Low temperature district heating micro-networks in Austria

comparison of four case studies

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Smart Energy Systems and 4th Generation District Heating

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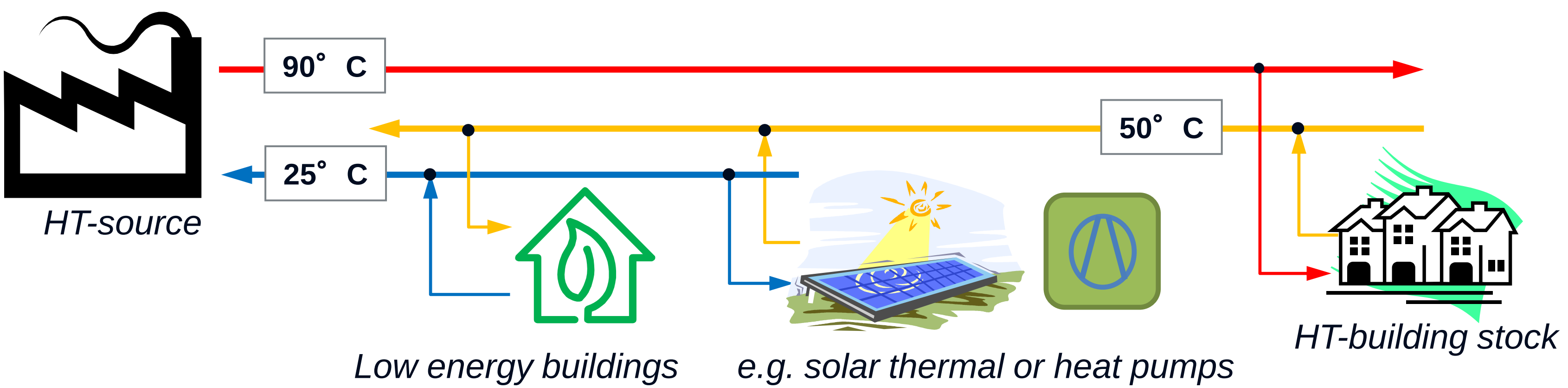
Why low temperature DH?

- Possible usage of unused LT and renewable energy sources for DH
- Reduction of network heat losses and investment costs
- Increase of efficiency of production plants
- Coupling of LT-Buildings in HT return line to increase network capacity



NextGenerationHeat

- National funded research project, 8 project partner

- **Aim:** develop and evaluate
  - economically and ecologically optimized concepts/scenarios for **low temperature district heating (LTDH) networks** tailored to 4 different regions in Austria with low energy demand
  - optimized solutions to the problem of **hygienic domestic hot water preparation**, taking into account heat pumps and other external energy sources

- **Method:**
  - development of **technical system variants**
  - dynamic **network simulation**
  - **economic evaluation**

This project is supported with funds from the Climate and Energy Fund and Implemented in line with the "New Energies 2020" programme.

NextGenerationHeat - case studies

- 4 representative case studies with low energy demand due to passive and low energy buildings
- DH supply temperature max. 65°C

NextGenerationHeat - case studies

location	Hummel Kaserne	Aktivpark Güssing	Winklweg Siedlung	Seestadt Aspern
city	Graz	Güssing	Wörgl	Vienna
type	New construction	New construction	building stock	New construction
usage	residential, care home for old people	tourism, SFH (villa, hotels, golf club)	residential neighbourhood (MFH)	residential (MFH, office, commerce)
possible LTDH energy sources	return line of existing network	Bio mass CHP (condensor waste heat)	Heat pump, return line of existing network	return of HT consumer, existing HT network

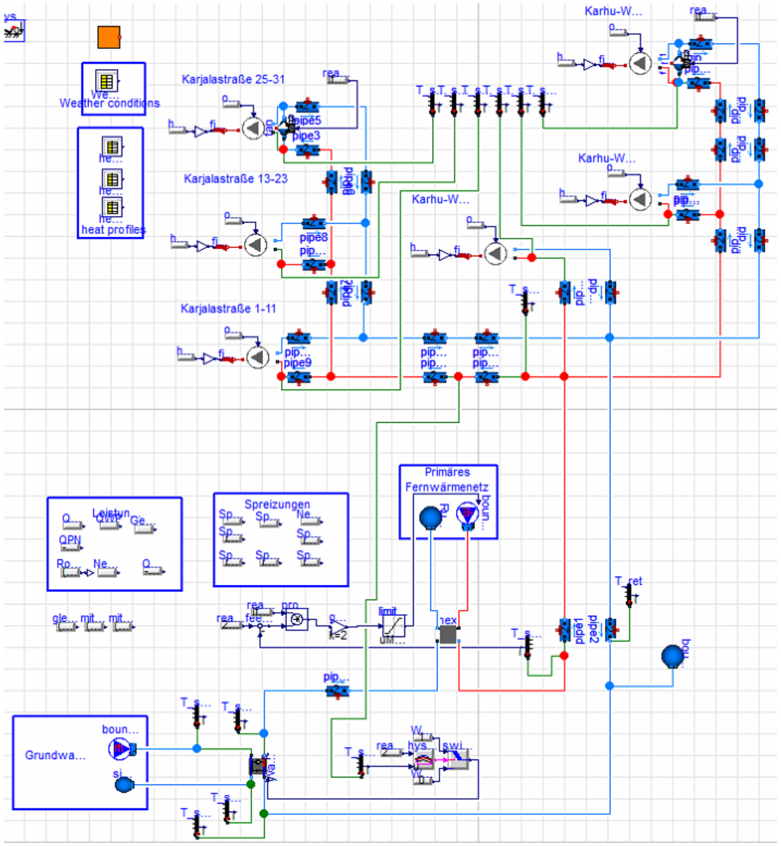
Technical barriers for LTDH

- No technical problems for **space heating** of passive and low energy buildings with suitable heat system

- **Domestic hot water** preparation
  - Proliferation boost for legionella @ 20°C<T<50°C
  - Austria regulation (ÖNORM B5019)
    - DHW pipes **> 6m** → T>55°C at each point and T>60°C at the outlet of the distributor
  - Minimum comfort requirements
    - DHW pipes **< 6m** → T>40°C at the shower tap or T>45°C at the bath tube tap
  - Alternative **sterilization treatments** (e.g. chemical) to thermal treatments → **not in the scope** of the project

Modelling and simulation

- 16 different substation types were modelled and evaluated
- Selection of the suitable substation typ for each scenario in the different case studies
- Implemented together with simplified building models and grid components in the dynamic network simulation in Modelica/Dymola

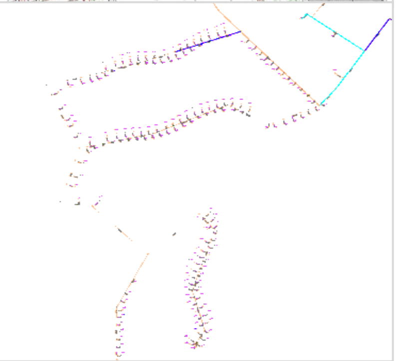


Modelling and simulation

- Modelling and simualtion of the 4 case studies
  - Developing different supply scenarios
  - Implementing different control strategies for Substation, storages and other components
  - Using measurment and design input data
- Simulations
  - Duration: 1 year
  - Time step: 15 min
- Outcome
  - Ecological and energetic KPI
- Followed by economic evaluation

Hummel Kaserne
(Graz)

Aktivpark
(Güssing)

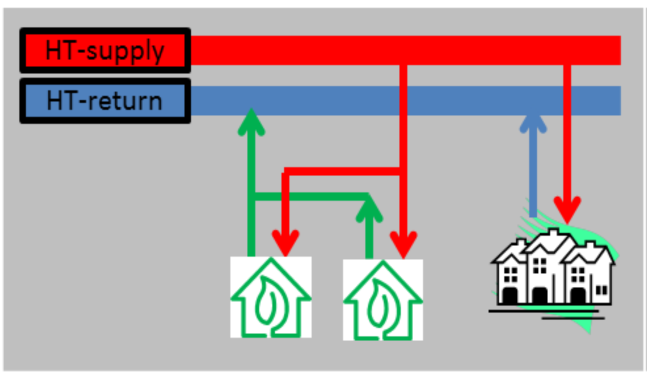


Winklweg
(Wörgl)

Seestadt Aspern
(Vienna)

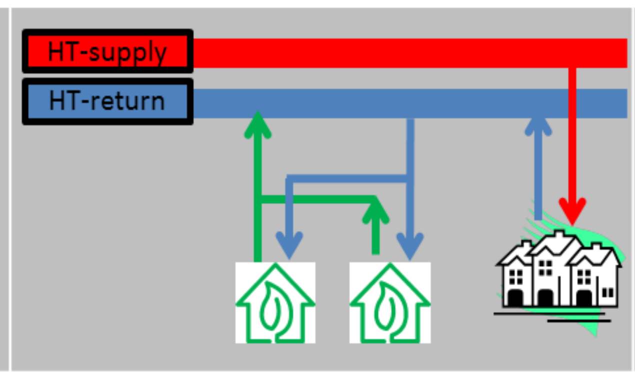
Simulation supply scenarios - Graz

HTDH
Reference scenario
HTDH supply connection



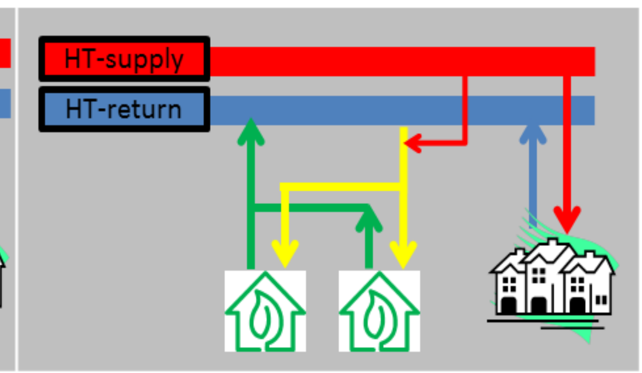
Supply temperature
120°C @ -12°C;
75°C @ +12°C

LTDH
Using the **return line** of existing HTDH grid
DHW preparation by using **Booster HP** and **electrical Booster**



Supply temperature
58 °C constant

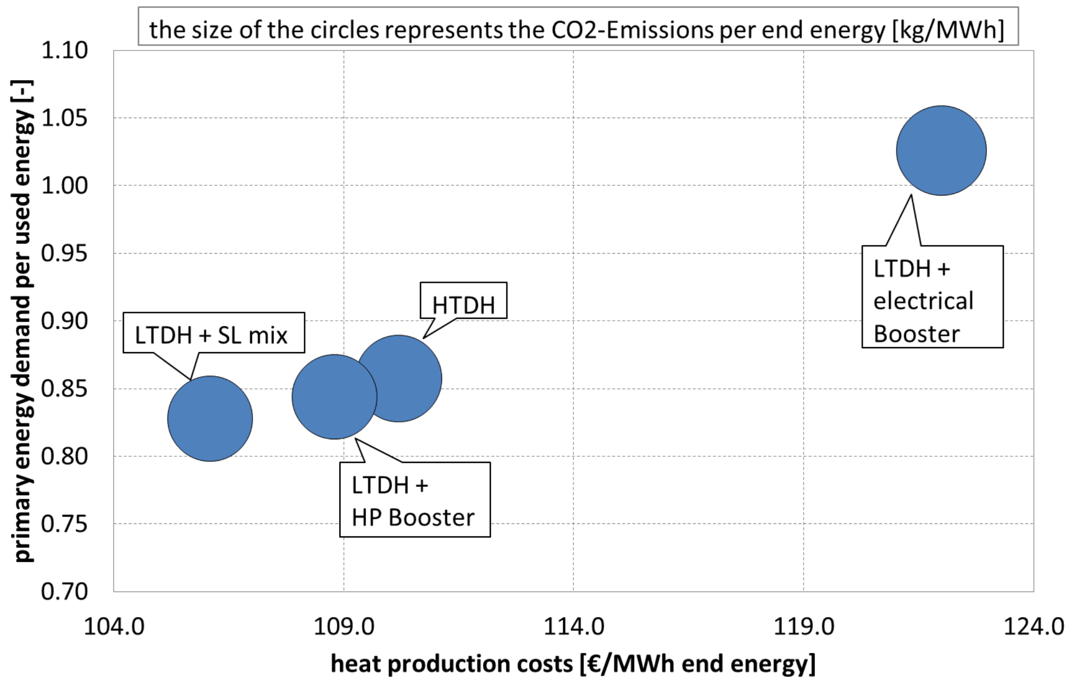
LTDH
Using the **return line** of existing HTDH grid
with HTDH **supply line mix** (SL mix)



Supply temperature
65 °C constant

Main results Graz

- CO2-Emissions similar in each scenario
  - Best: LTDH + SL mix
  - worst: LTDH + electrical Booster
- Primary energy demand
  - Best: LTDH + SL mix
  - worst: LTDH + electrical Booster
- Heat production costs
  - Best: LTDH + SL mix
  - worst: LTDH + electrical Booster



Simulation supply scenarios - Güssing

HTDH

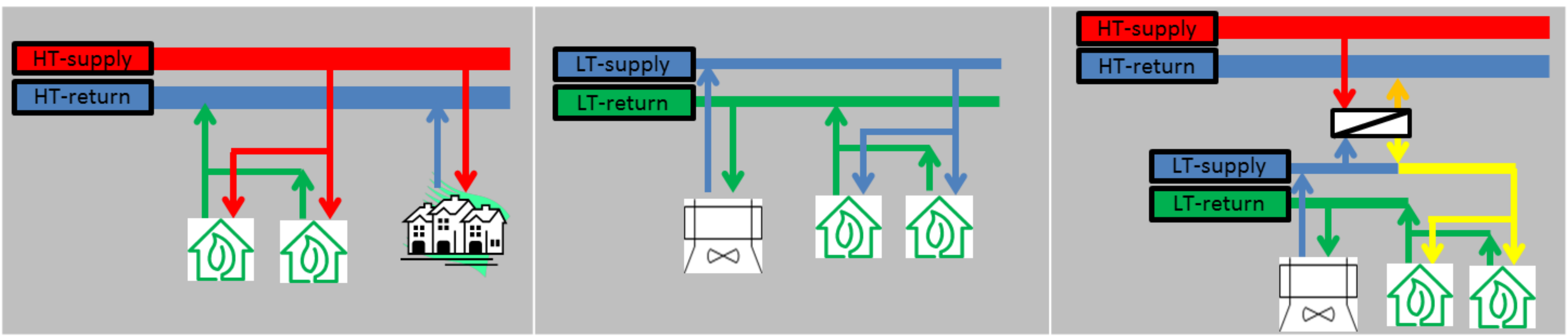
Reference scenario
HTDH supply connection

LTDH

Using **waste heat** from condenser of existing CHP DHW preparation by using **Booster HP** and **electrical Booster**

LTDH

Using **waste heat** from condenser of existing CHP with HTDH **supply line mix** (SL mix)



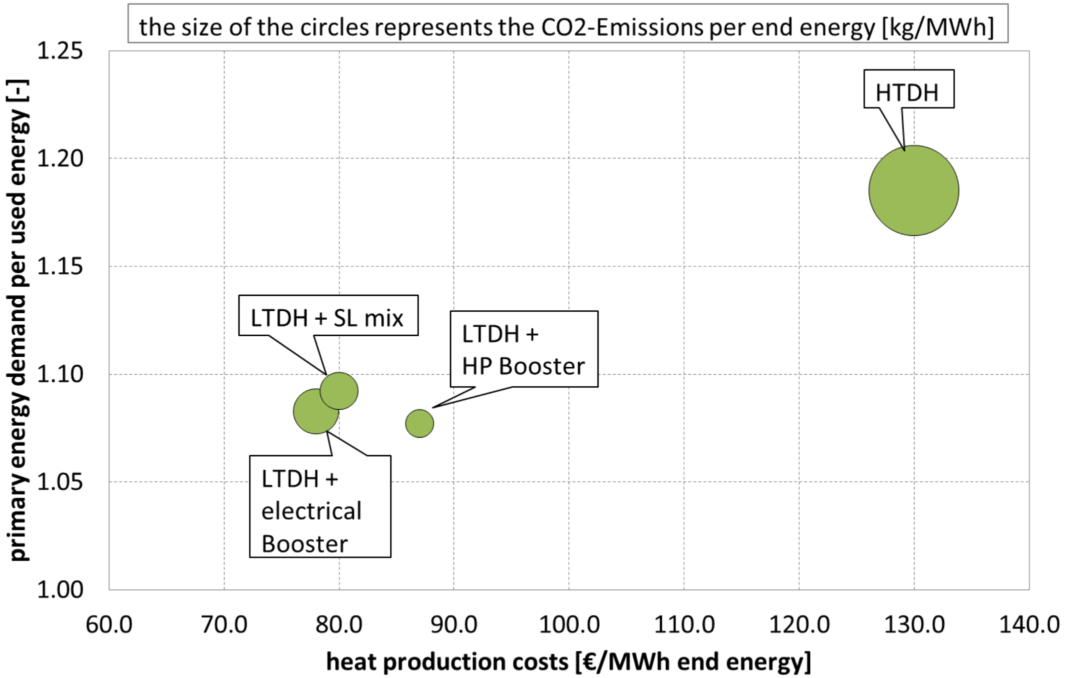
Supply temperature
90°C constant

Supply temperature
49 °C constant

Supply temperature
55 °C constant

Main results Güssing

- CO2-Emissions
  - Best: LTDH + HP Booster
  - worst: HTDH
- Primary energy demand
  - Best: LTDH + HP Booster
  - worst: HTDH
- Heat production costs
  - Best: LTDH + electrical Booster
  - worst: HTDH



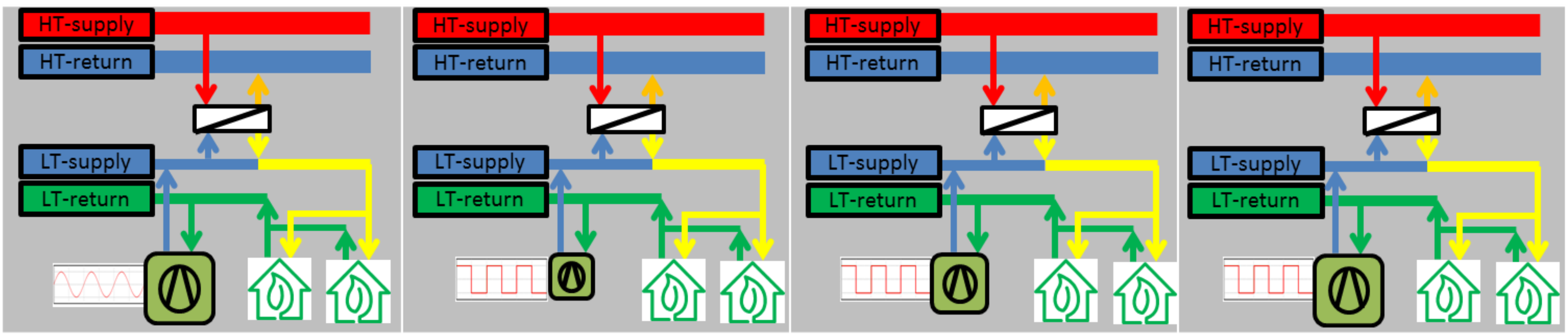
Simulation supply scenarios - Wörgl

LTDH
Dynamic HP control
HP capacity **440kW**

LTDH
On/Off HP control
HP capacity **220kW**

LTDH
On/Off HP control
HP capacity **330kW**

LTDH
On/Off HP control
HP capacity **440kW**

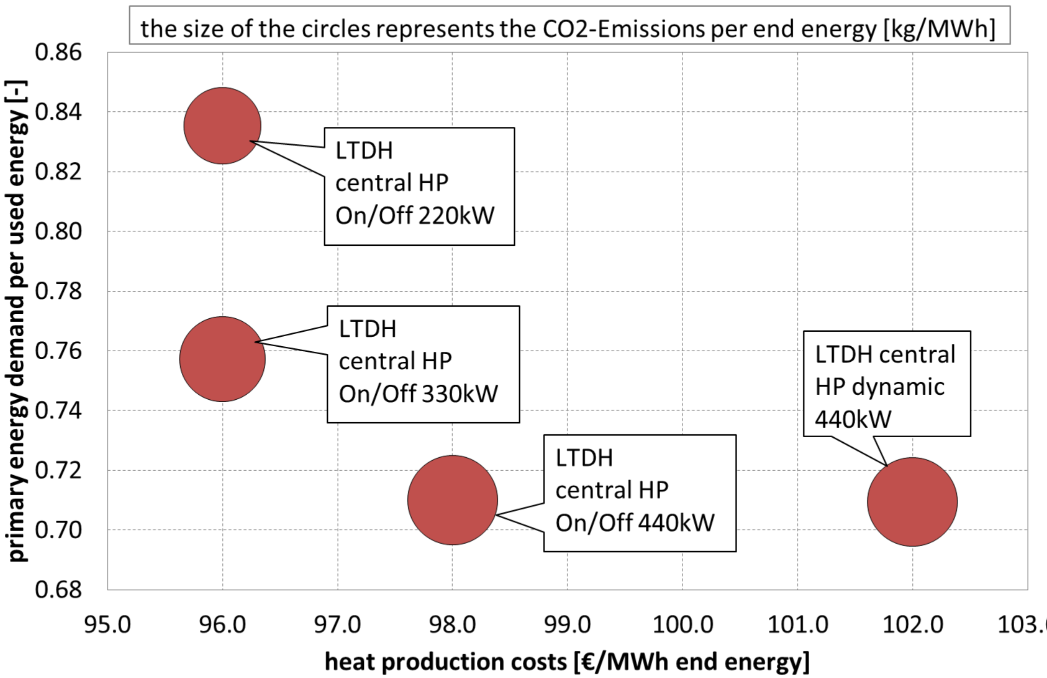


No DHW preparation
Backup from HTDH

Supply temperature:
48°C @ -18°C
25°C @ +15°C

Main results Wörgl

- CO2-Emissions similar in each scenario
  - Best: On/Off HP 220kW
  - worst: On/Off HP 440kW
- Primary energy demand
  - Best: dynamic & On/Off HP 440kW
  - worst: On/Off HP 220kW
- Heat production costs
  - Best: On/Off HP 220kW & On/Off HP 330kW
  - worst: dynamic HP 440 kW



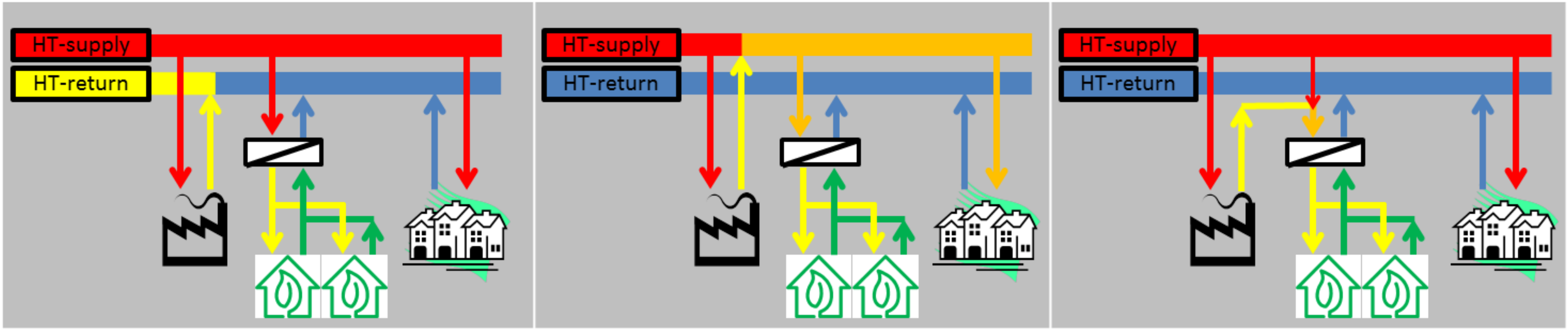
- due to missing information, the effect of lower number of cycles in the dynamic operation mode of the HP was not considered for the economic evaluation

Simulation supply scenarios - Vienna

LTDH
HTDH supplies Micro grid via heat exchanger return flow of a HT industrial consumer increases primary return line temperature

LTDH
Using return flow of a HT industrial consumer **Mixing in primary supply line**

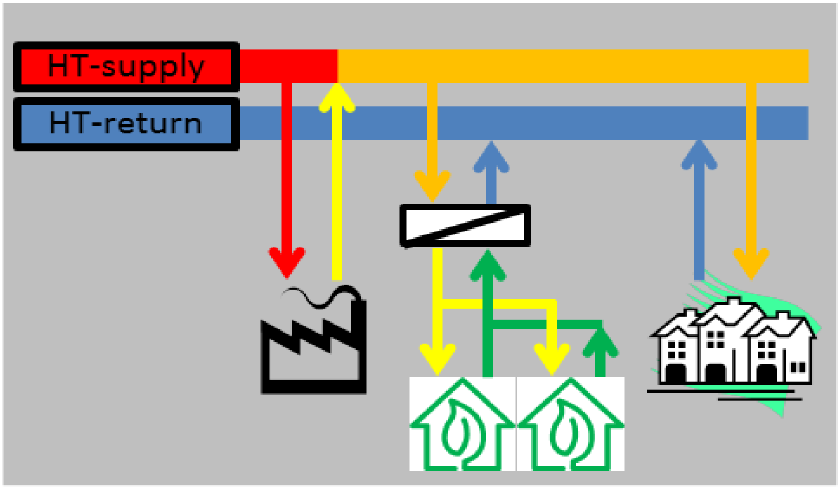
LTDH
Using return flow of a HT industrial consumer **Direct line to Aspern** with Backup from HTDH

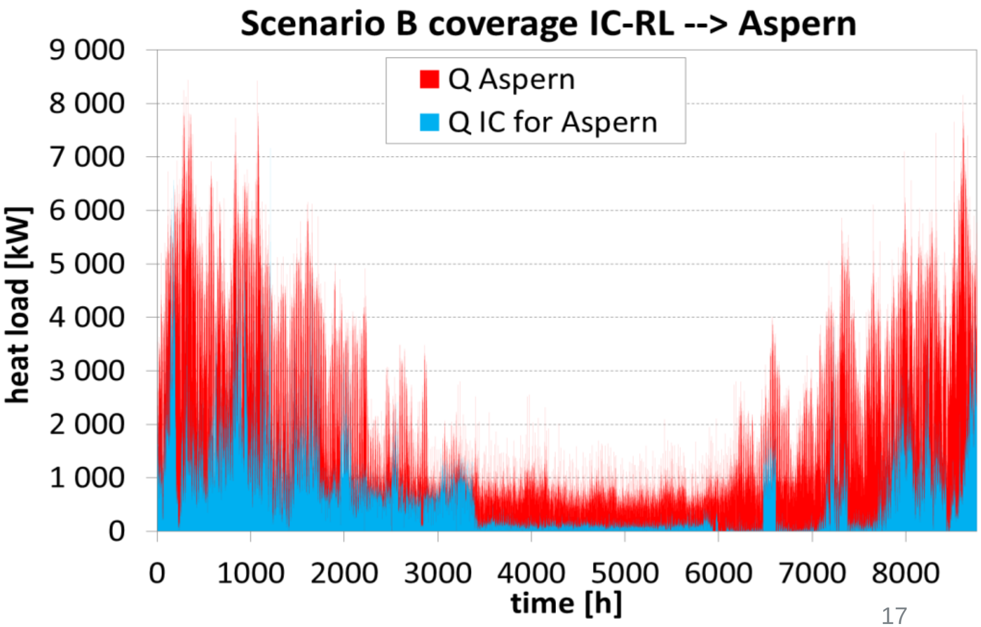


Micro grid
Supply temperature
63 °C constant

Main results Vienna (I)

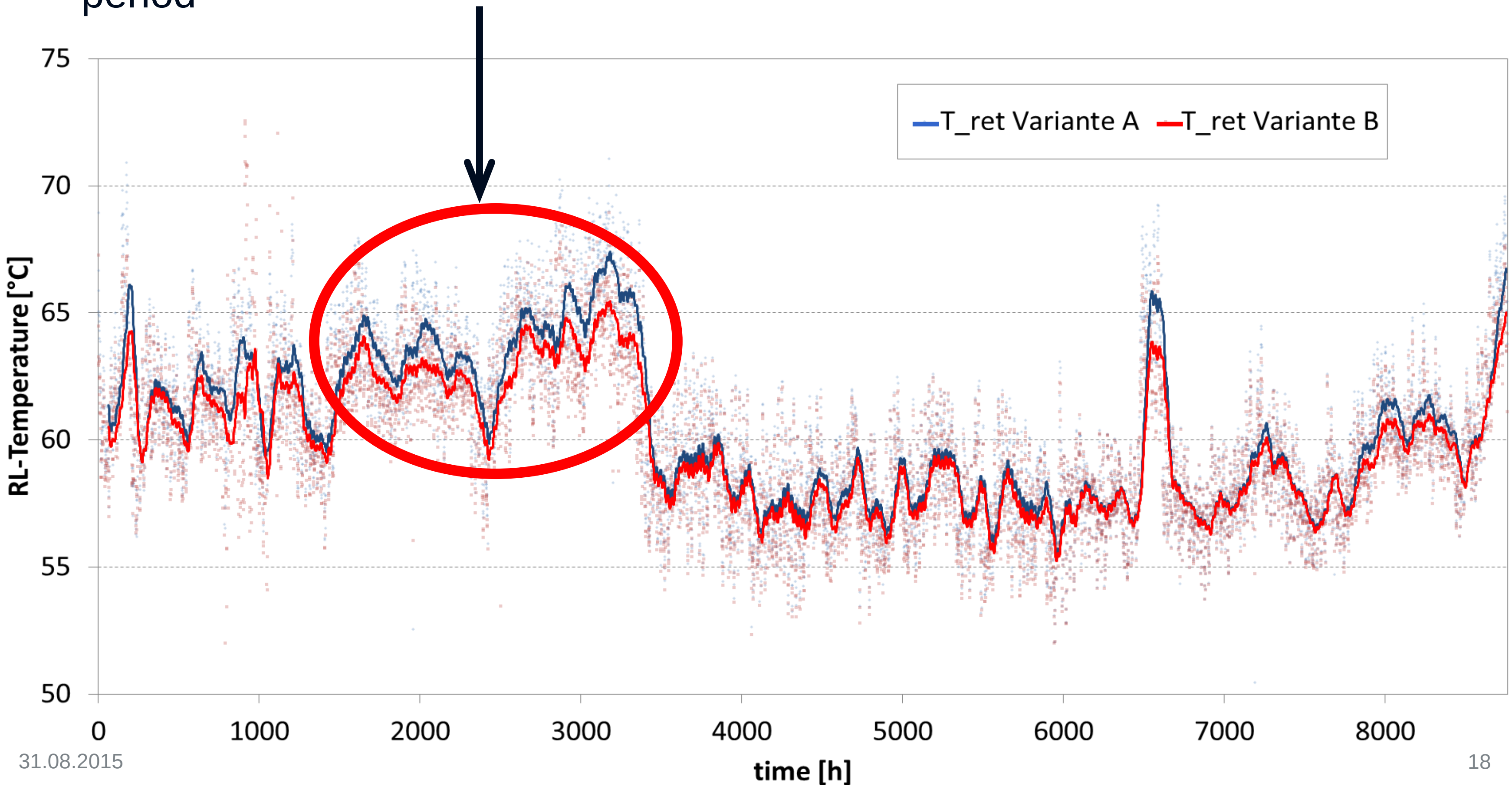
- ~33 % of heat demand in Aspern can be covered by return flow of an industrial HT-consumer
- Dimensions of HX in surrounding consumers need to be checked
  - HX could be to small at cold winter days (outdoor temperatur < -10°C)
  - This problem occur for ~ 100h during the year
  - During this time the temperature for down stream secondary grids can not be guaranteed





Main results Vienna (II)

- By using the return of the industrial HT-consumer the return temperature of the considered area can be decreased by max. 9.7 K during transitional period



NextGenerationHeat - Summary

- LTDH with HTDH-Backup for peak loads or to increase supply temperature (for DHW) is a ecologically and cheap solution

- Booster for DHW preparation are possible solutions if grid temperature is to low or DHW needs to be stored in big buildings (e.g. Hotels)

- Using return flow of HT-consumers can cover parts of the energy demand
  - Special analyses of demand and supply profiles required
  - Only feasible if backup (e.g. traditional DH grid, storages, additional heat sources,…) is available

- Investment costs and energy costs have a big impact on economic results
  - Different energy prices in different regions in Austria
  - Uncertainties for investment costs of substations and tariff for RL usage

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