Chillventa CONGRESS 2018
Industrial Heat pumps in District Heating
Denmark

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The Danish Energy system > Renewable energy

New agreement on energy June 2018 supported by all parties in parliament, incl.

By 2050
- Overall goal: Nett 100% CO₂ neutral

By 2030 (in 11 years…)
- + 100% Renewable energy based power supply
- 100% phased out coal in power production
- < 10% fossil fuel based district heat

65% of all Danish dwellings are heated by district heat
Large part of the solution expected to be
- Electrical Heat Pumps
- Larger share of waste heat
Realized Industrial Heat pumps in Denmark

Survey for IEA HPT Annex 48:

- Data on Total: 77, 120 MW (2007 – 2018)
- Industrial energy recovery: 11, 8.7 MW
- District Heating: 66, 111 MW
  - Waste heat
  - Environmental sources
Tools supporting the heat pump implementation

- Inspiration and guide lines ("Playbook") incl. cases
- Simple calculation tools
Danish Playbook (guideline) and Inspiration Catalog

For large heat pump projects in district heating system
Danish “Playbook” (guideline)
For large heat pump projects in district heating system

Produced for Danish Energy Protection Agency (EPA) + Green Energy (Danish District Heating)

Content
- 1. Good reasons to establish collective heat pumps in district heating
- 2. What heat sources are available?
- 3. Heat Pump types
- 4. Regulatory approval
- 5. Economic conditions and markets
- 6. Economy
- 7. Guidance to spreadsheet for simple heat pump calculations
- 8. Tariffs and organizational conditions
- 9. Supply and selection of supplier
- 10. Test of performance / delivery
- References
Danish “Playbook” (guideline)

The diagram shows the different heat sources applicable in connection with a heat pump. The details of each heat source is described in the report listing various scenarios.

Translated from “Drejebog til store varmepumpeprojekter i fjernvarmesystemer, 2017”
Calculation tools

- Estimation of operation of DH system and economic figures

From "Drejeblog til store varmepumpeprojekter i fjernvarmesystemer, 2017"
Calculation tools

HP FAT (First assessment Tool)

- Estimation of heat pump COP and economic figures

Free download from: [www.teknologisk.dk/ydelser/varmepumper/beregningsprogram-hp-fat/22685,2](http://www.teknologisk.dk/ydelser/varmepumper/beregningsprogram-hp-fat/22685,2)
Cost calculation of projects

41 realized and offered natural refrigerant heat pump projects 0.2 to 10MW\textsubscript{th} in Denmark analysed:

- Wide range of specific total investment cost: 0.8 to 1.1 Mio. EUR
- Economy of scale effects minor (70-90% at 100% capacity increase)
  An explanation could be: Multiple units instead of larger units for larger total capacity
- Other costs than the heat pump accounts at least ca. 50% strongly depending on source

Pieper, H et. al. “Allocation of investment costs for large-scale heat pumps supplying district heating”
Limited heat sources at large capacities

If a large heat demand is to be covered by heat pumps the capacity of the sources can be a limiting factor the individual heat pump size.

- Sewage water, ground water, river water, excess heat, district cooling etc.

- More sources at geographically different locations probably needed

Ex.

- Copenhagen will (probably) needs a variety of sources to reach the goal of 250 – 300 MW\textsubscript{th} heat from heat pumps.
Integration of heat pumps in district heating: Potential sources and sinks

COP versus COSP

Steam extraction CHP plant + heat pump

COP of the heat pump

Overall System COP

Danish R&D project on heat pumps and their implementation in district heating systems

SVAF "Large electrical heat pumps in district heating, phase 2", Copenhagen

- 5 MW\textsubscript{th} R717 heat pump on sewage and sea water (start up spring 2019)
- 5 MW\textsubscript{th} heat pump on geothermal source (in planning)

www.hofor.dk/baeredygtige-byer/udviklingsprojekter/store-varmepumper-fjernvarme/
Danish R&D project on heat pumps and their implementaion in district heating systems

THERMCYC, Advanced thermodynamic cycles utilising low-temperature heat sources

- Both heat pumping and power producing processes, their working fluids and components are addressed

zeotropic blends

www.thermcycc.mek.dtu.dk/
Danish R&D project on heat pumps and their implementation in district heating systems

MIREHP “Mixed refrigerant heat pumps/cooling systems”

- Analysis and demonstration of heat pumps utilizing working fluid blends
- In demonstration phase

https://www.dti.dk/projects/project-mixed-refrigerant-heat-pumps-cooling-systems-mirehp/38461
Danish R&D project on heat pumps and their implementation in district heating systems

EnergyLab Nordhavn: New urban energy infrastructure
- A Smart City Energy Lab

[Link to EnergyLab Nordhavn website: energylabnordhavn.weebly.com/]

[Images of EnergyLab Nordhavn construction and graphics]
Conclusion

- The Danish energy system is transforming from fossil fuel to electrical power: Electrical heat pumps expected to have a major role in the district heating

- The transition process is supported by
  - Guide lines incl. cases
  - Simple calculation tools to make the first estimations

- Total cost analysis shows
  - little economic of scale impact
  - high share of other cost than the heat pump it self

- Right implementation has to be chosen
  - System COP (COSP) can be much lower than COP of the heat pump

- Some relevant Danish R&D project in the field of heat pumps and their implementation was presented
Thank you

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