The CellFlux concept for increased flexibility in sensible heat storage

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Aims of the development of the CellFlux concept:

New concept for sensible heat storage at medium and high temperatures

- Significant potential for cost reduction
- Flexibility:
  - in temperature range
  - in working fluid
  - in power / capacity
  - in space requirements
  - in storage materials

Choice of basic storage concept

solid storage material (locally available)

+

air at ambient pressure
as heat transfer medium

- cost effective (< 50 €/ton)
- flexible in working temperature (0 - 800 °C)
- no corrosion, no freezing, no leakage, no environmental risk

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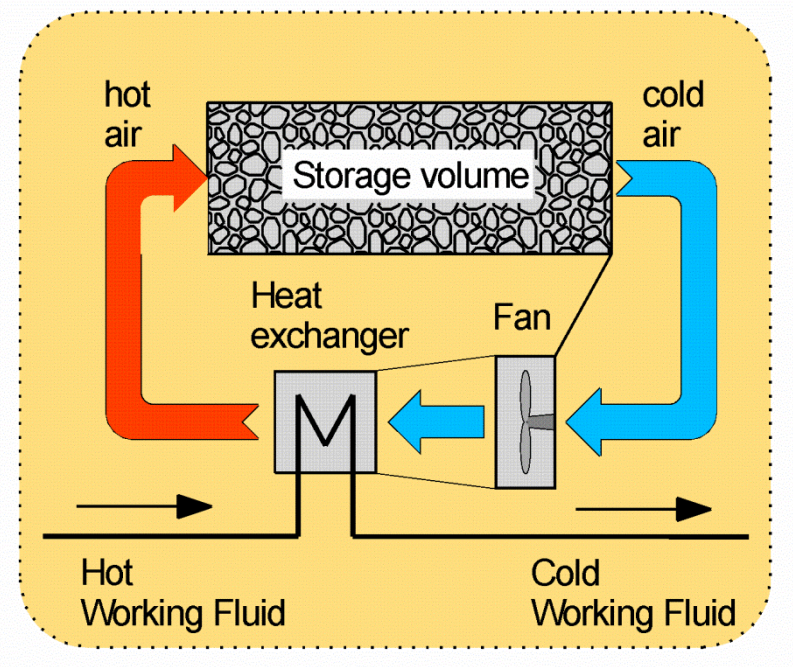
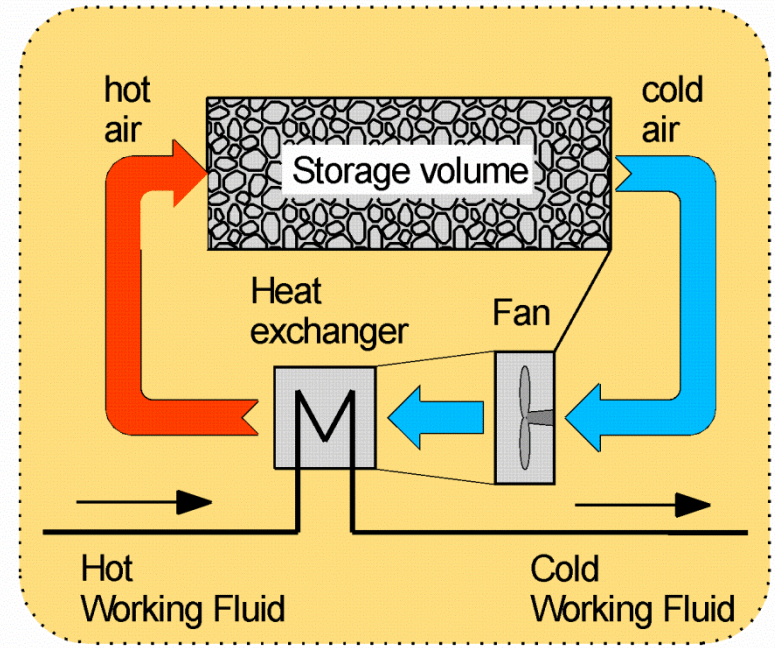
Indirect storage concept



- Flexibility in choice of primary working fluid

Indirect storage concept



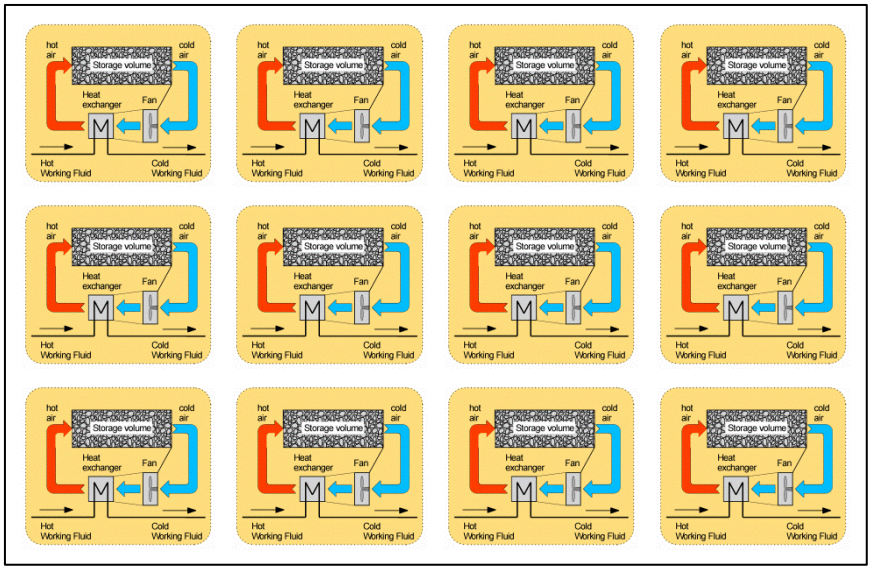
Problem:
Low power density of hot air

Example: 150 $MW_{thermal}$
t_{Hot} = 390 °C, t_{Cold} = 290 °C

required air mass flow: 1410 kg/s
required air volume flow: 2750 m^3/s

air velocity in a tube with 10 m diameter:
126 km/h

The CellFlux concept:
Many storage cells in parallel



- scalable
- path length of air flow minimized
- flexibility in geometry of storage volume

Main questions:
- costs
- efficiency

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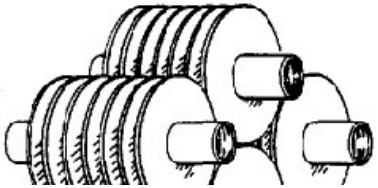
Application of Standard Components

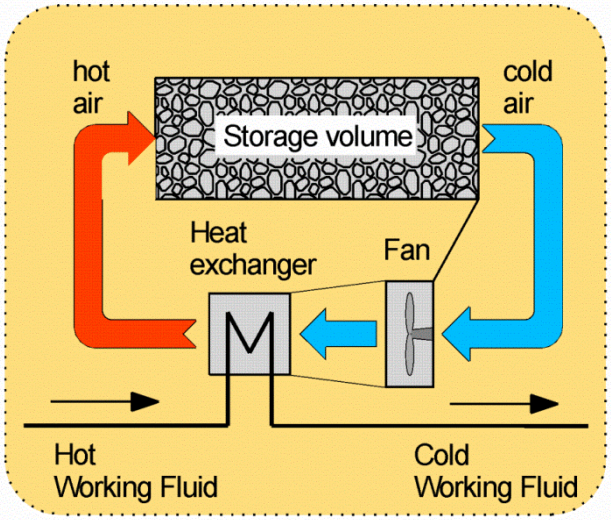
Bricks

Concrete

Stones

Finned tubes
heat exchanger





Vane axial fan

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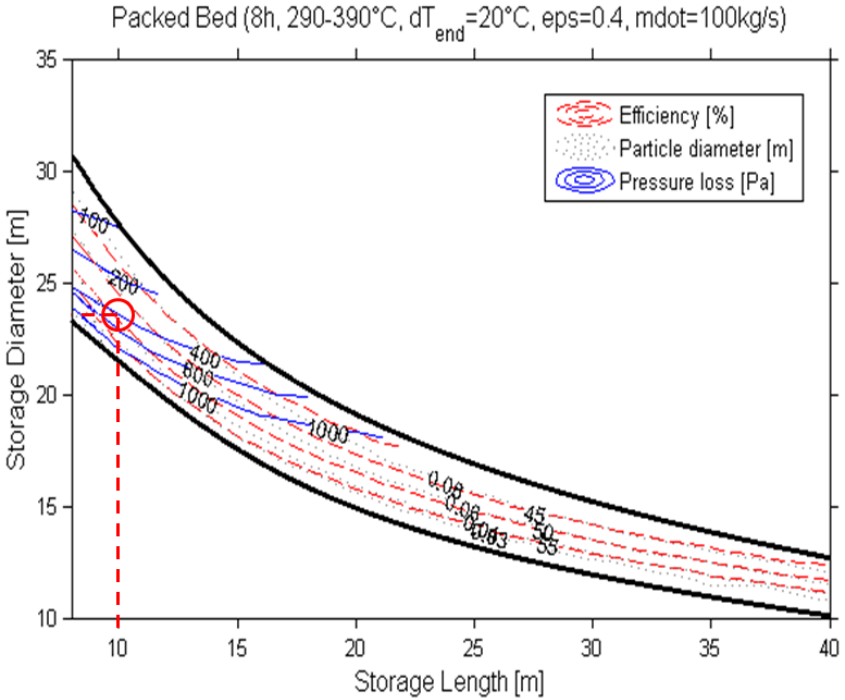
Analysis Storage volume



Generation of charts describing dependence of

- pressure loss
- storage efficiency

on

- particle diameter
- geometry of storage unit

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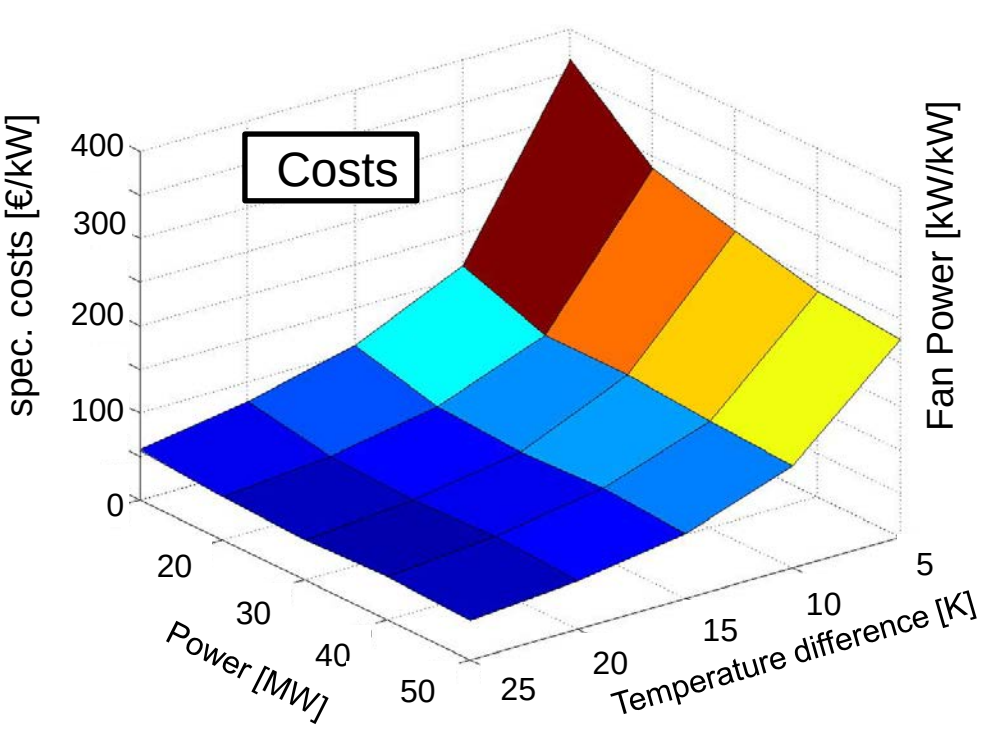
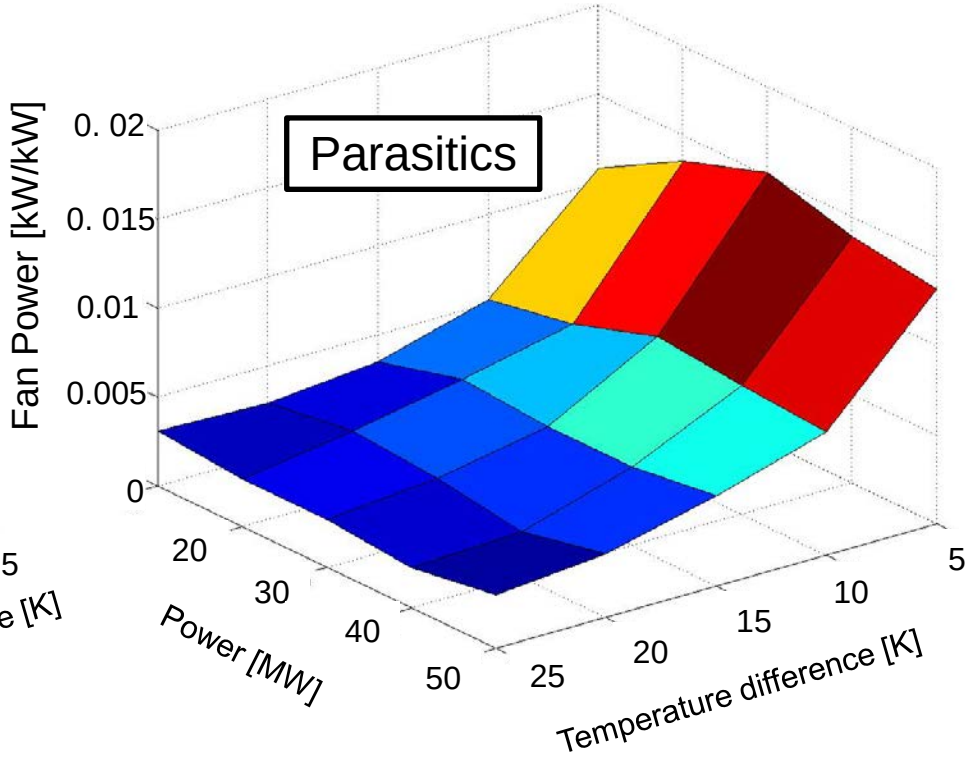
Analysis Heat Exchanger





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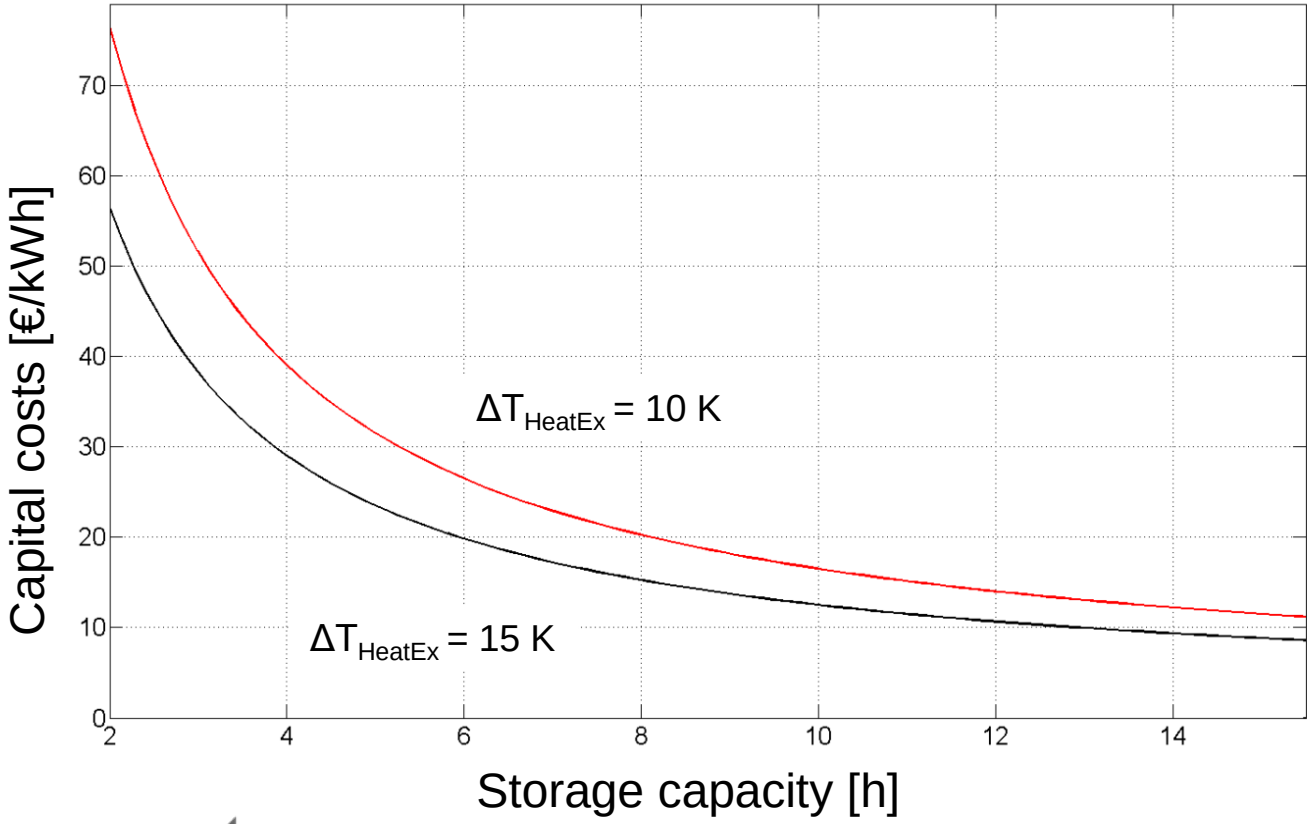
Estimation capital costs CellFlux storage system



50 MW_{el}
ΔT_{Cyclic} = 100 K
heat exchanger,
storage material, fans

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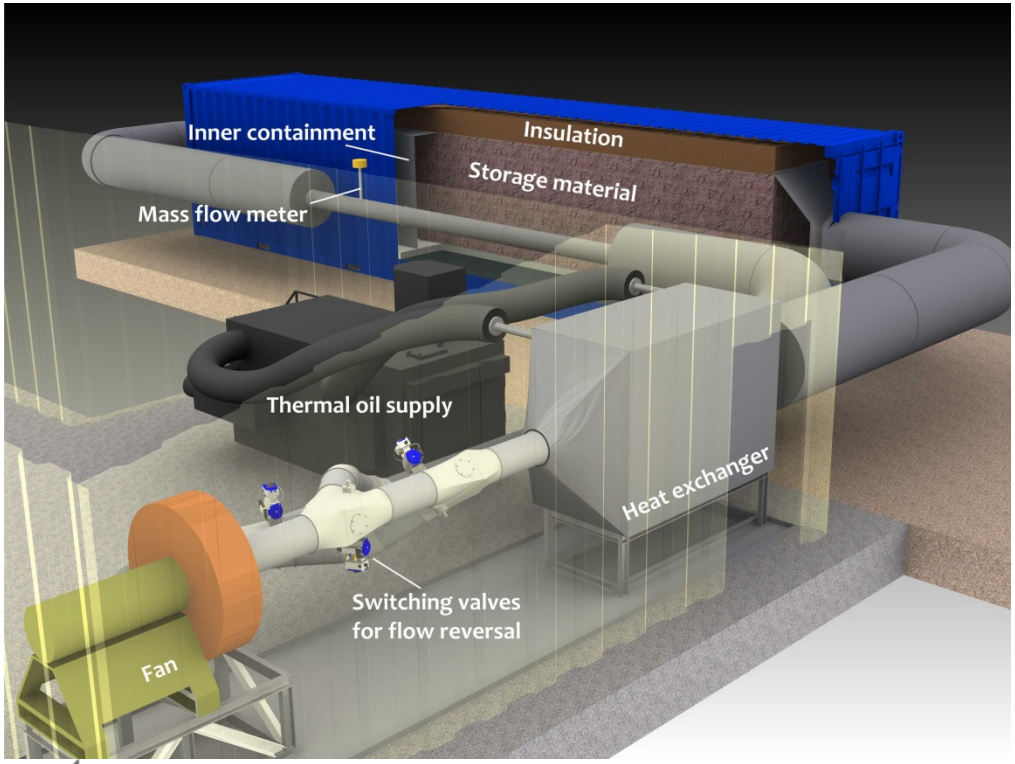
Proof of concept

Pilot scale test facility



- 30 m³ storage volume
- t_{max} 400 ° C
- p_{max}(therm.) 100 kW

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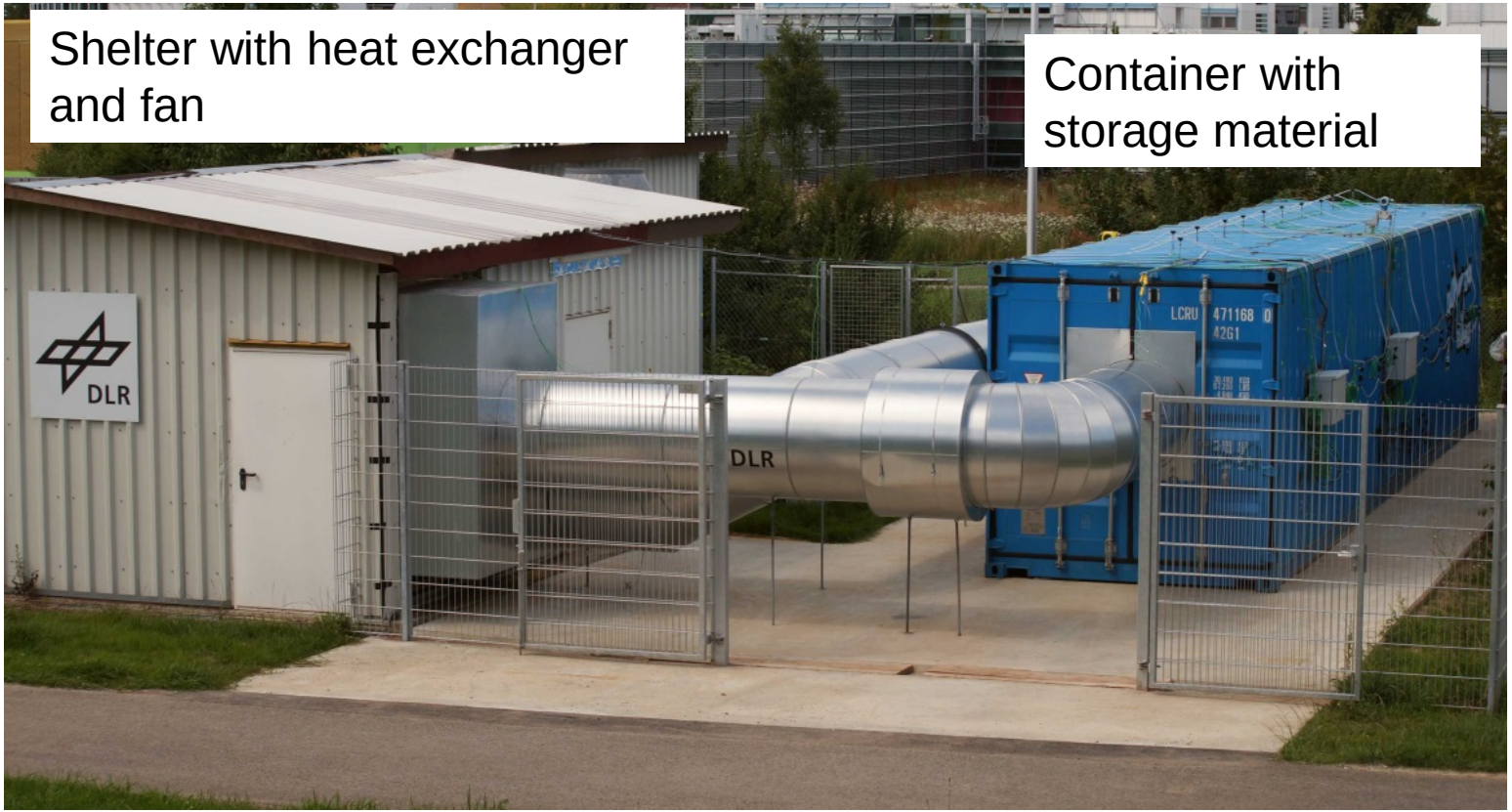
Proof of concept-Pilot scale test facility



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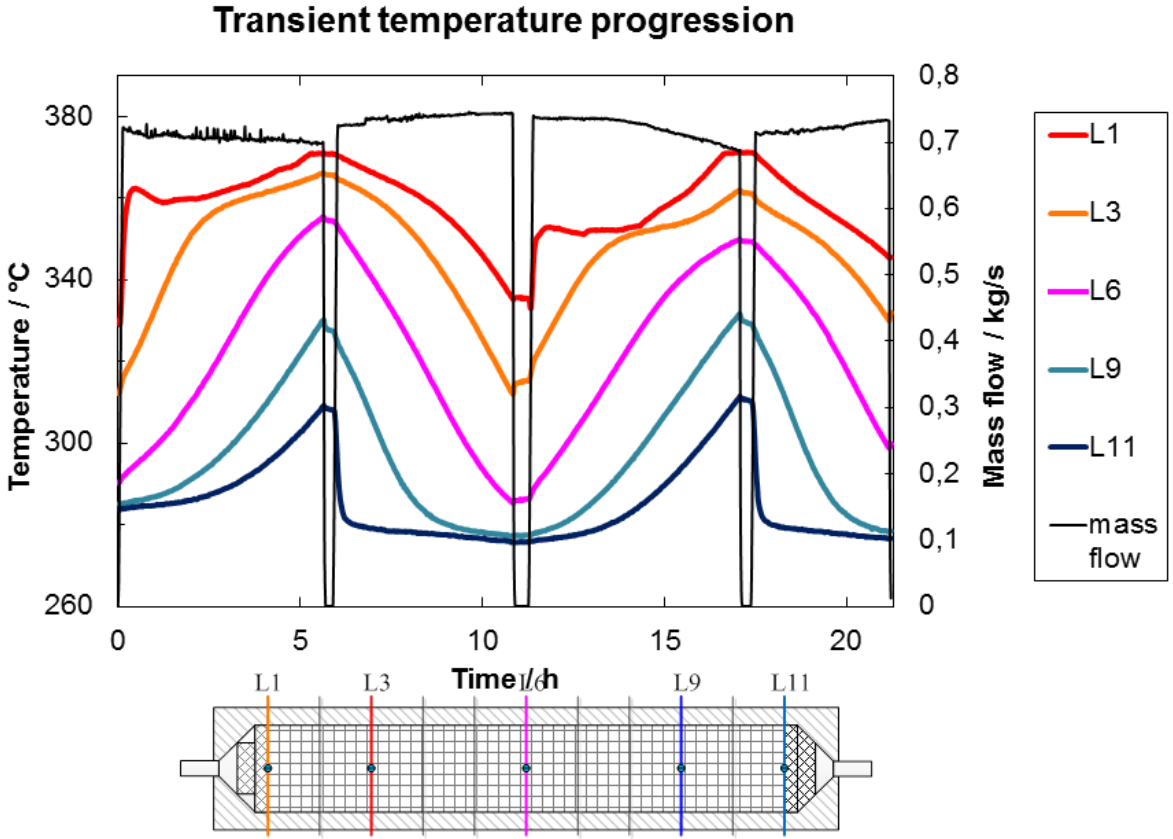
Experimental results



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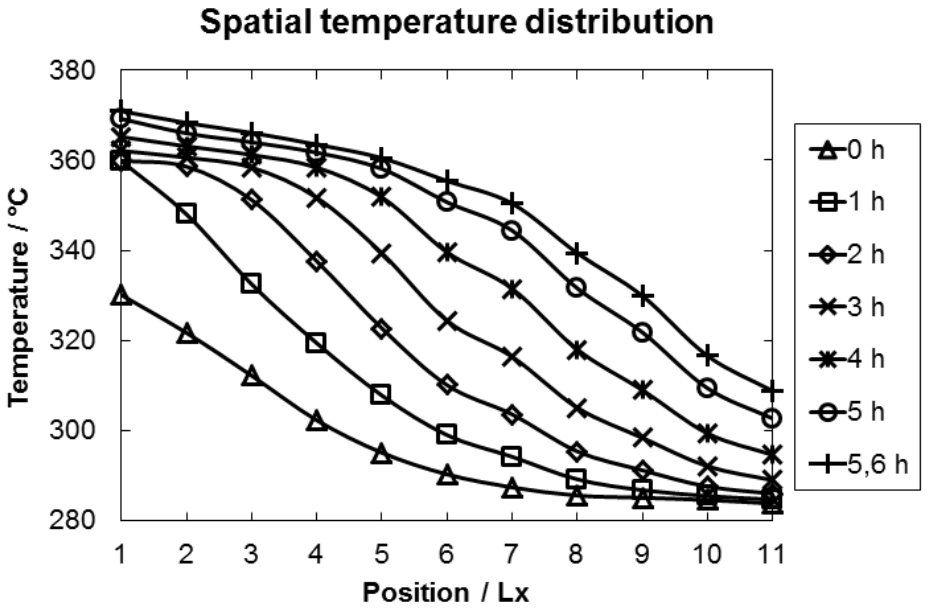
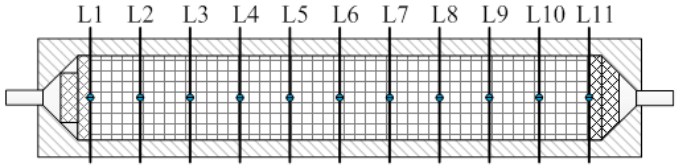
Experimental results





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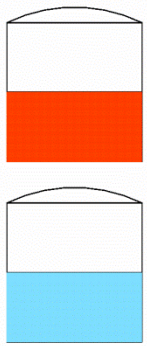
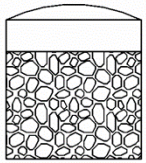
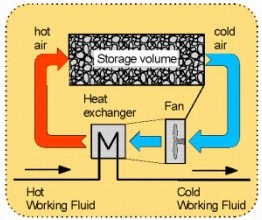
CellFlux + Alternative HTFs

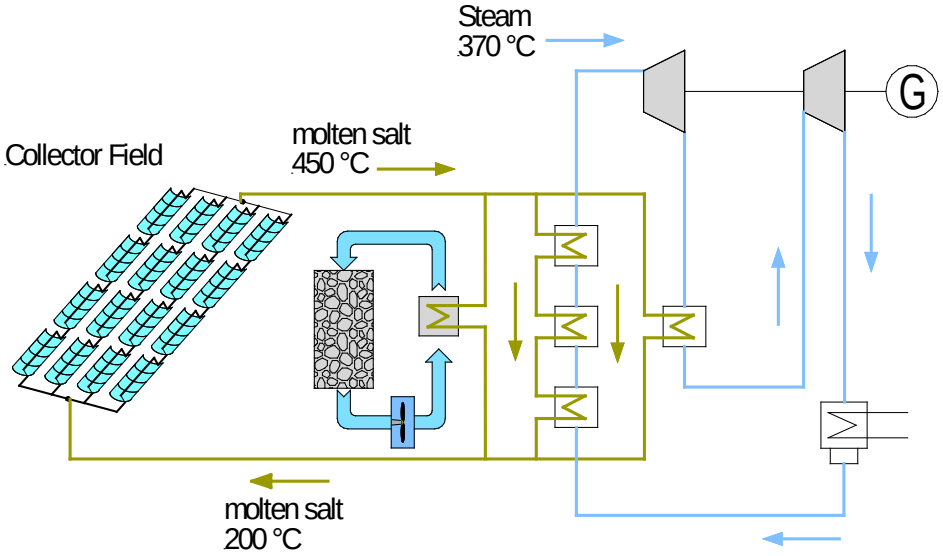
relative mass of HTF in storage system:

100 %	25 %	< 1 %
2-Tank	Thermocline	CellFlux









CellFlux can be used for HTFs which are too expensive for direct storage (e.g. Hitec HTS)

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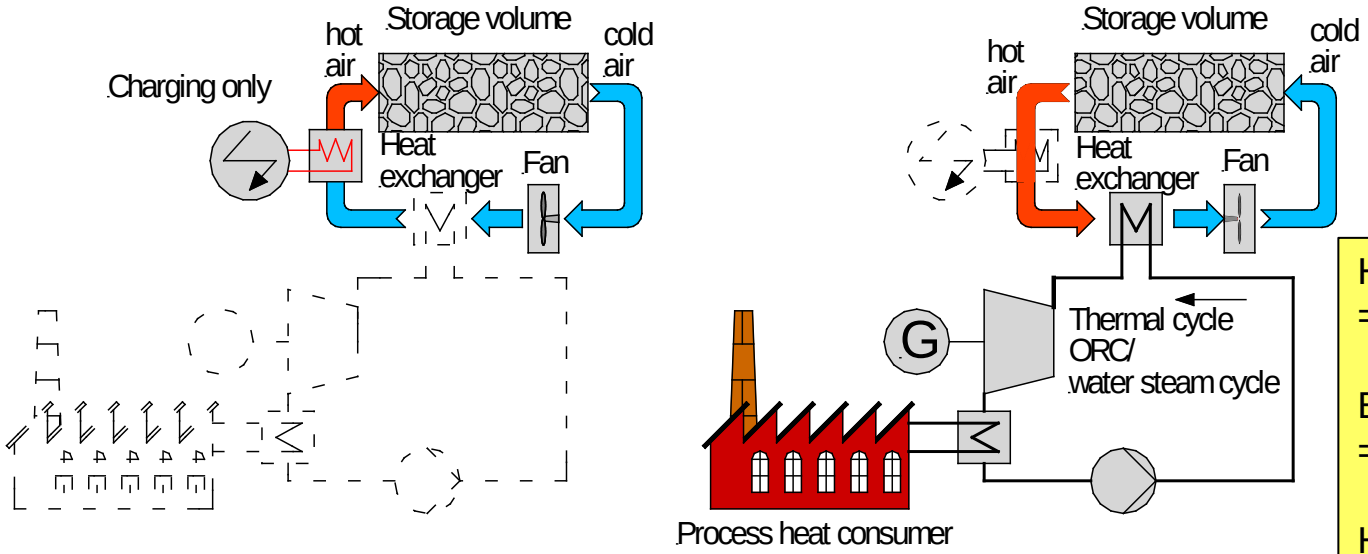
Power to Heat to Combined Heat and Power

Electrical CHP using CellFlux storage

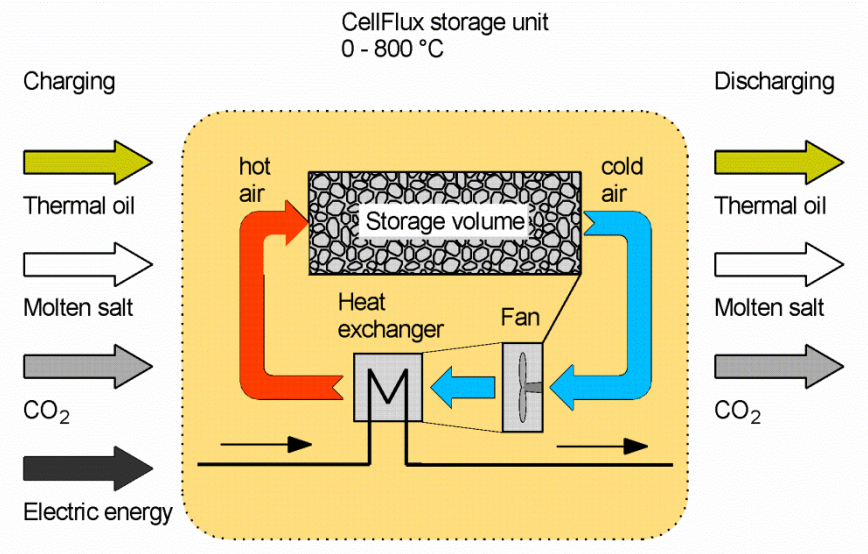


High temperature
=> High storage density

Emission-free/non-hazardous
=> Close to heat consumer

Heat from storage used to keep thermal cycle in stand-by
=> Short response time

Conclusions and Outlook



-The CellFlux concept offers a high flexibility in
- working fluid
- temperature range (0-800 ° C)
- storage material
- space requirements

- Scalable
- Feasibility has been proven in pilot scale
- Promising option for electrical CHP