Green transition of District Heating

Planning, Progress and Perspectives from Fjernvarme Fyn

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General introduction to DK and Funen
Targets and regulation in Denmark

Targets
• 70% carbon reduction in 2030
• 0% fossil energy in 2050
• Zero coal in energy sector by 2030

Regulation
• 3 offshore wind farms tendered (3*800 MW)
• Subsidies for biomass phased out
• Wind, solar and biomass to compete
• Electrification of heating sector
• Energy storage promoted
• New simplified tax on surplus heat

Source: Danish energy agreements
High levels of renewables and district heating in Denmark

Gross energy consumption by type of energy 1990-2030

Final energy consumption by households for heating 2017-2030
- Gas incl. natural gas, gas works gas and bio-natural gas
- Other renewable energy incl. firewood, solar heating and straw

Source: Denmark's Energy and Climate Outlook 2019
Electricity and district heating are phasing out fossils

Emissions of greenhouse gases by sector from 1990-2030 and in the 1990 UN base year [mill. tonnes CO2-eq.]

Source: Denmark's Energy and Climate Outlook 2019
Thermal Power is going down – wind turbines are going up

Green transition at the central plants

- Phase 1 (2010-2020): Large scale wood chips and wood pellets
- Phase 2 (2020-2030): Electrification (heat pumps), natural gas, surplus heat, geothermal, etc.
District heating competing with individual solutions

• District heating are natural monopolies but can compete through benchmark
• Today only voluntary benchmarks
• Future regulation could include regulated benchmarks
• Individual heat pumps are beginning to compete in most areas

Benchmark - Heating costs for standard houses (Q2-2019)
[130 m², 18.1 MWh/year]
Synergies between large heat pumps, the thermal plants and a large heat storage
Peak load supplied by gas on unit 7 (until 2029) as well as electric boilers

TBV: Tietgenbyens Varme Central (heat pumps near facebook)
EMV: Ejby Mølle Varme Central (heat pumps utilizing sewage sluge
Source: Fjernvarme Fyn
Nordic GTL 2030 - CO₂ and hydrogen pathway

Districh heating will also have a future role:
- Carbon capture from MSW and biomass
- Process heat and surplus heat
- System integration (RES-power/heat/fuel/carbon)
Key facts about Fjernvarme Fyn

- Fjernvarme Fyn is a shareholders company owned by the municipalities of Odense and North Funen
- Annual turnover: 200 mio. Euro (Heat, electricity, waste incineration)
- 285 employees
- First heat from CHP in 1929

Our legal structure includes entire value chain

Targets:

Top 3 on lowest price
by
Competitive development and cooperation along with automation and digitalization

Phase out coal by 2025
by
Stepwise installation of new technologies with synergies to existing units and a high level of electrification
One of the worlds largest district heating grids

- 65,000 connections/ meters
- 120 km transmission lines (80-90 °C)
- 2200 km distribution lines (70-75 °C)
District heating competing with individual solutions

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Benchmark - Heating costs for standard houses (Q2-2019)  
[130 m², 18.1 MWh/year]
Coal to be phased out by 2025 – already down to ~220,000 t in 2019

Electrical heat pumps will be a large part of future production mix

Heat pumps will utilize surplus heat from Facebook, sewage sludge and ambient sources (air and sea)
Fuel mix from 2017 to 2040
Synergies between large heat pumps, the thermal plants and a large heat storage
Peak load supplied by gas on unit 7 (until 2029) as well as electric boilers
To be translated
Fjernvarme Fyn will have ~100 MW electric heat pumps by 2020 - and potentially another 100-150 MW before 2030

Figure: Heat capacity (MW) electric heat pumps established (by 2020) and projected pumps (MW)
Facts about the heat recovery project

- Data center owned and operated by Facebook
- Heat pump plant owned and operated by Fjernvarme Fyn
- Both facilities supplied by renewable energy
- 100,000 MWh surplus heat ~ 6900 households
- 2017: Investment decision
- 2019/2020: Operation

Source: Facebook and Fjernvarme Fyn
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## Indblik i spidslasten

- Elkedlerne reagerer på lave elpriser (≈ høj VE-andel)
- Elkedlen agerer som marginale enhed, hvorfor varmen næsten lagres 1:1 i varmelageret.

- Varmepumper, elkedler og varmelagre vil kunne balancere elsystemet og sikre integration af fluktuerende elproduktion fra VE
- Samme ydelser og reaktionsevne som batterier og HTES - blot i endnu større skala, bedre virkningsgrad og lavere omkostninger

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**Figur 1:** Modelleret drift af elkedler, elspot og varmelager (januar til april 2030)

**Figur 2:** System virkningsgrad med elkedler og stort varmelager

Kilde: Fjernvarme Fyn
CFD model of a large energy storage (250 MJ/s from cold)
Load curve in 2030