ENERGY FLEXIBILITY OF THERMAL ENERGY STORAGE IN THE CONTROL OF BUILDING ENERGY SYSTEMS

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Outline

I. Main objective PhD
II. Thermal energy storage (TES) in buildings
III. Simulation case study “Energy flexibility of TES in buildings with optimal control”
IV. Current work

I. Main objective PhD

Determination and validation of energy flexibility of thermal energy storage (TES) in the control of building energy systems

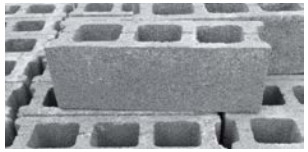
- potential energy flexibility of different TES in buildings
- potential control strategies enabling energy flexibility of TES in buildings
- simulation/experimental case studies

II. Thermal energy storage in buildings

Power density

Energy density

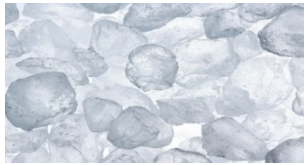
Water (hot-HW, cold)



Building thermal mass (BTM)

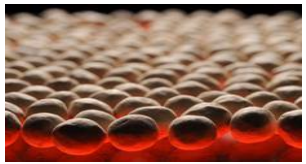
Sensible

Phase change materials (PCM)



Ice

Latent

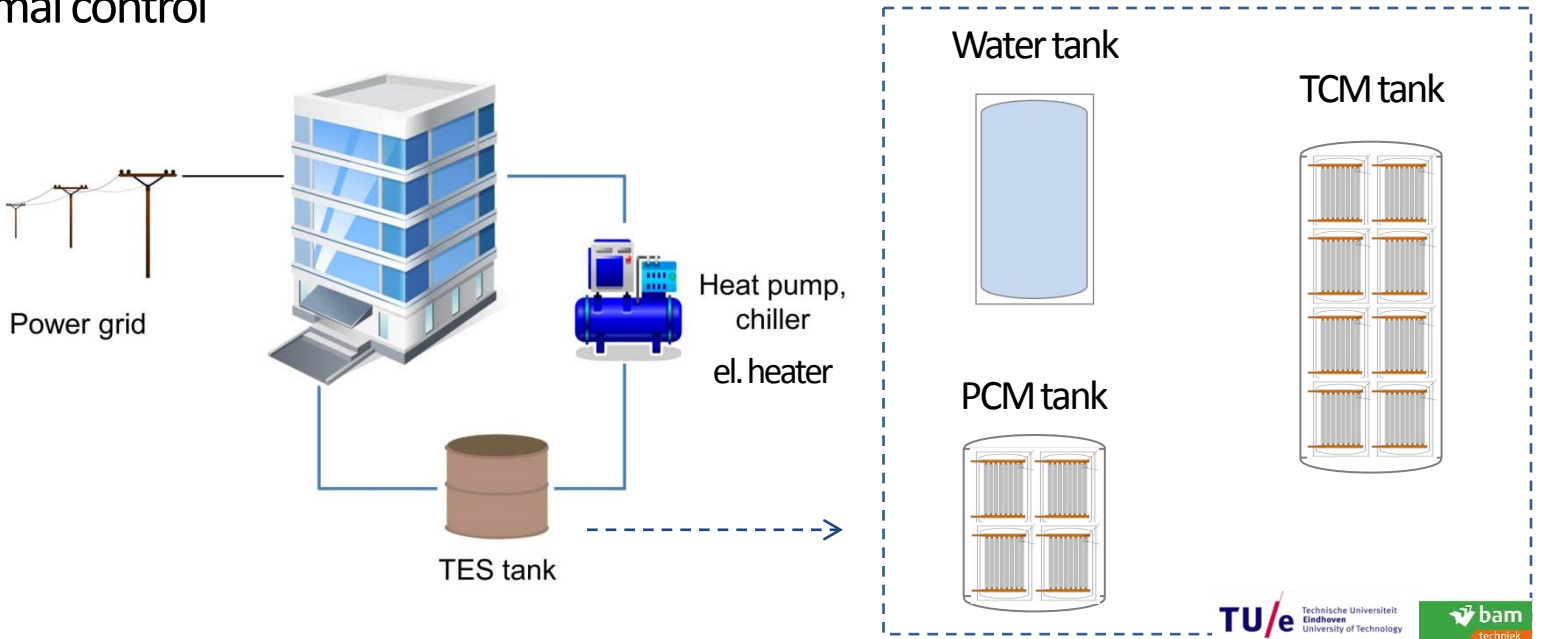


Thermo-chemical materials (TCM)

Thermo-chemical

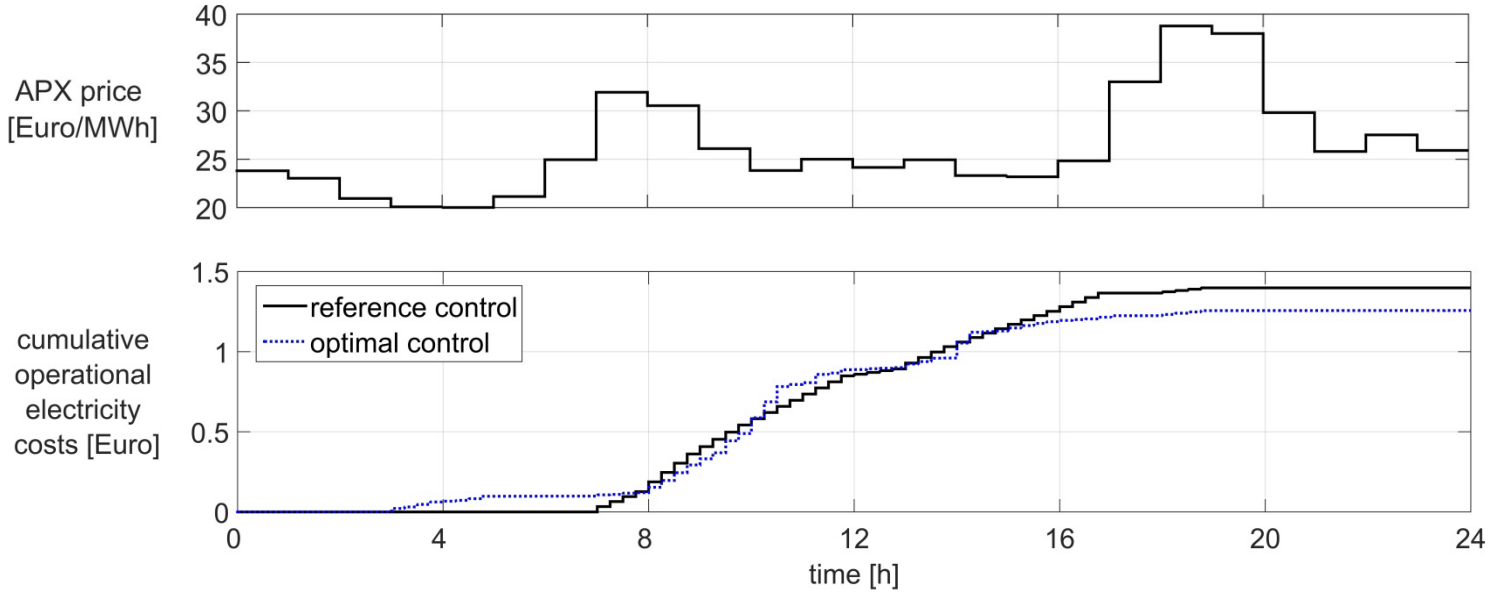
III. Simulation case study - “Energy flexibility of TES in buildings with optimal control”

Objective: Comparison of short-term energy flexibility of **different TES tanks** using optimal control



https://openclipart.org/

Objective: Comparison of **short-term** energy flexibility of different TES tanks using **optimal control**



Objective: Comparison of short-term **energy flexibility** of different TES tanks using optimal control

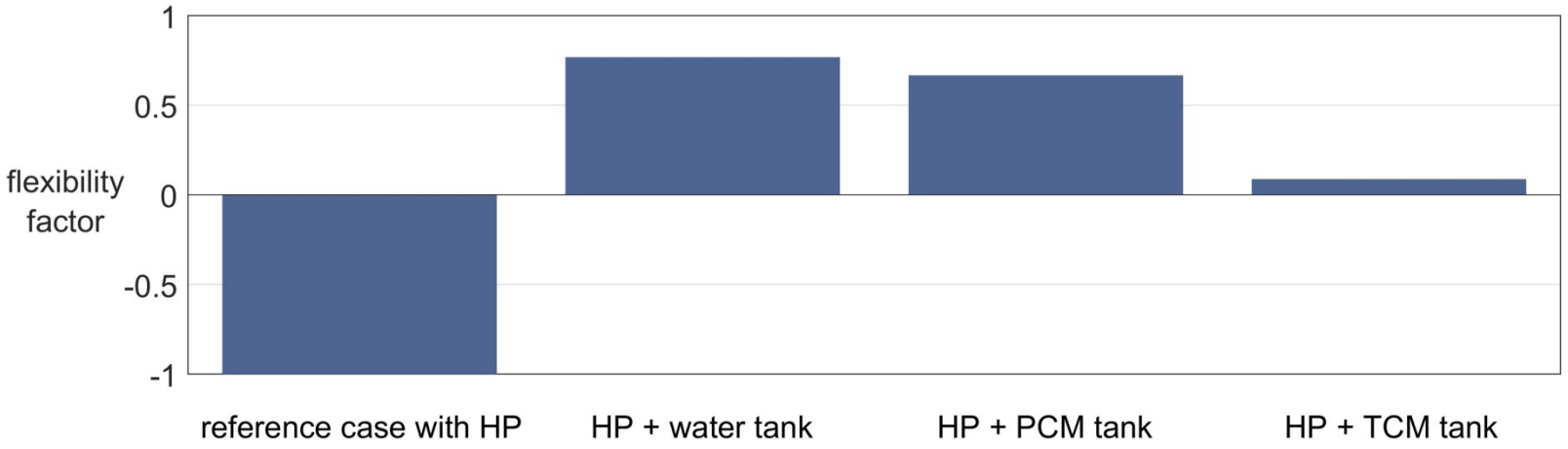
→ Determination of energy flexibility using key performance indicators *

$$flexibility\ factor \quad (ablility\ to\ shift\ energy\ use\ for\ heating)$$

$$flexibility\ factor = \frac{\int q_{heating,\,low\ price\ time}\ dt\ -\ \int q_{heating,\,high\ price\ time}\ dt}{\int q_{heating,\,low\ price\ time}\ dt + \int q_{heating,\,high\ price\ time}\ dt}$$

* *Overview of flexibility indicators in: Clauss, Finck, Vogler-Finck, Beagon – 2017 – BS2017 "Control strategies for building energy systems to unlock demand side flexibility – A review"*

Simulation results short-term energy flexibility with optimal control:



Conclusions from case study:

- Water, PCM, and TCM tanks can be designed to provide short-term energy flexibility
- Water, and PCM tanks can achieve higher short-term energy flexibility than TCM tanks
- Flexibility factor has limitations

  → Further work on flexibility indicators using optimal control

IV. Current work

Experimental case study "Model-predictive control (MPC) of heating system with water TES in a Dutch residential building providing short-term energy flexibility"

System set up:

- 23 m² PVT (Triple Solar)
- 8 kW HP (NIBE)
- 800 l space heating water tank
- 180 l domestic hot water tank

Thank you for your attention

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