Green transition of District Heating

Planning, Progres and Perspectives from Fjernvarme Fyn

Kim Winther, Head of Business Development
10 December 2019

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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

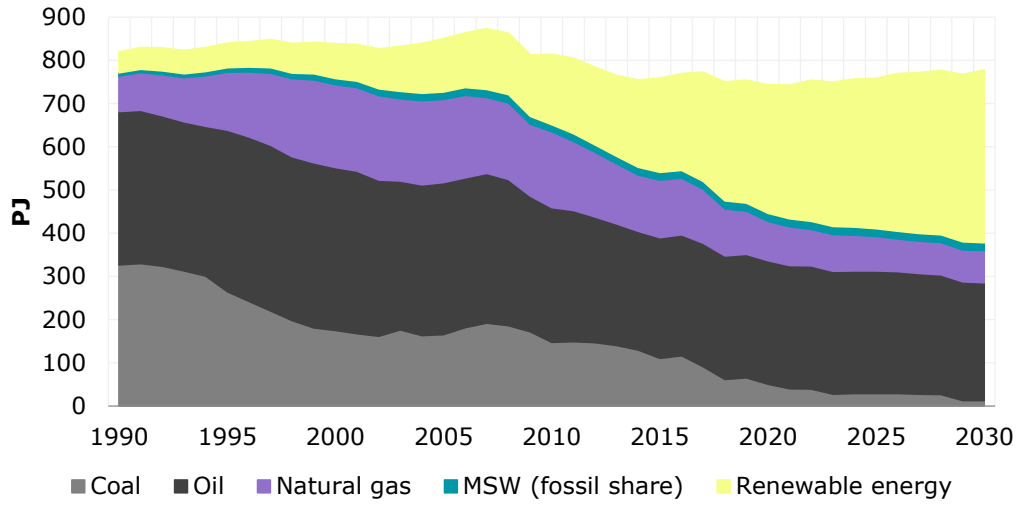
Regulation

- 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

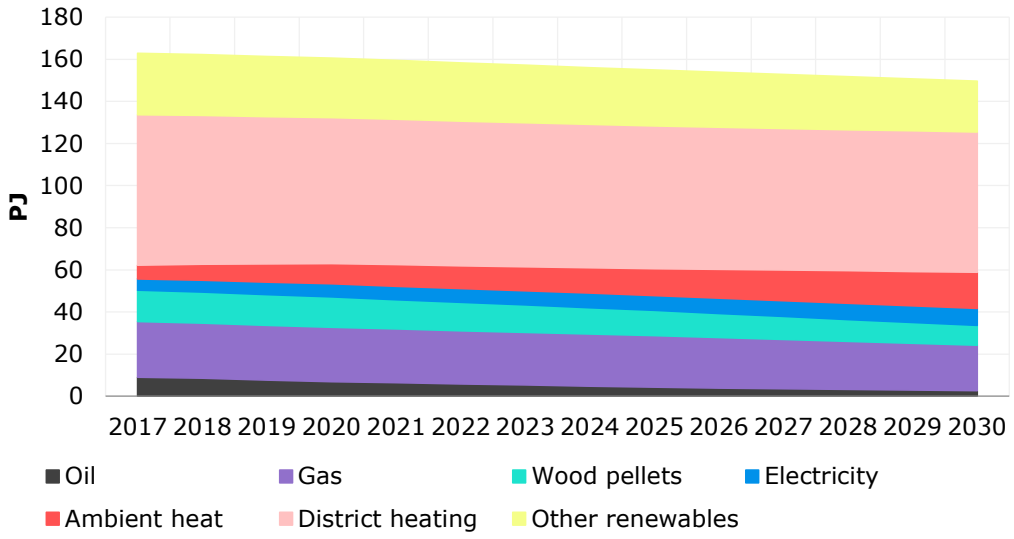
High levels of renewables and district heating in Denmark

Gross energy consumption by type of energy 1990-2030



Final energy consumption by households for heating 2017-2030

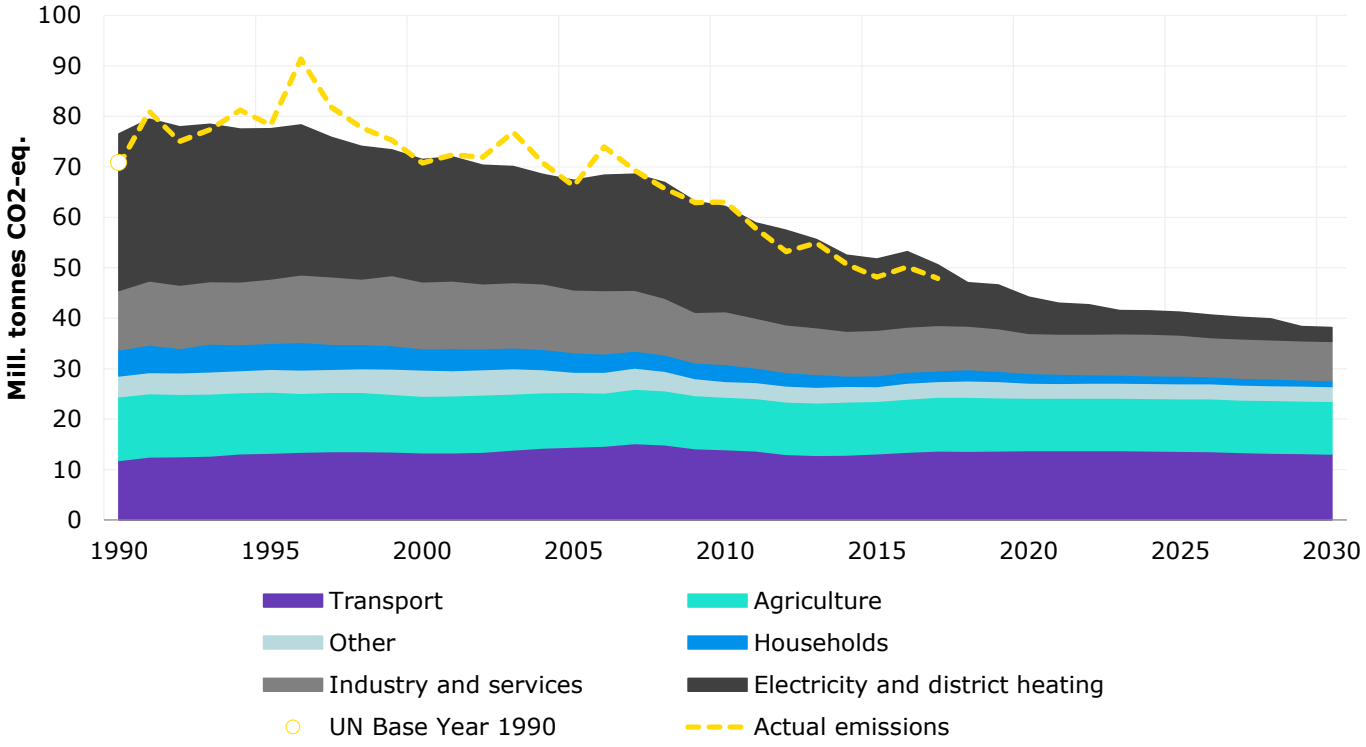
- Gas incl. natural gas, gas works gas and bio-natural gas
- Other renewable energy incl. firewood,solar heating and straw



Source: Denmarks Energy and Climate Outlook 2019

Electricity and districy 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.]



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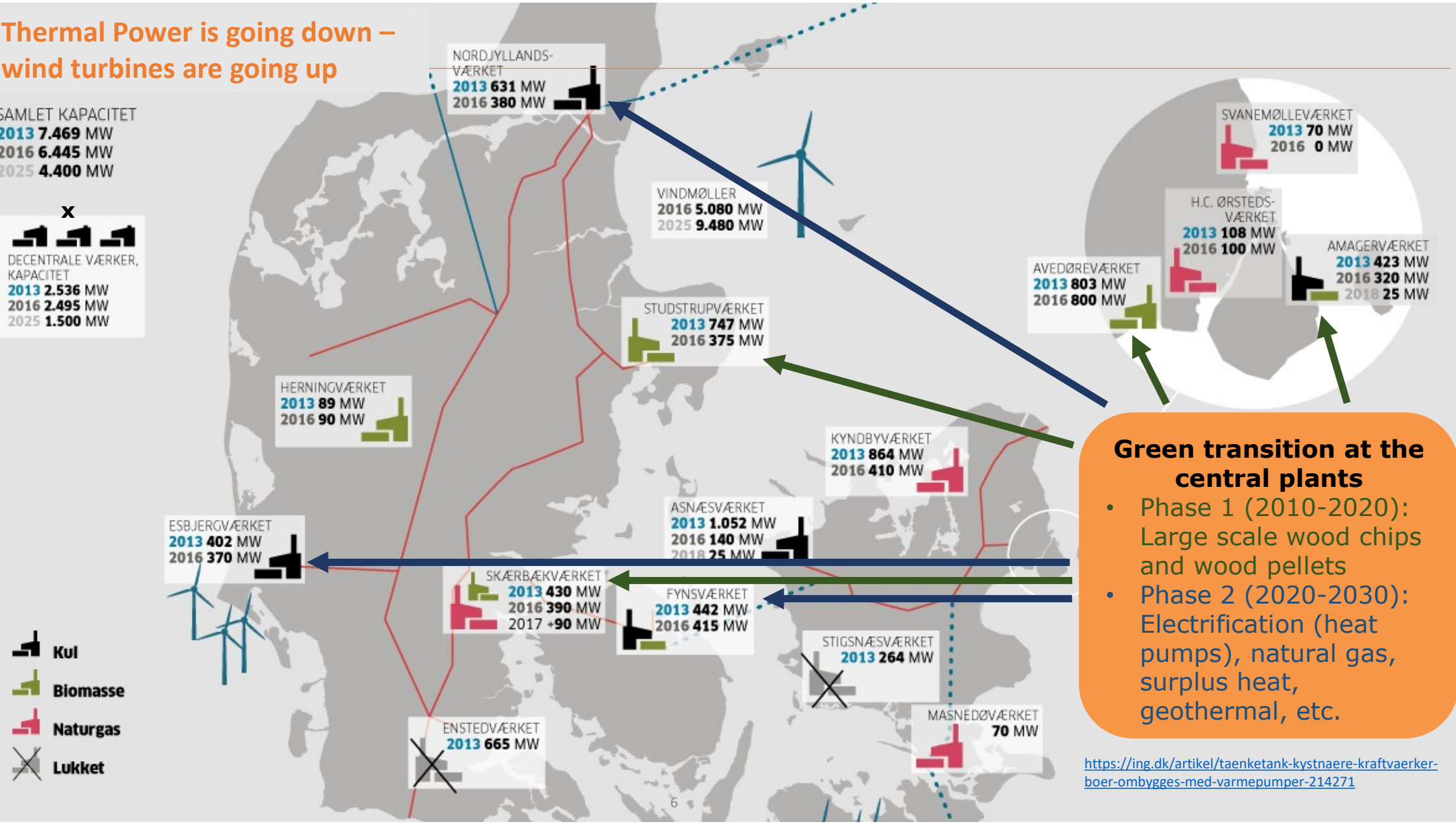
Thermal Power is going down – wind turbines are going up



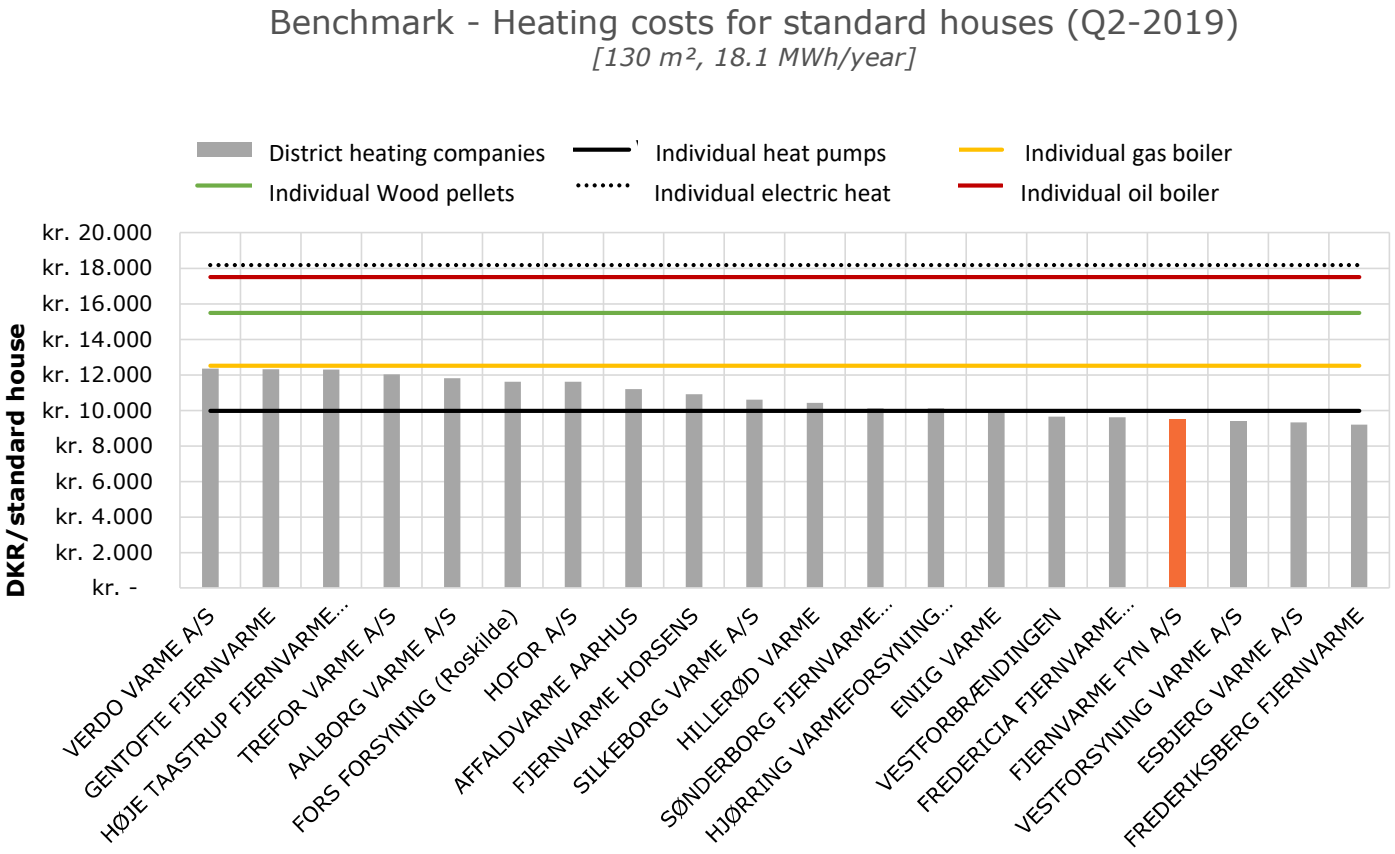
Green transition at the central plants

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

https://ing.dk/artikel/taenketank-kystnaere-kraftvaerker-boer-ombygges-med-varmepumper-214271

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



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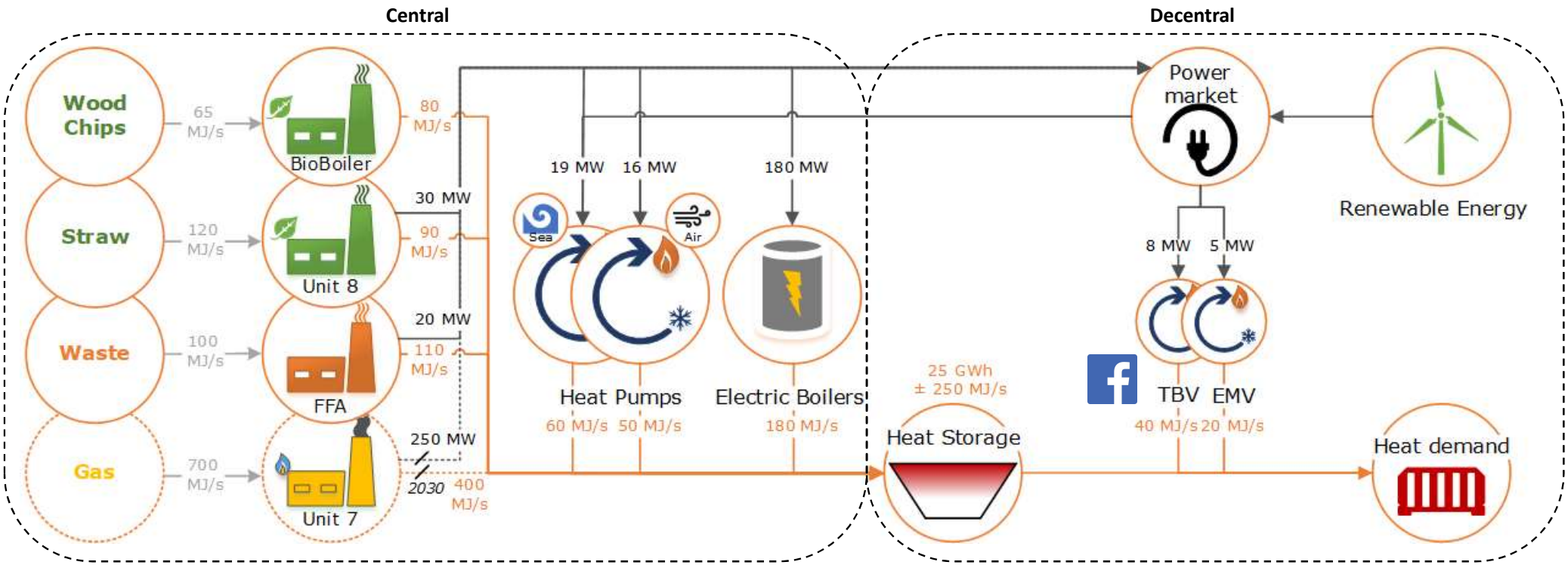
Future concept for district heat production in 2030



- 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

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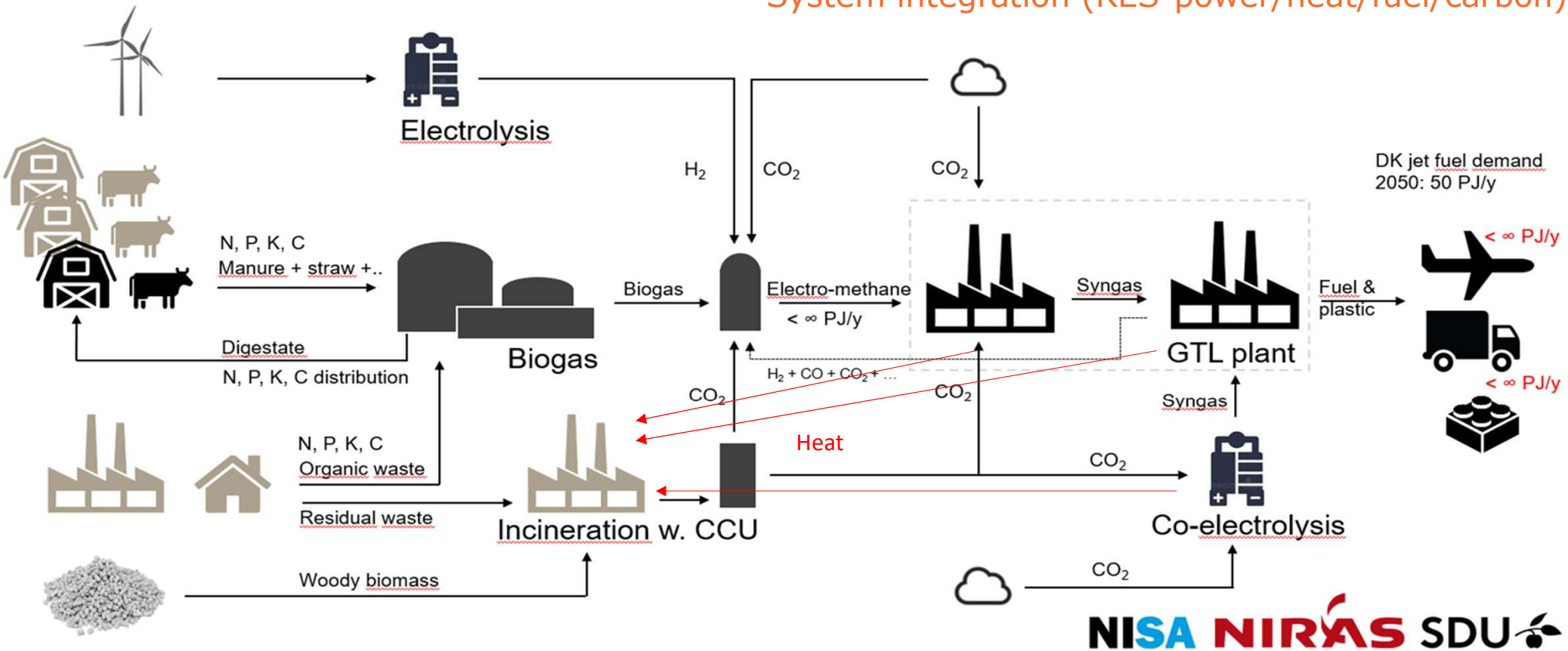
Nordic GTL 2030
- CO_2 and hydrogen pathway

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)



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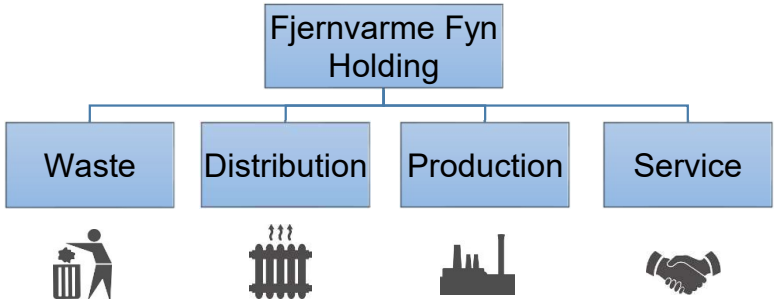
Fjernvarme Fyn

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

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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)

Source: Fjernvarme Fyn

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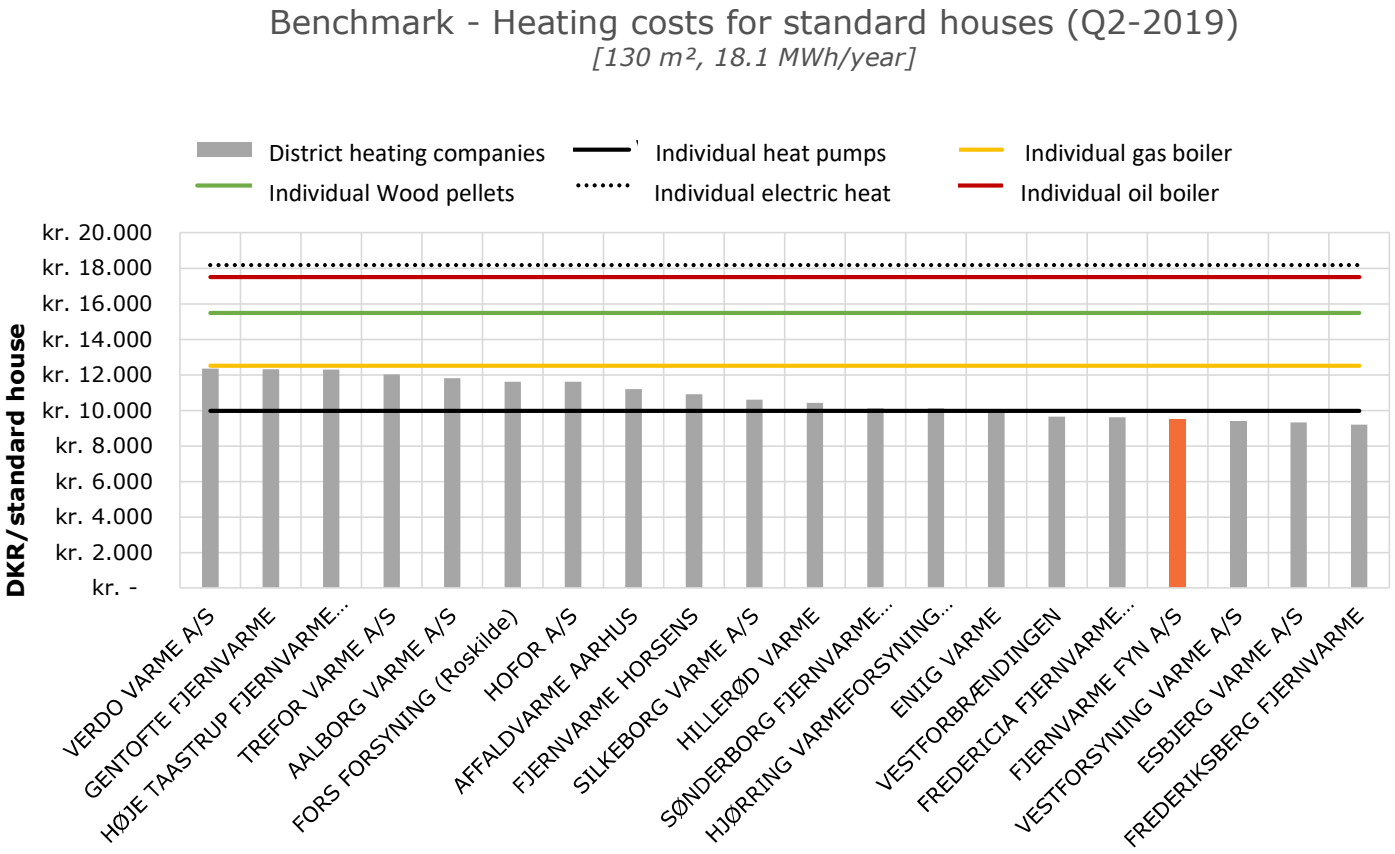

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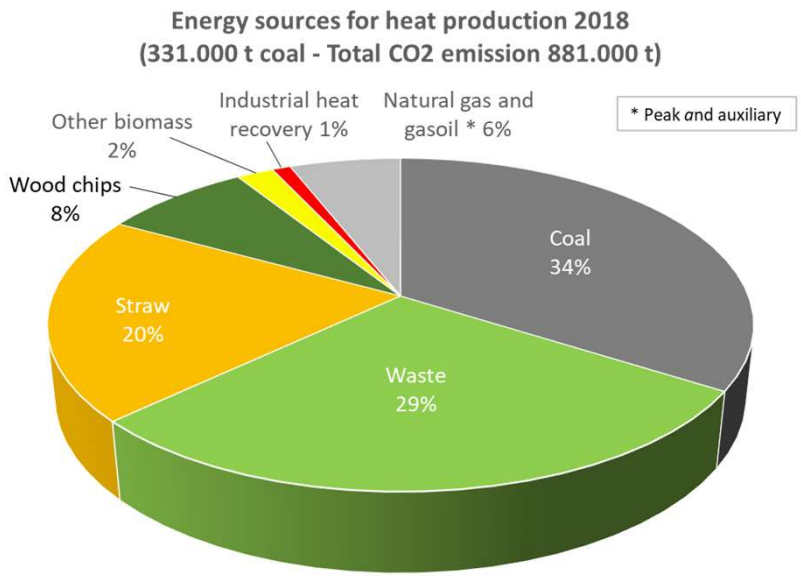
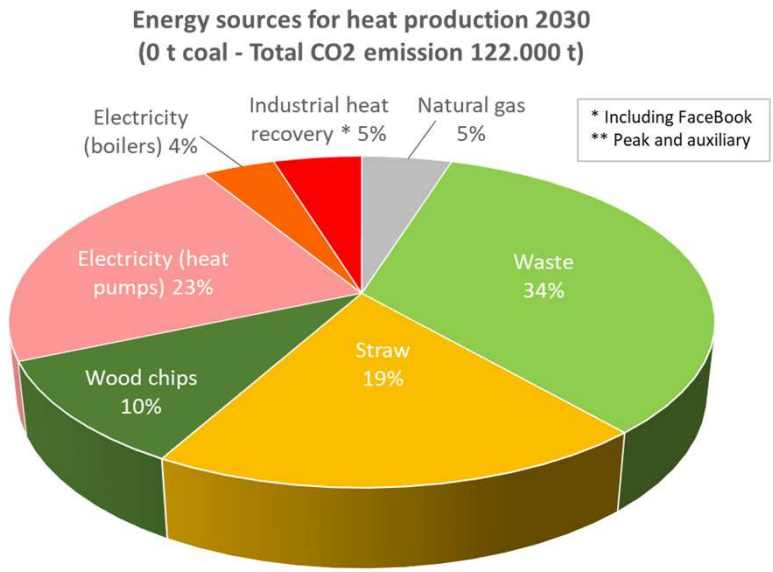
Heat production in 2018 and 2030





- Coal to be phased out by 2025 – allready 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)

Source: Fjernvarme Fyn

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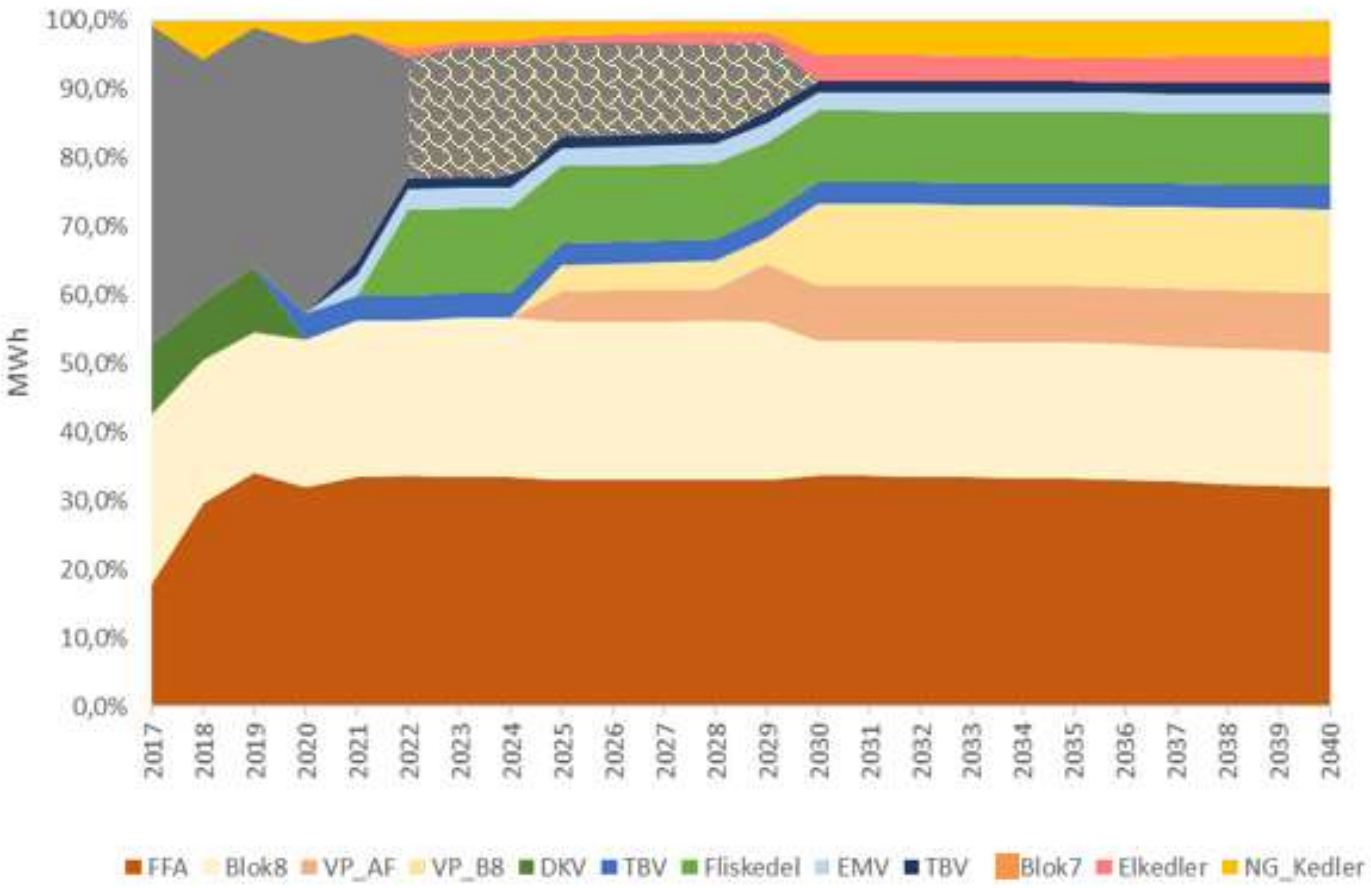
Fuel mix from 2017 to 2040



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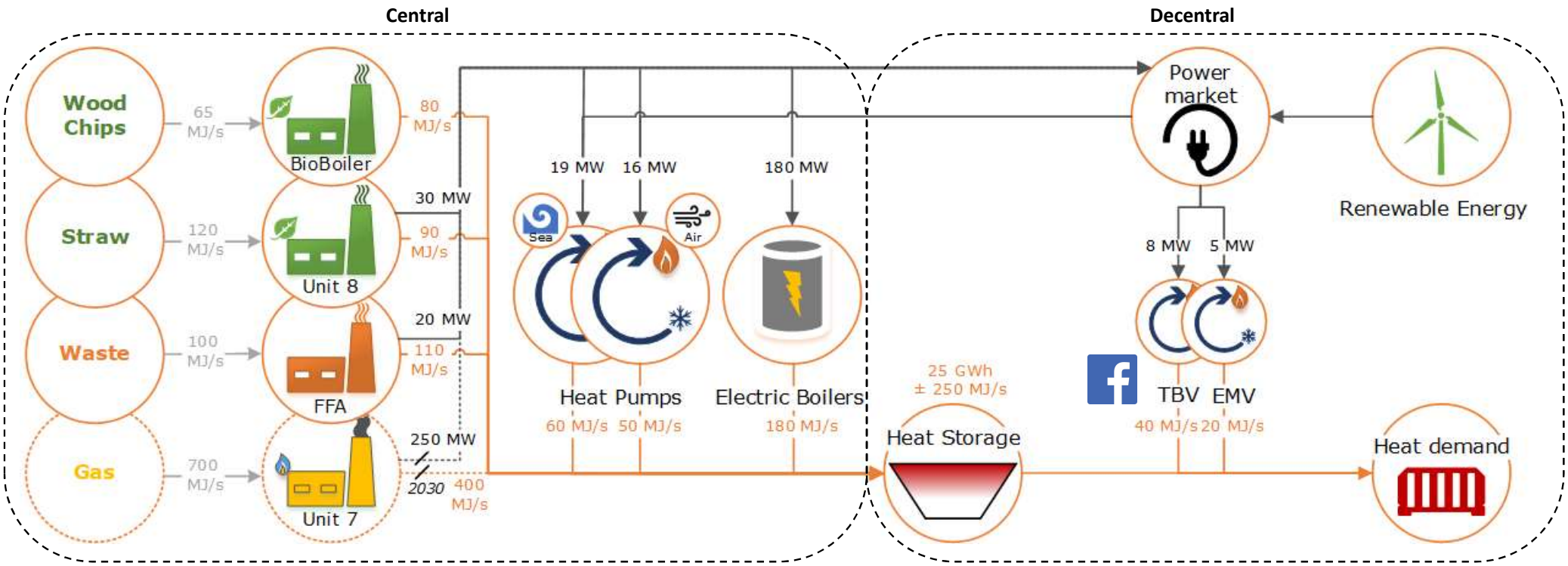

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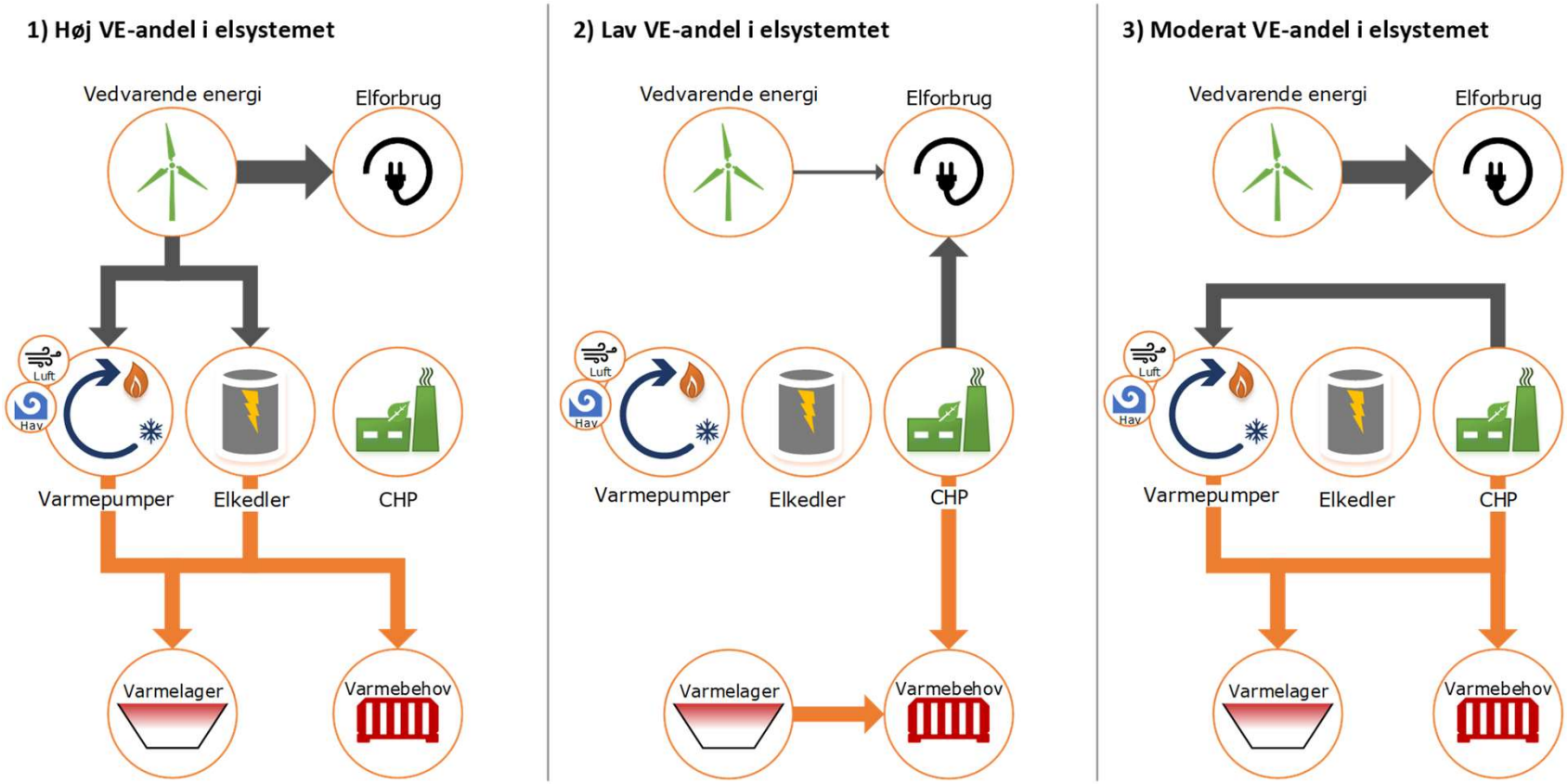

Kilde: Fjernvarme Fyn

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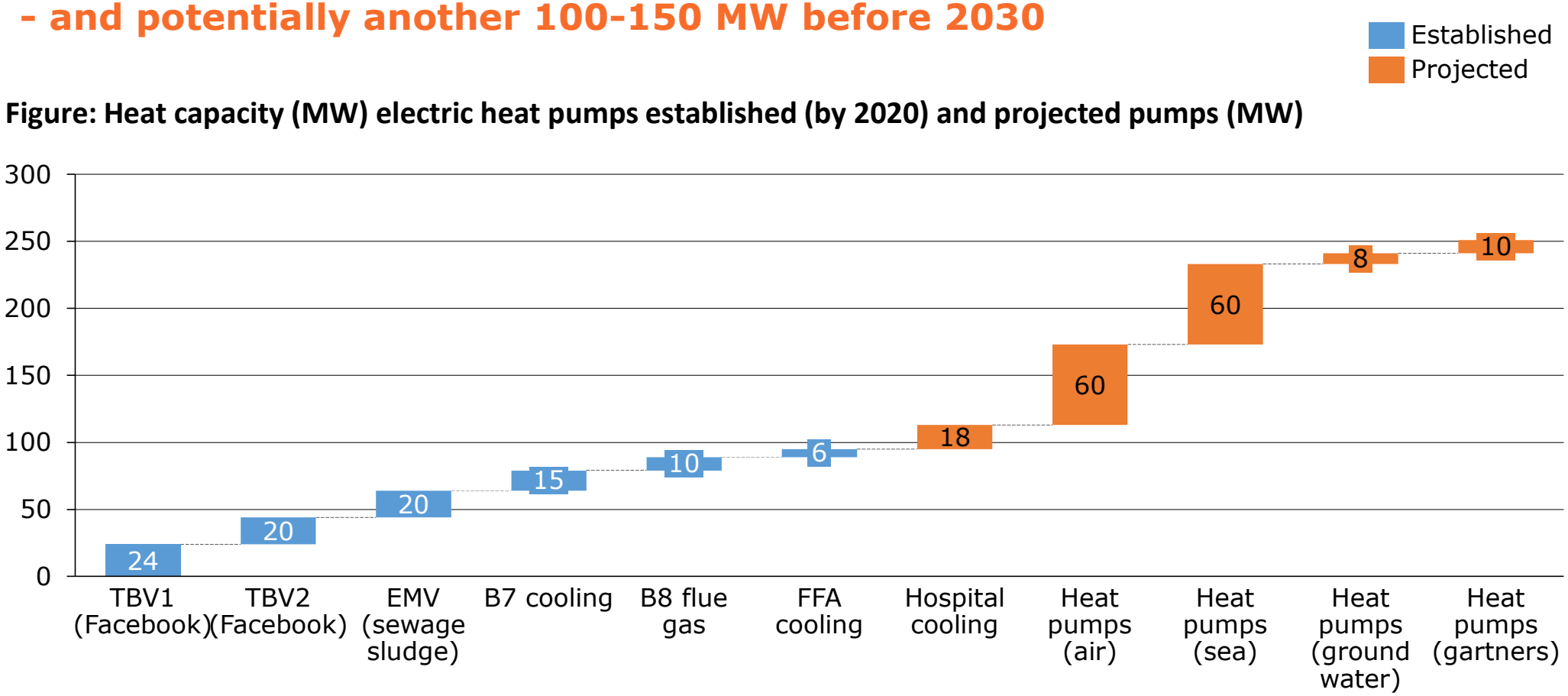
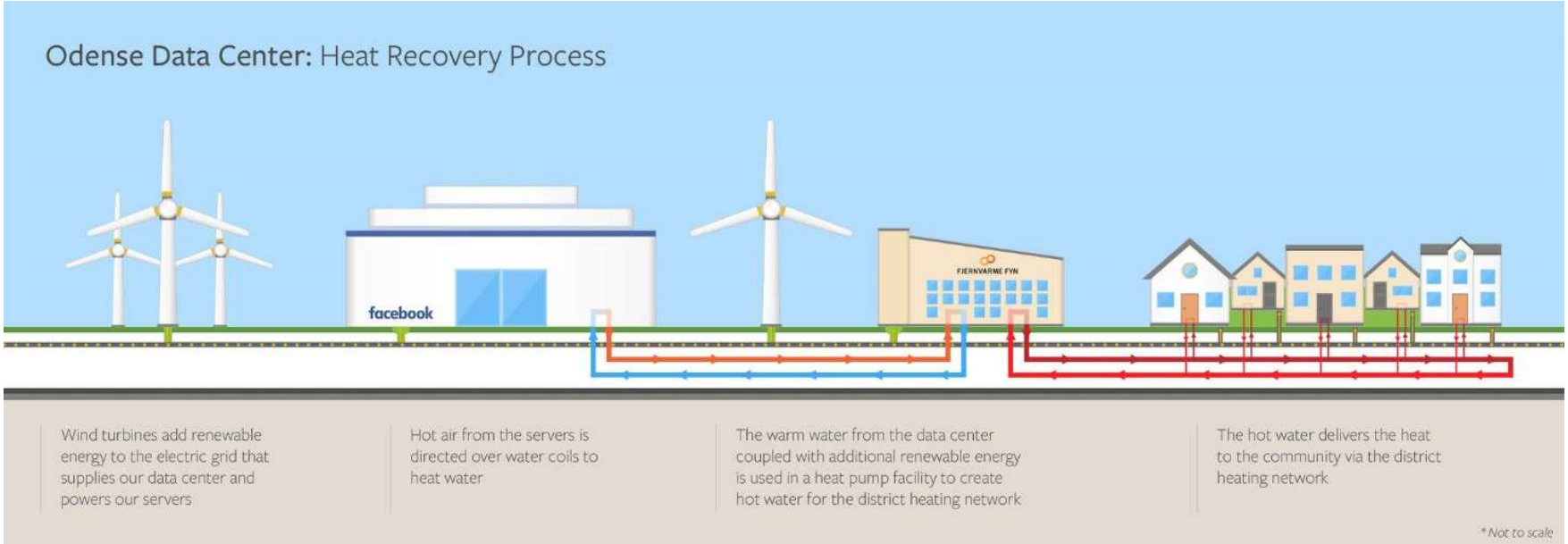
Fjernvarme Fyn will have ~100 MW electric heat pumps by 2020 - and potentially another 100-150 MW before 2030

Figure: Heat capacity (MW) electric heat pumps established (by 2020) and projected pumps (MW)



Facts about the heat recovery project



Facts:

- 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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TBV heat pump central


Facebook servers


Visitor center


Heat pump and manifold

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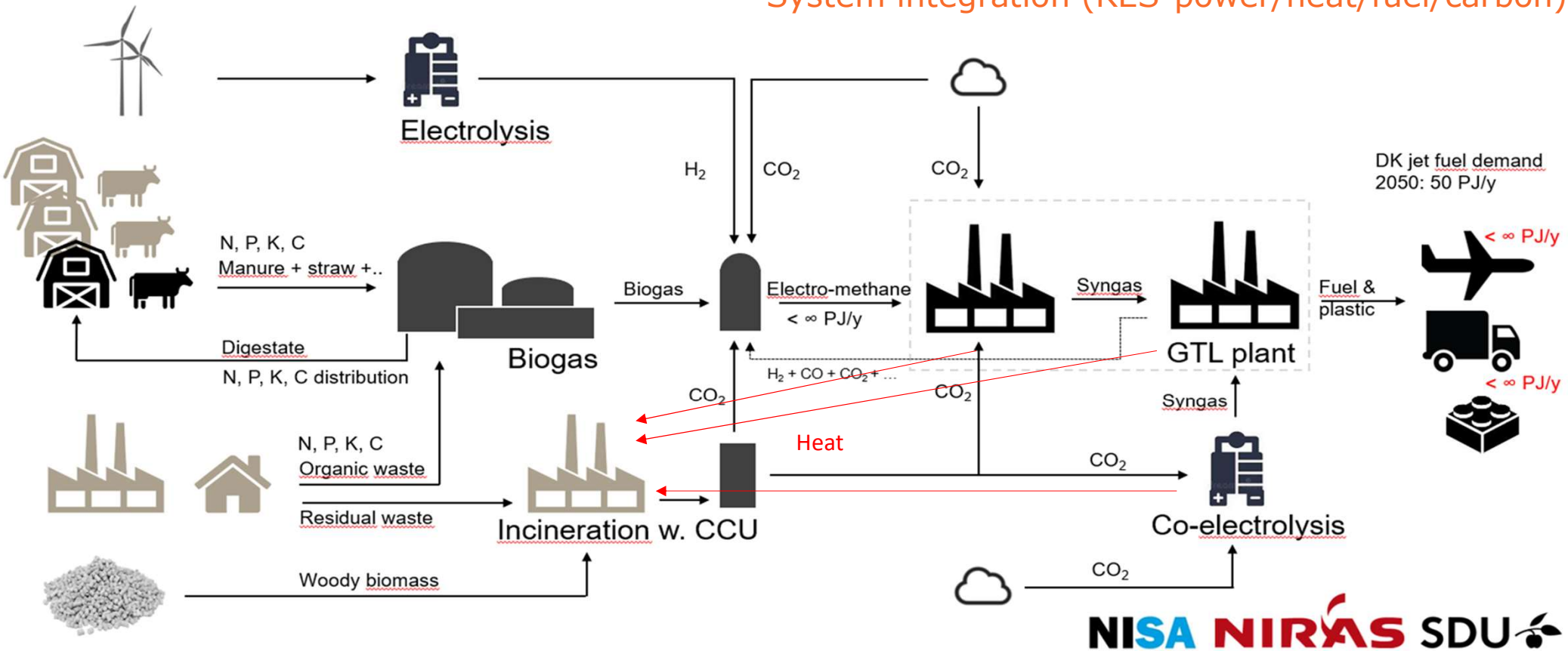

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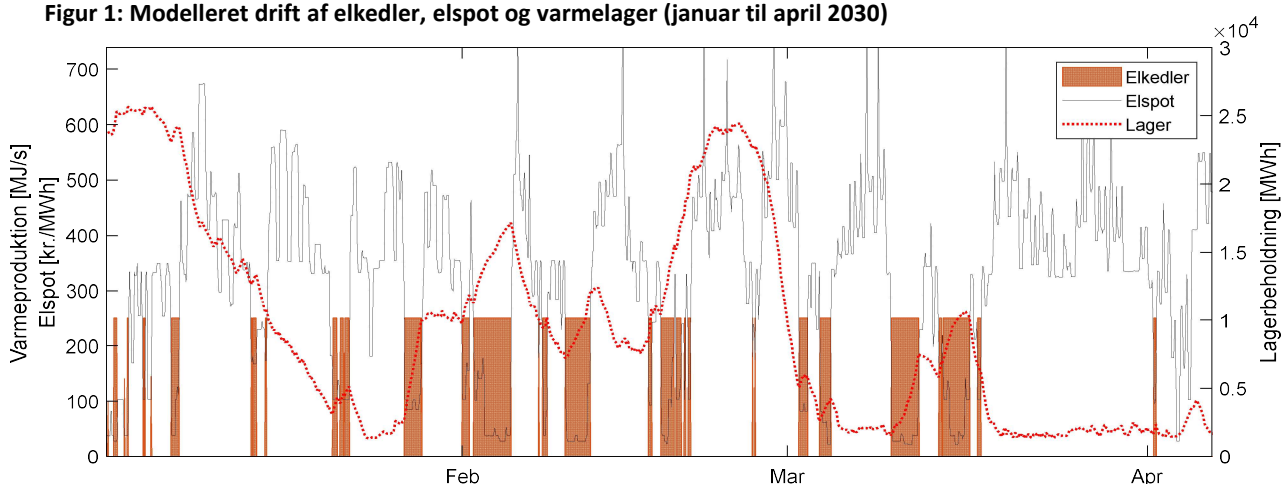
EKSTRA

Indblik i spidslasten

To be translated

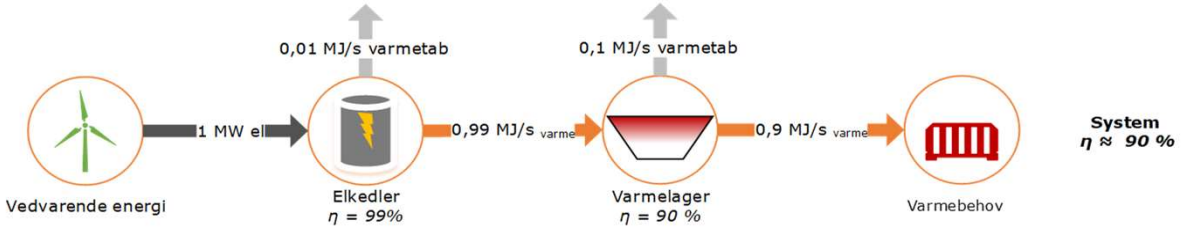
- Elkedlerne reagerer på lave elpriser (≈ høj VE-andel)
- Elkedlen agerer som marginale enhed, hvorfor varmen næsten lagres 1:1 i varmelageret.

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



- 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

Figur 2: System virkningsgrad med elkedler og stort varmelager



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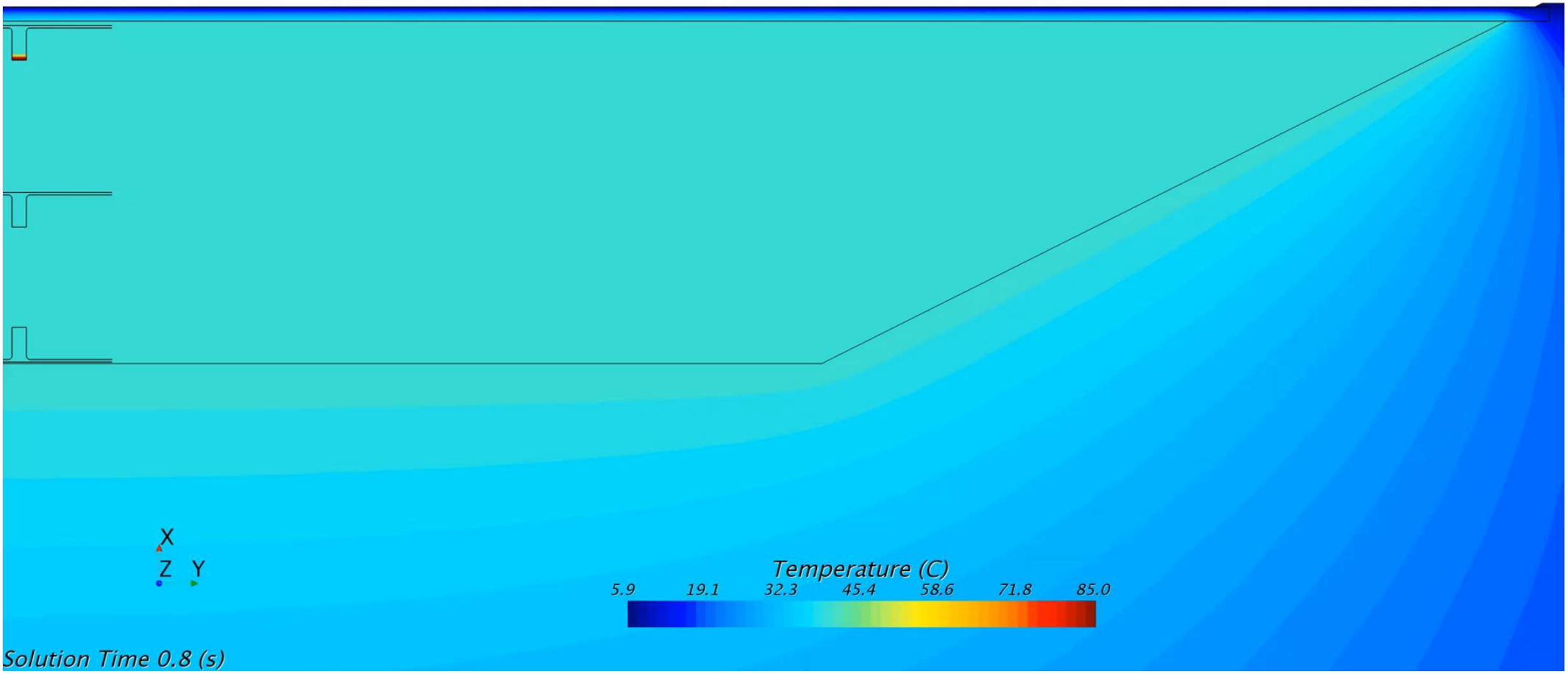
CFD model of a large energy storage (250 MJ/s from cold)



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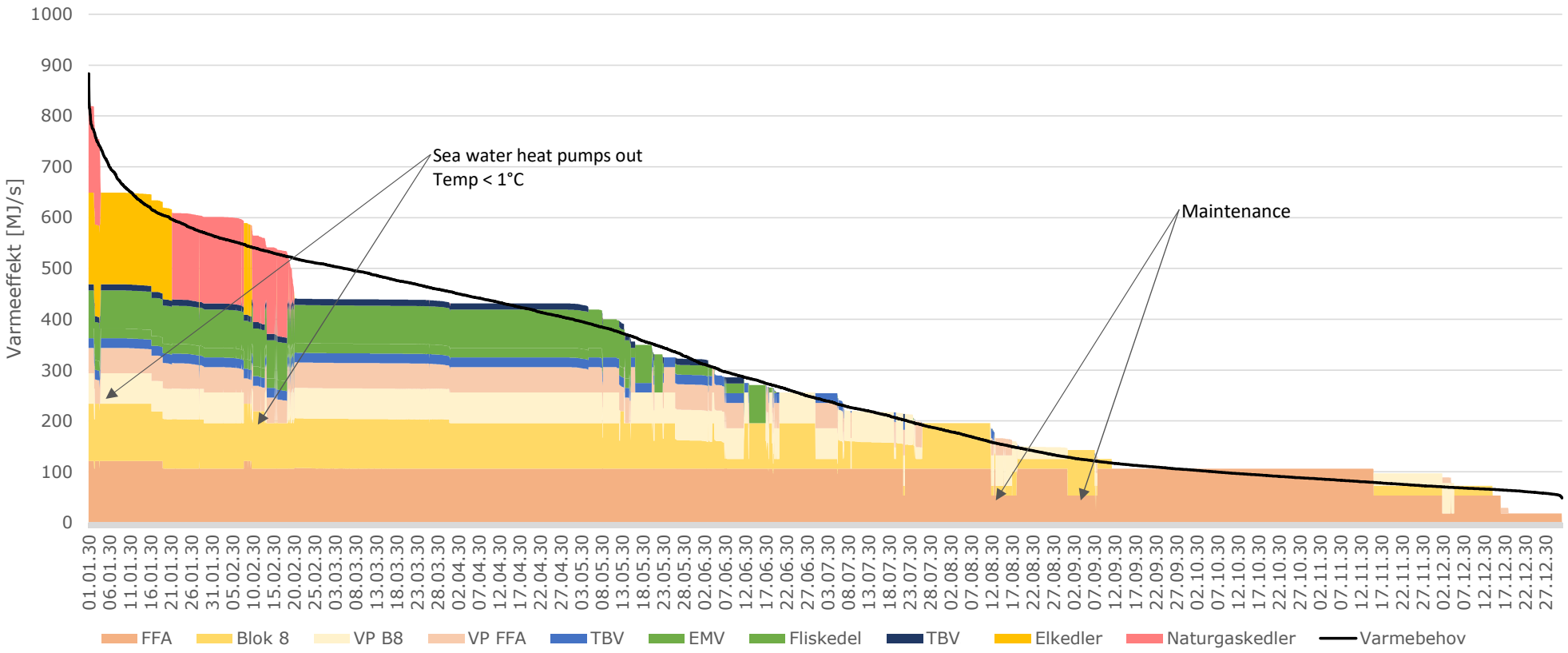
Load curve in 2030



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