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 partners

- **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

<table>
<thead>
<tr>
<th>location</th>
<th>Hummel Kaserne</th>
<th>Aktivpark Güssing</th>
<th>Winklweg Siedlung</th>
<th>Seestadt Aspern</th>
</tr>
</thead>
<tbody>
<tr>
<td>city</td>
<td>Graz</td>
<td>Güssing</td>
<td>Wörgl</td>
<td>Vienna</td>
</tr>
<tr>
<td>type</td>
<td>New construction</td>
<td>New construction</td>
<td>building stock</td>
<td>New construction</td>
</tr>
<tr>
<td>usage</td>
<td>residential, care home for old people</td>
<td>tourism, SFH (villa, hotels, golf club)</td>
<td>residential neighbourhood (MFH)</td>
<td>residential (MFH, office, commerce)</td>
</tr>
<tr>
<td>possible LTDH energy sources</td>
<td>return line of existing network</td>
<td>Bio mass CHP (condensor waste heat)</td>
<td>Heat pump, return line of existing network</td>
<td>return of HT consumer, existing HT network</td>
</tr>
</tbody>
</table>
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 type 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 simulation of the 4 case studies
  - Developing different supply scenarios
  - Implementing different control strategies for Substation, storages and other components
  - Using measurement and design input data

- Simulations
  - Duration: 1 year
  - Time step: 15 min

- Outcome
  - Ecological and energetic KPI
  - Followed by economic evaluation

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Simulation supply scenarios - Graz

**HTDH**
Reference scenario
HTDH supply connection

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

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

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

Supply temperature
58 °C constant

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 too small at cold winter days (outdoor temperature < -10°C)
  - This problem occurs for ~100h during the year
  - During this time the temperature for down stream secondary grids cannot 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 too 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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