TECHNISCHE UNIVERSITÄT WIEN

Impact of Building Design Variables on Demand Response Capability Considering Local Grid Profiles

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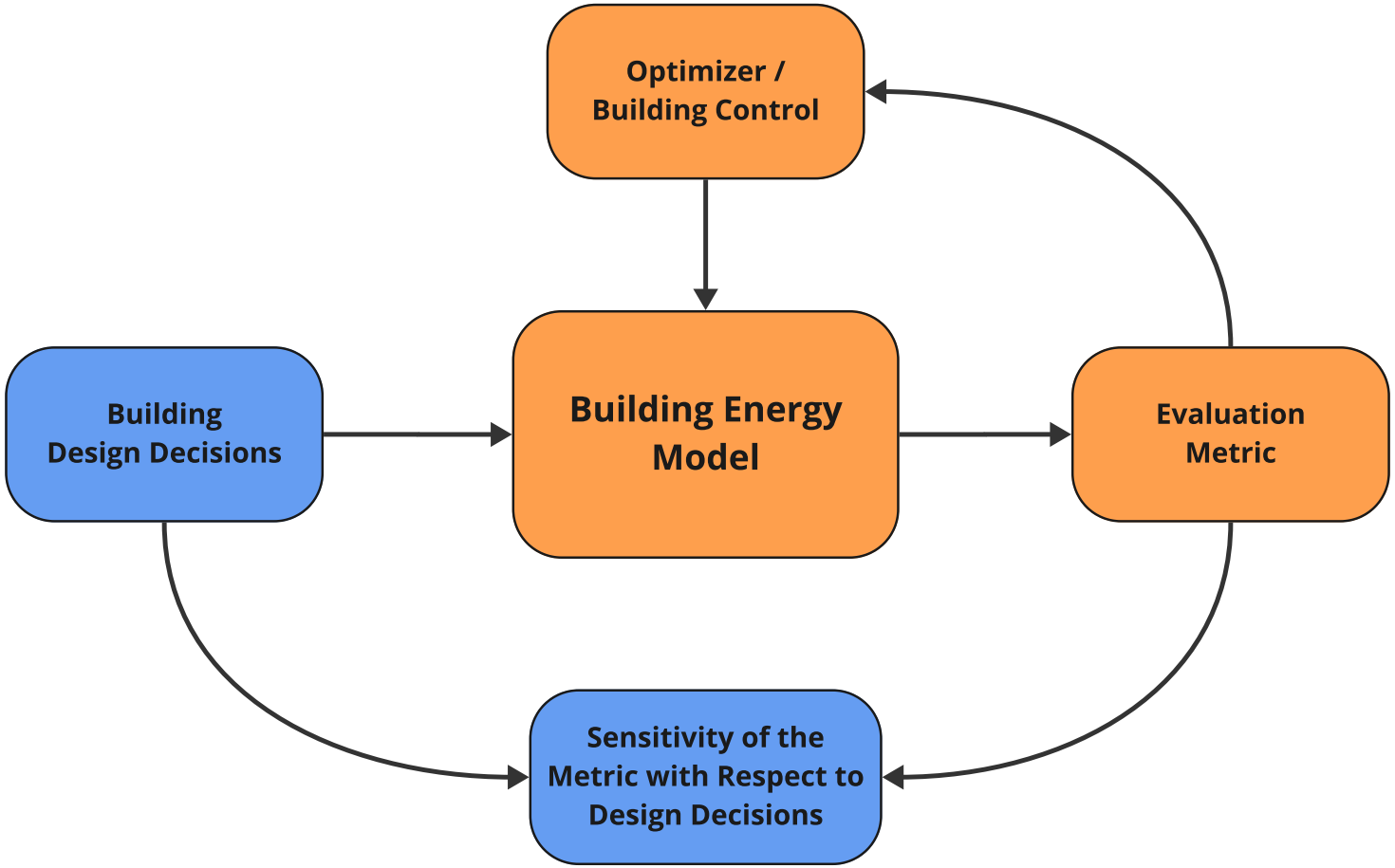
Motivation and Objective

- **Motivation**
  - Buildings are major energy consumers
  - Renewable energy sources are beneficial but volatile
  - Demand response strategies can help balance the system
  - Building design affects demand response capabilities

- **Objective**
  - Evaluate building design decisions with respect grid interaction qualities
  - Grid context sensitive evaluation

Approach


Optimizer / Building Control
Building Design Decisions
Building Energy Model
Evaluation Metric
Sensitivity of the Metric with Respect to Design Decisions

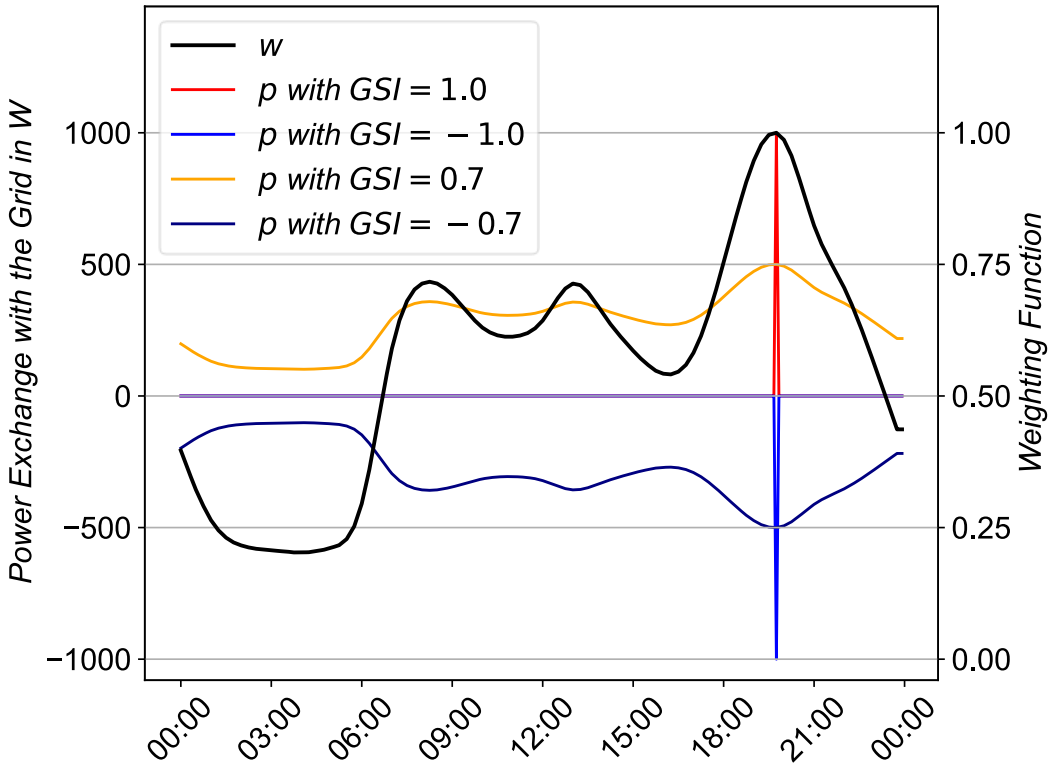
Evaluation Metric – Grid Stress Index (GSI)

- **Definition GSI** – weighted and normalized power consumption
  - $GSI = \frac{1}{E} \int_T w(t) \cdot p(t)\, dt$
  - w ... weighting function, p ... power consumption
  - $E = \int_T |p(t)|\, dt$

- **Weighting function**
  - Load at a chosen transformer / substation
  - Represents energy exchange with the higher-level grid
  - Choice defines local grid context
  - Requires cooperation with grid operator (data not publicly available)

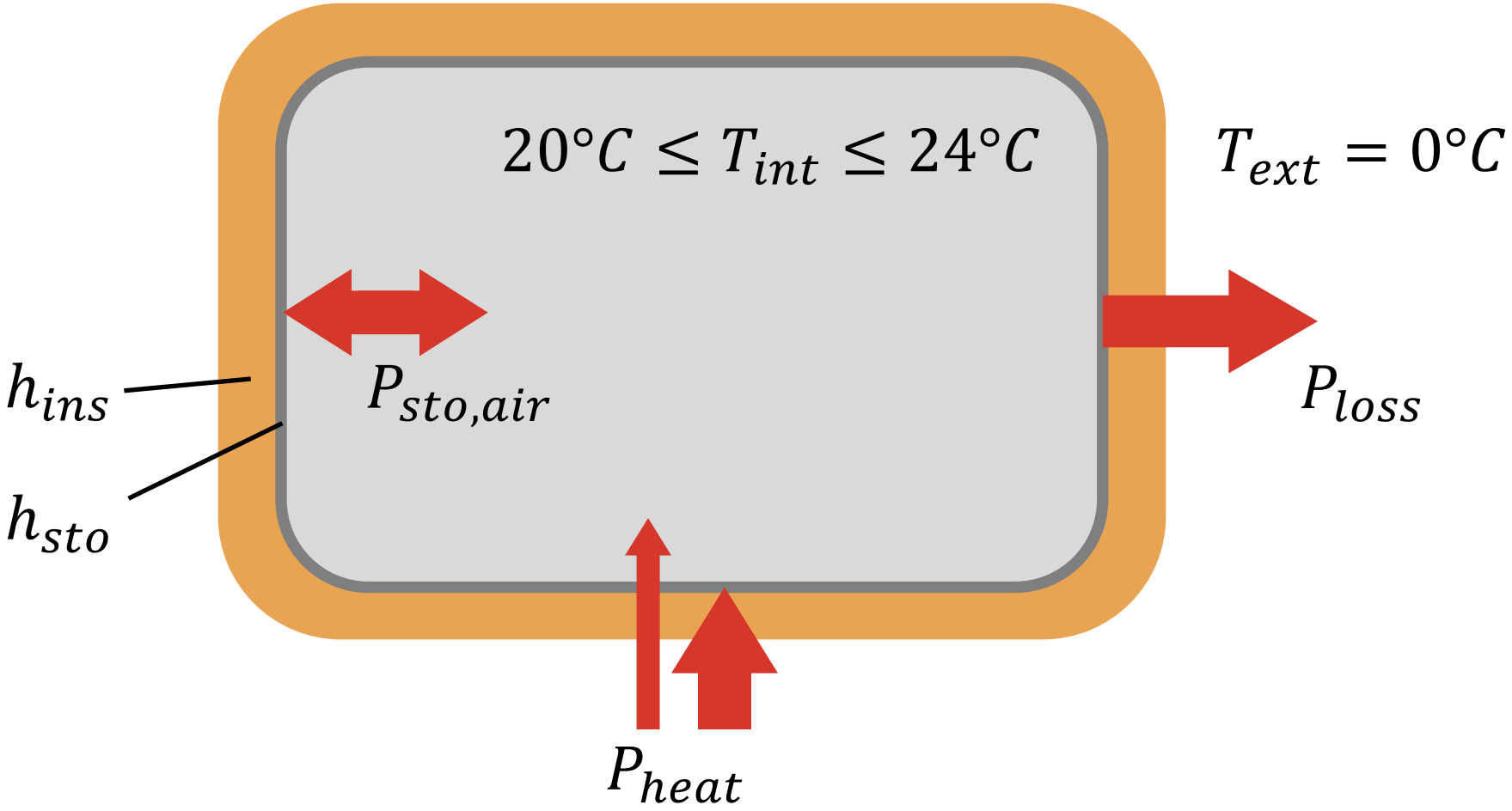
Grid Stress Index - Properties

- $-1 \leq GSI \leq 1$ (lower is better)
- $\mathrm{GSI} = \pm 1$ when consuming / feeding only at peak time
- Rewards consumption during local surplus
- Punishes consumption during local shortage



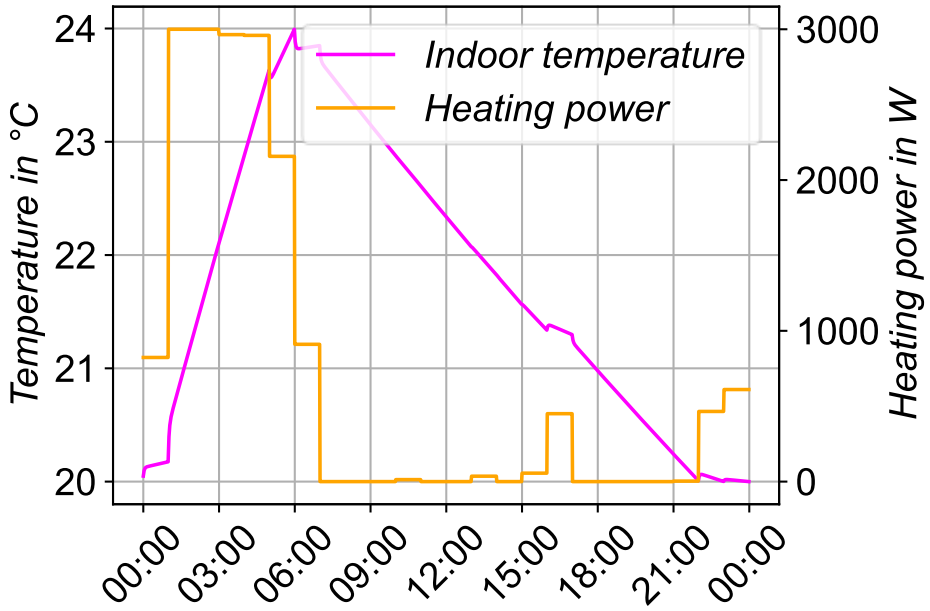
- *"How much does a grid participant's energy exchange support sub-grid self-sufficiency?"*

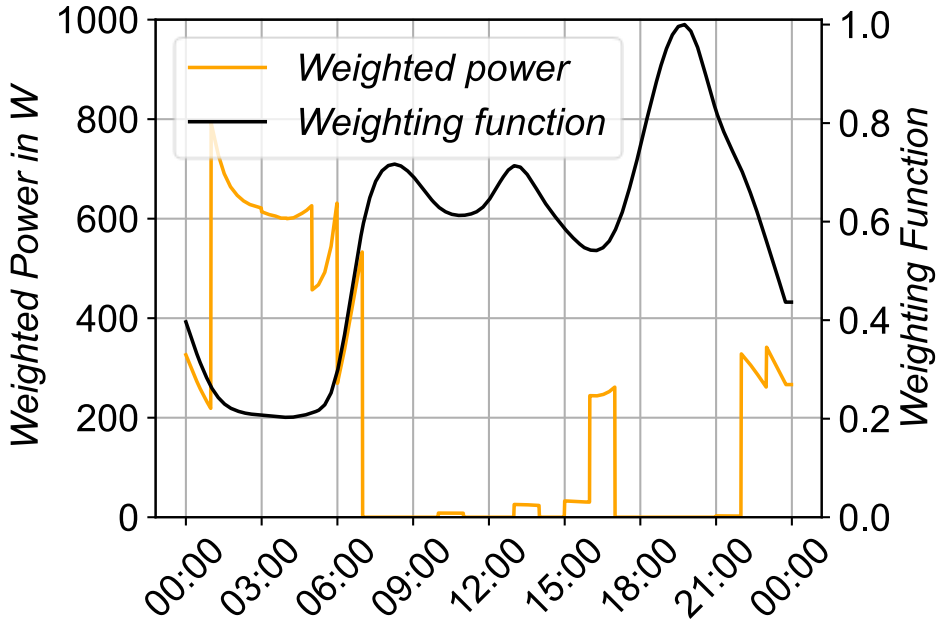
Proof-of-Concept Building Energy Model



Building Control / Optimizer

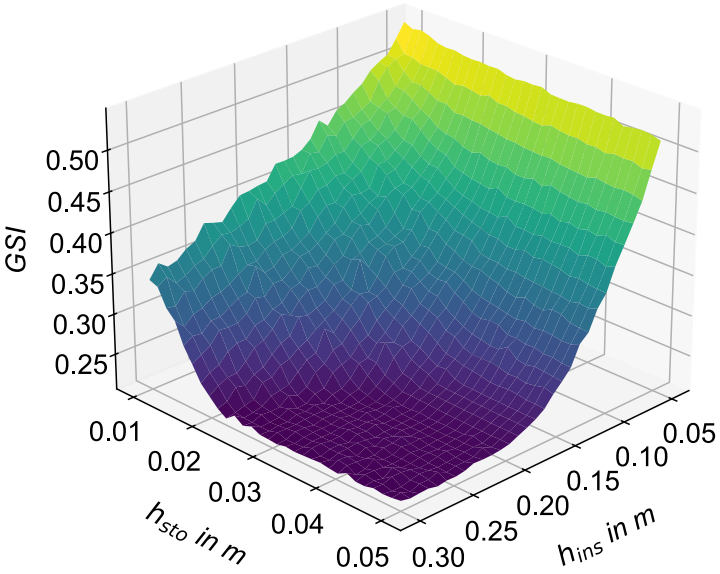
- Controls heating decisions
- Minimizes weighted energy consumption

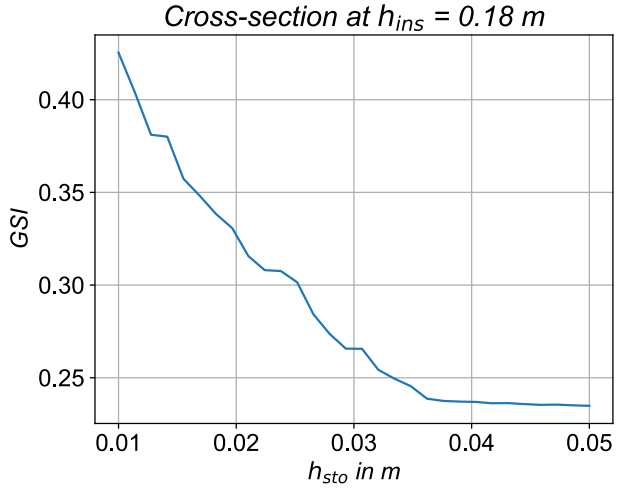


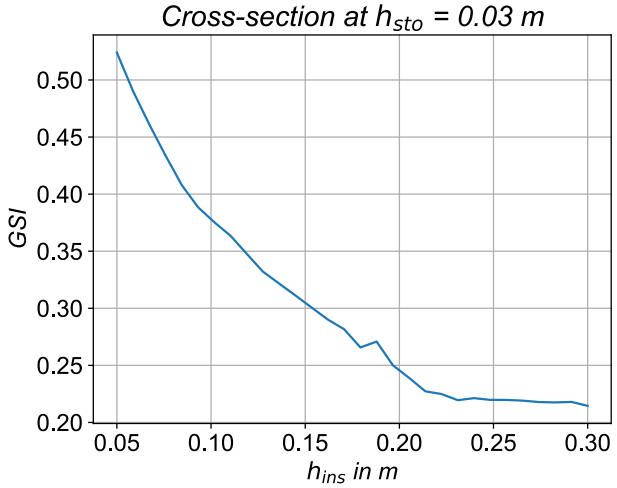


Impact of Design Decisions

- Varying design decisions for h_{ins} and h_{sto}
- Evaluate impact on GSI
- Inspect combined effects

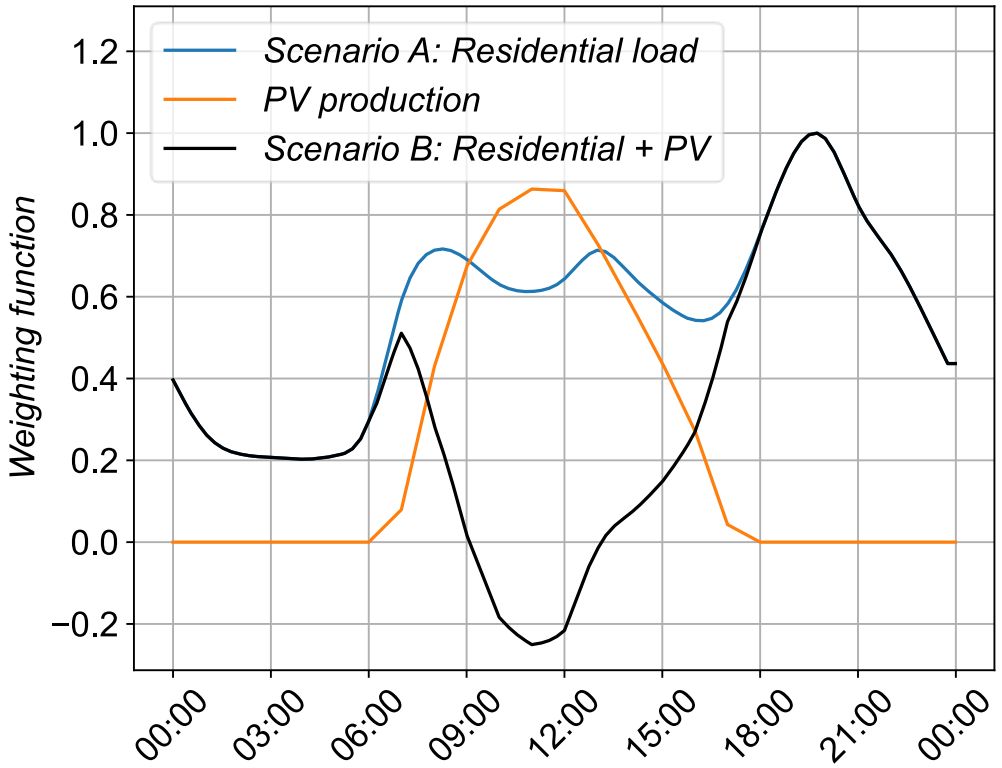






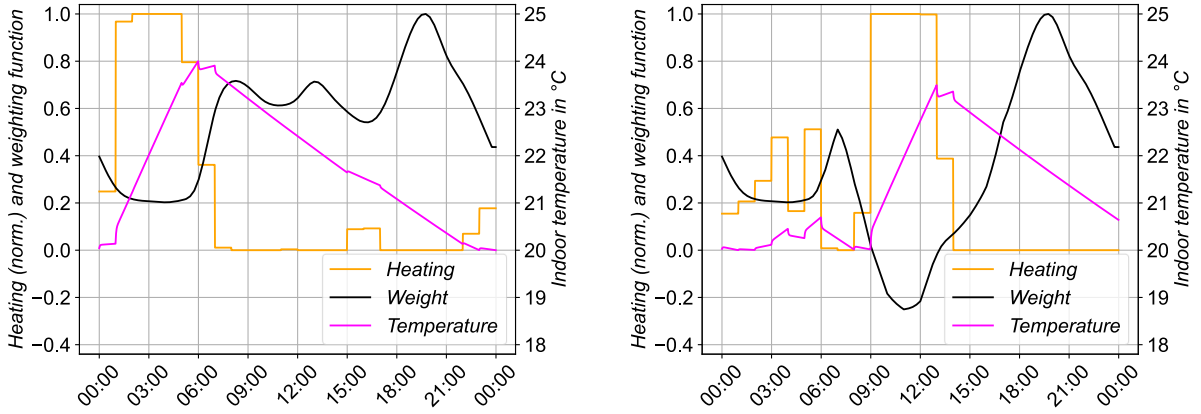
Grid Awareness of the GSI

- **Design Decision**
  - Scaling PV System
- **Grid context**
  - Scenario A: Default residential context
  - Scenario B: Residential + considerable PV

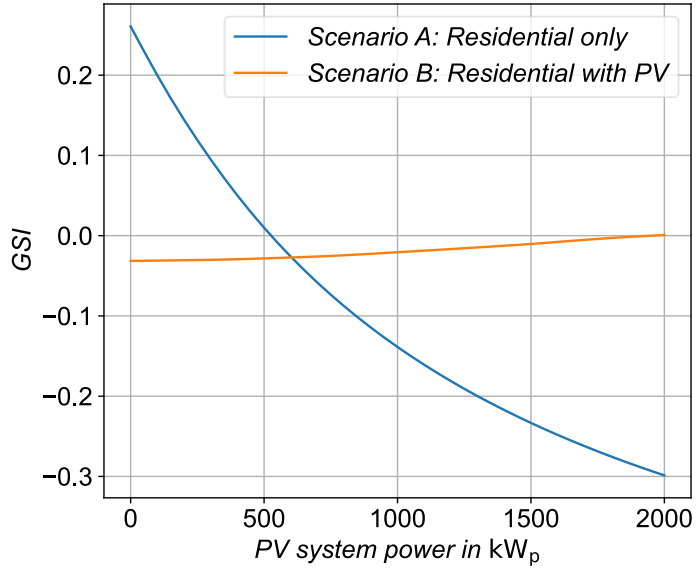


Grid Awareness of the GSI

- Heating decisions depend on grid context



- GSI evaluates PV in Scenario A differently than in Scenario B



Conclusion and Outlook

- **Conclusions**
  - GSI allows evaluation of design decisions
  - GSI is a grid aware metric
  - GSI requires grid provider cooperation

- **Outlook**
  - Modelling with focus on ISO 52000
  - MPC-Control with PSO-Optimizer
  - Apply to real world buildings

Acknowledgements

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…Questions…