FJERNVARME FYN

Utilizing Facebook Data Center Surplus heat for District heating in Odense – Denmark

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Targets and regulation in Denmark

Targets

- 0% fossil energy in 2050
- Zero coal in energy sector by 2030
- 70% carbon reduction in 2030 (New Climate Act)

Regulation

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

Source: Danish energy agreements

Key facts about Fjernvarme Fyn

- 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

Targets in 2025 Strategy:
- Top 3 on lowest price*
- Phase out coal by 2025

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)
- **Large network is key for surplus heat utilization**

* Compared to 20 largest district heating companies in Denmark
Source: Fjernvarme Fyn

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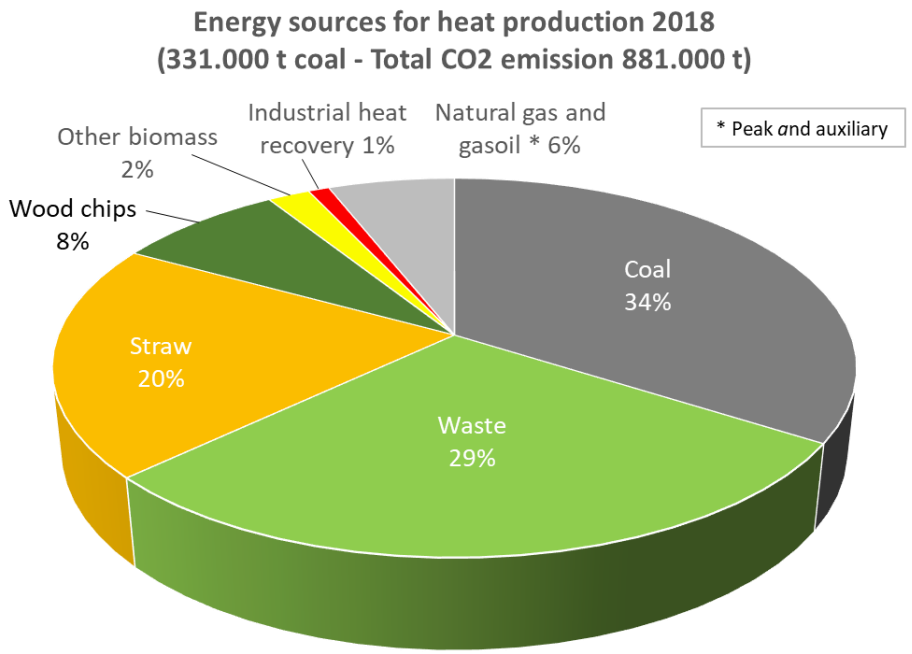
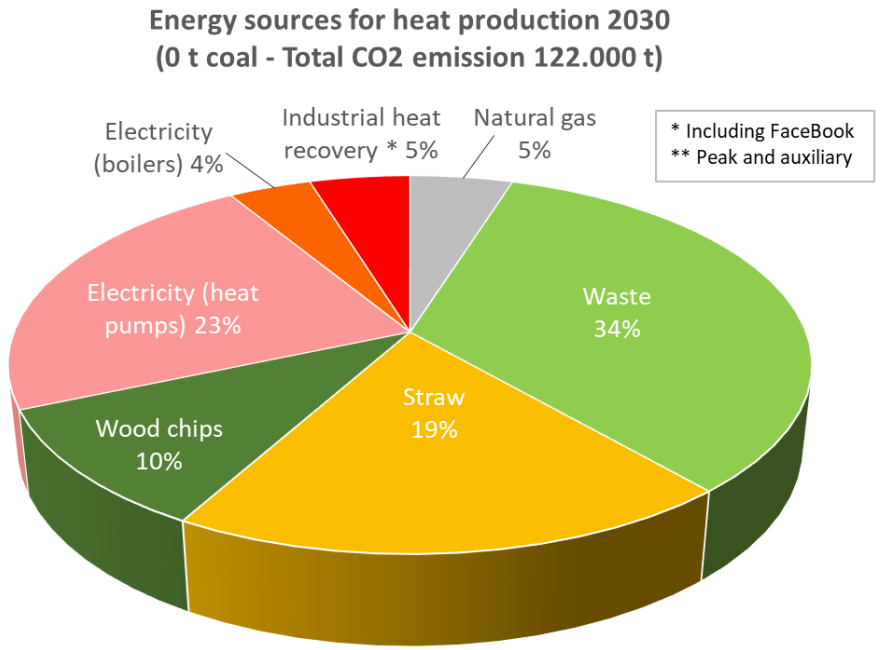
Heat production in 2018 and 2030 – phasing out coal





- Coal consumption down from 330.000 t in 2018 to ~220.000 t in 2019 – will be phased out by 2022
- 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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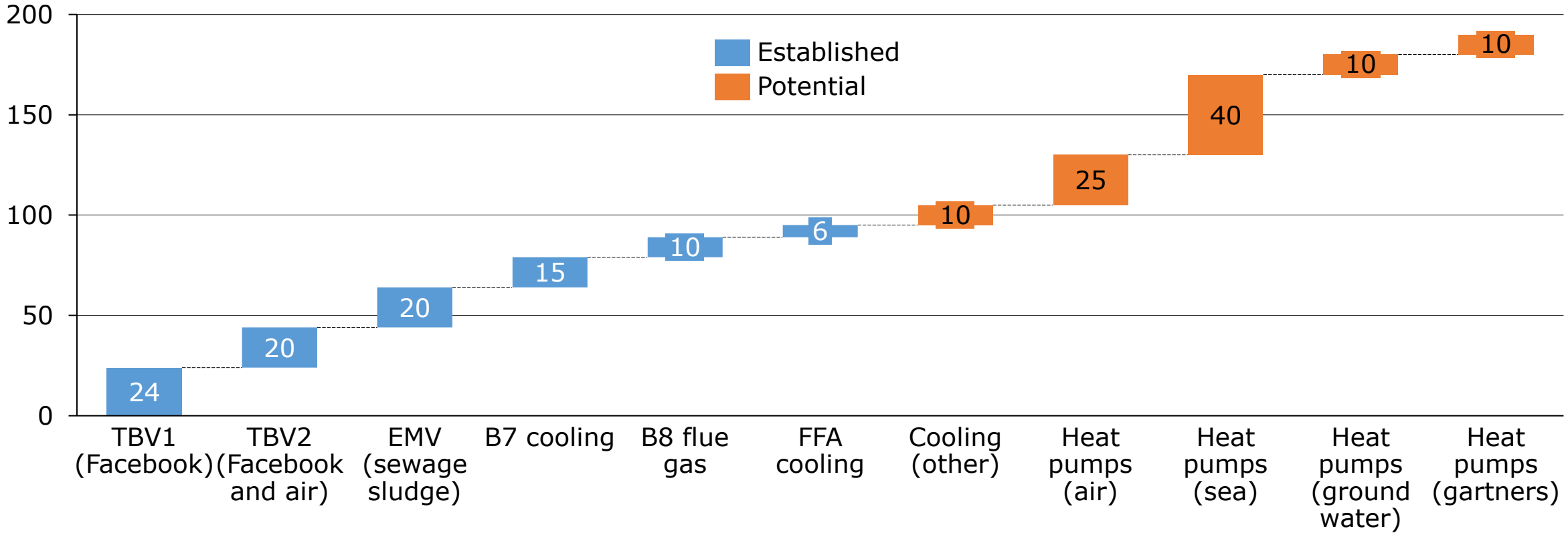
Fjernvarme Fyn will have ~100 MW electric heat pumps by end of 2020 - and there's a similar potential towards 2030

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



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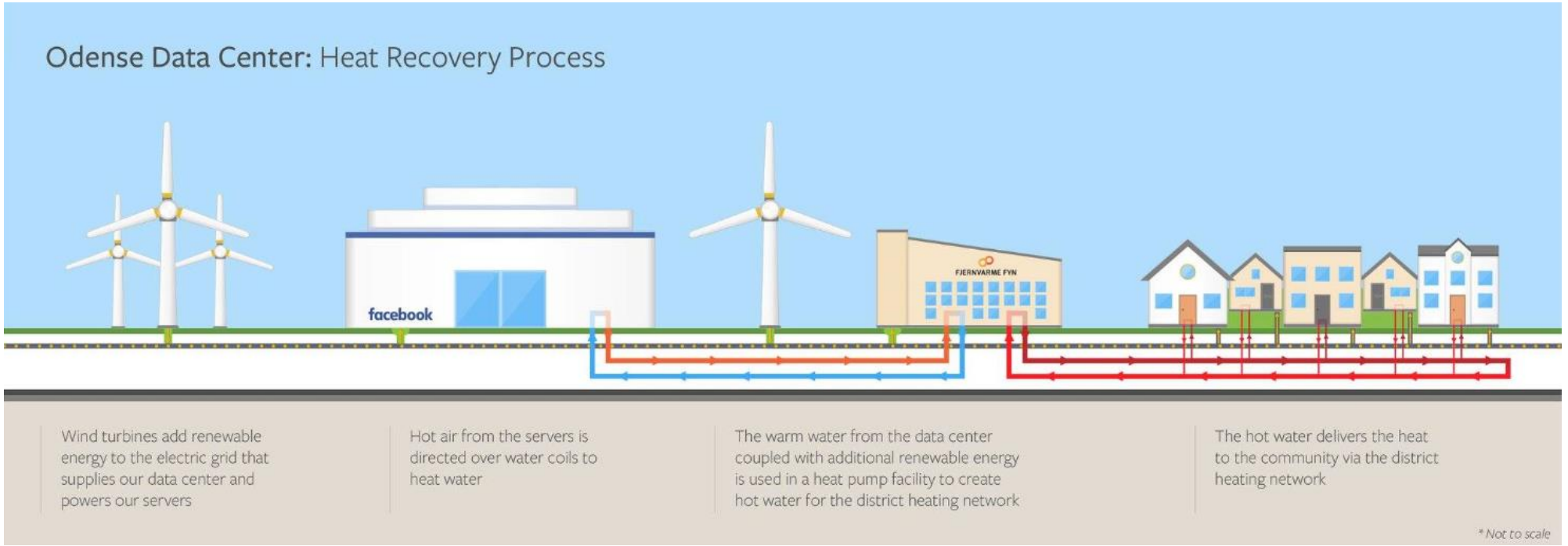
Facts about the heat recovery project with Facebook



Facts:

- Data center owned and operated by Facebook with independent cooling system.
- Heat pump plant owned and operated by Fjernvarme Fyn
- Both facilities supplied by renewable energy
- >100.000 MWh surplus heat ~ >6900 households
- Investment decision in 2017
- Operation in 2020

Source: Facebook and Fjernvarme Fyn

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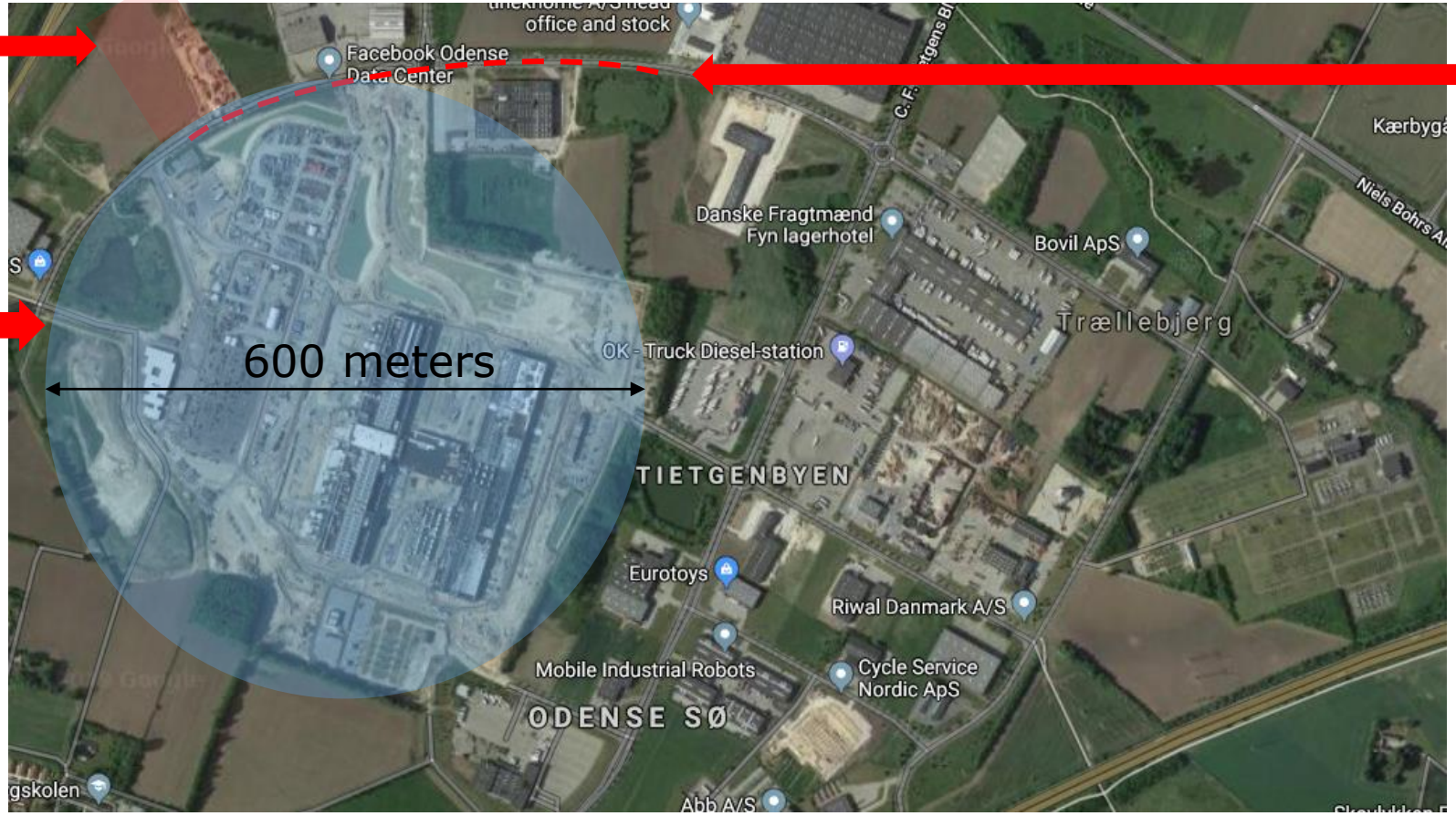
Situation map of heat pumps and data center in Odense - Denmark

Heat Pumps Central

Facebook Odense Data Center



Low temperature district heating pipe net

Characteristics of DK system:

- **High security of supply**
- **High RES**
- **Stable data**

Source: Fjernvarme Fyn

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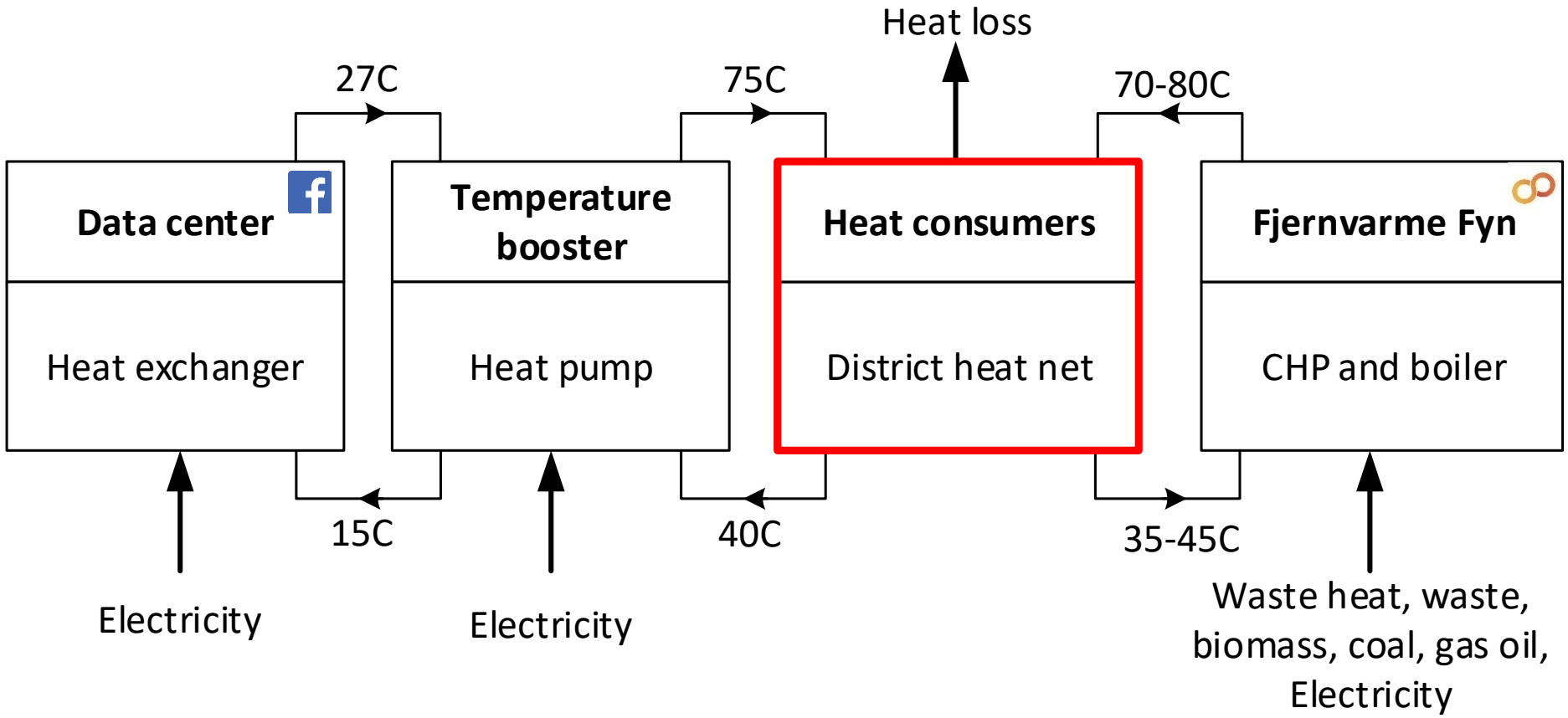
Energy system - Integration of Facebook and Fjernvarme Fyn



Source: Fjernvarme Fyn

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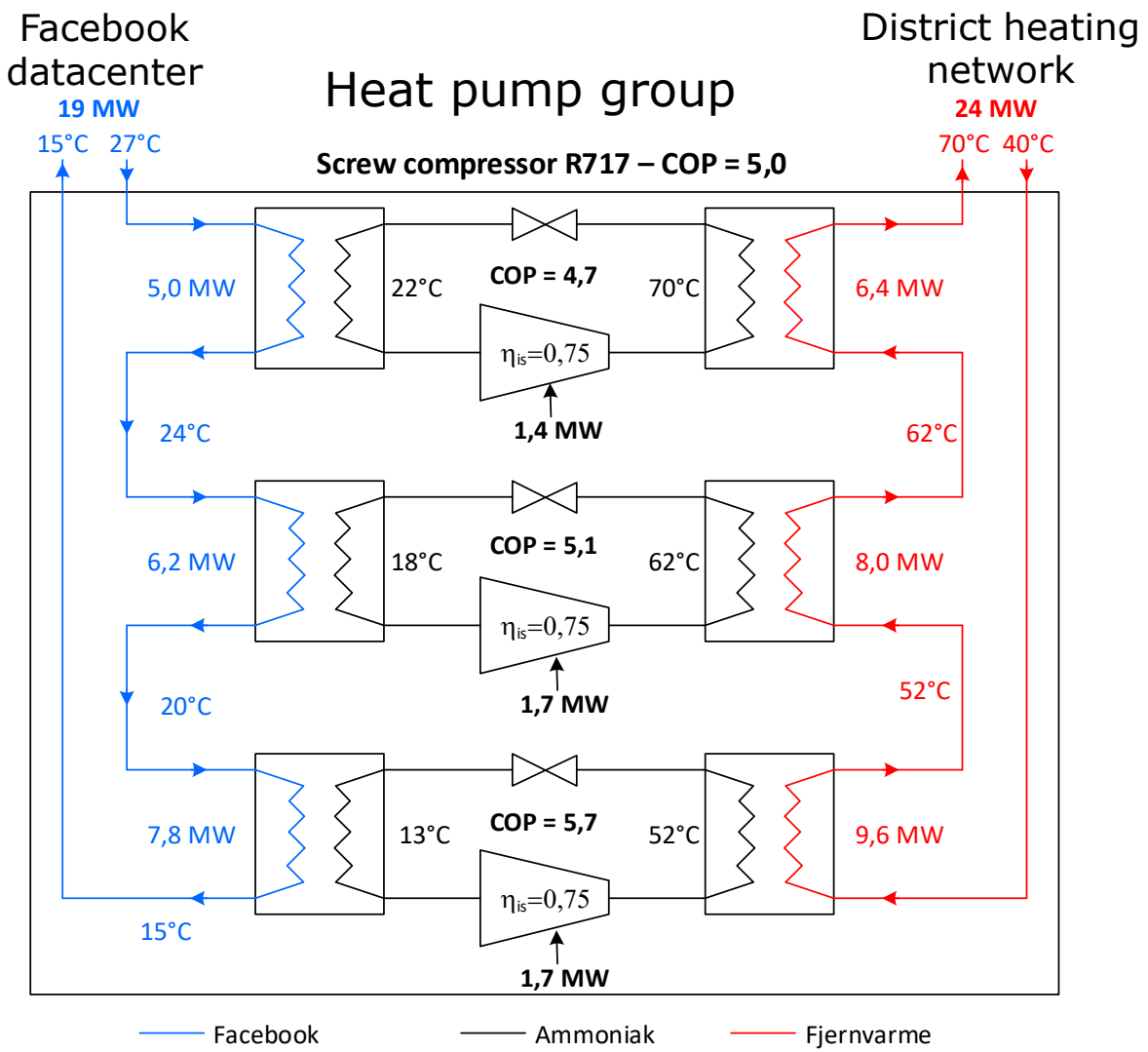
HEAT PUMP DESIGN



- 24 MW heating capacity
- COP heat for heat pumps = 4.5 – 5.0
- 3 groups of ammonia heat pumps
- Each group consist of 3 compressors in series
- 9 Single-stage economized screw compressors
- Ammonia as refrigerant
- Manufactured and tested at the factory (Johnson Controls)

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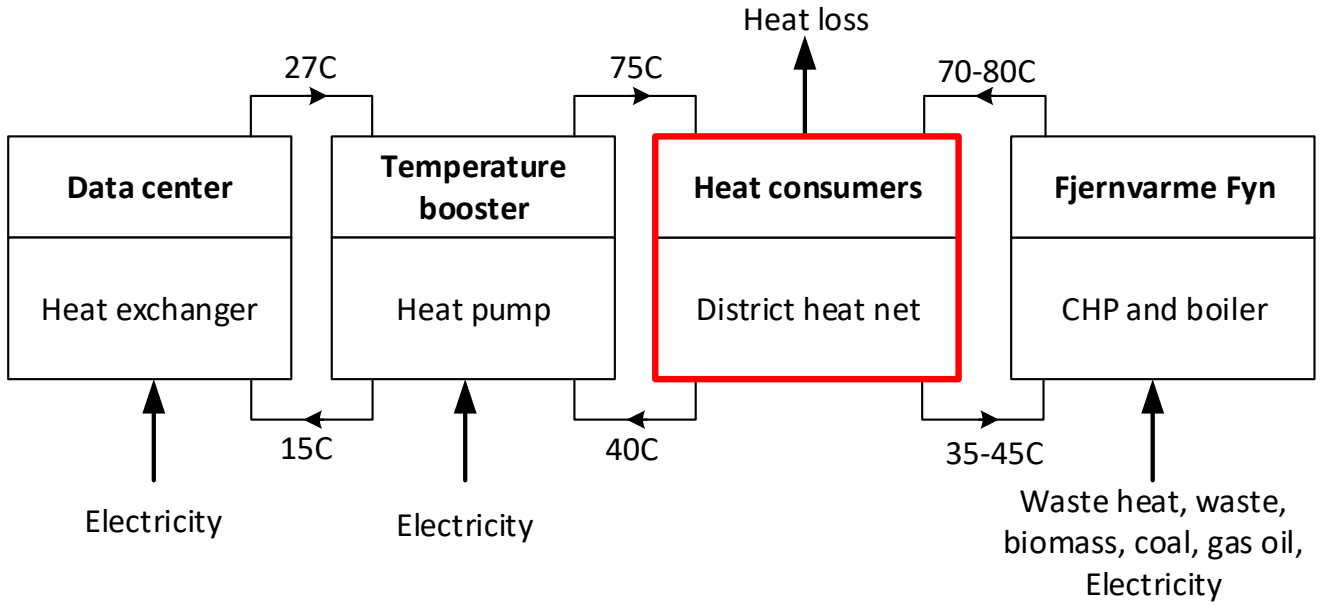
Business model

- Fjernvarme Fyn pay for the total investment of the waste heat recovery system.
- Facebook deliver surplus heat for free – no tax.
- The upgraded heat for district heating must be and is cheaper than existing heat production.
- In case Facebook stop providing surplus heat (for ever), Fjernvarme Fyn can install air energy absorbesr and can continue producing district heating with the heat pump plant. Less economic favourable but still cheaper than existing production from coal and biomass.



Criteria for successful heat recovery from hyper scale data center

1. **Low temperature district heating network and high temperature surplus heat.**
2. **Running cost of existing heat production must be relatively high.**
3. **Simplified regulation – no tax on waste heat.**
4. **Low electricity cost.**
5. **Each party must have a technical/economic backup plan.**

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