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#SESAAU2019

EnergyVille

Simulation-based assessment of energy flexibility offered by the thermal capacity in district heating network pipes

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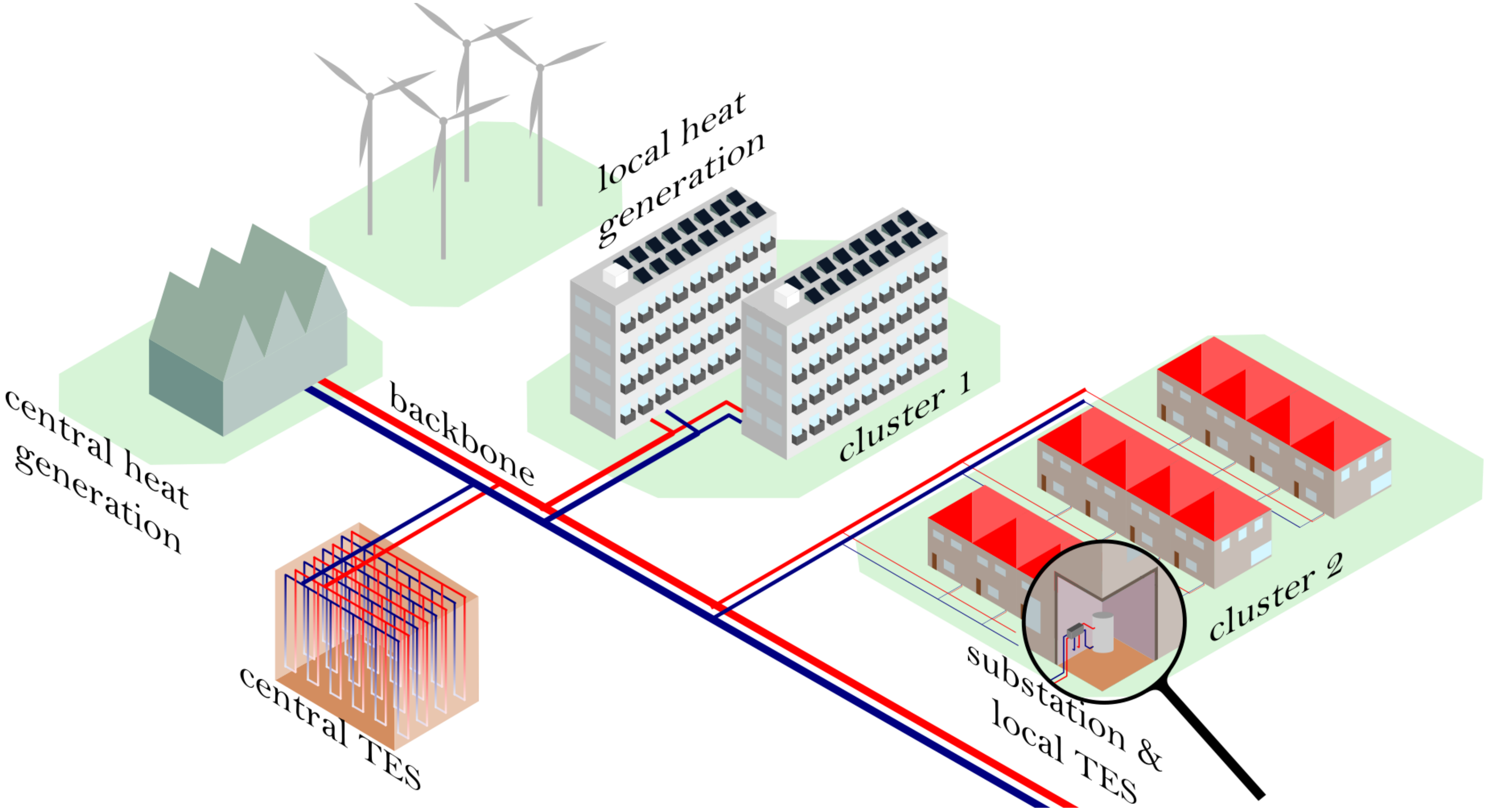
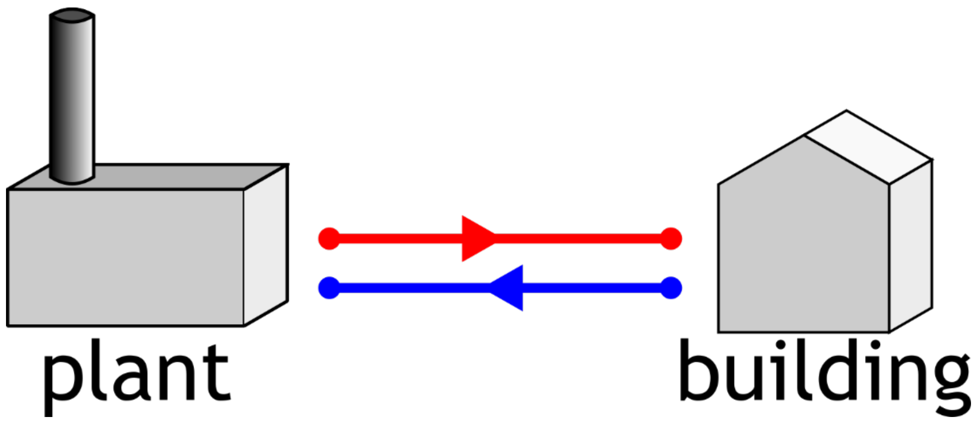
Context

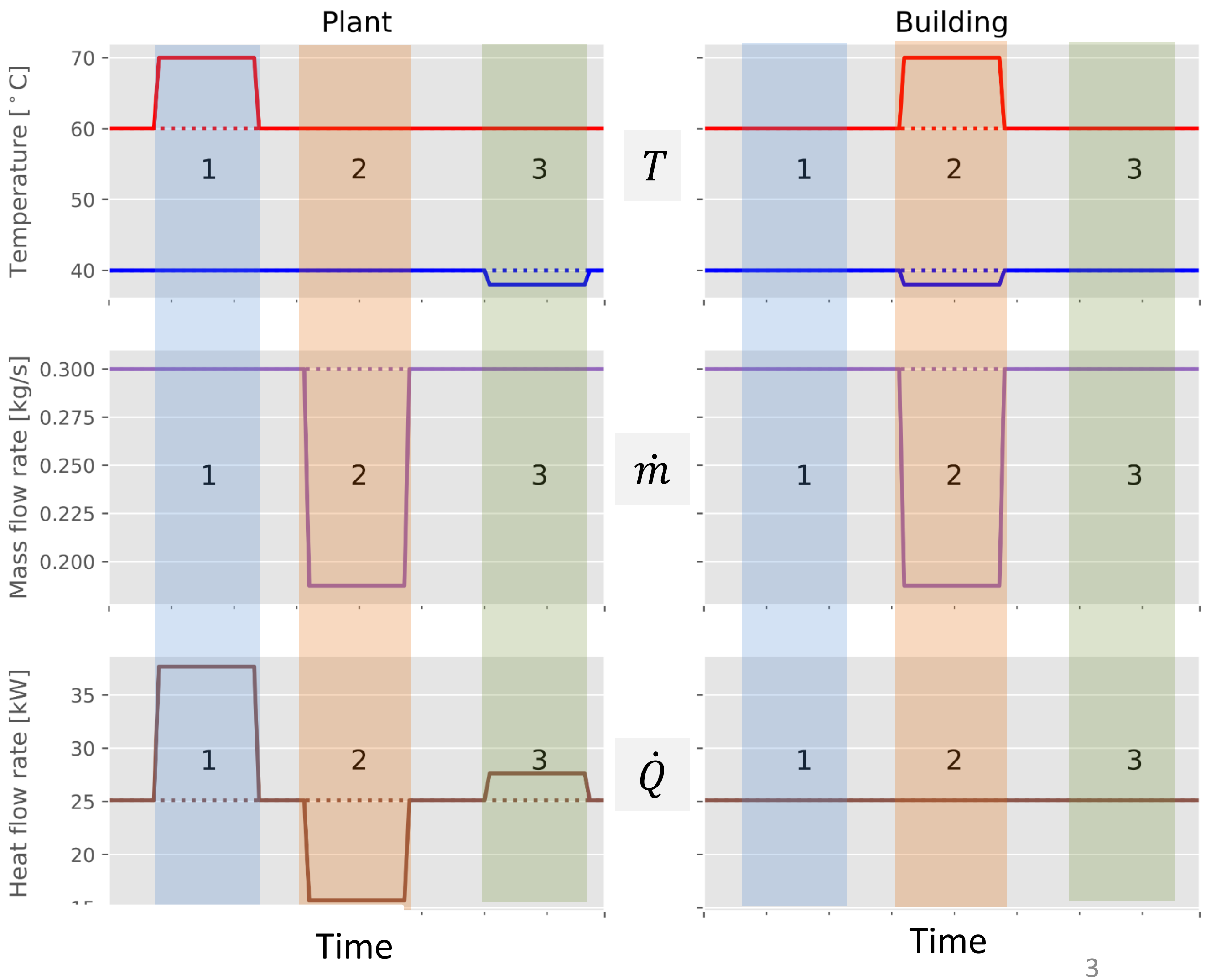

local heat
generation
central heat
generation
backbone
cluster 1
cluster 2
central TES
substation &
local TES

Network flexibility

1 Charge period
2 Discharge period
3 Rebound period

Network flexibility:
To use the thermal inertia of the water contained in the pipes to shift the plant heat load in time



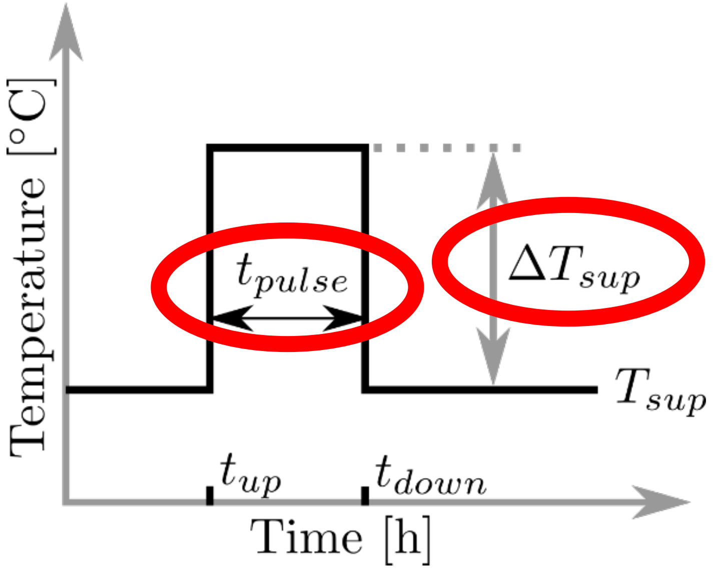


Research goal

How sensitive is the available network flexibility to the control parameters?

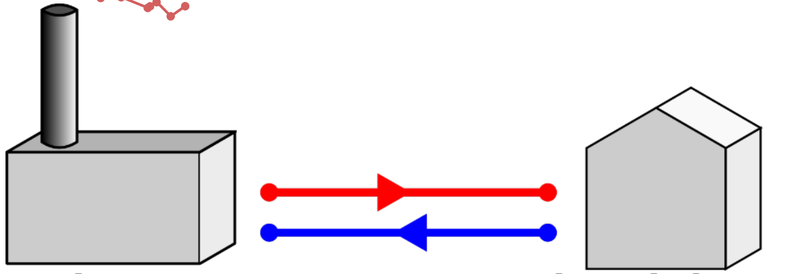
Control parameters:

- t_{pulse}
- ΔT_{sup}



Network model: Modelica

- Aggregated model of Waterschei (Belgium) – 1500 buildings
  - **Single building (Aggregated heat demand profile) [1]**
  - Extensive substation model
- Pipe: validated plug flow model [2]
- Plant: no ramping and power output constraints



[1] B. van der Heijde, A. Vandermeulen, R. Salenbien, and L. Helsen, “Integrated Optimal Design and Control of Fourth Generation District Heating Networks with Thermal Energy Storage,” *Energies*, vol. 12, no. 14, p. 2766, 2019.

[2] B. Van Der Heijde *et al.*, “Dynamic equation-based thermo-hydraulic pipe model for district heating and cooling systems,” *Energy Convers. Manag.*, vol. 151, no. July, pp. 158–169, 2017.

Simulated cases

Seasons:

- Winter
- Spring
- Summer

Scales:

- 1500 buildings
- 150 buildings
- 15 buildings

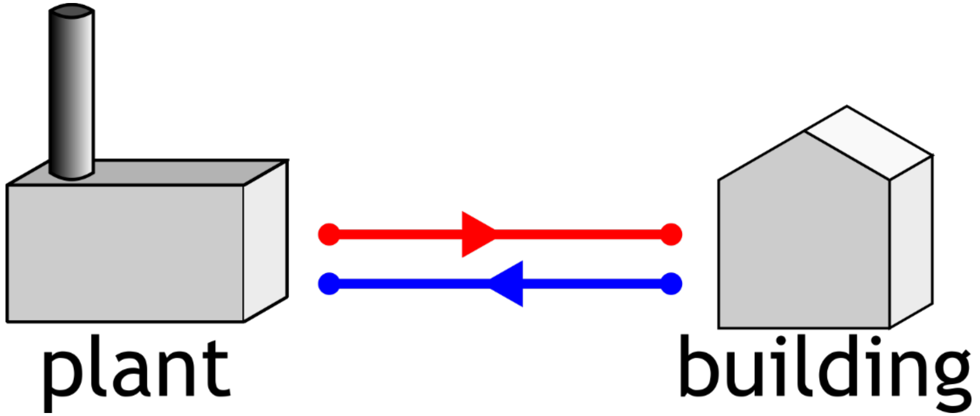
Control parameters:

- t_{pulse}
- ΔT_{sup}

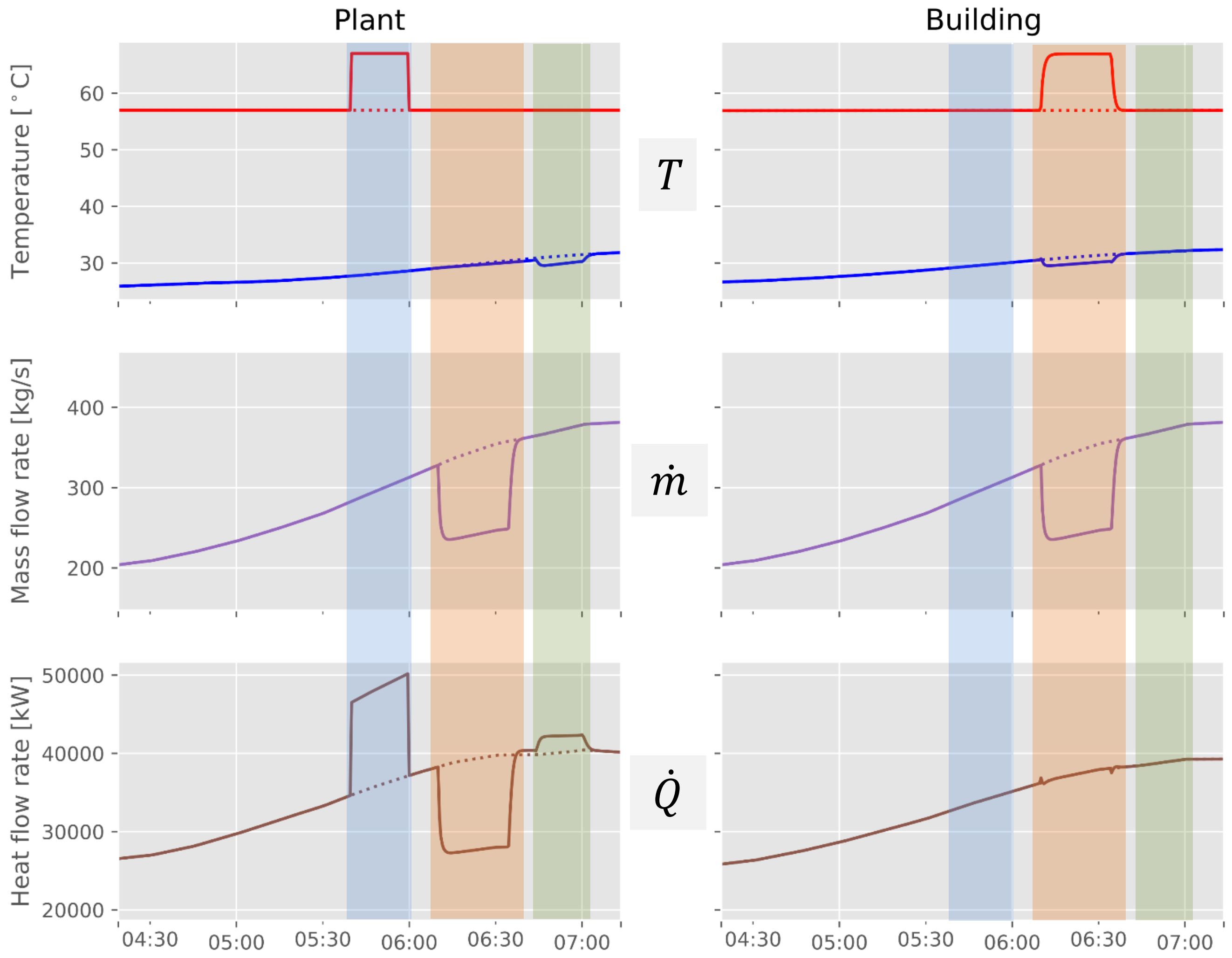
Methodology

Quantification of network flexibility:
By simulating two cases:

1) No flexibility: constant temperature
2) Flexibility: pulse temperature

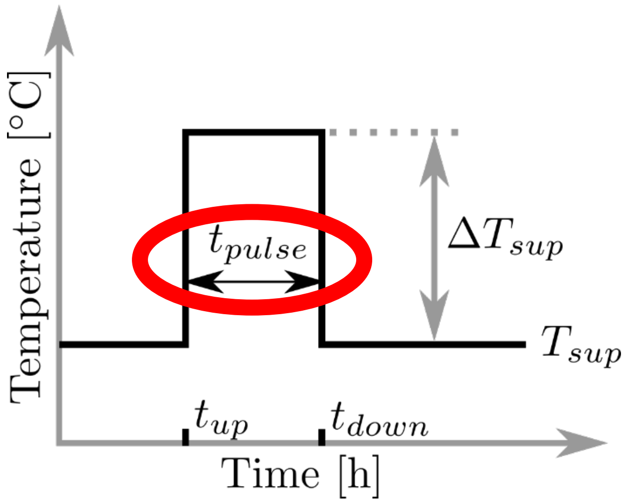


1 Charge period
2 Discharge period
3 Rebound period



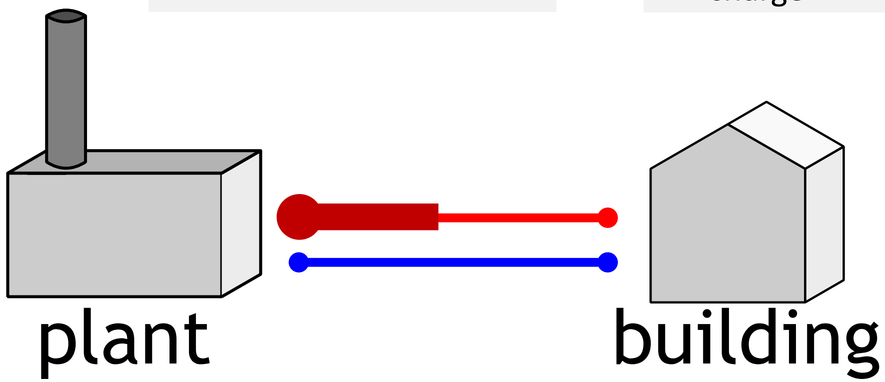
Variations of t_{pulse}

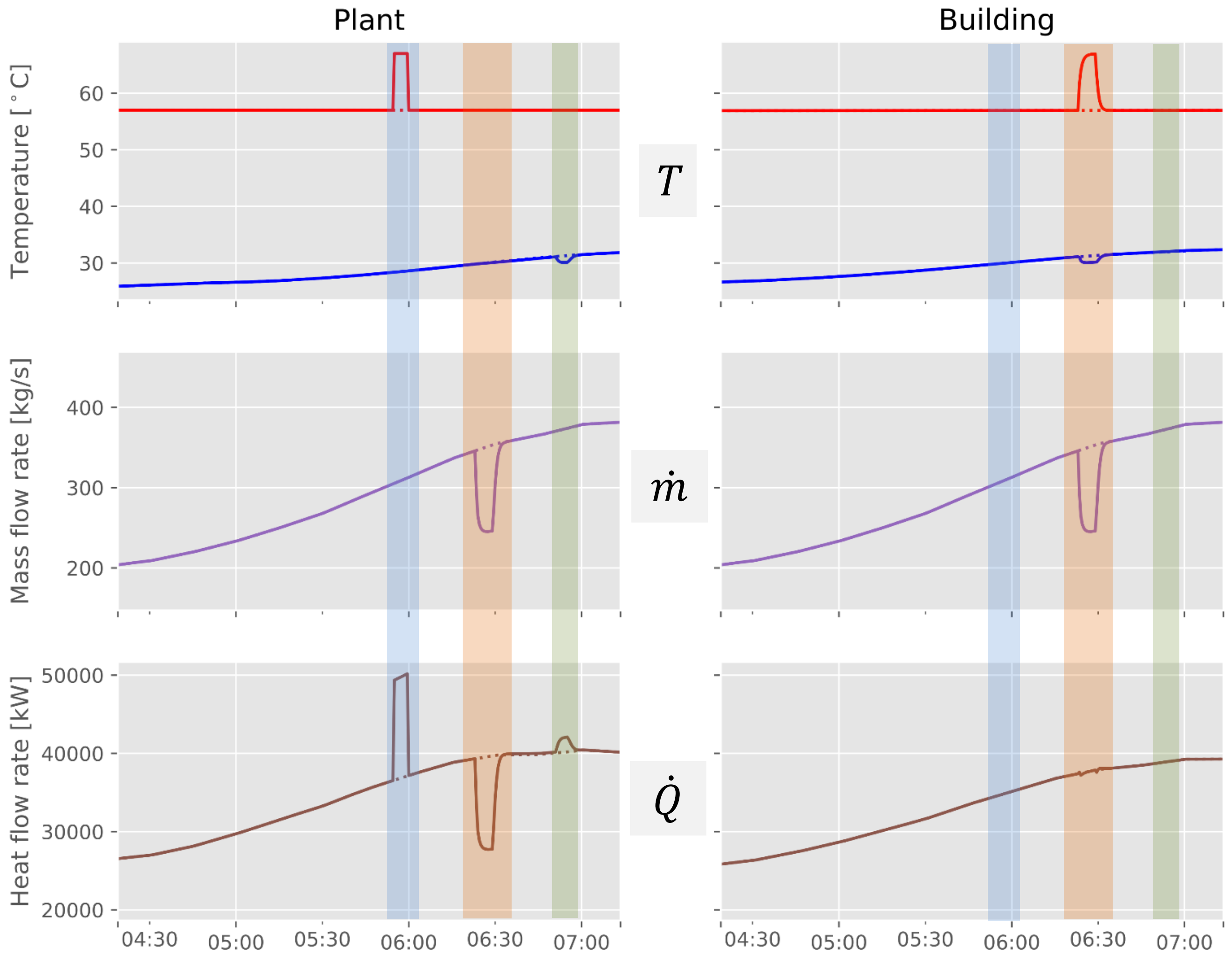
1 Charge period
2 Discharge period
3 Rebound period



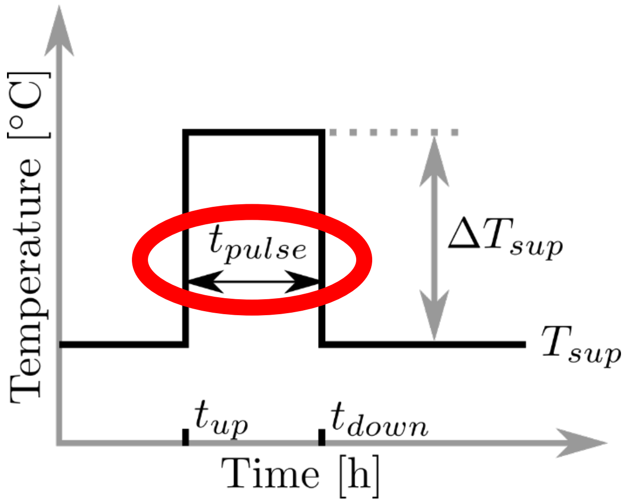
Short Charge

ΔT_{sup} = 9°C
t_{charge} = 5 min





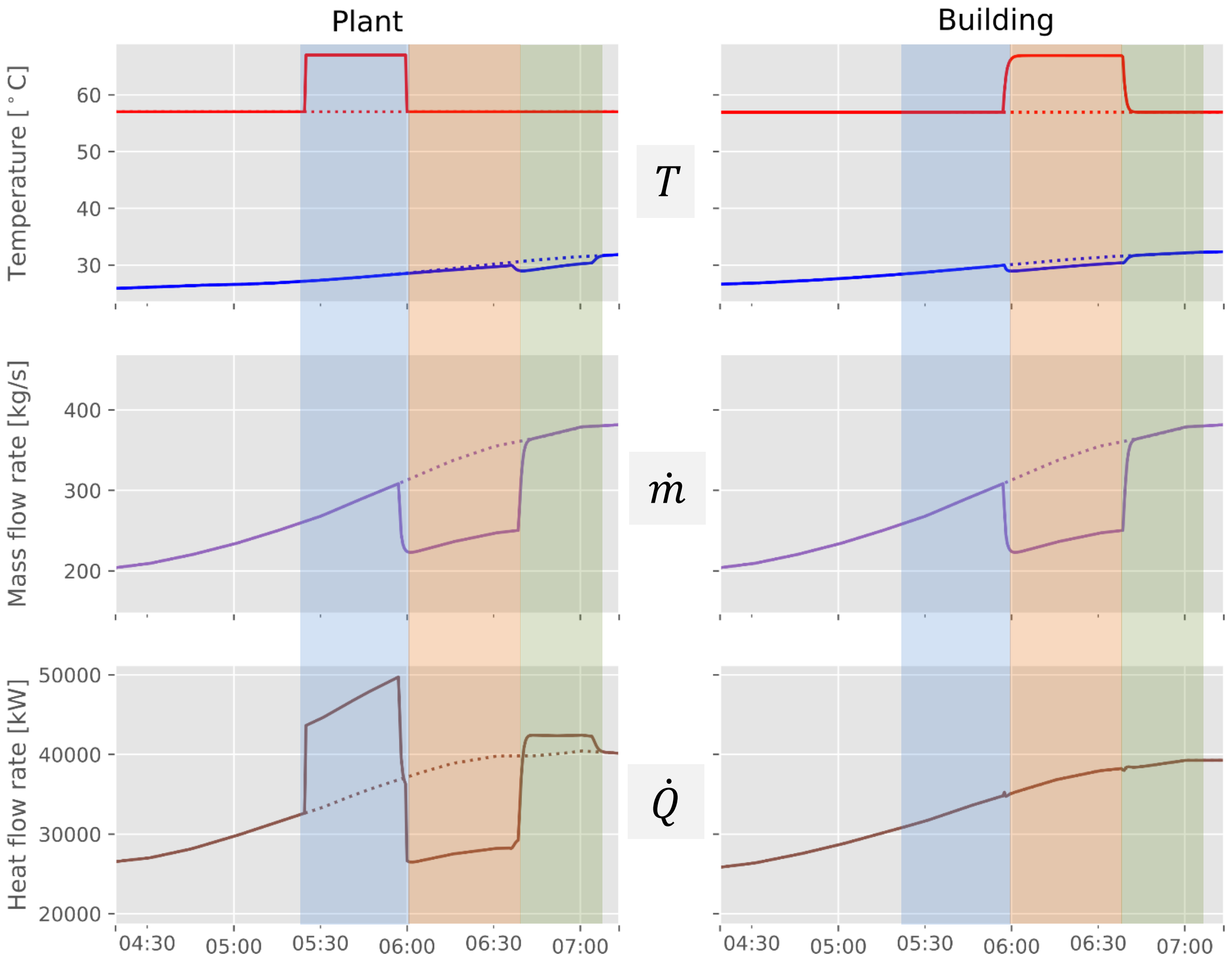
Variations of t_{pulse}



1 Charge period

2 Discharge period

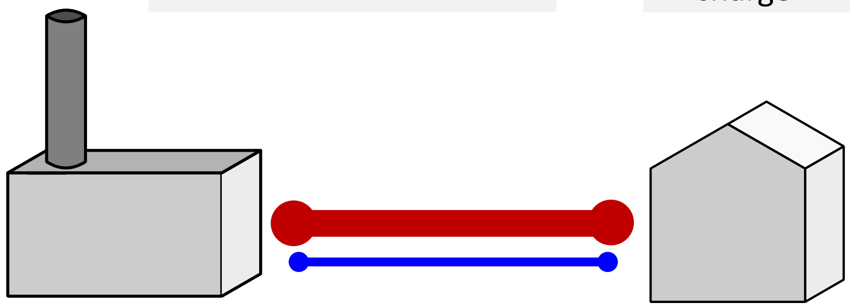
3 Rebound period



Optimal Charge

ΔT_{sup} = 9°C

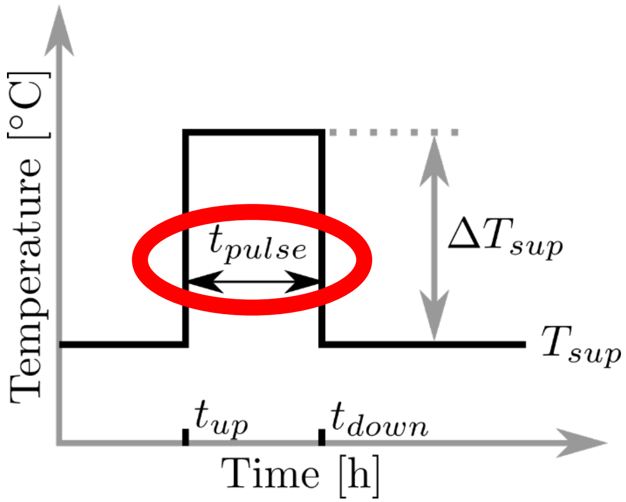
t_{charge} = 35 min



plant

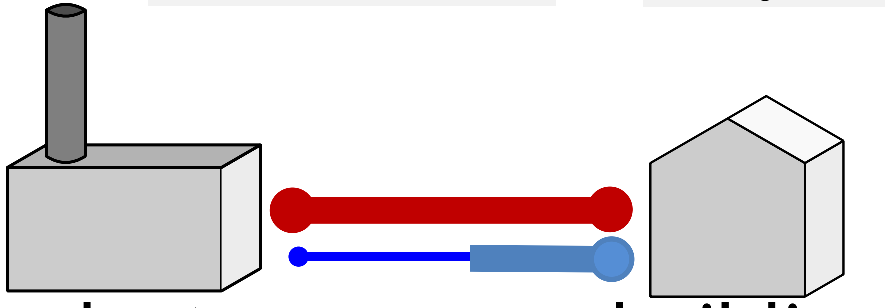
building

Variations of t_{pulse}

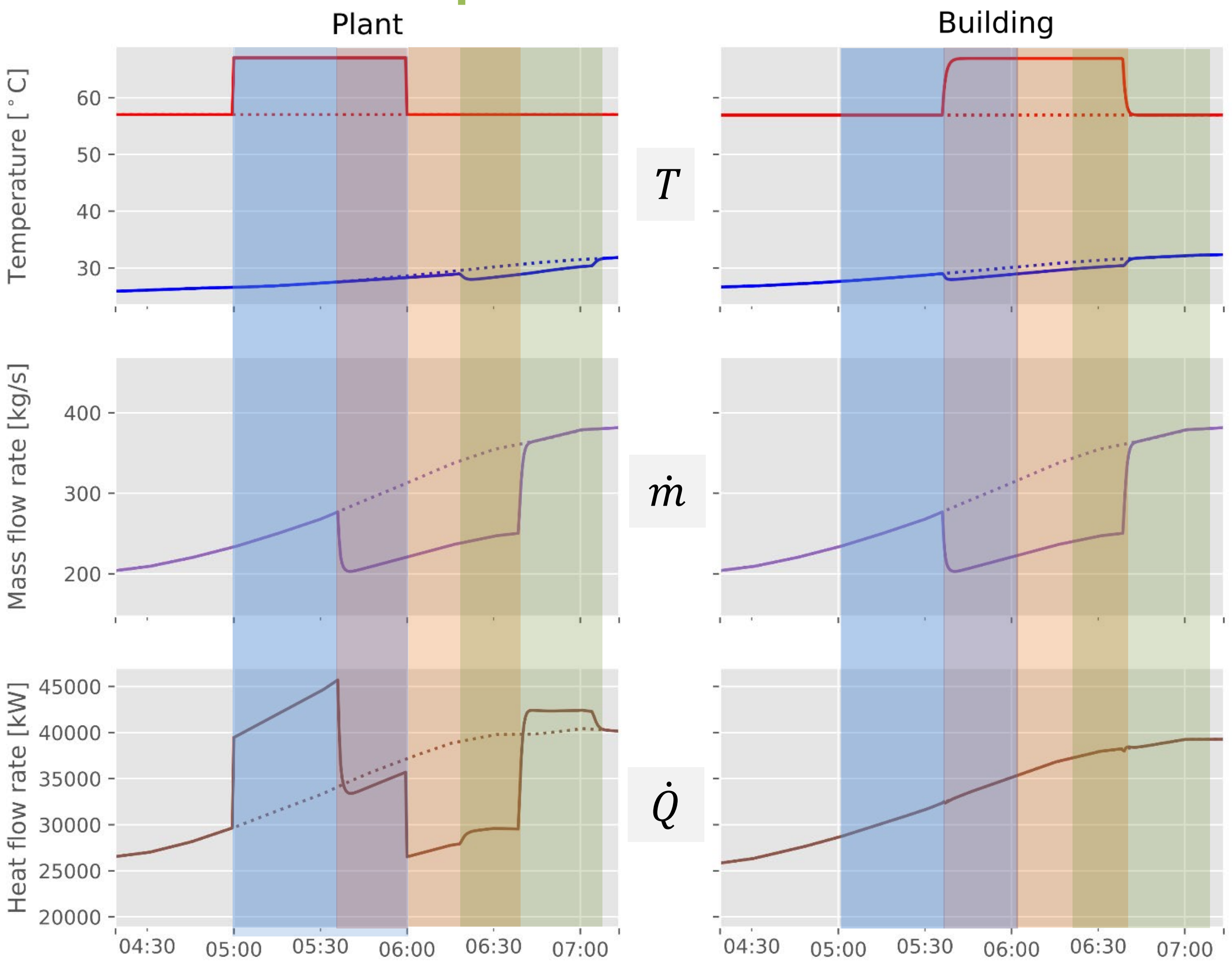


Long Charge

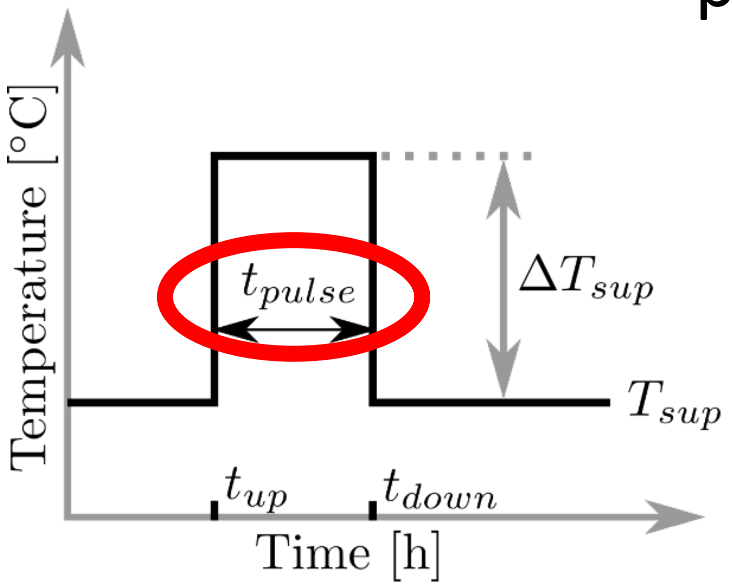
ΔT_{sup} = 9°C
t_{charge} = 60 min

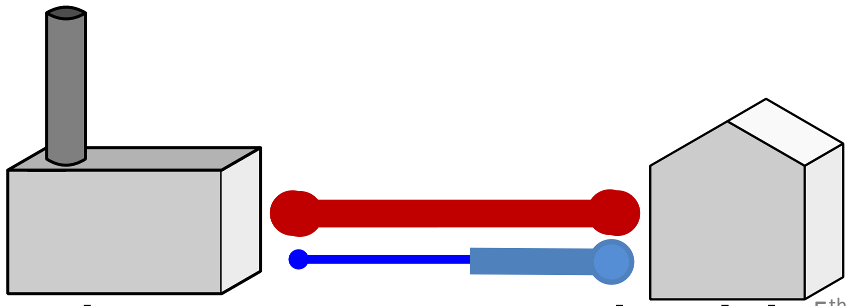


1 Charge period
Early discharge period
2 Discharge period
3 Rebound period

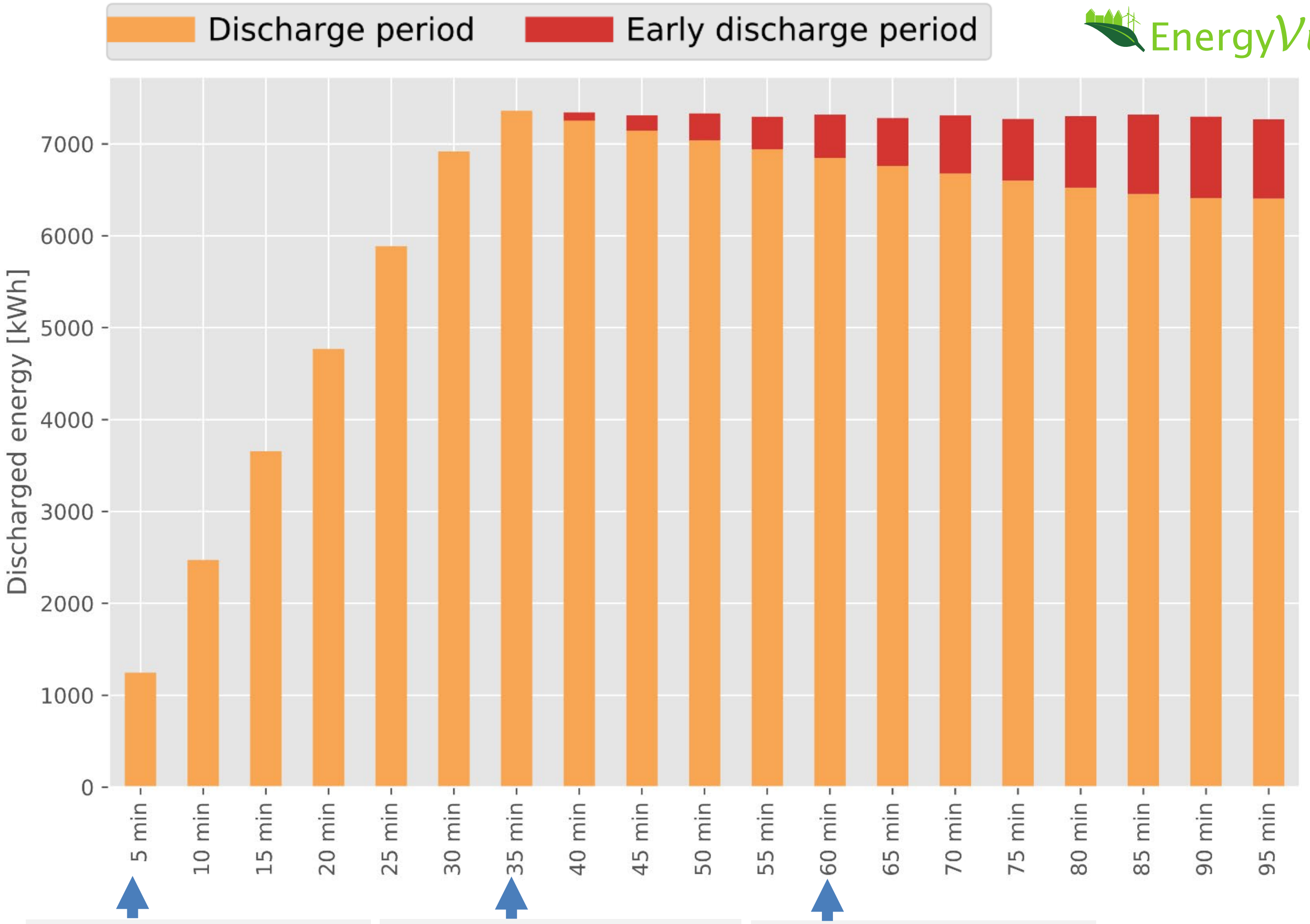


Variations of t_{pulse}





plant building

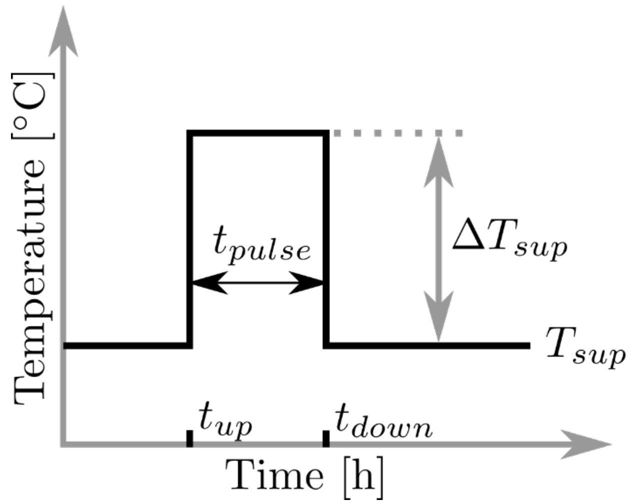


Short **Optimal** **Long**

Conclusions

Characterization of supply temperature pulse response:

- Charge period
- Discharge period
- Rebound period



To activate network flexibility: Limited charge duration is important to prevent early discharging

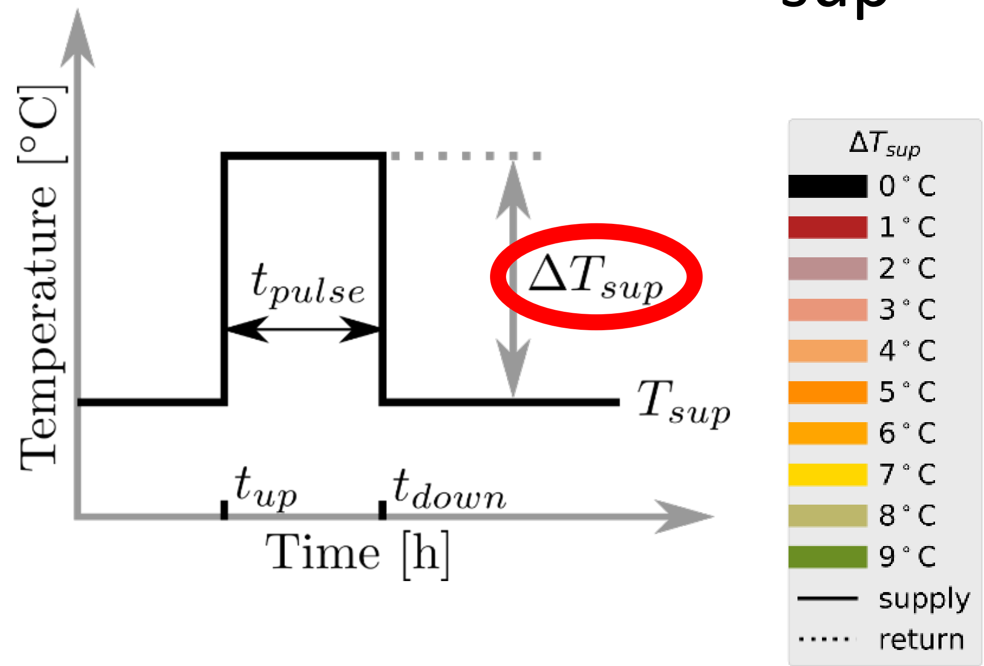
Questions?

Variations of ΔT_{sup}

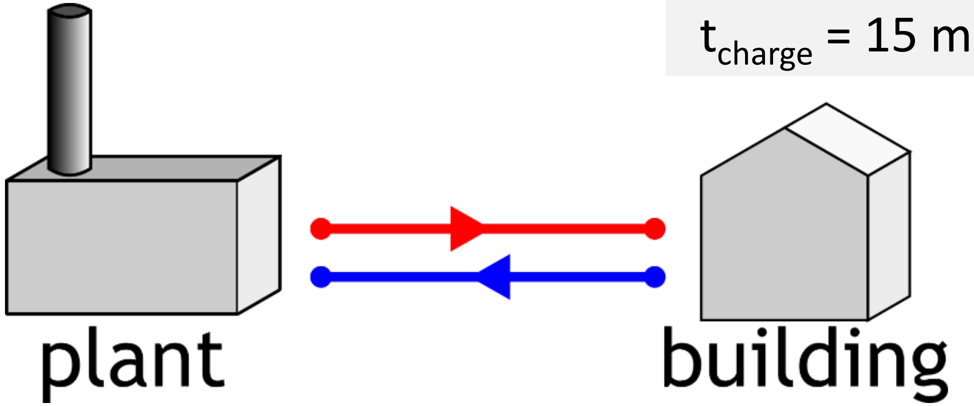
1 Charge period

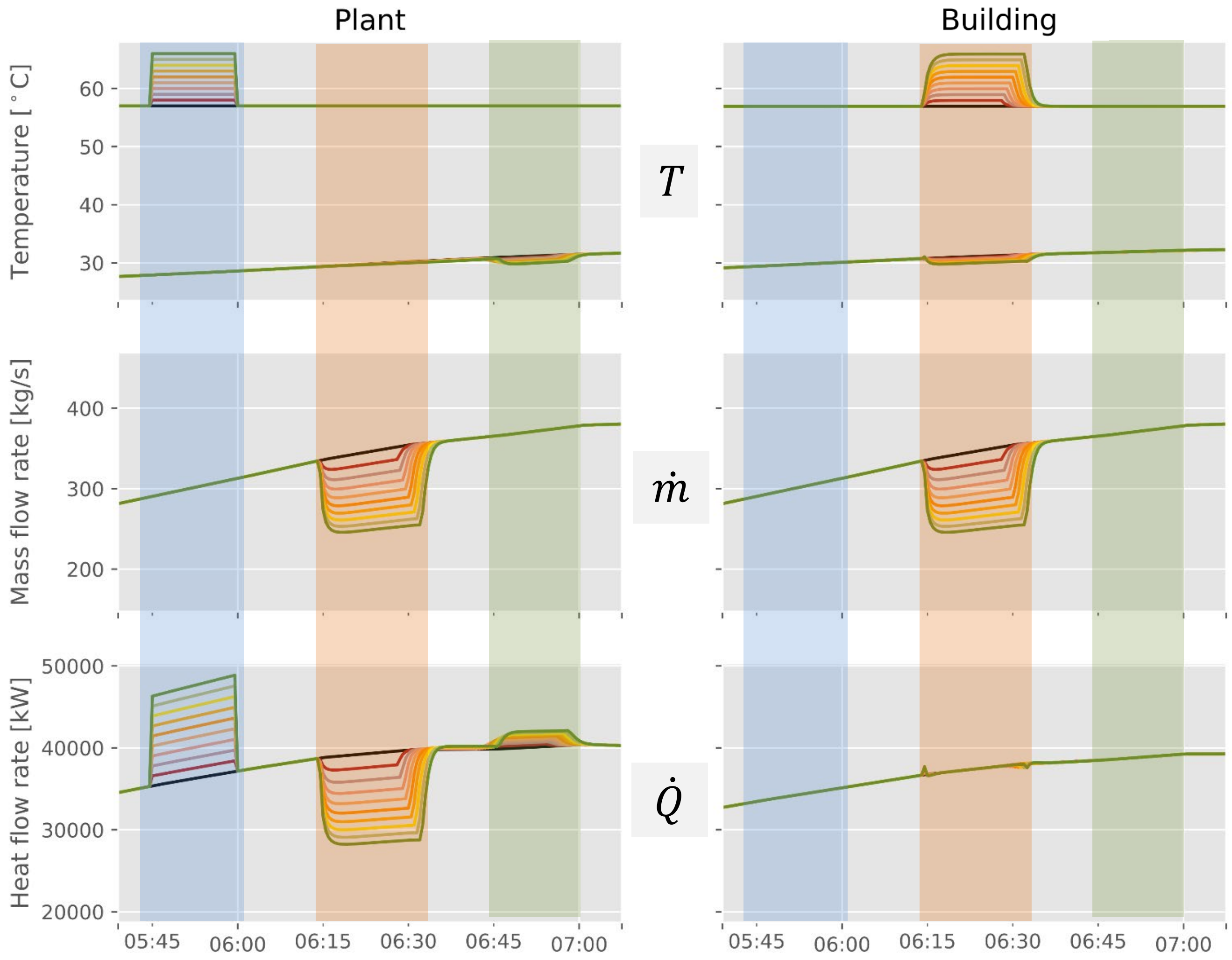
2 Discharge period

3 Rebound period

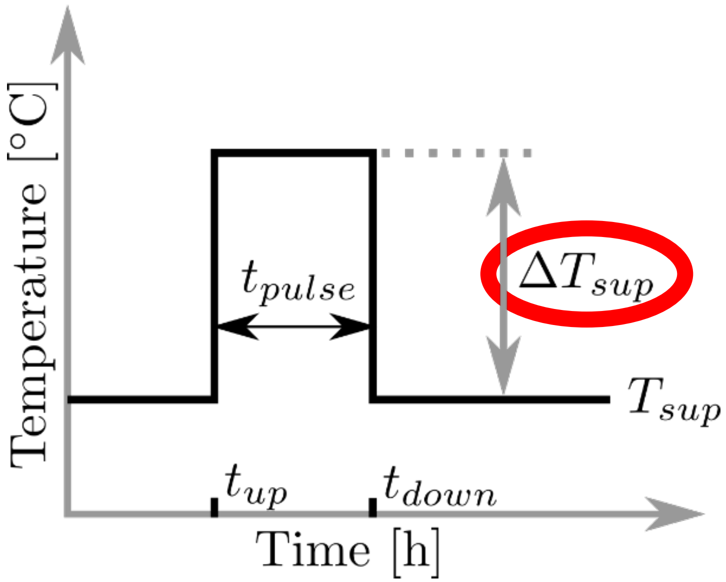


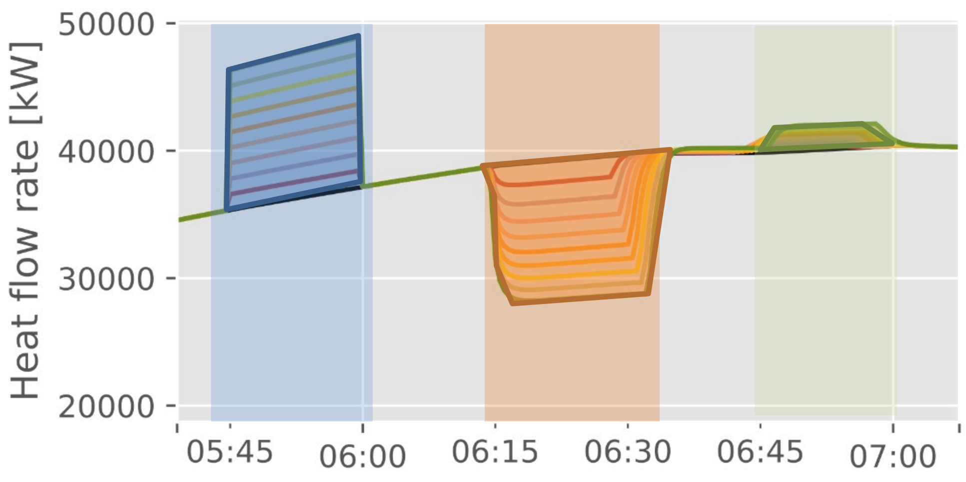
t_{charge} = 15 min

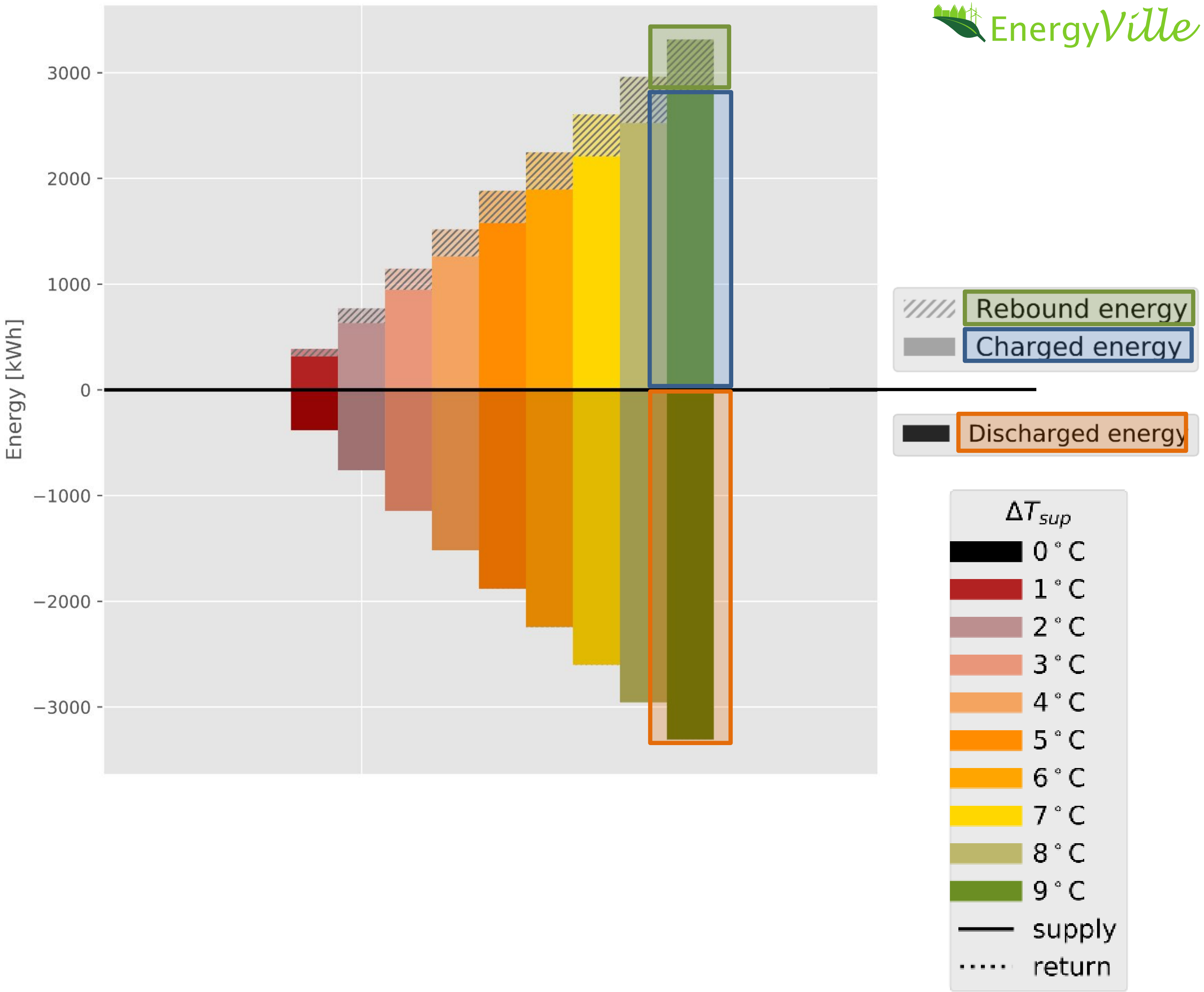




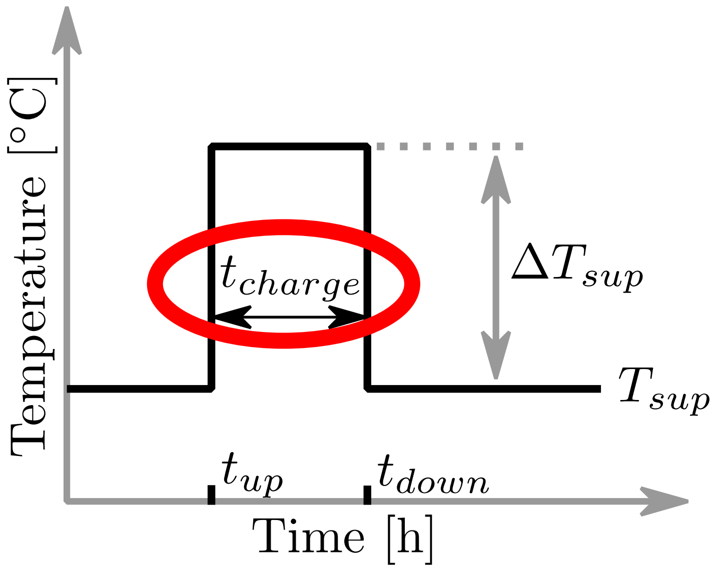
Variations of ΔT_{sup}

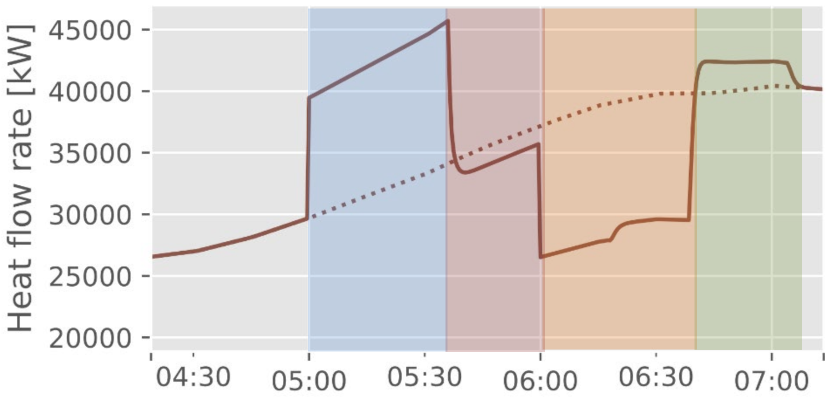


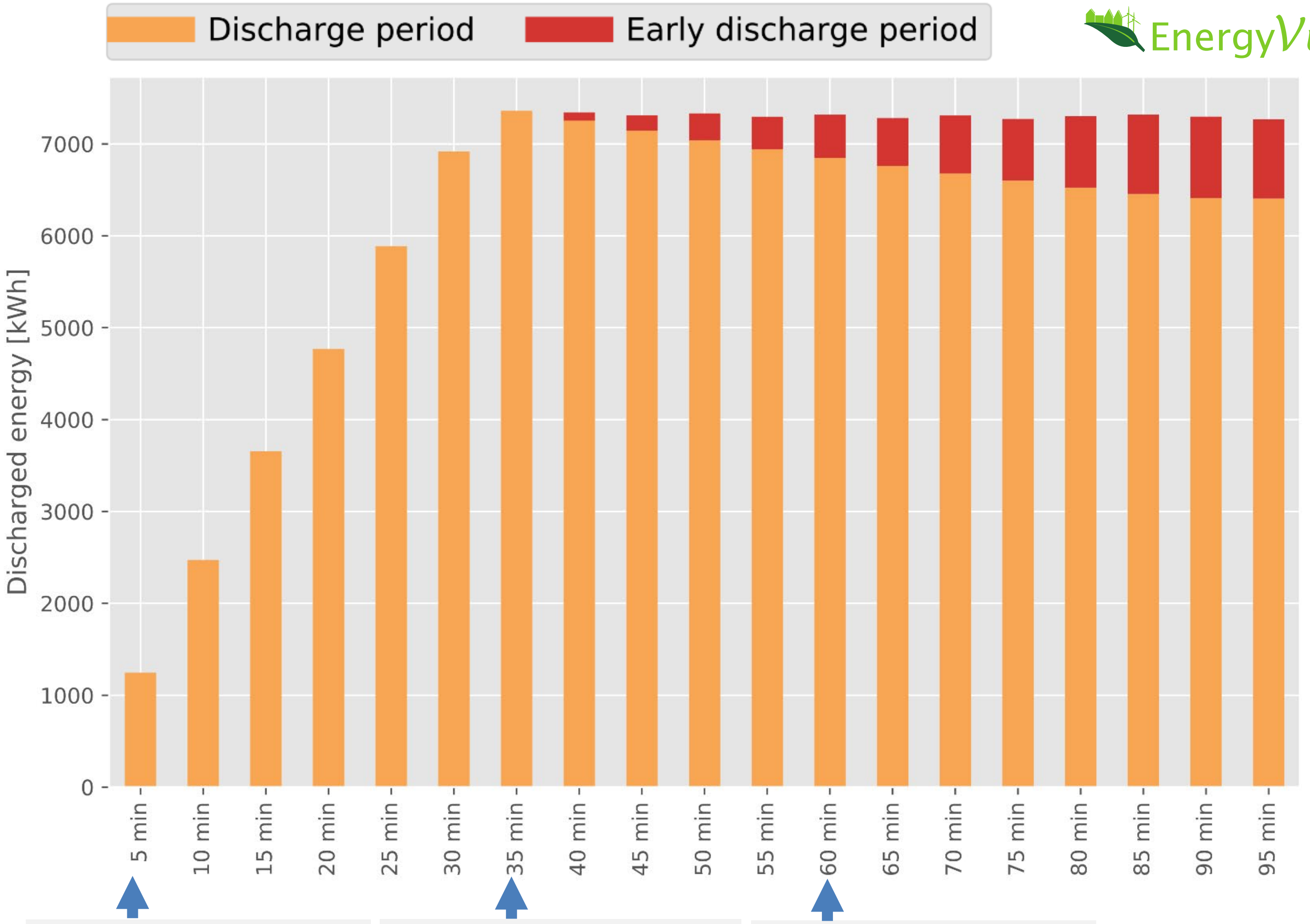




Variations of t_{charge}







Short **Optimal** **Long**