Annex 48 – Industrial Heat Pumps Workshop
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Situation in Denmark

Political treaties and strategies:
• Energy-Strategy (adopted in 2011)
  • By 2050:
    • Independent of fossil fuels
• Energy-Agreement (adopted in 2018)
  • By 2030:
    • 40 % Reduction in GHG emissions
    • 55 % Renewables
    • 33 % Increase in energy efficiency
    • < 10 % fossil fuels in district heating

• Plans for Copenhagen:
  • Carbon neutral by 2025
  • 300 MW heat supply to DH by HPs

Energy system:
• High share of renewables in electricity production:
  • 2017: 65 %
  • Increased share of biomass during last years
• High share of district heating in heat supply:
  • Approximately 65 % of households

→ High potential impact for heat pumps
Situation in Denmark: Industrial HPs

Survey for IEA HPT Annex 48:

• Data on Total (2007 – 2018) 77  120 MW
  Industrial energy recovery  11  8.7 MW
• District Heating  66  111 MW

• List is being updated with more detailed information
Situation in Denmark: Industrial HPs

Heat pumps in district heating:

• Different tools for planning support available
  • Planning guidelines, incl. all required information
  • Structured overview with possible scenarios
  • Catalogue with inspiration and best case examples
  • Calculation tools

• Situation is understood by all involved parties
• Solutions are becoming standardized
• Heat pumps are becoming preferred solution
Situation in Denmark: Industrial HPs

Heat pumps in district heating
- Heat pumps are an acknowledged technology in district heating

Focus of developments shifts to:
→ Operational issues
→ Upscaling of technology
→ Exploitation of secondary benefits

- Challenges through availability of potential heat sources
  - Waste heat
    - Flue gasses
    - Industrial excess heat
    - Sewage water
    - Data Centers
    - ...
  - Ambient sources
    - Seawater (or alternatively river, lakes, ...)
    - Air
    - Ground

- Potentials
  - Providing ancillary services (flexible heat consumption)
Situation in Denmark: Industrial HPs

Energylab Nordhavn: Smart City Lab
http://www.energylabnordhavn.com/
Situation in Denmark: Industrial HPs

Heat pumps in industrial applications

• Boundary conditions are more diverse
• Technologies are less standardized
• Integration often associated with process integration
• Increased effort in engineering
• Energy supply not the main business
• Different economic boundary conditions

• Challenges through increased diversity of boundary conditions

• Potentials and advantages
  • Exploitation of both heating and cooling
  • Reducing cooling utilities often important aspect
Best Case I: SVAF Heat Pump

• Demonstration plant for
  • Analysis if heat sources (Sewage water and seawater)
  • Testing new method of optimizing COP
  • Testing new method for monitoring operation

• Project investment:
  • Overall: 110 Mio. Dkk (≈ 15 Mio. €)
  • Funding: 23 Mio. Dkk (≈ 3 Mio. €)

<table>
<thead>
<tr>
<th>Source</th>
<th>Seawater Temperatures</th>
<th>Sewage water Temperatures</th>
<th>Heatflow 1</th>
<th>Heatflow 2</th>
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<tbody>
<tr>
<td>Sink</td>
<td>50 °C → 80 °C</td>
<td>50 °C → 80 °C</td>
<td>5194 kW</td>
<td>5177 kW</td>
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<tr>
<td>Power</td>
<td>1635 kW</td>
<td>1552 kW</td>
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<tr>
<td>COP&lt;sub&gt;h&lt;/sub&gt;</td>
<td>3.2</td>
<td>3.3</td>
<td></td>
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</table>
Sustainable District heating from Seawater, sewage water and Windpower

- **Heat supply**: 5.0 MW
- **Power consumption**: 1.5 MW
- **Heat Source**: Seawater, Sewage (clean)

**SVAF SYDHAVNEN**
Demonstration plant (funded)

- **Seawater inlet at Sjællandbroen**
- **SVAF Heat Pump** cools seawater and sewage water in two serially connected units and supplies heat at 80 °C
- **Heat is distributed to Copenhagen’s DH consumers**
Best Case I: SVAF Heat Pump
Best Case II: CP Kelco

Background:
- CP Kelco produces ingredients for the food sector → High cooling loads
- 2014: Energy symbiosis of VEKS (Utility company), CP Kelco, Sun Chemical, Fef Chemicals and Junckers
- Expansion of DH network to Køge region

Key factors for project realization:
- Expansion of DH network
- Availability of excess heat
- Strong interest from CP Kelco and VEKS
- Energy saving subsidy
- Government support
- Availability of similar business cases
## Best Case II: CP Kelco

### Technology

#### System level
- Energy symbiosis Køge
- Cooling towers
- Heat recovery system
- Buffer systems
- System efficiency

#### Production level
- Integration with existing system
- HX redesign
- Piping
- Securing redundancy

#### District heating
- Expansion of network
- Demand (temperature and loads)
- Ownership
- Agreement between VEKS and CP Kelco

#### District heating
- Management
- In house engineering
- Subcontractors

#### Technology
- Heat pump
- Heat storage
- HX equipment

### Partners

#### Authorities
- Municipality
- Applications for dispensation and construction
- Danish Working Environment Authority

#### Client (CP Kelco)
- In house engineering
- Maintenance
- Production
- Procurement
- Management
- EHS

#### District heating
- Management
- In house engineering
- Subcontractors

#### Suppliers
- Mechanical
- Electrical
- Building
- Civil
- **HEAT PUMP**
Best Case II: CP Kelco

Key figures:
- System COP > 80
- After system design
- Maximum district heating effect 8.7 MW (Business case 5 MW)
- Averages district heating effect 6.9 MW
- Expected district heating production of 55 GWh (Business case 40 GWh)
- Covering the heating demand in the Køge region approx. 5-6 month per year
Conclusions

• Ongoing transition of the Danish Energy system
• High share of renewables in electricity production → high potential for electrification of heat supply
• HPs are (becoming) an established solution and the preferred choice for supply in district heating → Good knowledge base for HPs in DH available
• Industrial applications are more diverse → Guidelines for integrating HPs (technically and in project handling)
• Two cases of successful implementations were shown and experiences outlined