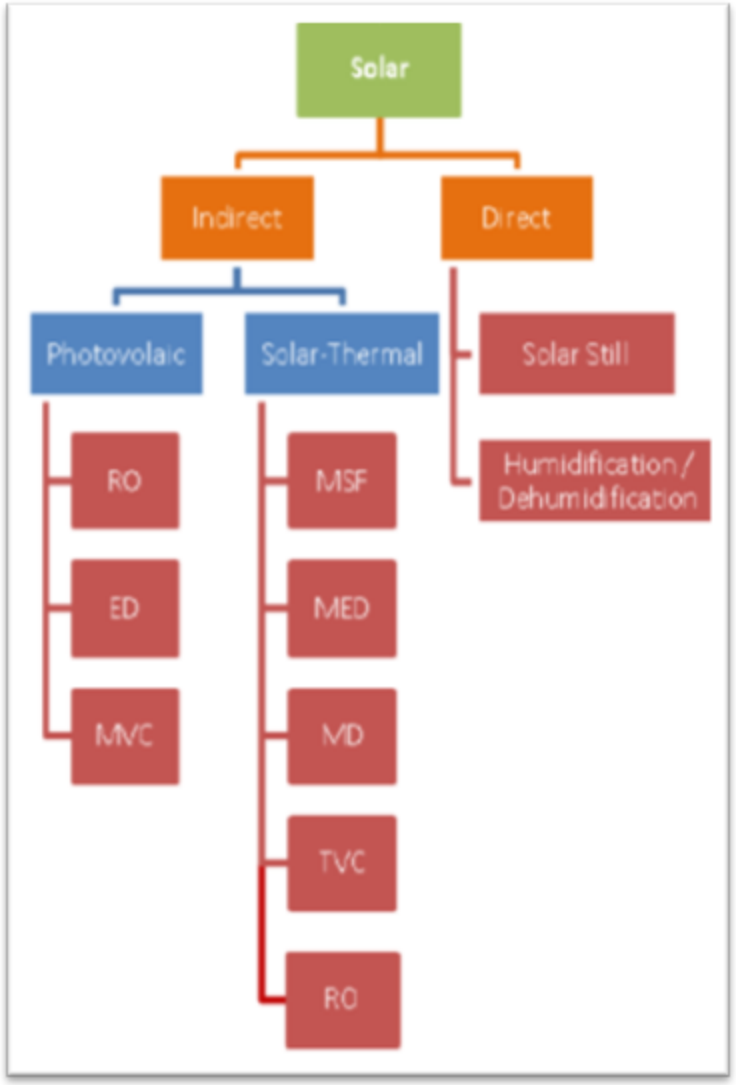
- Mechanical or Thermal Vapor Compression (MVC / TVC)
- Membrane Distillation(MD)
- Open Cycle OTEC Desalination
- Freezing

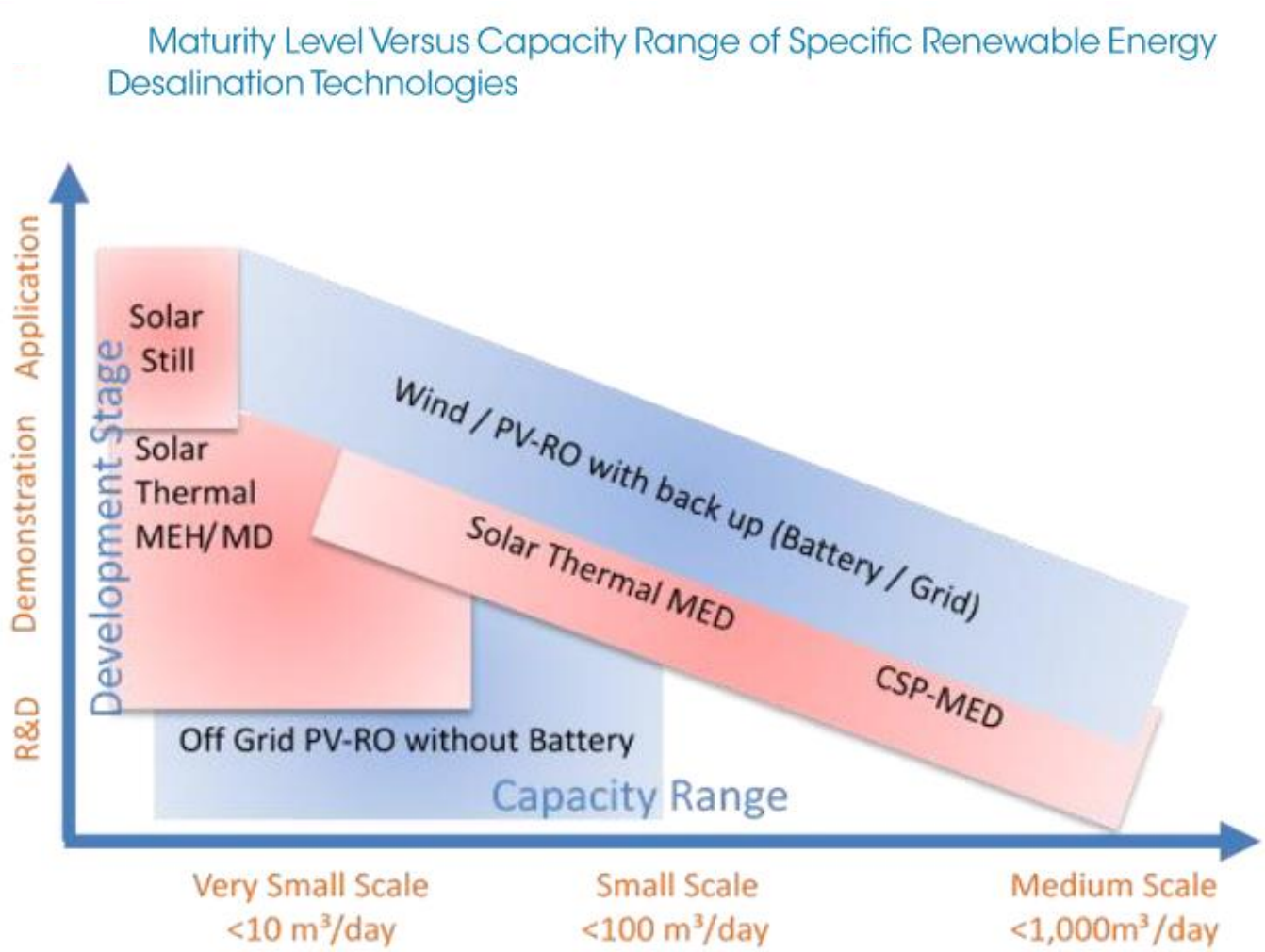
Desalination Market

- Mostly Fossil powered
- 200-20,000 Cubic Meter/Day
- RO Plants are most dominant



Renewable Desalination
Potential Combinations





Renewable Desalination

Technologically Viable Combinations

- **Photovoltaic Reverse Osmosis**
  - ✓Low cost of water
  - ✓Commercial plants & pilots already running
  - ✓Storage required to avoid supply fluctuations

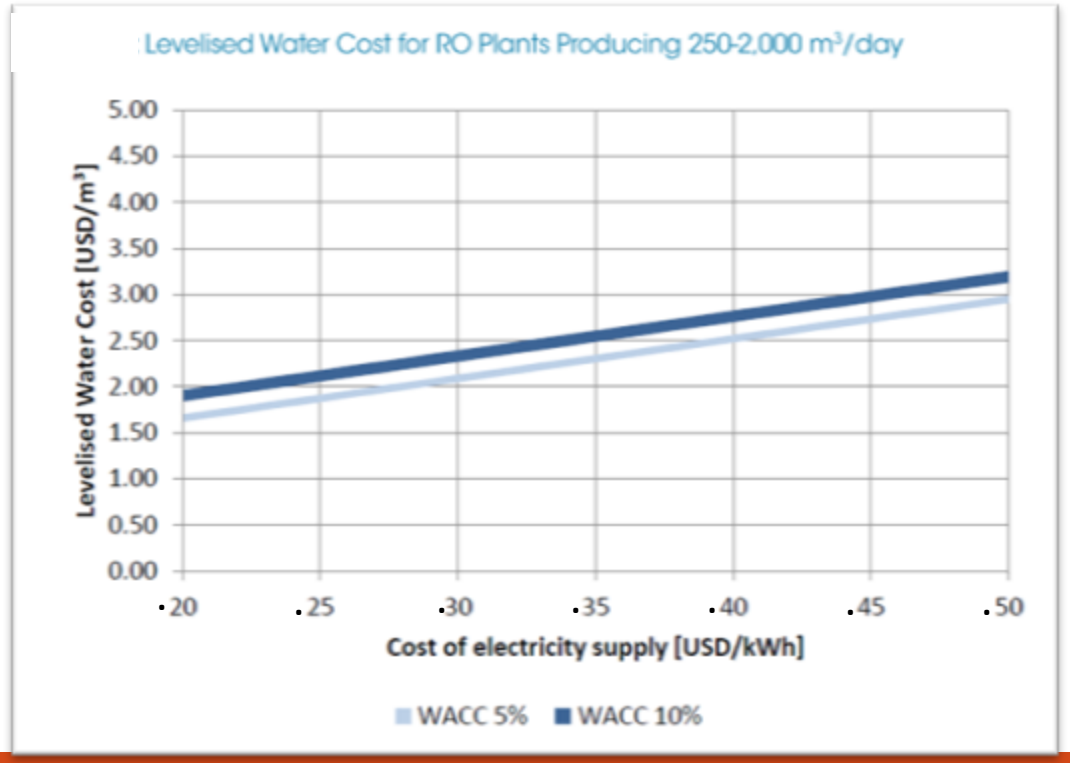
- **CSP Reverse Osmosis**
  - ✓More Efficient that CSP-MED
  - ✓More suitable for large RO plants
  - ✓In R&D and demonstration phase

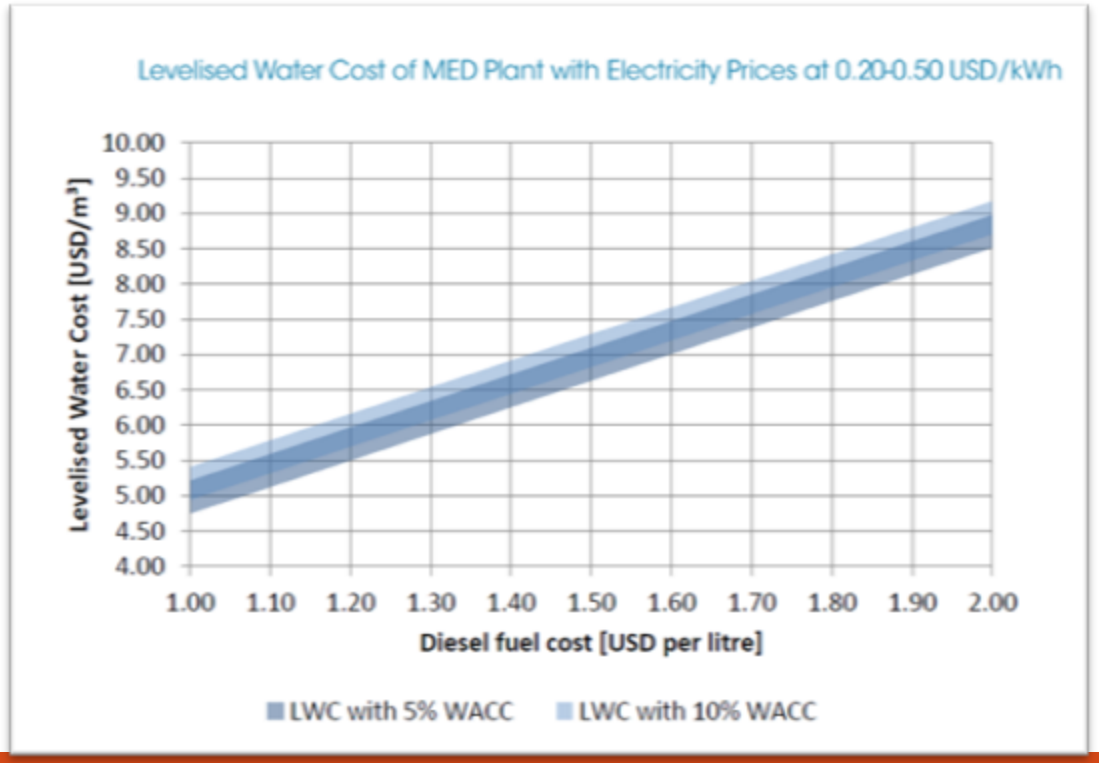
- **CSP Multi-Effect Distillation**
  - ✓Favorability increases when salinity is high
  - ✓Provides flexibility bonus
  - ✓Simultaneous heat and electricity utilization

Economics of Renewable Desalination

IRENA assessment report on SIDs 2015

- Report compared RE desalination solutions with fossil powered desalination
- Comparison was done for levelized cost of water (LWC) for 250-2,000 Cubic Meter/Day plant size range

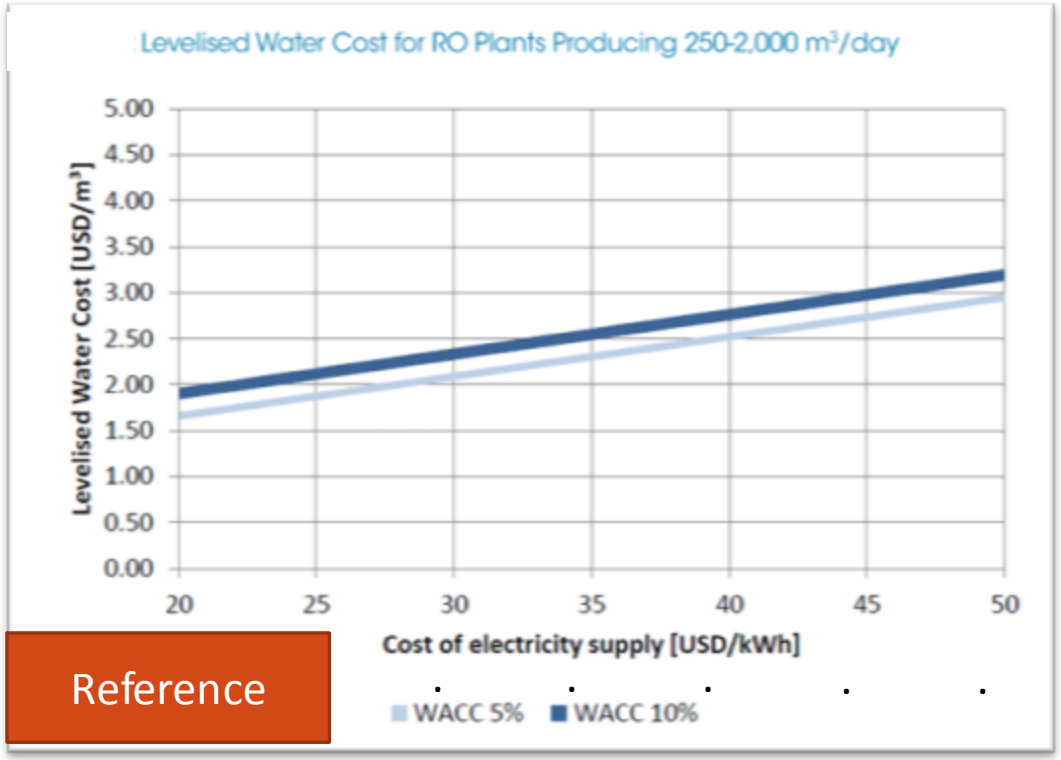




Economics of RE Desalination

IRENA assessment report on SIDs 2015

Comparison of Grid Connected PV-Reverse Osmosis



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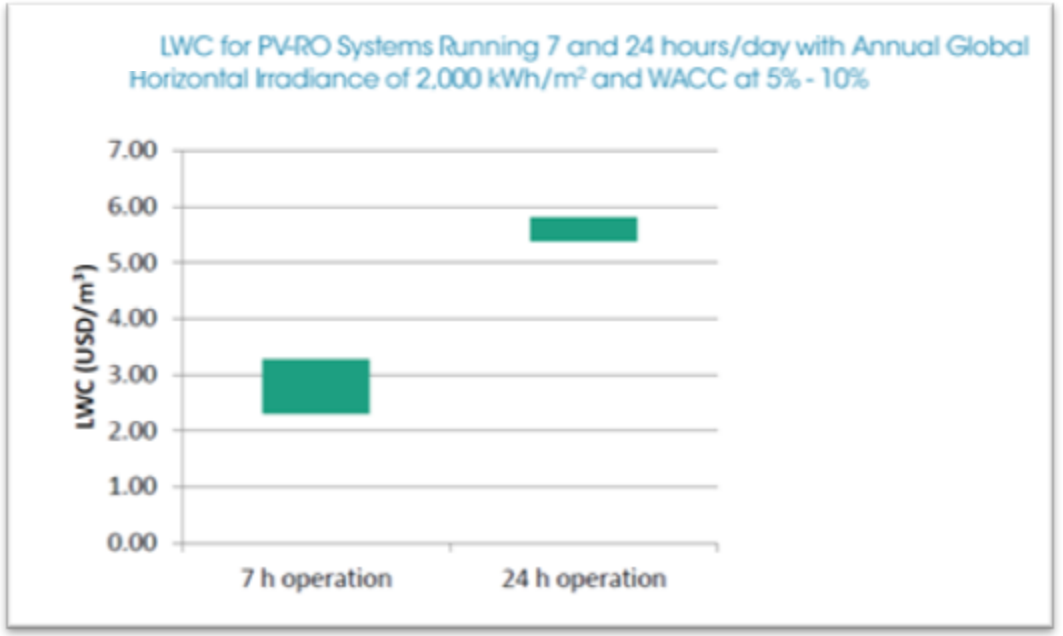
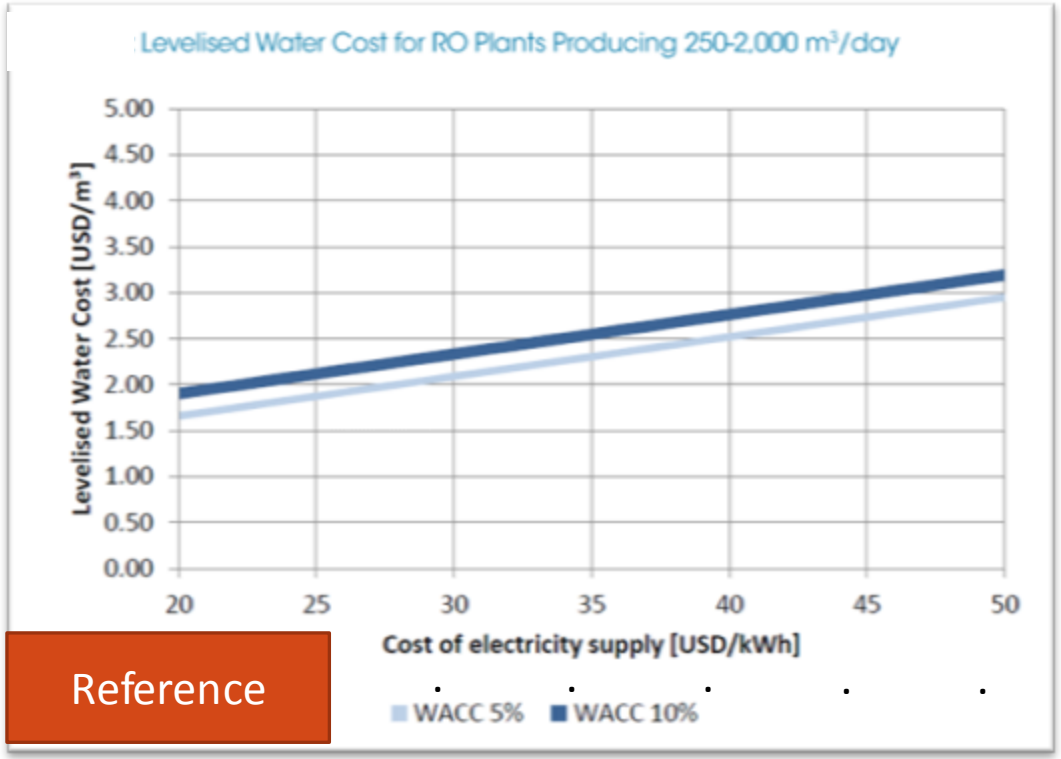


Economics of RE Desalination

IRENA assessment report on SIDs 2015

Comparison of CSP-Reverse Osmosis



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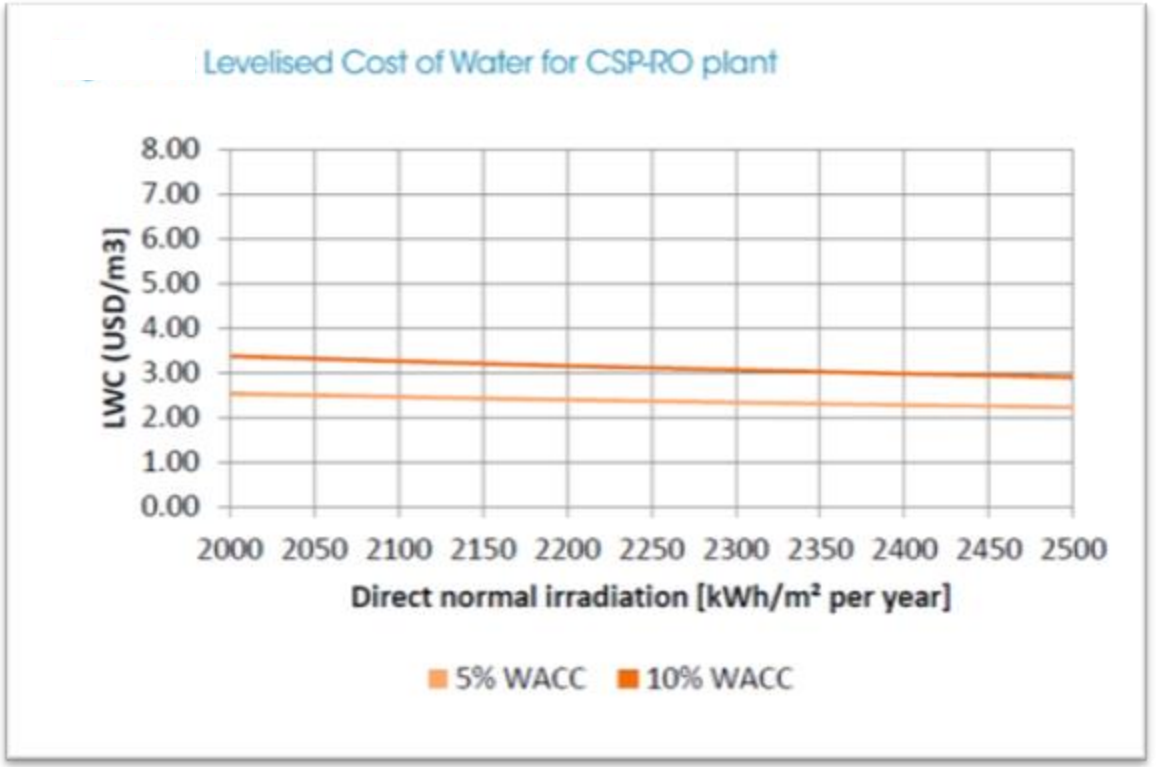
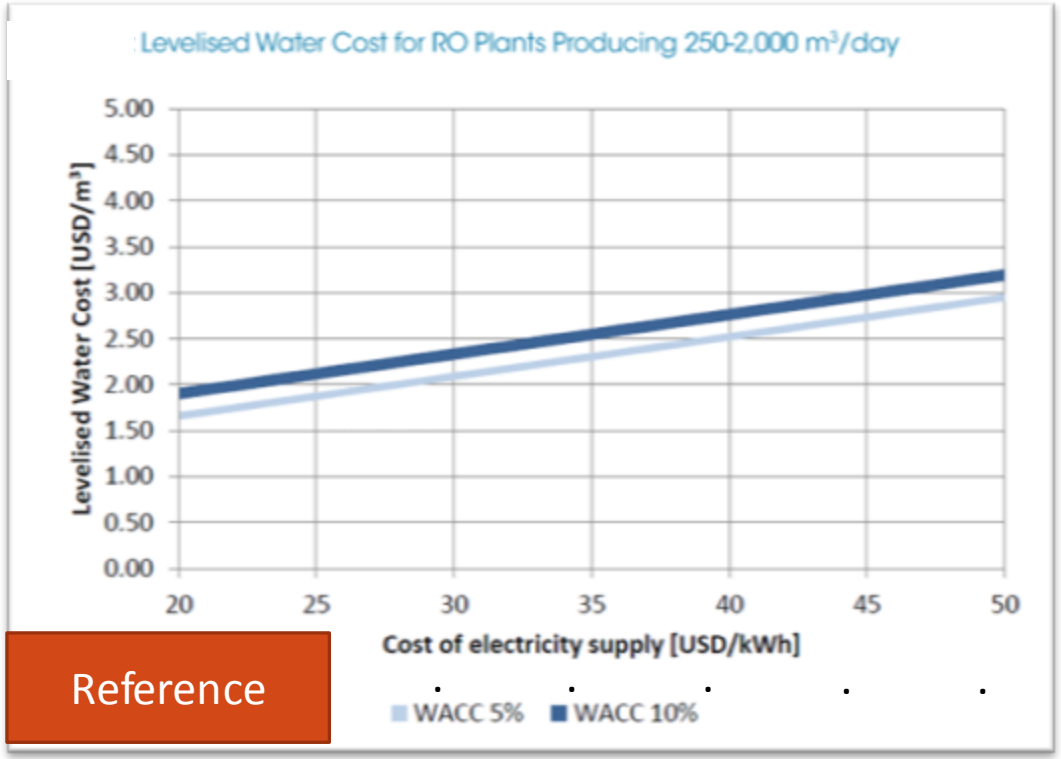


Economics of RE Desalination
IRENA assessment report on SIDs 2015

Comparison of CSP-Multi Effect Distillation (MED)



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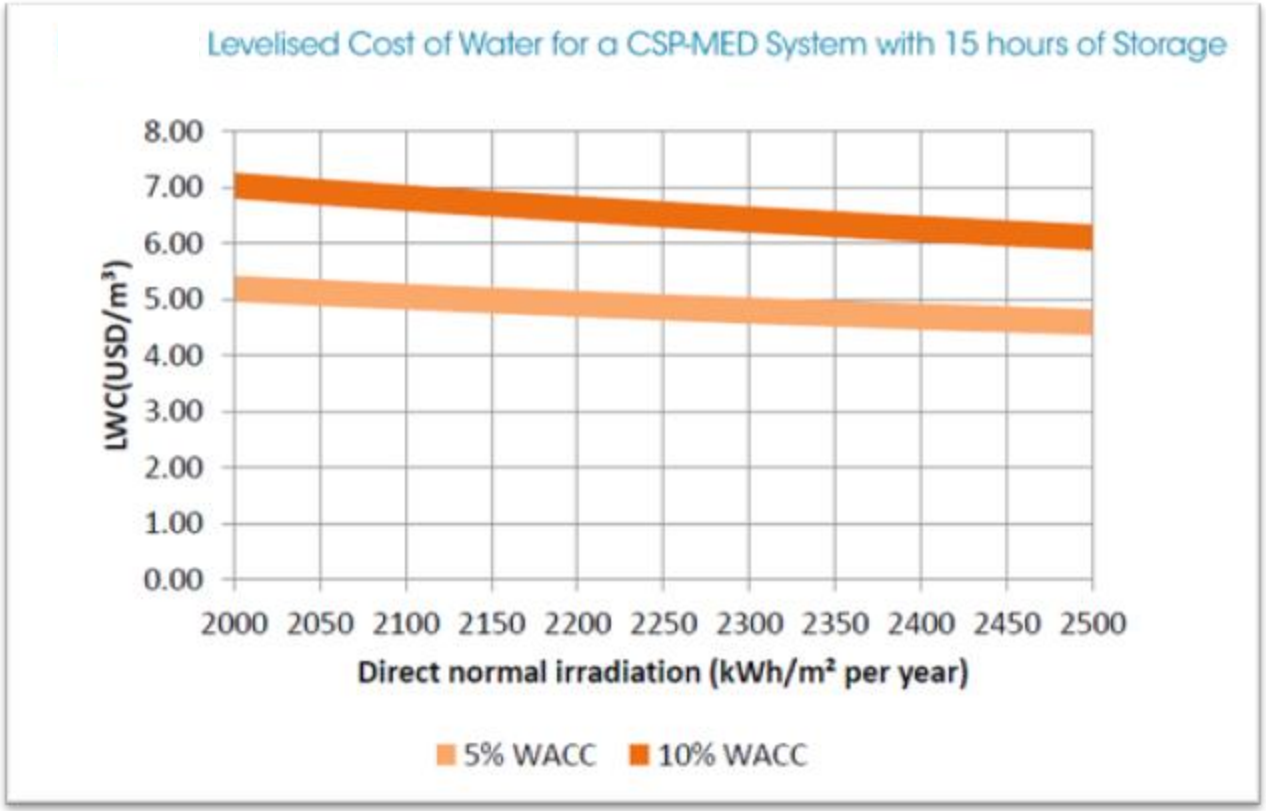
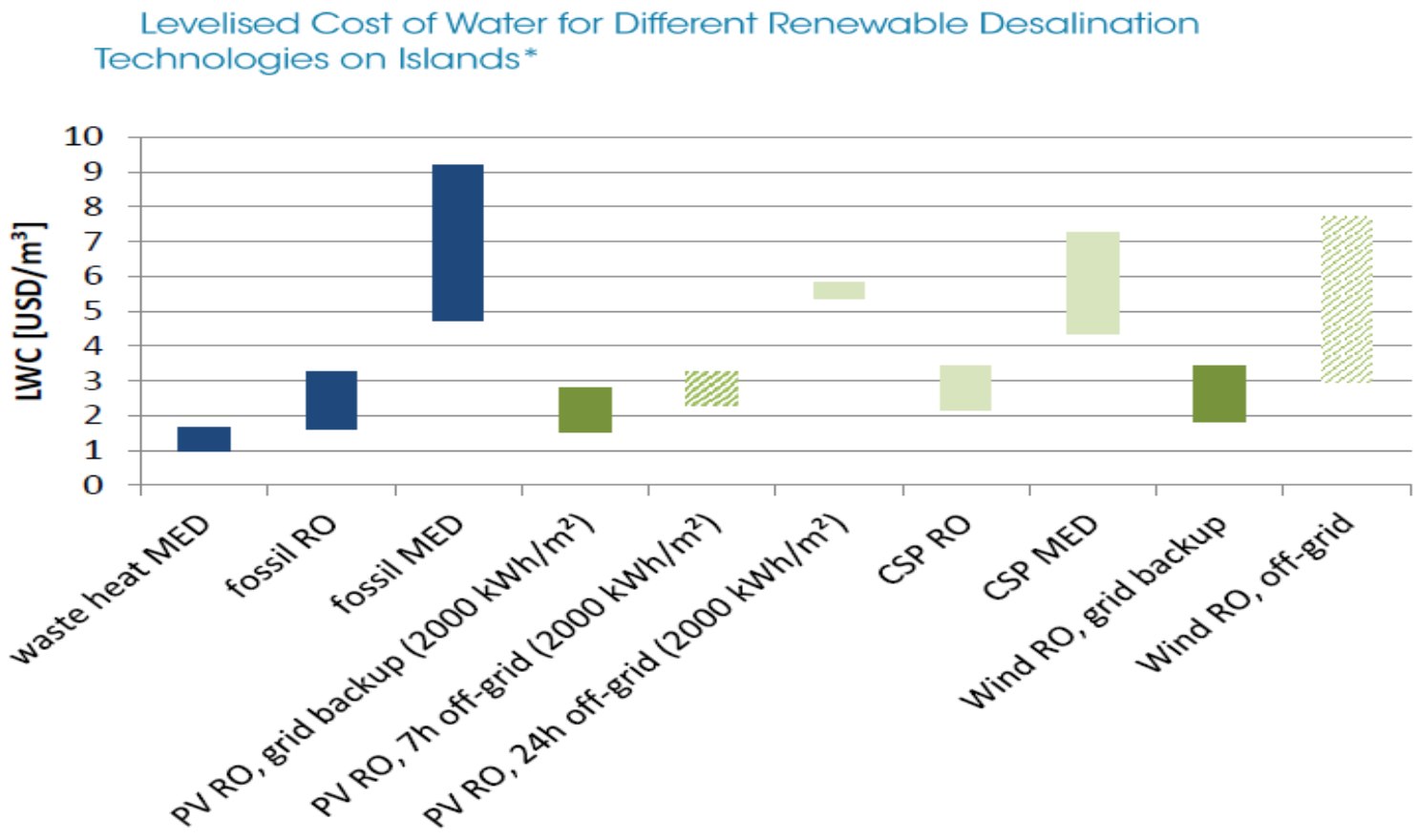


Economics of RE Desalination
IRENA assessment report on SIDs 2015

Summary Results



Outlook & Take Aways

- Declining energy storage costs will favor RE desalination in Future
- In Future, flexible RO desalination plants will attract more investors and energy companies
- Refilling the overexploited ground water lenses/aquifers with desalinated water is an interesting area to explore favorability of commercial RE desalination solutions
- Bigger size RE desalination plants are cost effective especially when operating on low temperature waste heat
- Asides the maturing technology options, expansion of RE desalination solutions requires better training and education facilities, information sharing on best practices and functioning supply chains

Thank you…