Large-scale heat pumps for district heating
Lessons learned from real applications

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Heat sources flow chart

- Exhaust gases
  - Are there enough operating working hours?
  - Is the exhaust gas produced within the DH plant?
  - Is the owner interested in the cooperation?

- Industrial excess heat
  - Is the plant in the proximity to DH?
  - Will the heat be available in the next 10-15 years?

- Geothermal heat
  - Are there geothermal resources in the area?
  - Refer to the section about geothermal heat source

- Sewage water
  - Is the plant in proximity to DH?
  - Will the heat be available in the next 10-15 years?
  - Is the owner interested in the cooperation?

- Groundwater
  - Is the water location easy to access?
  - Is there a Natura2000 area in the proximity?
  - Are there existing potable water drilling?
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  - Will the drillings owner sell or cooperate? Are new drillings possible?

- Lake/River
  - Is the plant in the proximity of DH?
  - Are there enough operating working hours?
  - Are there rigorous environmental regulations for the area?

- Other sources
  - Sea Water
    - Refer to the section about geothermal heat source
  - Drinking Water
  - Air

Follow the steps to initiate a project:
1. Make estimated calculations
2. Involve an energy consultant to perform a detailed analysis
3. Develop cooperation agreements with stakeholders
Economics

- With more (fluctuating) renewable electricity, the integration of electricity in heating sector becomes more relevant and beneficial for the overall system
  - Operation costs (by far linked to the cost of electricity) represents the majority of the LCoH, i.e. feasibility relies on electricity costs
  - Economic conditions regulated politically to incentivize heat pumps
  - Lowering taxes to improve feasibility =>
    - heat pump operation cheapest option regardless of carbon footprint of the electricity
    - extra costs to connect to higher grade heat source becomes less feasible
Economics

- “The incentive dilemma”: Lowering electricity taxes to improve HP feasibility also reduces the incentive to improve COP (relatively)

- Key issue:
  - Not simply a need for electricity use, but for intelligent interaction with the electricity grid

- Upcoming:
  - More variation in tariffs to divert electricity away use from peak load hours
  - (New common CO₂ tax to promote using renewable electricity?)
Environment

Global:
• GHG emissions avoided when using RE-based electricity
• Refrigerants

Local:
• Particle emissions avoided by replacing fuels
• Potential noise impact
• Potential impact on heat source

Use natural refrigerants!
Noise may or may not be an issue
Electrical connection

- Type of connection affects operation costs (tariffs)
  - 0.4 kV
  - At 10/0.4 transformer: 0.4 kV or **10 kV**
  - At 60/10 transformer: 10 kV or 60 kV

- Many systems presently connected with “cut-off option” to save connection fee

- New situation for DSOs
Using cold winter air to heat homes
Several systems commissioned recently in Denmark

- Operating in winter conditions
- Defrosting works
- Some plants did not meet promised COP and capacity
- Still things to improve about design and operation
Configurations

With a range of heat production units, it is relevant

- a) to construct the system to enable flexibility
- b) to consider the operation strategy optimizing the assets and total system

Example:
Lessons leaned & new lessons

• Ongoing process of optimizing solutions

• Fact sheets released later in 2021 – check planenergi.dk/ts3

• Data gathering on heatpumpdata.eu
  • In Danish varmepumpedata.dk. English version coming soon
  • Overview of Danish large-scale HP in DH
  • Real time and historical data of HP operation (temperatures, COP etc.)
  • Developed over time with more and more systems added