



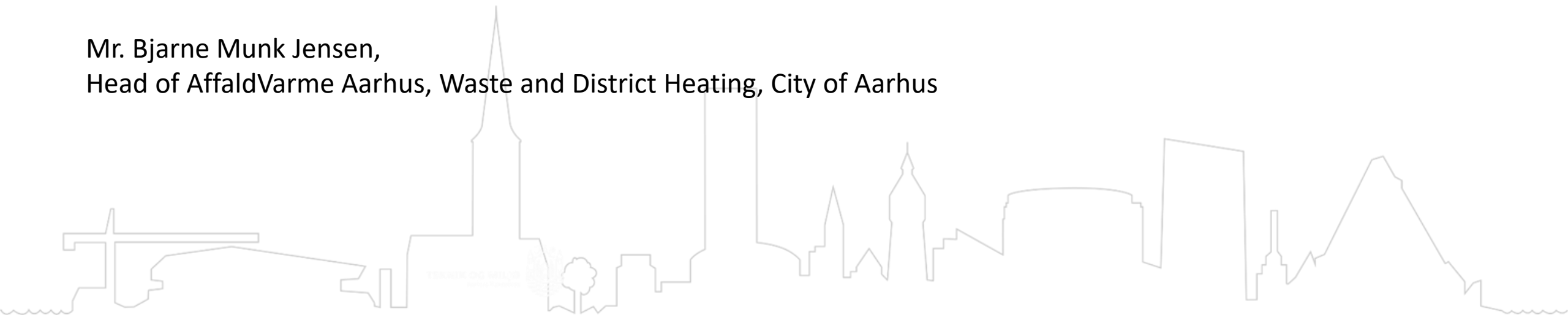
The Aarhus Case

Cutting Carbon Emissions in Half with District Energy



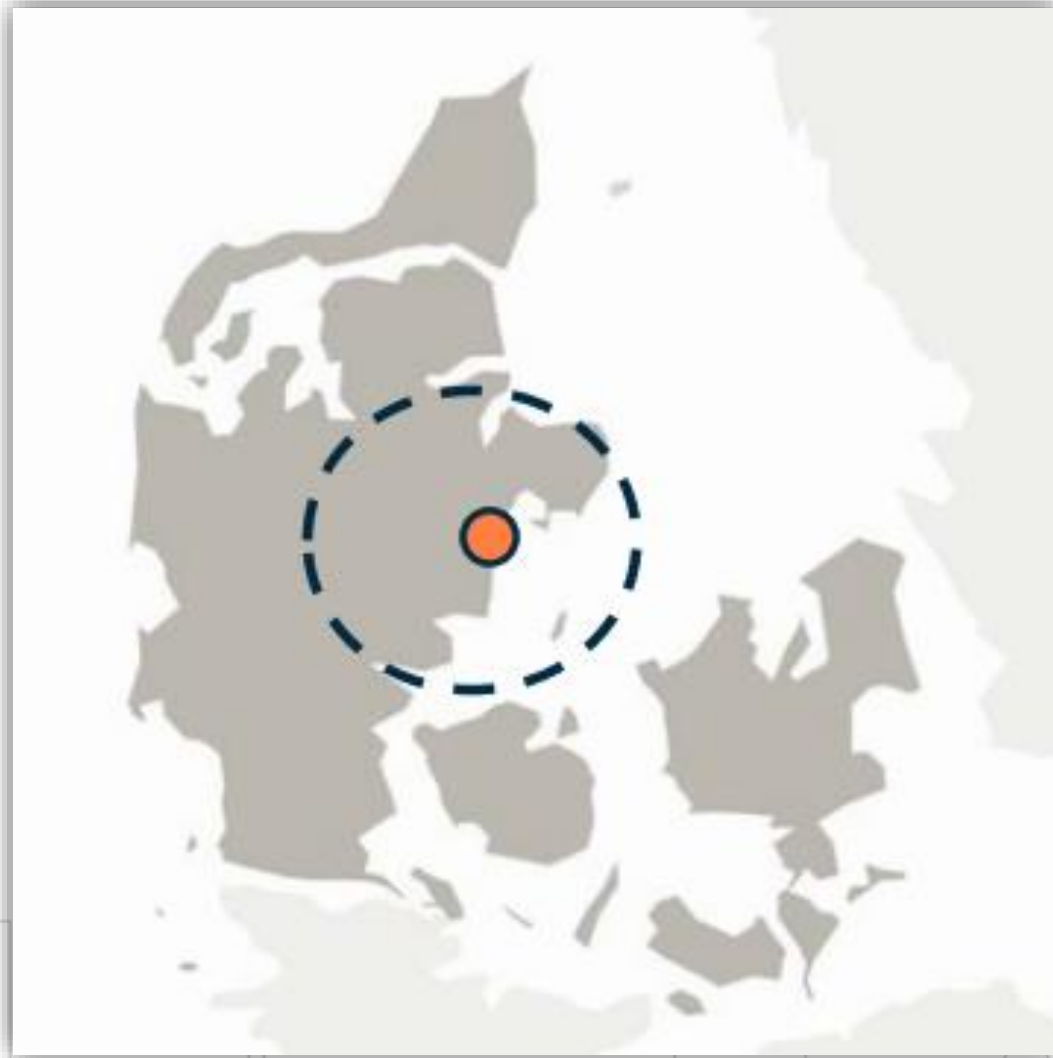
The Role of District Heating in District Energy

Mr. Bjarne Munk Jensen,
Head of AffaldVarme Aarhus, Waste and District Heating, City of Aarhus



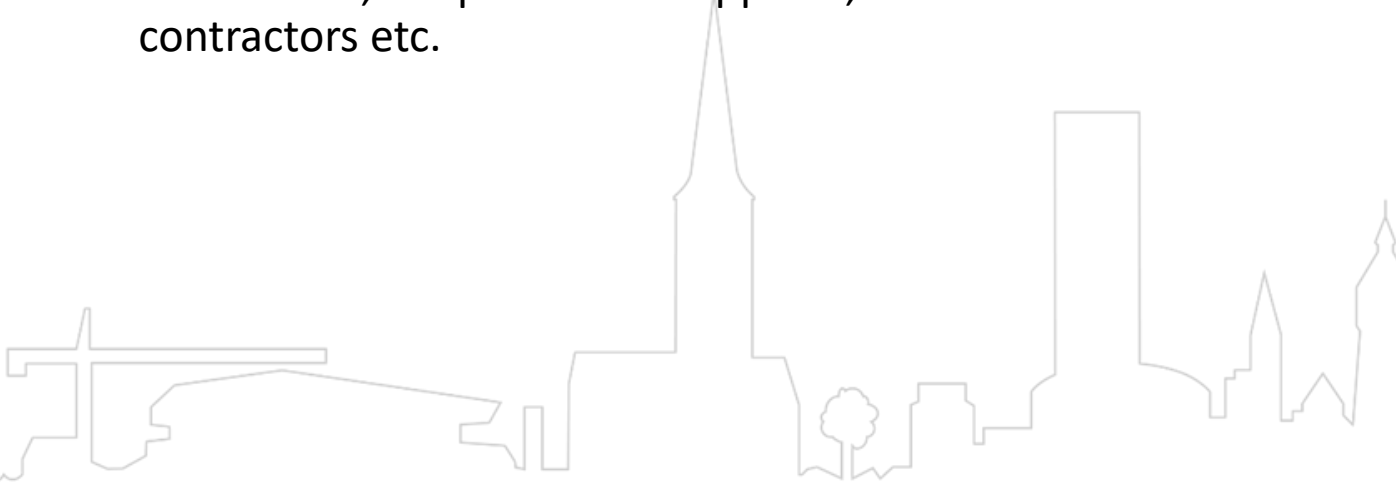
ABOUT AARHUS

- 340,000 inhabitants.
- Fastest growing city in Denmark.
- 1.5% increase in inhabitants per year.



DANISH DISTRICT HEATING

- 430 district heating companies.
- Owned by the consumers or municipalities.
- Non-profit economy.
- 65% of all houses in Denmark are heated by district heating.
- 60,000 km. -> 37.300 miles of district heating pipes.
- Employments in the sector:
 - Direct: 1,700 persons at plants and district heating companies.
 - Indirect: 21,700 persons at suppliers, contractors etc.



DANISH DISTRICT HEATING

- Average single family house.
 - 19 MWh heat consumption per year = 64.83 mmBTU/yr
 - 130 m² ~ 1400 ff².
 - DKK 14,000 per year (EUR 1,900)(USD 2,100) same MWh price for all costumers private and industry.
 - Typically cheaper than individual oil or gas heating.



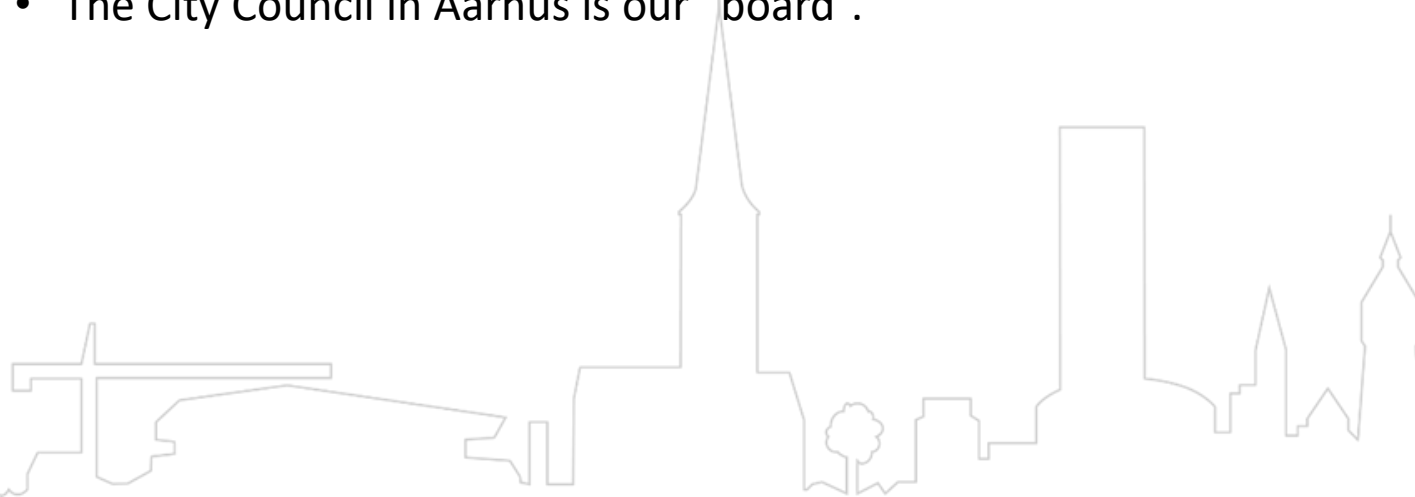
NATIONAL POLITICAL TARGETS

- The national energy agreement from 2012:
 - No heat production from fossil fuels in 2030.
 - All electricity and heat based on renewable energy in 2035.
 - The entire energy supply in DK based on renewable energy in 2050.
- Denmark as a showroom for green technologies and knowhow.
- Apply taxes as means to achieve the climate goals.



ABOUT AffaldVarme Aarhus

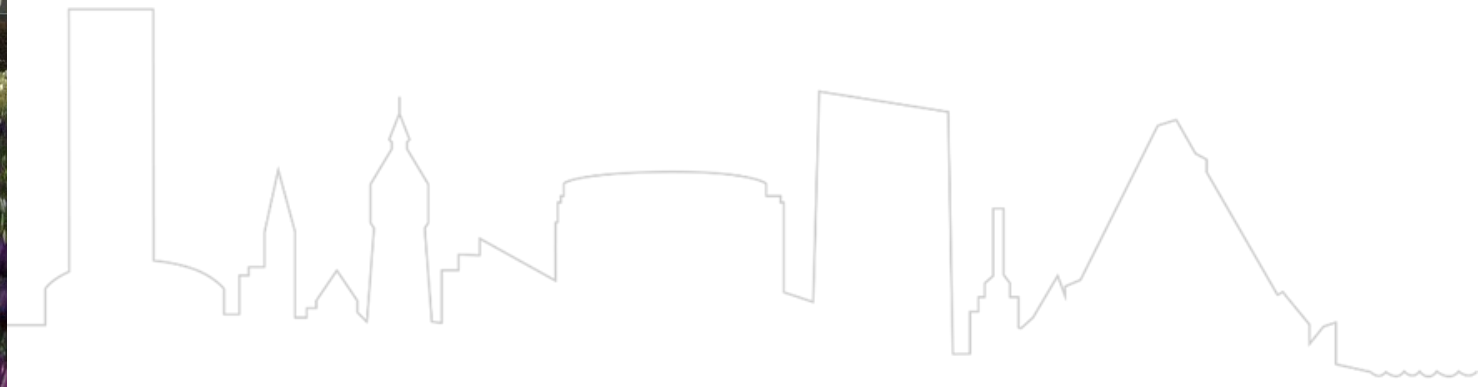
- The waste and district heating department in Aarhus.
- Annual turnover approx. DKK 3.0 billion (USD 450 mill.).
- 400 employees.
- Non-profit company.
- Tariff financed.
- Politically controlled, owned by the City of Aarhus.
- The City Council in Aarhus is our “board”.



LOCAL POLITICAL TERMS

The City Council approves

- Budgets.
- New investments.
- Tariffs.
- Technical terms of district heating (temperature, payment etc.).

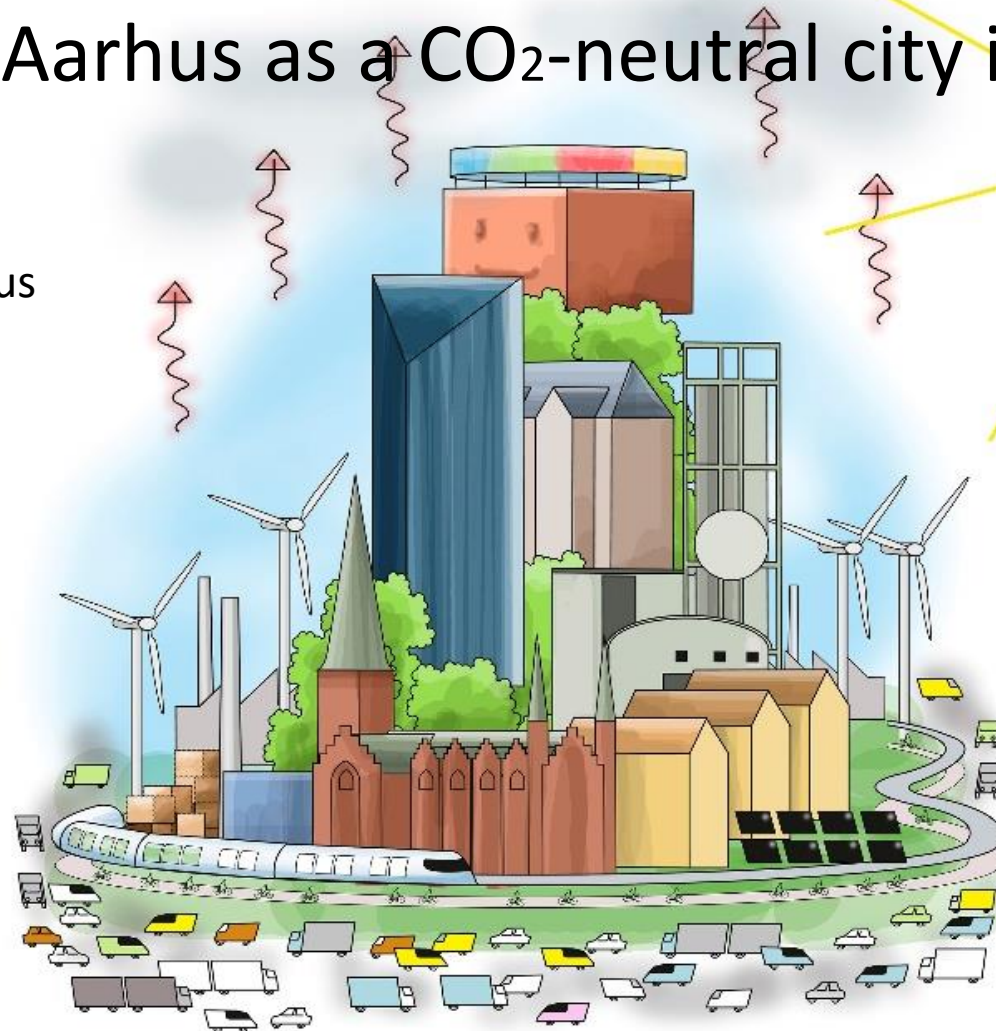


AARHUS TARGETS

In 2009 the City Council signed a declaration of intent:

Aarhus as a CO₂-neutral city in 2030

The beginning of a
green transformation of Aarhus



CLIMATE HEAT PLAN 2010

A strategic plan for development of district heating towards 2030

Focus

- Security of supply.
- Less CO₂.
- Energy efficiency.
- Less fuel (also regarding biomass).
- Sustainable energy.
- Integration with the power market.





CLIMATE PLAN 2016-2020

6 focus areas



Energy



Transportation



Industry



Buildings



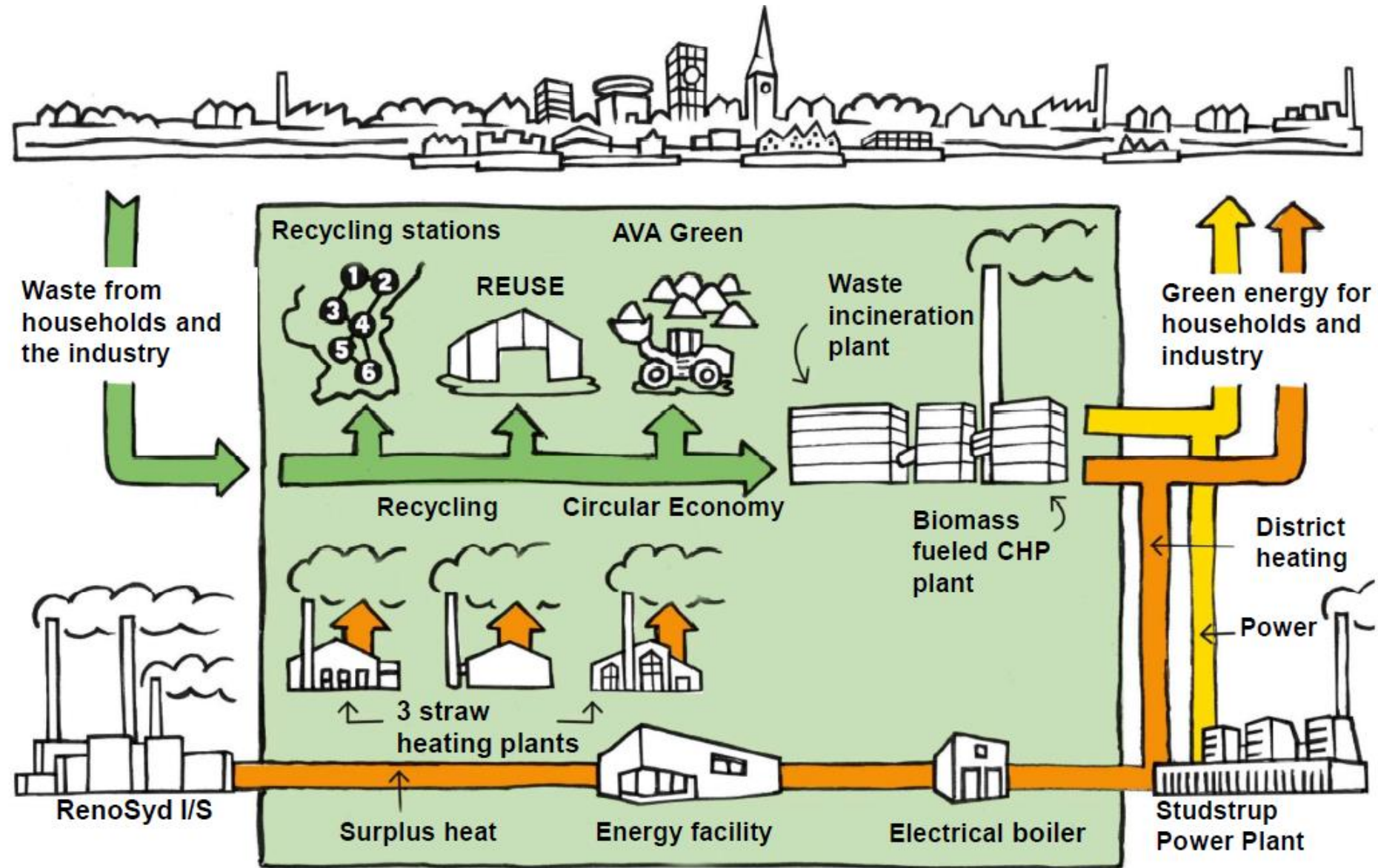
Our workplace



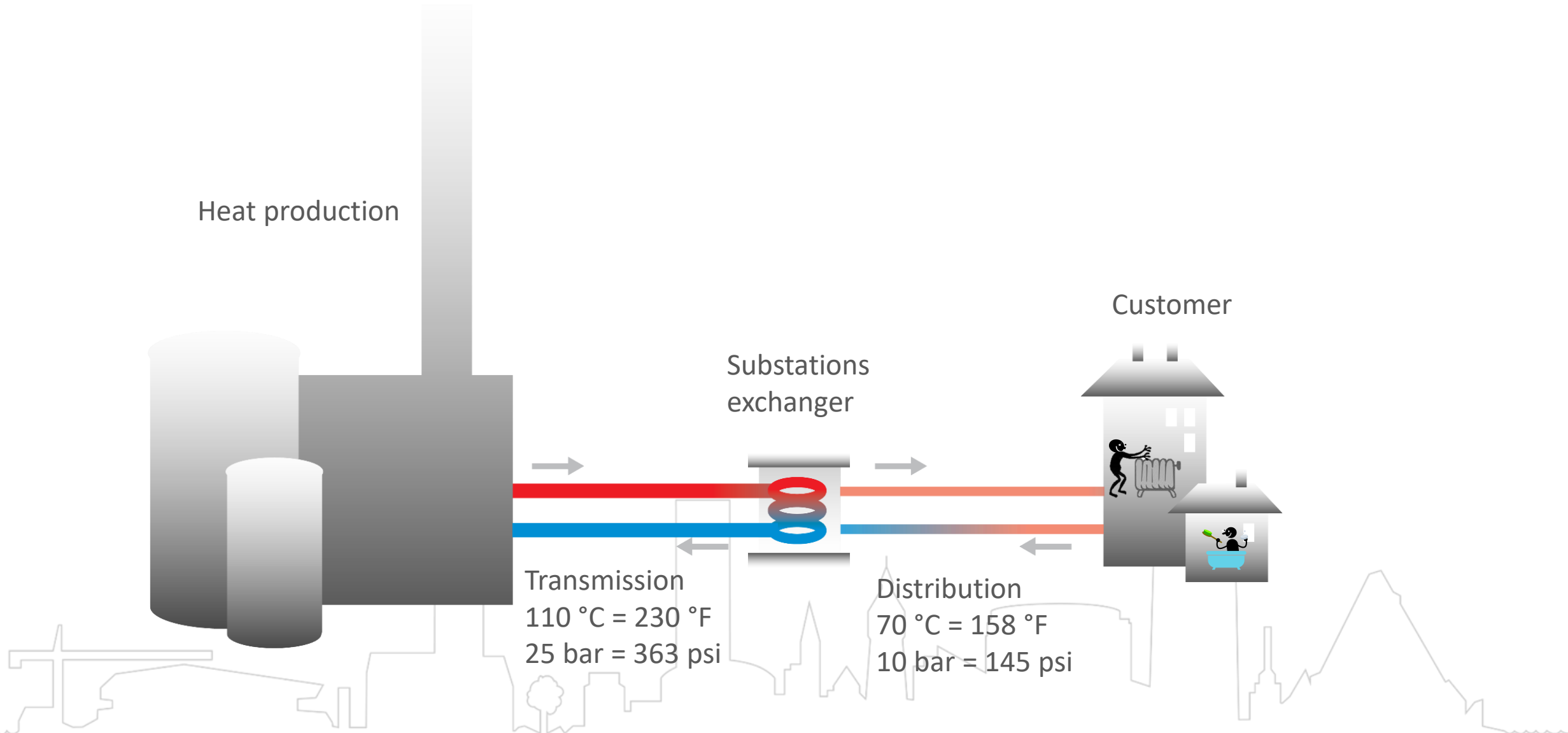
**Local engagement
and growth**



AffaldVarme Aarhus



TWO SEPERATE PIPE SYSTEMS



CO₂ NEUTRAL HEAT SINCE 2017

Supply 3,100 GWh = 10,6 billion BTU heat from 4 main production sites.

50% Wood pellets (CHP).

25% Waste (incineration plants).

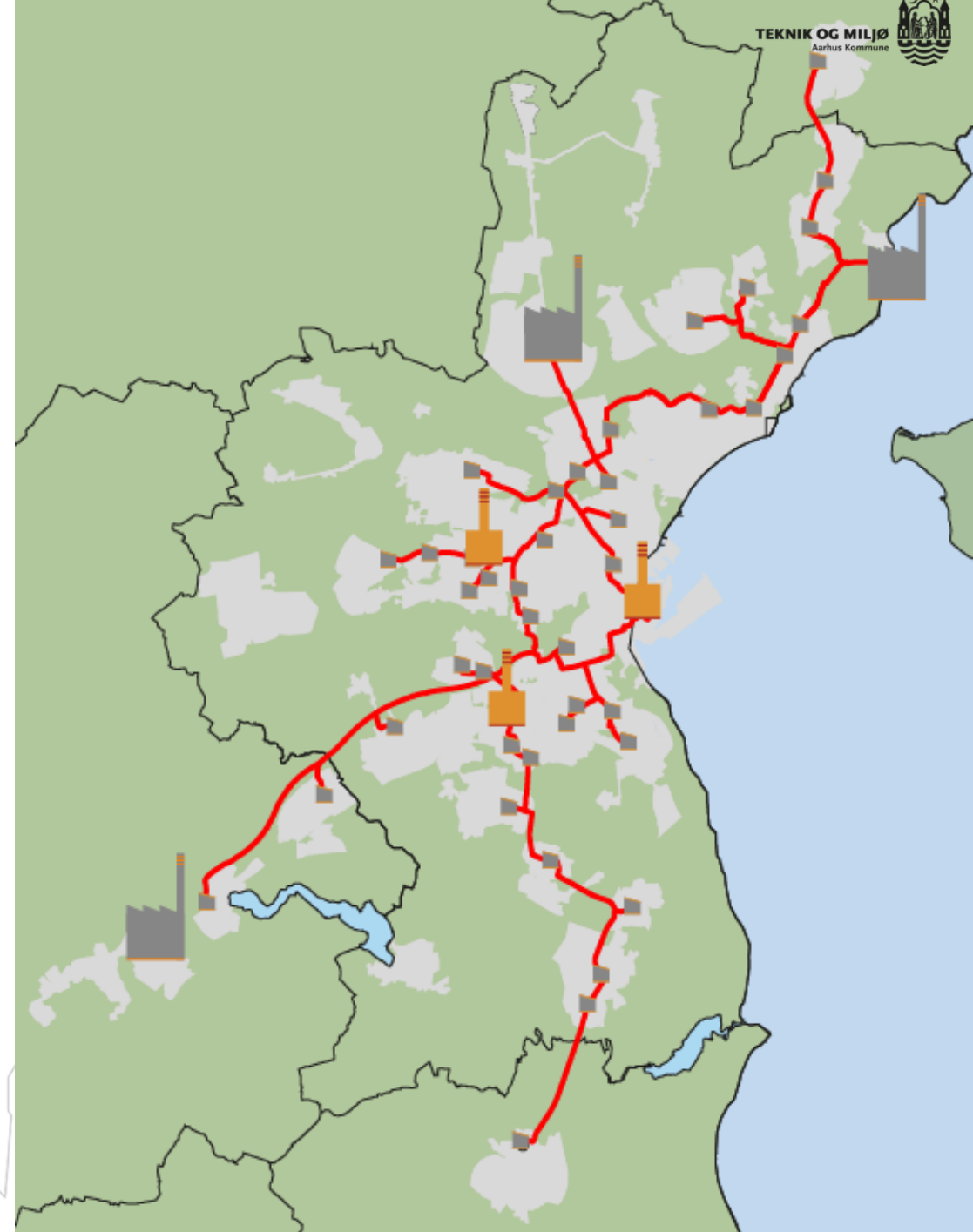
20% Straw (CHP).

3% Surplus heat (heat pumps).

1% Electricity (heated boiler).

<1% Biogas.

<1% Oil.



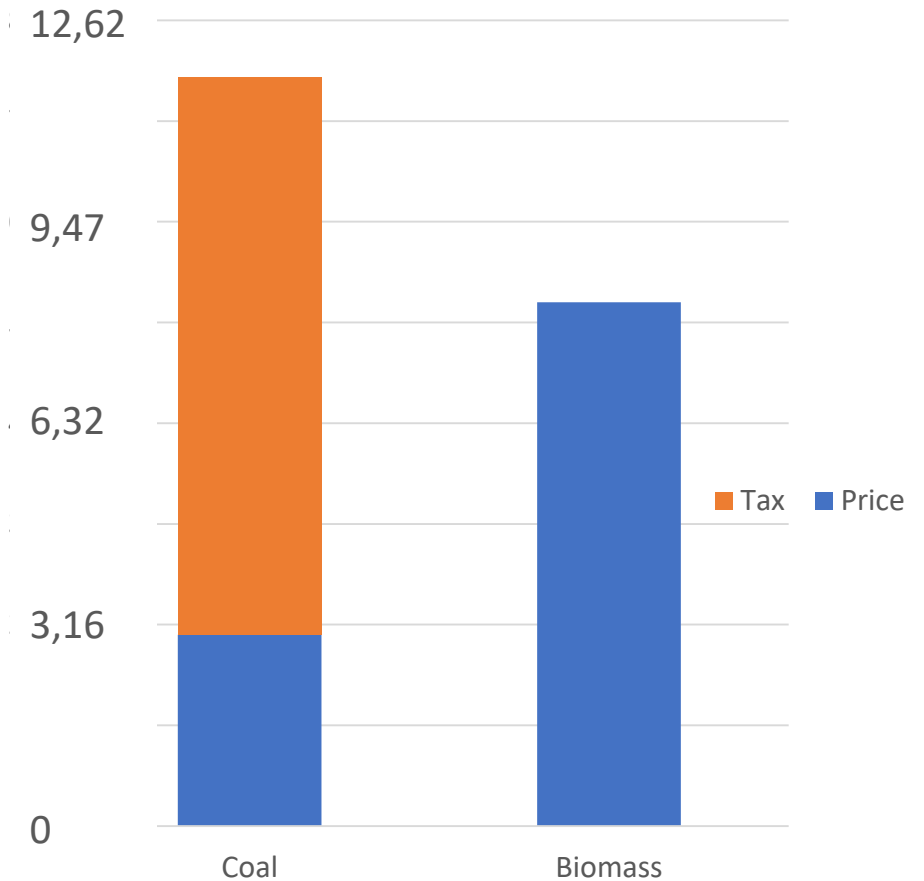
THE ROAD TO CO2 NEUTRALITY

Investment for DKK 1,8 billion (USD 270 mill.)

- Electric heated boiler (80 MW->273 MMBTu).
- The CHP plant converted from coal to wood pellets (540 MW-> 1840 MMBTu).
- New CHP plant on straw and wood chips (80 MW-> 273 MMBTu).
- Heat pump based on sea water (2 + 12 MW->7+41 MMBTu).

Without increasing the price for our customers.

Prices and Taxes USD/MMBTu/hr



GEOTHERMAL ENERGY – NEW PROJECT

Investigate the potential with MAERSK (A.P. Møller Holding).

The concept is at Power-Purchase-Agreement.

A.P. Møller Holding takes the geological risk.

Danish city Aarhus and A.P. Moller Holding plan geothermal district heating project



City view over Aarhus, Denmark (source: flickr/ User:Colin, creative commons)

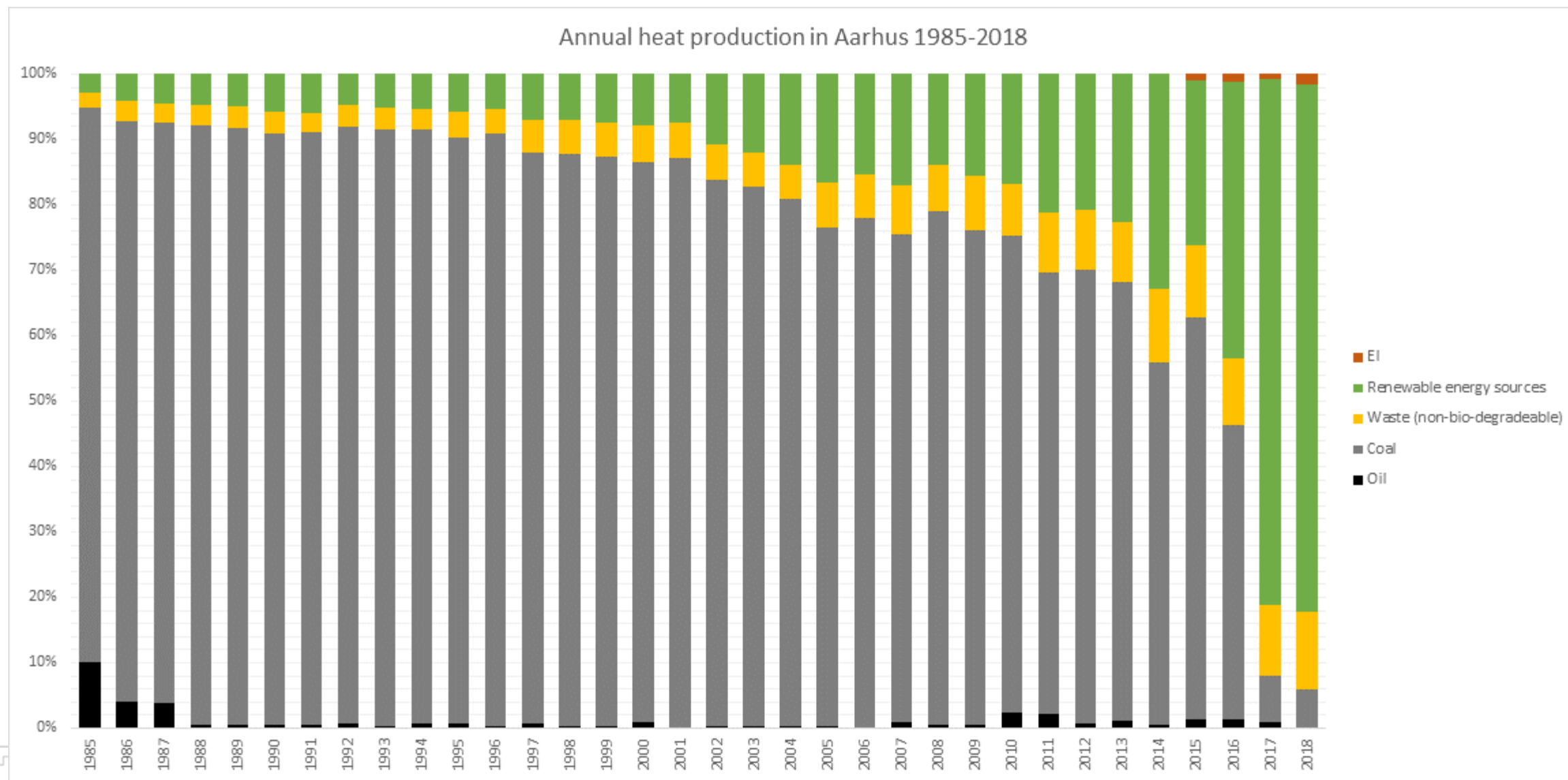


Alexander Richter
23 Oct 2018

The municipality of Aarhus in Denmark and A.P. Moller Holding are preparing for a large-scale geothermal district heating system project in Denmark.



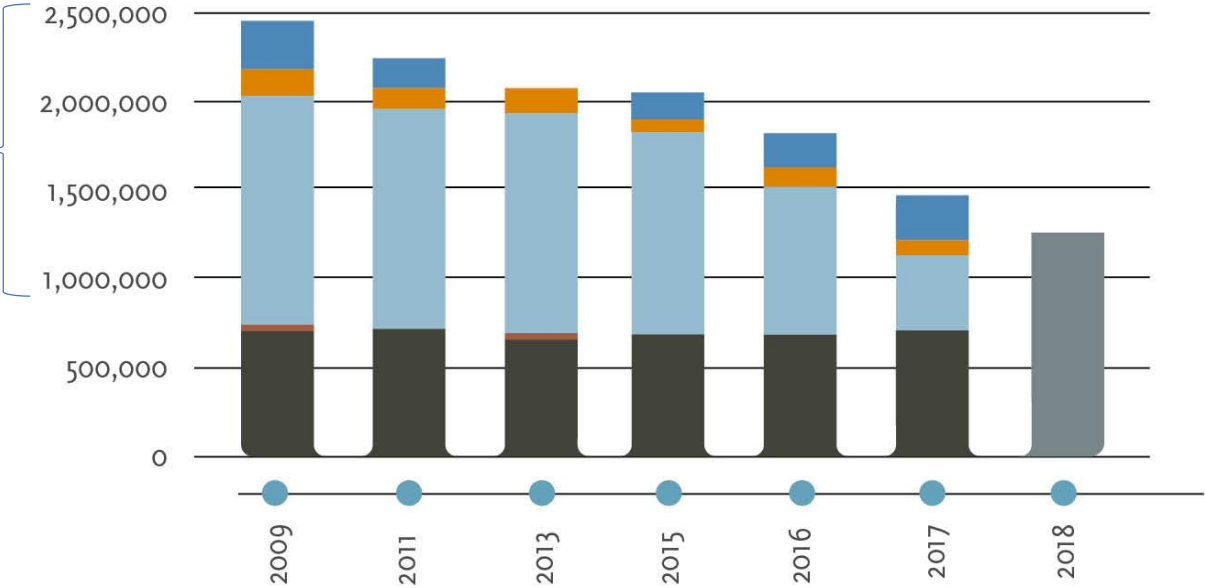
HEAT PRODUCTION IN AARHUS



CUTTING EMISSIONS IN HALF IN JUST 10 YEARS

Municipality emissions, ton CO₂e pr year [Scope 2]

- 50 % CO₂



Power Import



Industry



District Energy



Individual Heating



Mobility

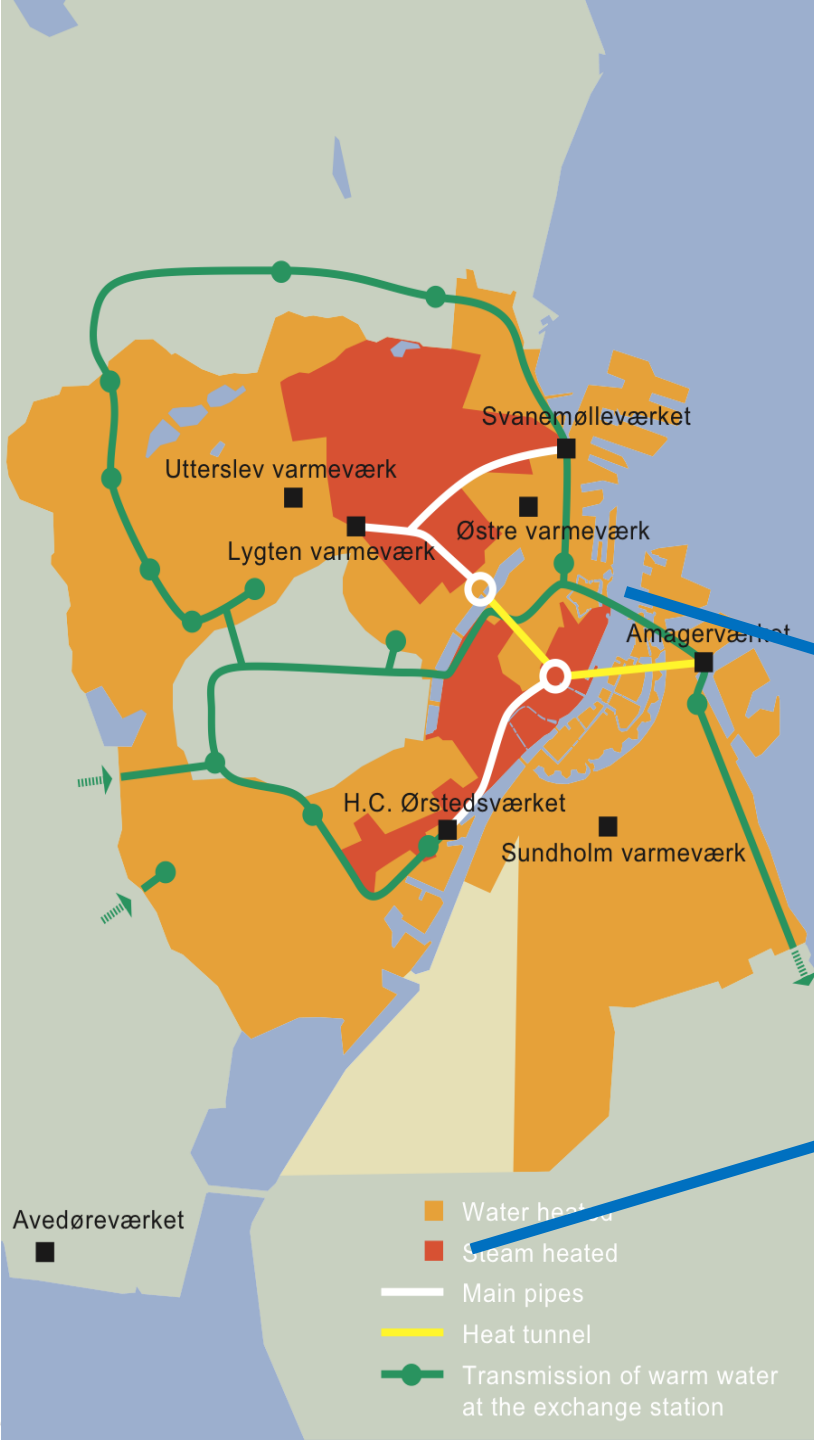


HOFOR. District Heating in Copenhagen

We supply more than 98% of the heat demand in Copenhagen Municipality (i.e. half a million people).

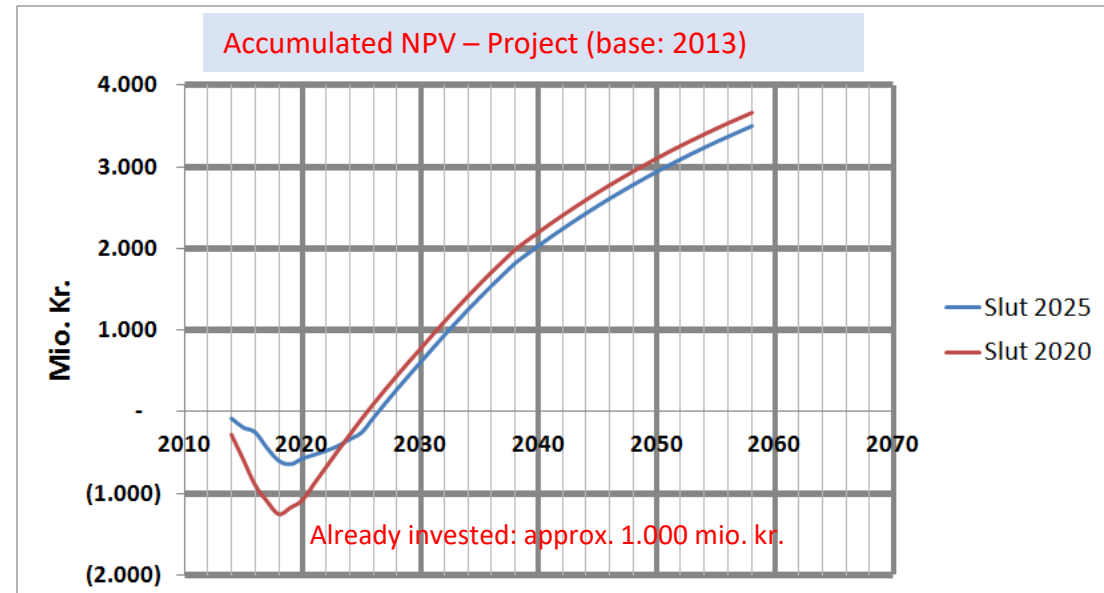
In 2008 we maintained two networks:

- A 1240 km = 770 miles water network supplying 3,700 GWh/year = 12,625,000 mmBTU/yr.
- A 140 km = 86 miles steam network supplying 1,800 GWh/year = 6,140,000 mmBTU/yr.

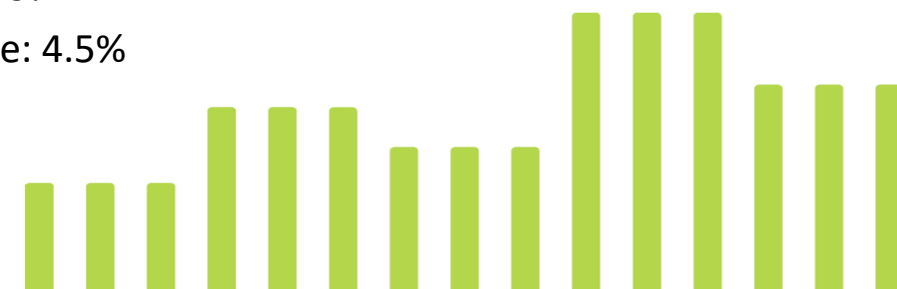


Steam conversion – Why?

- **Underlines HOFOR-Strategy**
 - CO₂-reduction
 - Reliability
 - Customer costs reduction
 - BIO4
- **Business Case very good (NPV)**
 - Accumulated NPV by 2040: approx. DKK 2 billion.
 - Investments (2008-2021): approx. DKK 2.2 billion.
 - Completing by 2021 instead of 2025: plus DKK 200 mill.
 - 4% reduction in heat price for a period of 25 years



- ▶ NPV/INV: Approx. 2 (year: 2040)
- ▶ IRR: approx. 9%
- ▶ Discount rate: 4.5%



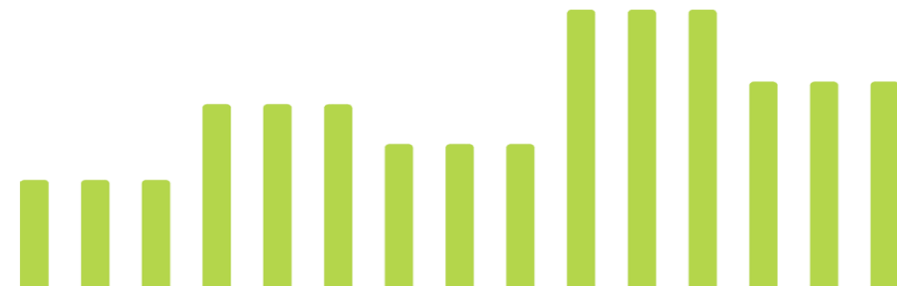
Assumptions – from steam to hot water

- Project period 2009-2021.
- Investments, total: EUR 260 mill = USD 293 mill.
- Distribution heat loss reduced from 16% to 7%.
- O&M reduced from EUR 23.7 m/year to EUR 1.9 m/year = USD 8.14 ft/year to USD 0.65 ft/year.

Steam/Condensate (140 km = 87 mile): EUR 3.3 mill./year = USD 3.7 mill./year.

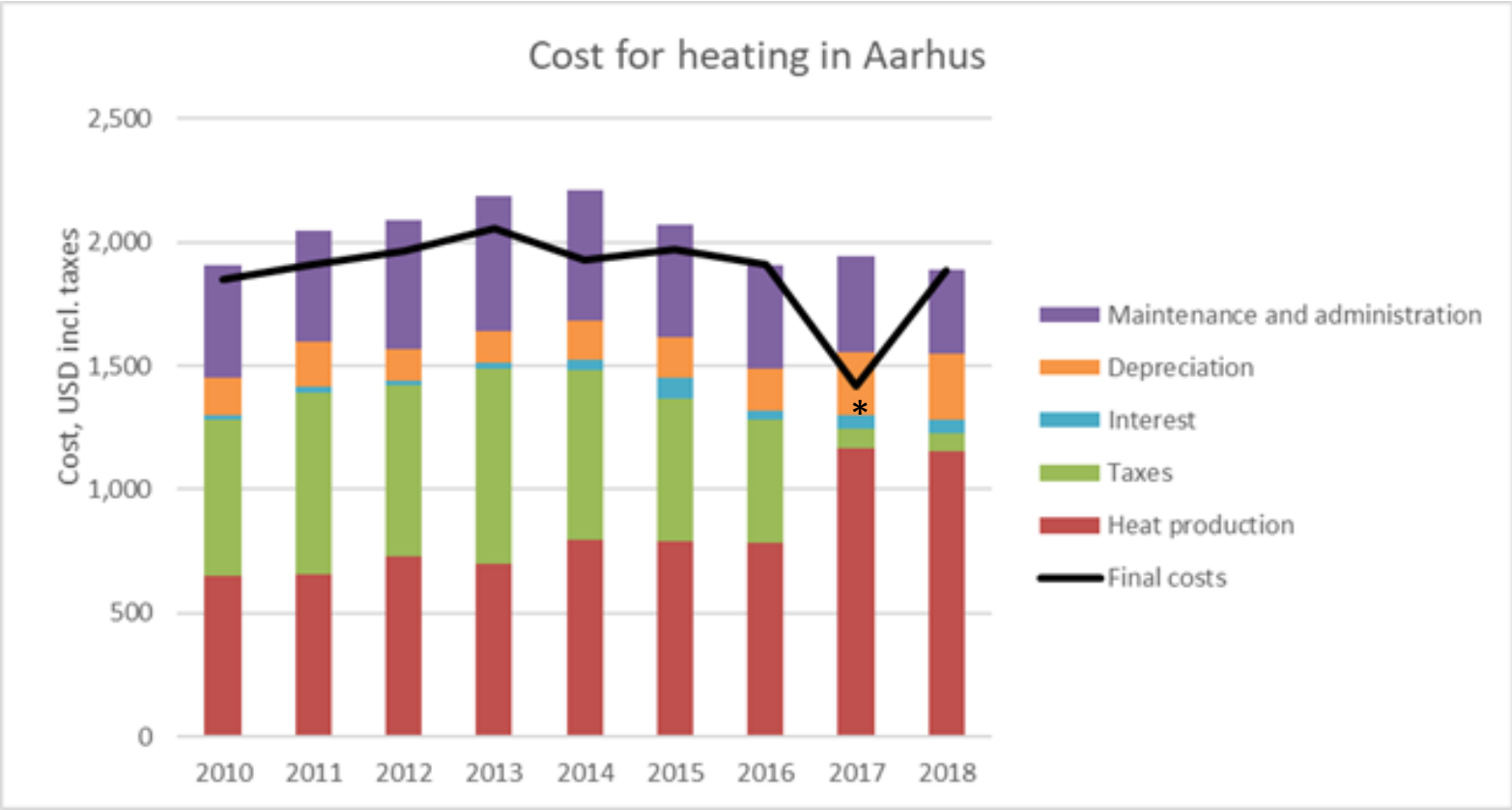
Hot water (96 km = 60 mile): EUR 0.2 mill./year = USD 0.23 mill./year.

- DH purchase: DH water expected to be produced approx. EUR 1.75 GJ = USD 2.08 mmBTU cheaper than steam.
- Reduced water losses.



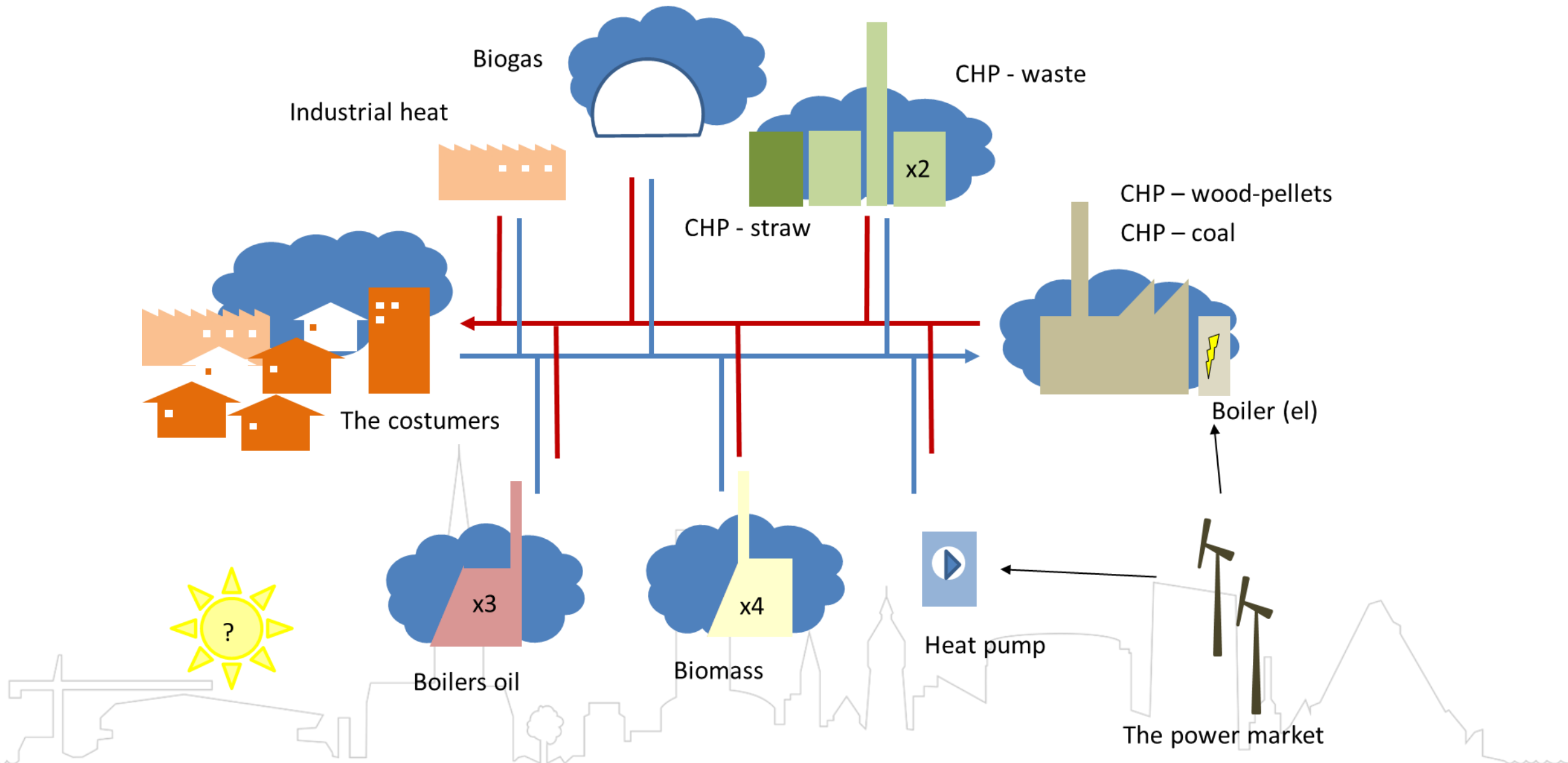
COST FOR HEATING IN AARHUS

Cost for heating for an average single-family house in Aarhus. Typical cost for heating is 3-7% of available income.



*Special circumstances due to historical taxes and VAT.

FROM SIMPLE TO COMPLEX





DISTRICT HEATING WITH VARMEPLAN AARHUS

The historical background

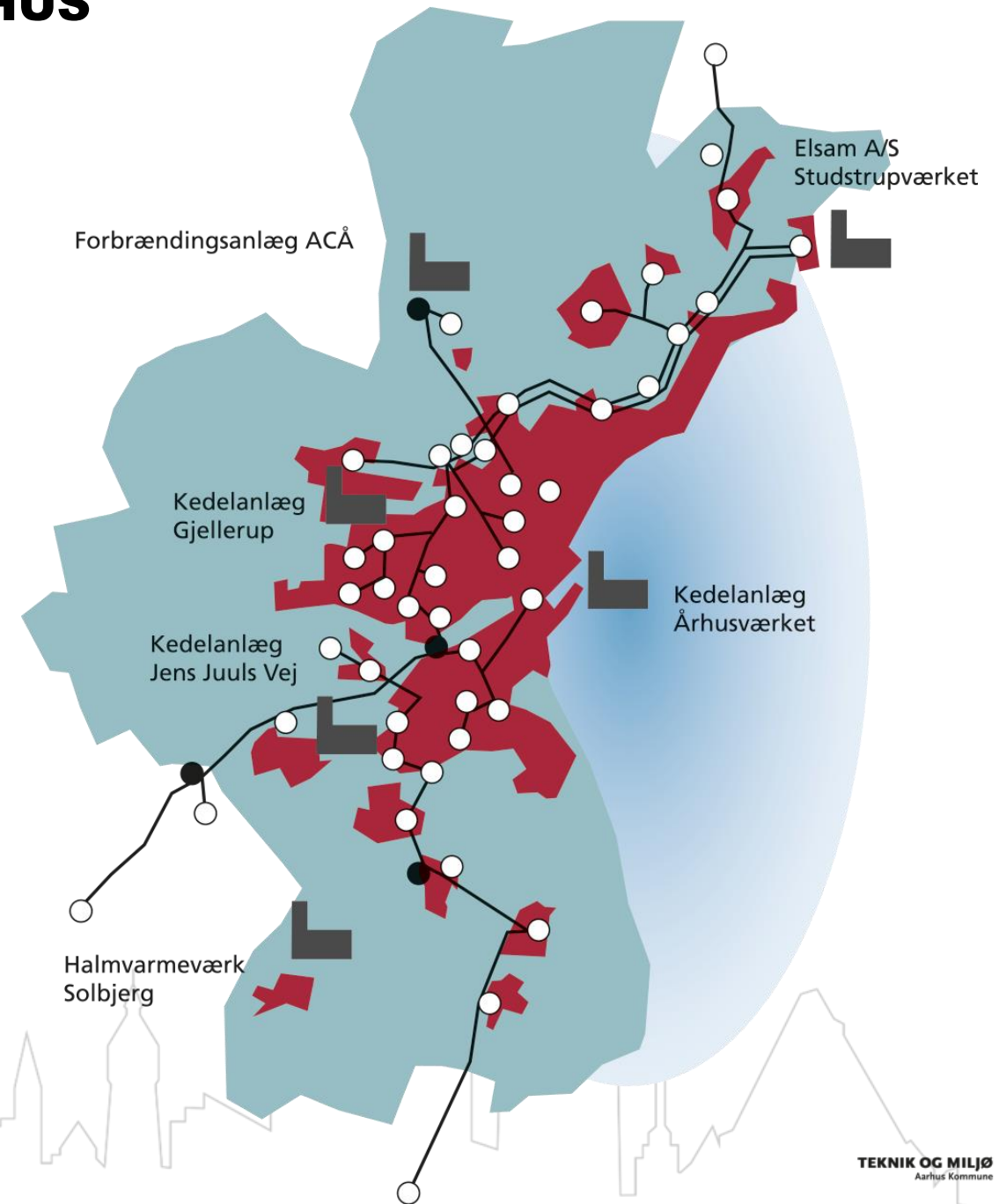
- 1968: Studstrup Power Plant – a new coal-fired and oil-fired power plant.
- 1973: Energy crisis.
- Idea of using waste heat from energy production to district heating.
- 1995: A new energy policy - 90 percent of district heating in the Aarhus area must be combined heat and power.



DISTRICT HEATING WITH VARMEPLAN AARHUS

The historical background

- The co-operation in Varmeplan Aarhus is established.
- 16 independent district heating plants and the municipality of Aarhus agree to buy heat from Studstrup Power Plant.
- 1985: A new transmission network connect the heat supply together.
- District heating companies distribute district heating.
- Advantageous from an economic point of view.
- High security of supply.





NEW COMPLEX WORLD

“Yesterday” the planning was “simple” .

The cheapest plant are also the most CO₂-neutral

The planning today is complex.

The heat prices will vary from hour to hour depending on the weather (wind and sun).

Integration with electricity, buildings, transport etc.

Data is important!





Foto Kollision



Thank you for your attention
