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SolarSplit – Latent Heat Storage in VRF Systems

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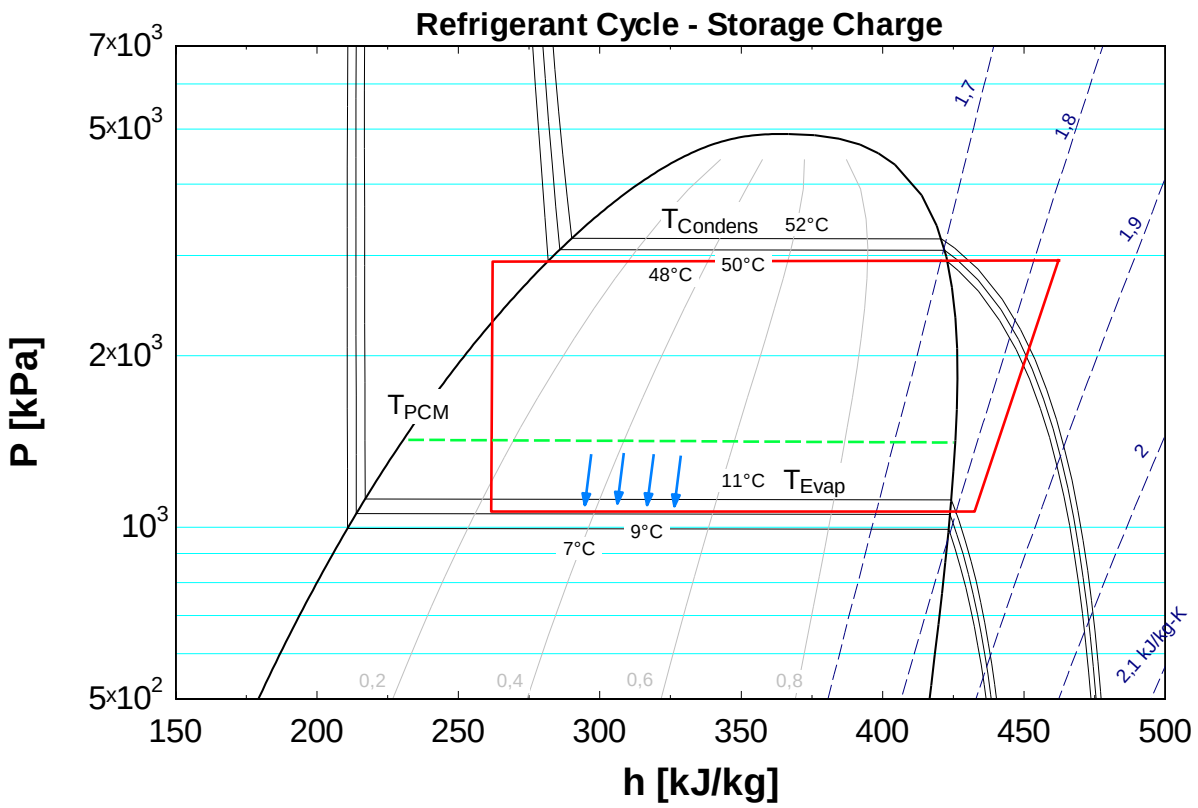
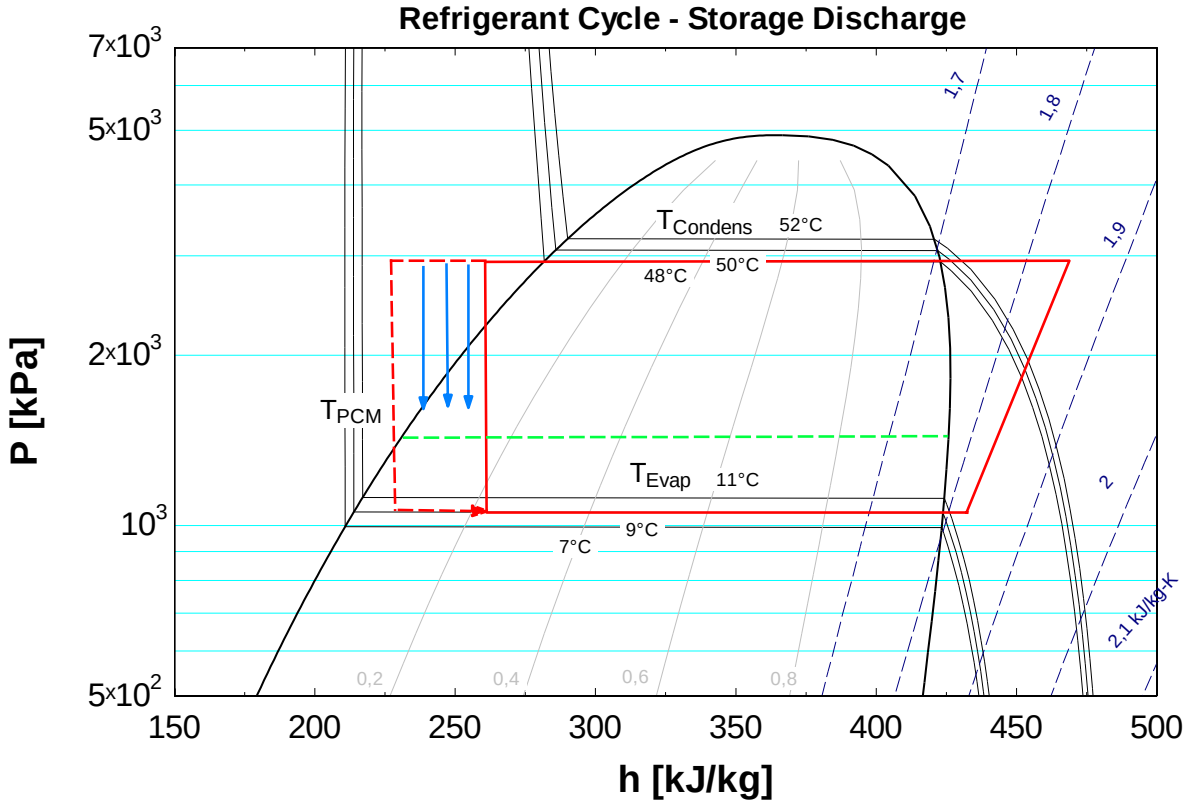
Outline

1. System Approach | PCM Storage in VRF-Systems
2. PCM-Storage | Design and Measurement results of experimental storages
3. Pilotinstallation | Current status VRF, PV and Monitoring
4. Outlook

1. System Approach
PCM Storage as Subcooler in VRF-Systems

Relatively fixed levels of Evaporation and Condensation in VRF-Systems.
Storage Charging on common evaporation level using PV-surplus.
Storage Discharge by Subcooling of Refrigerant – Lowering of VRF peak demand.





1. System Approach
PCM Storage as Subcooler in VRF-Systems

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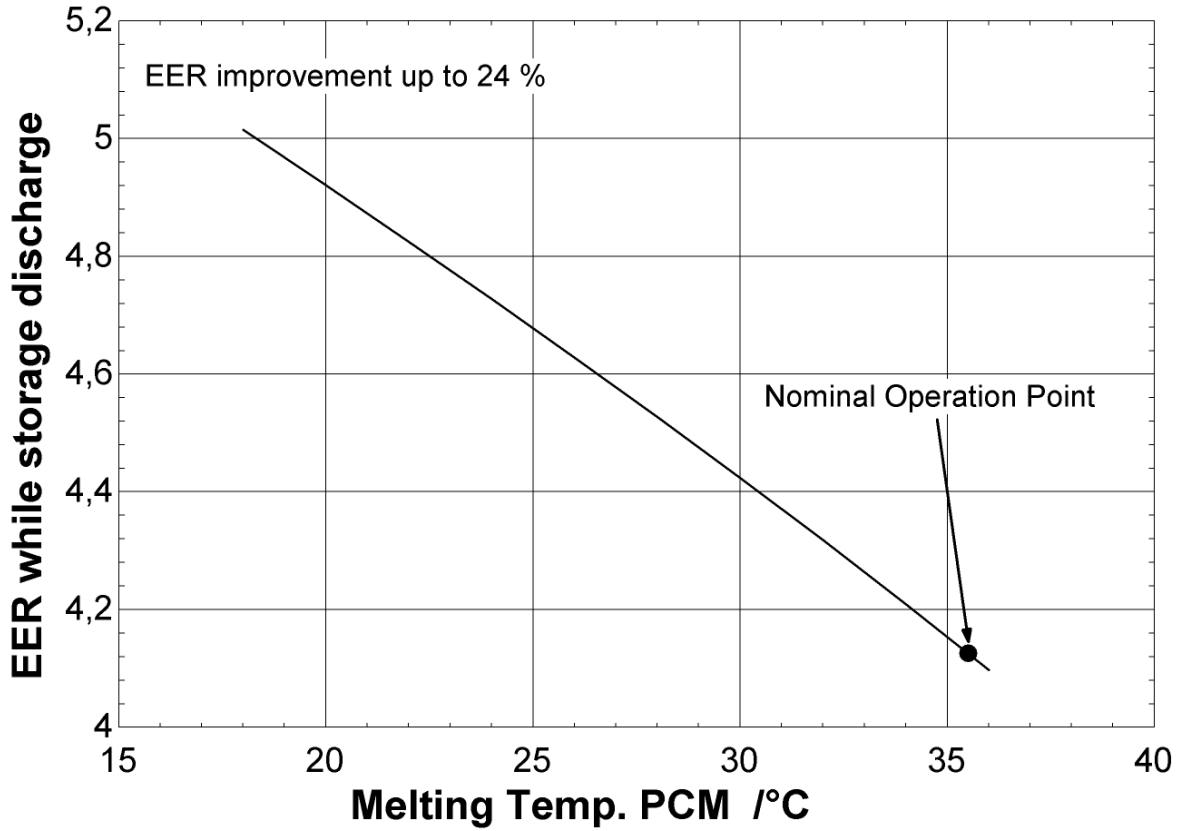
EER benefit of lower subcooling in case of discharge



1. System Approach
Main design parameters

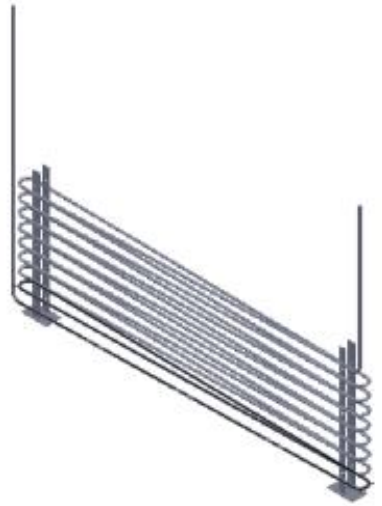
After finalized Systemsimulation: Building up of VRF-system with PCM storage at the ZAE institutes building.

VRF/PV Installation

- Nominal thermal load 21 kW Cooling / 24 kW Heating
- Supply of 7 offices, 3 laboratories and plant room.
- PV-installation with 5.4 / 6 / 6.6 kWpeak

Pilotinstallation Storage

- Melting temperature ca. 18 °C → RT18HC / Parafol 16-97 + Graphit (17 weight-%)
- Energy content: 17 to 20 kWh
- Power range: 6 to 8 kW
- 30 % of cooling demand via subcooling in case of discharge
- 6 parallel pipelines à 26 m

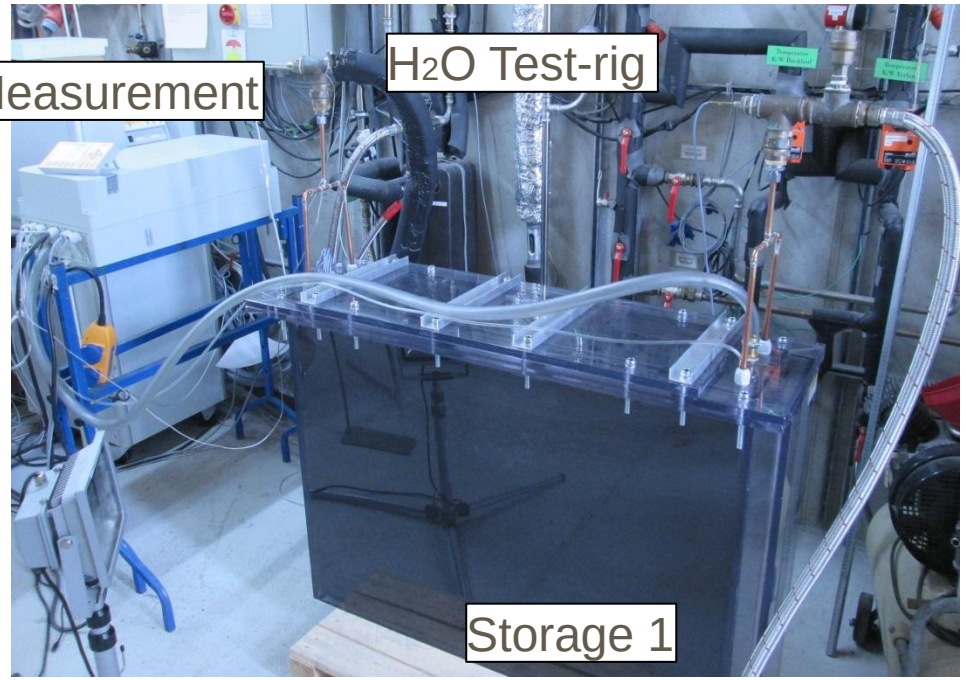


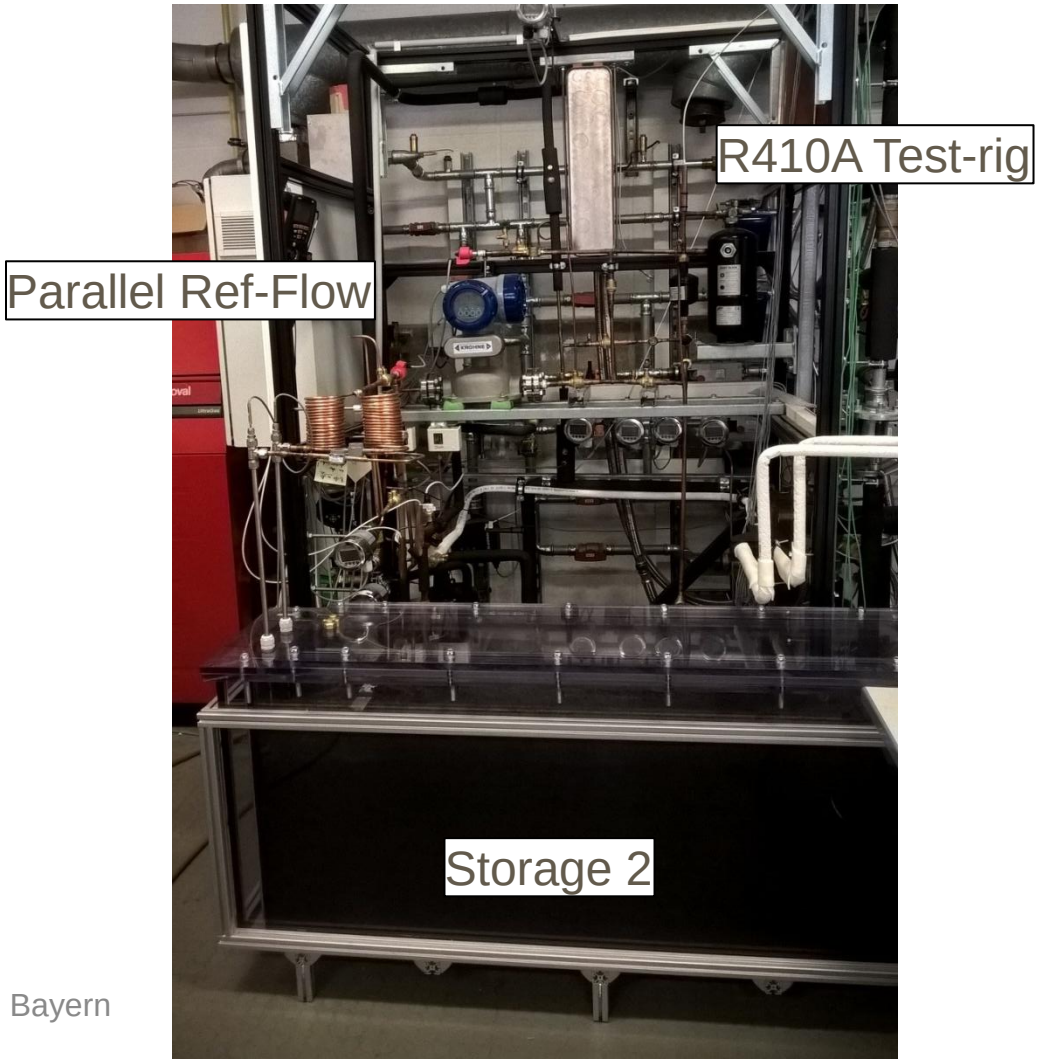
Experimental Storages

- 1/3-Scale, 132 l /106 kg charge. 2 parallel pipelines
- First functional model for sensible measurement at ZAE test-rig
- Second functional model for R410A-test rig at Universtiy of Applied Sciences Munich

2. PCM-Storage
Building and Measuring of experimental storage

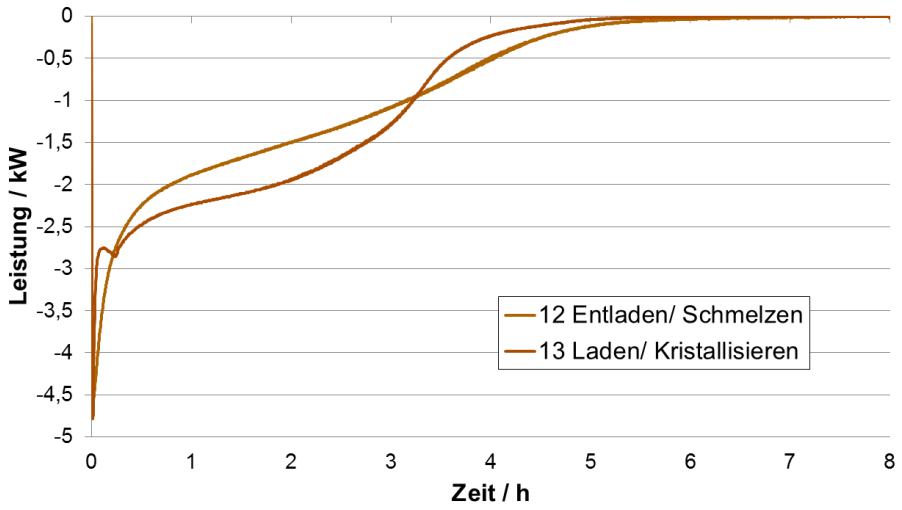
Storage 1: Test-rig ZAE Bayern -> Capacity, Cycling, State of Charge
Storage 2: Test-rig HM Munich -> Power-characteristics, Presure-drop, Refrigerant Distribution, Subcooling

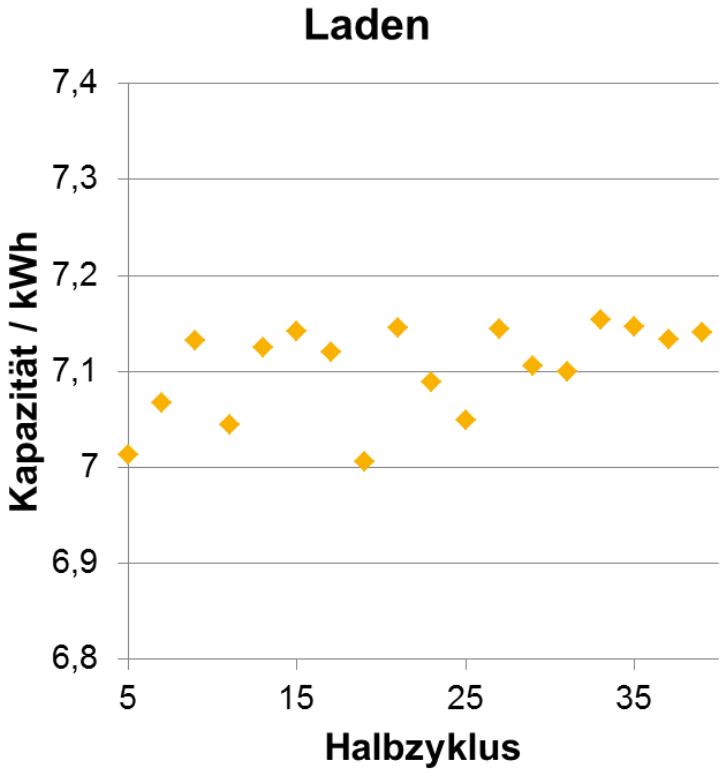


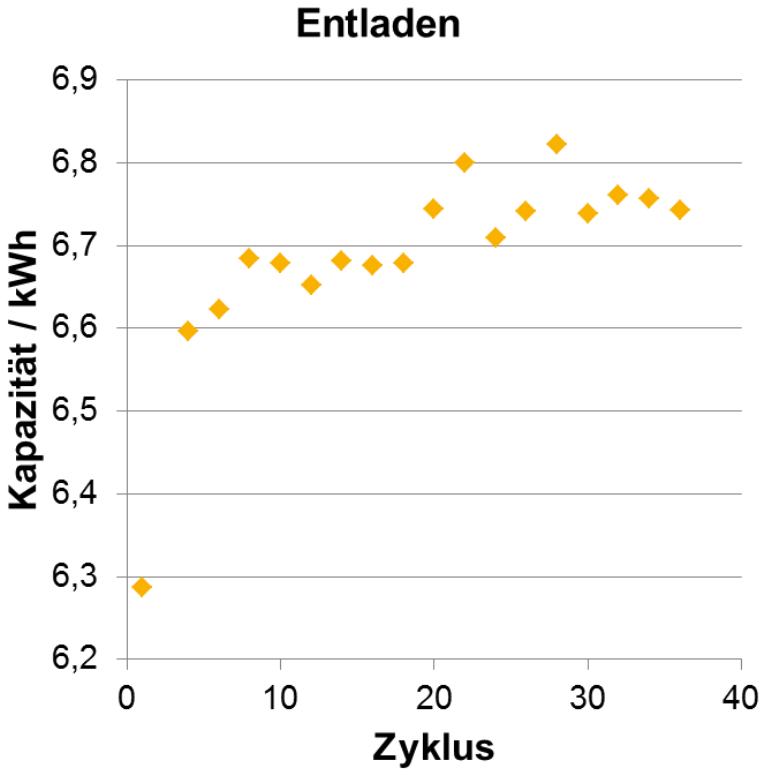


2. PCM-Storage
Key Results experimental storage 1 (ZAE Bayern)

Reference Cycle: 4 l/min Water, Feed line 8 °C / 28 °C

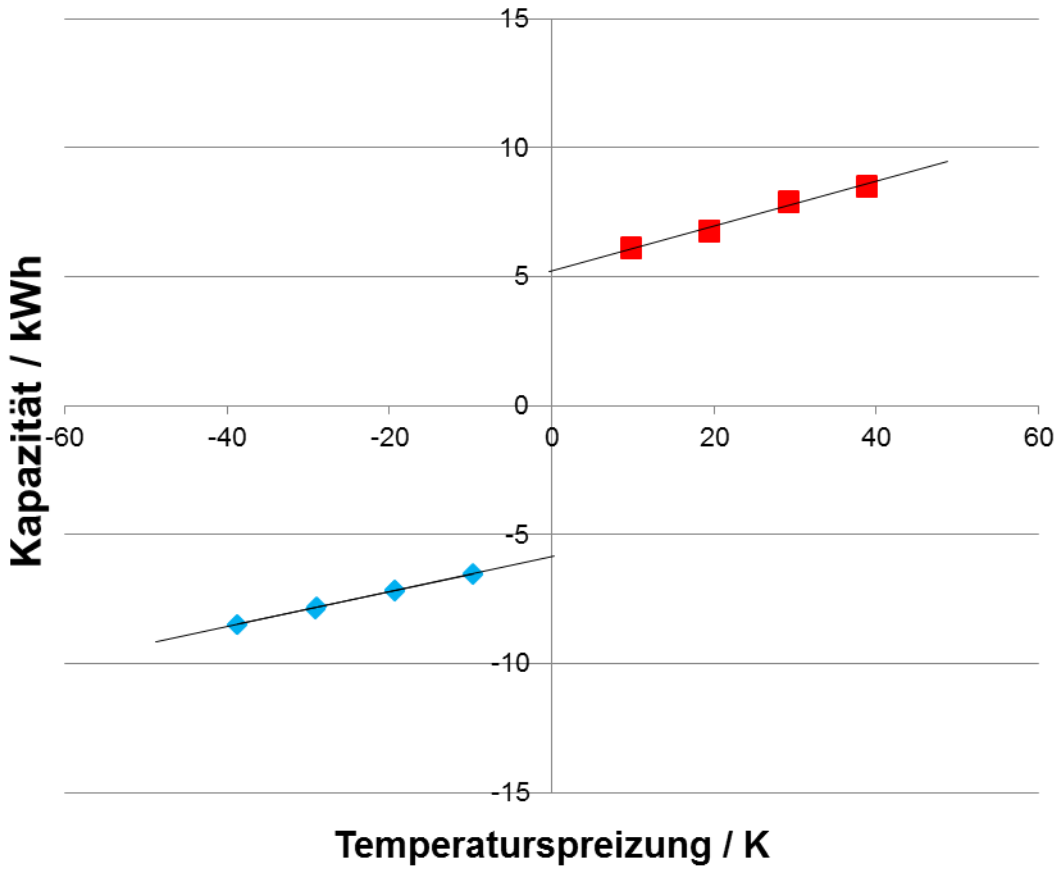






2. PCM-Storage
Key Results experimental storage 1 (ZAE Bayern)

Temperature Variation: Identifiing latent and sensible capacity content



- 5,3 / 5,9 kWh latent
- 0,07 / 0,09 kWh/K sensibel

2. PCM-Storage
Key Results experimental storage 2 (Un. of applied Sciences Munich)

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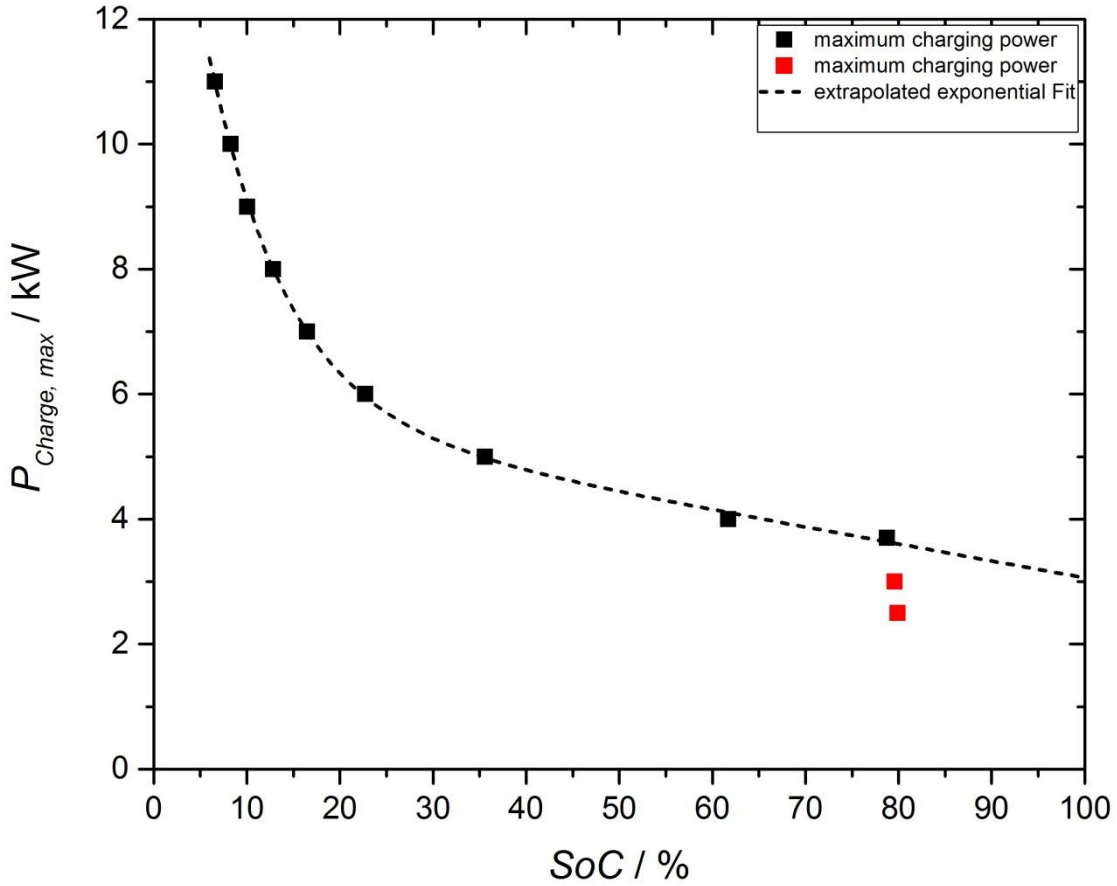
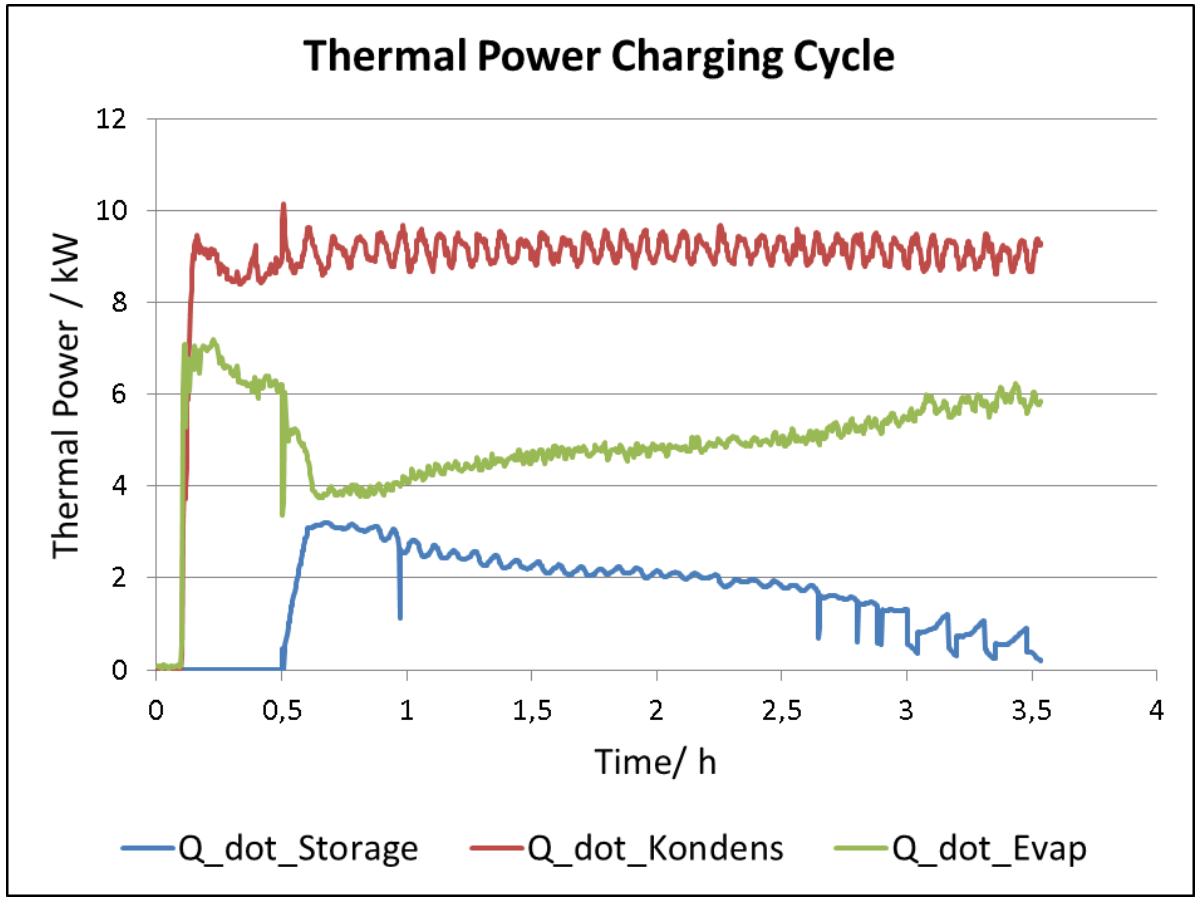
Storage charging through Evaporation





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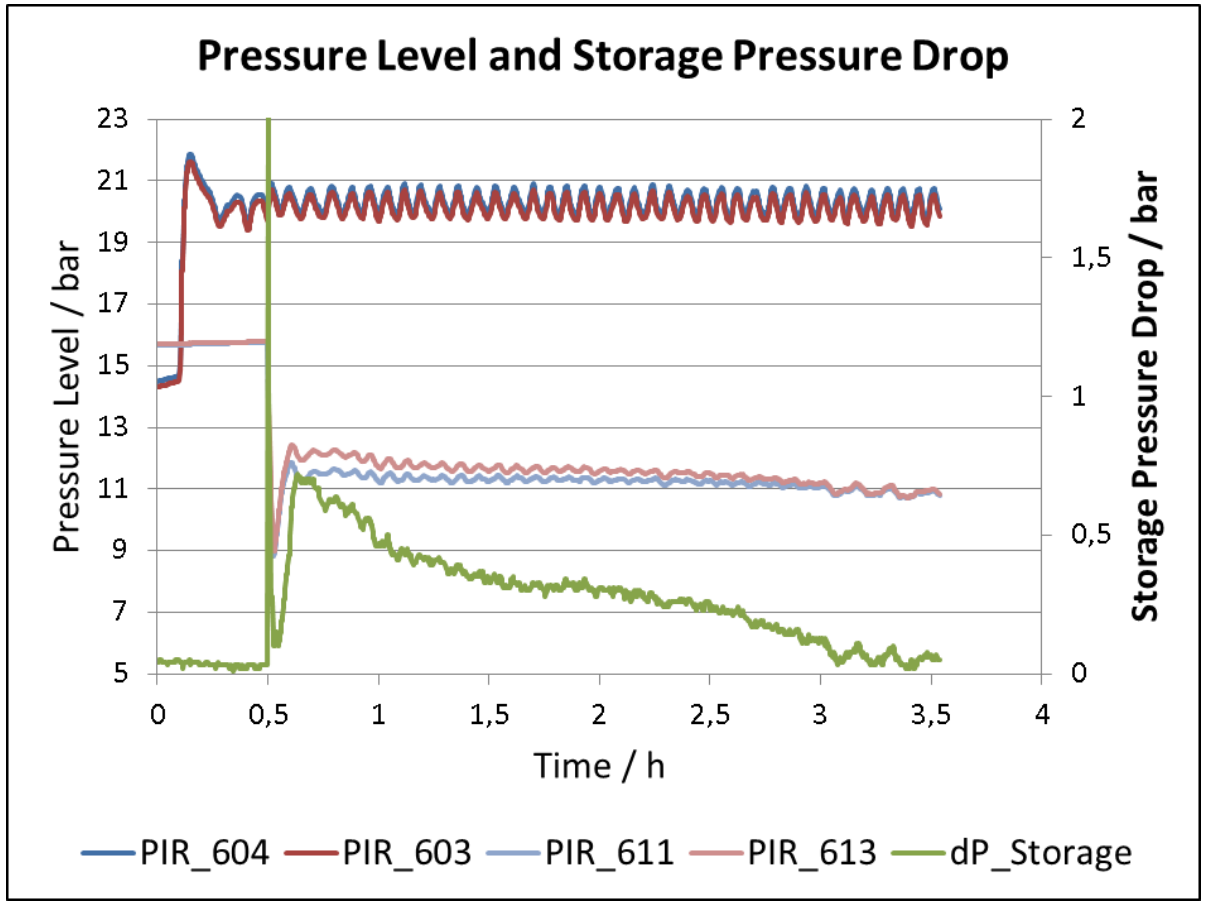

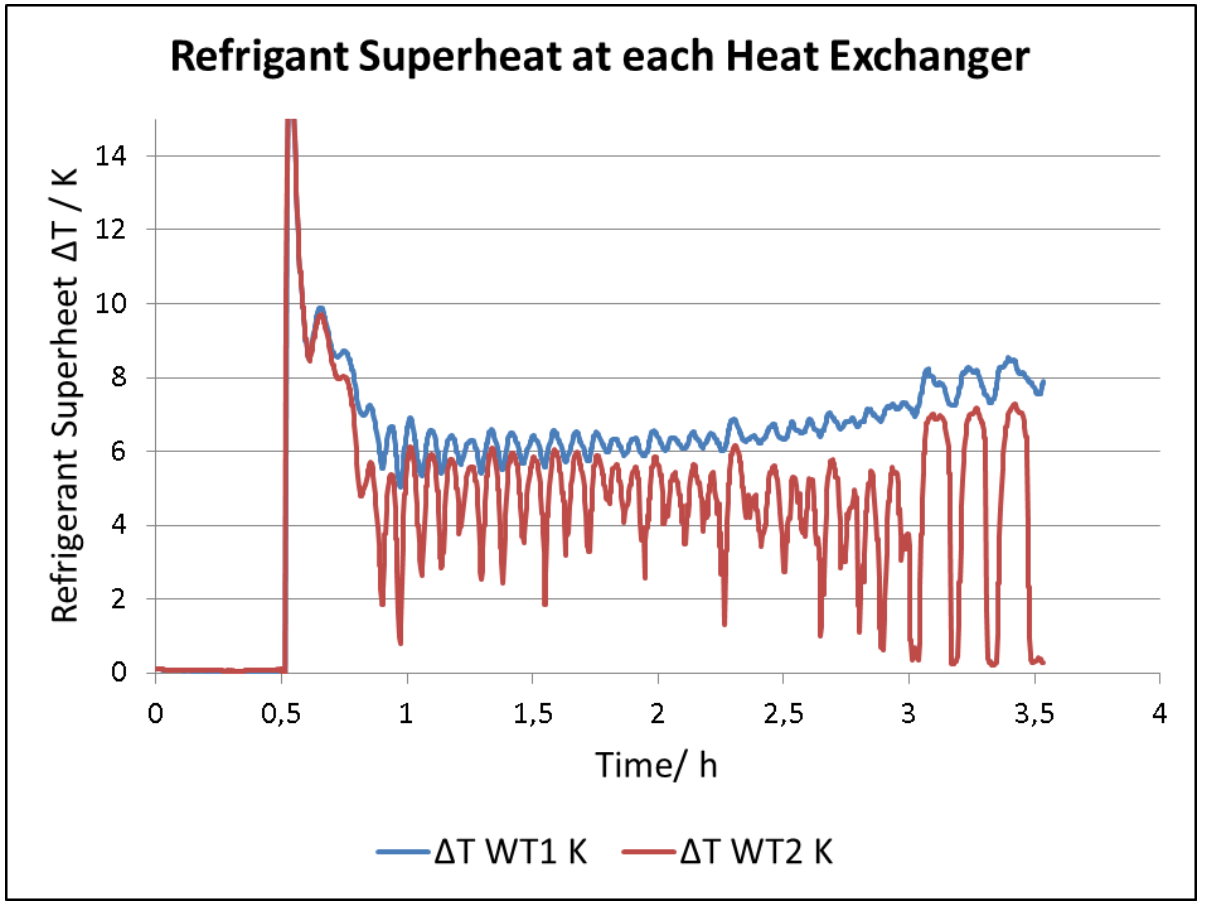

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Key Results experimental storage 2 (Un. of applied Sciences Munich)

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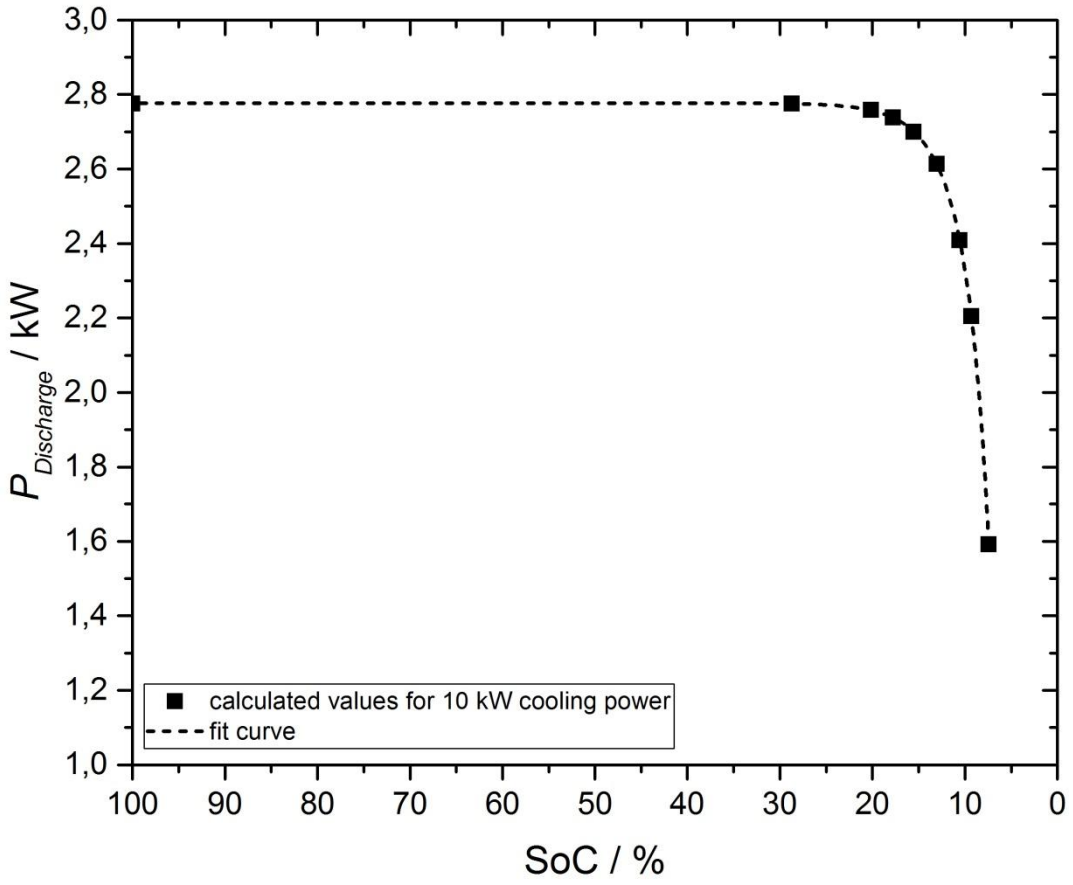
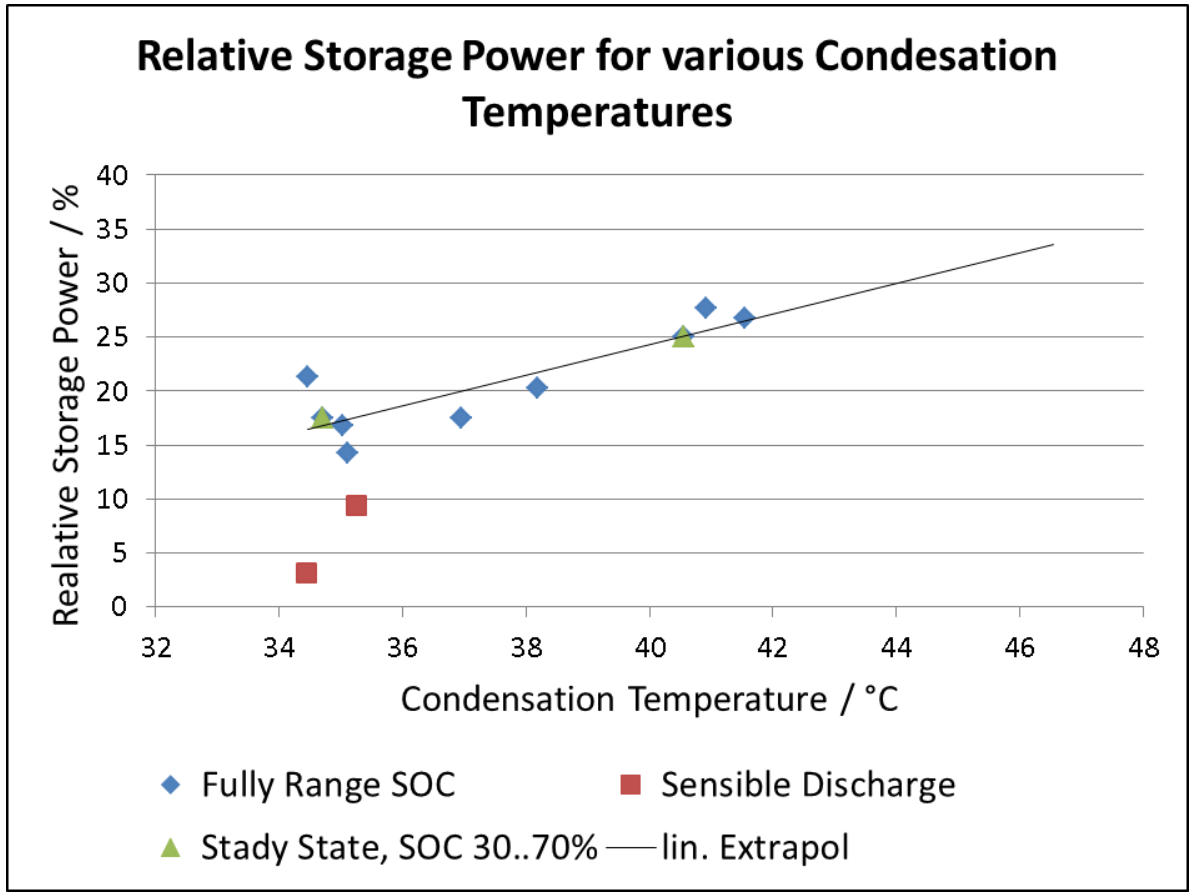
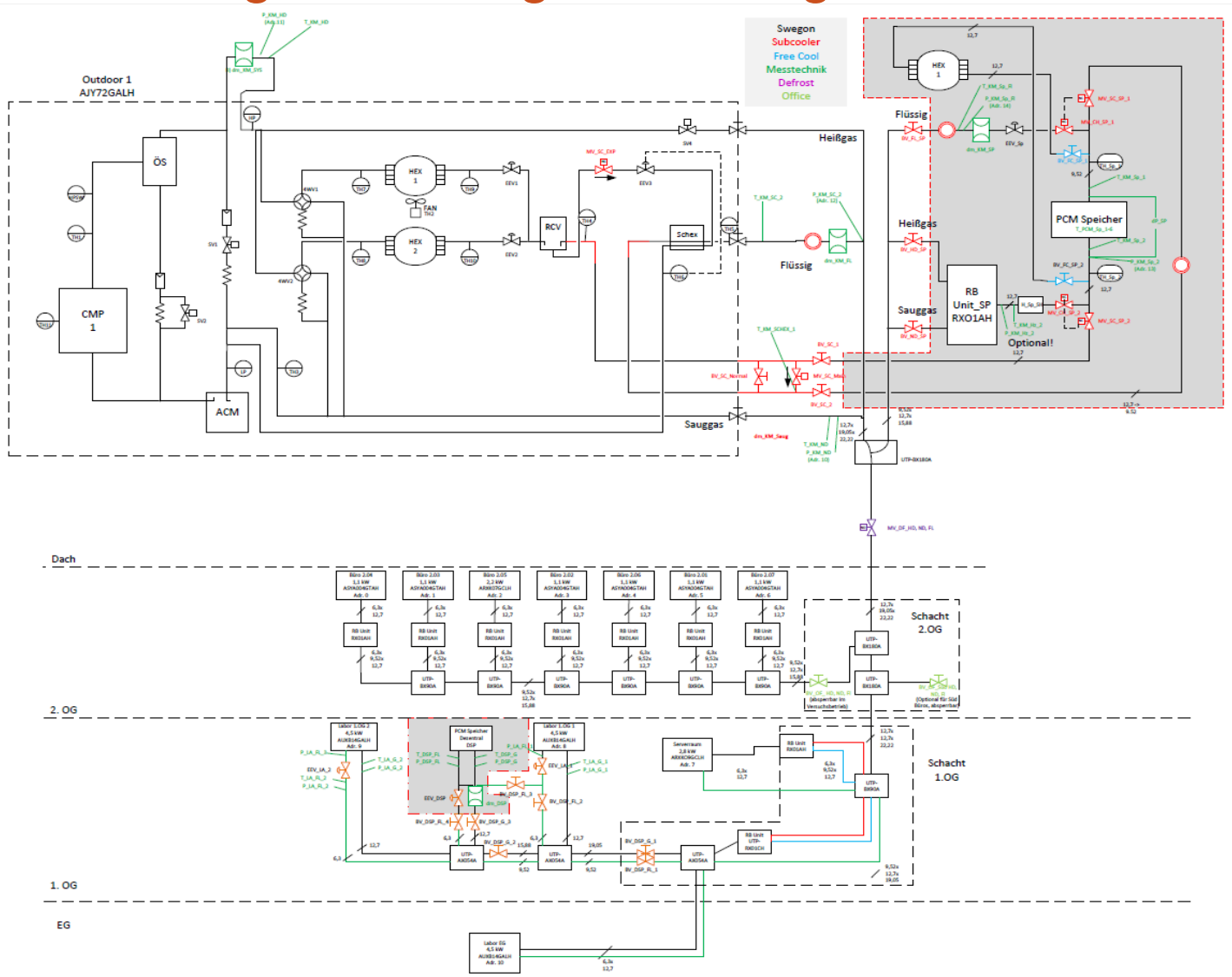
Storage discharge by subcooling the Refrigerant.





3. Pilotinstallation
VRF System including Monitoring and Storage connection



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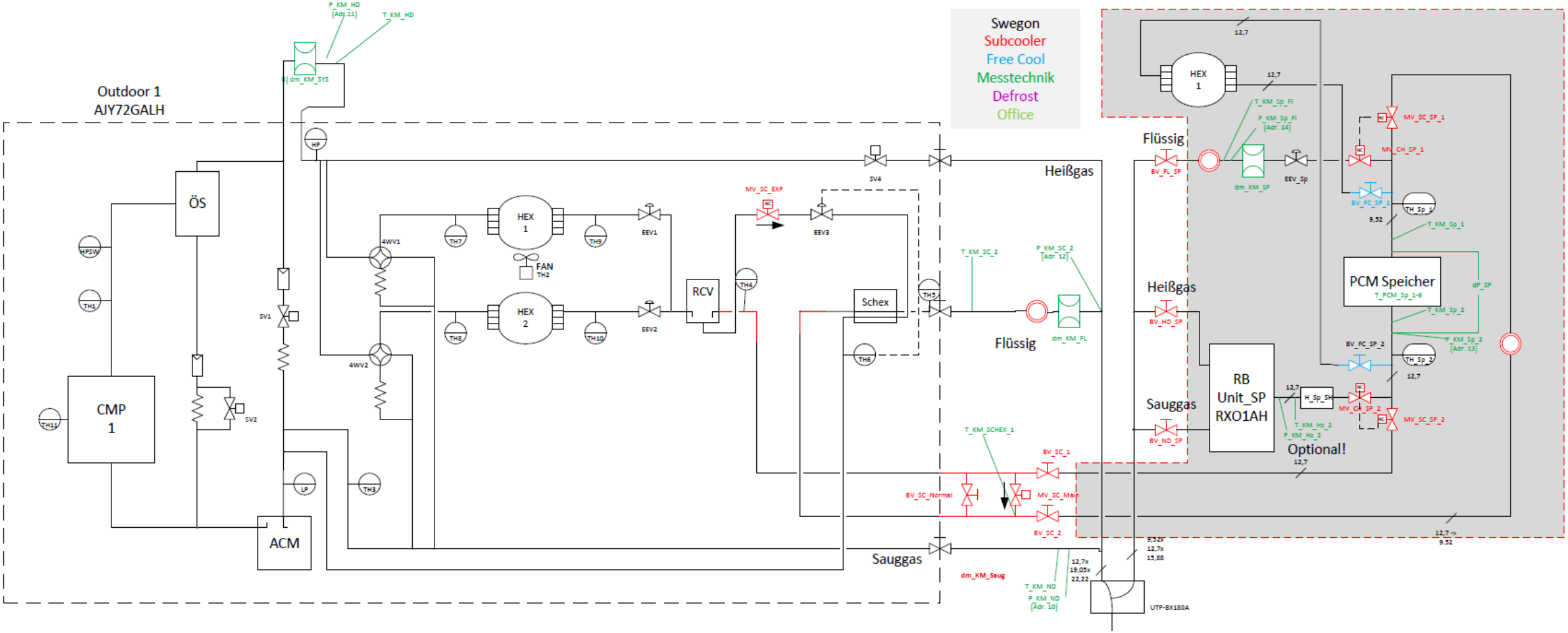
Outdoor Unit and Storage Connection



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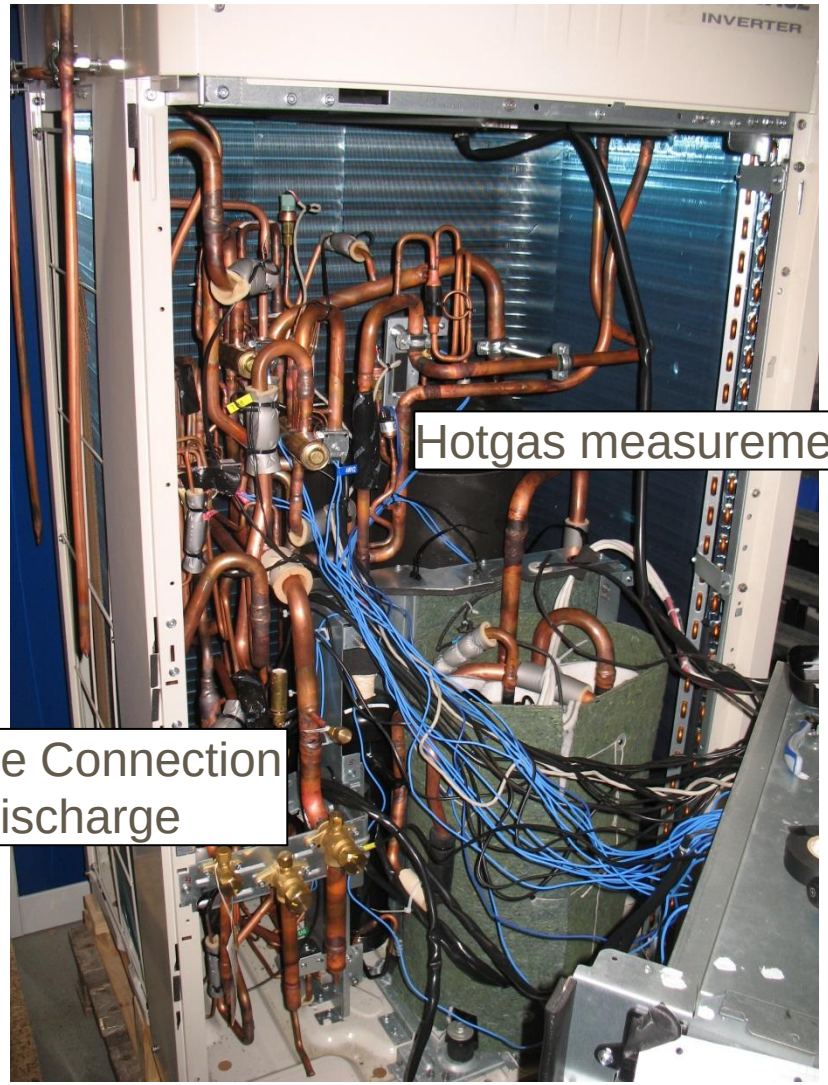

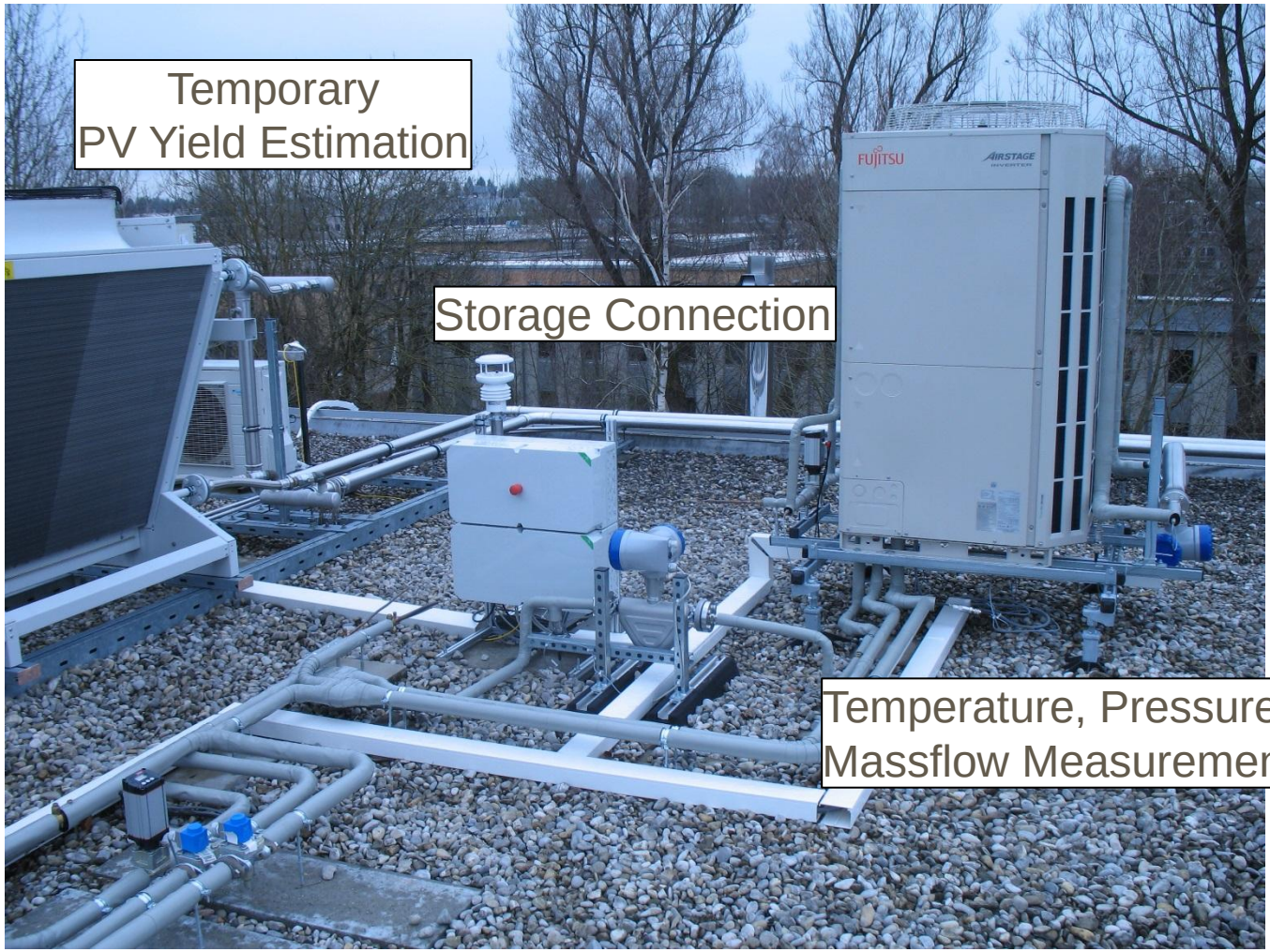

3. Pilotinstallation
First cooling Data of conventional VRF System

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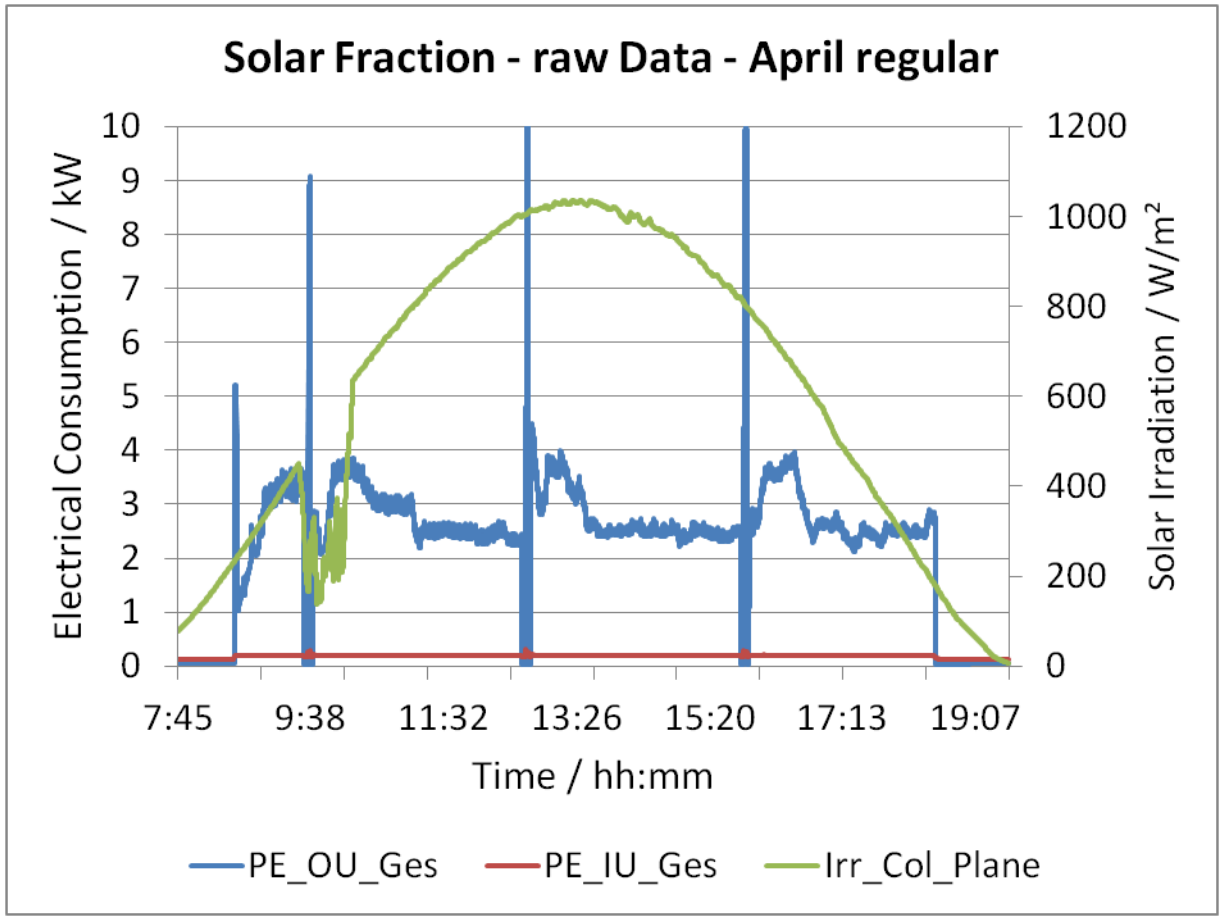
Solar-fraction raw data. Validation of Relation PV-peak/P_El_VRF(rated).



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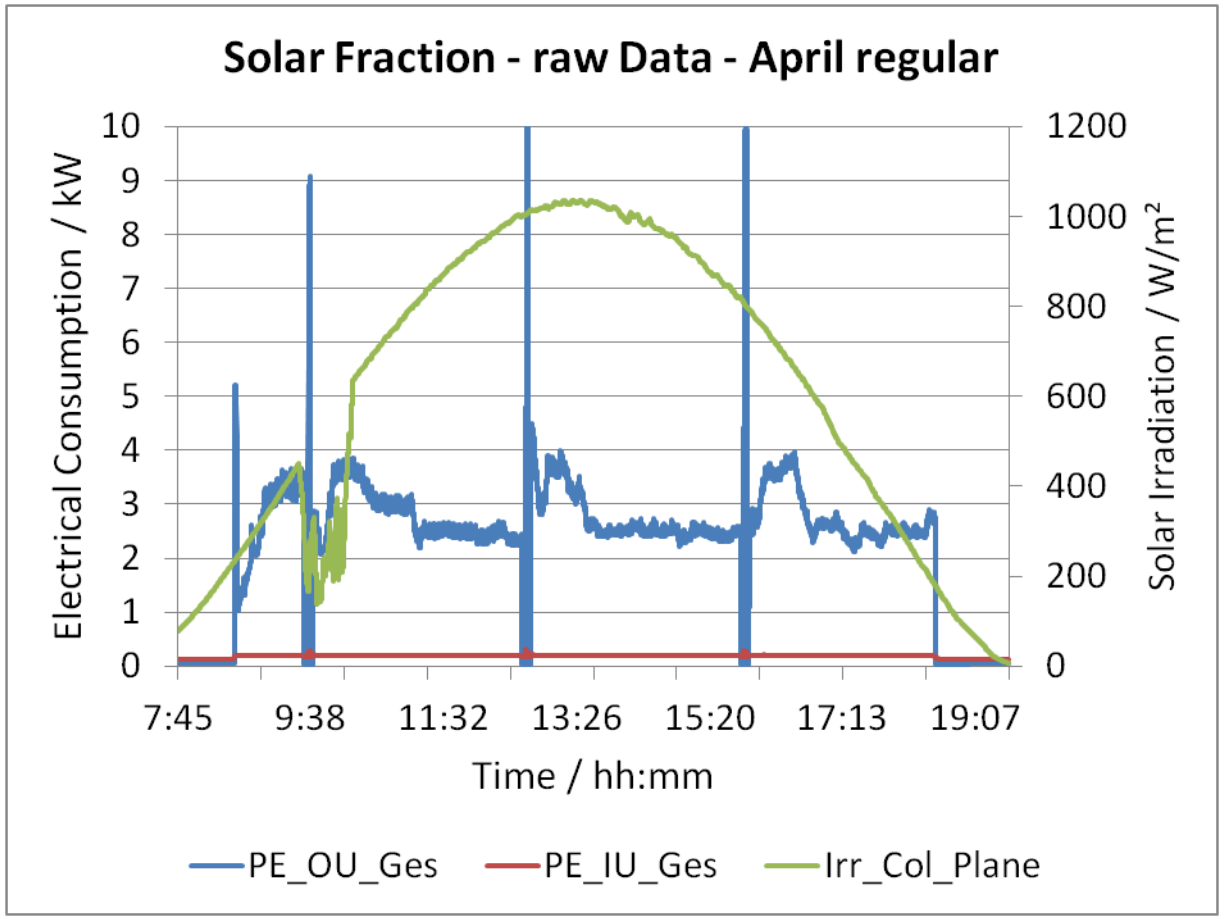

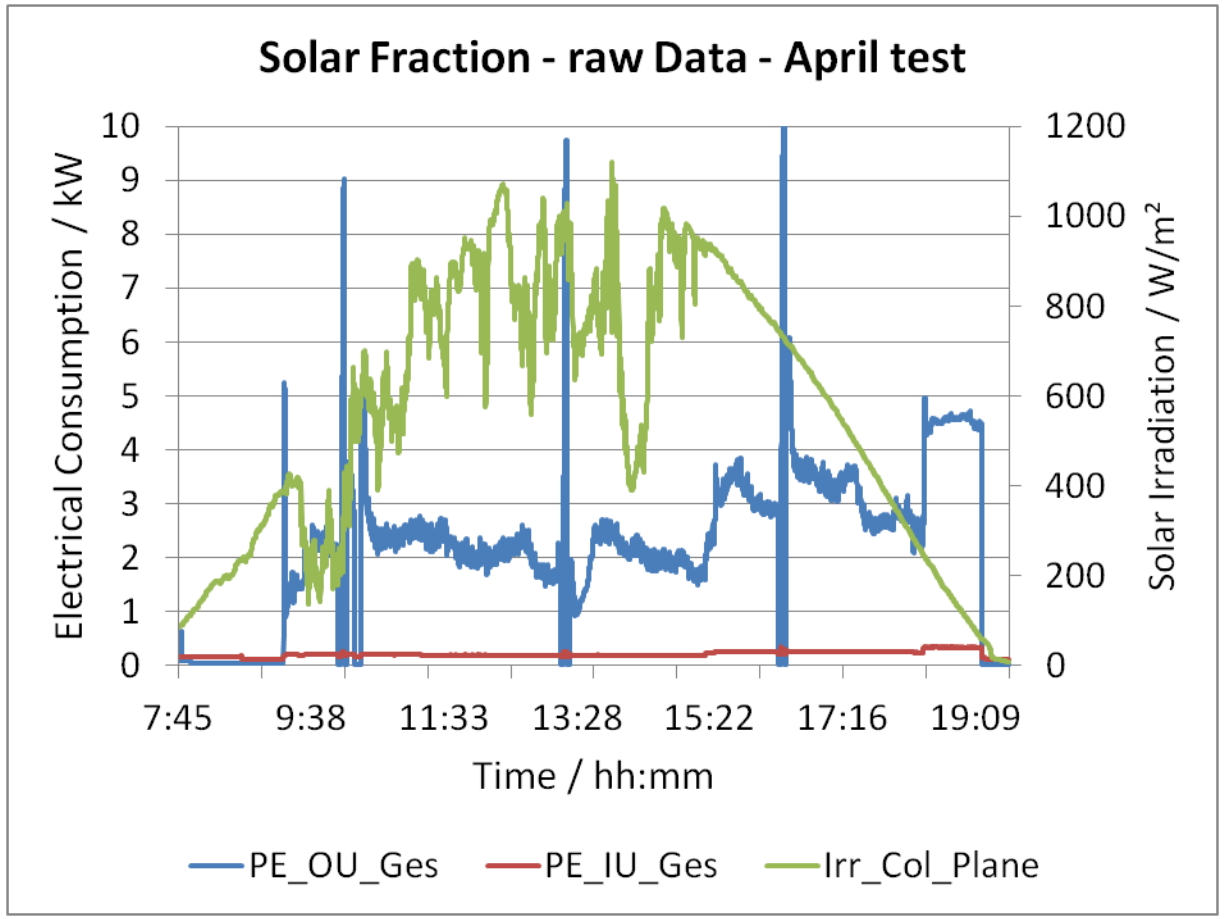

4. Outlook

Storage Development

- Building up Pilotstorage with minor adaptions
- Improvement of Refrigerant distribution
- Handling State of Charge measurement issues

Pilotinstallation

- Ongoing measurement of conventional VRF system. Heat Recovery balancing
- Building up max. 6.6 kW PV installation with VRF system as first load
- Implementation and startup of Pilotstorage
- Implementation of predictive storage control strategies

Thank you for your attention!

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