



CIRCIE 2019

Challenges for the Islands in the era of the Circular Economy

Coupling Concentrated Solar Power (CSP) with Multiple Effect Distillation (MED) for Seawater Desalination

Under the auspices of



Dr. Aris Bonanos
The Cyprus Institute

SMile 2019

6th Sustainable Mobility & Intelligent Transport conference





- Global Water Stress

- Water Stress Index:

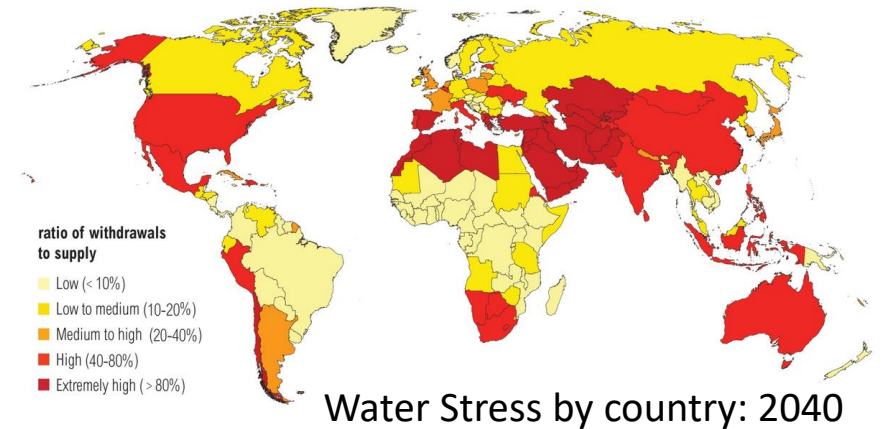
- Total water use vs. water availability
 - > 3 billion people experience water scarcity

- Precipitation predictions

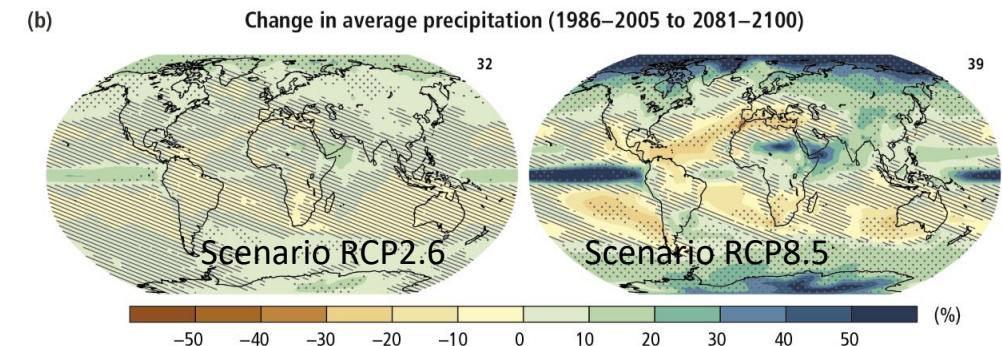
- Reduction in both winter and summer precipitation rates in near future

- Desalination

- 97.6% of Earth's water is in oceans/saltwater
 - A potential solution for water scarcity!



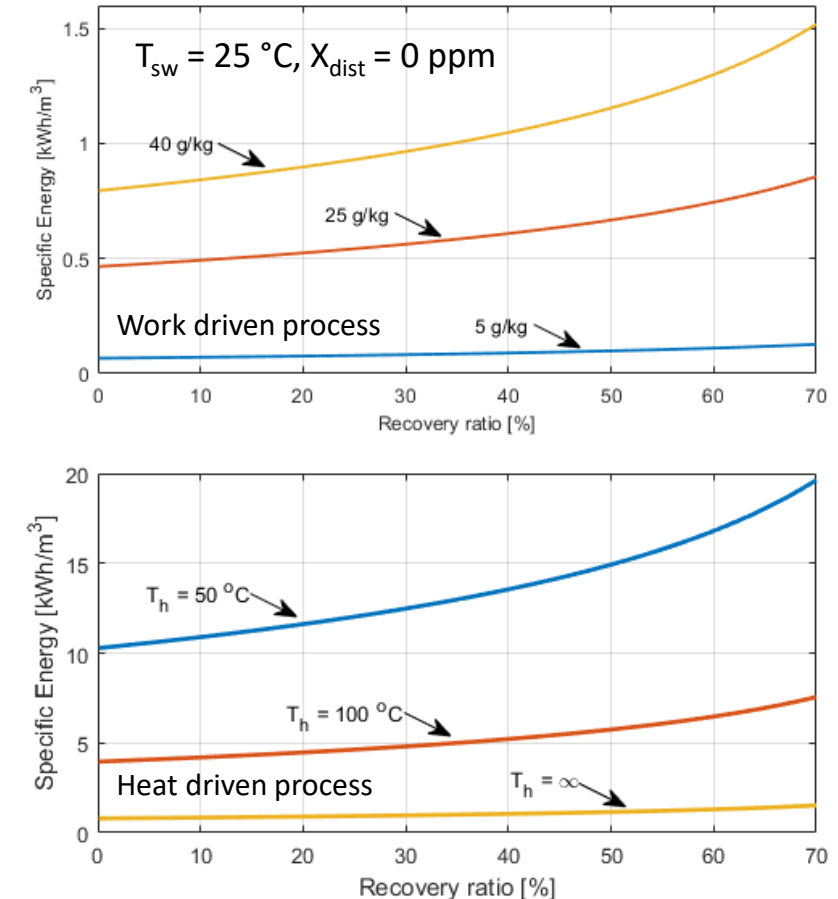
Water Stress by country: 2040





• Desalination

- Very energy intensive process
- Energy form impacts energy consumed by process
 - Energy depends on source salinity & recovery ratio
 - RO \rightarrow *electrical* energy \rightarrow 3-3.5 kWh/m³
 - MED \rightarrow *thermal* energy \rightarrow 20-30 kWh/m³
- Theoretical energy of separation
 - Much less than energy of actual process
 - Room for improvement!
- In Cyprus:
 - >1 % of GDP and 4% of energy goes towards desalination

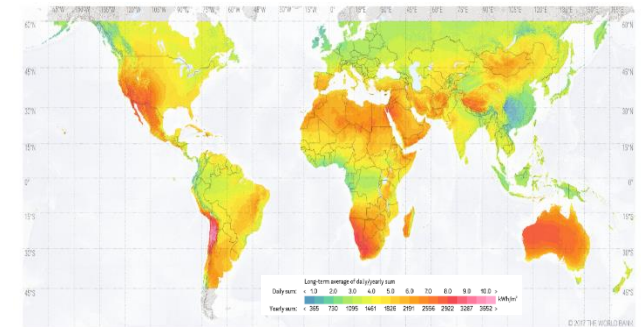
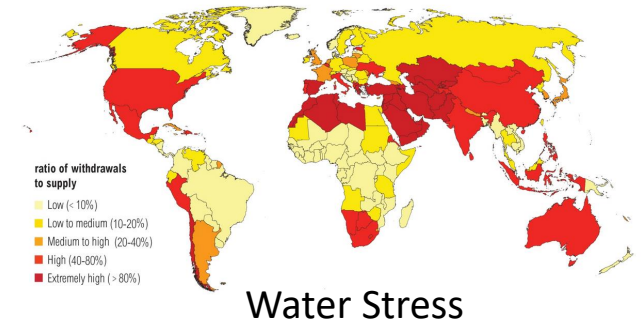
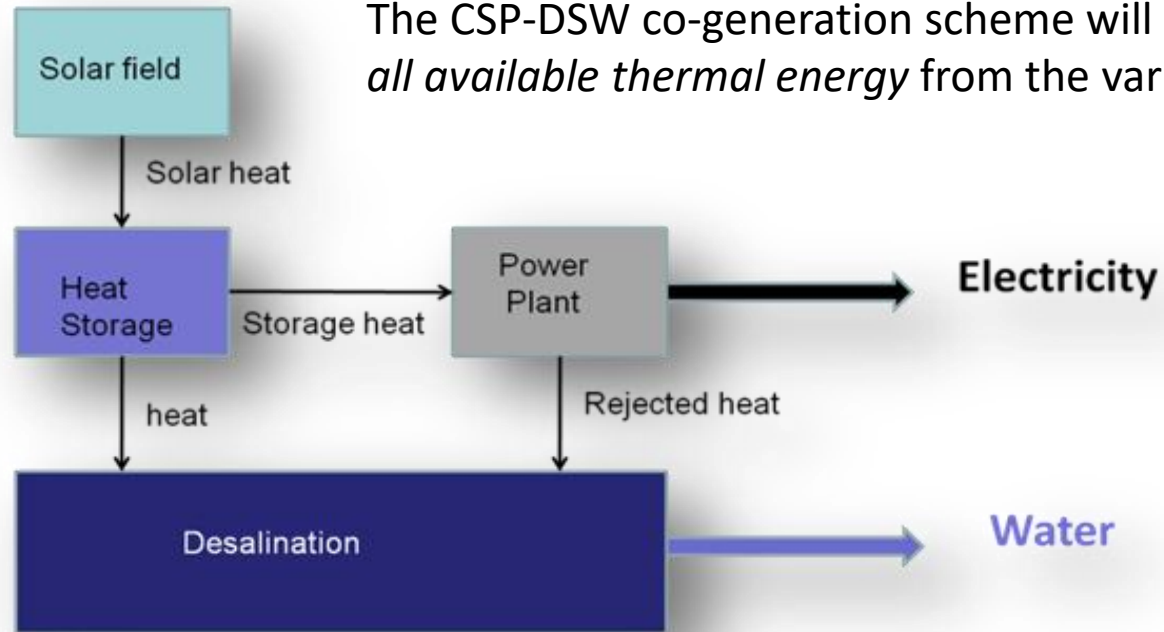




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The advantages of CSP-DSW are realized only when the power and desalination cycles are integrated thermally and optimized together.

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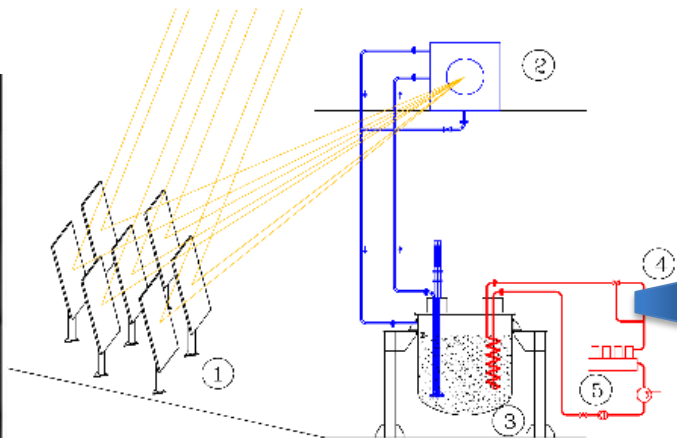




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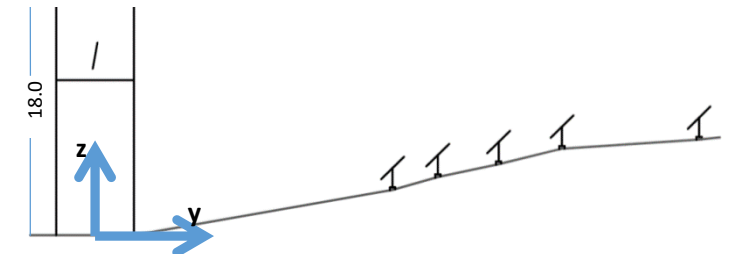
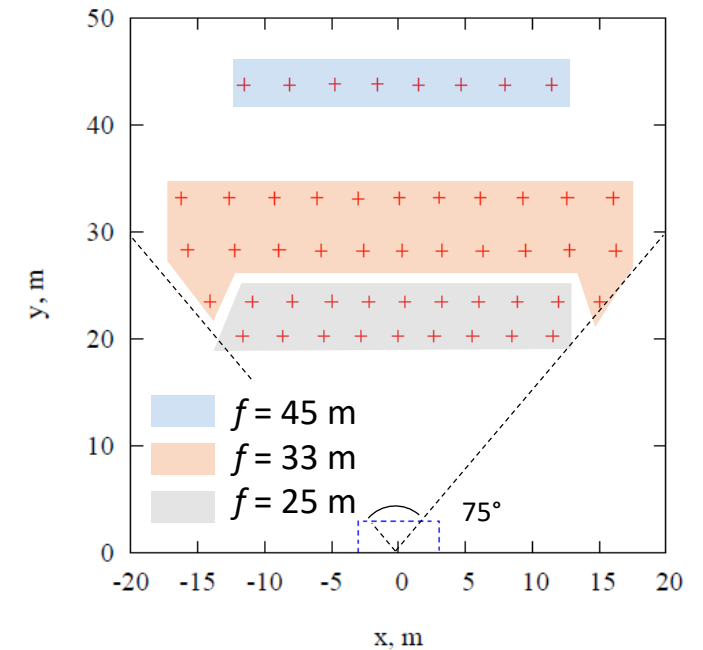
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- Heliostat field layout:

- Deployment on hilly terrain
- 50 heliostats
- 5 rows
- 3 focal lengths
 - 25, 33 and 45 m
- Field angle of 75-deg





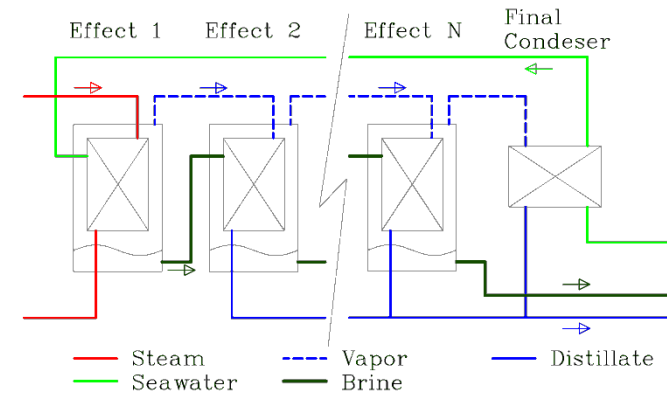
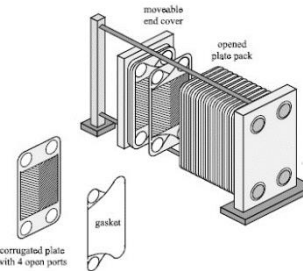
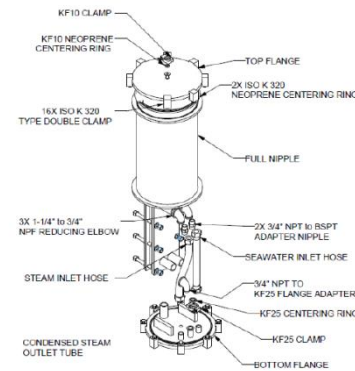
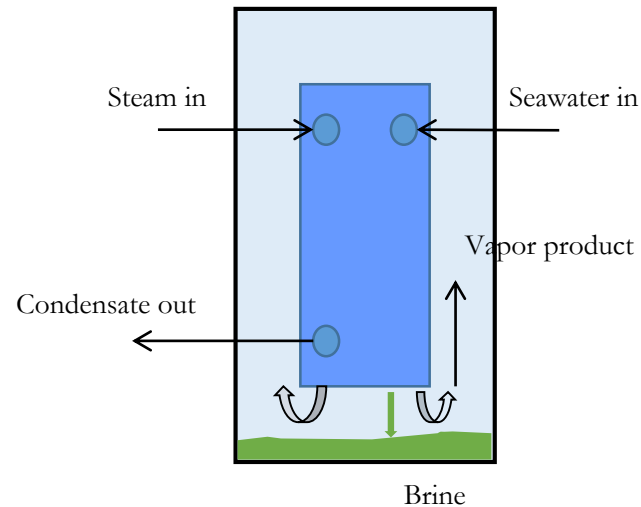
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- Multiple Effect Distillation (MED)
 - Utilization of waste heat from plant
 - Energy recycling to decrease specific energy requirements



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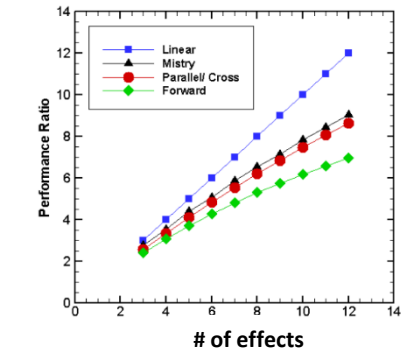
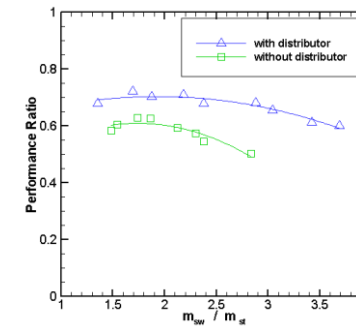
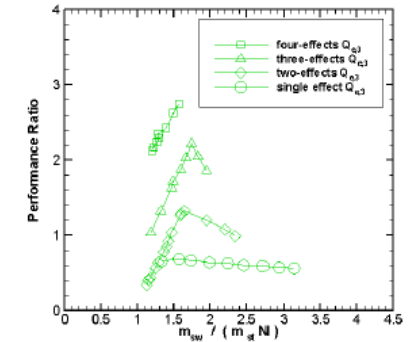
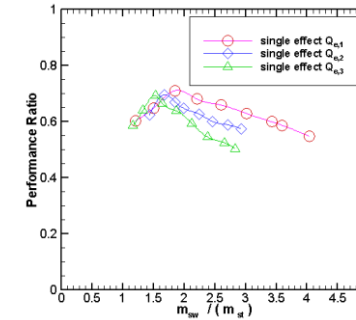
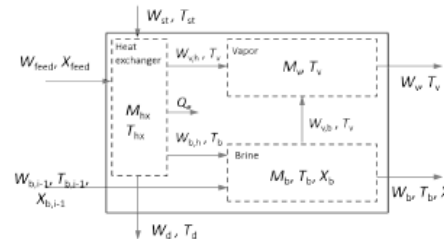


- Experimental characterization of a 4-effect unit

- Performance ratio (PR)
- $PR = \langle \text{mass of distillate} \rangle / \langle \text{mass of seawater} \rangle$
- Study influence of parameters on PR
 - Seawater temperature
 - Steam temperature
 - # of effects

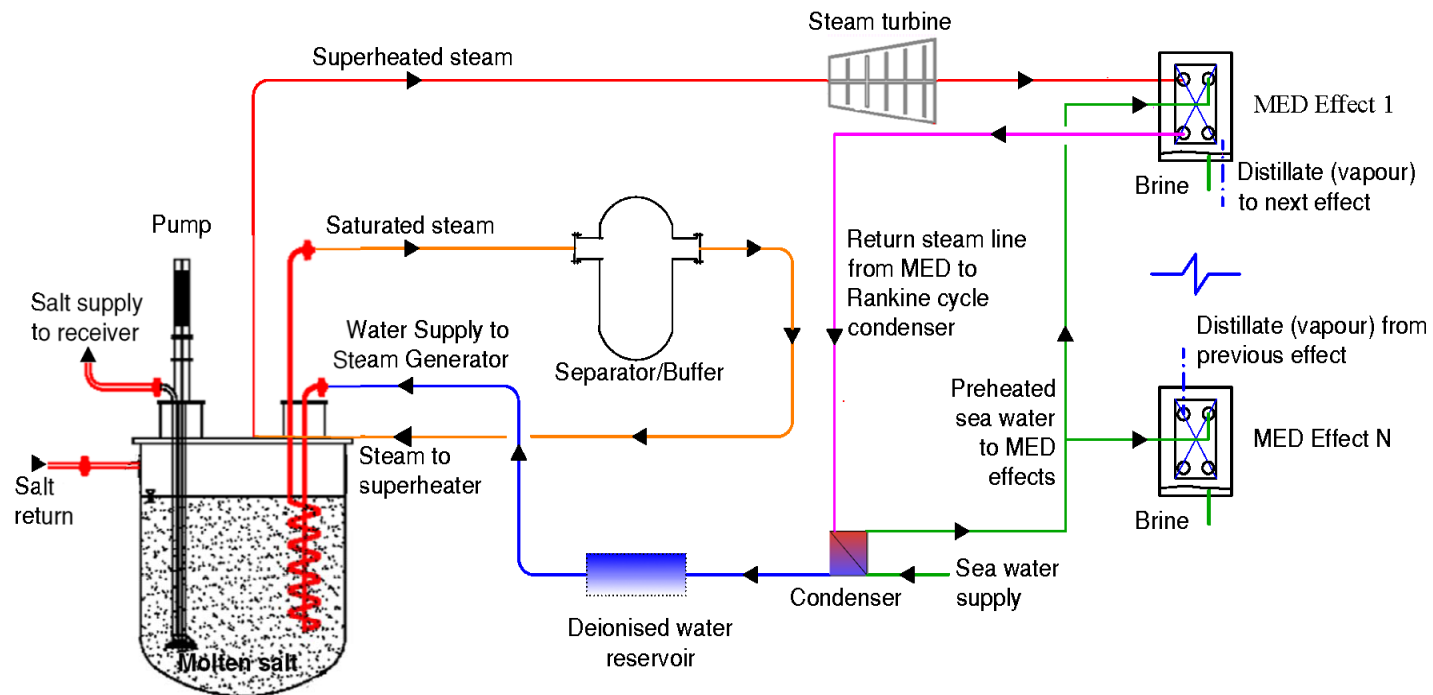
- Development of model

- Focus on predicting dynamic behavior of unit
- Flexibility in terms of
 - Feed water configuration
 - Feed-heater utilization
 - Heat transfer coefficient



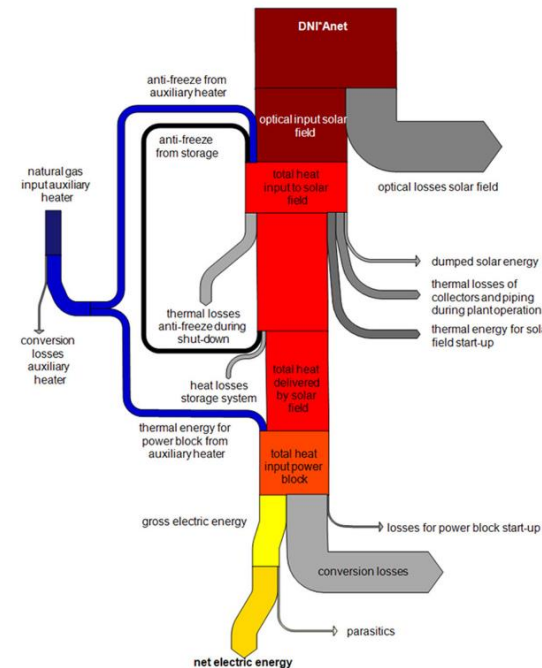
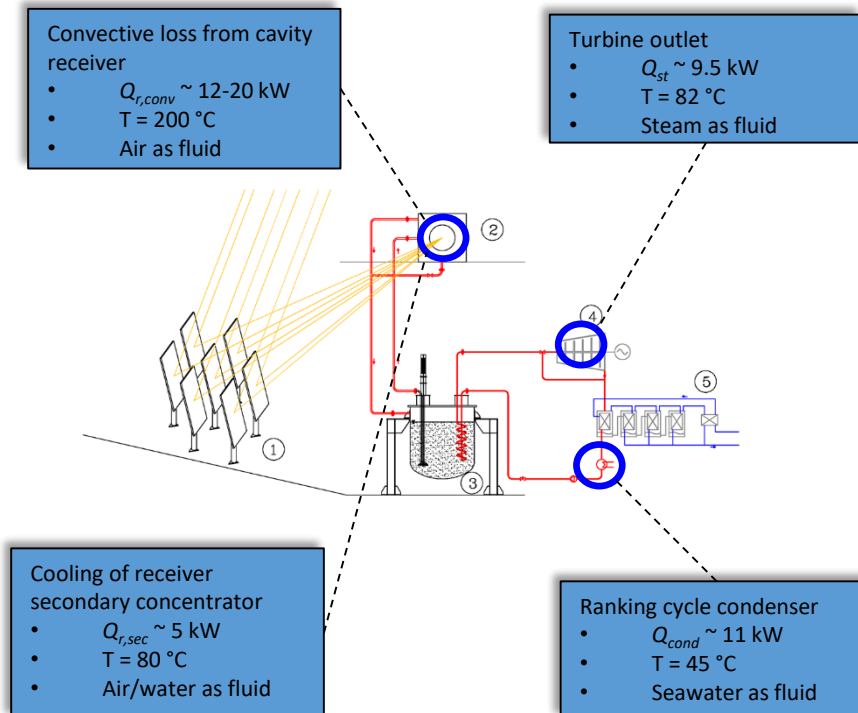


- Coupling MED with the CSP plant





- Heat flow in a CSP-Plant
- Identification of sources to drive MED



- Use other waste heat sources of the plant:
 - Thermal vapor compression to improve PR
 - Requires higher temperature source
 - Energy for zero-liquid discharge setup
 - Reduce environmental impact



Thank you for your attention



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Thursday 28 - Friday 29 March 2019, Nicosia, Cyprus

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