Technische Hochschule Ingolstadt
Institut für neue Energie-Systeme

CARNOT User Meeting

(Annual simulation of a hybrid) Heat pump including inverter control

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Agenda

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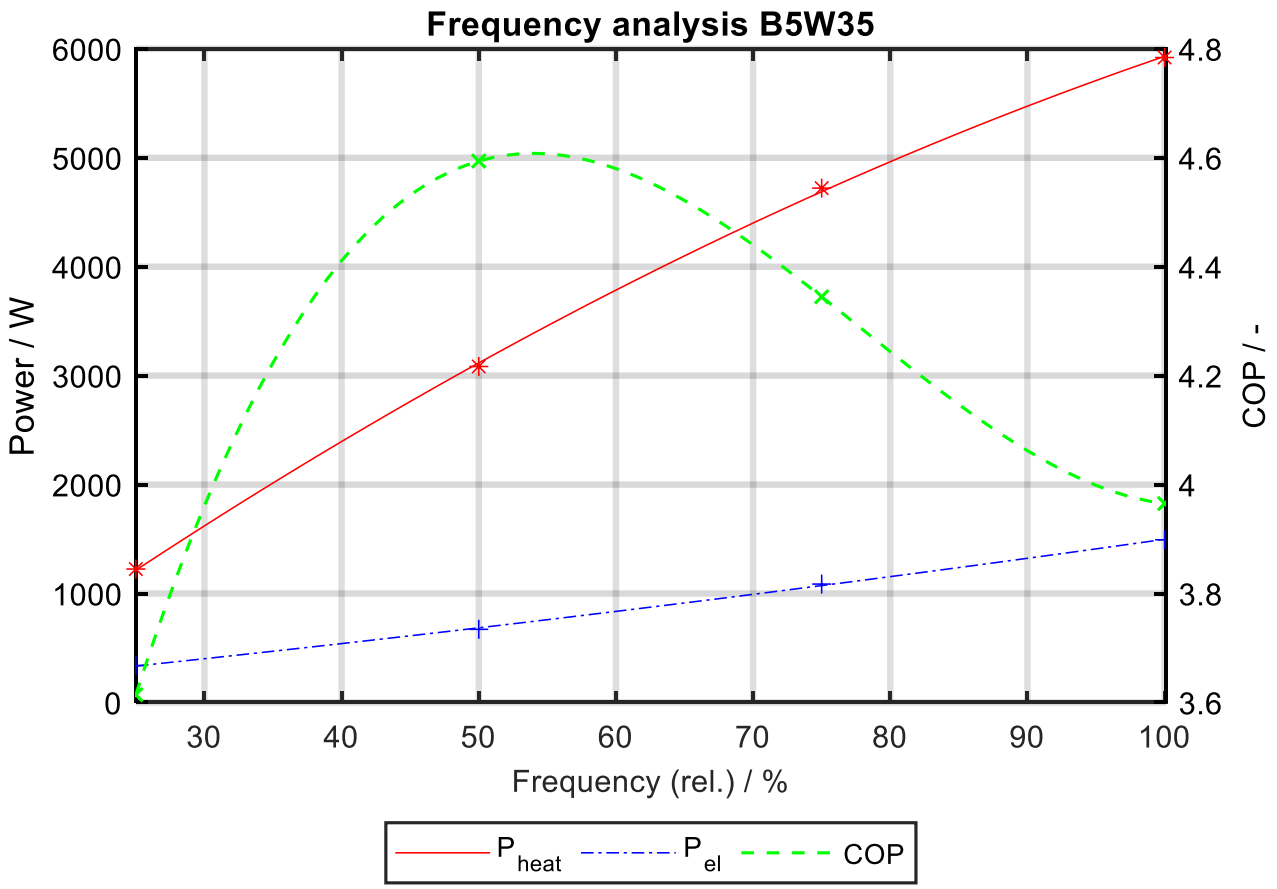
1. Background
2. Additional steps
3. Discussion

1 Background

- Modern heat pumps employ inverters to vary the heating power:
  - Usually between 25 to 100 %
  - Requires inverter (losses)
  - Reduces compressor starts significantly
- Effects on heat pump efficiency positive, but highly dependent on individual heat pump system

1 Background

Measurement



$$P_{heat} = -0.2641 * f^2 + 95.91 * f - 1018.8$$

1 Background

Implementation in CARNOT heat pump

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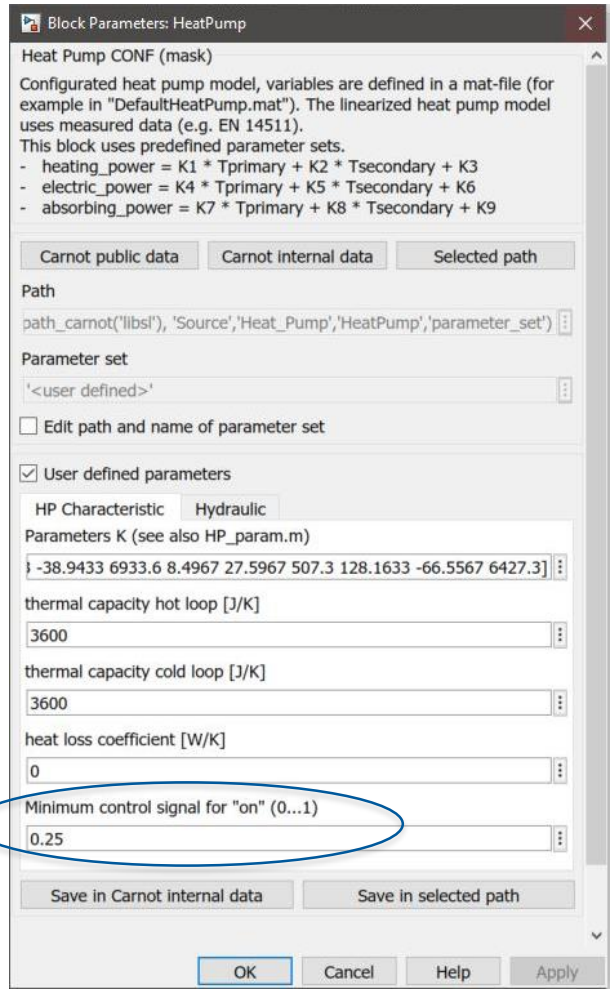
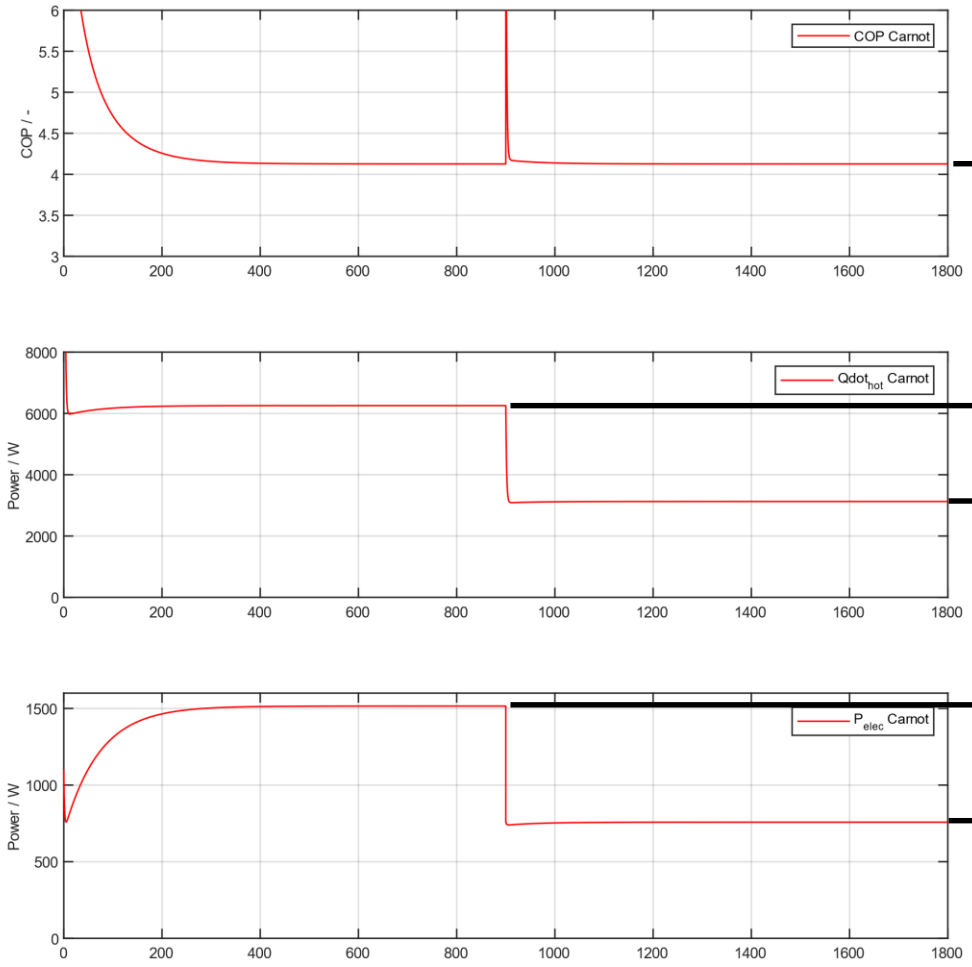
- Current implementation in CARNOT model: „minimum control signal“
- However: only factor on heating power Qdot_hot and electrical power Pelec

→ Couple of comparison simulations at B5W35, switching from 100 % to 50 %



1 Background

Implementation in CARNOT heat pump



const

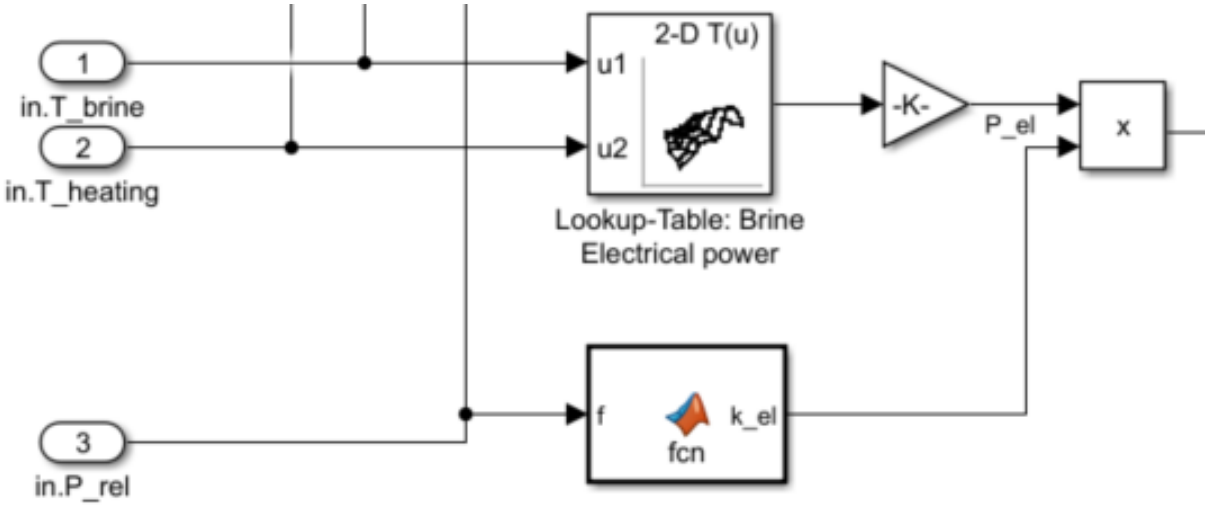
50%

50%

2 Additonal steps

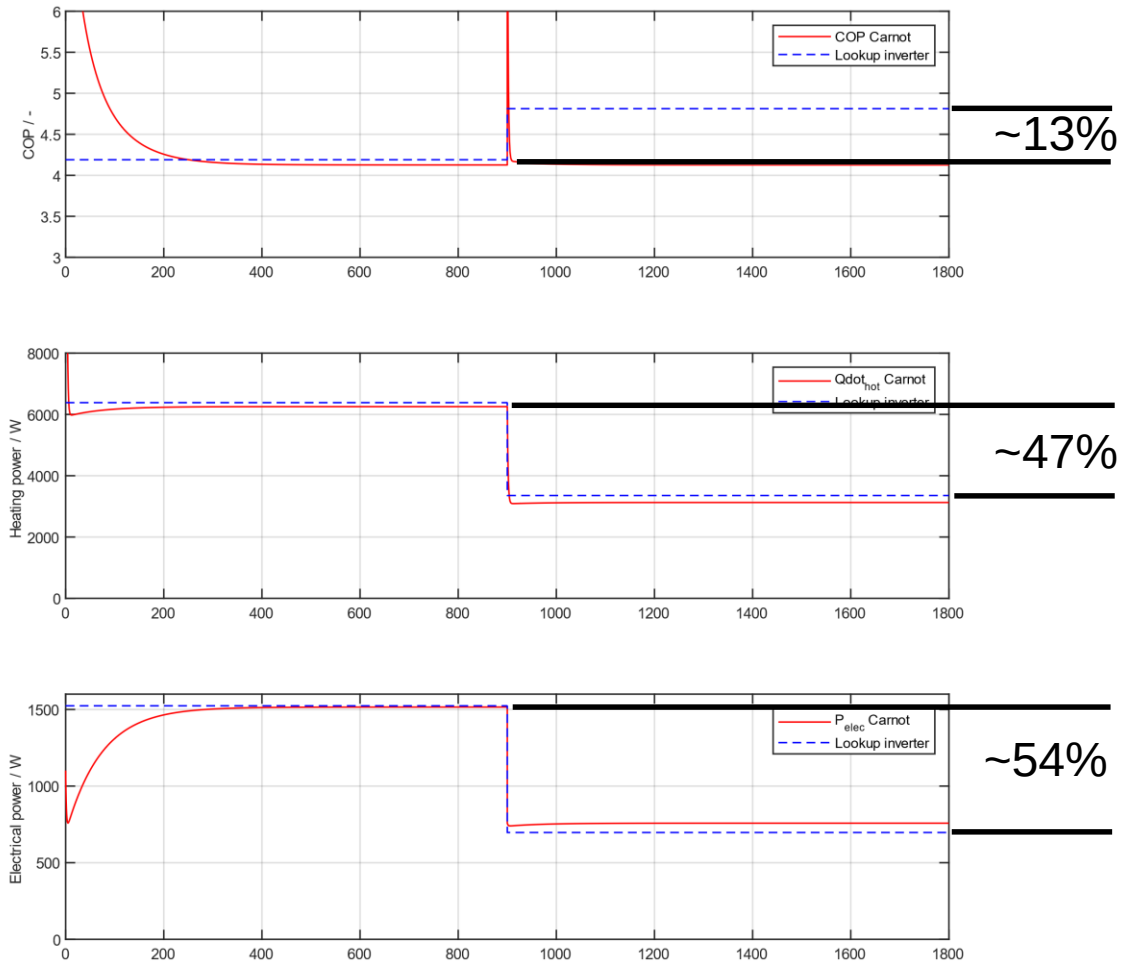
Lookup table with equation-based fit

- Switched to a lookup table with a correction factor
- Correction factor based on measurement (at one specific boundary condition point)



2 Additonal steps

Lookup table with equation-based fit



2 Additonal steps

Equation-based fit into CARNOT heat pump

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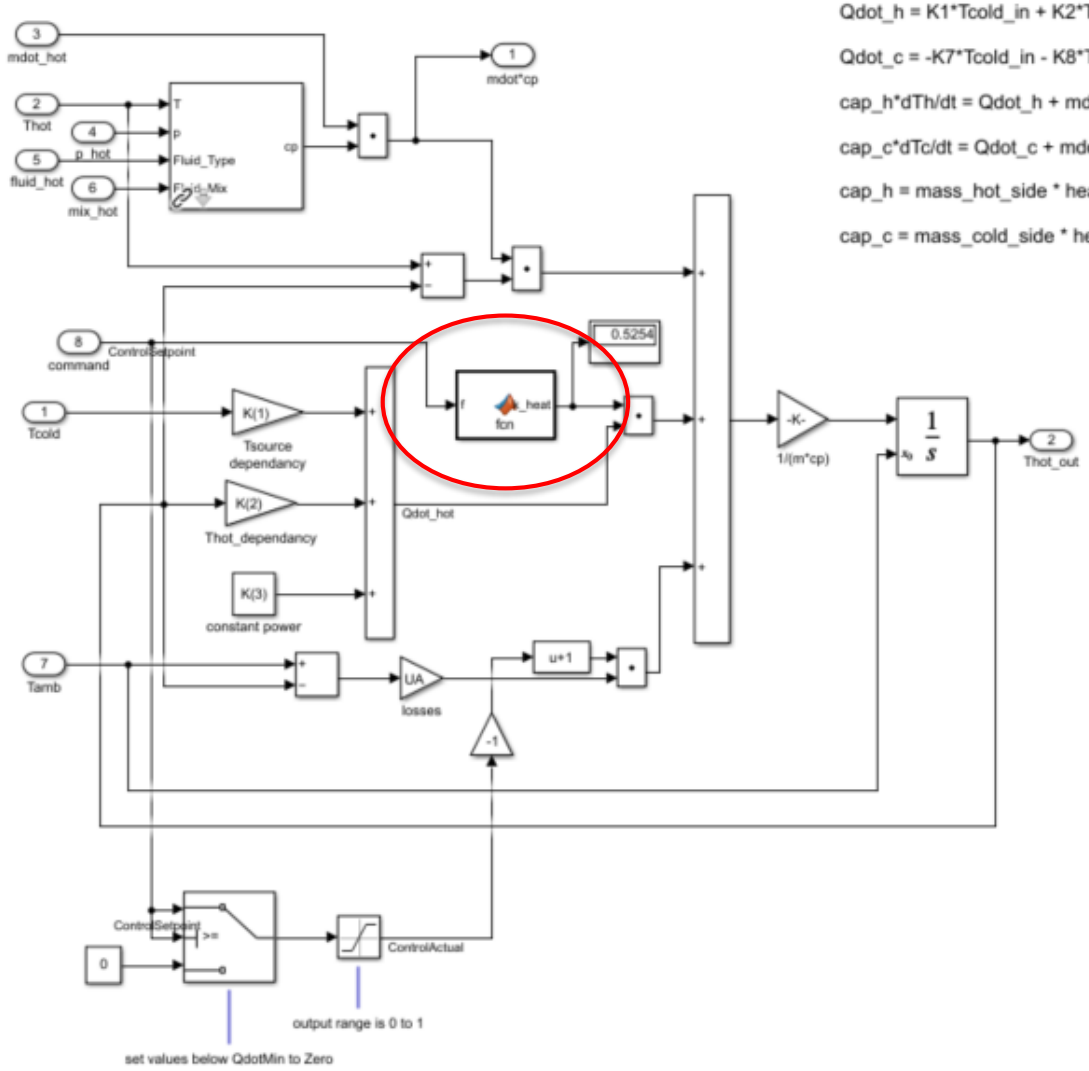

Qdot_h = K1*Tcold_in + K2*Thot_out + K3

Qdot_c = -K7*Tcold_in - K8*Thot_out - K9

cap_h*dTh/dt = Qdot_h + mdot_h*cp_h*(Th_in-Th) + UA*(Tamb-Th)

cap_c*dTc/dt = Qdot_c + mdot_c*cp_c*(Tc_in-Tc) + UA*(Tamb-Tc)

cap_h = mass_hot_side * heat_capactiy_hot_side

cap_c = mass_cold_side * heat_capactiy_cold_side

2 Additonal steps

Equation-based fit into CARNOT heat pump

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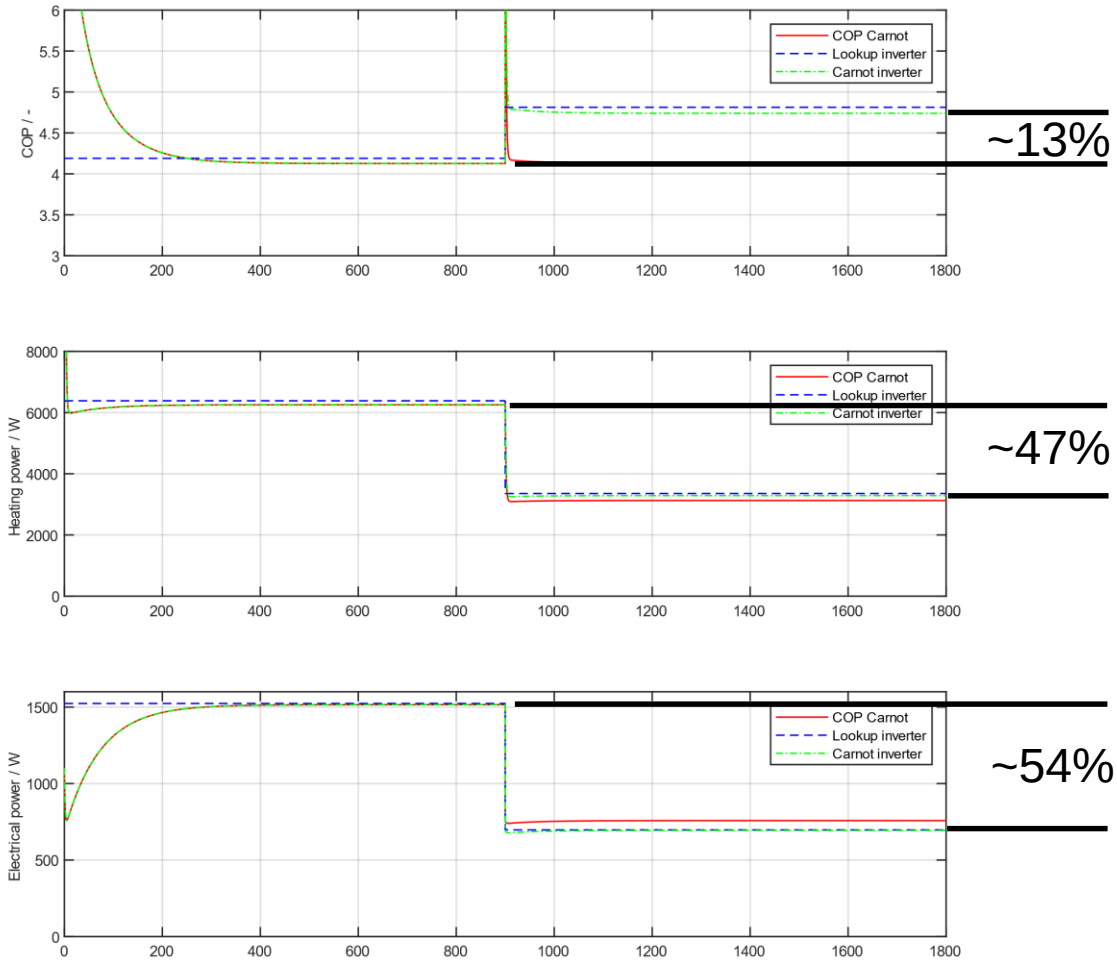

3 Discussion

Issues with this implementation

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- Implementation could be done in the same way like the heat pump model (parameter-based equation fit in external function)
- But: The precision with „fewer“ measurements is lacking.
  - Barely available from manufacturers
  - Own Measurements mean a lot of work (potentially)
  - Still, even with a single measurement or even a standard parameter set, the model should become more realistic in part-load situations

Thank you for the attention!

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