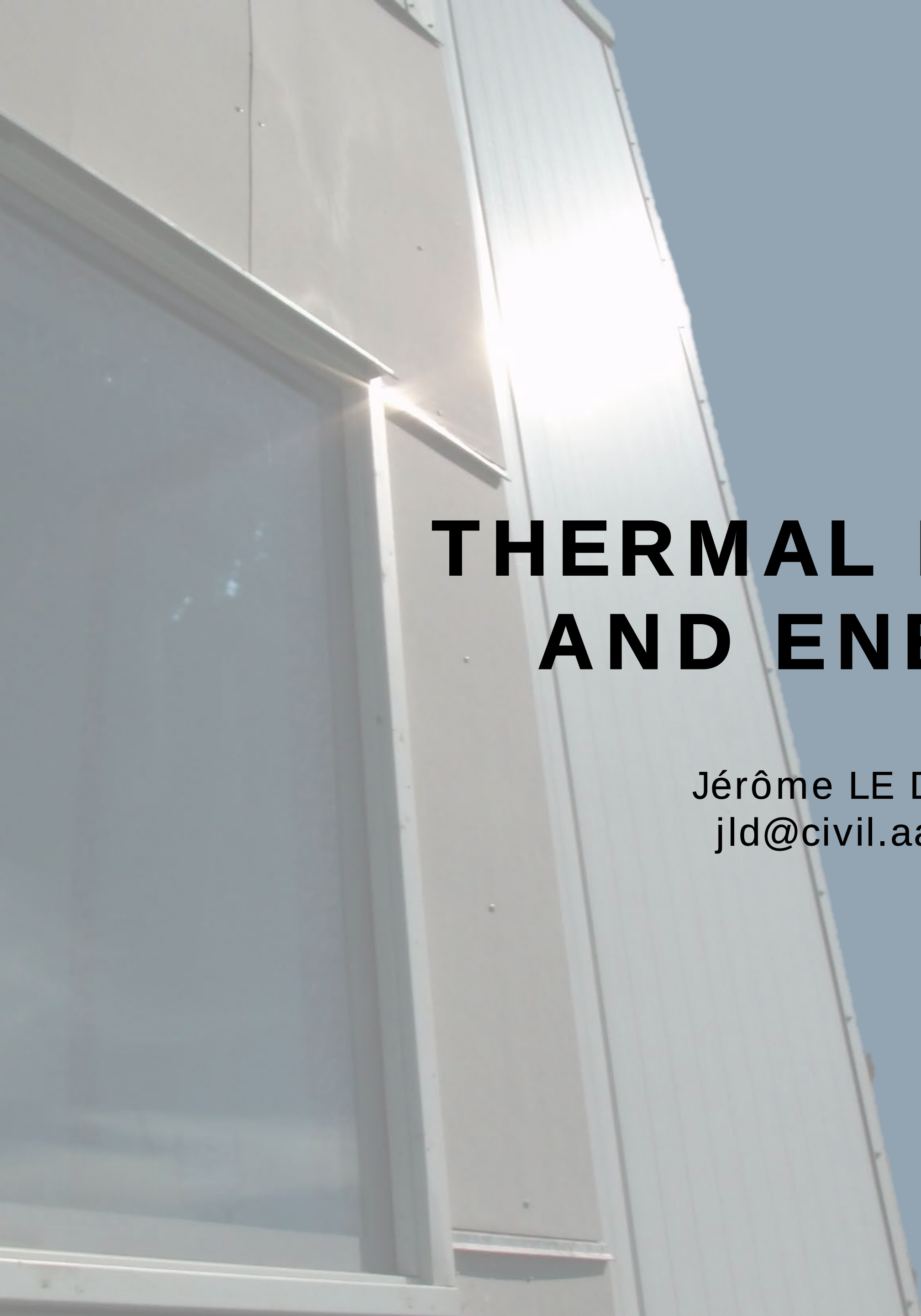

THERMAL MASS IN BUILDINGS AND ENERGY FLEXIBILITY

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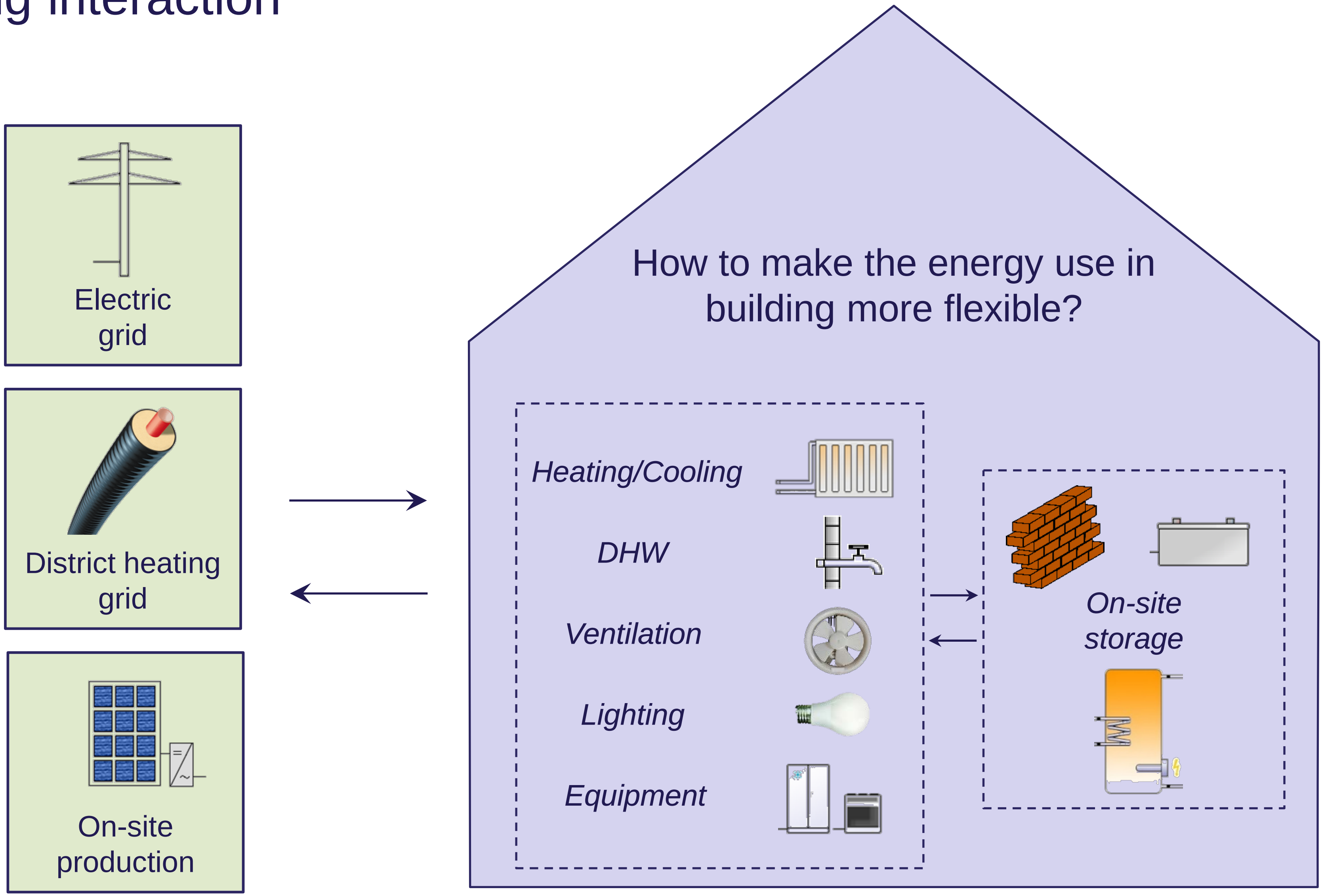
CITIES project (*27/05/2015*)
WP 3 - Intelligent Energy System Integration

Grid / Building interaction



Pictures: Polysun

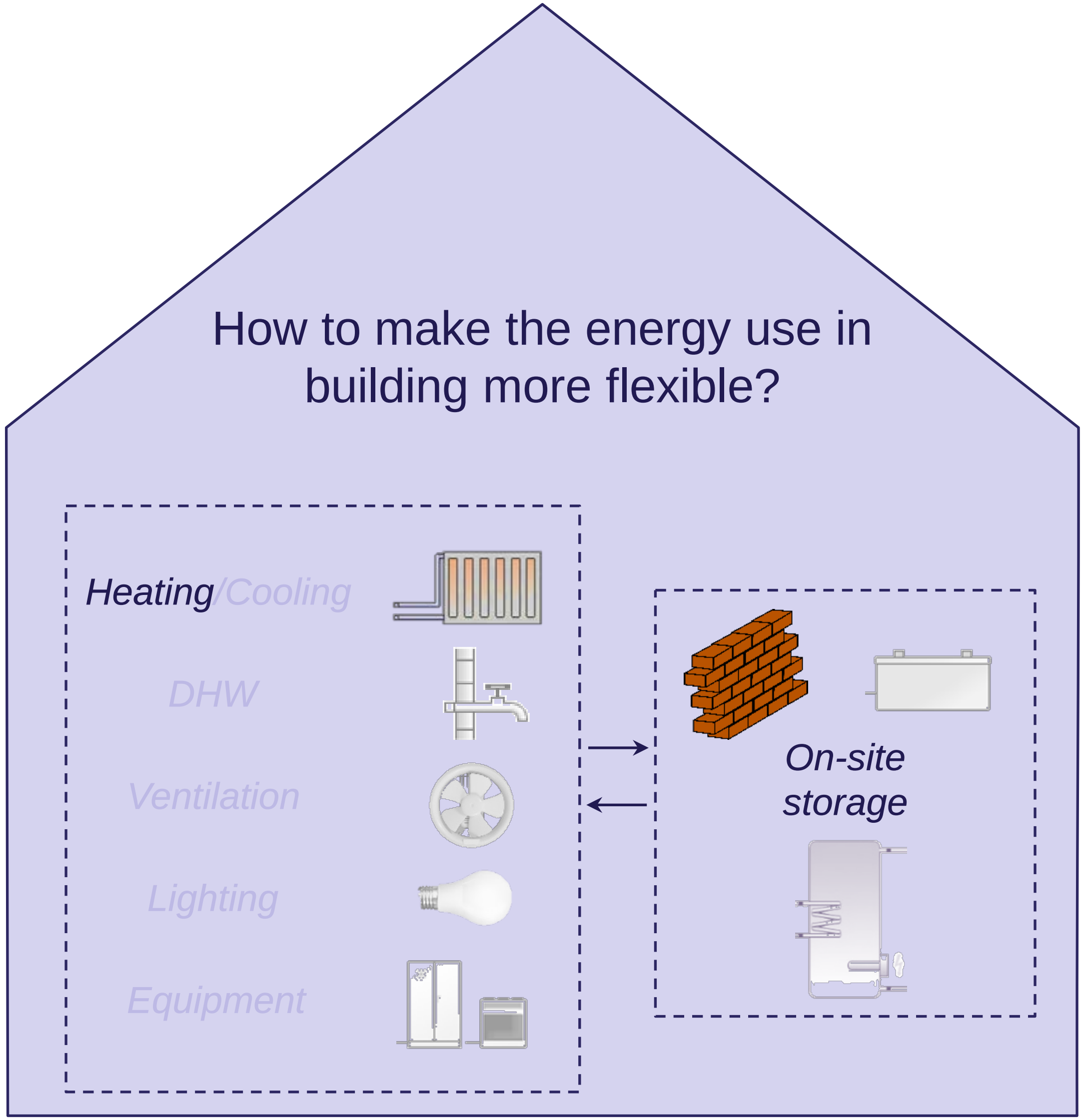
Scope and Objectives

Scope: space heating for residential applications with storage in the thermal mass of the building

Objectives: quantify the flexibility of different terminals for heating

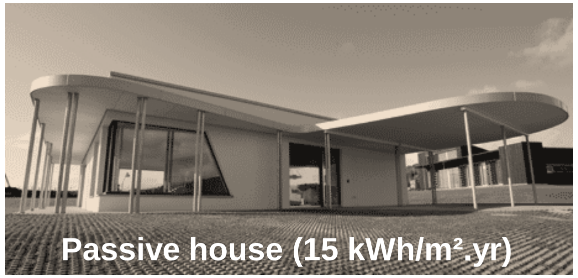
- Storage
- Heat release

Building stock

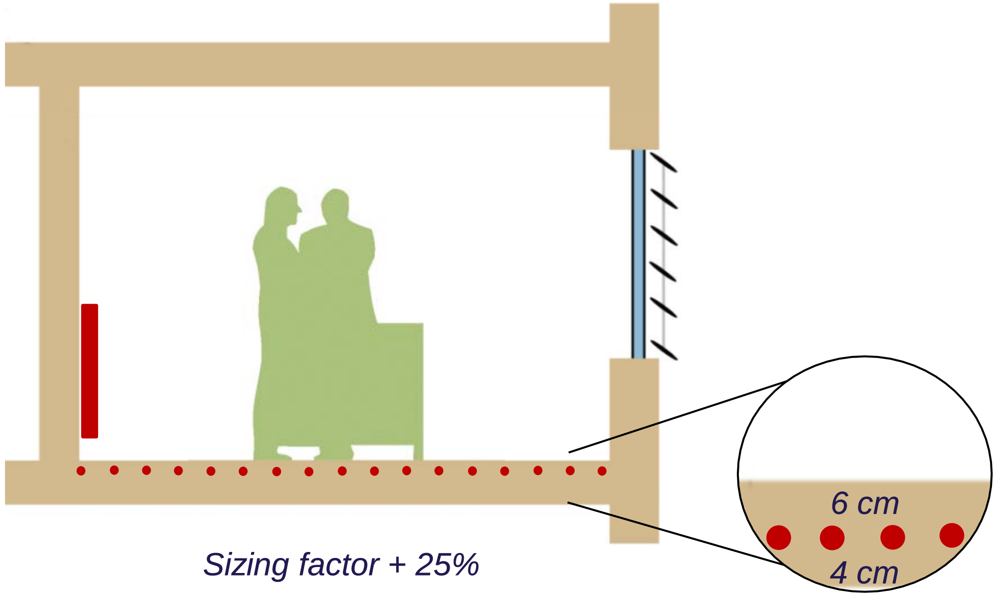


Parameter variation

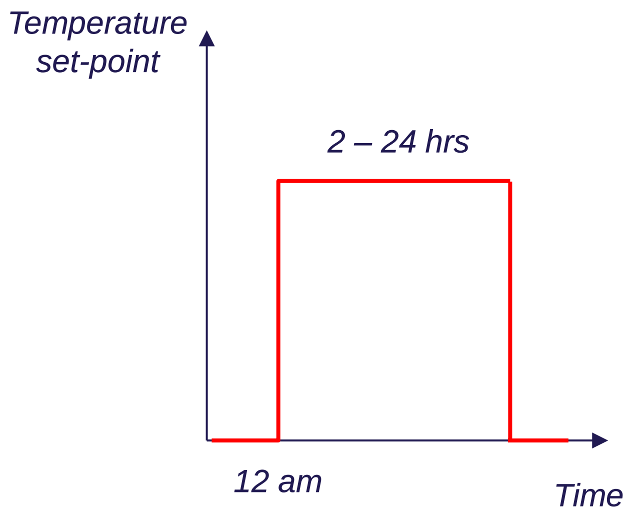
Type of buildings



Type of emitters



Length of activation



U_{walls} = 0.32 W/m².K
Natural ventilation 0.4 ACH
Infiltration 0.2 ACH

Thermal mass: light (44 Wh/K.m²)
τ = 27 hrs

Heating set-point: 20°C
Design power: 75 W/m²
Primary water tmp: 70°C radiator, 40°C UH

U_{walls} = 0.09 W/m².K
Mechanical ventilation 0.4 ACH (η = 0.8)
Infiltration 0.07 ACH

Thermal mass: medium (53 Wh/K.m²)
τ = 105 hrs

Heating set-point: 21°C
Design power: 15 W/m²
Primary water tmp: 45°C radiator, 30°C UH

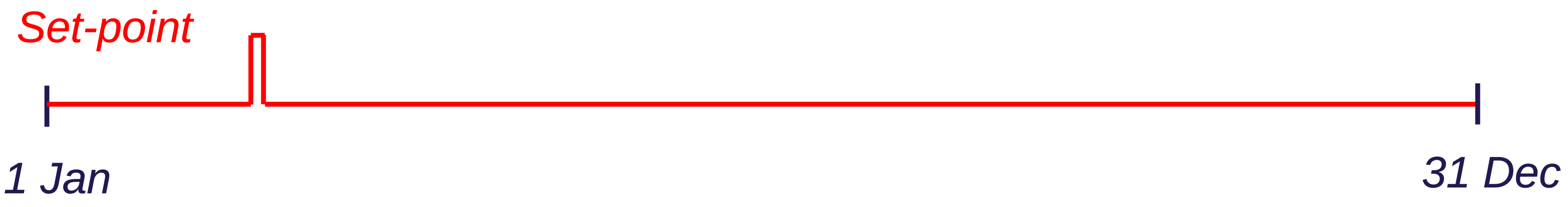
Simulations

Main characteristics:

- Danish weather file (DRY.v2)
- Equipment load from hourly pattern (*Marszal et al., 2015*)
- 8 thermal zones
- Solver: time-step 2 minutes, conduction modelled using FDM

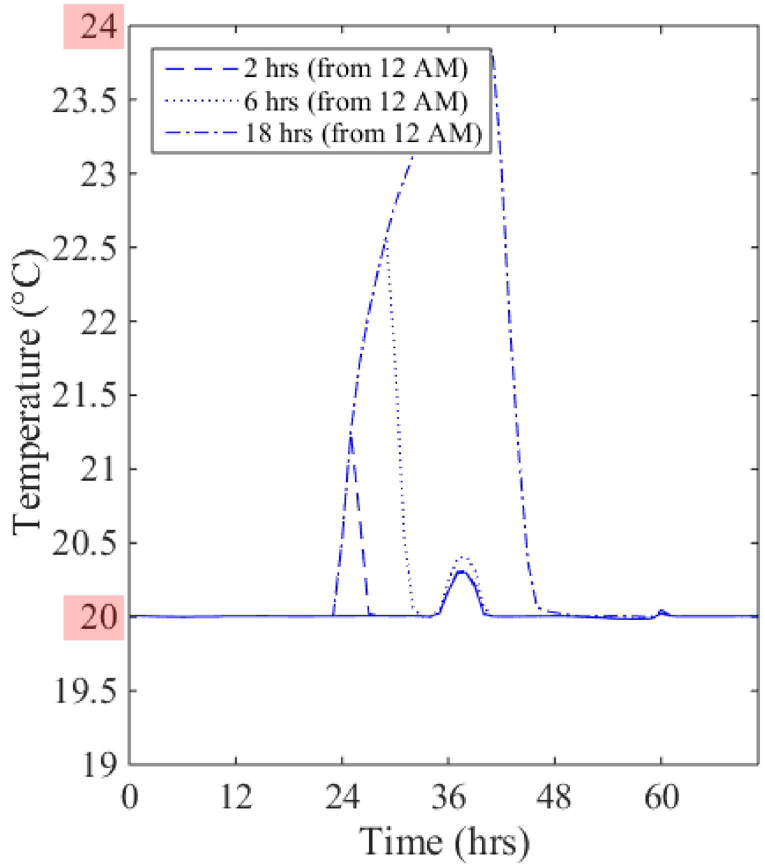
Simulation procedure:

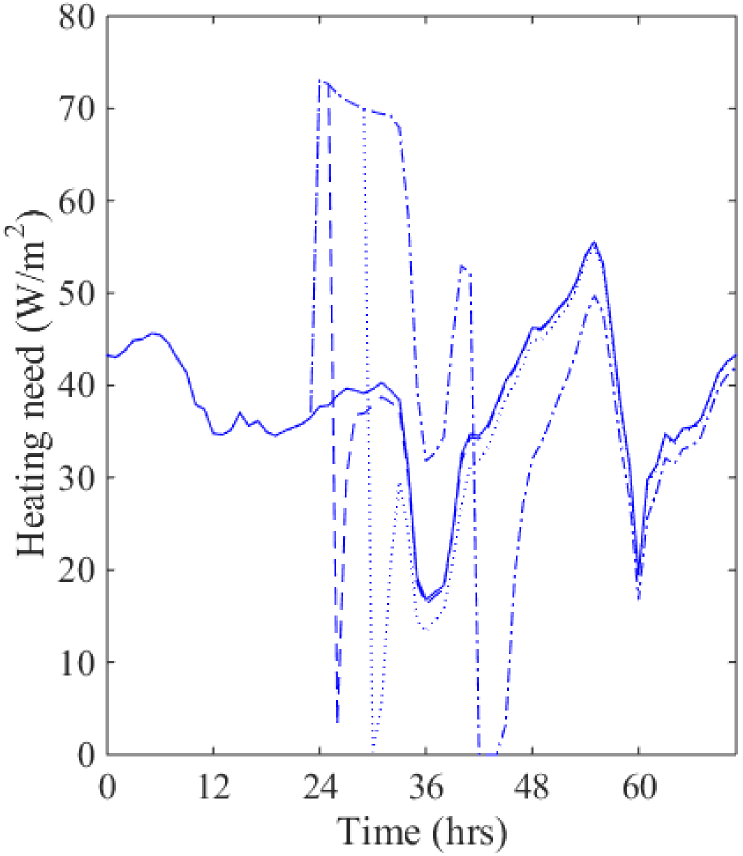
- Single activation at different time of the year
- No interaction between activations (i.e. full discharge)



× 365 activations

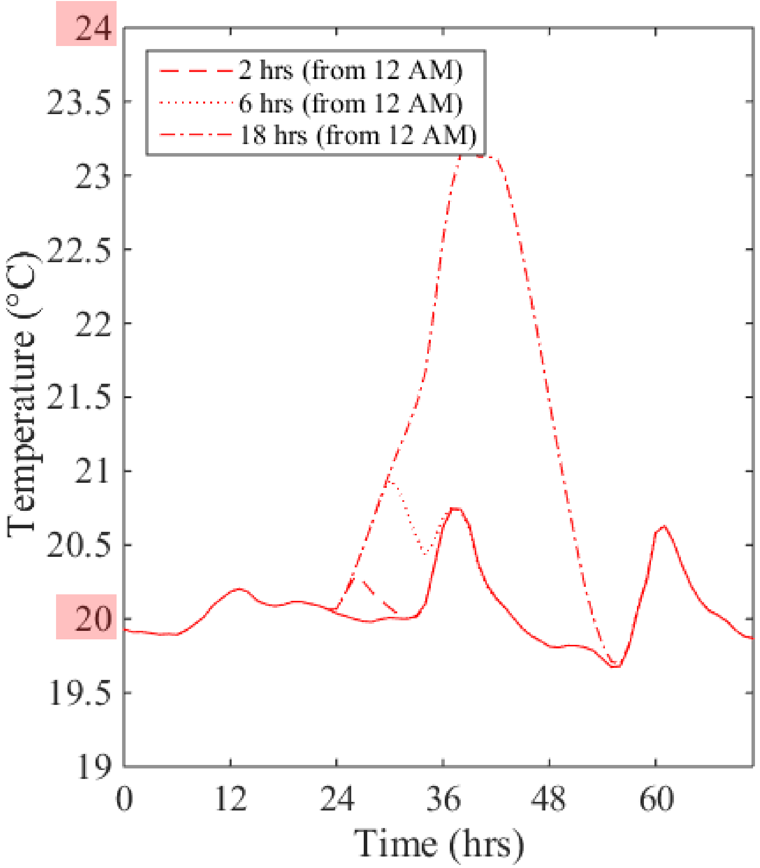
Radiator *[20th of January]*

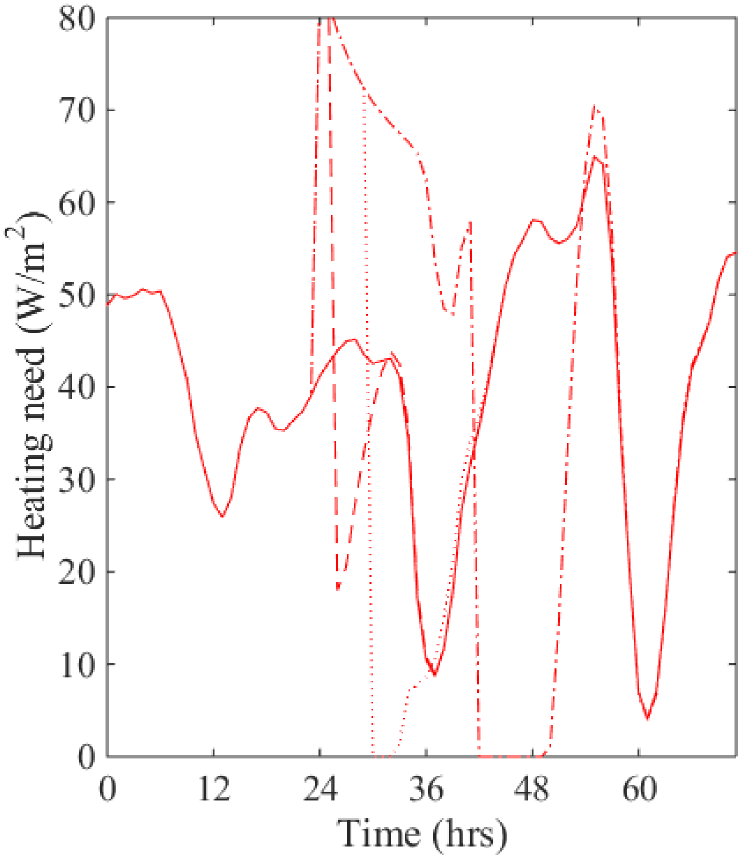




- Large influence on the indoor temperature
- Small potential for full disconnection

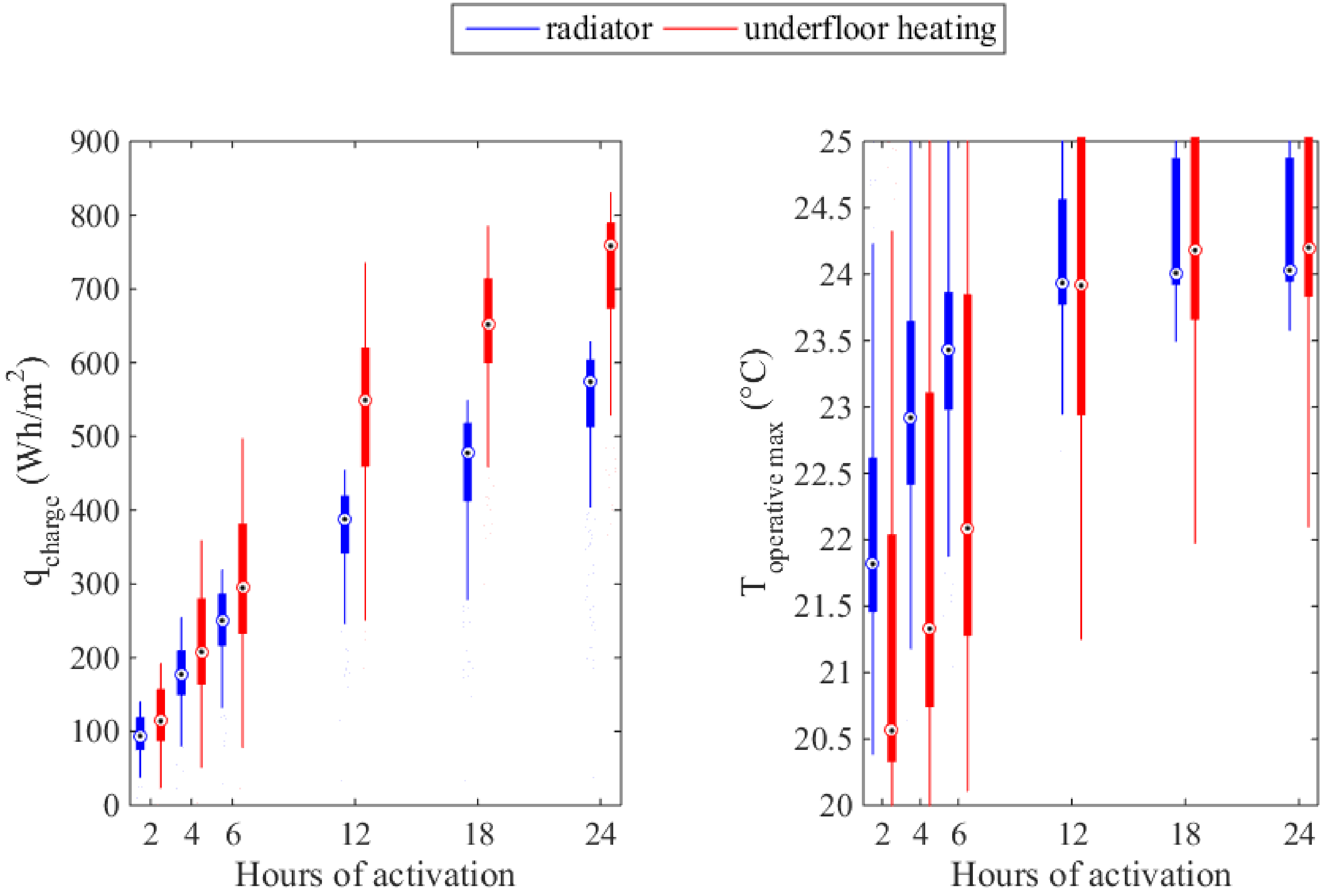
Underfloor heating (UH) *[20th of January]*





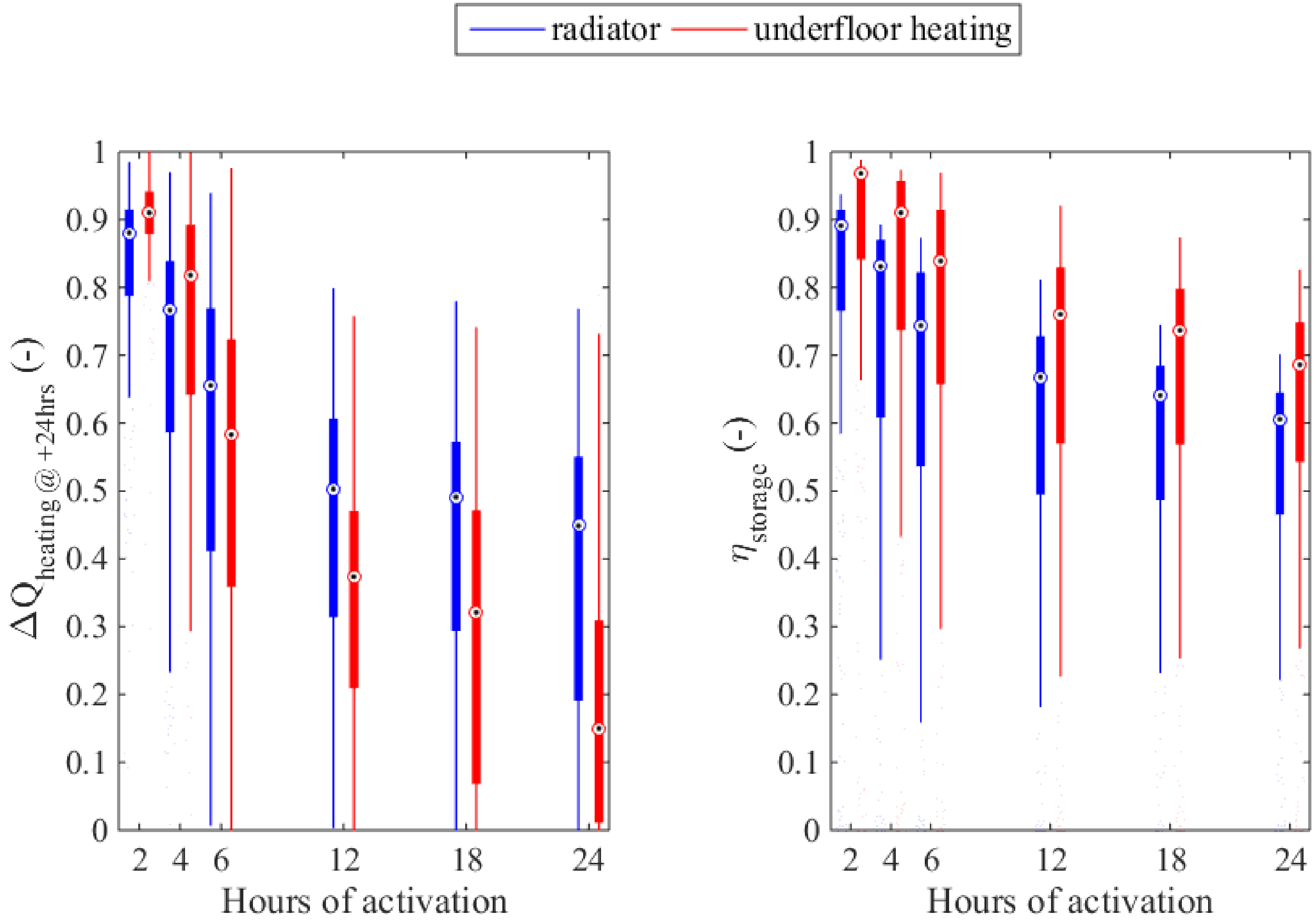
- Low influence on the indoor temperature

Radiator vs. Underfloor heating *[All days of heating season]*

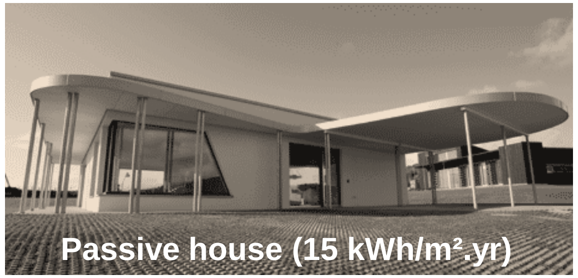


- Lower influence of UH on the indoor environment
- Lager charging potential of UH, but risk of overheating

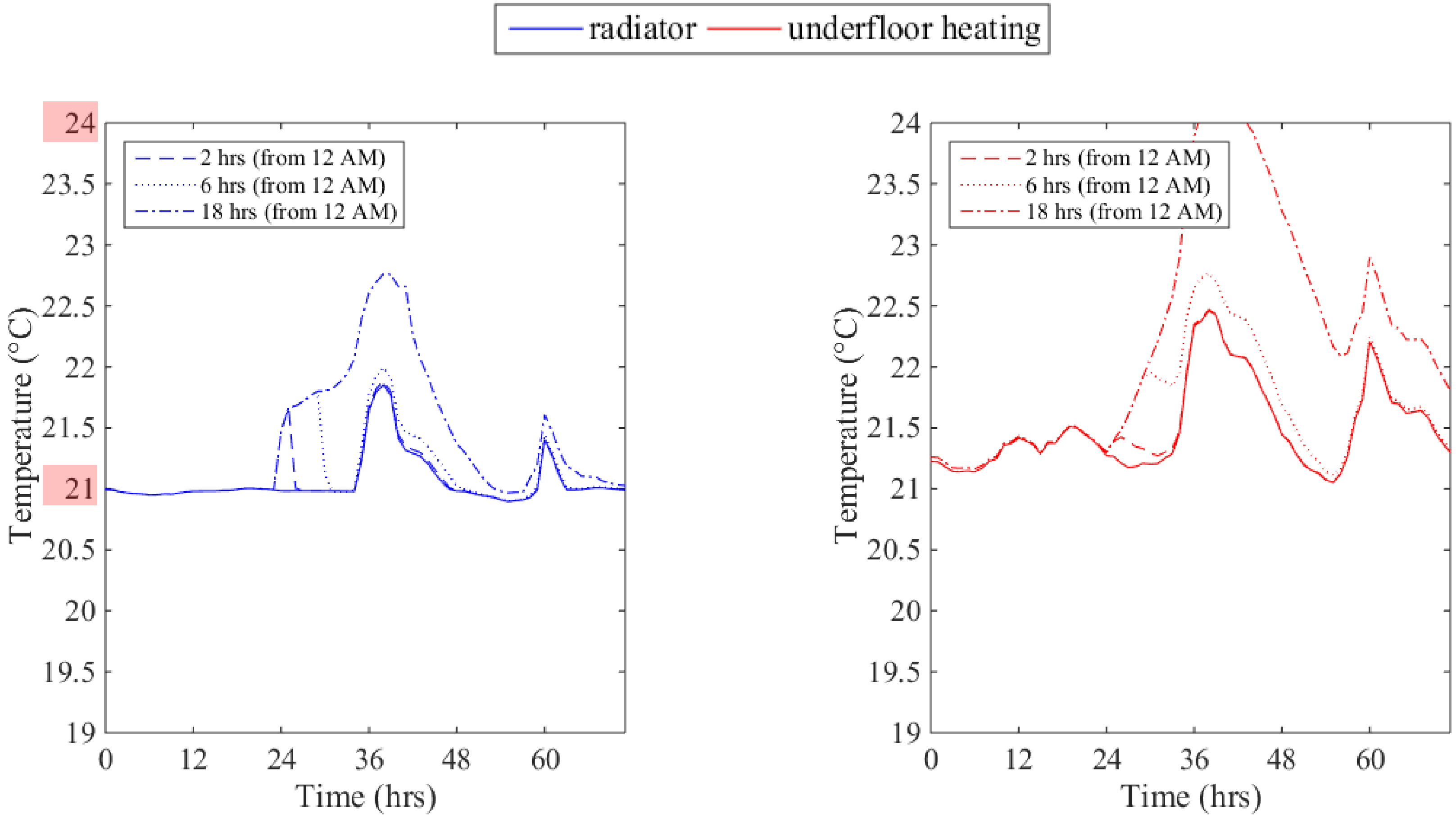
Radiator vs. Underfloor heating *[All days of heating season]*



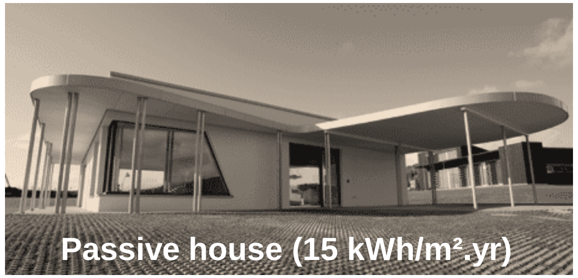
- Large differences between cold & transition seasons
- Efficiency storage between 0.9 and 0.6
- Efficiency of floor heating storage better



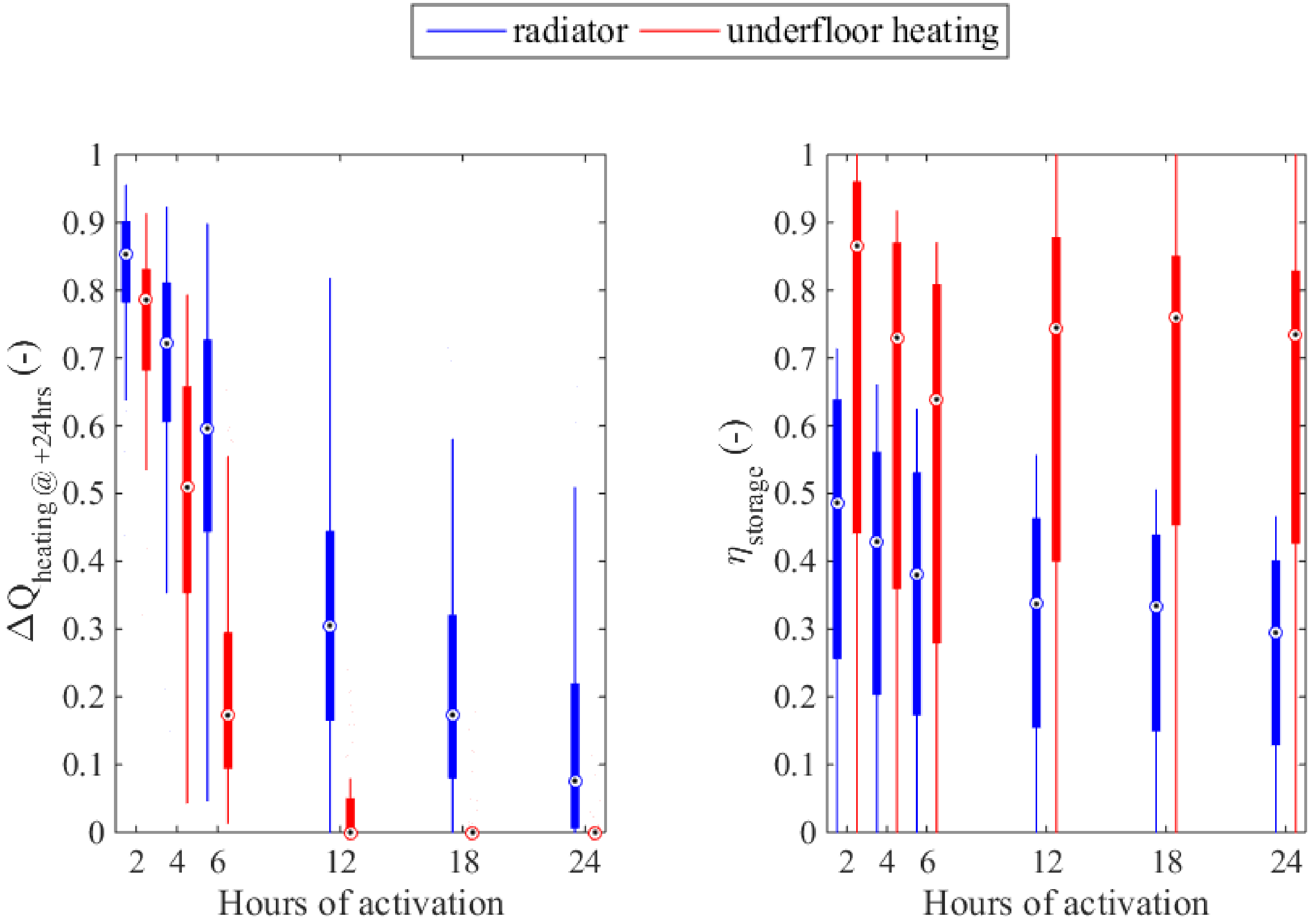
Radiator vs. Underfloor heating [20th of January]



- Increase of the risk of overheating



Radiator vs. Underfloor heating



- Efficiency of radiator much lower than UH

Conclusions

- Estimation of the efficiency of storage
- Differences between radiator and underfloor heating (T_{op}, Charge, efficiency)
- Risk of overheating (for charges over 6 hrs)
- Passive house vs. BR 79 (time constant)

Future work

- Analysis of comfort (e.g. overheating)
- Analysis of the discharge curves (differences radiator/underfloor heating)
- Validation with experimental data (district heating in Sweden)
- Simulation with other types of buildings (e.g. terraced houses)

How to perform the activation in practise?

From the primary circuit

Weather-compensation
(emitters with valves or TRV with large P-band)

From the emitter

Control of digital thermostatic valves

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