The impact of global warming and building renovation measures on district heating system techno-economic parameters
Content

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• Methodology
• Case study
• Results
• Conclusions
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Research motivation

DHS for sustainable urban environment

Significant infrastructure

Significant investment costs

Increased temperature levels

Climate change

Building renovation

Decreased heat demand
Study scope

Climate change

Techno-economic parameters

Linear heat density
Heat production mix
CO2 emission levels
Heat sales
Heat price
Methodology outline

- Historical weather data
- Reference weather data
- AOGCM output files
- CCWorldWeatherGE
  - Weather Scenarios
  - Heat demand model
    - District heat demand profile
  - Building renovation scenarios
    - Building selection criteria
    - Renovation depth
      - Renovation level

- Reference building data
- Google maps
- LiDAR
- Municipality data
- Techno-economic parameters
  - Techno-economic model
  - The impact of climate change on district heating systems
Heat demand model
Techno-economic model

- Heat demand profile
- Technical data
  - Energy production mix
  - CO2 emission levels
- Techno-economic model
- Linear heat density
- Economic data
  - CAPEX
  - OPEX
- Heat price
Building renovation scenarios

<table>
<thead>
<tr>
<th>Year</th>
<th>Renovation measure</th>
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</thead>
<tbody>
<tr>
<td>2010</td>
<td>Reference building state, no renovations were conducted since the construction</td>
</tr>
<tr>
<td>2020</td>
<td>Installation of typical polystyrene foam board insulation; Improvement in air sealing by using caulk and foam; Installation of double glazed windows;</td>
</tr>
<tr>
<td>2030</td>
<td>Installation of typical polystyrene foam board insulation; Improvement in air sealing by using weatherstripping and mastic; Installation of triple glazed windows;</td>
</tr>
<tr>
<td>2040</td>
<td>Addition of aerogel insulation and vacuum insulated panels; Installation of energy plus windows;</td>
</tr>
<tr>
<td>2050</td>
<td>Addition of insulation and air sealing technologies, such as nano-insulation materials and composites, that are currently in an R&amp;D phase;</td>
</tr>
</tbody>
</table>

Source: International Energy Agency
Case study district

Network length: 4831m
Base load unit: 75%, biomass
Peak load unit: 25%, nat. gas

Two case scenarios for heat prices:

Existing network (only OPEX)
Planned network (CAPEX+OPEX)
Linear heat demand and heat density

LEGEND
- District heat demand
- Linear heat density
Heat production, sales and losses

18%
Heat production mix and emissions
Heat prices & integration of solar panels

The impact on heat prices

<table>
<thead>
<tr>
<th>Scenario/Year</th>
<th>Heat price [€/MWh]</th>
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<tr>
<td></td>
<td>2010</td>
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<tr>
<td>Existing DHN</td>
<td>47</td>
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<tr>
<td>New DHN</td>
<td>66</td>
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</table>

Integration of solar thermal panels

<table>
<thead>
<tr>
<th>Year/Scenario</th>
<th>Annual district heat demand [GWh]</th>
<th>Annual solar thermal collectors heat production [GWh]</th>
<th>Number of hours with space (SH) [h]</th>
<th>Number of hours when solar thermal collectors do not satisfy heat demand (SH+DHW) [h]</th>
<th>Number of hours when solar thermal collectors exceed heat demand (SH+DHW) [h]</th>
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</thead>
<tbody>
<tr>
<td>2010</td>
<td>35.56</td>
<td>0</td>
<td>5654</td>
<td>0</td>
<td>0</td>
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<td>2020</td>
<td>16.88</td>
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<td>5221</td>
<td>3539</td>
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<td>2030</td>
<td>13.21</td>
<td>49.21</td>
<td>4626</td>
<td>5066</td>
<td>3695</td>
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<tr>
<td>2040</td>
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<td>3204</td>
<td>4956</td>
<td>3804</td>
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<td>2050</td>
<td>9.40</td>
<td>49.91</td>
<td>1438</td>
<td>4887</td>
<td>3873</td>
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</tbody>
</table>
Conclusions

- Decrease in linear heat demand density
- Increase in heat losses
- Impact on heat production mix
- Increase in emissions
- Heat price increase
- Heat storage integration
Further developments

- Validation of the RC model with the measured data
- Integration of cooling demand calculations
- Improvement of the techno-economic model
- Integration with other software packages
References

Journal publications


**Andric, I.**, Pina, A., Ferrão, P., Lacarrière, B., Le Corre, O., 2017. “Environmental performance of district heating systems in urban environment: an emergy approach”, *Journal of Cleaner Production*, 142, Part 1, p109-120. DOI: [https://doi.org/10.1016/j.jclepro.2016.05.124](https://doi.org/10.1016/j.jclepro.2016.05.124);


Conference publications


Thank you for your attention!

Questions?

Comments?

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