Recommendations for Combined District Heating and Cooling Networks

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Agenda

1. The FLEXYNETS concept
2. Potential advantages
3. Pre-design numerical tool
   – Results & discussions
4. Conclusions
The FLEXYNETS concept

- The FLEXYNETS concept consists of a distribution network that works at “neutral” temperatures.

- Reversible HPs exchange heat with the network on the demand side. In this way, the network can provide simultaneously heating and cooling.
Potential advantages

- The FLEXYNETS concept has the following potential advantages:
  - Simultaneous supply of heating and cooling
  - Recovery of condensing heat from cooling demand
  - Lower heat losses from the network
  - Lower installation cost for the network
  - Direct exploitation of low-temperature heat sources
Principle scheme (winter)

- HP (heating) with $Q_{\text{evap}}$
- HP (cooling) with $Q_{\text{cond}}$
- Waste Heat with $Q_{\text{waste}}$
- Central heater
- Central cooling unit
- $T_{\text{DH,s}}$
- $T_{\text{DH,r}}$

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#SES4DH2018

Aalborg University Denmark
Principle scheme (summer)
# General parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Rome</td>
<td></td>
</tr>
<tr>
<td>Heating demand</td>
<td>76</td>
<td>GWh/y</td>
</tr>
<tr>
<td>Cooling demand (nominal)</td>
<td>34</td>
<td>GWh/y</td>
</tr>
<tr>
<td>Waste heat available</td>
<td>59</td>
<td>GWh/y</td>
</tr>
<tr>
<td>Space heating temperatures</td>
<td>50 – 30</td>
<td>°C</td>
</tr>
<tr>
<td>Space cooling temperatures</td>
<td>10 – 15</td>
<td>°C</td>
</tr>
<tr>
<td>Central heater</td>
<td>Gas boiler</td>
<td>-</td>
</tr>
<tr>
<td>Price of electricity (private)</td>
<td>200</td>
<td>€/MWh</td>
</tr>
<tr>
<td>Price of electricity (industrial)</td>
<td>100</td>
<td>€/MWh</td>
</tr>
<tr>
<td>Price of natural gas</td>
<td>30</td>
<td>€/MWh</td>
</tr>
<tr>
<td>Price of waste heat</td>
<td>10</td>
<td>€/MWh</td>
</tr>
<tr>
<td>FLEXYNETS supply temperature</td>
<td>25</td>
<td>°C</td>
</tr>
</tbody>
</table>
Profiles

- Heating demand (all cases, 10-18)
- 100% cooling demand (cases 12, 15, 18)
- Waste heat (60%) (cases 16, 17, 18)
Results (i)

Equivalent annual cost [M€/year]

- DH, 25% cool.
- FL, 25% cool., 0% WH
- FL, 25% cool., 60% WH
- DH, 100% cool.
- FL, 100% cool., 0% WH
- FL, 100% cool., 60% WH

Legend:
- Cap. cost of DH network
- Operation cost of heaters
- Cap. cost + fixed O&M of cooling units
- Operation of HP (heating)
- Pumping cost
- Cost of excess heat
- Operation cost of cooling units
- Operation of HP (cooling)
- Cap. cost + fixed O&M of substations
- Cap. cost + fixed O&M of reversible HP
- Cap. cost + operation of central chiller

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Results (ii)

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Conclusions

The FLEXYNETS concept can be competitive against conventional DH in the following scenarios:

- Low electricity prices
- Lower HP installation prices
- Presence of cooling demand
- Abundant waste heat at low temperature

Under the right boundary conditions, FLEXYNETS promises to offer

- Competitive price with respect to conventional DH
- Equivalent installation costs for the network
- Lower CO2 emissions and primary energy
Thank you for your attention!

More information available at www.flexynets.eu

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<table>
<thead>
<tr>
<th>Scenario</th>
<th>Settlement typology</th>
<th>Location</th>
<th>Heating price [€/MWh]</th>
<th>Cooling price [€/MWh]</th>
<th>Total CO₂eq [kton/year]</th>
<th>CO₂eq from electricity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FL – 25% cooling – 0 WH</td>
<td>MFH-45</td>
<td>Rome</td>
<td>75</td>
<td>77</td>
<td>20.9</td>
<td>38.9%</td>
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<tr>
<td>FL – 100% cooling – 0 WH</td>
<td>MFH-45</td>
<td>Rome</td>
<td>66</td>
<td>74</td>
<td>23.6</td>
<td>48.3%</td>
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<tr>
<td>DH – 25% cooling – 0 WH</td>
<td>MFH-45</td>
<td>Rome</td>
<td>53</td>
<td>70</td>
<td>20.6</td>
<td>2.9%</td>
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<tr>
<td>DH – 100% cooling – 0 WH</td>
<td>MFH-45</td>
<td>Rome</td>
<td>53</td>
<td>85</td>
<td>22.4</td>
<td>10.6%</td>
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<tr>
<td>FL – 25% cooling – 60% WH</td>
<td>MFH-45</td>
<td>Rome</td>
<td>66</td>
<td>77</td>
<td>13.2</td>
<td>61.3%</td>
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<tr>
<td>FL – 100% cooling – 60% WH</td>
<td>MFH-45</td>
<td>Rome</td>
<td>58</td>
<td>74</td>
<td>16.5</td>
<td>68.8%</td>
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<tr>
<td>FL – 25% cooling – 60% WH PTES</td>
<td>MFH-45</td>
<td>Rome</td>
<td>70</td>
<td>77</td>
<td>8.2</td>
<td>99.1%</td>
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</table>
Cooling demands – no waste heat

<table>
<thead>
<tr>
<th>Equivalent annual cost [M€/year]</th>
<th>FL - 25% cooling</th>
<th>DH - 25% cooling</th>
<th>FL - 100% cooling</th>
<th>DH - 100% cooling</th>
</tr>
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<tbody>
<tr>
<td>Cap. cost of DH network</td>
<td></td>
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<td></td>
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<tr>
<td>Operation cost of heaters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation cost of cooling units</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Operation of HP (cooling)</td>
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</tbody>
</table>

- FL - 25% cooling
- DH - 25% cooling
- FL - 100% cooling
- DH - 100% cooling

- Cap. cost of DH network
- Operation cost of heaters
- Operation cost of cooling units
- Operation of HP (cooling)