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SolarSplit – Latent Heat Storage in VRF Systems

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ZAE BAYERN

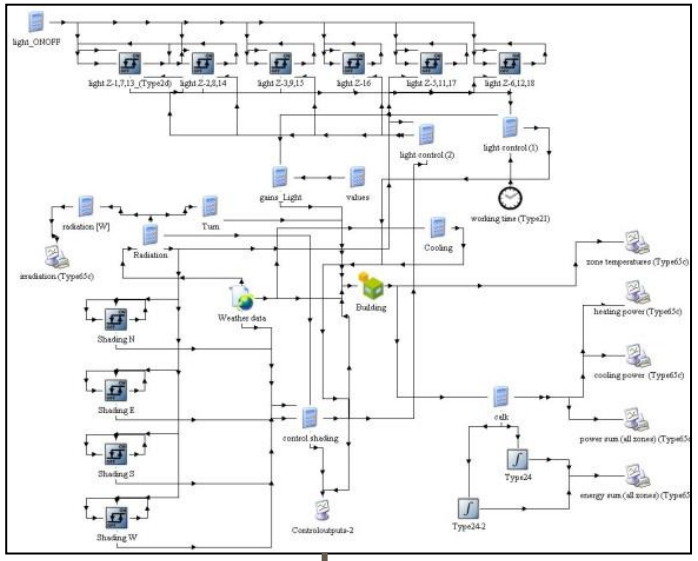
Outline

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

1. System Approach
Modelling of a specific Building Load / PV-Yield / VRF load

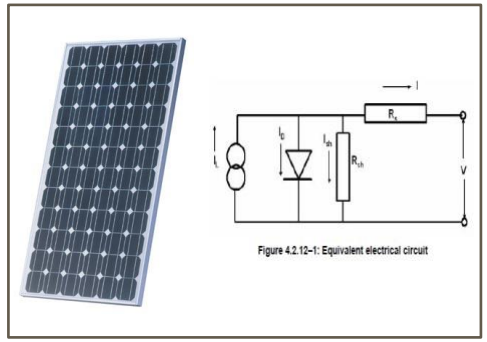
Design of VRF system, PV size and Storage Potentials
Specification of System characteristics

Building Model



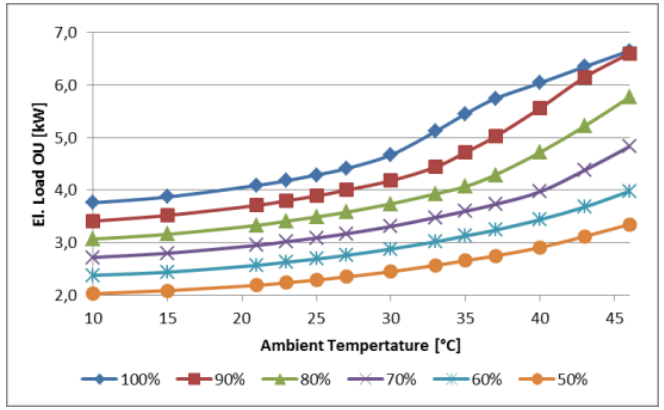
Thermal Load

Type 194 PV-Model



PV-Yield

COP, EER heat pump



Performance Heat Pump

1. System Approach
Modelling of a specific Building Load / PV-Yield / VRF load

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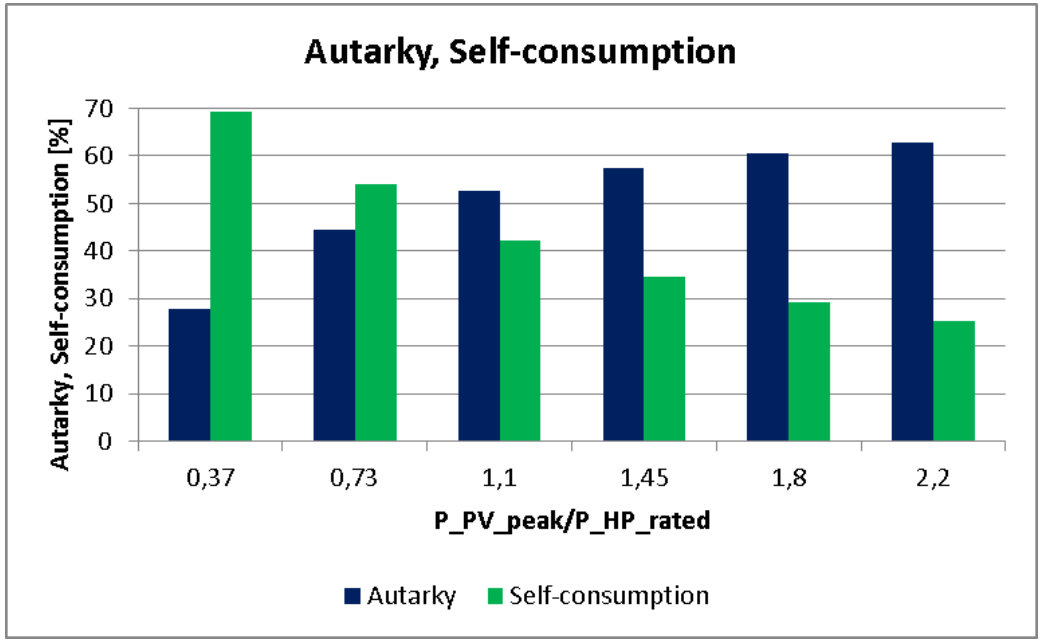
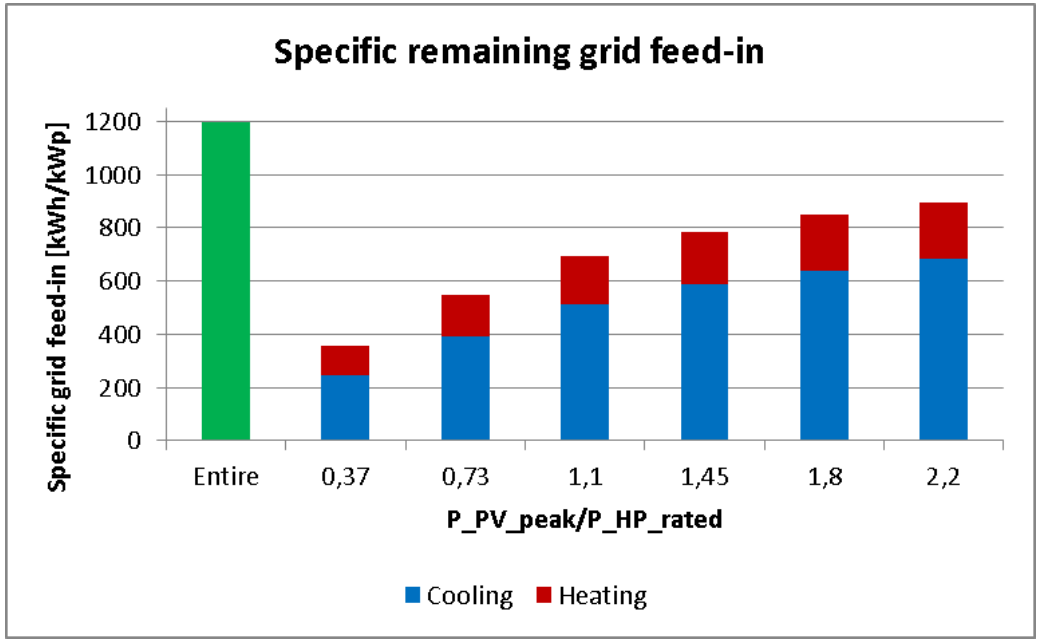
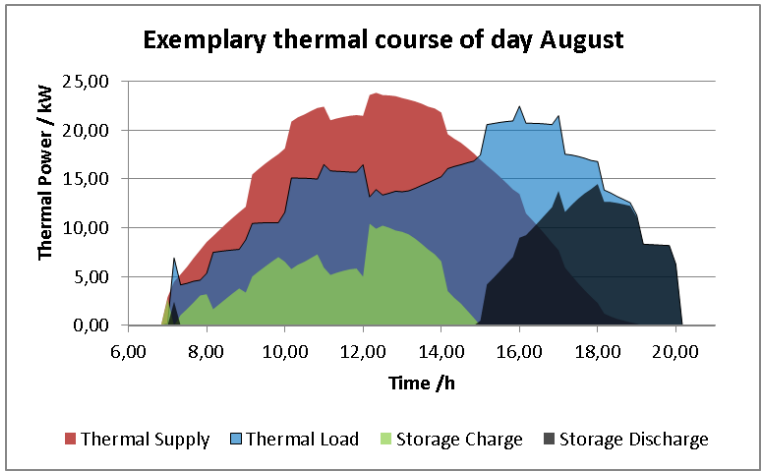
Good balance of Autarky and Self-consumption for a ratio PV/HP of 1.1 to max. 1.5
Major part of remaining grid feed-in in dominant Cooling Mode

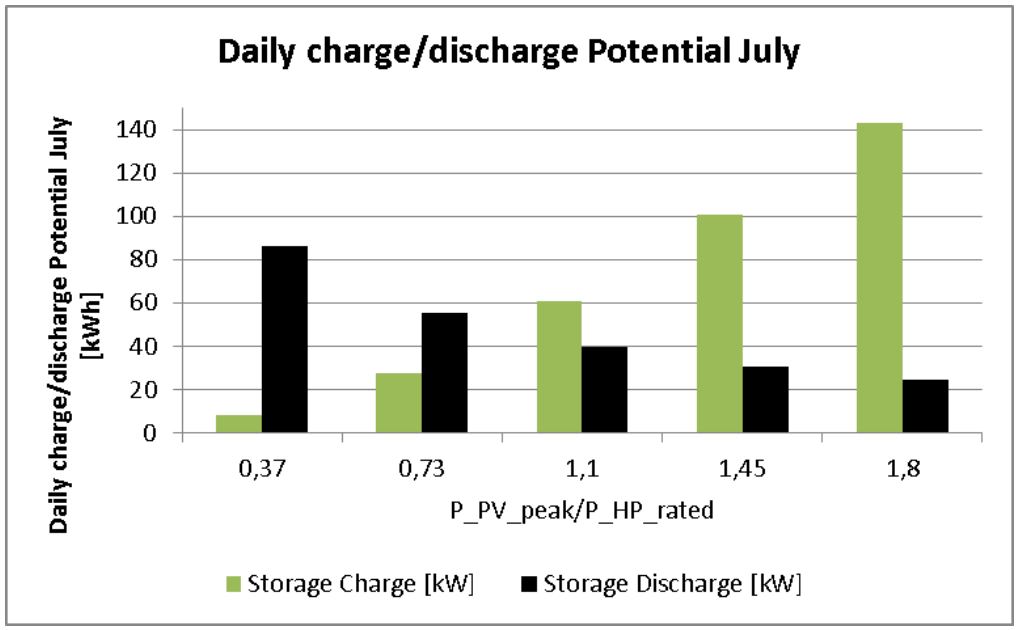


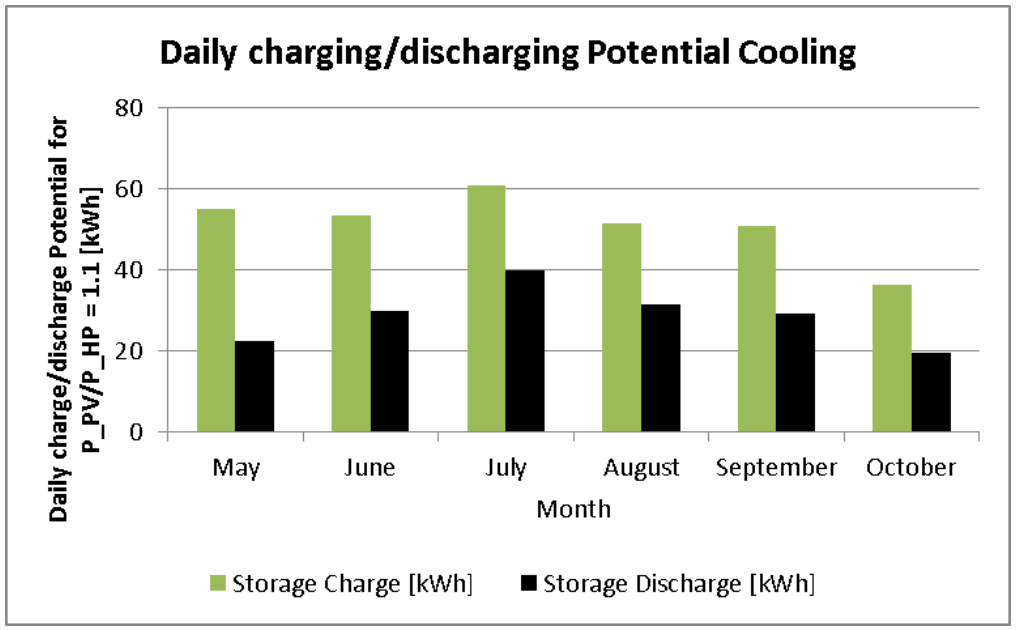


1. System Approach
Modelling of a specific Building Load / PV-Yield / VRF load

Thermal Storage Potential

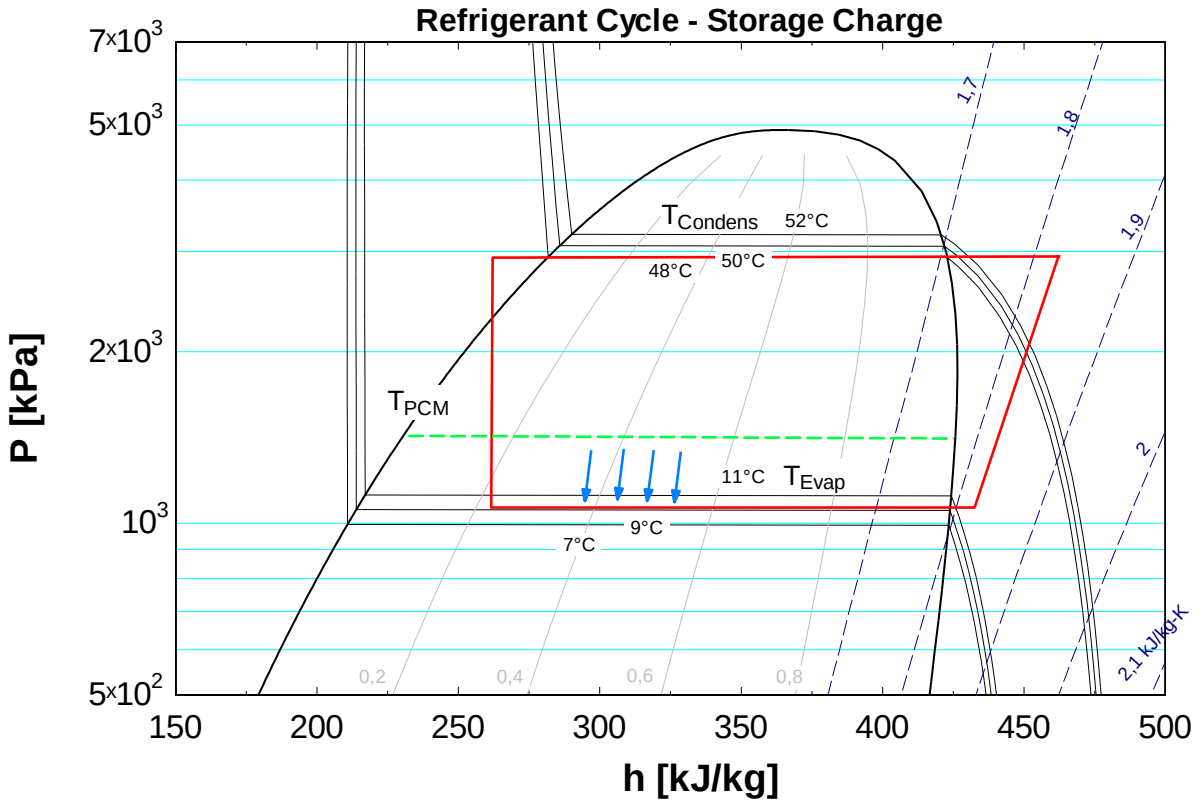


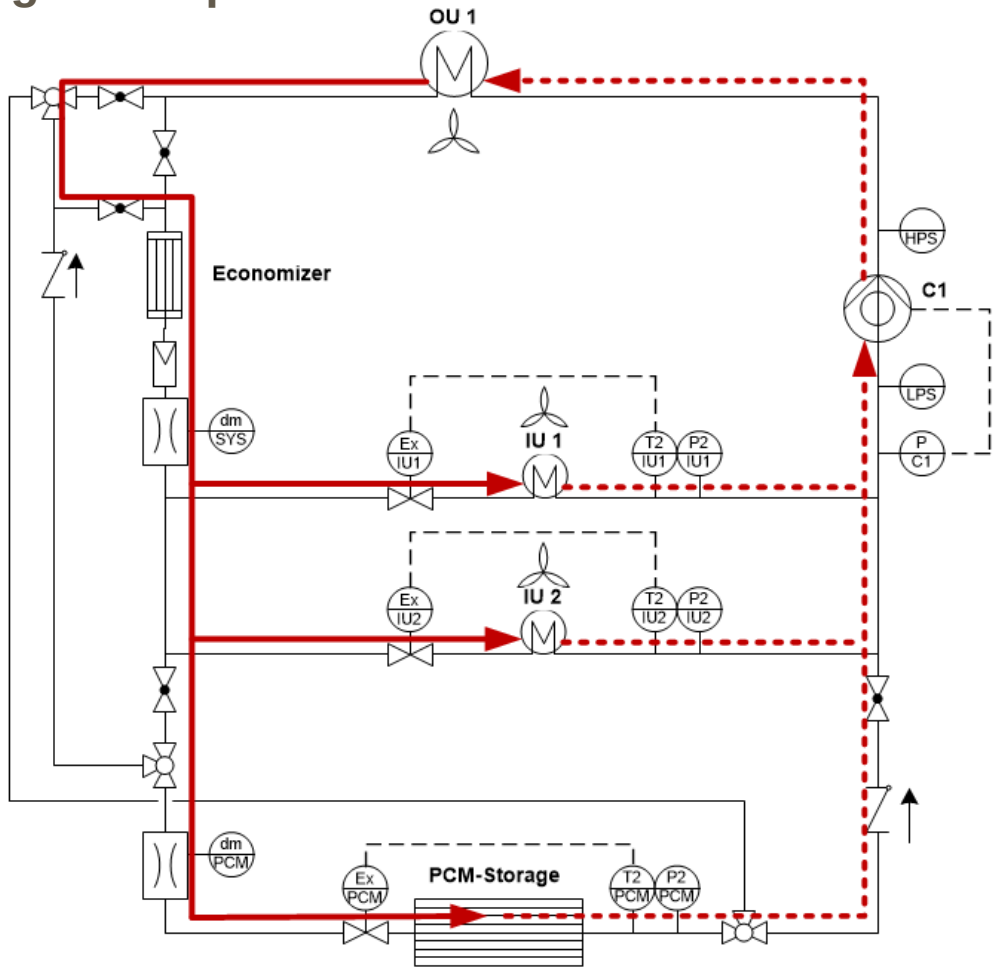




1. System Approach
PCM Storage as Subcooler in VRF-Systems

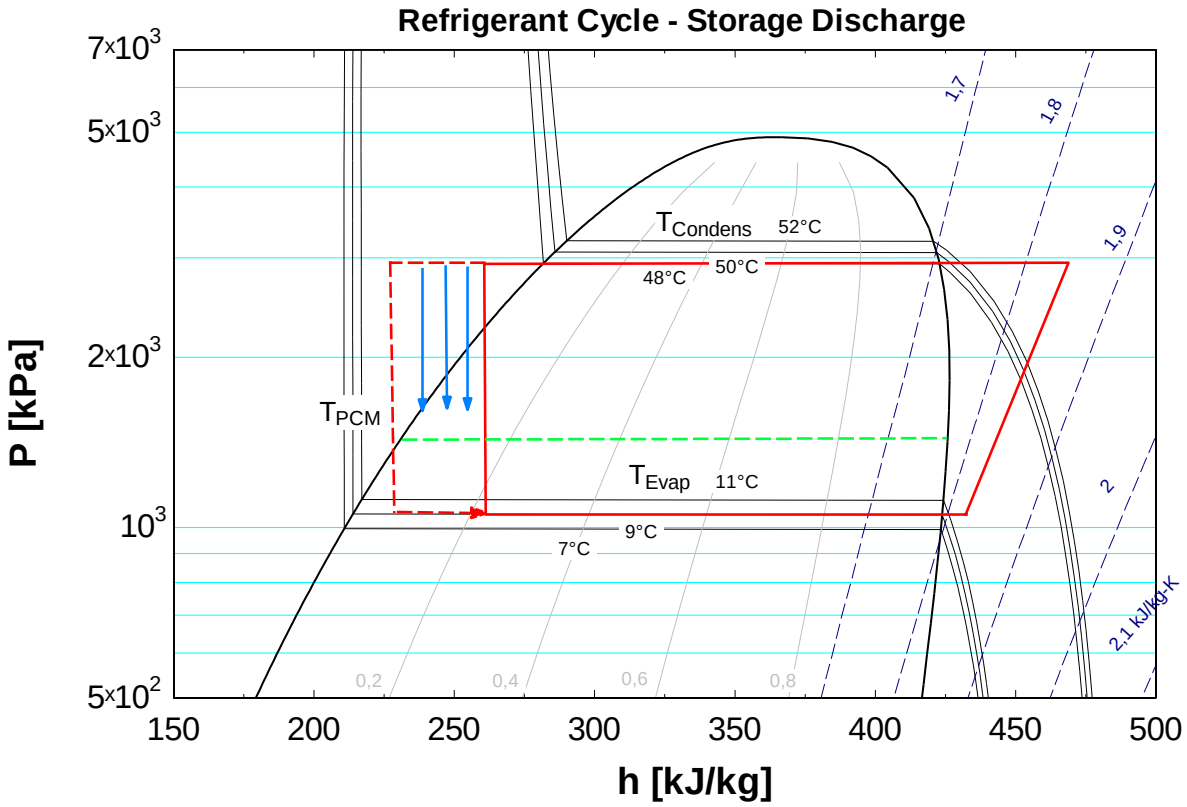
Relatively fixed levels of Evaporation and Condensation in VRF-Systems.
Storage Charging on common evaporation level using PV-surplus.

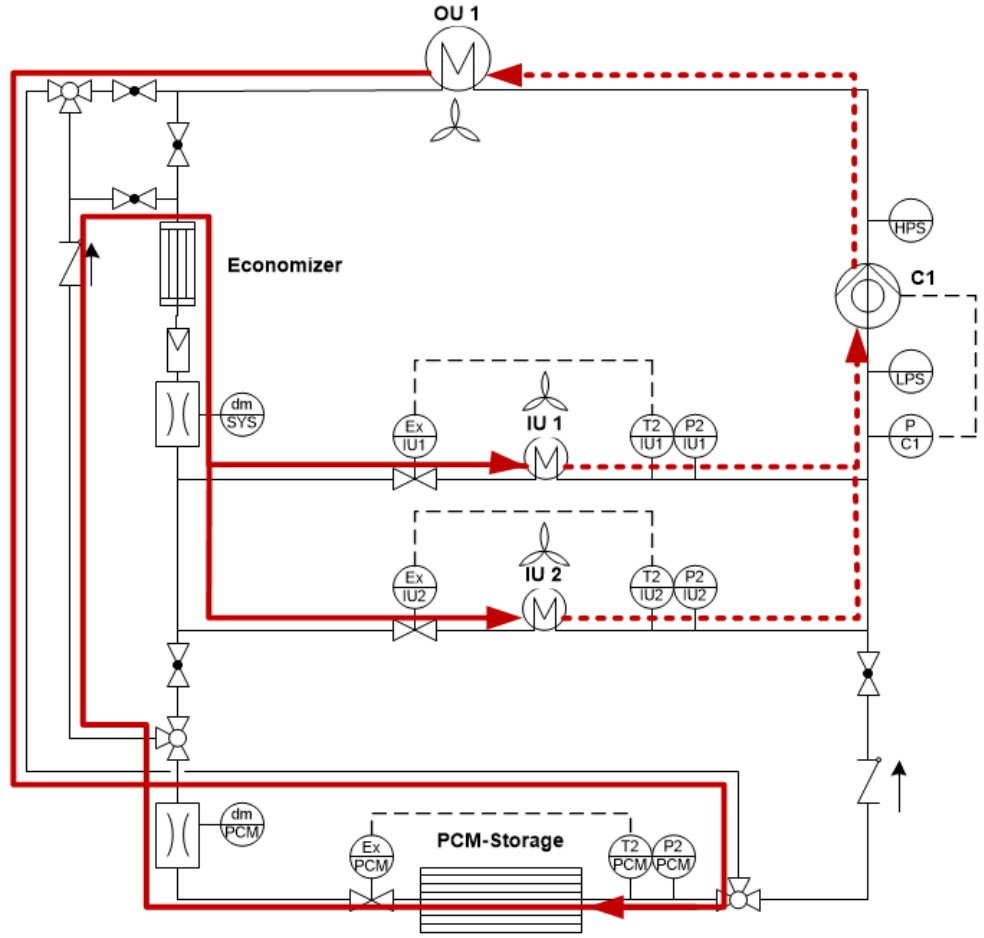




1. System Approach
PCM Storage as Subcooler in VRF-Systems

Relatively fixed levels of Evaporation and Condensation in VRF-Systems.
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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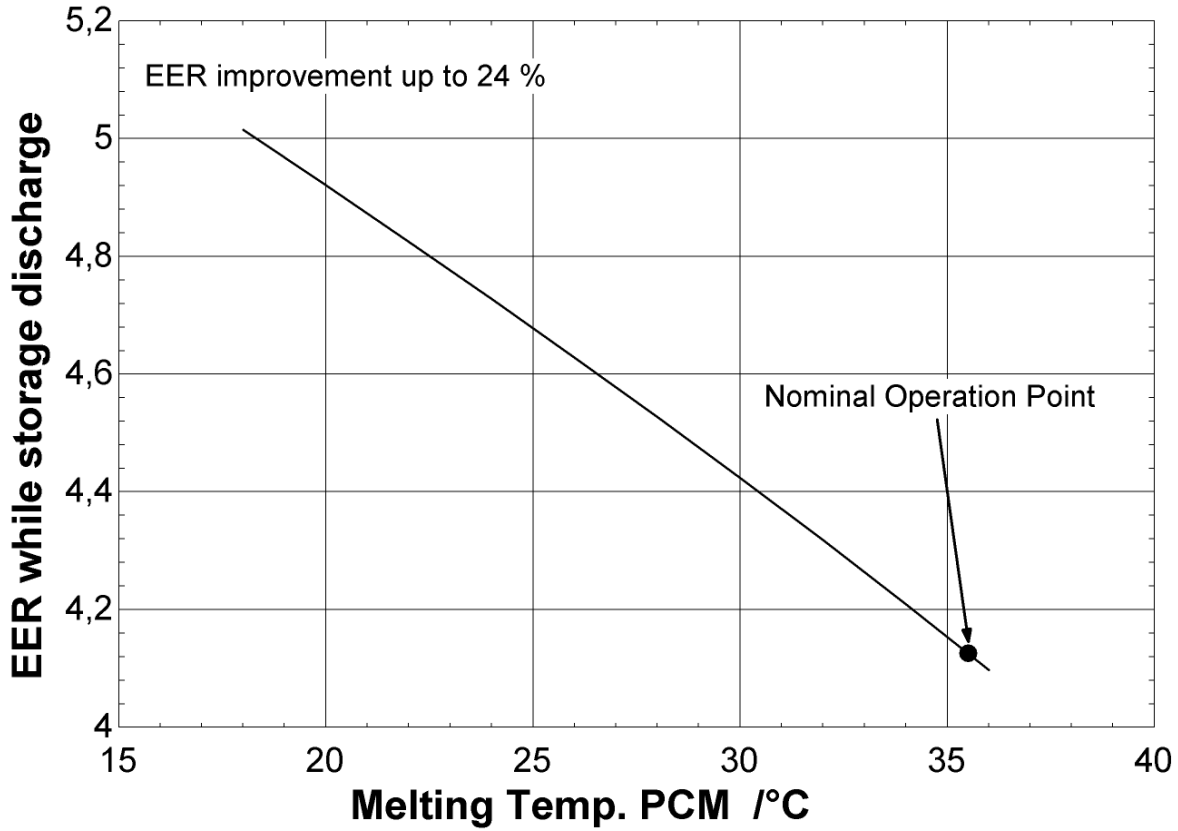
EER benefit of lower subcooling in case of discharge



1. System Approach
Main design parameters

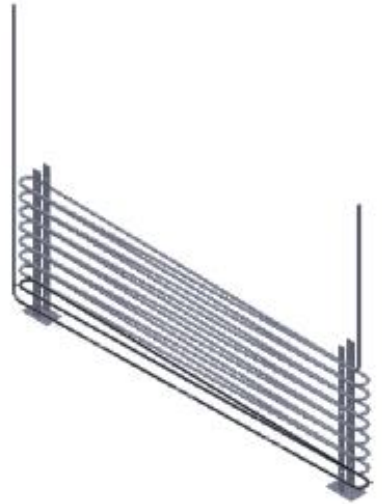
After finalized Systemsimulation: Building up of VRF-system with PCM storage at the ZAE institutes building.

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

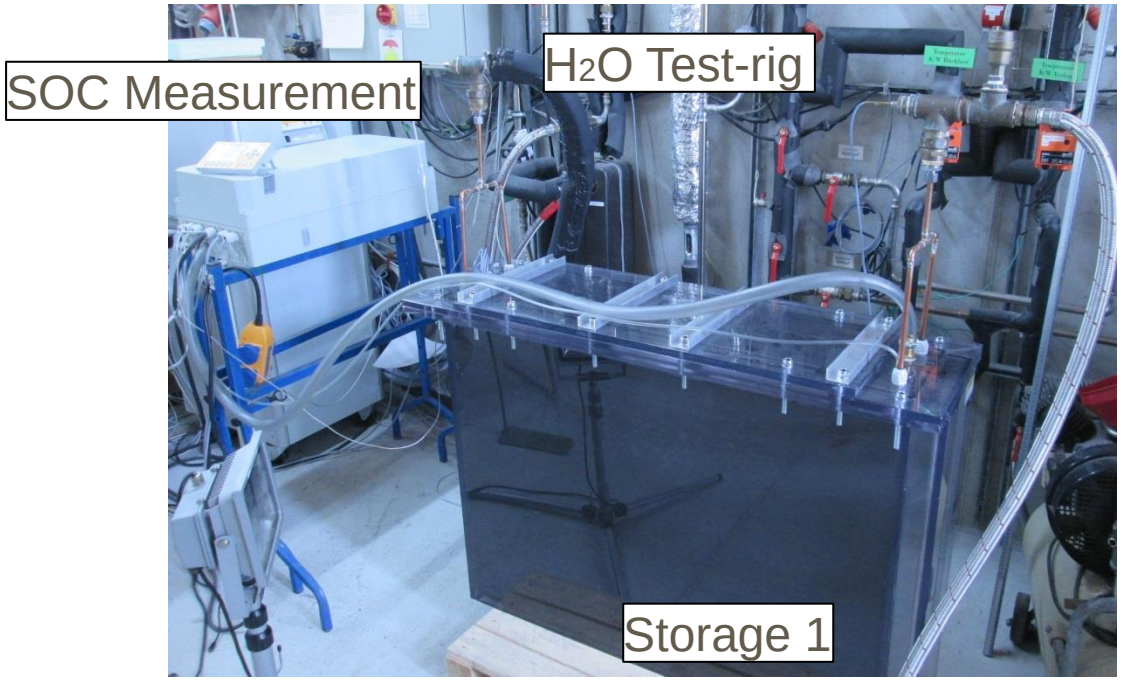


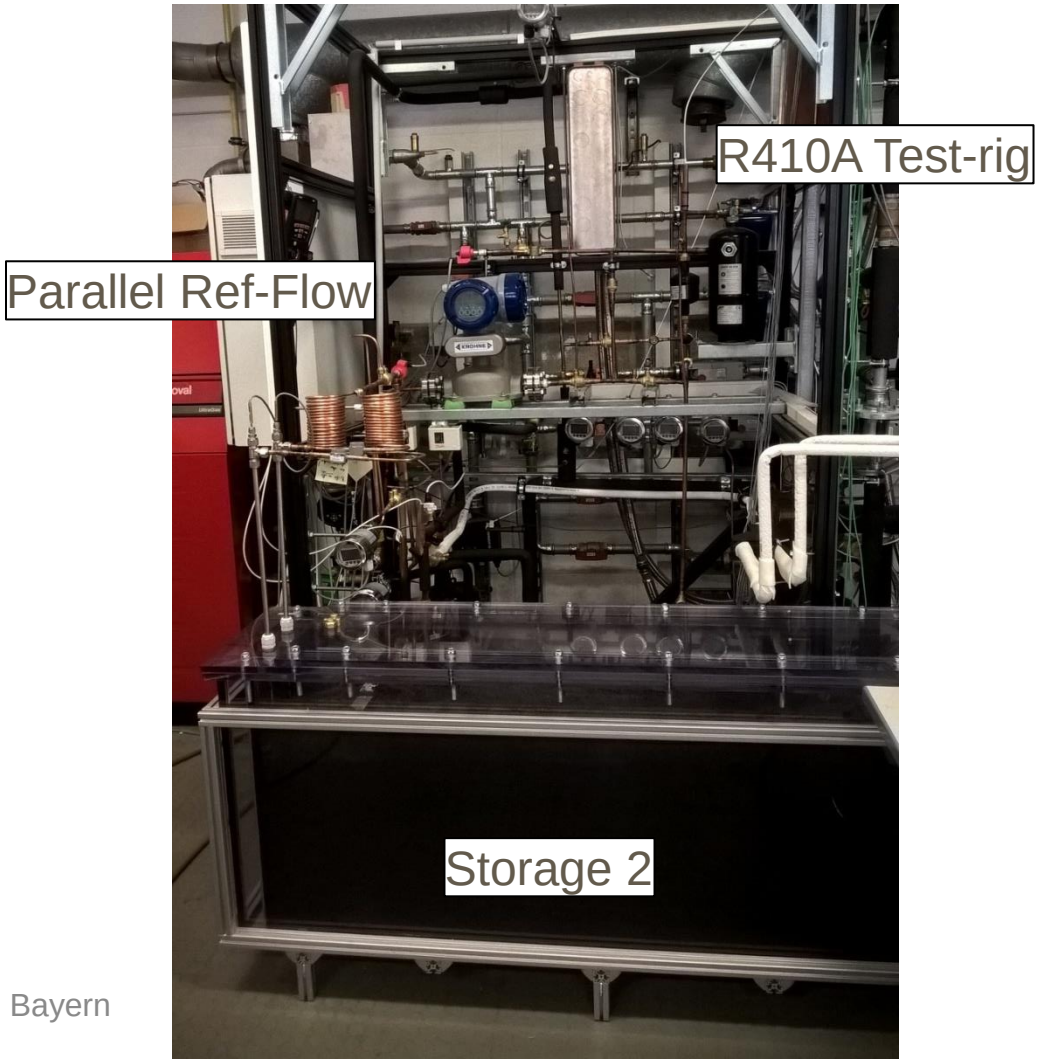
Experimental Storages

- 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

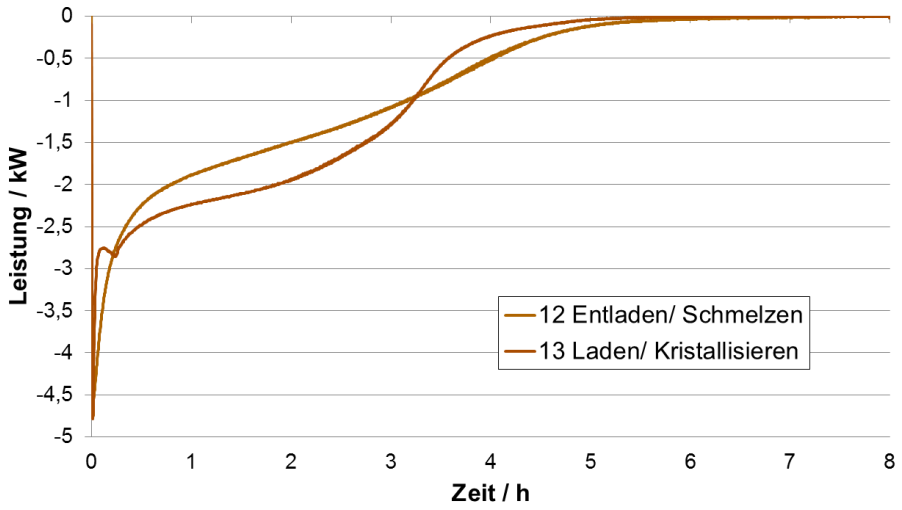
Storage 1: Test-rig ZAE Bayern -> Capacity, Cycling, State of Charge
Storage 2: Test-rig HM Munich -> Power-characteristics, Presure-drop, Refrigerant Distribution, Subcooling

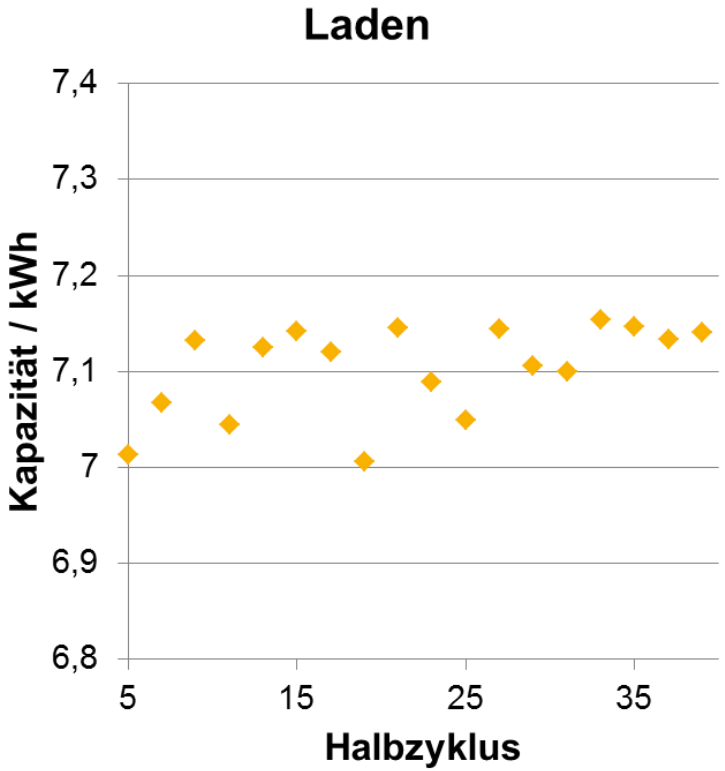


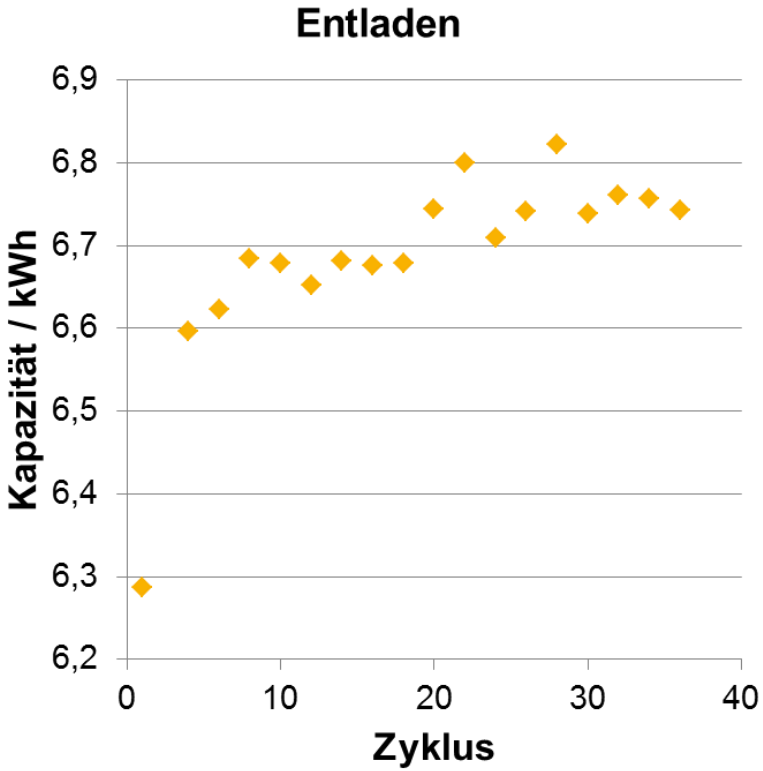


2. PCM-Storage
Key Results experimental storage 1 (ZAE Bayern)

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







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

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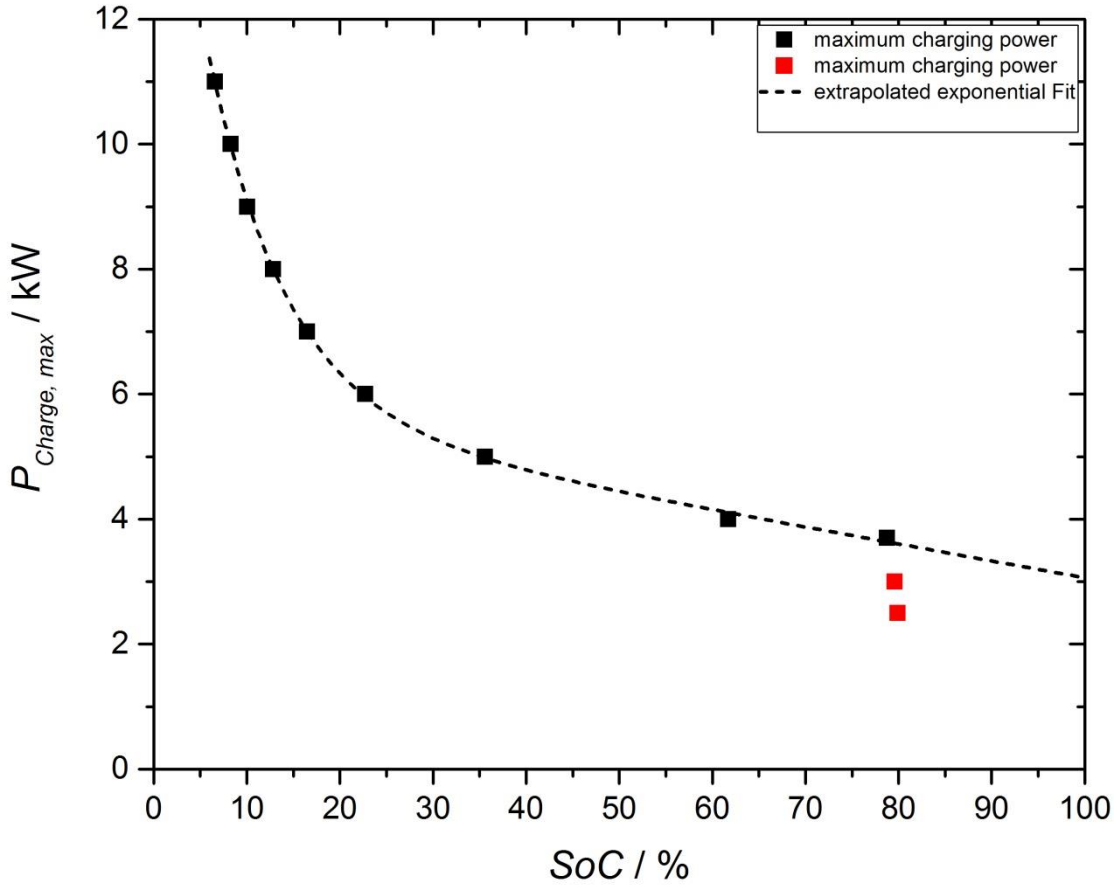
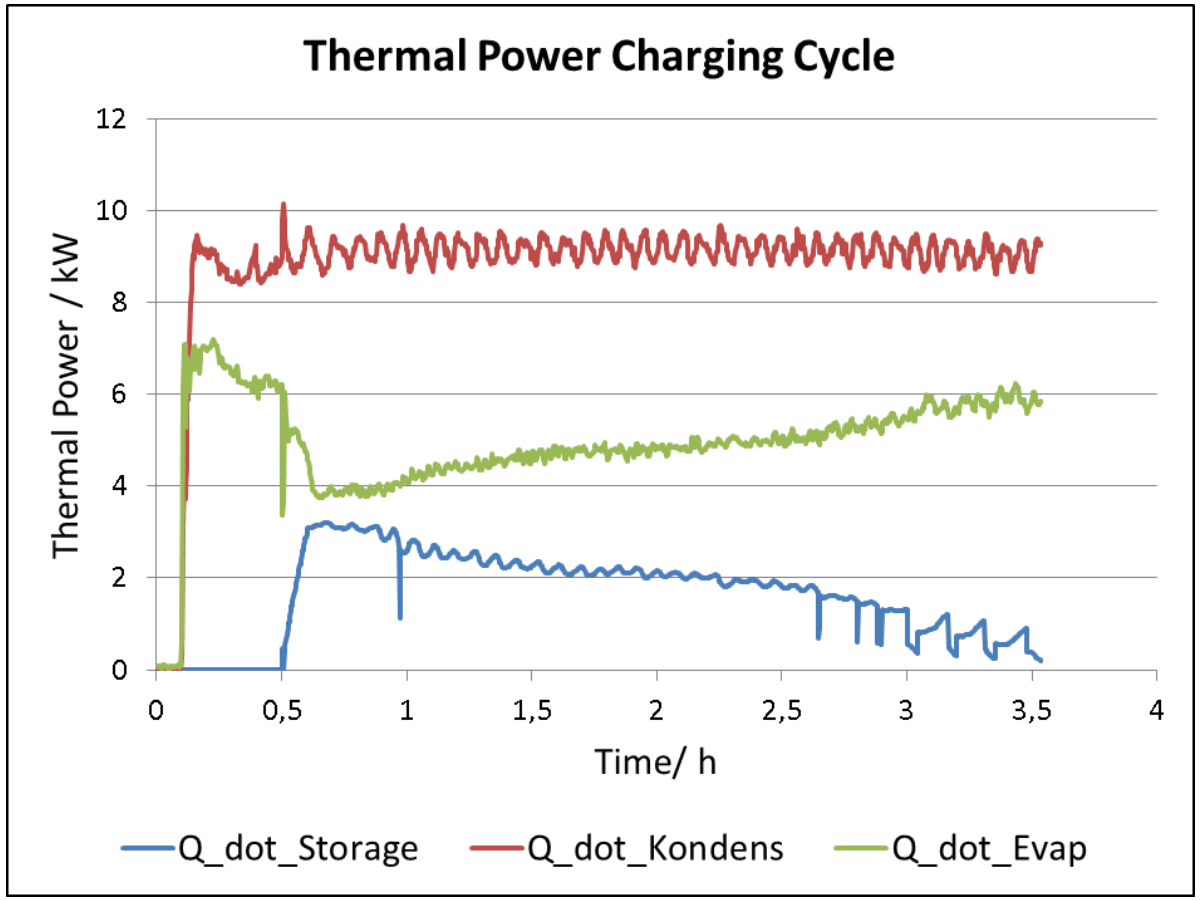
Storage charging through Evaporation





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

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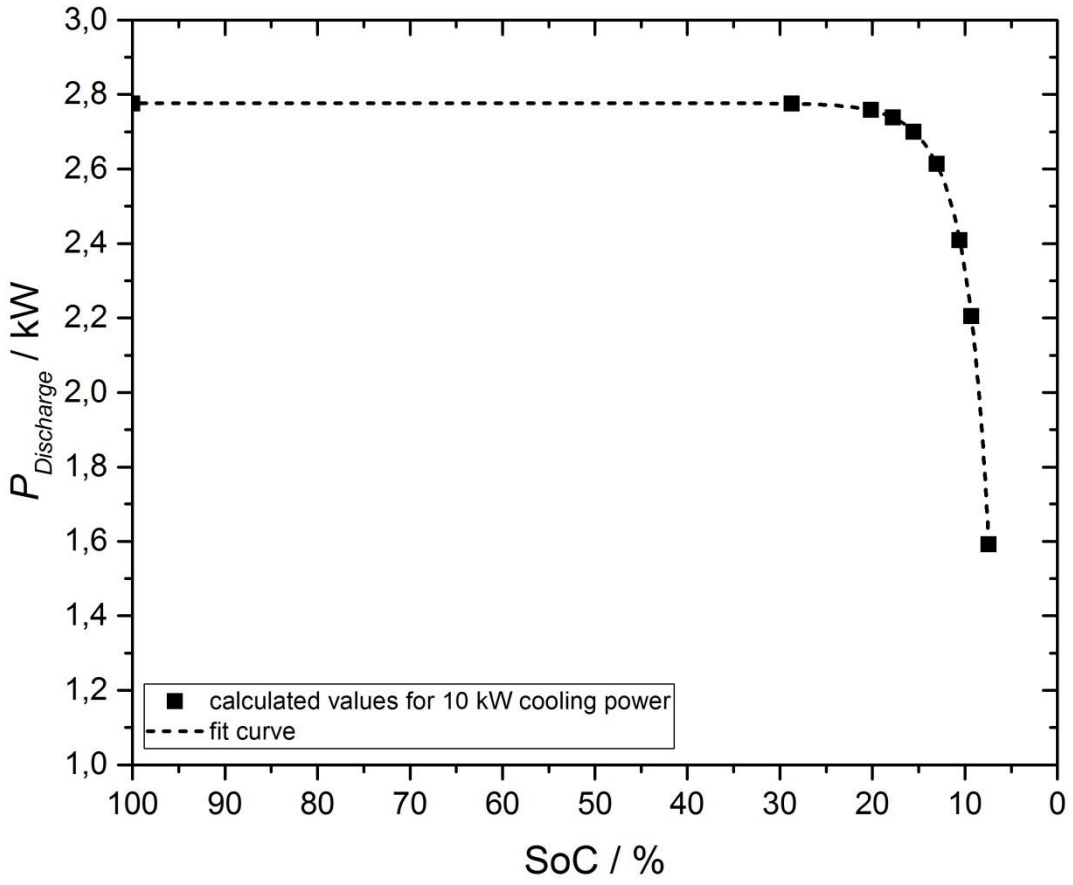
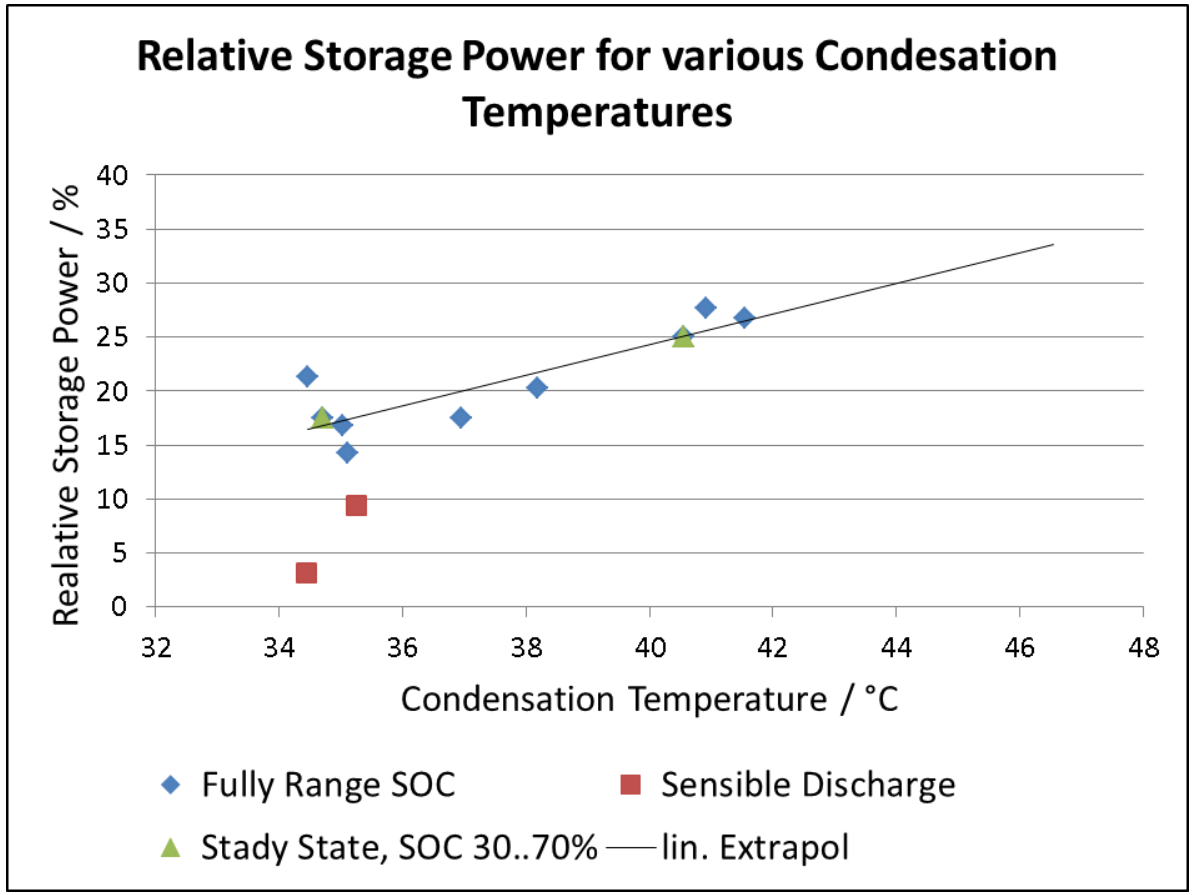
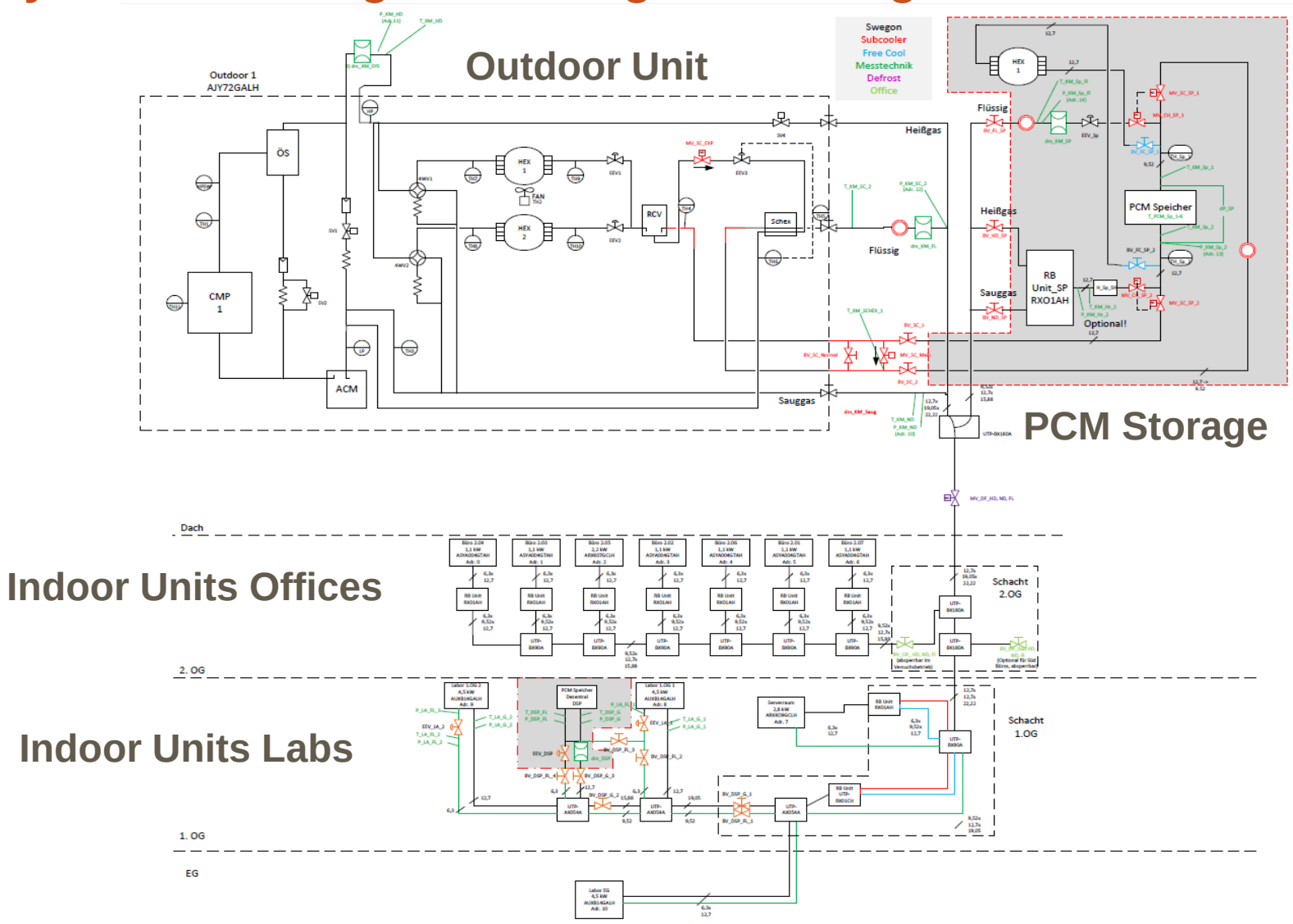
Storage discharge by subcooling the Refrigerant.

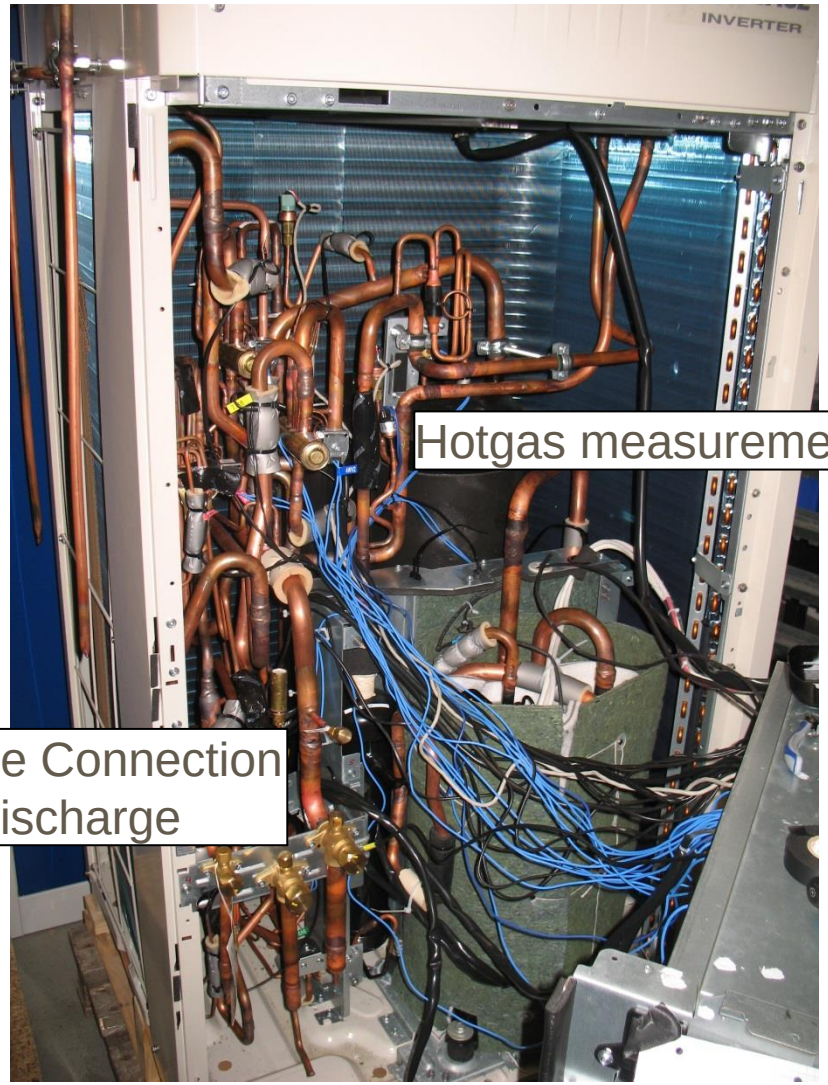


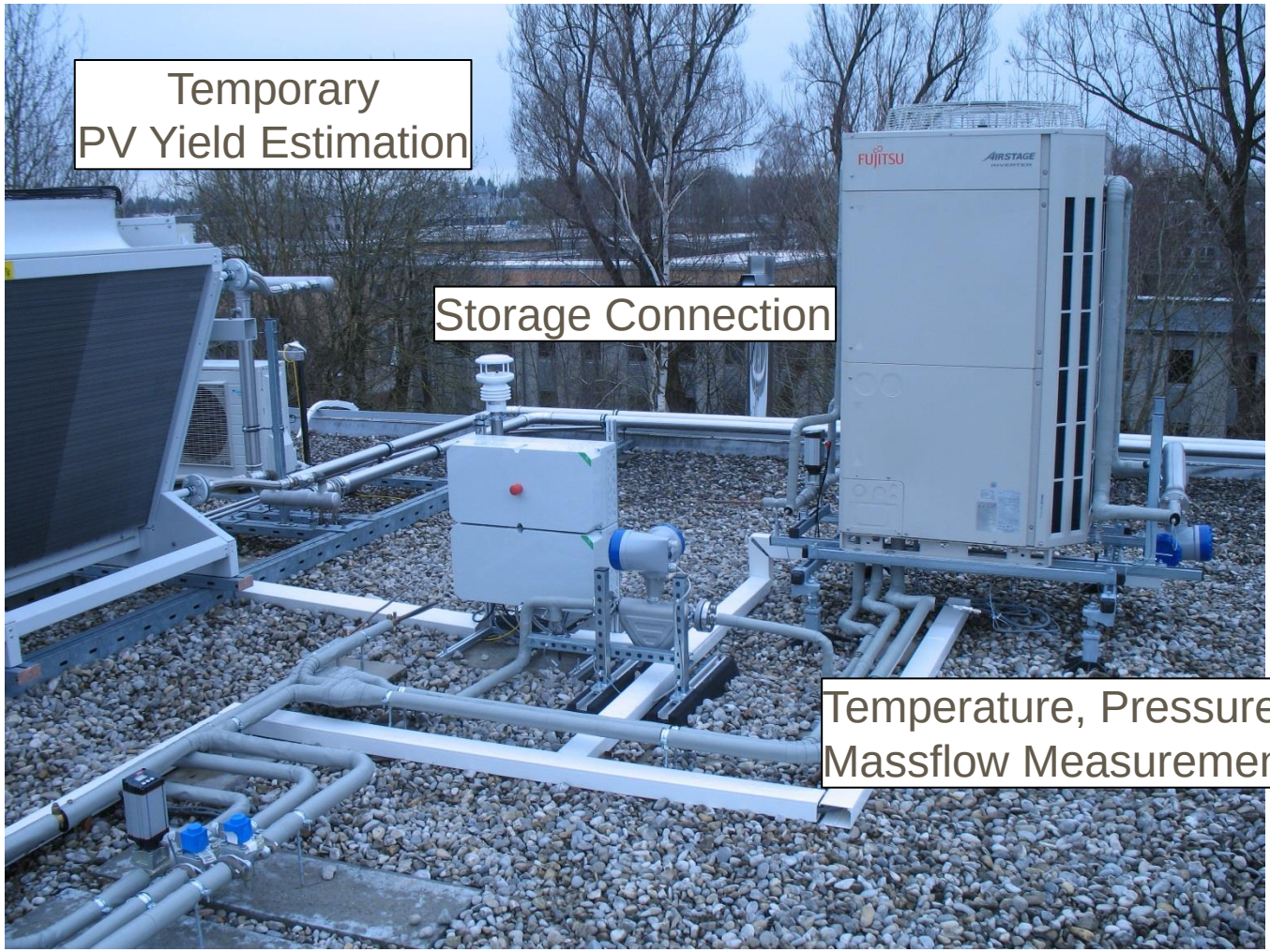


3. Pilotinstallation
VRF System including Monitoring and Storage connection



3. Pilotinstallation
Outdoor Unit and Storage Connection





3. Pilotinstallation
First cooling Data of conventional VRF System

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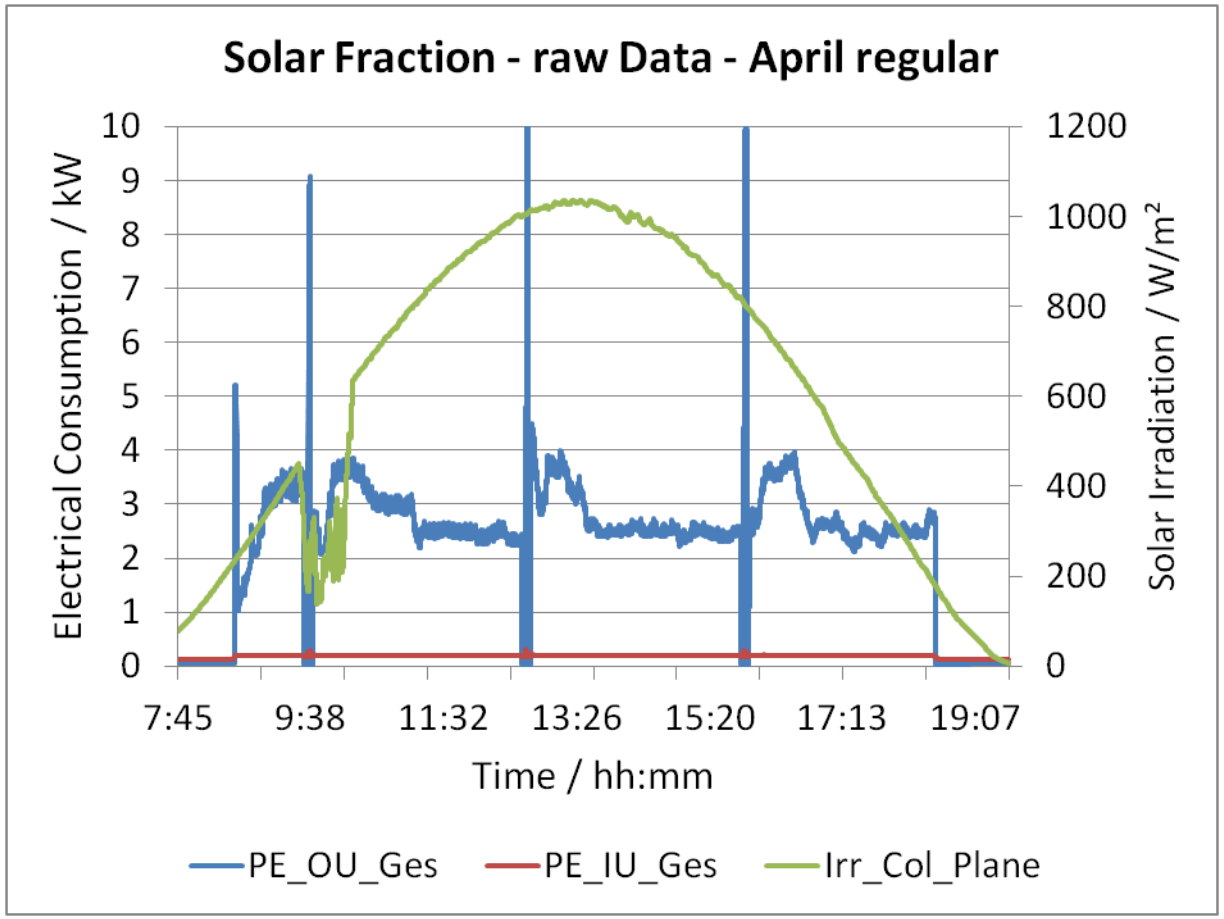
Solar-fraction raw data. Validation of Relation PV-peak/P_El_VRF(rated).



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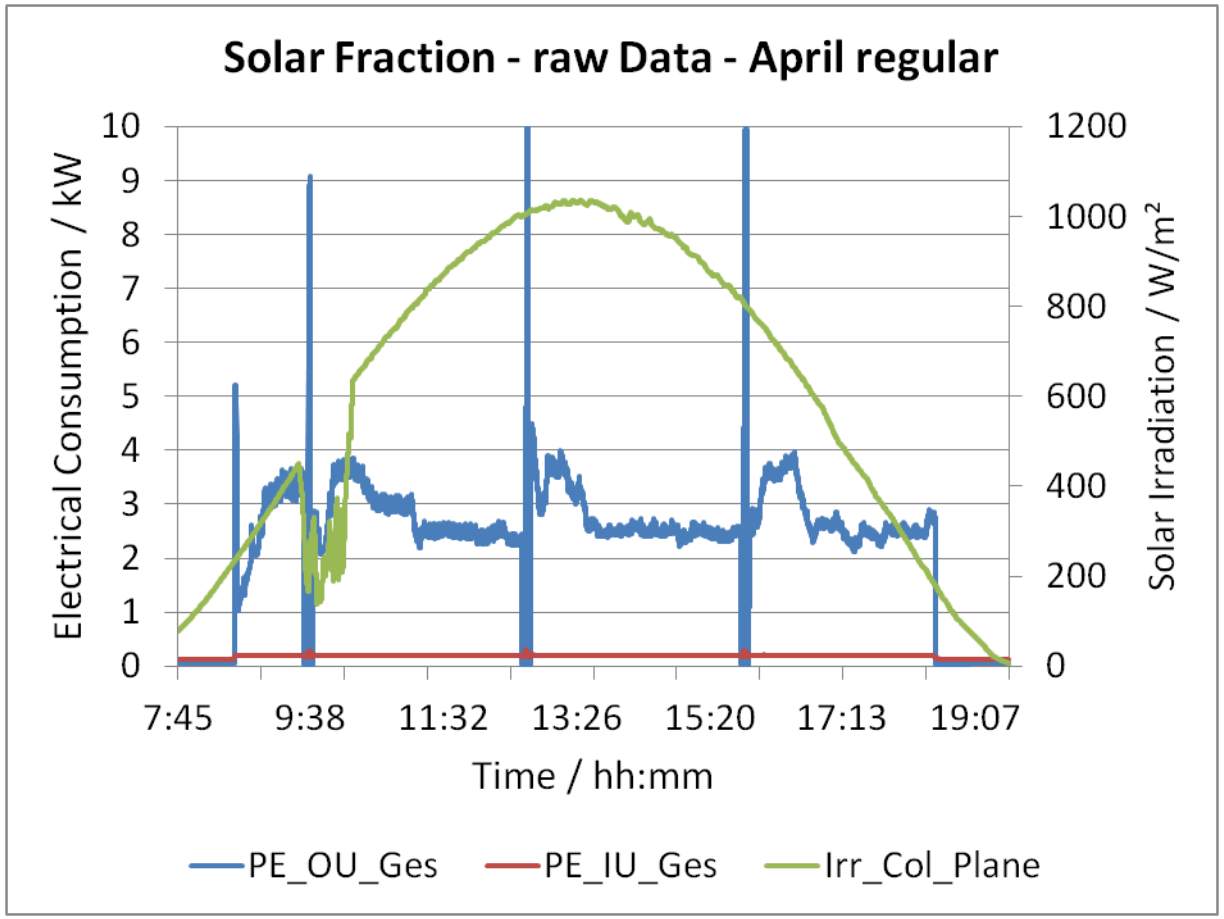

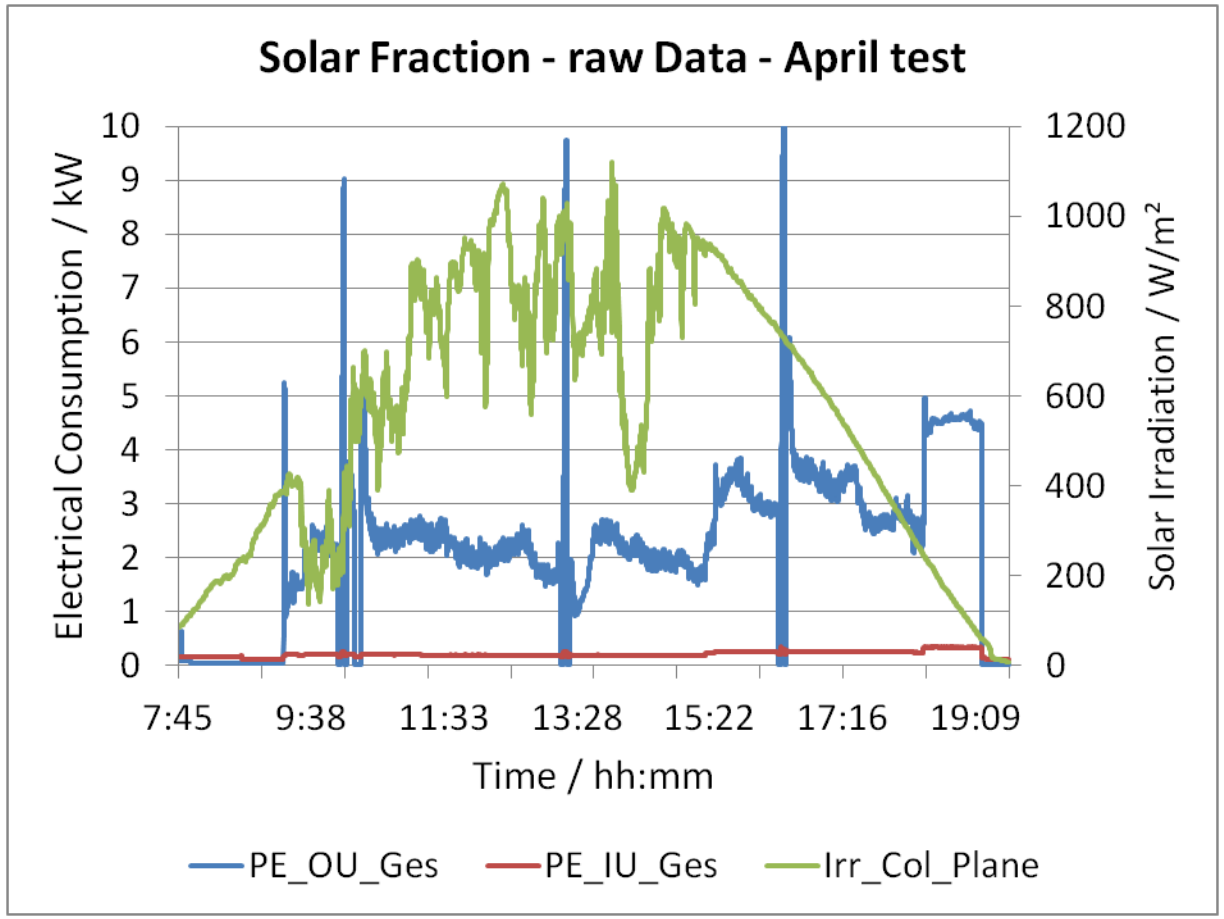

4. Outlook

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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