Utilization of excess heat for district heating in the future Danish energy system

Stefan Petrovic, Mikkel Bosack Simonsen & Fabian Bühler
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Plan of presentation

- Previous research
- TIMES models
- TIMES-DK model
- Analysed scenarios
- Results
- Sensitivity analysis
- Conclusion
- Future work
Previous work

• District heating in Denmark should be expanded in the future
• Excess heat should contribute to district heating production
• The role of industrial excess heat is not analysed in more details

• In previous work we have allocated industrial excess heat to single production units
• Excess heat is defined in 15 temperature intervals
• We have performed spatial analysis (using the cut-off distance)
• 5.1% of DH demand can be supplied by industrial excess heat from thermal processes
• What if we let the model to decide?
Previous work – Excess heat density

Previous work – from theoretical to practical potential

Previous work – share of DH demand which can be covered by industrial excess heat

TIMES-DK – geographical structure

Technical University of Denmark
TIMES-DK – geographical structure
TIMES-DK – Industrial excess heat

- Low Temp Excess Heat
  - Low Temp Heat Exchanger
  - Low Temp Heat Pump
  - Connection to district heating network
  - District heating network

- Medium Temp Excess Heat
  - Medium Temp Heat Exchanger
  - Medium Temp Heat Pump

- High Temp Excess Heat
  - High Temp Heat Exchanger

Seasonal COPs defined for
- DKE/DKW
- Central/Decentral

- Inside DH areas
- 3 steps outside of DH areas

Potentials:
- Central/Decentral
- DKE/DKW
- Inside/3 steps outside of DH areas
- 6 Industrial sectors
- No Cost in the Base runs

Investment Costs:
- Fix O&M
- Variable O&M

Efficiency:
- COP

Fixed O&M:
- Fix O&M

Variable O&M:
- Variable O&M
Analysed scenarios

- EH_Base – 50% of electricity production from wind from 2020

- EH_2050 – 50% of electricity production from wind from 2020
  Fossil fuel free energy system from 2050

- EH_2035 – 50% of electricity production from wind from 2020
  Fossil fuel free energy system from 2050
  No fossil fuels in production of electricity and from 2035
Results – Residential heat production

![Graph showing residential heat production from 2010 to 2050](image-url)
Results - District heating production

Scenarios

- EH_Base
- EH_2050
- EH_2035

District heating production (PJ)

- Industrial EH
- Biorefinaries
- Large heat pumps
- Solar heating
- Boilers
- CHP
Results – Industrial Excess heat and biorefinaries

Scenarios:
- EH_Base
- EH_2050
- EH_2035

Share of district heating production (%)
- Industrial EH
- Birefinaries
Results – Share of DH produced from industrial EH

Share of DH demand supplied by industrial excess heat (%)

- DKE HETC
- DKE HETD
- DKW HETC
- DKW HETD

Time (years): 2012, 2015, 2020, 2025, 2030, 2035, 2040, 2045, 2050

Share of DH produced from industrial EH in the future Danish energy system
Results – Excess heat at different temperatures
Sensitivity analysis

Excess heat potentials

- Energy efficiency measures with 10 year pay back time – fixed from 2015 to 2050
- No efficiency
- +50% compared to existing potential
- THERMCYC project (22.6 PJ; more manufacturing industries and more processes)
- Base potential linearly reduces to 50% in 2035
- Base potential linearly reduces to 50% in 2050

Excess heat costs

- 10 DKK/GJ
- 20 DKK/GJ
- 15 EUR/MWh=31 DKK/GJ
- 30 EUR/MWh=62 DKK/GJ

EH_2050 scenario is the basis for the sensitivity analysis
Sensitivity analysis

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EH_2050 scenario is the basis for the sensitivity analysis
Sensitivity analysis – industrial excess heat share in DH production
Conclusions

• Optimal share of industrial excess share in DH production of around 5%
  • All excess heat within low and medium cost potentials are being utilized

• With biorefinaries the share grows up to around 20%

• In DKW the share of industrial excess in DH production is 7-8%

• 70-80% of excess heat is high temperature

• If potentials from THERMCYC project are included, 12-14% of DH production can come from industrial excess heat
Future work

• Sensitivity analysis on the costs and efficiencies of competing technologies - large scale heat pumps and electric boilers

• Finding appropriate value for socio-economic cost of excess heat

• Private-economic analysis (tax on excess heat is a big topic in Denmark)

• Excess heat potentials from data centers (Master thesis by Alessandro Colangelo)
Thank you for your attention!

Stefan Petrović  
*Postdoc*  
Systems Analysis division  
DTU management Engineering  
Email stpet@dtu.dk  
Phone +45 24655732

Mikkel Bosack Simonsen  
*Research Assistant*  
Systems Analysis division  
DTU management Engineering  
Email mibsi@dtu.dk  
Phone +45 29383337

Fabian Bühler  
*PhD Student*  
Section of Thermal Energy  
DTU Mechanical Engineering  
Email fabuhl@mek.dtu.dk  
Phone +45 22471020