Hydrothermal district heating in Schwerin – reviving the geothermal potential of the North German Basin

Stefan Thiem¹, Marco Wunsch¹, Christian Buse¹, Rafael Mathes¹, Ingmar Budach¹, Matthias Franz², Benjamin Kielgas³, Rene Tilsen³

¹ Geothermie Neubrandenburg GmbH
² Geowissenschaftliches Zentrum der Georg-August-Universität Göttingen
³ Energieversorgung Schwerin GmbH & Co. Erzeugung KG

21.02.2024
Geothermal history of Northern Germany

**Development**

- 6 heating plants in operation
  - 4 built until 1995
  - 2 built until 2007

- Schwerin started operational trial in 2023
Geothermal history of Northern Germany

Challenges

- Exploration risk
  - main reservoir = fluvial channel systems
  - distributional variability of sandstones

- Moderate reservoir temperature (< 60°C)
  - demand > 80 °C for direct transfer
  - requirement for large scale heat pumps
Reduction of exploration risk

- Development of facies model

  - Classical approach
  - Advanced reservoir characterization
  - Facies model

Feldrappe et al. (2008)
Franz et al. (2018)
Zimmermann et al. (2018)
Schwerin Lankow

1st application of facies model
Schwerin Lankow

Reservoir characteristics

<table>
<thead>
<tr>
<th></th>
<th>Schwerin 6</th>
<th>Schwerin 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth - TOP (m TVD)</td>
<td>1,245</td>
<td>1,220</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>57</td>
<td>56</td>
</tr>
<tr>
<td>Thickness (m)</td>
<td>49</td>
<td>42</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>Permeability (D)</td>
<td>6.2</td>
<td>6.3</td>
</tr>
<tr>
<td>Salinity (g/l)</td>
<td>145</td>
<td>147</td>
</tr>
<tr>
<td>Productivity (l/s/bar)</td>
<td>35</td>
<td>18</td>
</tr>
</tbody>
</table>

- Design parameters heating plant
  - Rate = 42 l/s
  - Production temperature = 55.5 °C

Limitation factors for flow rate
- Reservoir integrity
- Screen design
- Economic costs for pump

Improved knowledge on these factors is major challenge for future development

Impressive reservoir quality
Moderate reservoir temperature

- High temperature large scale heat pumps

- Coefficient of performance

\[
COP = \frac{\text{heat output}}{\text{drive power}}
\]

\[
COP = 4:
\]

- COP of ideal process:

\[
COP_{\text{Carnot}} = \frac{T_S}{T_S - T_I}
\]

\[
\text{COP} = \text{COP}_{\text{Carnot}} \times \text{factor}
\]

Decisive factor is the difference between supply temperature and injection temperature.
Moderate reservoir temperature

COP improvement by cascade connection

\[ \text{COP}_{\text{Carnot}} = \frac{(80 + 273.15) \text{ K}}{(80 - 20) \text{ K}} = 5.89 \]

\[ \text{COP}_{\text{Carnot}} = \left( \frac{(80 + 273.15) \text{ K}}{(80 - 40) \text{ K}} + \frac{(70 + 273.15) \text{ K}}{(70 - 30) \text{ K}} + \frac{(60 + 273.15) \text{ K}}{(60 - 20) \text{ K}} \right) \]

\[ = \frac{(8.83 + 8.58 + 8.33)}{3} = 8.58 \]
Schwerin Lankow

1st application of 4 large scale heat pumps

- Flow rate = 42 l/s
- $T_{\text{Production}} = 55.5 \, ^\circ \text{C}$
- $\text{COP}_{\text{HP-mean}} = 4.35$
- Heating Capacity $\text{max} = 7.5 \, \text{MW}$
- Heat supply = 60 GWh/a

Economical utilization feasible
Geothermal Potential Northern Germany

- Exploration risk is reduced due to application of facies maps
- Utilization of moderate reservoir temperatures in combination with large scale heat pumps is economically feasible
- Geothermal reservoirs don’t need to be as deep as possible

**It is time to untap the vast geothermal potential of the North German Basin**
Exploration risk

Facies model

FRANZ et al. (2018)
Exploration risk

Facies model

ZIMMERMANN et al. (2018)

WOLFRAMM et al. (2014)