SOLAR DESALINATION AND WATER TREATMENT

Dr.–Ing. Joachim Koschikowski

Fraunhofer-Institute for

Solar Energy Systems ISE

joachim.koschikowski@ise.fraunhofer.de

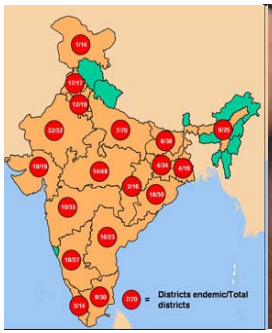
Fraunhofer ISE

Outline

- Introduction and overview
- Desalination technologies
- Comparison of technological approaches
- Examples of technological approaches
- Summary of our capabilities

Introduction

The shortage of clean and safe water is one of the most critical problems to be solved
Water has no alternative !!!

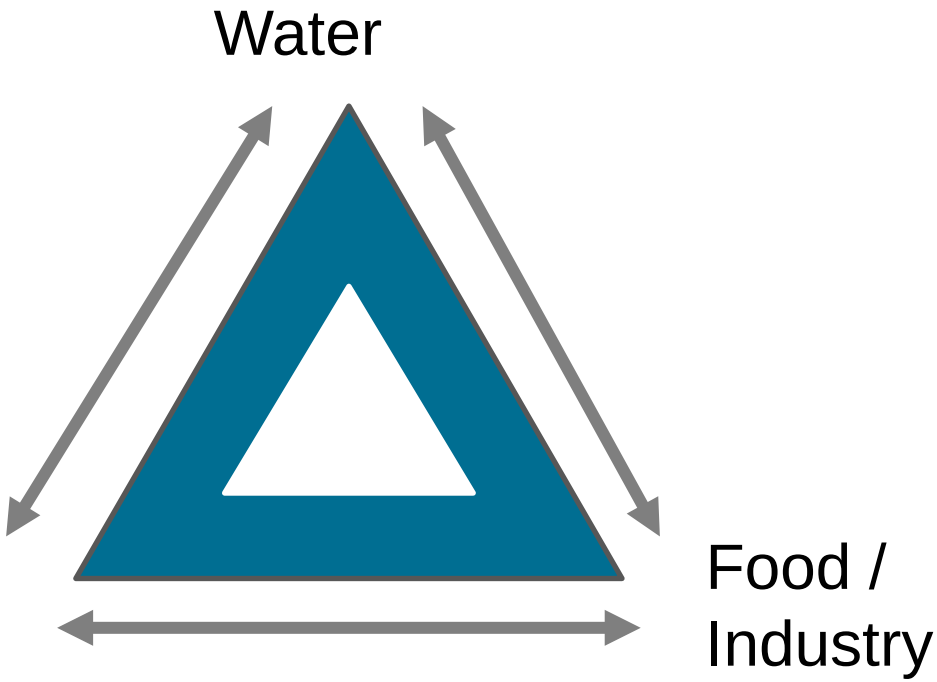


Fraunhofer ISE

Introduction

The shortage of clean and safe water is one of the most critical problems to be solved
Water has no alternative !!!

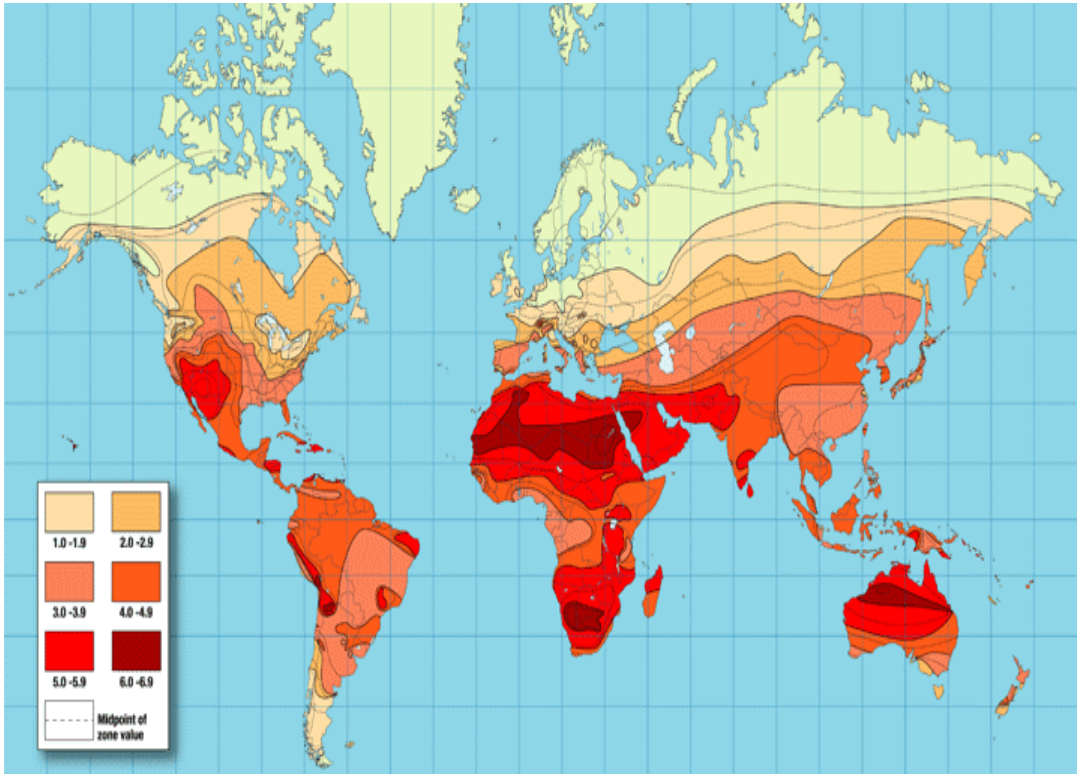
The Nexus…



Introduction

Decrease of fresh water resources due to:

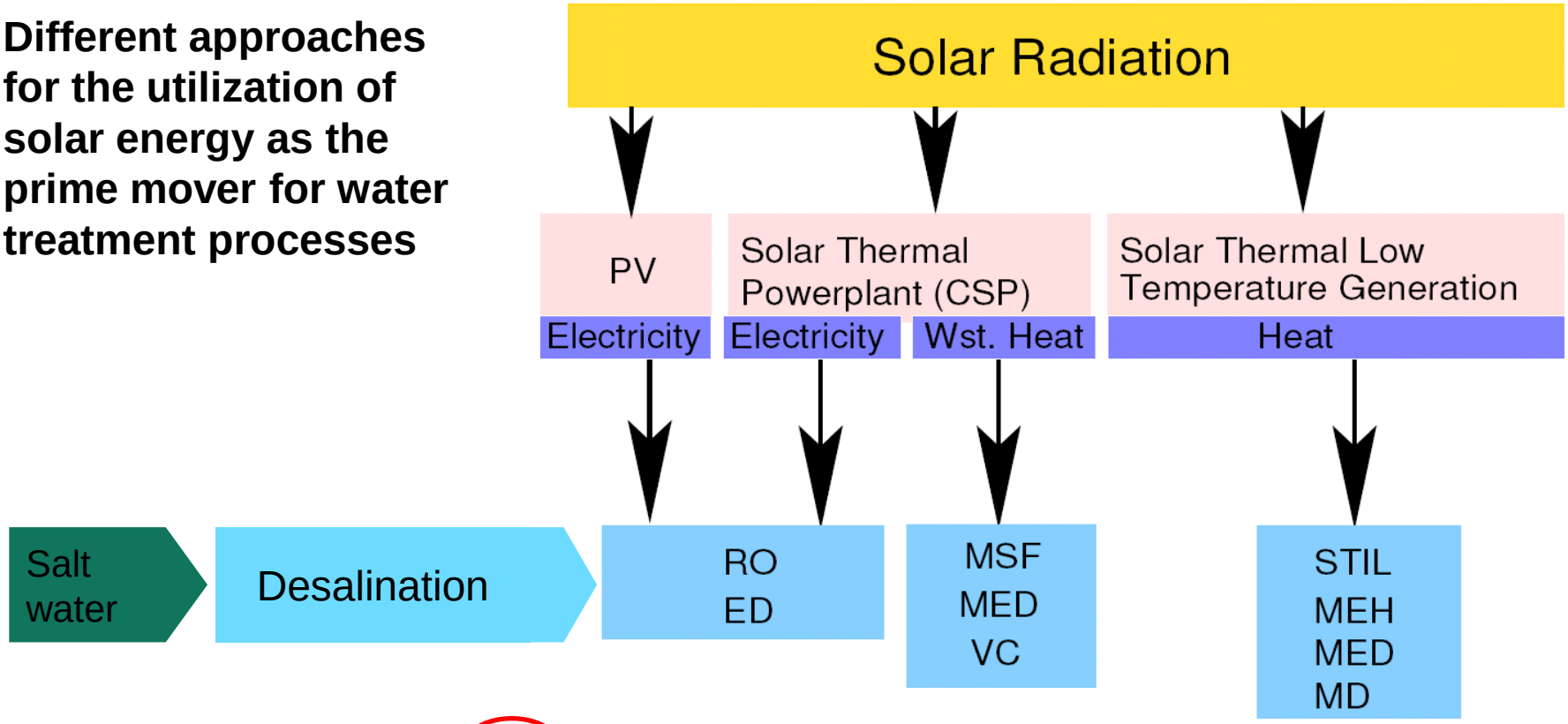
- Deepwelling ground water levels
- Intrusion of salt water
- Draining of fossil ground water reservoirs
- Pollution of surface water



Potential of solar energy e.g. 6kWh/(m²d)→0.6 l oil /(m² d)→220 l oil /(m² y)

Overview on solar driven water treatment

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

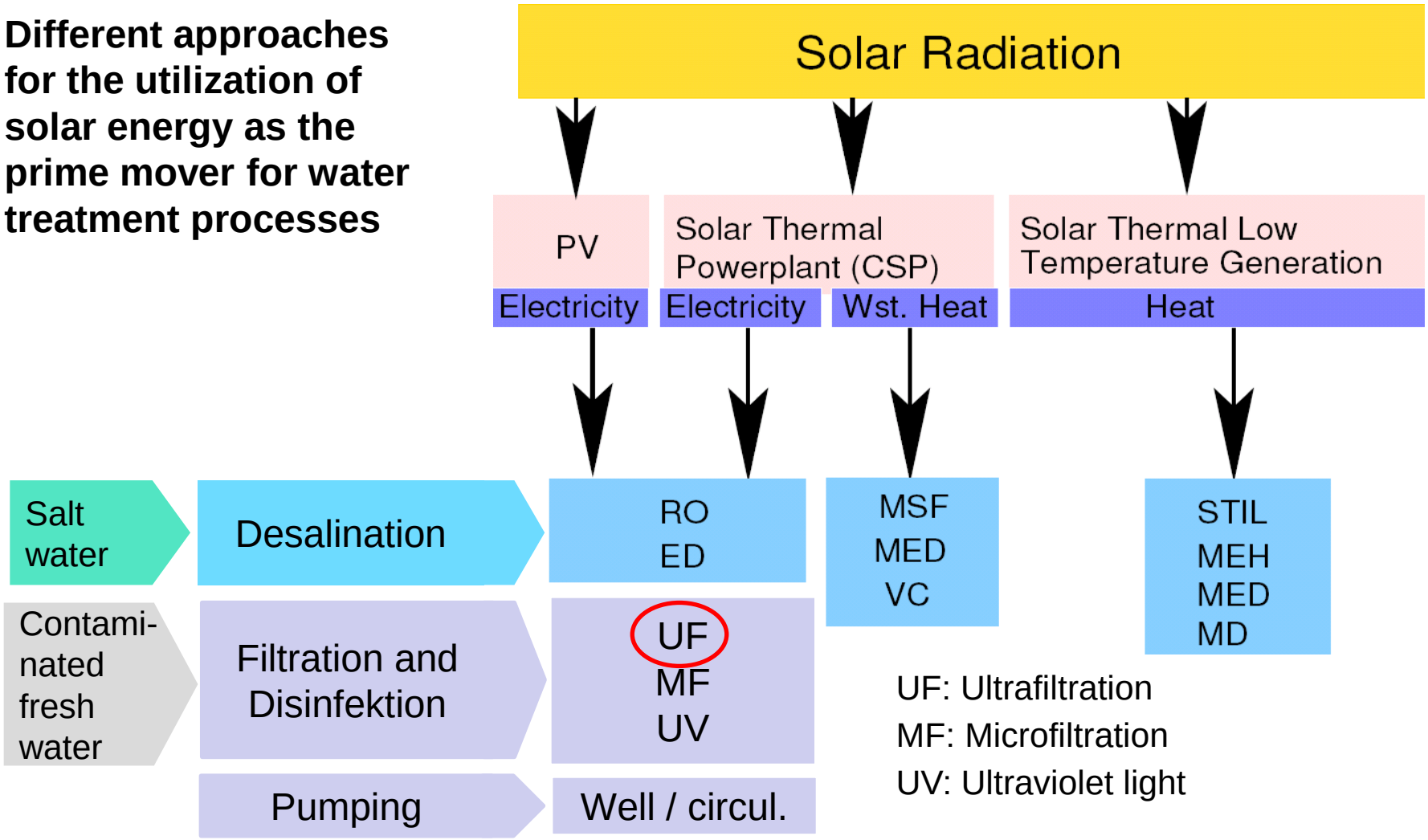


RO: Reverse Osmosis
ED: Electro Dialysis
MSF: Multi stage flash
MED: Multi Effect Distillation
VC: Vapor Compression
STIL: Simple Solar Stil
MEH: Multi Effect Distillation
MD: Membrane Distillation

Fraunhofer ISE

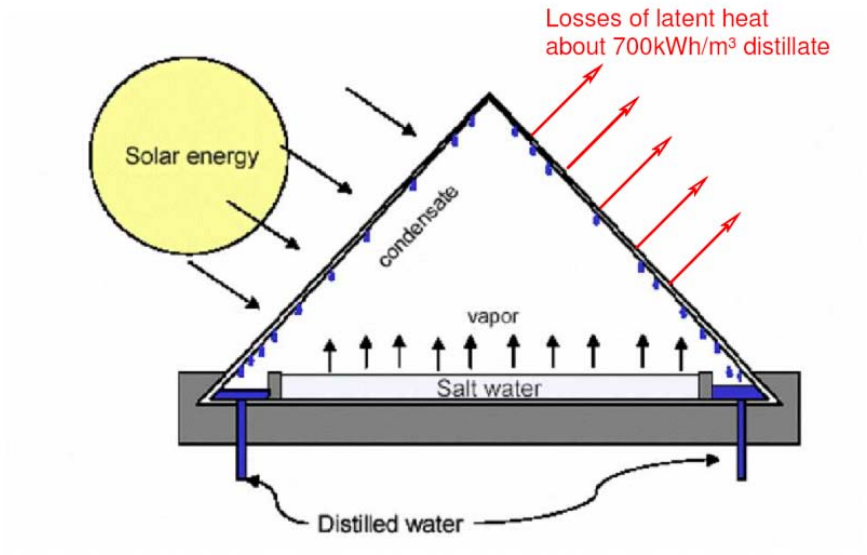
Overview on solar driven water treatment

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



Desalination technologies

Solar still, simplest technology for solar desalination

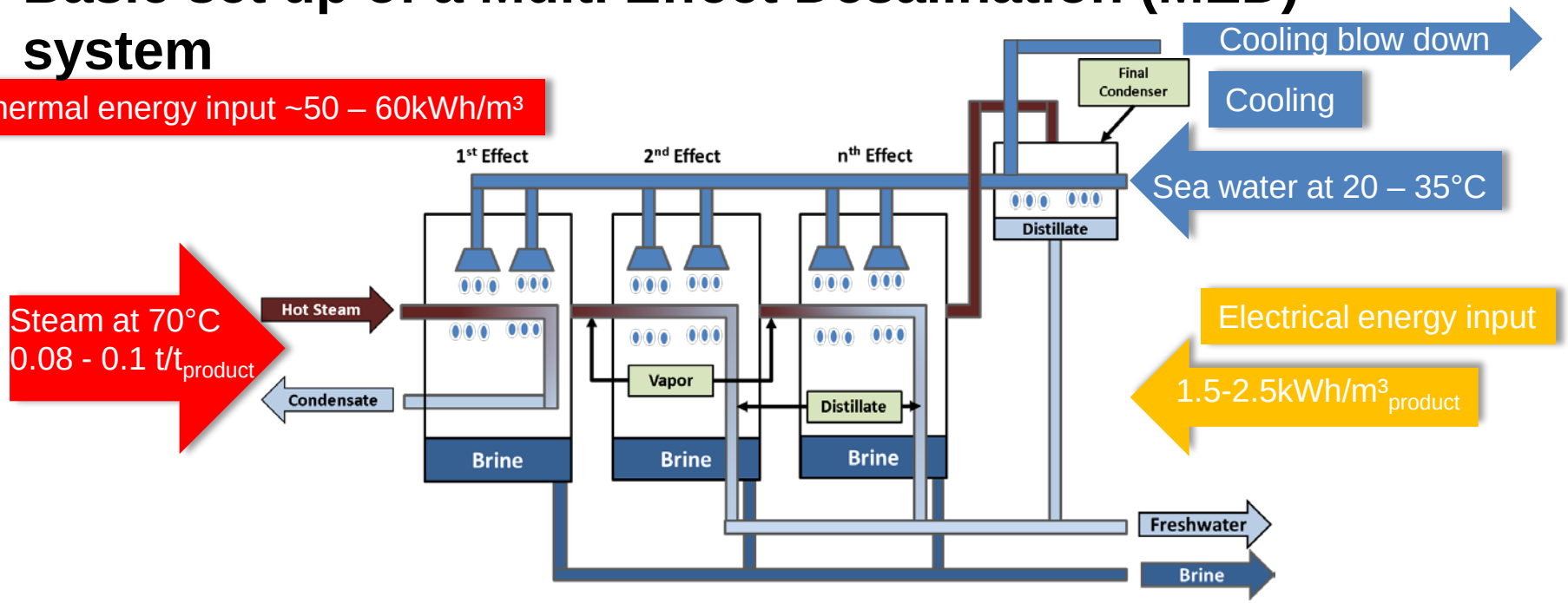


Disadvantage: Very inefficient (2 – 4 l/m² day)

Desalination technologies

Basic set up of a Multi Effect Desalination (MED) system

Thermal energy input ~50 – 60kWh/m³



Number of effects 2 -20

Energy demand

Investment costs

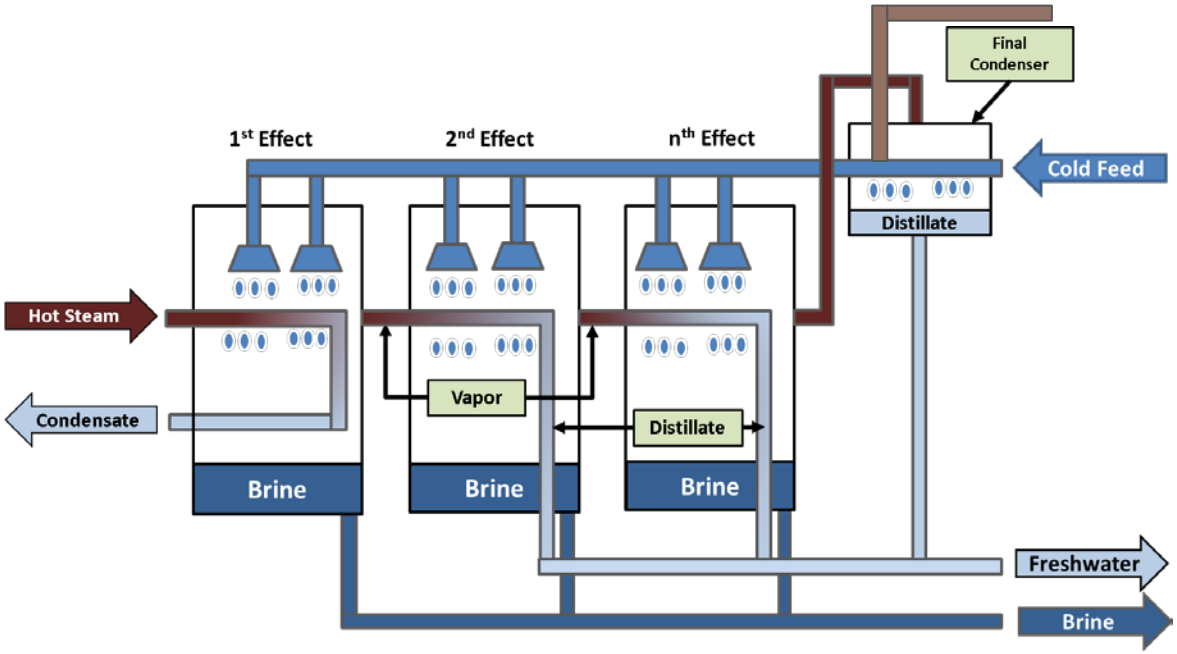
Fraunhofer ISE

Desalination technologies

Examples of Multi Effect Desalination system

10m³/day unit by Fischer Ecosolutions

36Tm³/day plant in Trapani (Sicily)

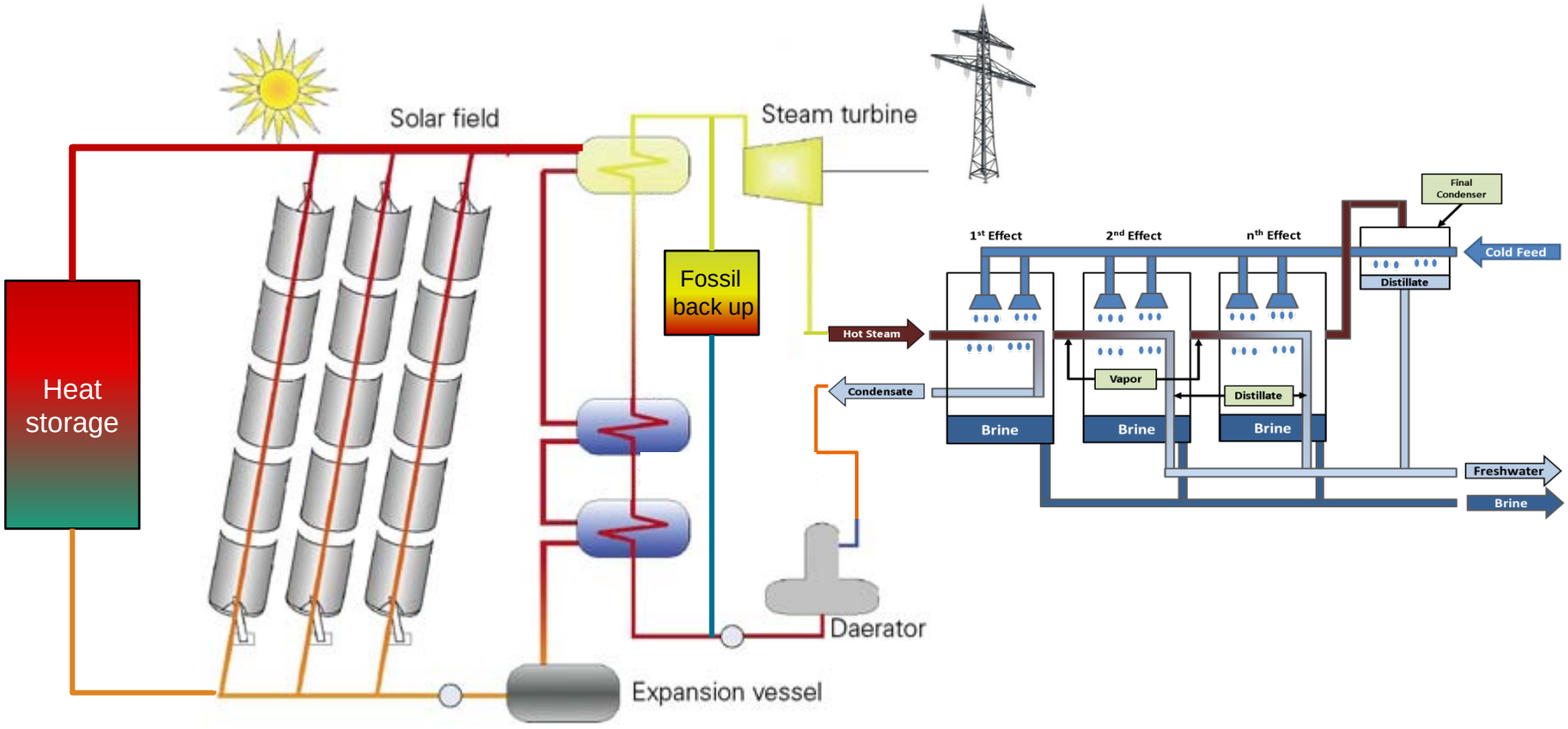


MED is more efficient since latent heat of evaporation is recovered

Fraunhofer ISE

Desalination technologies

Solar driven Multi Effect Desalination system



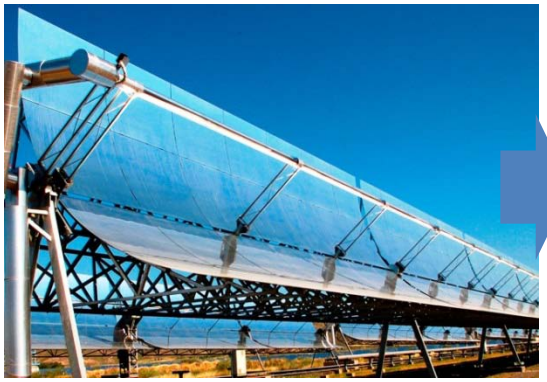
Fraunhofer ISE

Desalination technologies

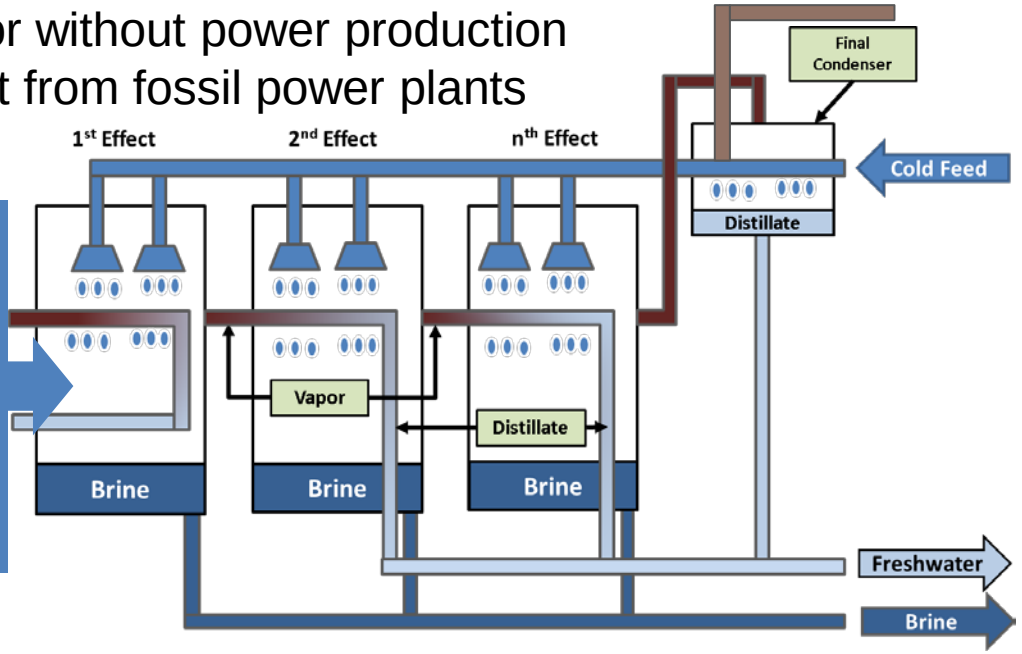
Heat supply for Multi Effect Desalination system

Heat supply by

- Solar thermal flat plate or vacuum tubular collectors
- CSP with or without power production
- Waste heat from fossil power plants



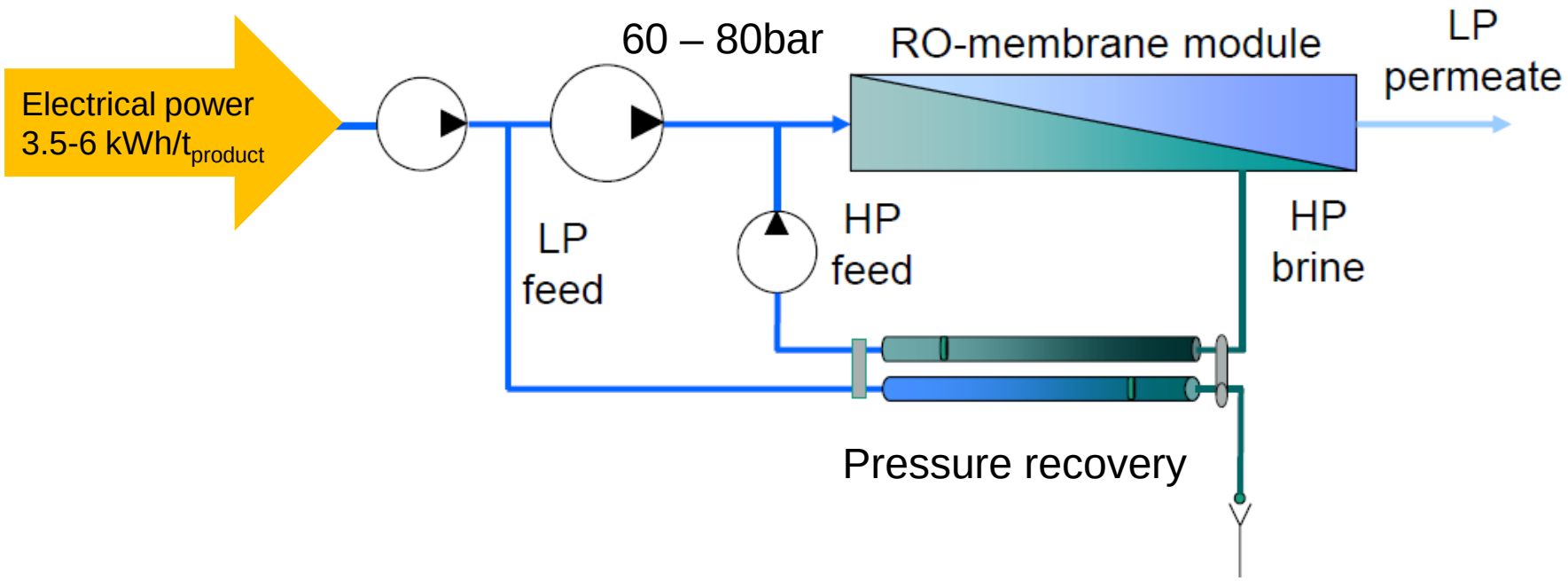
Power plant



Fraunhofer ISE

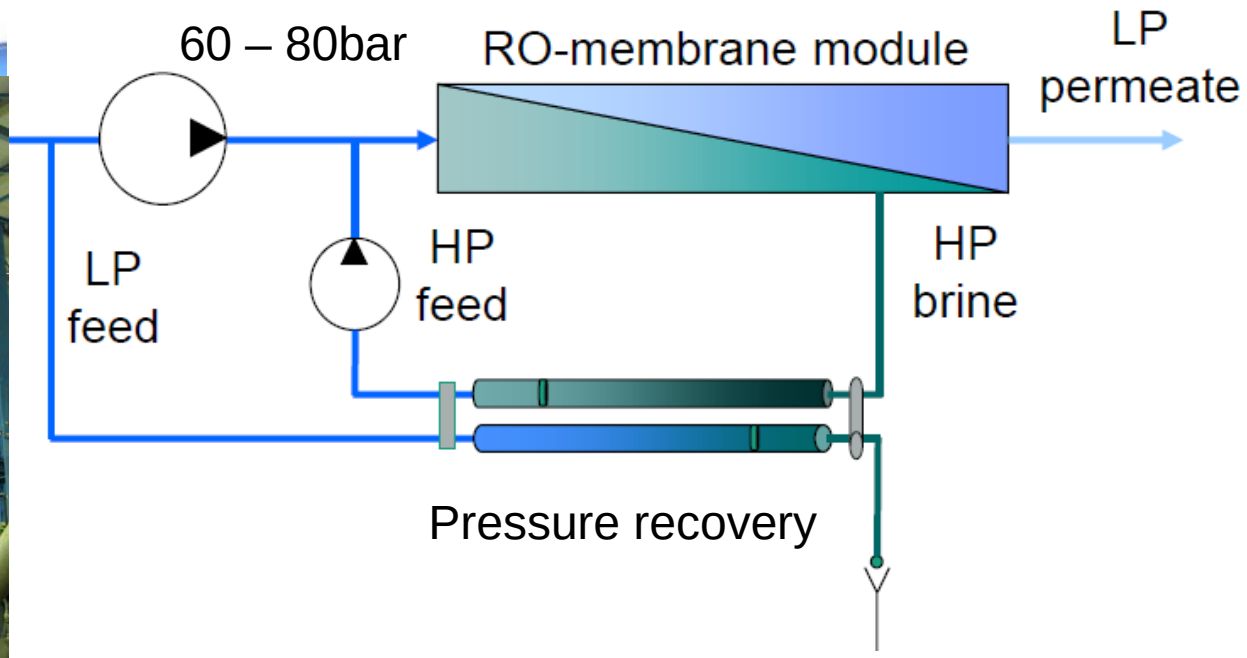
Desalination technologies

Basic set up of a Reverse Osmosis (RO) system



Desalination technologies

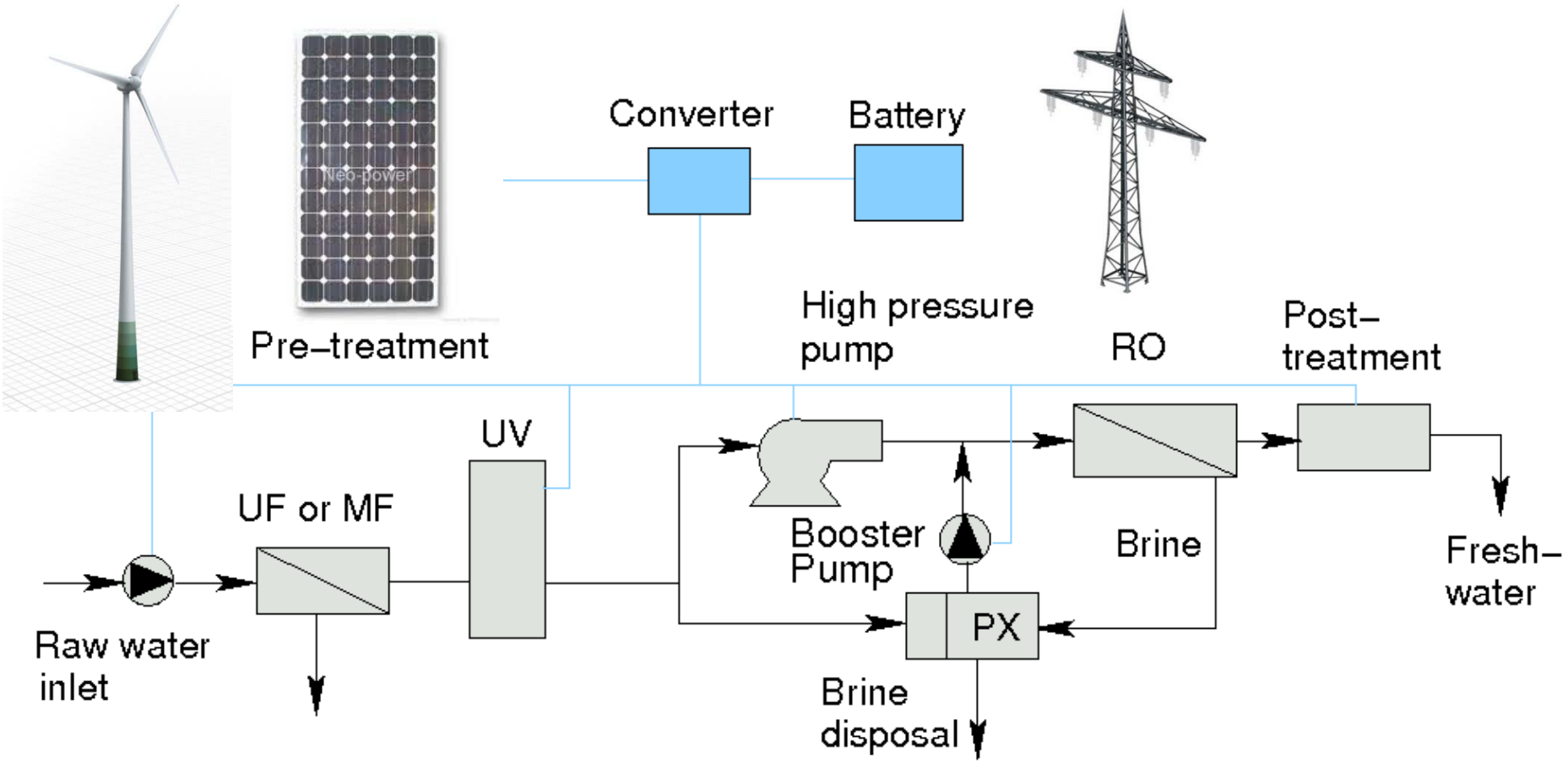
Examples for Reverse Osmosis (RO) system



Desalination technologies

Energy supply Reverse Osmosis (RO) system

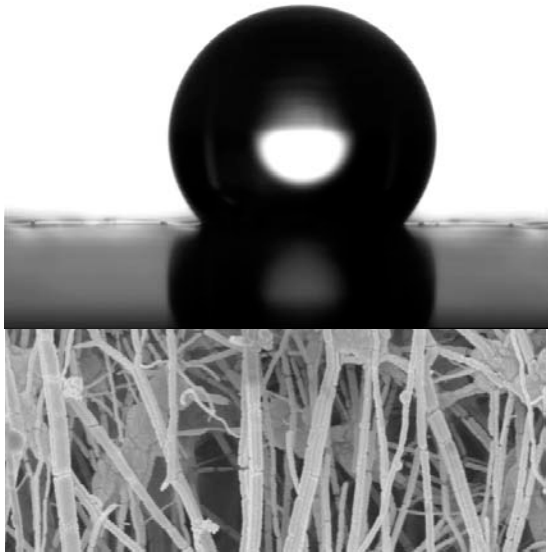
PV-RO - stand alone system configuration for small scale application

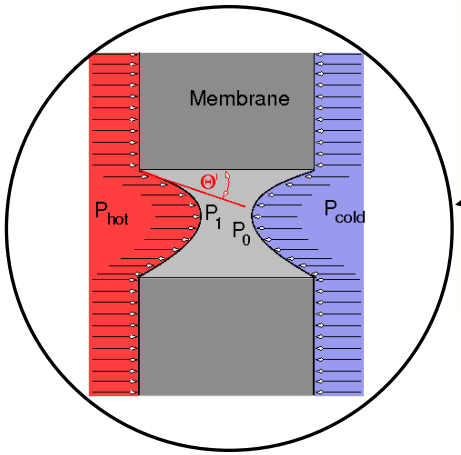


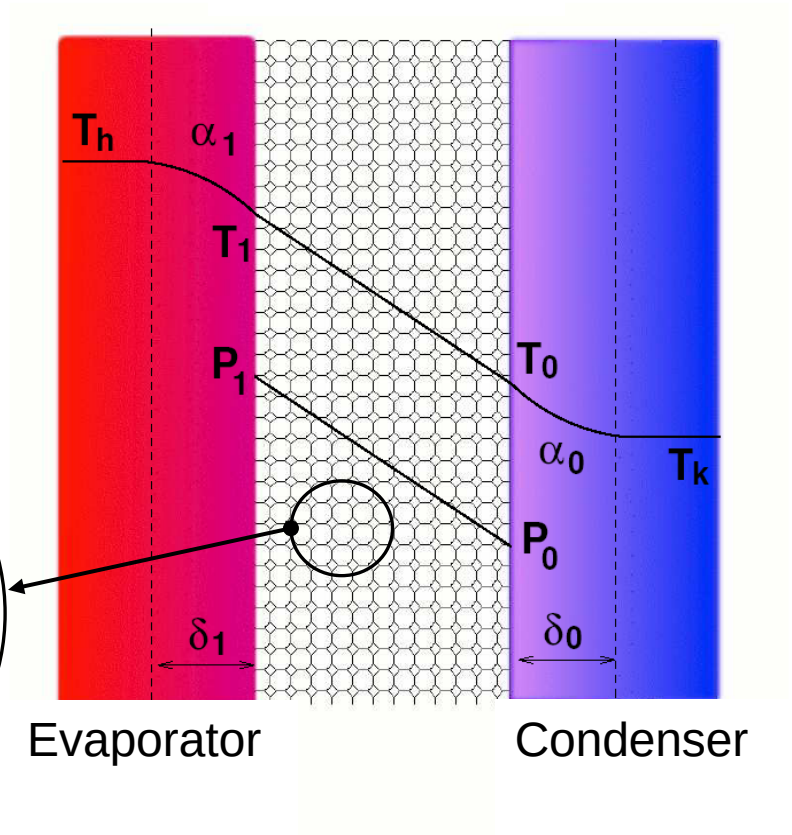
Desalination technologies

Basic set up of Membrane Distillation system

Driving force:
Difference of water vapor pressure between both membrane boundary layers





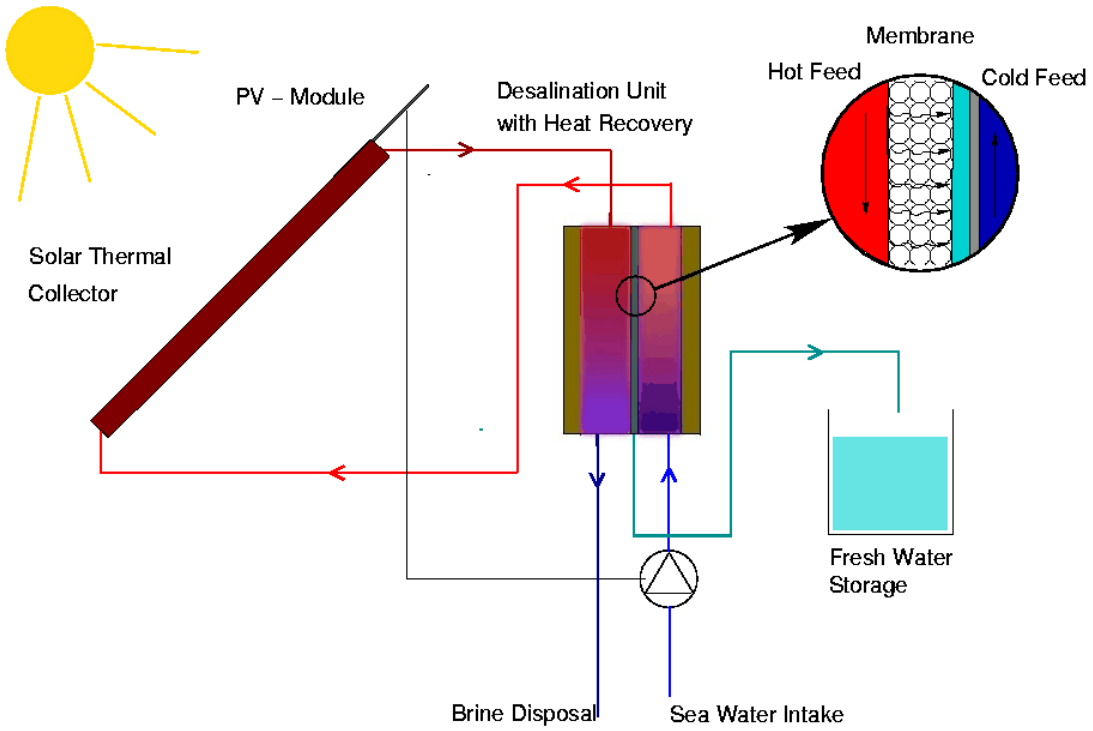


Fraunhofer ISE

Desalination technologies

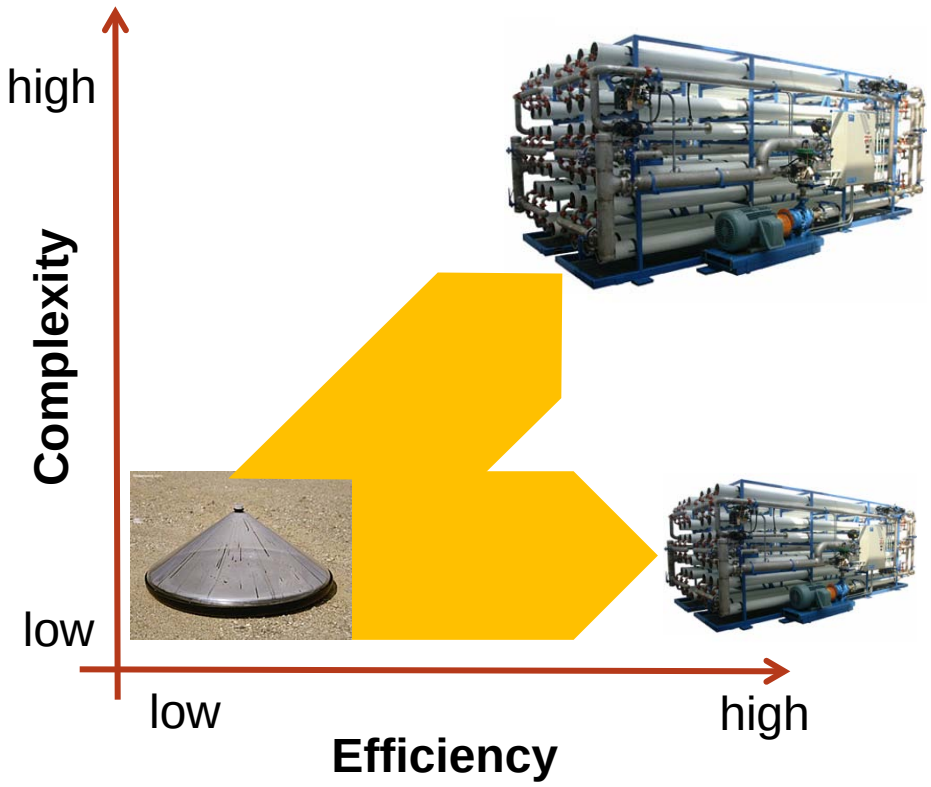
Example for Membrane Distillation system

Driving force:
Difference of water vapor pressure between both membrane boundary layers



Comparison of technological approaches

Correlation between efficiency and complexity:
As higher the efficiency as higher the complexity of the system



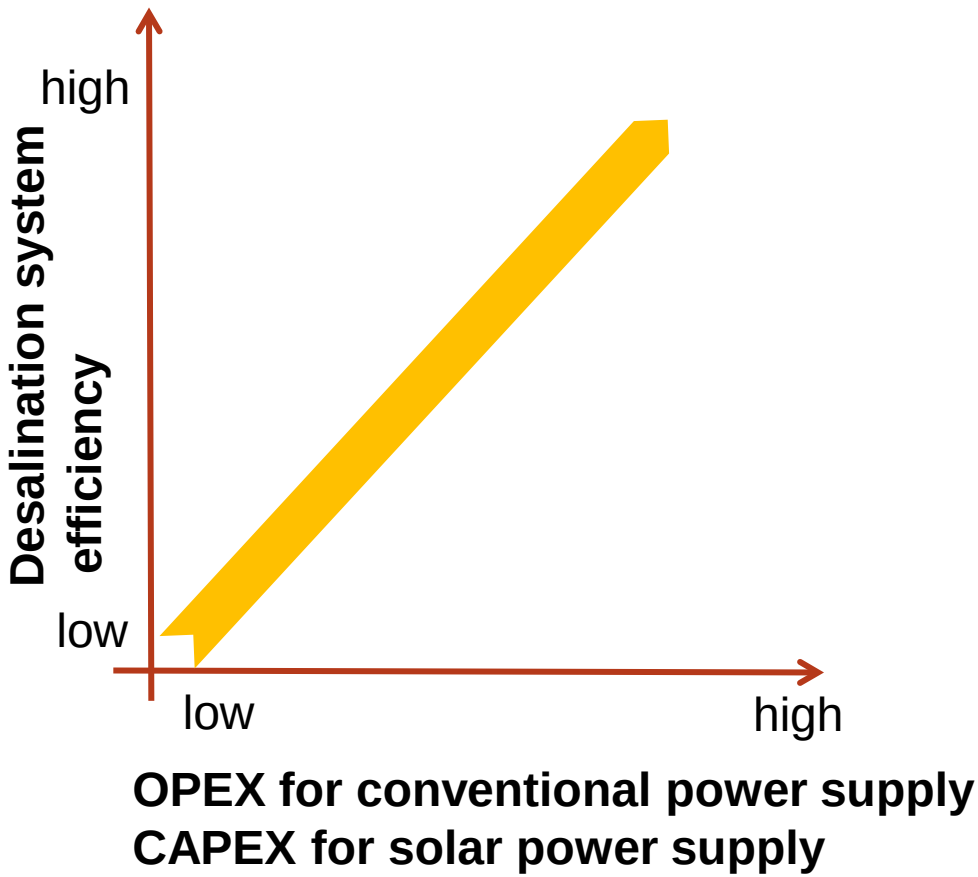
Fraunhofer ISE

Comparison of technological approaches

Correlation between energy costs and system efficiency:
As higher the costs for energy, as higher the efficiency (= investment costs) can be

Costs for water distribution must be considered (savings for distributed systems)!!!

Solar energy is not for free due to significant investment costs !!!



Comparison of technological approaches

Centralized water supply

- Low water production costs
- Large urban communities can be supplied with water
- Financing is possible since successful business models exist
- Complex, expensive, lossy distribution grids are required

Decentralized water supply

- Minimized distribution costs
- Water supply to remote regions
- Minimized distribution grid but maintenance of system is difficult
- Financing of systems difficult since attractive business models do not exist

Comparison of technological approaches

Centralized water supply

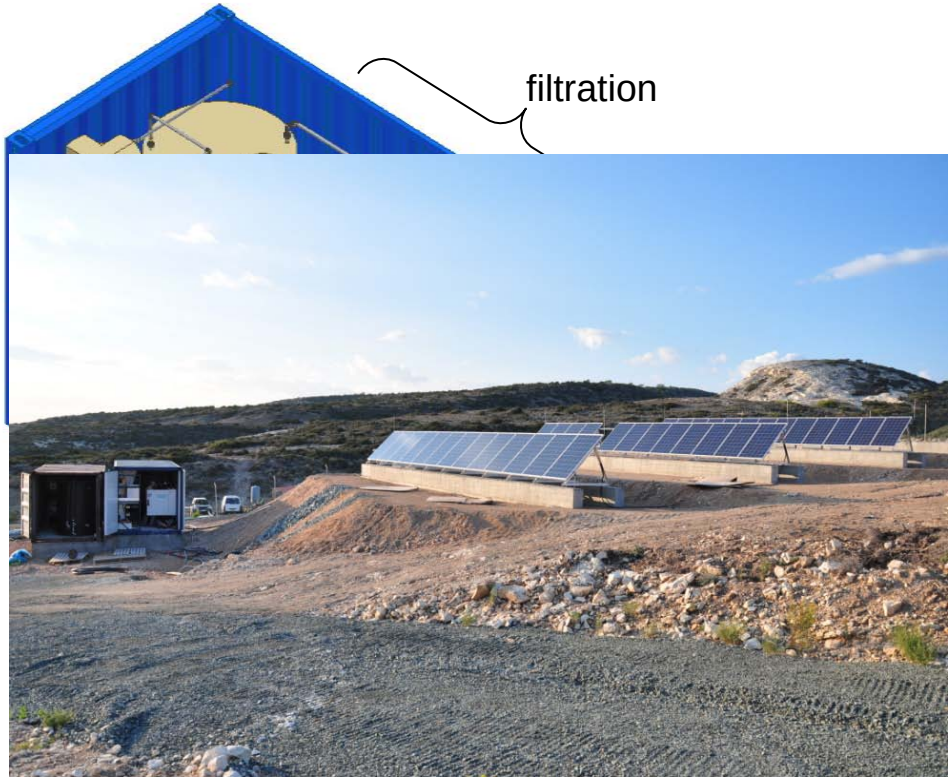
- Stand alone solar only supply is challenging since large scale energy storage is expensive
- Solar energy can be used efficiently as fuel saver
- 100% coverage by solar energy possible in average annual net balance in grid connected systems

Decentralized water supply

- Full coverage by solar energy in stand alone systems possible – further development for cost reduction
- Very remote regions can be reached
- CAPEX is high but levalized costs of water can be competitive

Examples of technological approaches

Solar PV driven RO plant designed by Fraunhofer ISE and tested in Cyprus



Examples of technological approaches

Solar thermally driven MD systems developed and tested by Fraunhofer ISE in different locations

Gran Canaria Spain

Solar collector : 180m²

Nominal capacity: 5 m³/day

Pantelleria Italy

Waste heat from power plant

Nominal capacity: 5m³/day

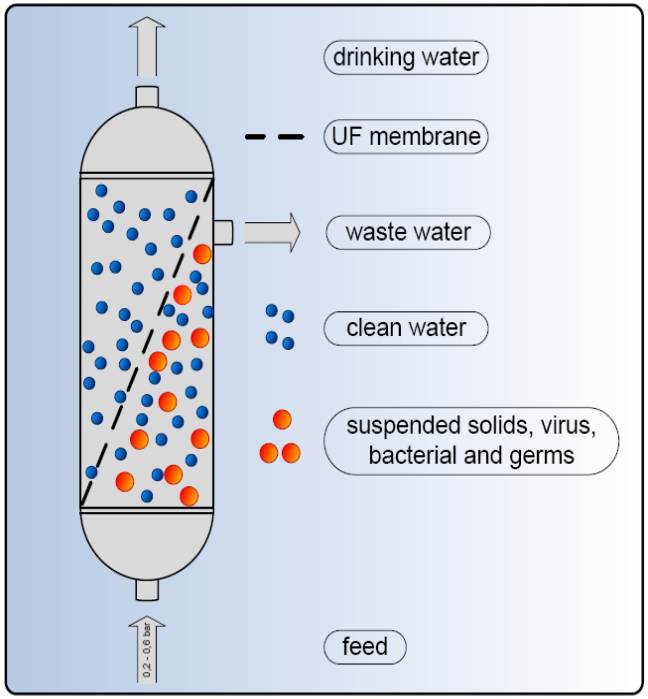
Amarika Namibia

Solar collector: 225m²

Nominal capacity: 5 m³/T

Examples of technological approaches

Solar PV driven stand alone ultra filtration (UF) system for purification of contaminated surface water



- Physical membrane filtration technology
- Retains 99,9999 % microorganisms, bacteria and viruses
- Low pressure driven extremely effective and very low energy consumption
- Used in municipal water treatment plants all over the world

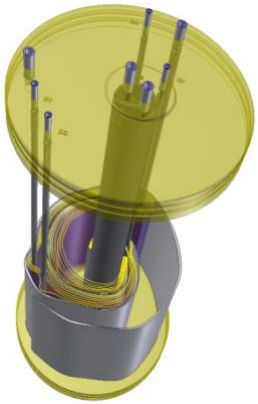
Examples of technological approaches

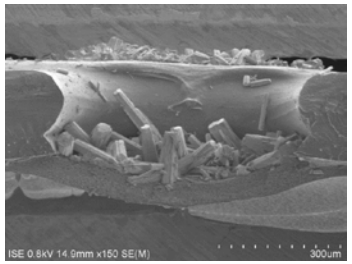
Solar PV driven stand alone ultra filtration (UF) system for purification of contaminated surface water

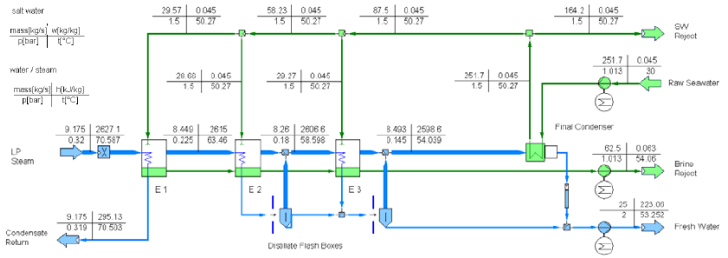
- Nominal capacity: 100 - 2.500l/h
- For mobile or stationary application
- High quality UF-membrane with automatic backflush system
- Solar generator: 1500Wp
- Battery capacity: 200Ah

Summary of our capabilities in water treatment

- Basic research on membrane performance and reliability
- Development of new membrane based desalination modules
- Development, installation and evaluation of lab to pilot scale desalination systems
- Design study and evaluation of CSP connected desalination systems
- Conduction of techno-economical studies for the evaluation of renewable driven desalination systems







Fraunhofer ISE

Fraunhofer ISE