Low-temperature district heating grids

Secure the lowest Total Cost of Ownership in district heating networks

2nd international conference on Smart Energy Systems and 4GDH

Peter Jorsal
27 September 2016
The LOGSTOR Group & global presence

- Headquarters in Denmark
- 1,500 employees
- Annual turnover > 250 MEUR
- Owner: Triton Fund III

- 8 plants in Europe, 1 in Asia, 2 mobile production units
- 14 Sales units
- Joint ventures in China and Dubai
- Distributors in more than 30 countries
- More than 6,000 km pre-insulated pipes every year
- More than 185,000 km LOGSTOR pipe supplied to date
Agenda

- Service life cost/Total Cost of Ownership (TCO)
  - the most important design parameter
- Heat loss and service life cost at low temperature grids (55/25 °C)
  - Example distribution pipe lines and service pipe lines
- Example distribution pipe lines
- Return of investments
- Alternative pipe materials
Focus on total cost of ownership (TCO)

• Essential for a long life time is the right choice of products and the right system design

• Essential for the lowest TCO is the balance between the investment in pipe system and installation and the heat loss of the system over life time

• Lowest heat loss is achieved on systems with axial conti pipes with a diffusion barrier and low lambda value

• The diffusion barrier will secure the low heat loss in the entire life time
Service life cost/Total cost of ownership (TCO)

Pipes + installation + heat loss + operation over 30 years

- Twin S2 conti w. barrier
- Series 2 conti w. barrier
- Series 1 conti w. barrier
- Series - 1 pair traditional no barrier

Legend:
- pipes
- pump inst.
- civil work
- asphalt
- control
- heat loss
- operation
Focus on total cost of ownership (TCO)

### Temperature
- **Flow**
  - Winter: 85
  - Summer: 75
- **Return [°C]**
  - Winter: 55
  - Summer: 45
- **Ambient [°C]**
  - Winter: 4
  - Summer: 14
- **Days**
  - Total: 215

### System Parameters
- **Definition λ**
  - Period avg.: 30
- **PUR calculating year**
  - Soil cover (h): 700
- **Ambient Certificate Lambda**
  - Soil (Normal)
  - No

### Finance
- **Currency**
  - GBP
- **Price / kWh**
  - 0.01
- **Interest rate [%]**
  - 4

### CO2-emission
- **Fuel type**
  - Natural Gas
- **Efficiency [%]**
  - 85
- **Operation Time / Year**
  - 8760

### Return on Investment

<table>
<thead>
<tr>
<th>No</th>
<th>Pair(eq) Steel Trad DN 100 Serie 1</th>
<th>Pair(eq) Steel Conti DN 100 Serie 2</th>
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ROI 13.8 Year
Low temperature grid project example

Liseborg Bakke

- Project in Viborg, 20 houses
- New build area
- Investigation of designing area for low temperature DH
- Different pipe scenarios where investigated
- 55/25°C
- Distribution pipes
  - 343 m DN20 – DN50, TwinPipe
  - 7 m single pipe
- Service pipes
  - 185 m 20-16 AluFlextra Double pipe
- Comparison series 2 and series 3
- Budget prices all inclusive
- Total Cost of Ownership
- Return of investment
<table>
<thead>
<tr>
<th>Liseborg Bakke; 104-142</th>
<th>Pipe trench</th>
<th>dimension</th>
<th>service pipe</th>
<th>Investment cost (budget)</th>
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</table>

Budget prices – all inclusive

Liseborg B.; Distr. = 350 m; serv. 20 stk = 185,0 m

- Pipe material: 44%
- Pipe work: 32%
- Excavation: 24%
Heat loss calculation series 2 and 3

55/25°C

<table>
<thead>
<tr>
<th>Temperature</th>
<th>System Parameters</th>
<th>Finance</th>
<th>CO2-emission</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Flow: 99</td>
<td>Deflection X PUR: 25° C</td>
<td><strong>Price / kWh</strong>: 0.15</td>
<td><strong>Efficiency (%):</strong> 85</td>
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<tr>
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<td>Soil cover (%): 30</td>
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### Heat loss

<table>
<thead>
<tr>
<th>Serie</th>
<th>MWh/year</th>
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<tbody>
<tr>
<td>Serie 2</td>
<td>22,76</td>
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<tr>
<td>Serie 3</td>
<td>20,20</td>
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### System Parameters

<table>
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<tr>
<th>No.</th>
<th>Type of system</th>
<th>Pipelayer</th>
<th>Length (m)</th>
<th>C (mm)</th>
<th>Series d1</th>
<th>d2</th>
<th>D1</th>
<th>Series d2</th>
<th>d2</th>
<th>D2</th>
<th>Diff.</th>
<th>Lambda</th>
<th>W/m</th>
<th>MWh/year</th>
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<tbody>
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<td>0.033</td>
<td>0.15</td>
<td>2.35</td>
</tr>
</tbody>
</table>

Total MWh/year 22,76

Total MWh/year 20,20

### Heat loss comparison

- **Liseborg Bakke serie 2**: 22,76 MWh/year
- **Liseborg Bakke Serie 3**: 20,20 MWh/year

**Compare Heat loss (MWh/year)**

- Bar chart showing a 11% saving from using Serie 3 compared to Serie 2.
Service life cost over 30 years, 55/25 °C

![Service Life Cost Diagram]

- **Liseborg Bakke serie 2**: 719,806.68 DKK
  - Price pipe: 26% 184
  - Price install: 55% 398
  - Cost heat loss: 19% 138

- **Liseborg Bakke Serie 3**: 724,570.13 DKK
  - Price pipe: 28% 204
  - Price install: 55% 398
  - Cost heat loss: 17% 122
Service life cost over 30 years, 80/40 °C

10% saving on total cost by going for lower temperature if anything else is equal
Low temperature grid project example

Hedeskærnten

- Project in Viborg, 12 houses
- New build area
- Investigation of designing area for low tempetaure DH
- Different pipe scenarios where investigated
- 55/25°C
- Distribution pipes (no service pipes)
  - 268 m DN20 – DN40, TwinPipe
  - 2 m single pipe
- Comparison series 2 and series 3
- Budget prices all inclusive
- Total Cost of Ownership
- Return of investment
### Hedeskrænten 85-107

<table>
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<tr>
<th>Hedeskrænten 85-107</th>
<th>Pipe trench</th>
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## Heat loss calculation series 2 and 3

### 55/25°C

### Temperature

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<th>Return</th>
<th>Ambient</th>
<th>Cost</th>
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<td>25</td>
<td>9</td>
<td>365</td>
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### System Parameters

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<tr>
<th>Parameter</th>
<th>Value</th>
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<td>Deflection A/FUR</td>
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### Finance

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<th>Parameter</th>
<th>Value</th>
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</thead>
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<td>Currency price / kWh</td>
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<td>Interest rate %</td>
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### CO2-emission

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<td>Fuel type</td>
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<td>Operation Time/Year</td>
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### Heat loss

<table>
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<tr>
<th>Serie</th>
<th>Heat loss (MWh/year)</th>
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<td>12,44</td>
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<tr>
<td>Serie 3</td>
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</table>

### Comparison

- **Serie 2**
  - Heat loss: 12,44 MWh/year
  - Saving: 11%

- **Serie 3**
  - Heat loss: 11,03 MWh/year
  - Saving: 15%
Service life cost over 30 years, 55/25 °C
Service life cost over 30 years, 80/40 °C

12% saving on total cost by going for lower temperature if anything else is equal
Simple return of investments series 2 vs series 3
Conclusions heat loss at 55/25 °C

- The heat loss is between 17-25% of the life cycle cost
  - The design of the trench has huge influence
  - The length of the service pipes has huge influence

- There is a potential in optimizing on pipe work and excavation
  - There is too much "that is how we are used to work"

- With an energy price of 350 Dkk/MWh or more series 3 is getting interesting

- Return of investment is shortest at service pipe lines where dimensions are small

- Use service pipe lines that are diffusion tight against water vapour diffusion (steel, coppar or Alupex)
  - Secures that insulation properties is not getting worse over time

- Use diffusion barrier in the casing
  - Secure that the insulation gasses stay in the foam
  - Insulation properties will remain the same over life time

- In the hydraulic calculation the maximum effect for house connections must be evaluated
  - Secure that service pipes are not over sized
  - Eco-showers or Waterfall showers
Comparison Pex vs Steel as distribution pipe line

- **PexFlextra**, Twin 63 x 63 mm
  - Limited in casing pipe diameter and higher insulation series
  - More expensive than steel
  - Flexibility when there are a lot of branches?

- **Steel**, Twin ø60,3, series 1,2,3
  - Possible to make system with much lower heat loss than PexFlextra in coils
  - Higher insulation series are possible

- **Assumptions for the calculation**
  - Actual material cost
  - Base case on installation cost is TwinPipe steel where pipe material is 30%, pipework is 25% and excavation is 45%
  - Installation of PexFlextra 5% cheaper than TwinPipe steel series 1
  - Installation of TwinPipe steel series 2 and 3 is 5% more expensive per increase of series

Pipes in coils in bigger dimensions will only be competitive when there are no branches or fittings
Service pipe lines

- Chose a media pipe with no water vapor diffusion to the PUR foam
  - Alupex
  - Steel
  - Coppar

- Chose a Pre insulated pipe with diffusion barrier in the casing
  - To secure the low heat loss during entire life time
Low-temperature district heating grids

Secure the lowest Total Cost of Ownership in district heating networks