

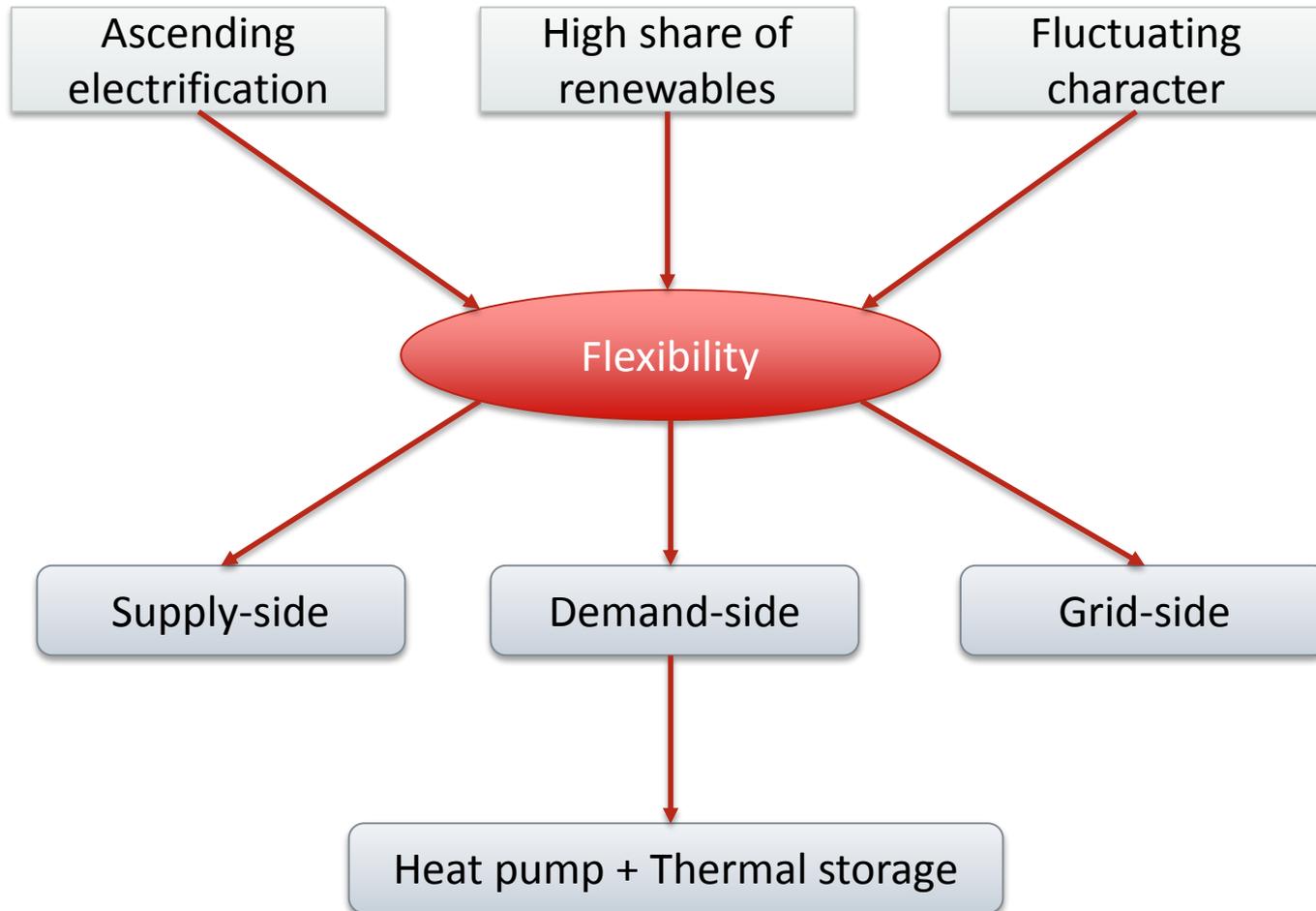
3rd International Hybrid Power Systems Workshop

Potential of a PCM-Based Storage Concept combined
with an Electric Heat Pump

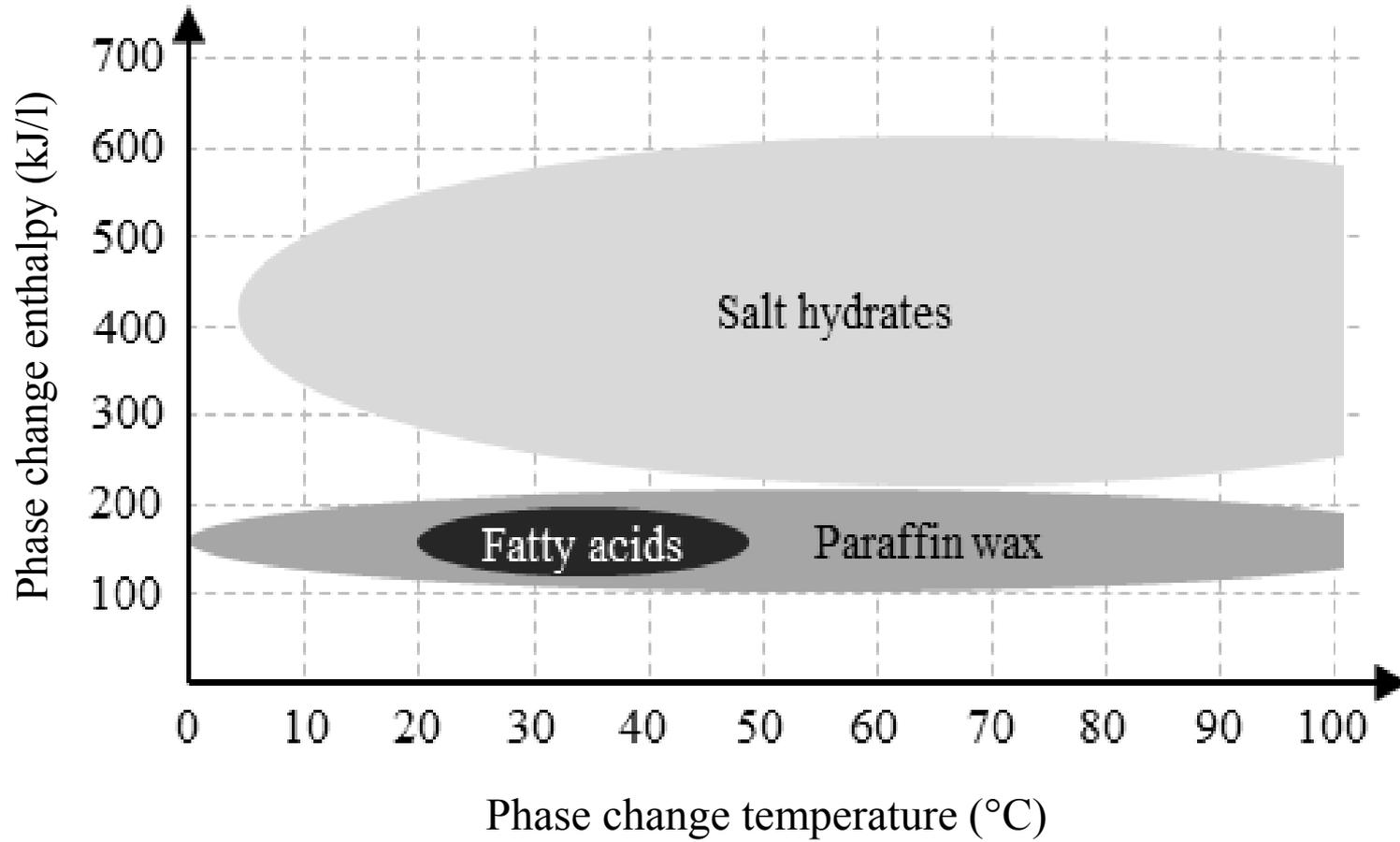
8th May 2018

Prof. Dr.-Ing. W.H. Wellßow, M. Sc. A. Benzarti
Chair for Energy Systems and Energy Management

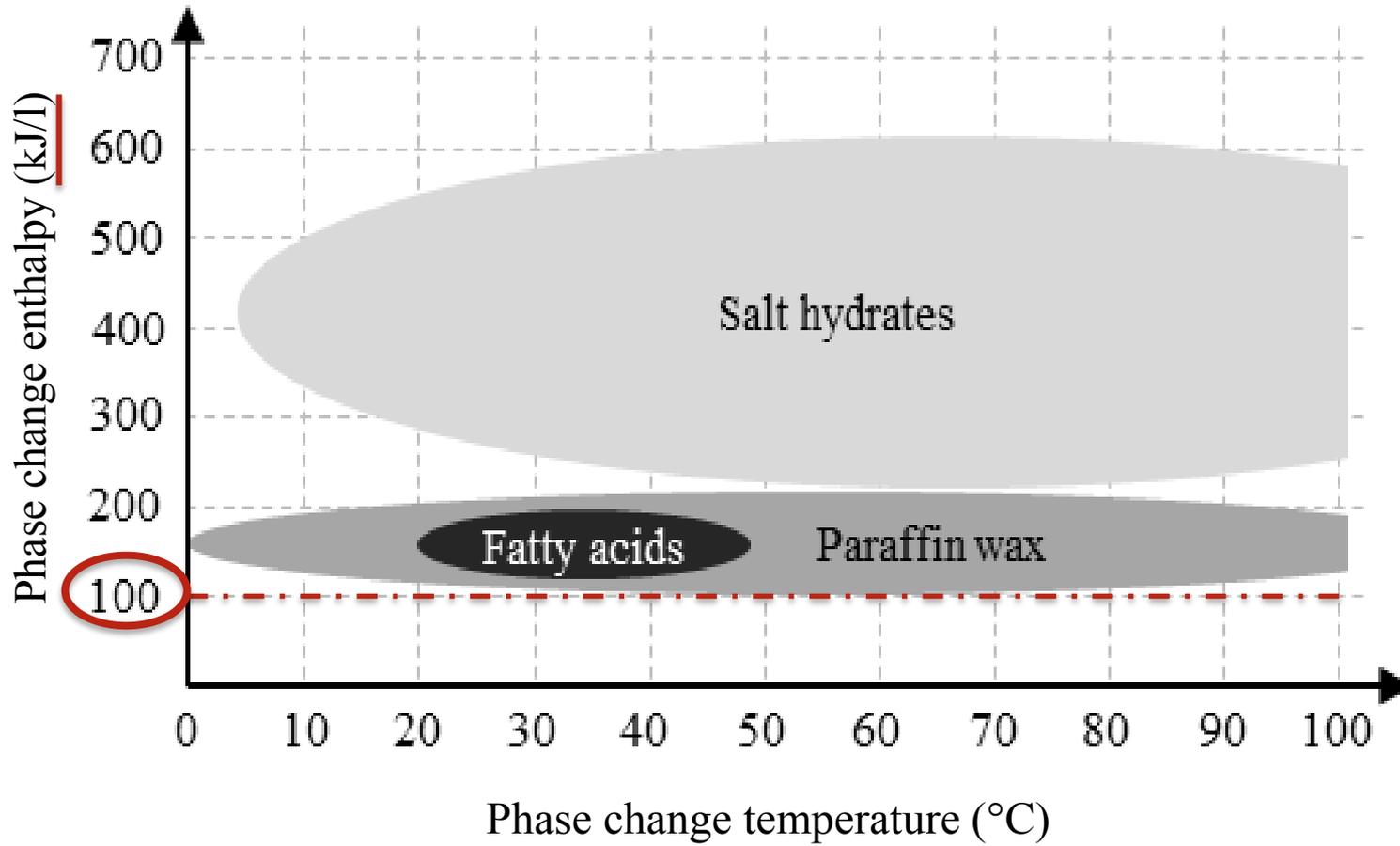




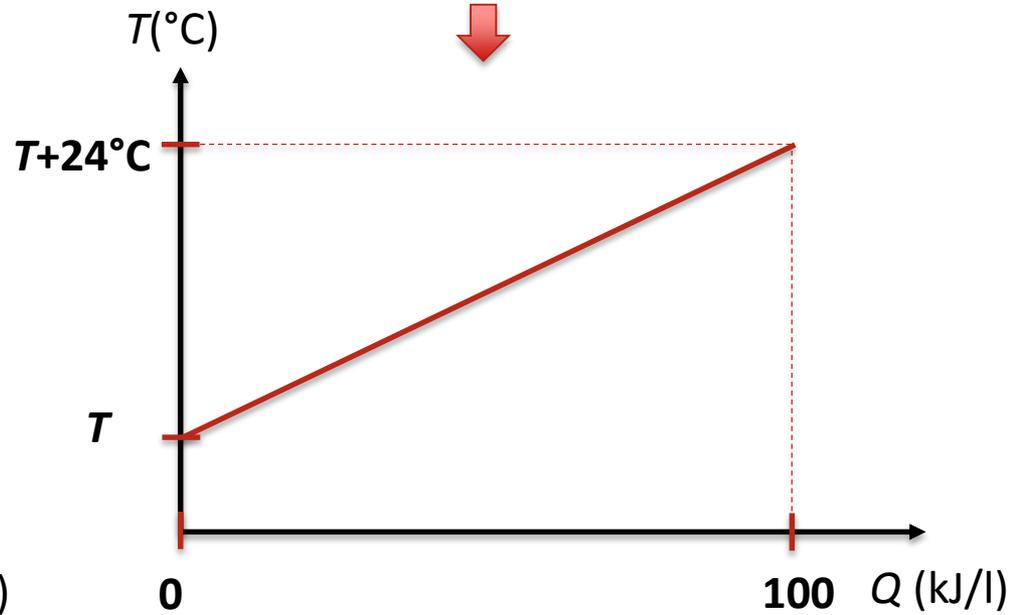
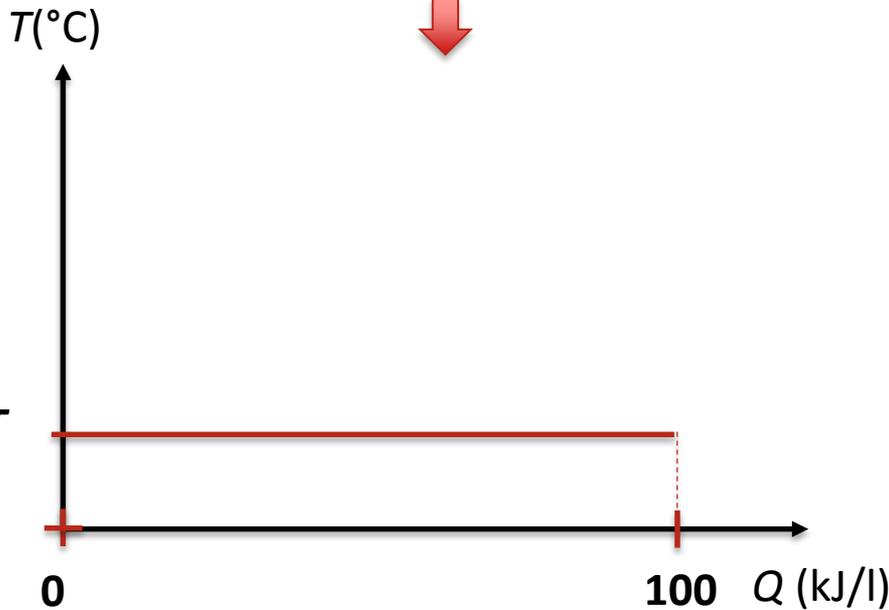
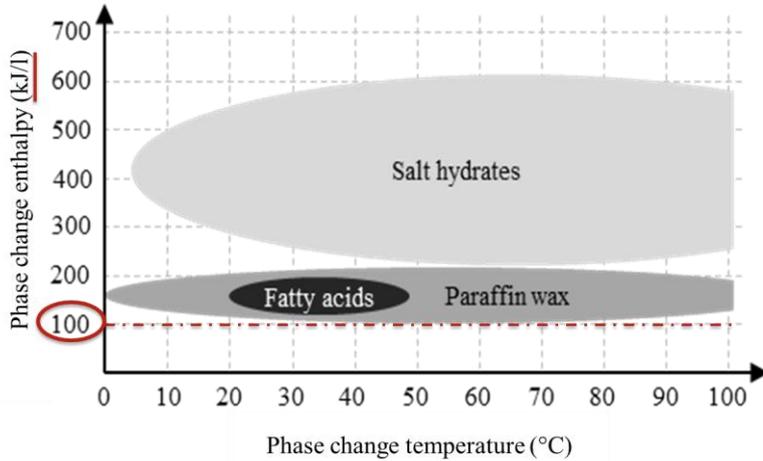
Phase Change Material (PCM)



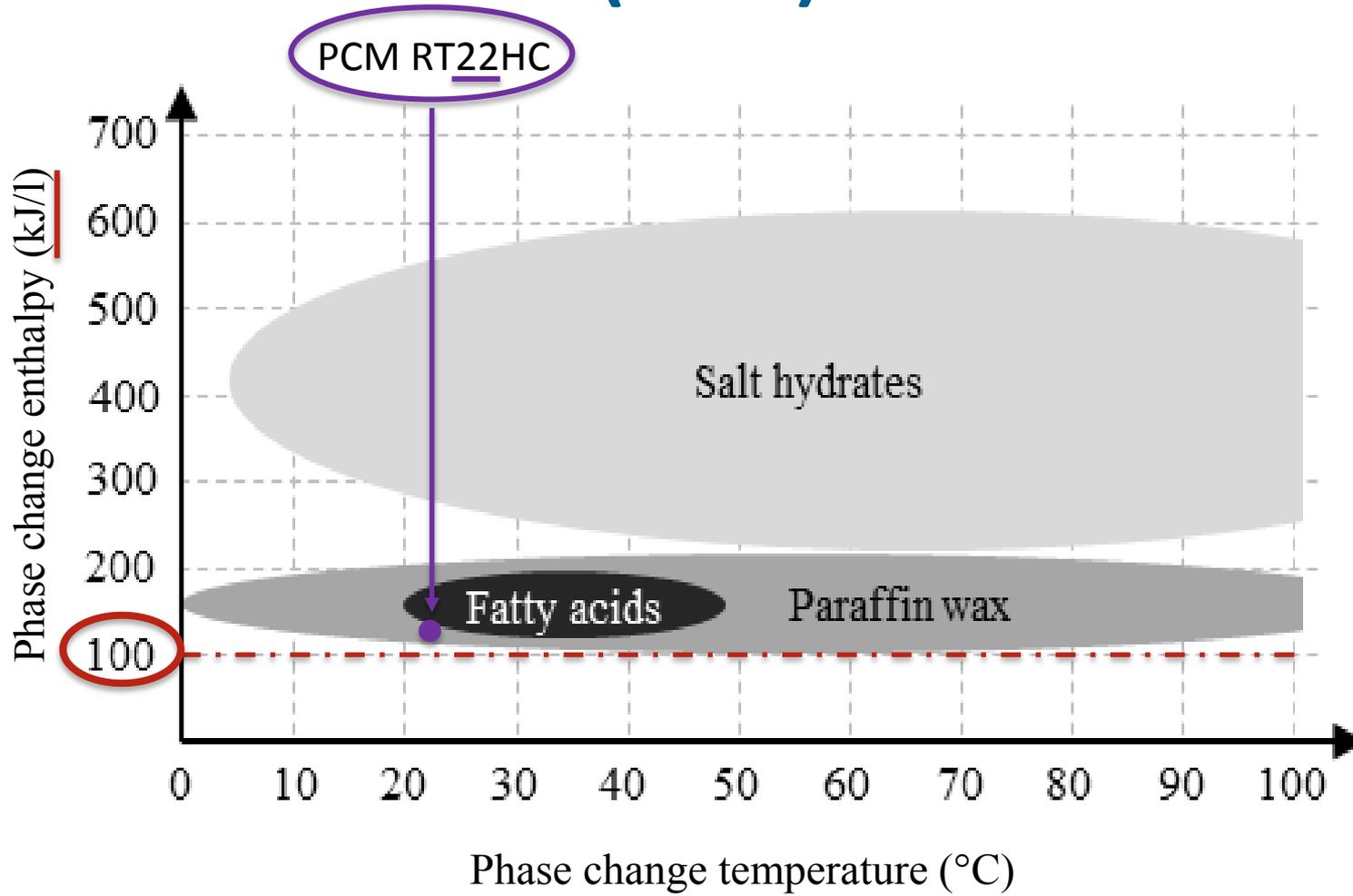
Phase Change Material (PCM)



Latent VS. Sensible



Phase Change Material (PCM)

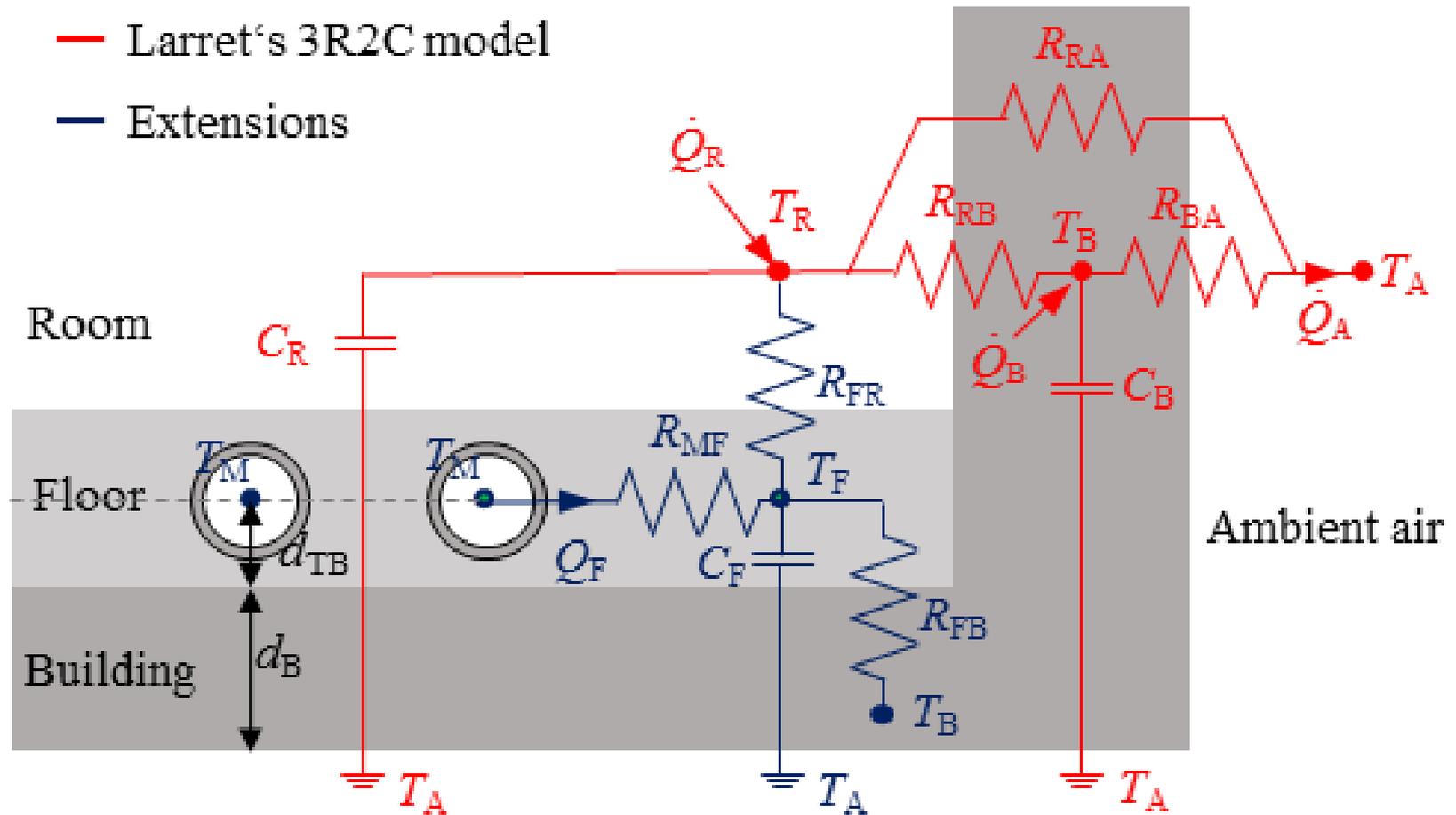


Building

Storage

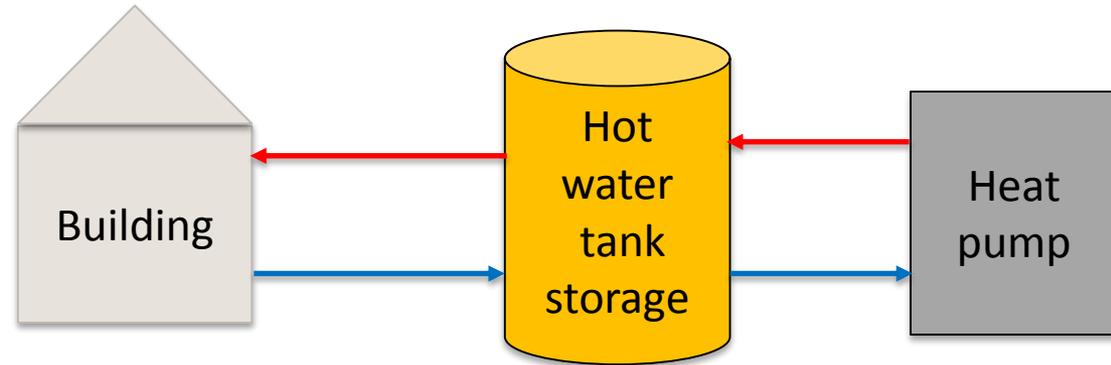
— Larret's 3R2C model

— Extensions



Building Storage

**Sensible
(REF-case)**

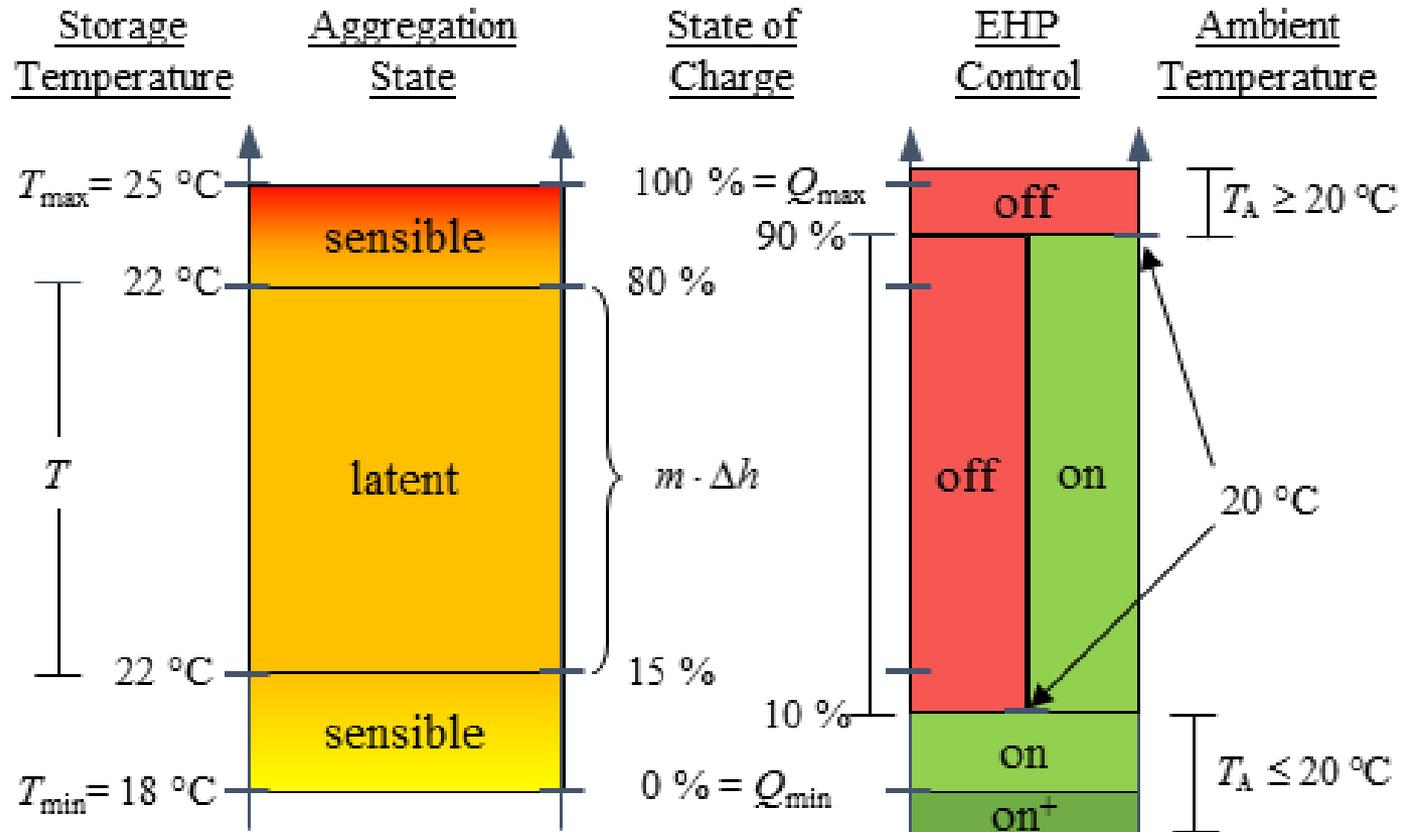


**Latent
(PCM-case)**



Building Storage

- PCM-Case
- Low storage temperature
- Very low thermal losses

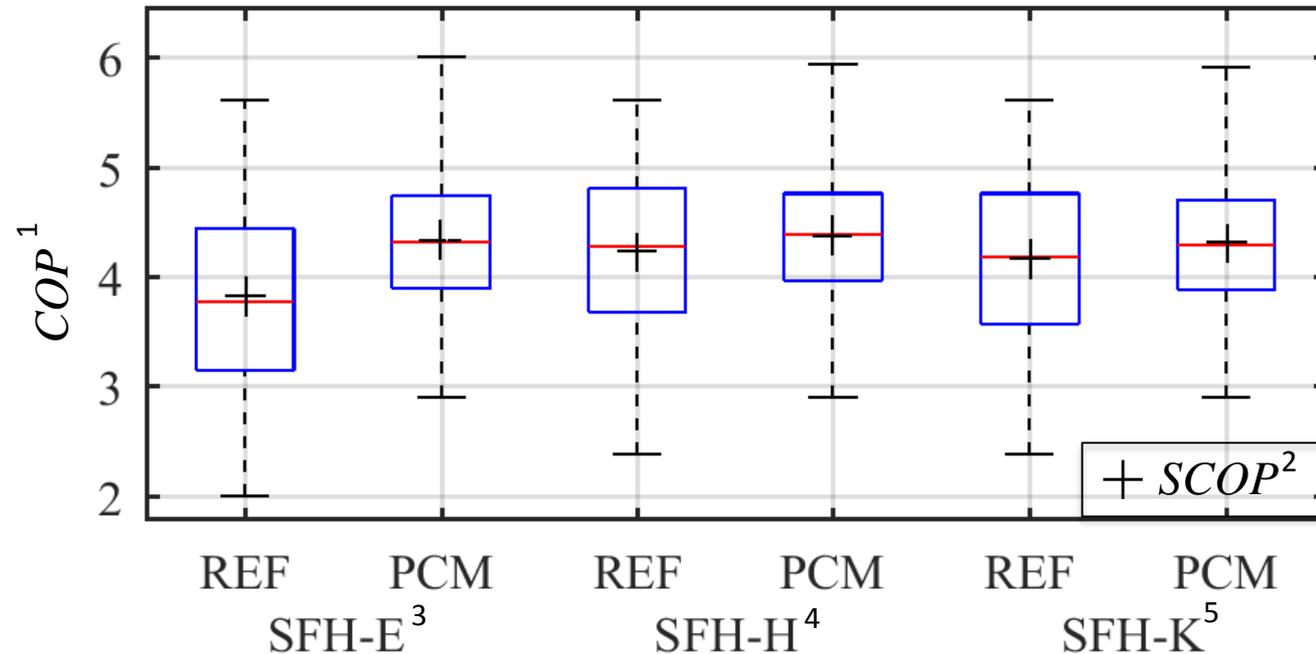


Efficiency

Comfort

Flexibility

- $SCOP_{REF} < SCOP_{PCM}$
- COP_{PCM} : Small deviations
- **Costs:**
 $\frac{OPEX_{PCM}}{OPEX_{REF}} \approx 0.8$



¹ COP: Coefficient of Performance

² SCOP: Seasonal Coefficient of Performance

³ SFH-E: Single Family House, construction year 1958-1968

⁴ H: construction year 1984-1994

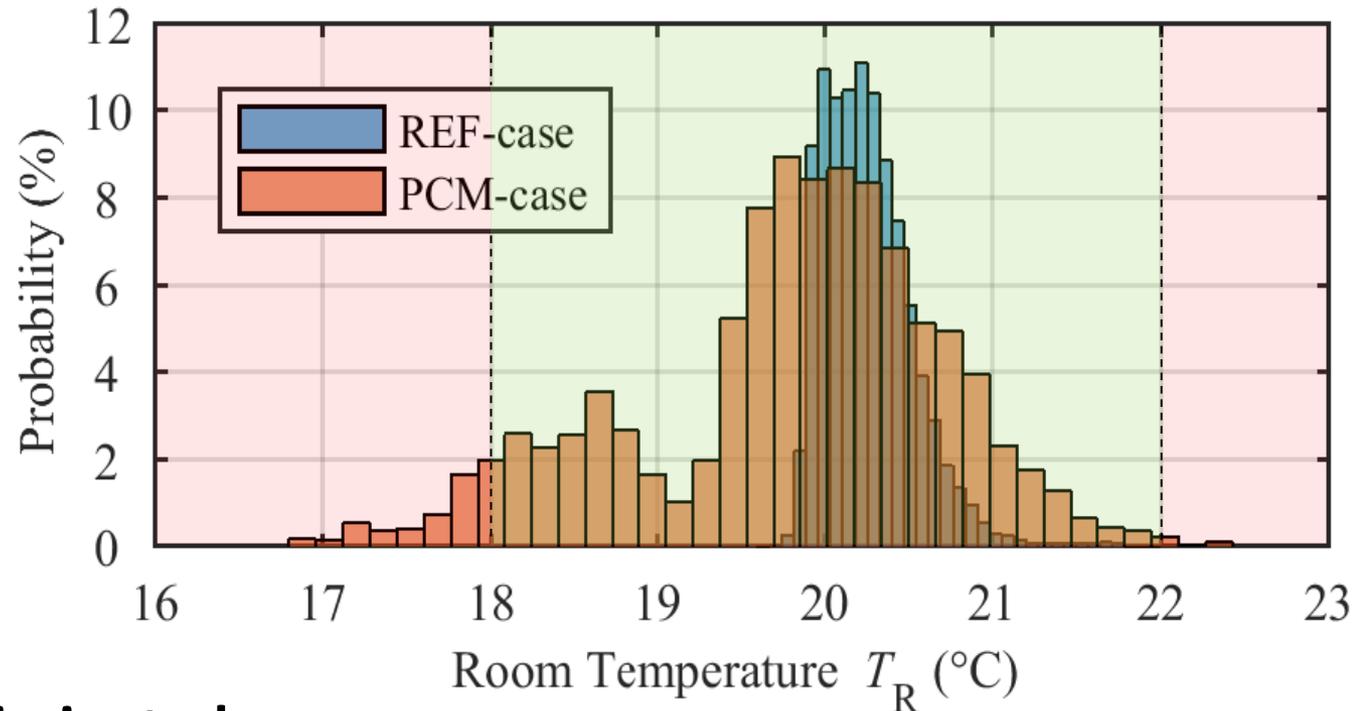
⁵ K: construction year 2010-2018

Efficiency

Comfort

Flexibility

- SFH-H
- $T_{\text{tar}} = 20 \text{ }^\circ\text{C}$
- $\Delta T_{\text{tol}} = \pm 2 \text{ }^\circ\text{C}$
- 3 % discomfort for the PCM-case



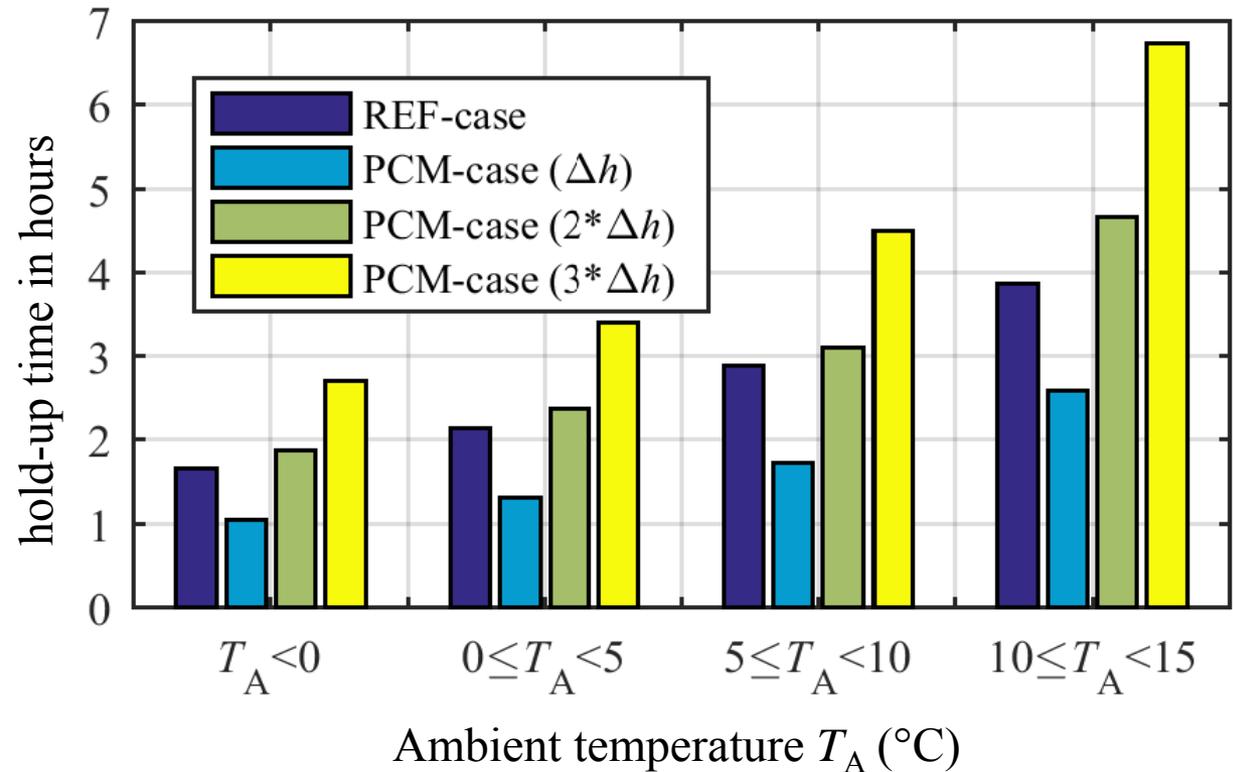
➔ **Can be easily eliminated**

Efficiency

Comfort

Flexibility

- SFH-H
- Strongly depending on:
 - Ambient temperature T_A
 - Storage material
 - Storage volume



Δh : Phase change enthalpy of the PCM RT22HC

- The **SCOP** could be **improved up to 13 %**
 - Attractive for **heat pump manufacturers** as the efficiency can be increased
- Heating **costs** could be **reduced** about a **fifth**
(small degradation in comfort)
 - Savings for **end costumers**
- **Hold-up time** of heat pumps can be **increased**
 - Huge flexibility potential on the demand side for **grid operators**
- **Only PCM** allows **significant hold-up times** in combination with
building **core activation**

- Improvement of the control scheme
- Improvement of the system dimensioning
- Assessment on alternative PCM with higher storage capacity
- Examination of the effects of additional wall activation

Thank you for your attention!

M. Sc. Anes Benzarti
University of Kaiserslautern
Chair for Energy Systems and Energy Management
Erwin-Schroedinger-Strasse
D -67663 Kaiserslautern
benzarti@eit.uni-kl.de
www.eit.uni-kl.de/esem