DeStoSimKaFe

DEVELOPMENT & RATING OF TECHNICAL & ORGANIZATIONAL SYSTEM SOLUTIONS FOR COLD DISTRICT HEATING TO SUPPLY HEATING AND COOLING

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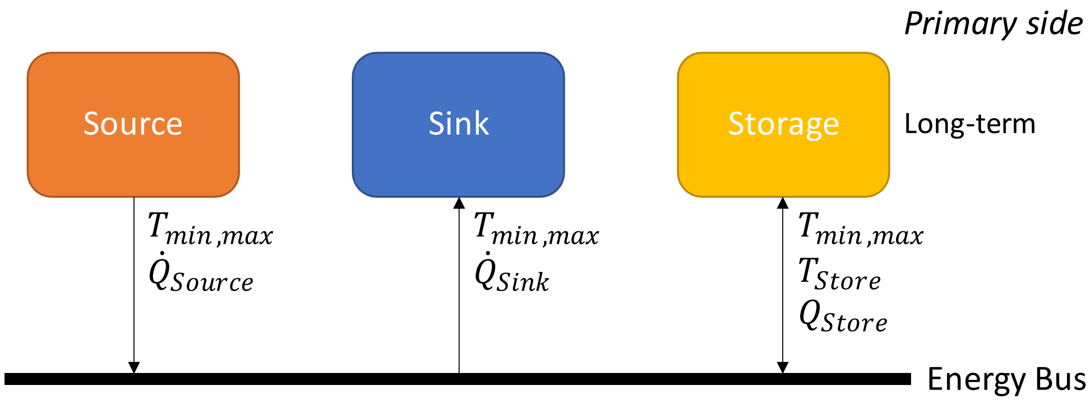
Basics of cold DHC

- Low temperatures:
  - Better integration of more renewable heat sources (solar, waste water treatment plants, industrial processes, server farms, etc.)
  - Considerably lower losses in piping system
    - Enabling the use of uninsulated pipes
    - Potentially lowering investment costs
  - Possibility for free-cooling

- Bi-directional grid topology
  - System easily expandable
  - Customers can be producers AND consumers (prosumers)

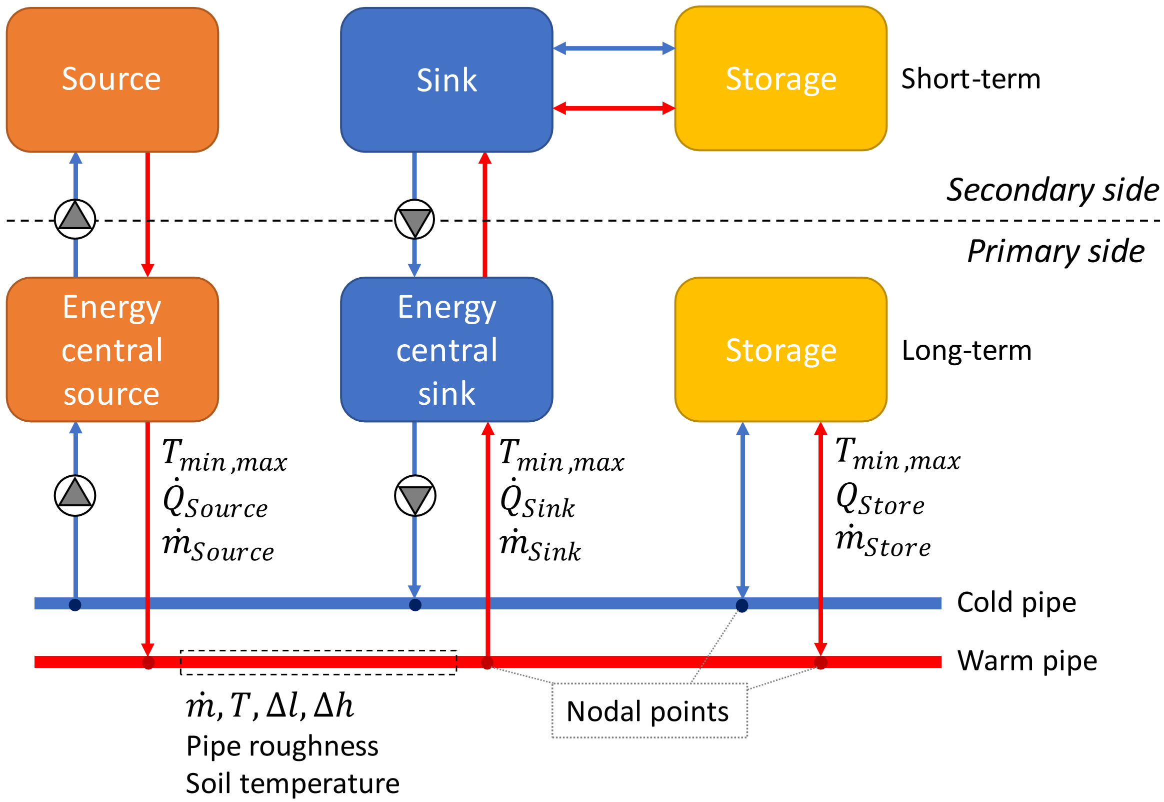
Development of simulation models (1) Energy balance tool

- „Quick and dirty“ method for preliminary results
- Enabling long term investigation with reasonable computational effort
- Abstract storage/piping model (Energy Bus), calibrated with measured values
- All essential components (HP, PVT-Collectors, etc.) are available

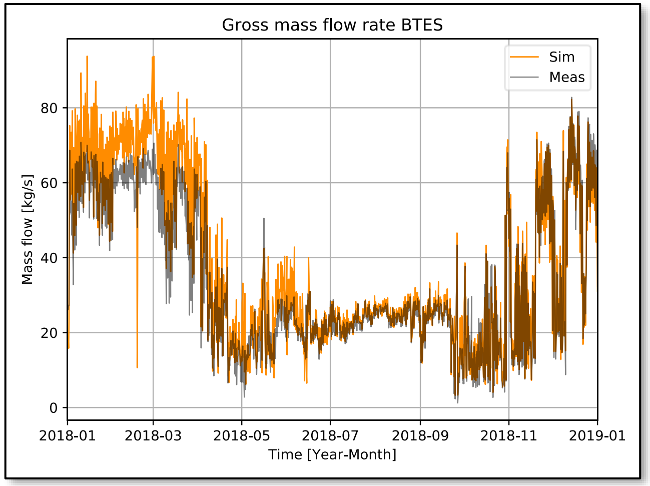


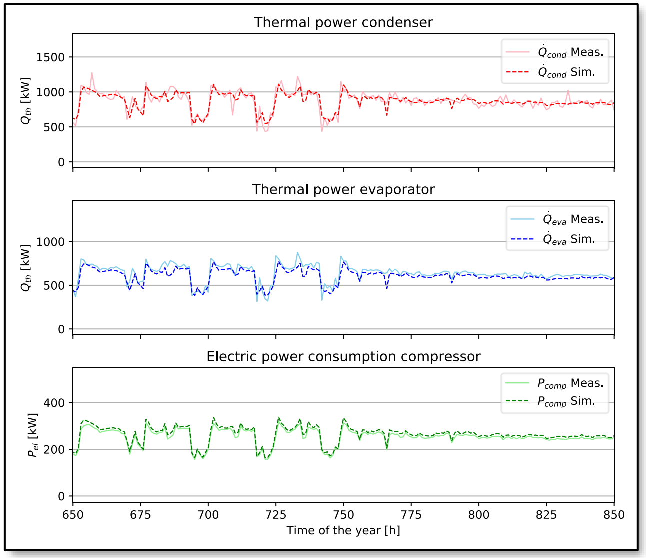
Development of simulation models (2) Thermohydraulic model

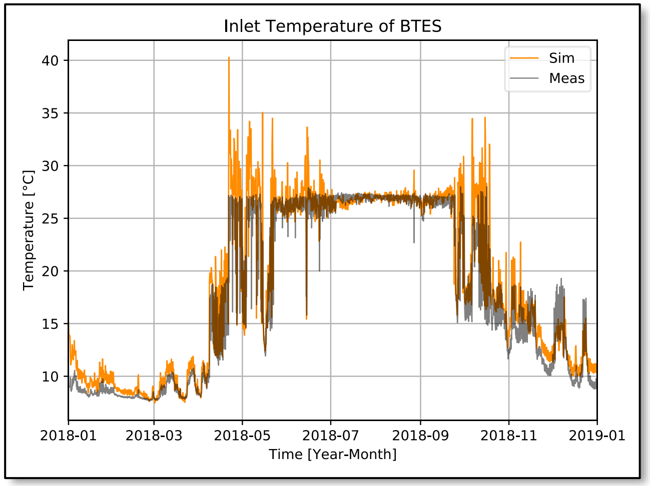
- Detailed simulations of overall system
- Piping system modelled distinctively
- Long-term storage modelled in detail (with soil model)

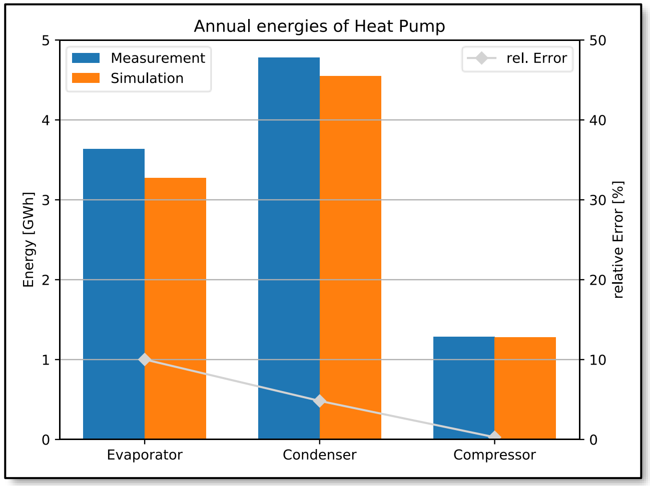


Development of simulation models
Validation



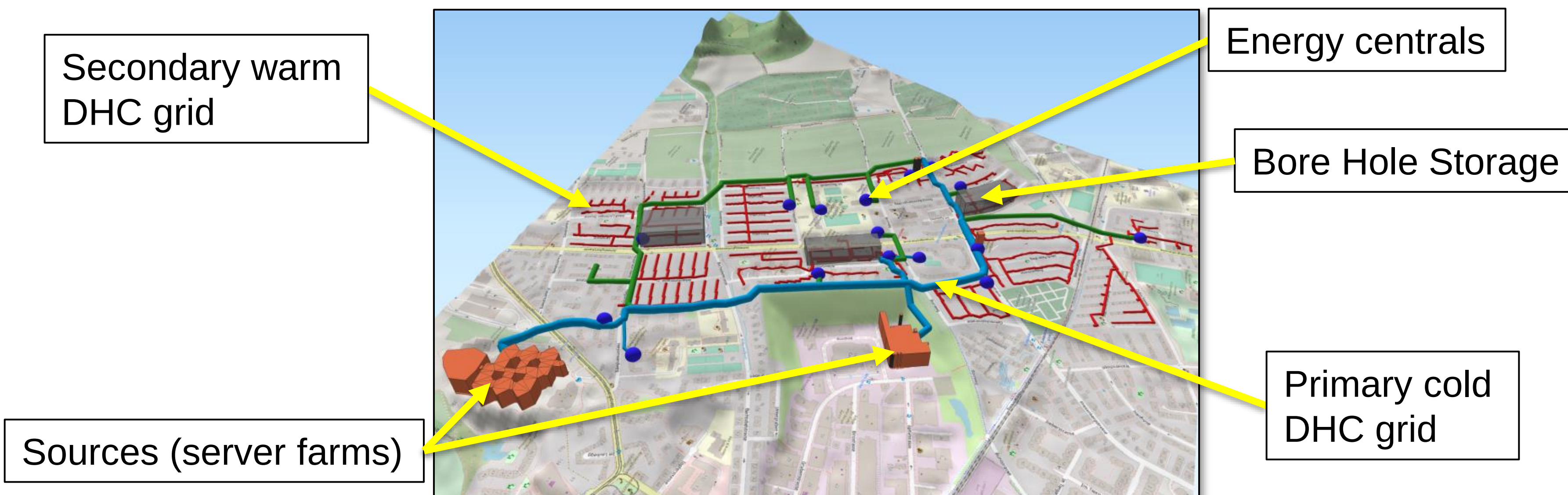






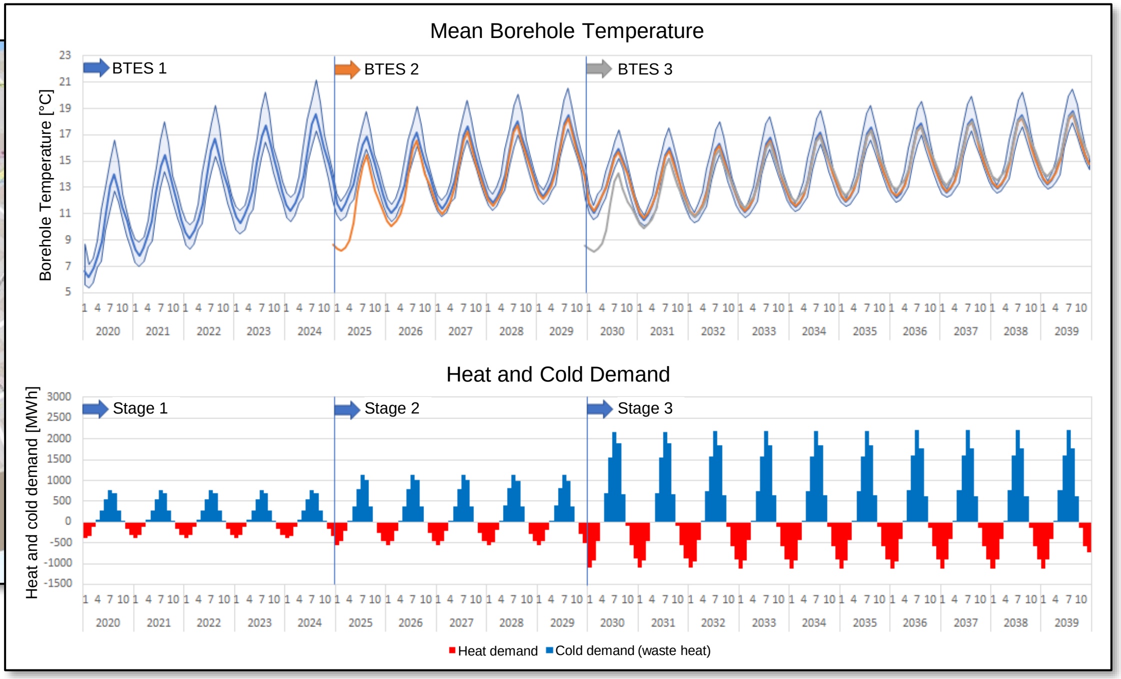
Use Cases of different demonstrators

- FGZ Zürich
  - Living Quarter with 5500 Inhabitants
  - Heat Supplied by two data centres (@35°C)
  - Decentralized Heat Pumps
  - Borehole long-term storage
  - Constantly developed and expanded
  - Measurement data used for validation



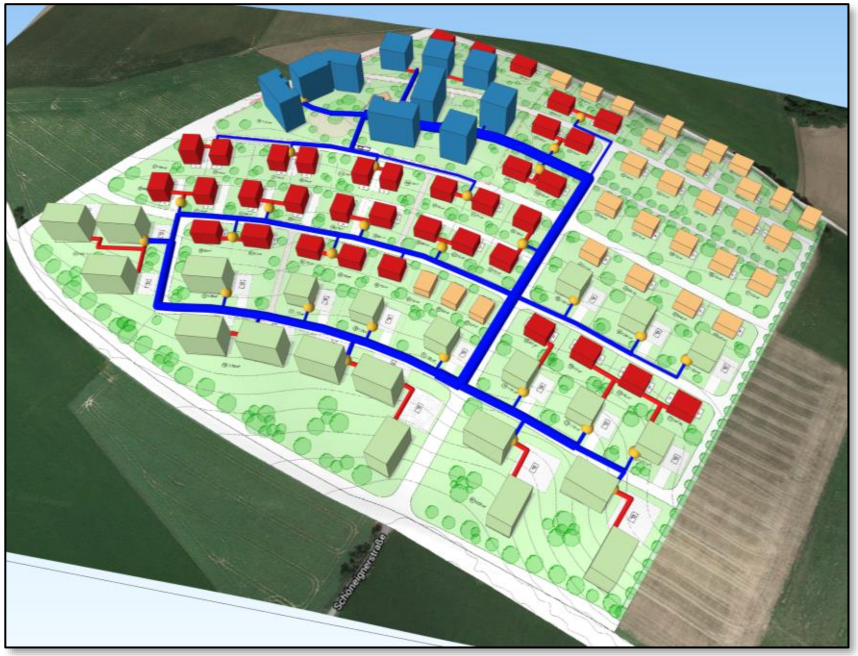
Use Cases of different demonstrators

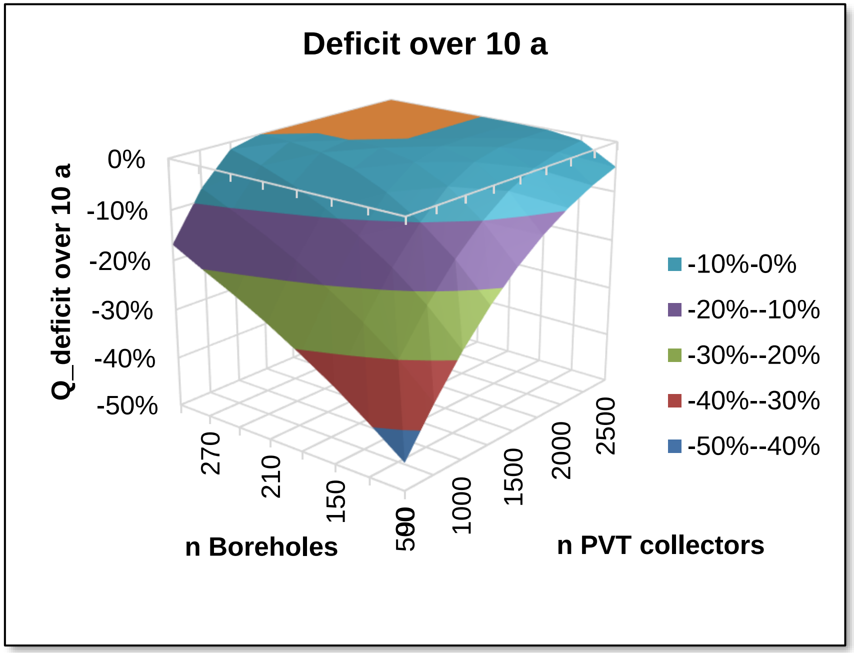
- Hospital complex
  – Waste Heat from clinical machines and air conditioning
  – Seasonal storage in Borehole fields (3 in succession)
- Long-term simulation
  – Heat supply higher then demand
  – More consumers can be connected



Use Cases of different demonstrators

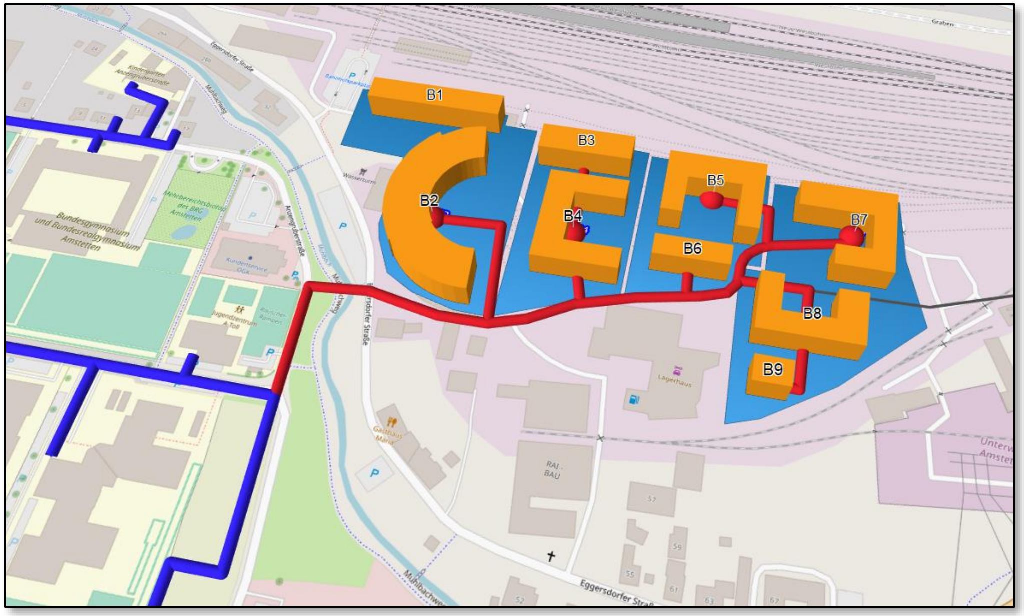
- Living quarter
  - No external heat sources available
  - Instead supply via Solarthermal/PVT collectors
- Investigation on Number of collectors and boreholes
  - Investment cost too high for Cold DHC solution
  - Energetically possible, economically not viable





Use Cases of different demonstrators

- Living quarter in city centre with access to conventional HT DH
- DH High Temp: 3rd gen
  - 95-55°C
  - Insulated Steel Pipes (series 2)
- DH Low Temp: 4th gen
  - 55-35°C
  - Insulated Steel Pipes (series 2)
- Cold DH: 5th gen
  - 5-15°C
  - Un-Insulated PE-pipes



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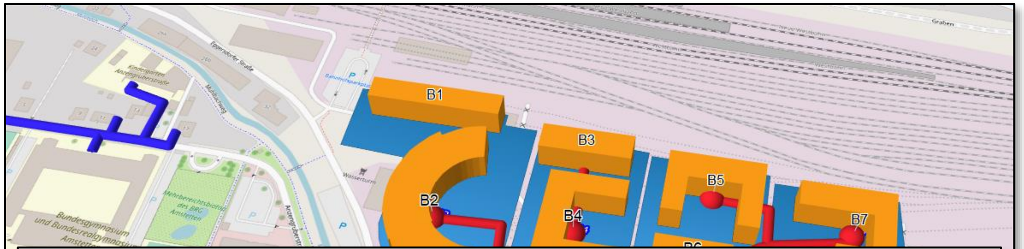
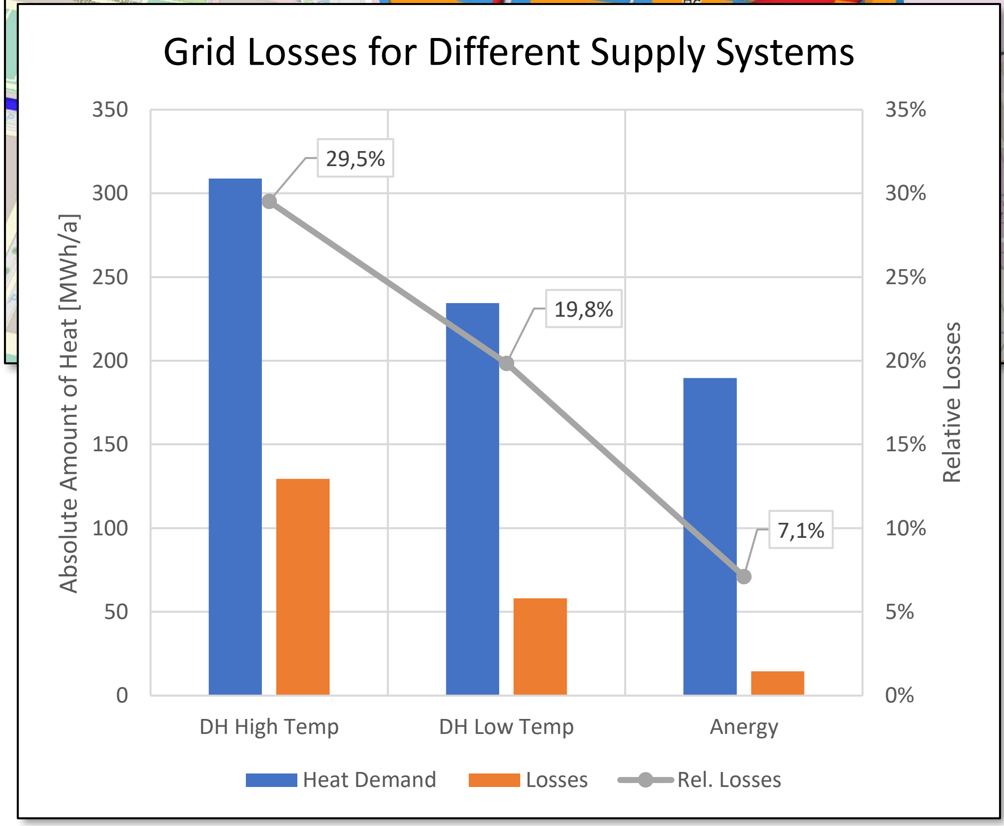
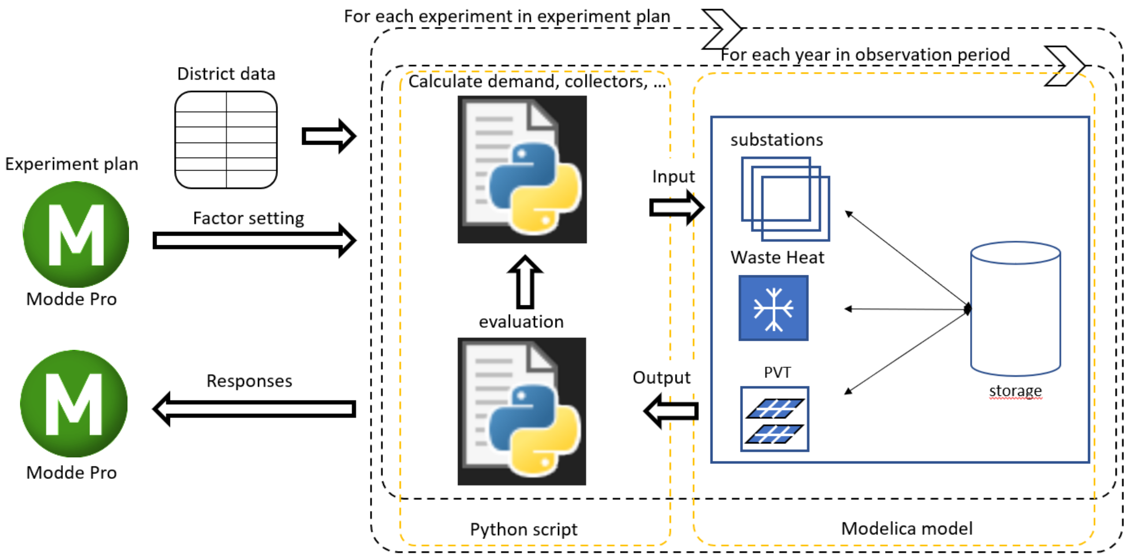




Stochastic approach
Setup

- Use of deterministic model in Modde Pro (DoE-tool)
- Experiment plan set by varying factors
  - Renovation rates, climate scenarios, population growth
  - Minimum grid temperatures, waste heat ratio, storage capacities (primary side), solar collectors
  - CO_2-price, electricity price, oil/gas price



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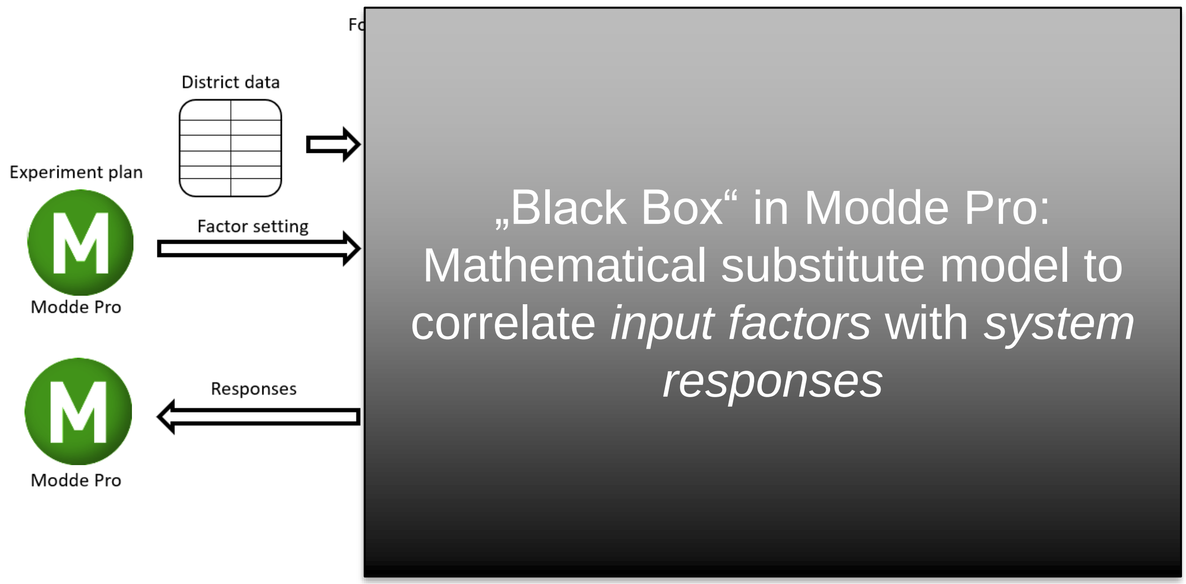
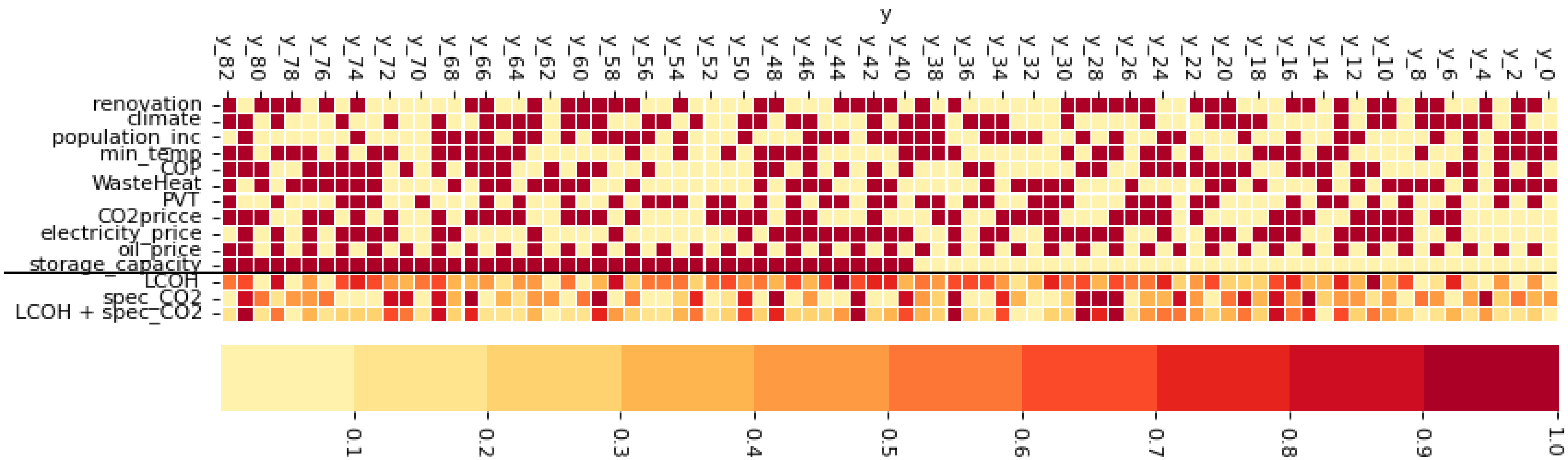


Stochastic approach
Results

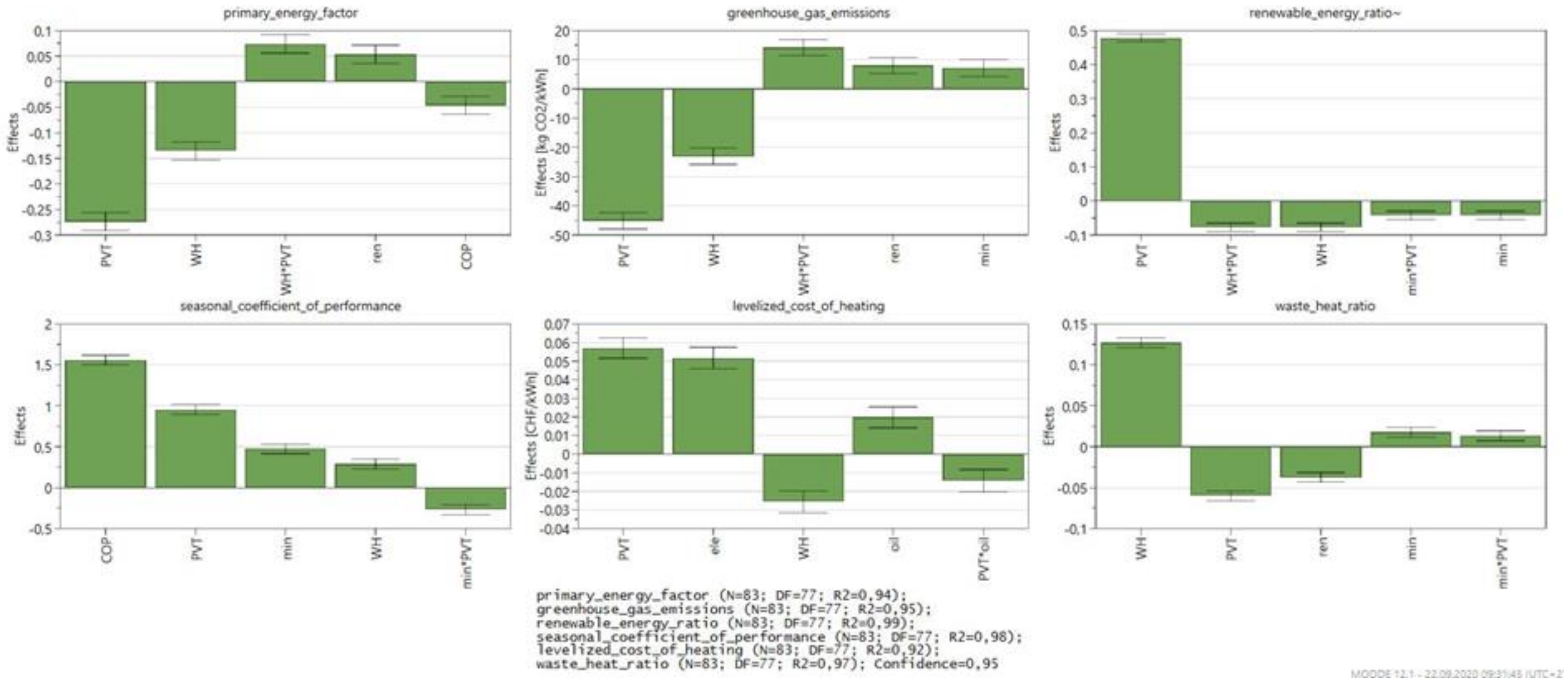
- 83 different system combinations
- Predefined KPIs used to compare variants
  - SCOP, LCOH, CO_{2eq}, f_{PE}, RER, WHR
- Exemplary: LCOH + CO_{2eq}



Normalized scale (0 ≙ lowest value, 1 ≙ highest value)

Stochastic approach
Results

- Technical parameters predominant
- Influence of “soft” parameters smaller



Results
Lessons Learned / Future Development

- Take-aways:
  - Cold DHC allows for better integration of renewables
  - Waste heat source on-site indispensable
    - Need for “waste-heat” awareness, that T<30°C is still usable
  - Economic boundary conditions are essential for a successful implementation
  - Chicken-egg dilemma for new built areas and grids

- Follow-up, scientific questions:
  - How can model-predictive control contribute to more efficient load management?
  - How big is the energy saving potential with load management on the secondary (consumer) side?
  - How can other renewable sources (waste water, sea water, etc.) be integrated?

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IDEA TO ACTION

Thank you for your attention