Technische Hochschule Ingolstadt
Institut für neue Energie-Systeme

Peak load reduction by optimized management of storage capacities

Preliminary results of a simulative study

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Agenda

1. **Background and Motivation**
2. **Methodology**
3. **Example case**
4. **Conclusion and Outlook**

Background and Motivation

Need for Predicitve Control of Air-Source Heat Pumps

- Domestic Sector one of the major CO2-emittors
- Electrification yields potential to reduce GHG emissions
- Air-Source Heat Pump (ASHP) mostly installed type

- higher load on public electricity grid

  → potential grid extension needed

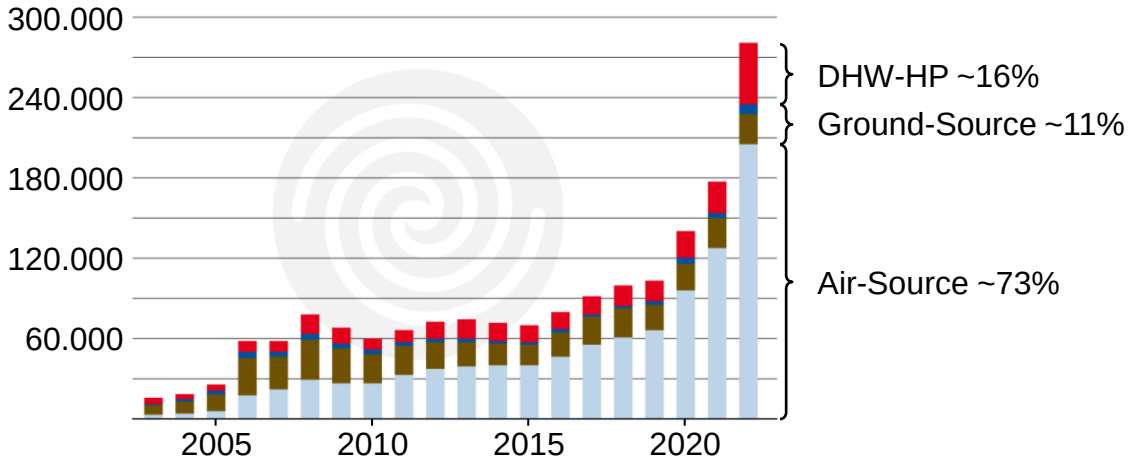
  → grid extension needs time & ressources

  (suitable solutions might be too slow)

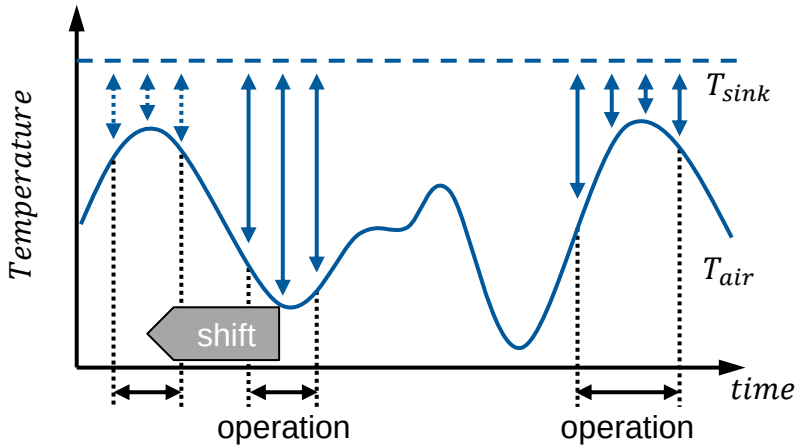
- Solutions to reduce the grid load needed
- Load shifting / Peak shaving possible solution

  → Predictive control can schedule the ASHP operation optimally

Number of sold Heat Pumps in Germany



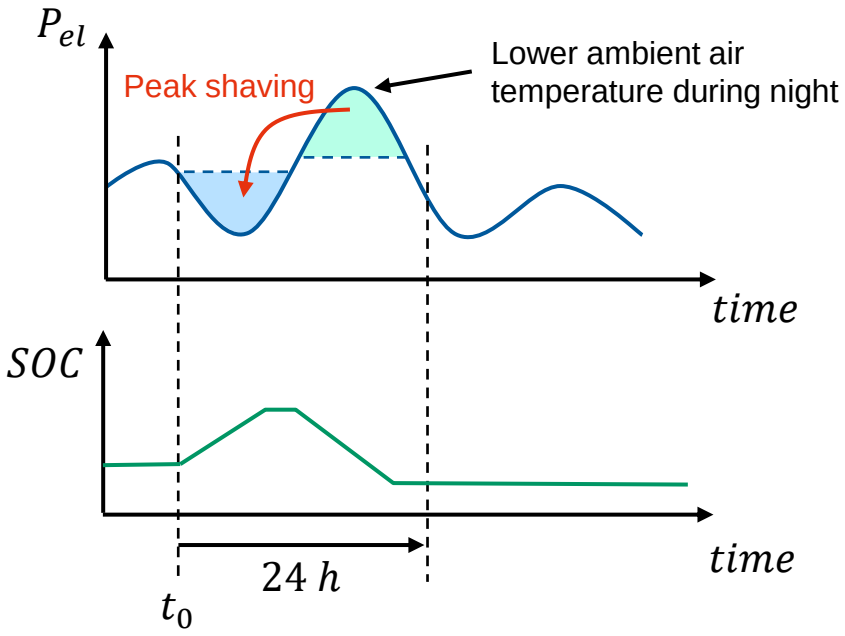
Source: BWP/BDH Absatzstatistiken



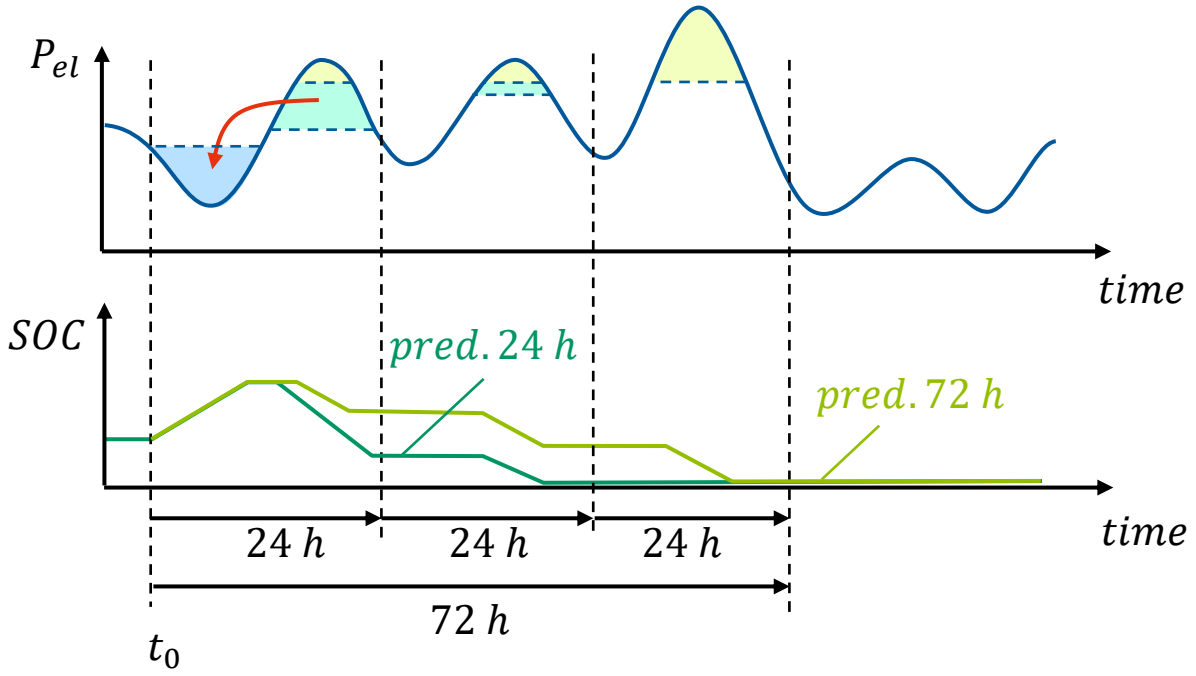
Background and Motivation

Predictive Control and Peak Shaving – Influence of different prediction horizons

1st case: Single Peak



2nd case: Multiple Peaks



Can the electrical peak loads of an ASHP reduced by optimal storage management?

Methodology

MATLAB Simulink & CARNOT

Electric Load Profile

+

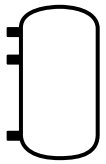
Power Limitation

Heat Load Profile

Storage Capacity

Heat Load Profile (Charging & Discharging)

MATLAB Simulink & CARNOT



$T_{supply} \geq T_{min,supply}$

Theoretical Potential

Example case

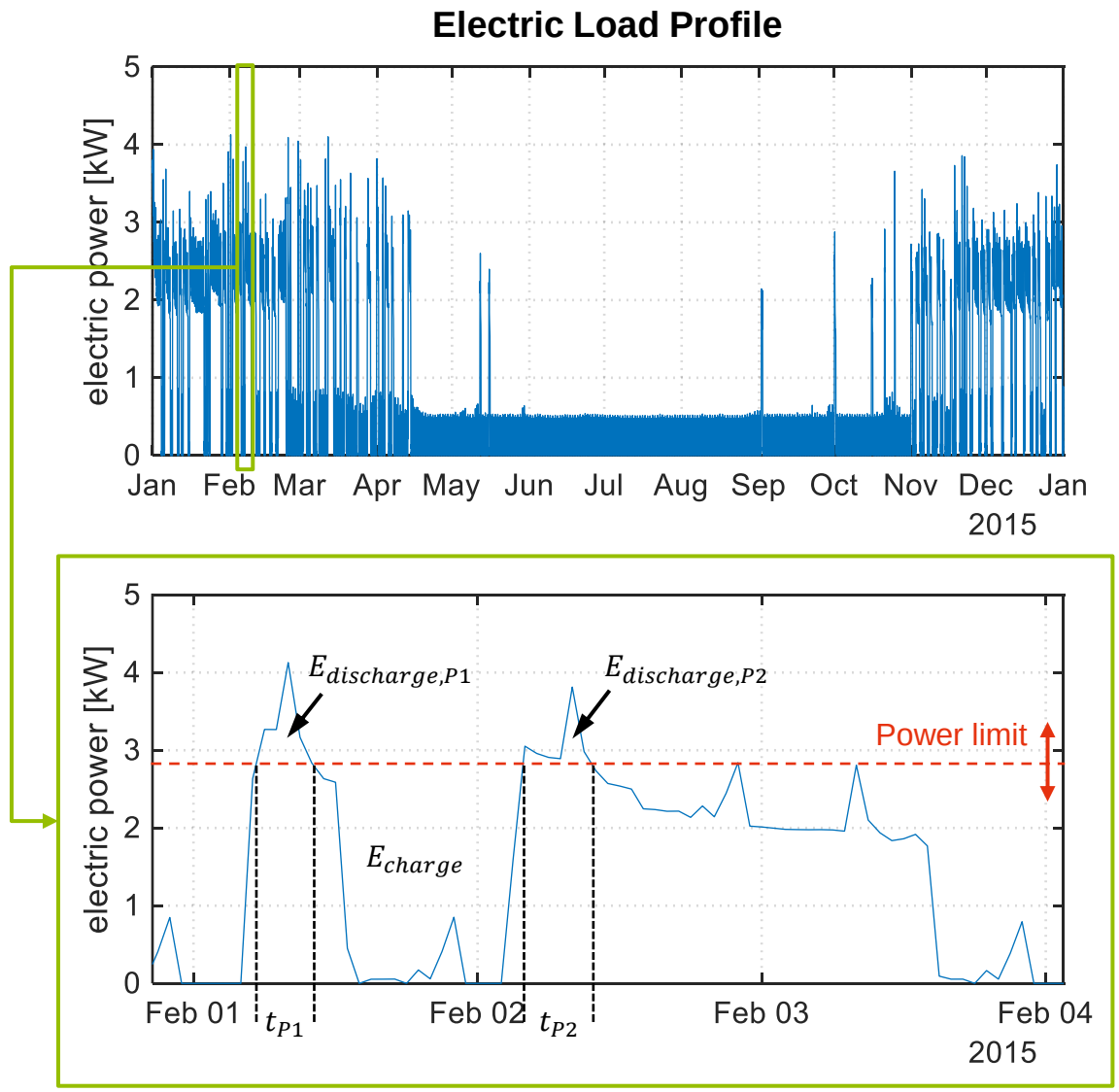
Electric Load of a SFH 45 with ASHP in South Germany

Germany, Ingolstadt
(48.8° N, 11.4° E)

German Weather Service
TRY 2015 „extreme cold Winter“

SFH45, CARNOT Toolbox (9250 kWh/a)
EU-Tapping Profile (2150 kWh/a)

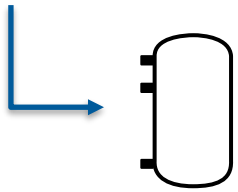
Air-Source Heat-Pump (ASHP)
8kW Heating Power



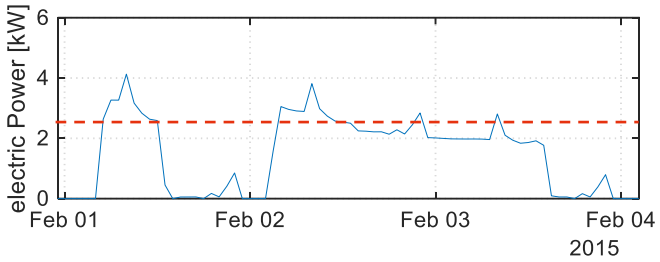
Example case

Peak load reduction using a 500 Liter buffer storage

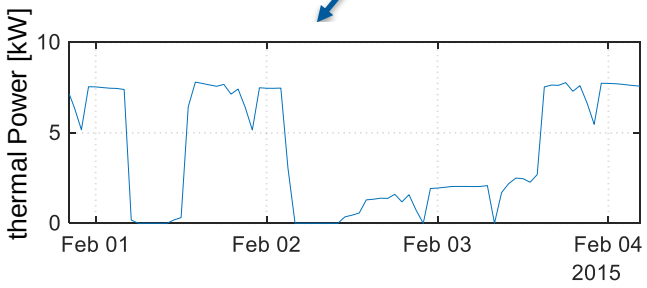
$T_{max,ASHP} = 70°C$
$T_{min,heating} = 35°C$



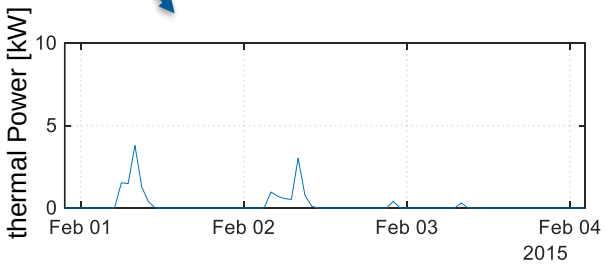
Volume: 500 Liter
ΔT = 60°C – 35°C = 25°C
Capacity = ~15kWh

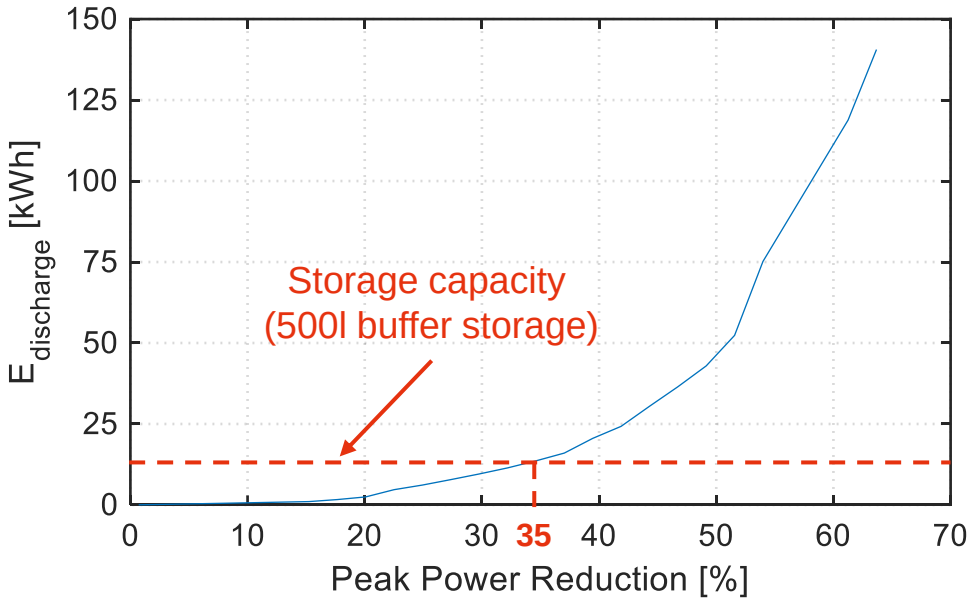


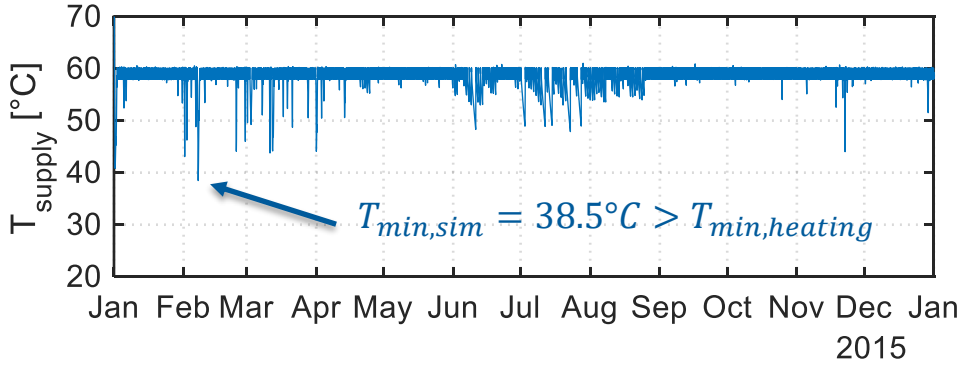
Charge Profile



Discharge Profile







Conclusion and Outlook

- Optimally managed storage capacity can reduce the peak load drastically
- Combining different storage technologies (e.g. thermal building activation, buffer storage, battery) can extend the technical potential
- Long-term predictive control algorithms are needed to manage storage capacities optimally

- **Futher investigations**:
  - Compare with standard controller for an ASHP with Storage
  - Combine different storages (e.g. Thermal building activation)
  - Building standards / Heat demand profiles
  - Weather Data of different locations

Thank you for the attention!

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