Impact of heating planning on the economic viability of district heating in Brasov-Romania

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13 November 2018
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DH in Brasov

• Primary purpose:
  – To supply steam to the industry consumers,
  – To supply hot water to the residential consumers.

• Inefficiency in Brasov DH system:
  – Shutdown of industrial consumers in 1990 -> Oversized pipelines for remaining consumers
  – Lack of coherent policy in reviving the DH system
  – Loss of further consumers.

• In the recent years, the Local Counsel has established new actions toward increase of DH efficiency.
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progRESsHEAT project in Brasov

• ProgRESsHEAT project (H2020): aimed to support the market uptake of existing and emerging renewable technologies.

• Results among all, include policy recommendations for Brasov’s DH system:
  – provision of long-term loans for investments into the network infrastructure
  – implementation of heating and cooling planning to define zones that are preferable for DH

• DH areas were defined by areas around the existing distribution network

• Two scenarios were developed to study the least cost combination of heat savings, district heat and individual supply.
  – Simple socioeconomic perspective
  – Private economic perspective
Alternative Scenario
Private economic calculation

- Private economic calculation:
  - Investment in generation facilities
  - Investment in grids (For 50% of the grid that is not renovated so far.)
  - VAT and cost for connection of customers are NOT considered.

Reference:

Sensitivity of heat selling prices to sold district heat

Reference:
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DH area definition using GIS layers

- Input GIS Layers from Hotmaps* project (H2020 project):
  - European heat demand density map - 1ha resolution
  - European plot ratio map - 1ha resolution

- For each pixel of HDM in each year within the investment horizon (m years) is calculated:
  - Annual heat demand \( D_t \) based on expected accumulated energy saving,
  - Annual Supplied heat by DH system \( Q_t \) based on market share \( (MS_0 \& MS_m) \),
  - Distribution grid investment cost as proposed by Persson & Werner** (from Swedish experience).

\[
D_t = D_0 \cdot \sqrt{1 - S}^t \\
0 \leq S \leq 1 \quad ; \quad t \in \{0, 1, 2, ..., m\}
\]

\[
Q_t = D_t \cdot \left[ MS_0 + t \cdot \frac{MS_m - MS_0}{m} \right]
\]

\[
L = 1 / w = 1 / \left( 61.8 \cdot e^{-0.15} \right)
\]

\[
d_a = 0.0486 \cdot \ln \left( \frac{Q_t}{L} \right) + 0.0007
\]

\[
Inv_T = \frac{C_{1,T} + C_{2,T} \cdot d_a}{\left( \sum_{t=0}^m \frac{Q_{T+t}}{(1 + r)^t} + \sum_{t=m+1}^n \frac{Q_{T+m}}{(1 + r)^t} \right) / L}
\]

* www.hotmaps-project.eu
Coherent areas

- Outputs of this step are:
  - Coherent areas
  - DH potential in coherent areas
  - Distribution grid cost in coherent areas
Grid model

- The aim of grid model is to supply as much coherent areas as possible with existing heating sources and at the same time maintain the whole system economic.

- The model parameters are:
  - Center-to-center Euclidean distances between coherent areas,
  - Available heat sources and their cost functions (fix and operating costs),
  - Supplied heat by DH system in each coherent area,
  - Available range of pipeline capacities and their specific costs

- The main model variables are:
  - Binary variable for the coherent area,
  - Binary variable for the heat sources,
  - Binary variable for the pipelines,
  - Heat capacities that flow through pipelines.

- Objective function (revenue oriented prize-collecting problem)
  - Maximize difference between heat sale revenue and transmission line costs

\[
\text{max } \text{heat}_\text{sale}_\text{price} \times \sum_i Q_{\text{max},i} \times q_i - \sum_i \sum_j \text{TLC}_{ij} \times l_{ij} \times y_{ij} \quad \forall (i, j) \in A
\]
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Scenario parameters

- Use the inputs and outputs of the alternative scenario from ProgRESsHEAT project in the developed method.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time horizon</td>
<td>2014 - 2030</td>
</tr>
<tr>
<td>Grid depreciation time</td>
<td>25 years</td>
</tr>
<tr>
<td>DH connection rate 2014</td>
<td>16%</td>
</tr>
<tr>
<td>DH connection rate 2030</td>
<td>62%</td>
</tr>
<tr>
<td>Accumulated energy savings</td>
<td>17.50%</td>
</tr>
<tr>
<td>Interest rate</td>
<td>6%</td>
</tr>
<tr>
<td>Specific energetic distribution grid costs</td>
<td>27 €/MWh</td>
</tr>
<tr>
<td>Heat Sale price (without VAT)</td>
<td>89.5 €/MWh</td>
</tr>
</tbody>
</table>
Comparison (I)

- Investment costs in
  - GIS-based method
  - ProgRESsHEAT

- Data consistency
Comparison (II)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ProgRESsHEAT</th>
<th>GIS-Based method</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH FED (2014)</td>
<td>66.86 GWh</td>
<td>37 GWh</td>
<td></td>
</tr>
<tr>
<td>Distribution grid trench length</td>
<td>108 km</td>
<td>140 km</td>
<td>ProgRESsHEAT does not include house connections</td>
</tr>
<tr>
<td>Transmission grid trench length</td>
<td>46 km</td>
<td>16 km</td>
<td></td>
</tr>
<tr>
<td>Gird’s energetic specific cost</td>
<td>27 €/MWh</td>
<td>23.9 €/MWh</td>
<td>Simple transmission line model</td>
</tr>
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Conclusions

• In areas with existing infrastructure, considering available resources and budgets, a compromise may provide a better results compared to the optimal solution!

• For a better comparison of two methods, a consistence dataset is required.

• For the future works:
  – impact from heat losses in the grid,
  – street routes rather than Euclidean distances for the transmission lines,
  – Adapt the generic DH distribution grid cost to the case study conditions.