sweet swiss energy research for the energy transition

PATHFNDR

Electromobility + buildings

Heat pump flexibility provision from thermal inertia of buildings and buffer thermal storage

Work package 2

Curtis Meister[1], Sarah Schneeberger[1], Edward Lucas[1] & Philipp Schütz[1]

[1]Hochschule Luzern, Competence Centre for Thermal Energy Storage (CC-TES)

1 OBJECTIVES

With an increasing number of heat pumps in Switzerland, space heating and domestic hot water loads will soon represent a significant share of the electricity demand. For the electrical grid, it is advantageous if large loads may be operated flexibly. Buildings can provide such flexibility through utilization of their thermal inertia. By storing energy within the building itself, heat pump loads may be shifted away from peak periods, or towards periods with excess production.

This work aims to quantify the load-shifting potential from buildings. To this end, dynamic building models were developed based on information from publicly available databases ([1][2]). These models are simulated at a community level to investigate the effect of grid-level interventions (e.g. heat pump curtailment) and local heat pump control strategies.

2 CONTRIBUTION TO PATHFDNR

A major goal of WP2 is to provide recommendations regarding operational strategies for local energy networks. The flexibility available from end user loads is a critical piece of knowledge to conduct such analysis.

This work contributes to this goal by assessing the shifting potential of heat pumps serving building heating loads. Through a bottom-up approach, only address information is needed to generate dynamic building and heat pump models for a community.

Such flexibility models serve as a critical input to simulation frameworks at the district multi-energy system level constructed by our partners in WP2.

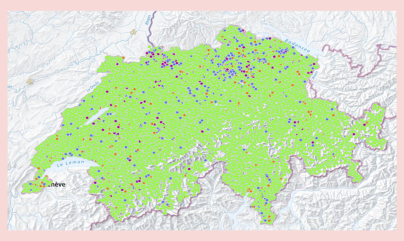
2 METHODOLOGY

Public / semi-public data

Gebäudeenergieausweis der Kantone (GEAK) [2]

Bundesamt für Energie (BFE) [3]

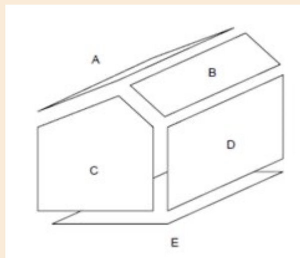
Eidg. Gebäude- und Wohnungsregister (GWR) [1]



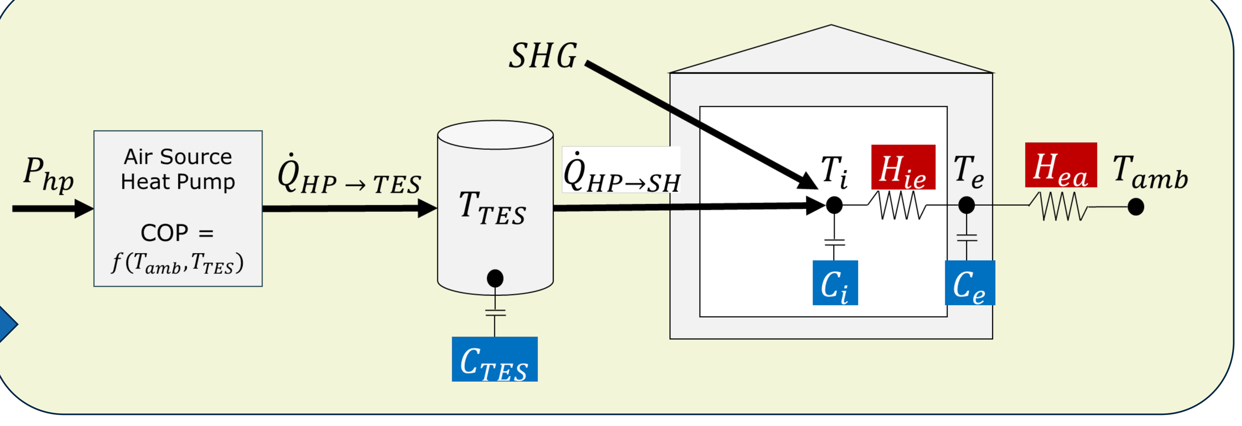
Building properties:

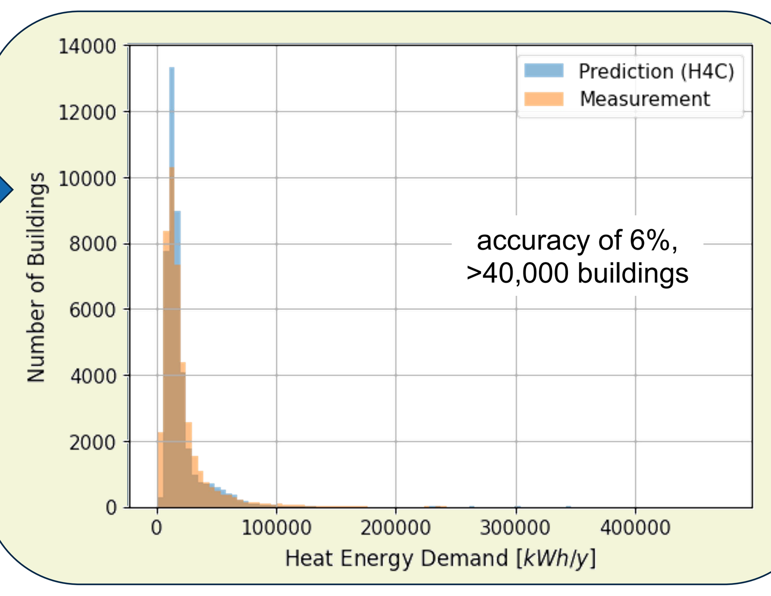
e.g. for one single family home

Property	Value
Year	1908
Area	128 m^2
Construction	Heavy
Annual heating	325 kWh/m^2
Heat pump power	3.3 kW
Time const, $\tau = C_{bldg}R_{bldg}$	37 hrs



Dynamic building & heat pump models





Validation of heat demands

Schneeberger et al [4]

3 RESULTS: How is a heat pump practically curtailed?

Our results provide insights into the effects of varying curtailment methods on total power savings, rebound effects, and comfort:

Forcing **heat pumps off** via ripple control signals eliminates the heat pump load completely (100% over 2 hours), but results in an immediate and significant rebound, with simultaneity factor reaching 100% post-curtailment. In this scenario, the space heating system may still draw reserved heat from the buffer heat storage, while available.

Forcing **space heating to buildings off** via a central thermostat offers similar power reductions (95% for 2 hours), but allows heat pumps to maintain the buffer storage, delaying and shortening the rebound peak. However, a significant fraction of the simulated buildings can not sustain 2 hours without heat.

Simply **reducing the space heating setpoint by 1°C** results in more modest savings (52% in 2 hours), but results in the mildest rebound, and guarantees buildings remain within a comfortable temperature range.

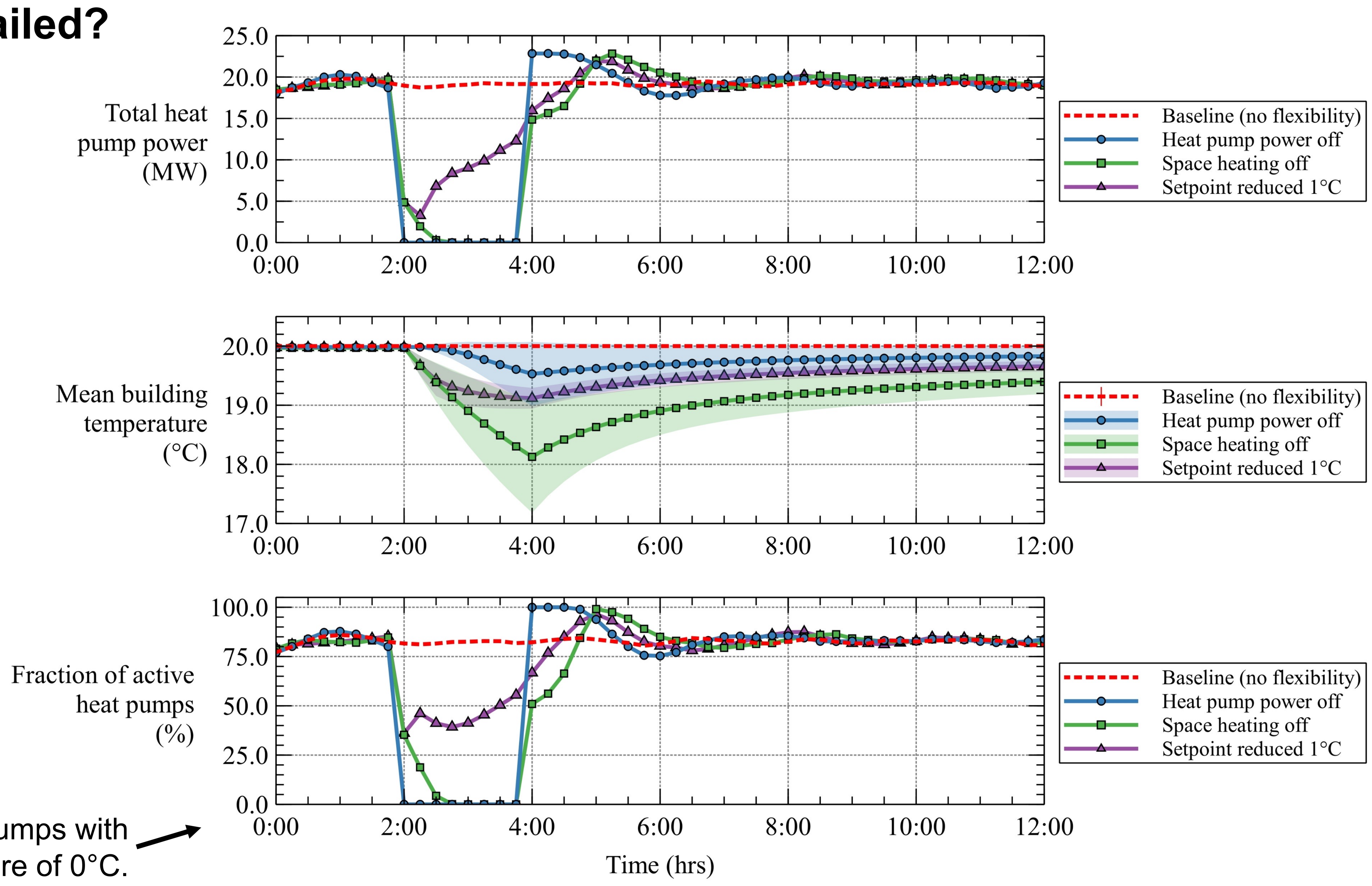


Figure (right): Simulation of a community of >2000 heat pumps with a 2-hour curtailment, at an ambient temperature of 0°C.

REFERENCES

1. "GWR | Eidg. Gebäude- und Wohnungsregister." https://www.housing-stat.ch/de/madd/index.html
2. "GEAK | Gebäudeenergieausweis der Kantone", https://www.geak.ch/
3. "Schweizerisch Gesamtenergiestatistik 2022", BFE, https://www.bfe.admin.ch/bfe/de/home/versorgung/statistik-und-geodaten/energiestatistiken/gesamtenergiestatistik.html/
4. Schneeberger, S., Lucas, E., Meister, C., & Schuetz, P. (2024). Wärmebedarfsschätzung für Wohngebäude. In Proceedings of the 18th Symposium Energieinnovation, February 14-16, 2024, Graz, Austria.

CONTACT

Curtis Meister
Hochschule Luzern
Senior Research Associate
Phone: +41 41 349 30 06
curtis.meister@hslu.ch
www.sweet-pathfndr.ch

ACKNOWLEDGMENTS

This work was performed by the PATHFNDR consortium, which is sponsored by the Swiss Federal Office of Energy's SWEET programme.