DME S-006-2013 – Lecture 05

DME
GERMAN DESALINATION

Stand Alone Driven Desalination Systems

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DME - Seminar

Key Solutions for Key Markets

December 03rd, 2013

Jeddah – Saudi Arabia

1-3 DECEMBER 2013, JEDDAH HILTON, SAUDI ARABIA
SWPF 2013 SAUDI WATER & POWER FORUM

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Fraunhofer Institute for Solar Energy Systems ISE

- Founded in 1981
- Largest solar research center in Europe
- Staff > 1300
- 2012 Budget about € 77 million
- 8 Areas of business
  - Energy Efficient Buildings
  - Applied Optics and Functional Surfaces
  - Solar Thermal Technology
  - Silicon Photovoltaics
  - Photovoltaic Modules and Systems
  - Alternative Photovoltaic Technologies
  - Renewable Power Supply
  - Hydrogen Technology

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Outline

- Introduction
- PV- driven Reverse Osmosis
- Thermally driven Membrane
- Distillation
- Conclusions

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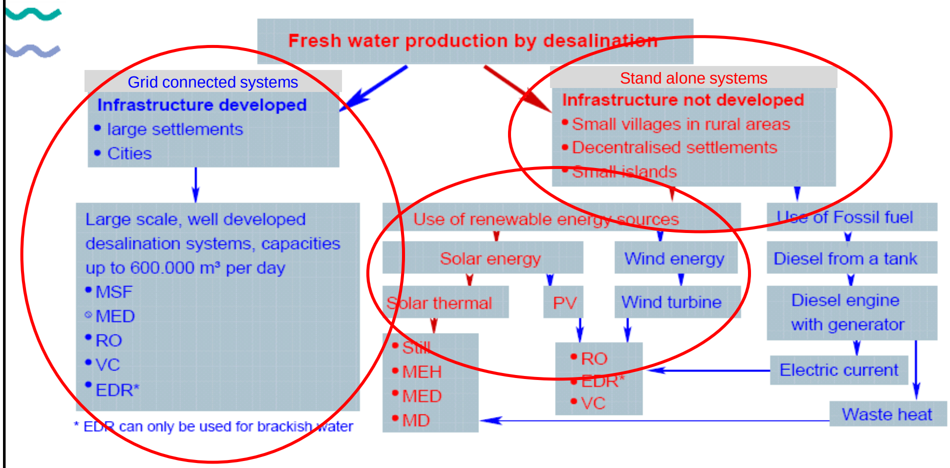
Introduction



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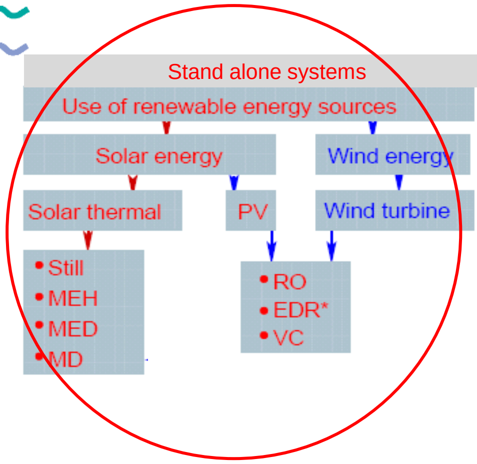
Introduction



Challenging approach because:

- Energy supply is not constant during the course of a year, during day and night time and during daytime even within seconds intensity can change
- Qualified technical staff for operation and maintenance is not available

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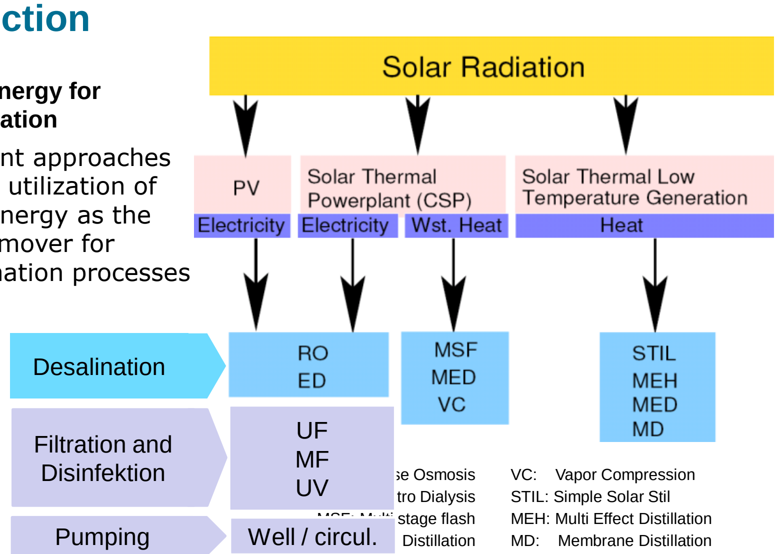
Introduction

Solar energy for desalination

Different approaches for the utilization of solar energy as the prime mover for desalination processes



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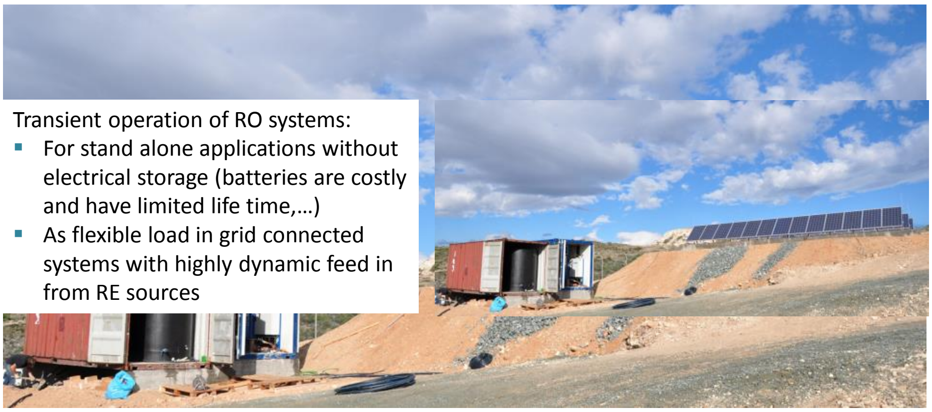
PV- driven Reverse Osmosis

PV- RO desalination systems for transient operation



Transient operation of RO systems:

- For stand alone applications without electrical storage (batteries are costly and have limited life time,...)
- As flexible load in grid connected systems with highly dynamic feed in from RE sources

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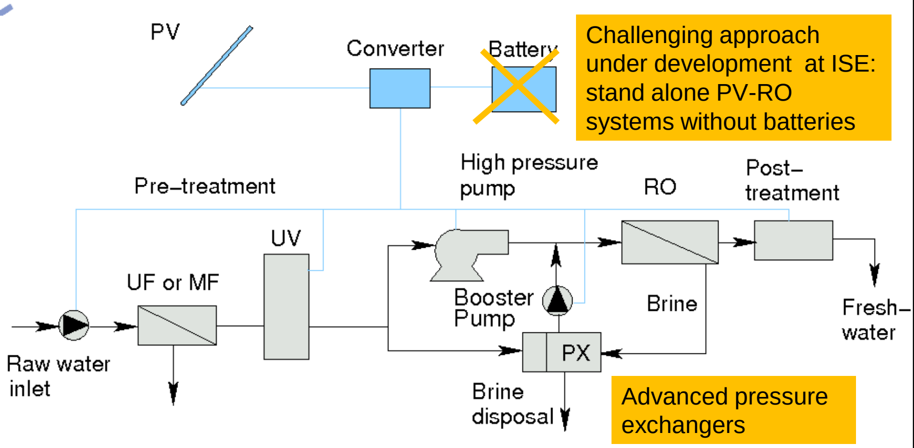
PV- driven Reverse Osmosis

PV-RO - stand alone system configuration



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PV- driven Reverse Osmosis

PV Reverse Osmosis Desalination System for Cyprus

Technical Requirements:

- System dimensions:
  - daily water withdrawal 5 m³
  - system capacity 1.1 m³/h
  - Spec. Enrgy cons. 4.4kWh/m³
- Powered by photovoltaics
- No battery storage
  - dynamic and intermittent operation
  - good partial load performance
- With energy recovery
- Durable, long lifetime

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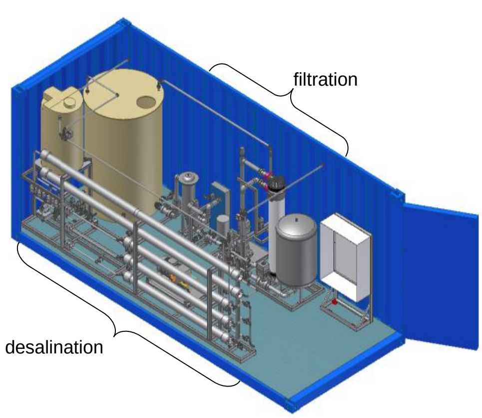
PV- driven Reverse Osmosis

Plant design – hydraulic part



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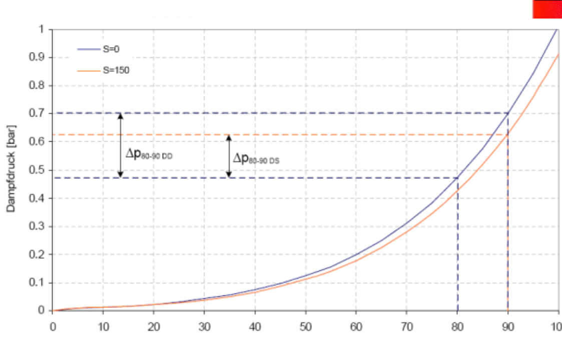
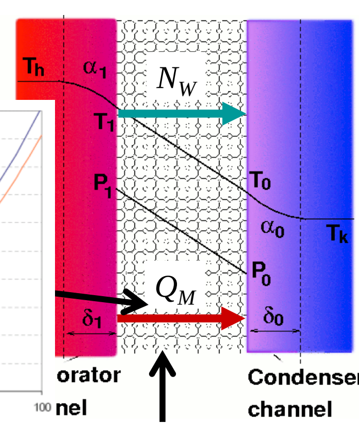
Thermally driven Membrane Distillation

Thermally driven Membrane Distillation

Driving forces in MD are established by a temperature profile across both membrane interfaces

$$N_W = C\frac{dp}{dT}(T_1 - T_0)$$

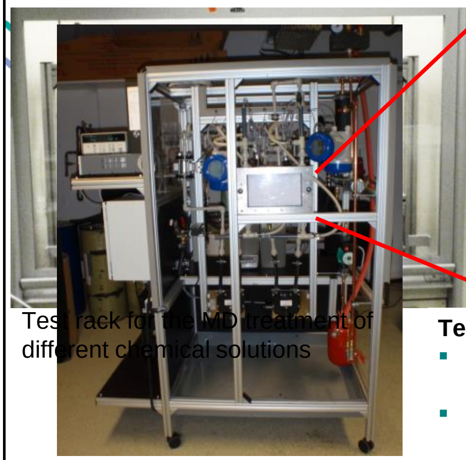




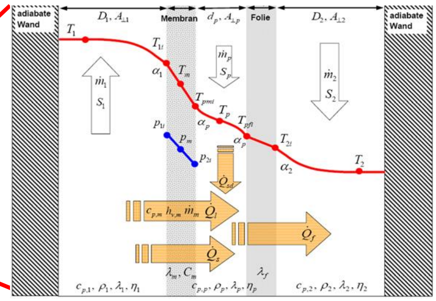
Hydrophobic, micro-porous membrane, pore diameter 0.1-0.4μm

Thermally driven Membrane Distillation

Experimental test facilities – test cell



Test rack for the MD treatment of different chemical solutions

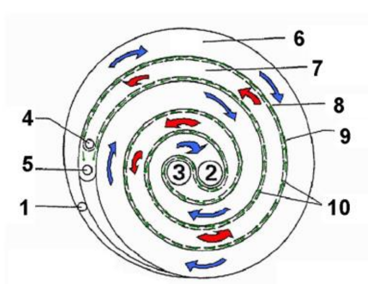


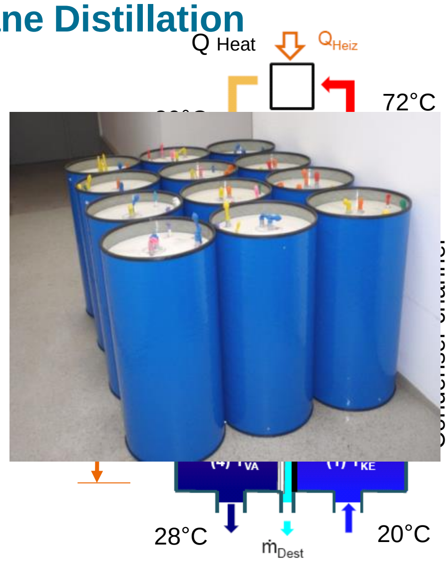
Test cell for membrane samples format A4

- All different MD configurations can be realized
- Characterization of membranes as service for membrane manufacturers
- Validation of single node simulation models

Thermally driven Membrane Distillation

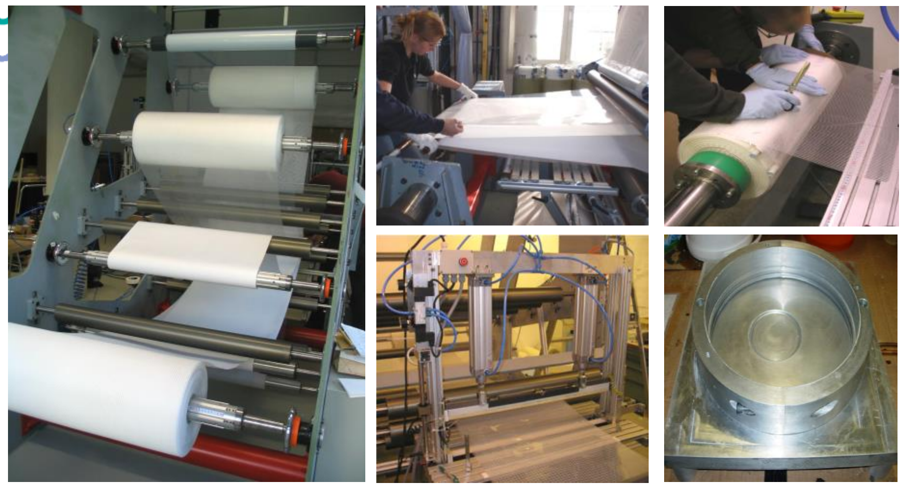
Configuration of spiral wound MD modules with internal heat recovery





Thermally driven Membrane Distillation

Production of spiral wound MD modules at ISE and SolarSpring



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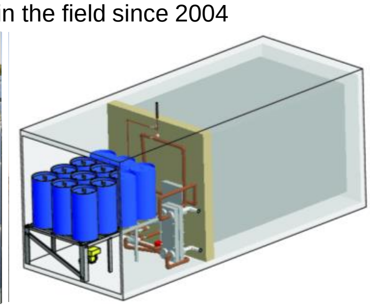
Thermally driven Membrane Distillation

Development and operation of MD pilot systems in different locations

- 15 solar or waste heat driven MD desalination systems in the capacity range between 100 and 5000 l/day have been tested in the field since 2004



Gran Canaria Spanien
Solar field: 180m²
Capacity: 5(3)m³/day

Pantelleria Italien
Waste heat
Capacity: 5m³/T

Amarika Namibia
Solar field: 225m²
Capacity: 5(3.5)m³/T

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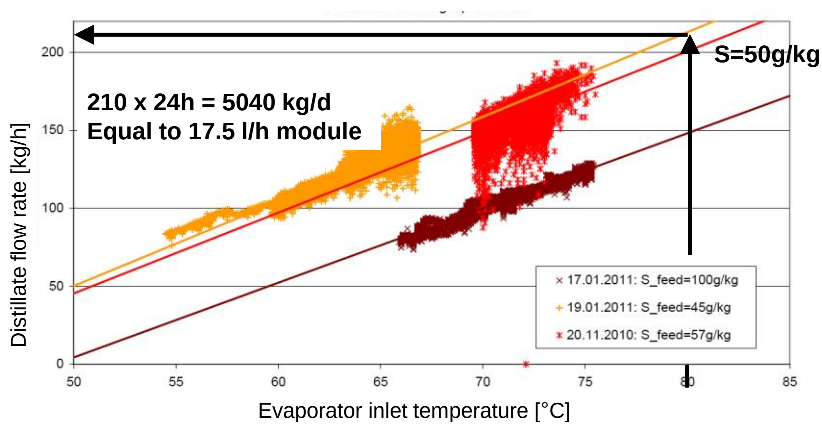
Thermally driven Membrane Distillation

Evaluation of a pilot plant in Pantelleria



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Conclusions

- All desalination technologies have advantages and disadvantages and must be chosen with respect to particular boundary conditions
- Small and medium size stand alone, solar driven desalination systems are still under development
- Long term experience for realistic life time estimations are not available but are important with respect to realistic water production costs
- Solar driven desalination systems are almost not on the market because they are considered as “too expensive” but there is a huge demand
- Cost savings due to decentralized production must be considered more carefully for the comparison of water production costs (no transportation, no grid, no subsidies for conventional energy,…)

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Thank you for your attention
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