

# Visit Japanese delegation

September 2014

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Vice-Director

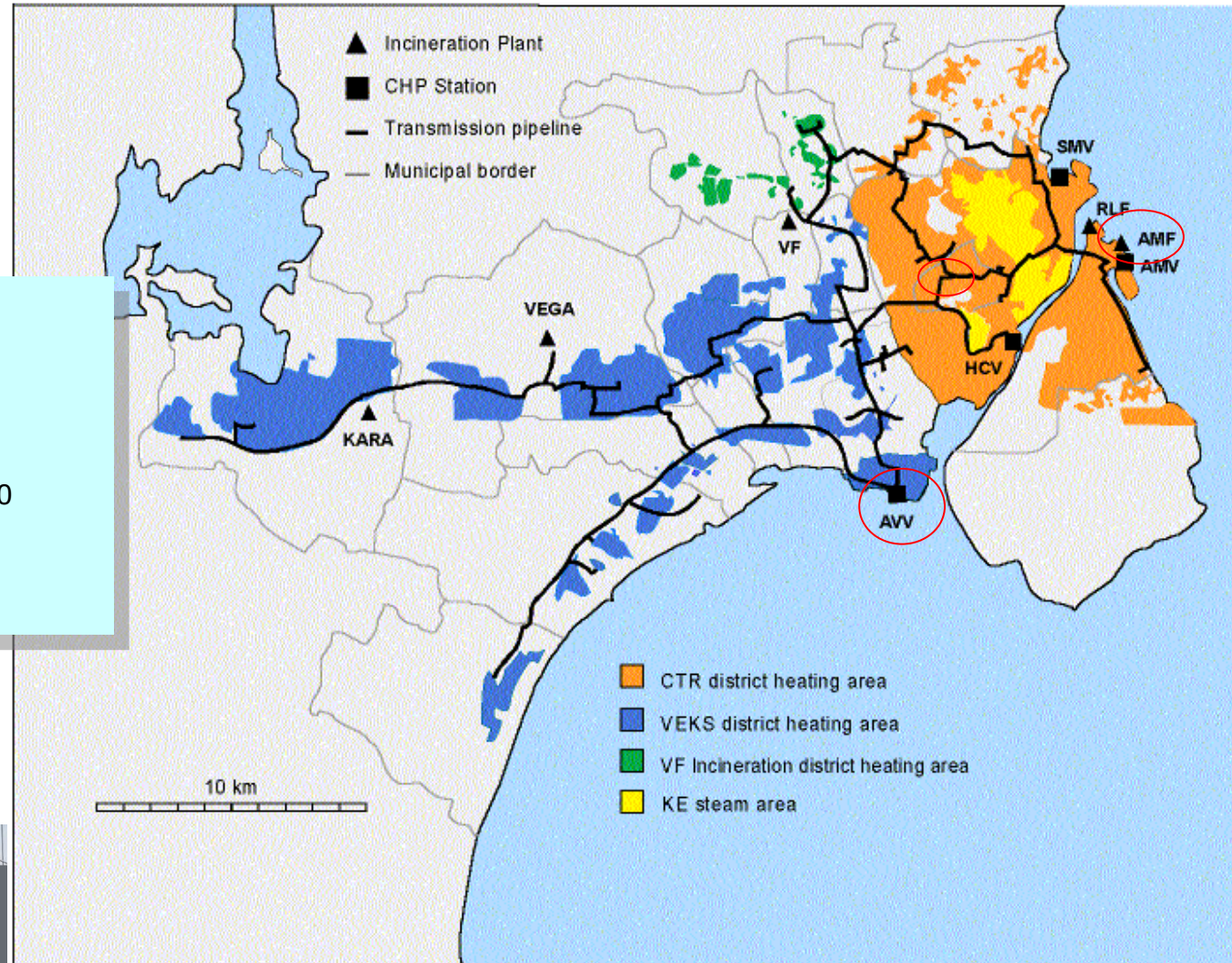


# District Heating in Greater Copenhagen



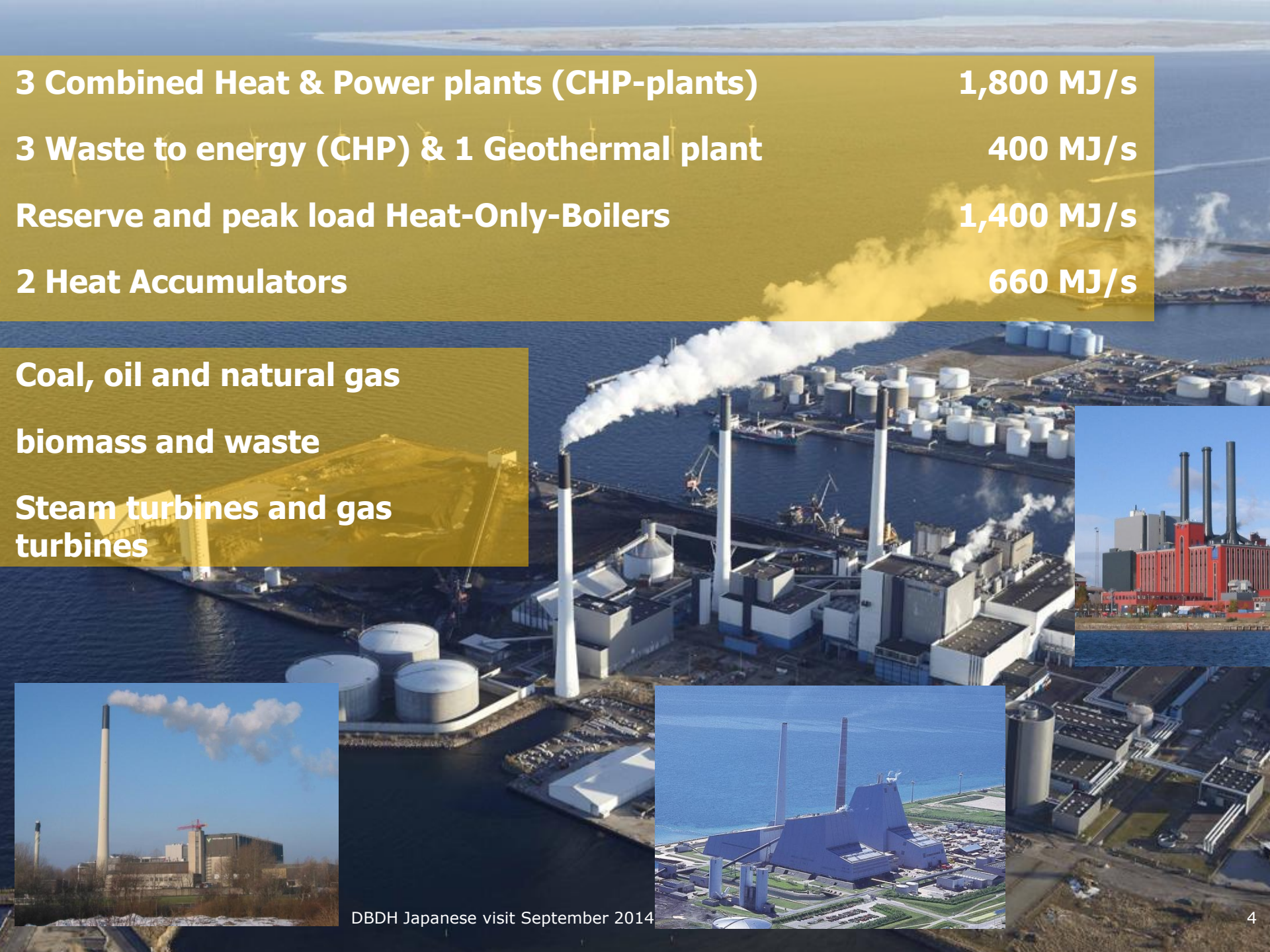
# The Greater Copenhagen DH system

18 municipalities  
4 integrated DH systems  
25 DH companies  
500,000 end – users  
34,500 TJ (9,600 GWh, 32,700 GBtu)  
Approx 20 % heat demand in Denmark



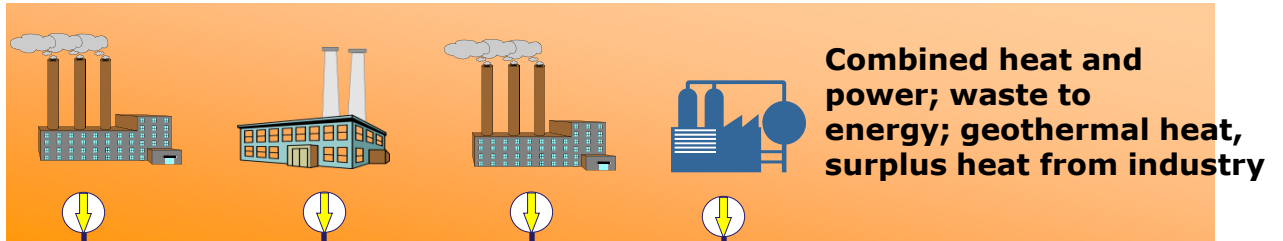
<b>3 Combined Heat &amp; Power plants (CHP-plants)</b>	<b>1,800 MJ/s</b>
<b>3 Waste to energy (CHP) &amp; 1 Geothermal plant</b>	<b>400 MJ/s</b>
<b>Reserve and peak load Heat-Only-Boilers</b>	<b>1,400 MJ/s</b>
<b>2 Heat Accumulators</b>	<b>660 MJ/s</b>

**Coal, oil and natural gas  
biomass and waste  
Steam turbines and gas  
turbines**

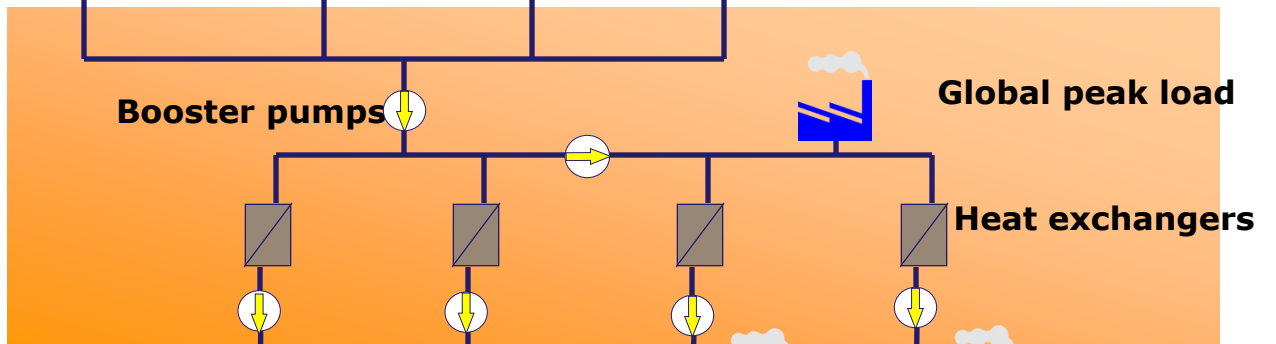


# Design Concept

Base load production

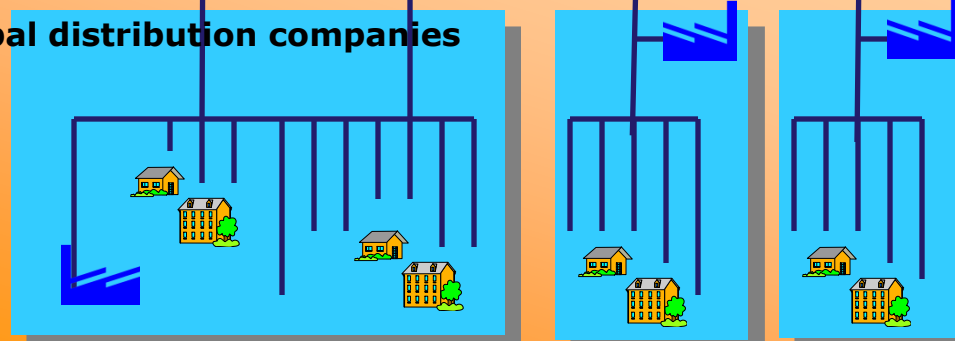


Transmission system



Distribution system

Municipal distribution companies

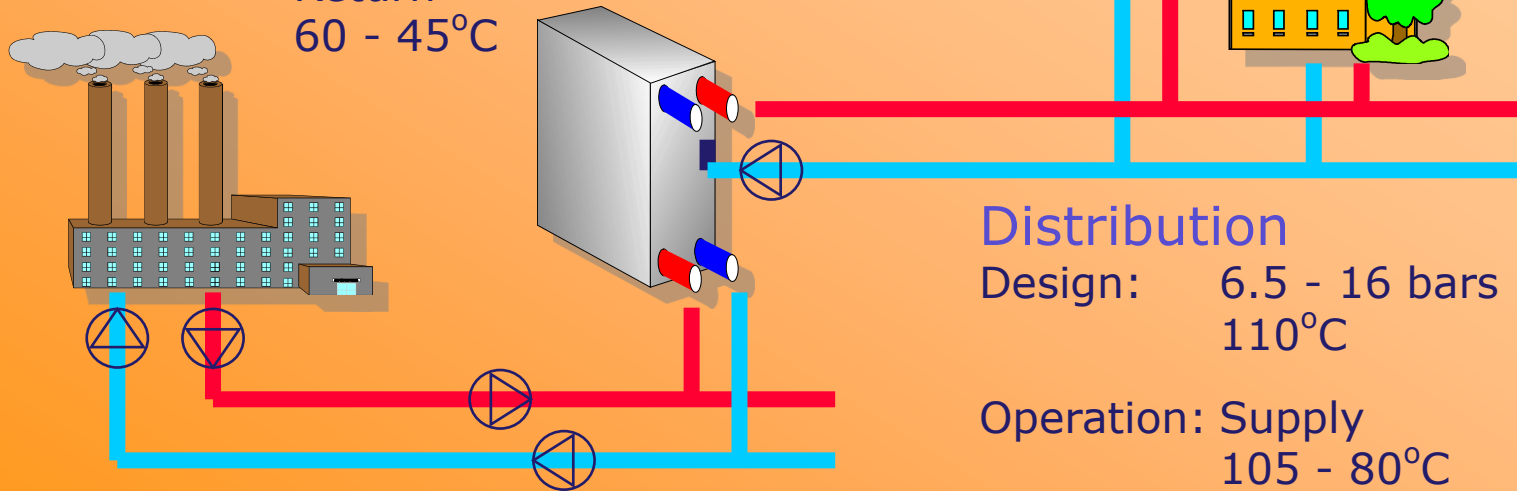


# Design Concept

## Transmission

Design: 25 bars  
120°C

Operation: Supply  
115 - 95°C  
Return  
60 - 45°C



## Distribution

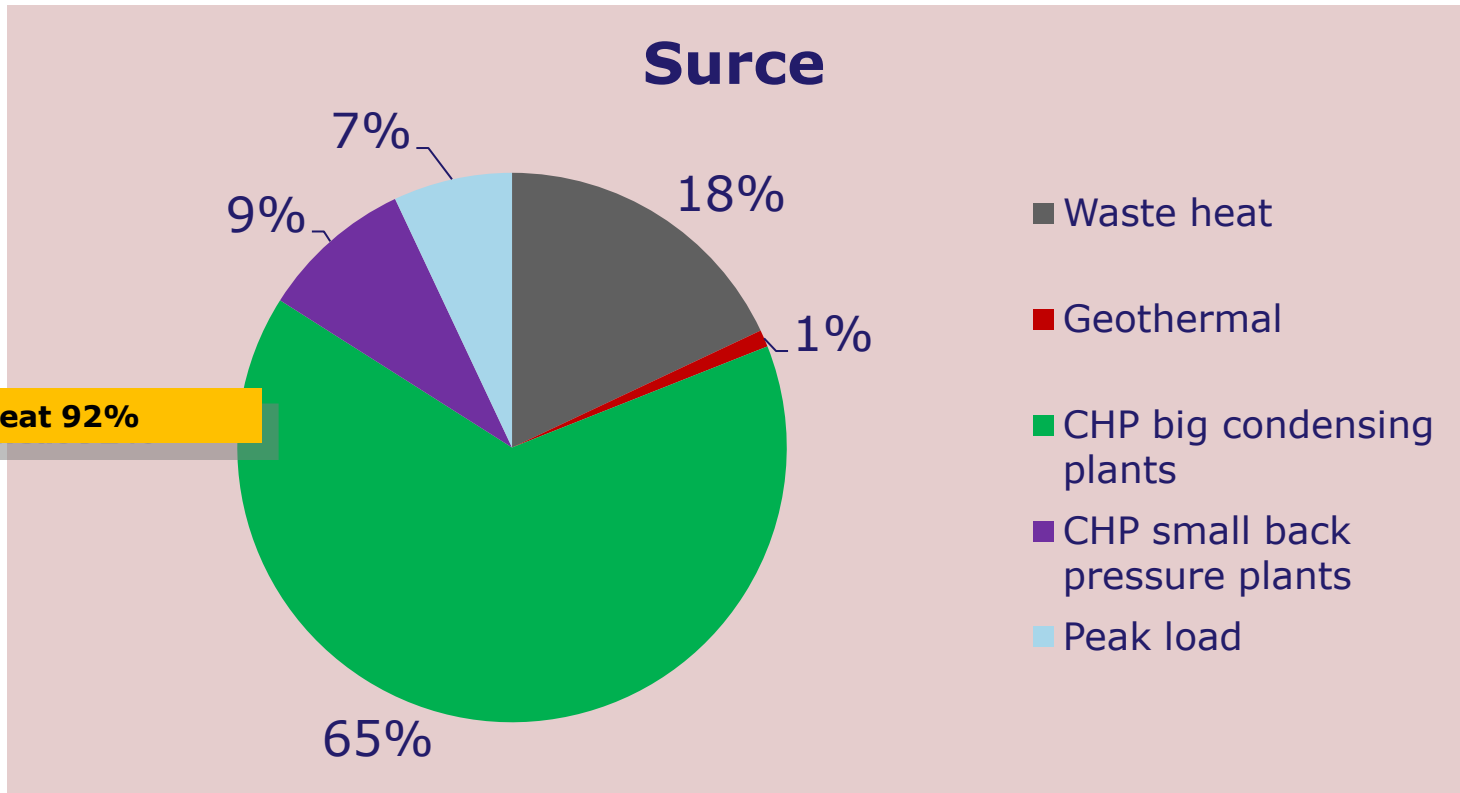
Design: 6.5 - 16 bars  
110°C

Operation: Supply  
105 - 80°C  
Return  
50 - 40°C

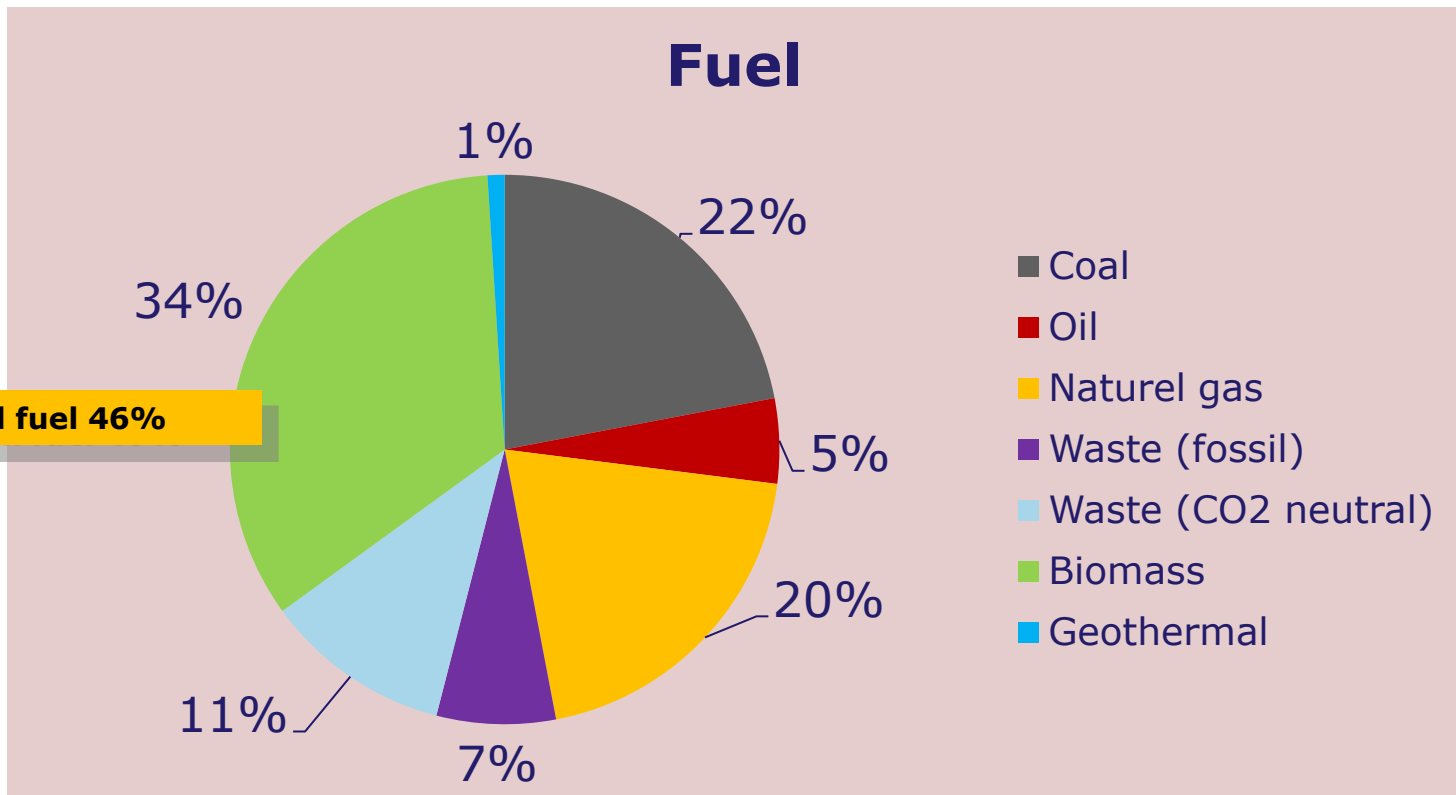
Variable flow and temperature control  
Symmetric pressure

Variable flow and temperature control

# Heat Production 2013

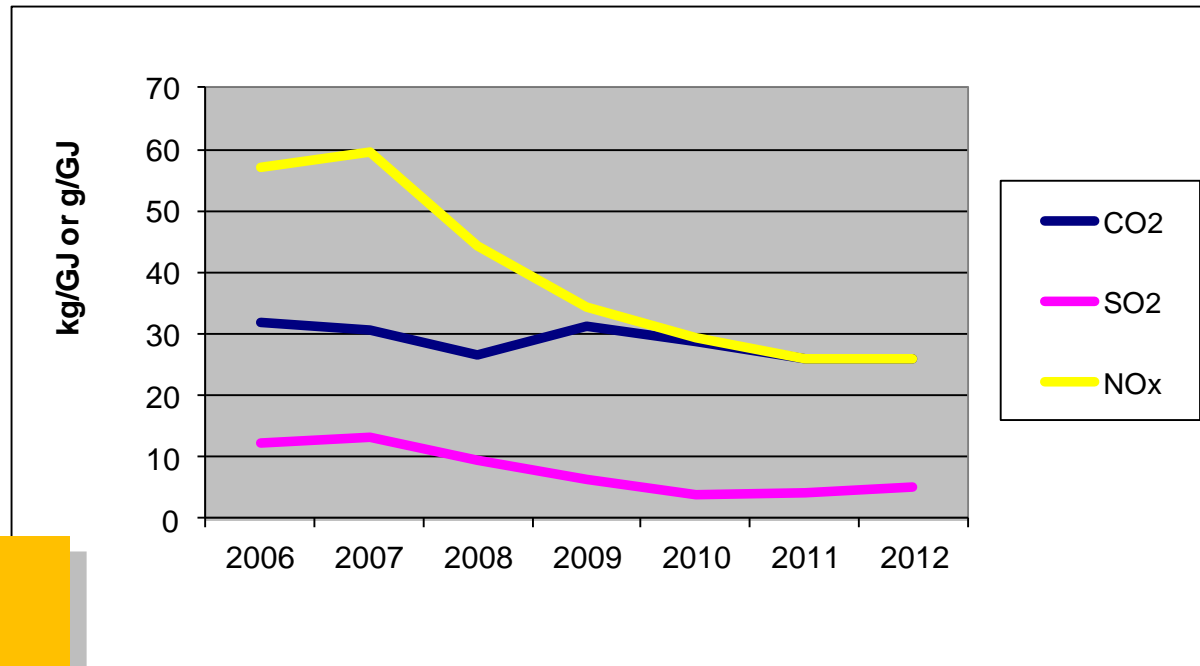


# Fuel consumption 2013





# Emissions CTR



## Yearly reduction

CO <sub>2</sub>	-3,0 %
SO <sub>2</sub>	- 9,8 %
NO <sub>x</sub>	- 9,1 %

**Strategy to be fossil free in 2025**

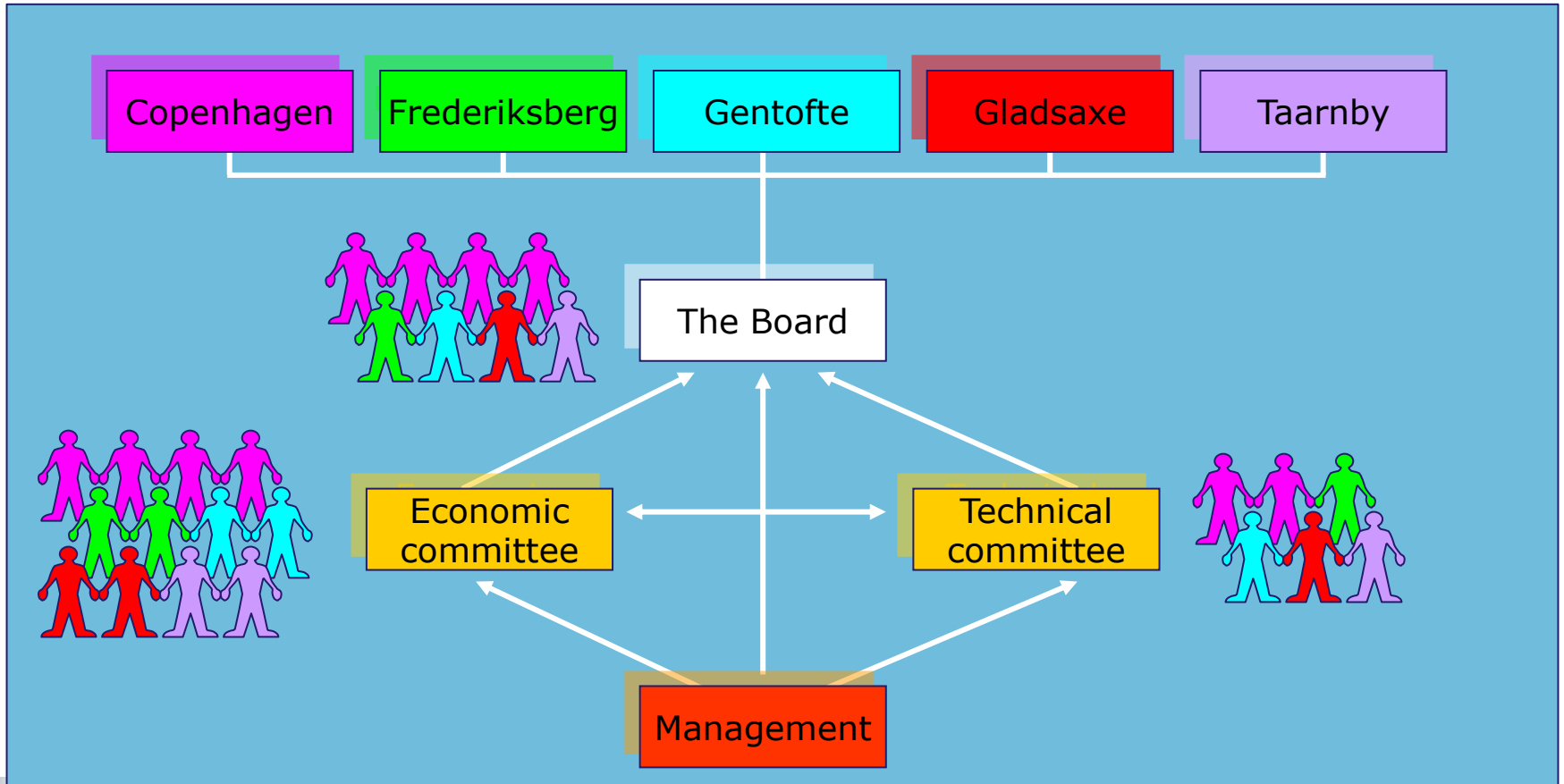


# The Company CTR I/S

- **Joint municipal partnership (five municipalities)**
- **Heat sold to partners district heating companies and heat exchanged with neighbour companies to cost prizes**
- **Establish and own district heating mains, pumps and heat exchanger stations plus heat only boiler stations for reserve and peak situations**
- **Share owner of a geothermal heat plant**
- **By heat from local CHP and waste to heat plant**
- **Responsible for the overall security of supply**
- **Assets financed through external loans and municipal guaranties**
- **Operates a 24/7 control rum**



# Organisational Structure



# Promotion and Subvention of DH in Denmark




# Legal Framework of District Heating

- No thermal power plants but CHP.
- Heat Supply Act sets frame for local decisions.
- Municipalities have traditionally had the authority.
- All DH companies are **non-profit** entities.
- Prices = Sum of true costs (no local subsidies).
- DH company forwards the heating bills directly to the consumers – not via local government.
- All consumers can complain about irregularities or misuse of tariffs and prices to an independent state regulatory authority.
- All DH companies must report on prices, budgets and delivery conditions to this authority.



# Statutory powers of the sector Government

- Implement energy strategy
- Implement laws
- Decide taxies (incentives)
- Decide grant and subsidies (incentives)
- Regulate the sector through the Energy Agency, Directives and guidelines
  - Directive regarding fuel and type of production
- Control the sector through the
  - Energy Regulatory Authority, Tariffs and prices
  - Competition Authority, market and monopoly



[www.energistyrelsen.dk](http://www.energistyrelsen.dk)  
[www.energitilsynet.dk](http://www.energitilsynet.dk)  
[www.konkurrencestyrelsen.dk](http://www.konkurrencestyrelsen.dk)

# Statutory powers of the sector Municipality

- Municipalities have statutory power
  - Heat planning in municipality
  - Approve all energy projects
  - Responsible for demarcation between DH and natural gas supply
  - Decide forced connection of end users
- Municipalities responsible for establishing DH companies



# District Heating companies

- DH companies have no statutory power
- Support the municipality in energy planning matters (technical experience)
- Support municipality defining environmental policy
- Responsible for development, operation and maintenance of DH-system
- Responsible for budgeting and pricing strategy within the framework of the Heat Supply Act
- Responsible for financing of projects





# Financing

- Due to the regulatory setup DH companies can get municipal security for loans
- Companies attains a very high international financial rating
  - No problem to get loans for financing
  - Long return (eg. 25 years)
  - Low rate of interests
- In Denmark special bank for municipal loans
  - Very low rate of interest
- Only loan for investment, not for operation



# Subvention of DH in Denmark

- **Very high energy taxes on fossil fuel**
  - Indirect subvention of CHP (200% efficiency)
- **No energy tax on biomass**
  - Security of supply tax was planned but dropped again
- **Direct subvention of power produced on biomass**



# Pricing and tariffs



# Consumer payment for heat – 1

## Cost

- **DH is by law a non profit monopoly business**
  - Only real cost can be covered by the heat payment
- Fixed cost not depending on heat consumption
  - Depreciation of investments
  - Administration
  - Fixed maintenance cost
- Variable cost depending on the heat consumption
  - Heat and energy (procurement or production)
  - Power
  - Taxes
  - Variable maintenance cost



## Consumer payment for heat - 2 Tariffs

- DH company decides split between fixed and variable element in the consumer tariff
  - High share on the variable part gives incentives for energy savings, but problems with the budget
  - Fixed element can be based on m<sup>2</sup> heated area, installed heating capacity (kW) or recorded max load (kW)
- Calibrated energy meters for variable (m<sup>3</sup> or kWh)
- The consumer can be a building complex
  - The building owner is responsible for the distribution of the heating cost on all the tenants

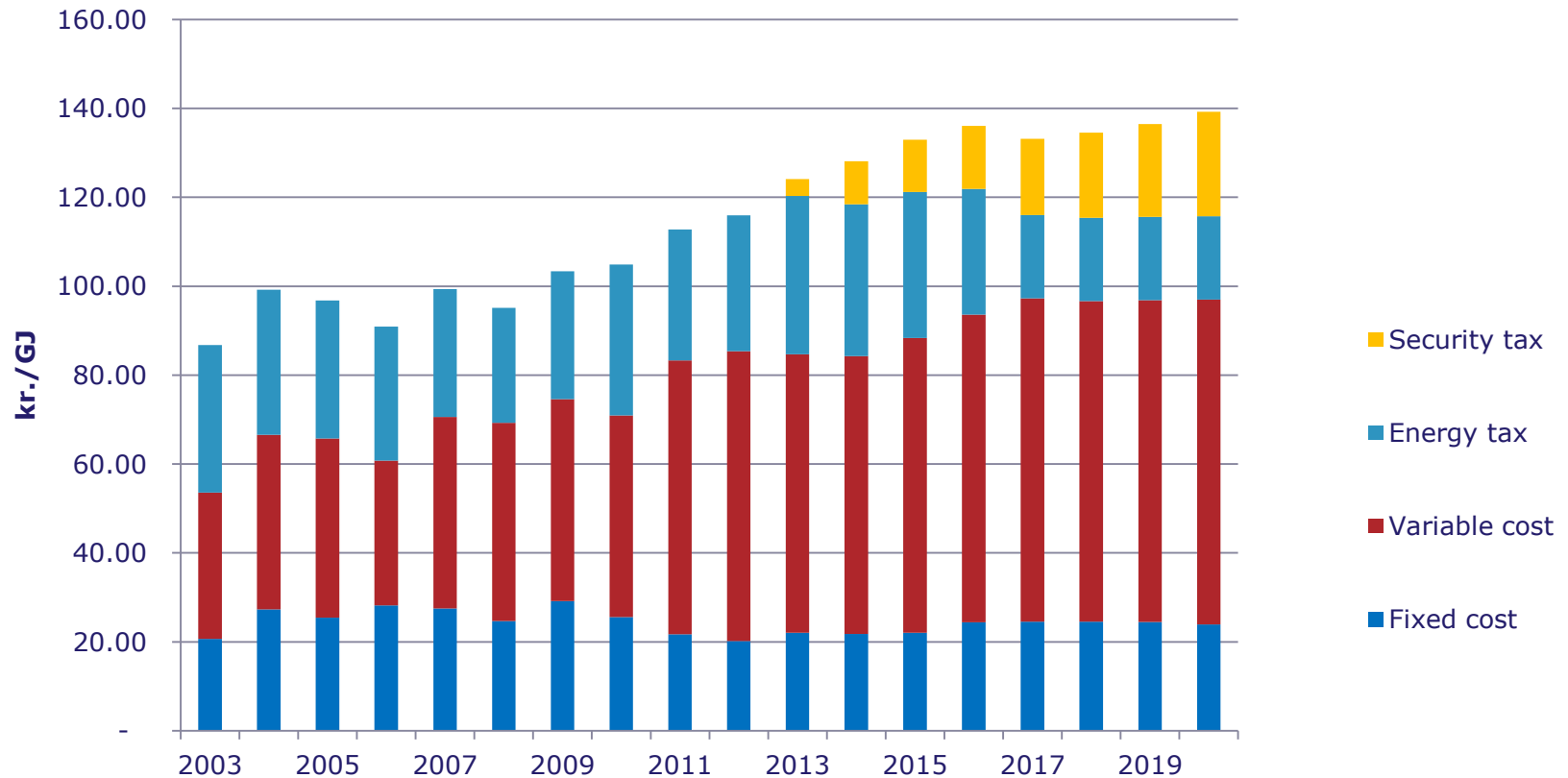


# Regulatory framework for tariffs

- **Tariffs for the coming year shall be present before the start of the year**
- **Tariffs shall be reported to the Energy Regulatory Authority**
- **All consumers can make a complaint about the tariffs to the Energy Regulatory Authority**
- **Every settlement made by the Energy Regulatory Authority can be proved by a individual Appeal Committee**
  - members pointed out by organisations representing authorities, consumers and producers



# Development in CTR pool price, fixed 2013

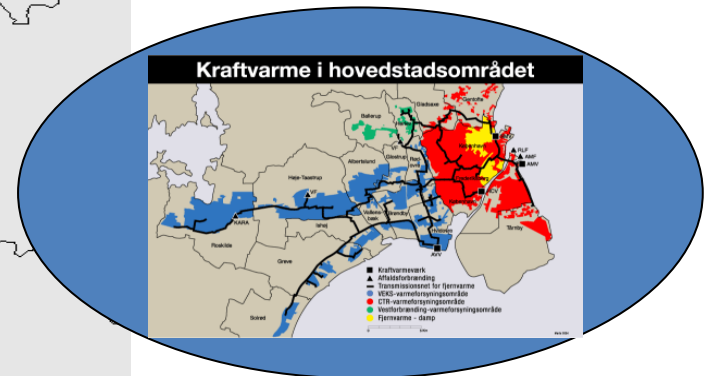
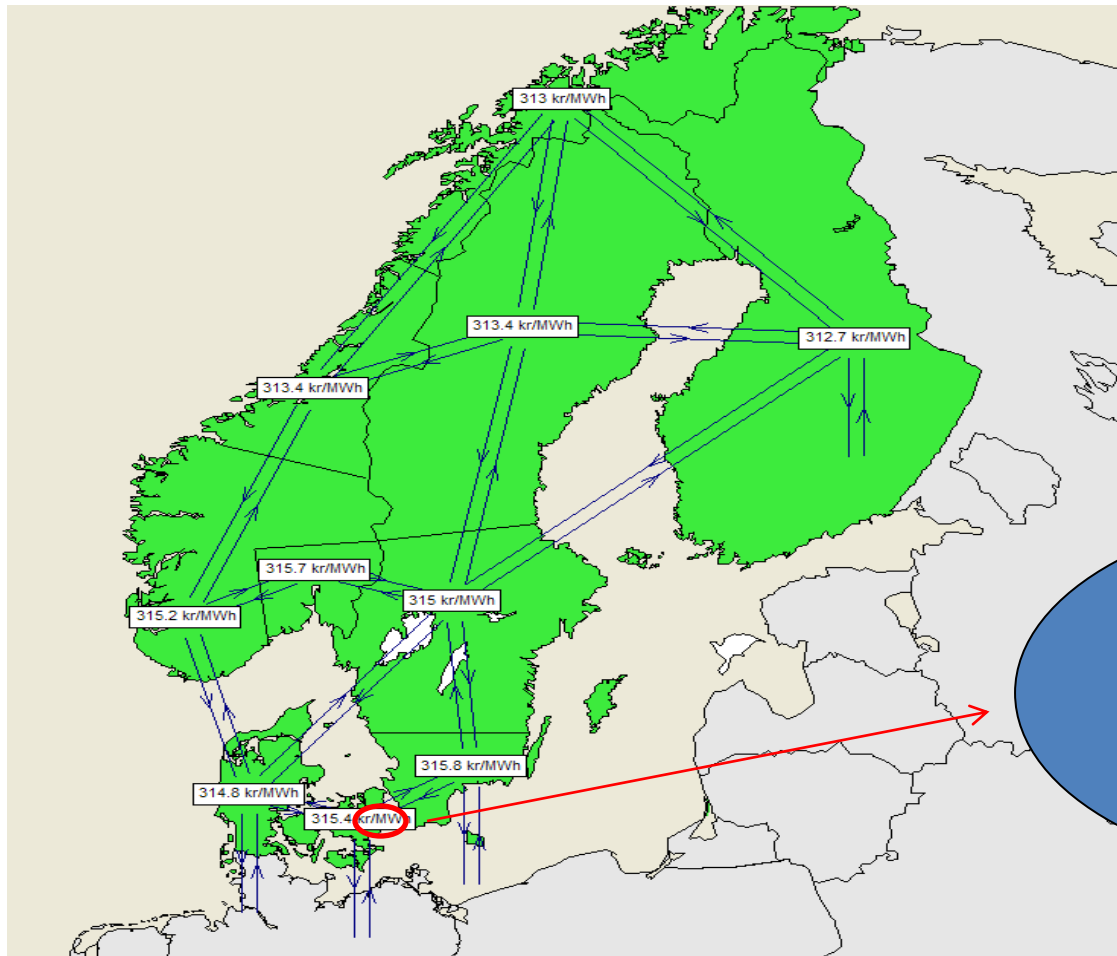


# Load dispatch of heating and power





# The Nordic power system



# Regulation of power marked in Denmark



- Energinet. dk is a company own 100% by the Danish state
  - Status as an authority on electricity marked
  - Owner of high voltage grid
  - Responsible for the security of supply
    - Negotiate necessary contract
    - Control and accept all changes in capacity
    - Can order power plants in back up
- NASDAQ OMX
  - European marketplace for power and gas
  - Operates daily on hour base
- Competition authorities
  - Copy of all tariffs, once a year
  - Evaluate all complains

# Organisation, payment and contracts



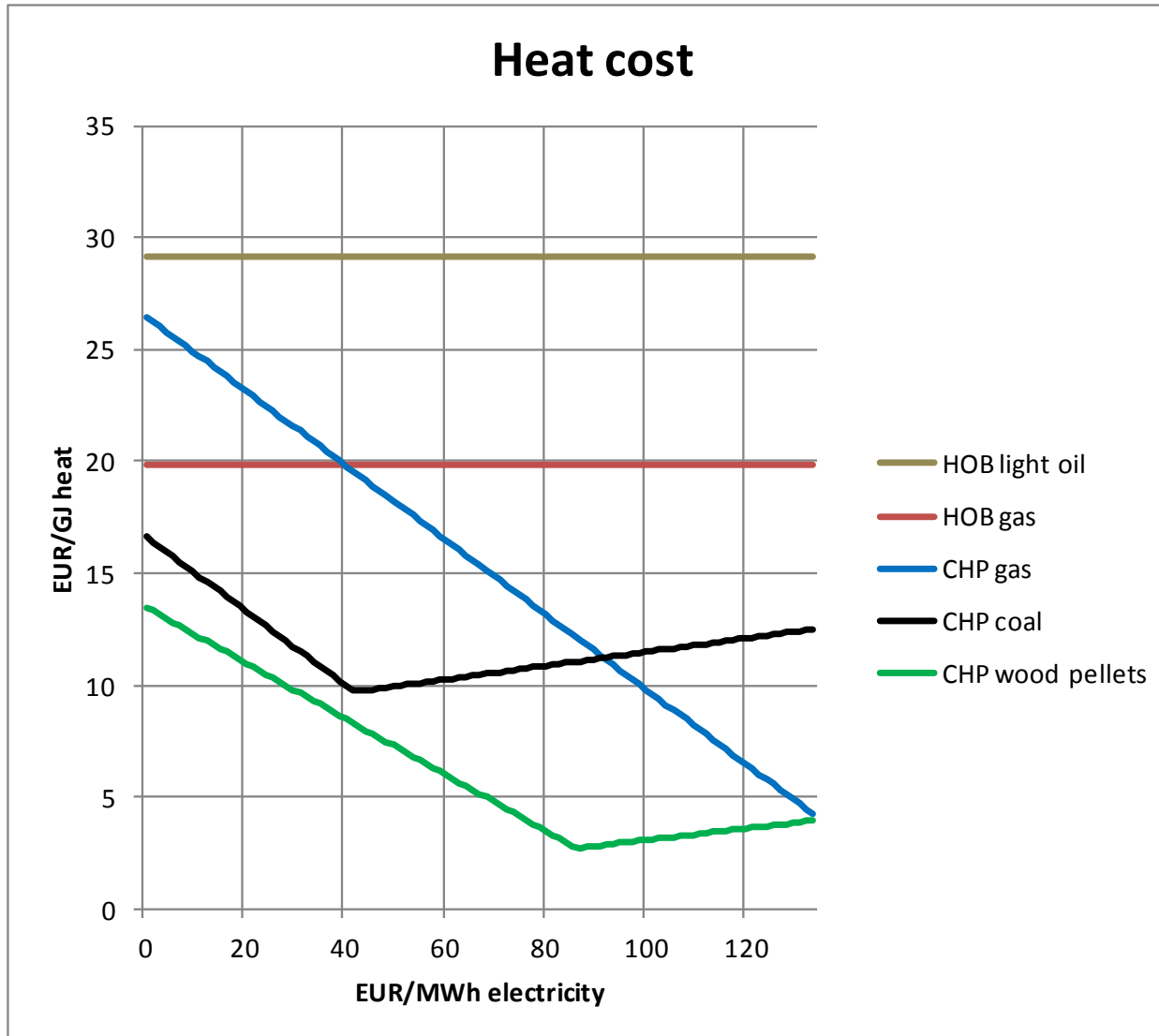
- Varmelast.dk is a cooperative between district heating companies
- Payment and heat load dispatch are covered by separate sets of contracts
- Heat load dispatch happens without regard to payment between producers and district heating companies

# Joint optimization of heat and power production

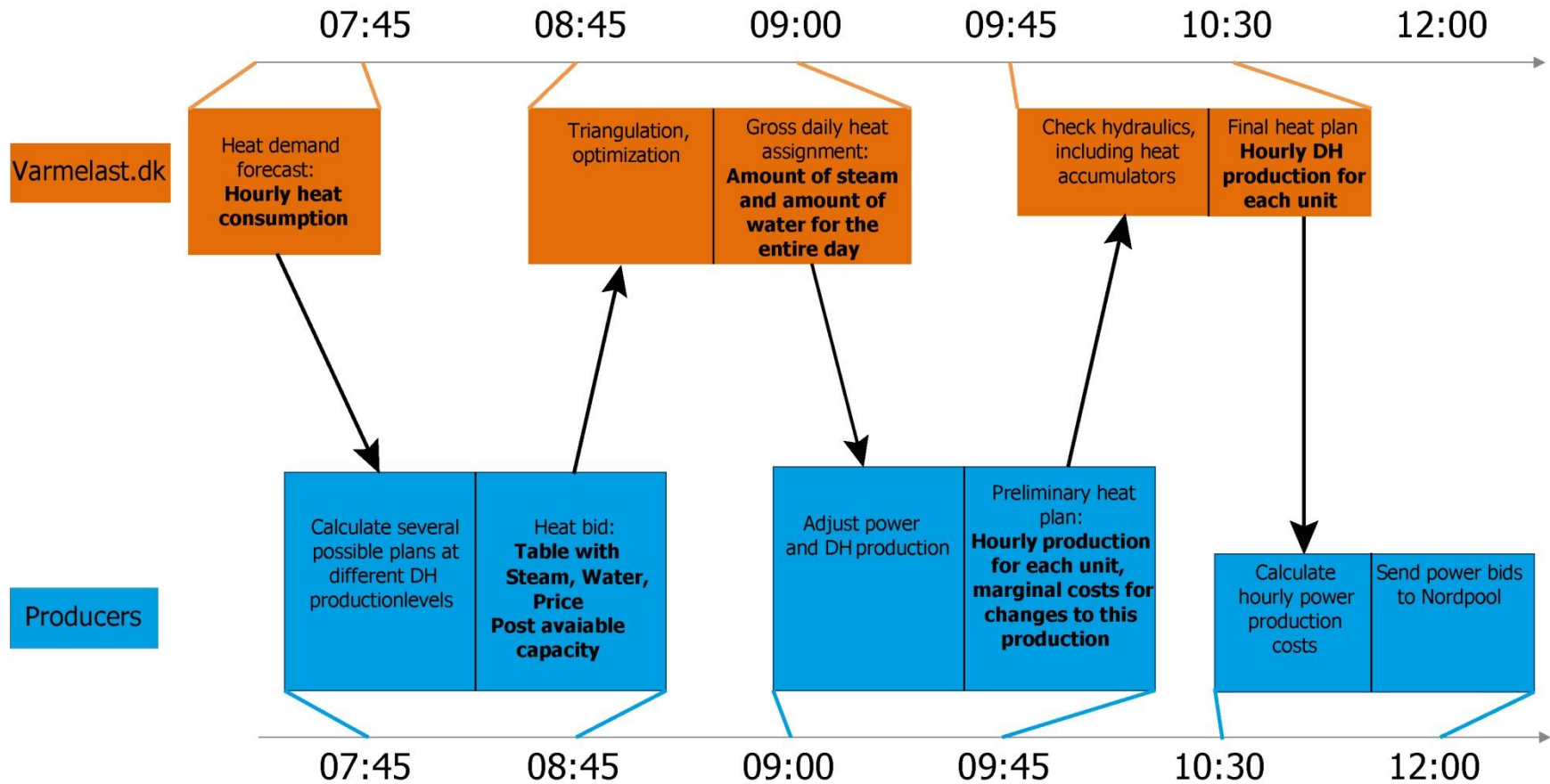


- All variable costs are considered in the optimization process
- Variable Costs:
  - Fuel
  - CO<sub>2</sub>-quotas
  - Operating and maintenance
  - Energy taxes
- Power sales:
  - Revenue from sale of power on the spotmarket
  - Subsidies to power production from biomass
- $\text{Power Sales} - \text{Variable Costs} = \text{Cost of Heat}$

# Heat costs of different technologies



# Dayahead procedures

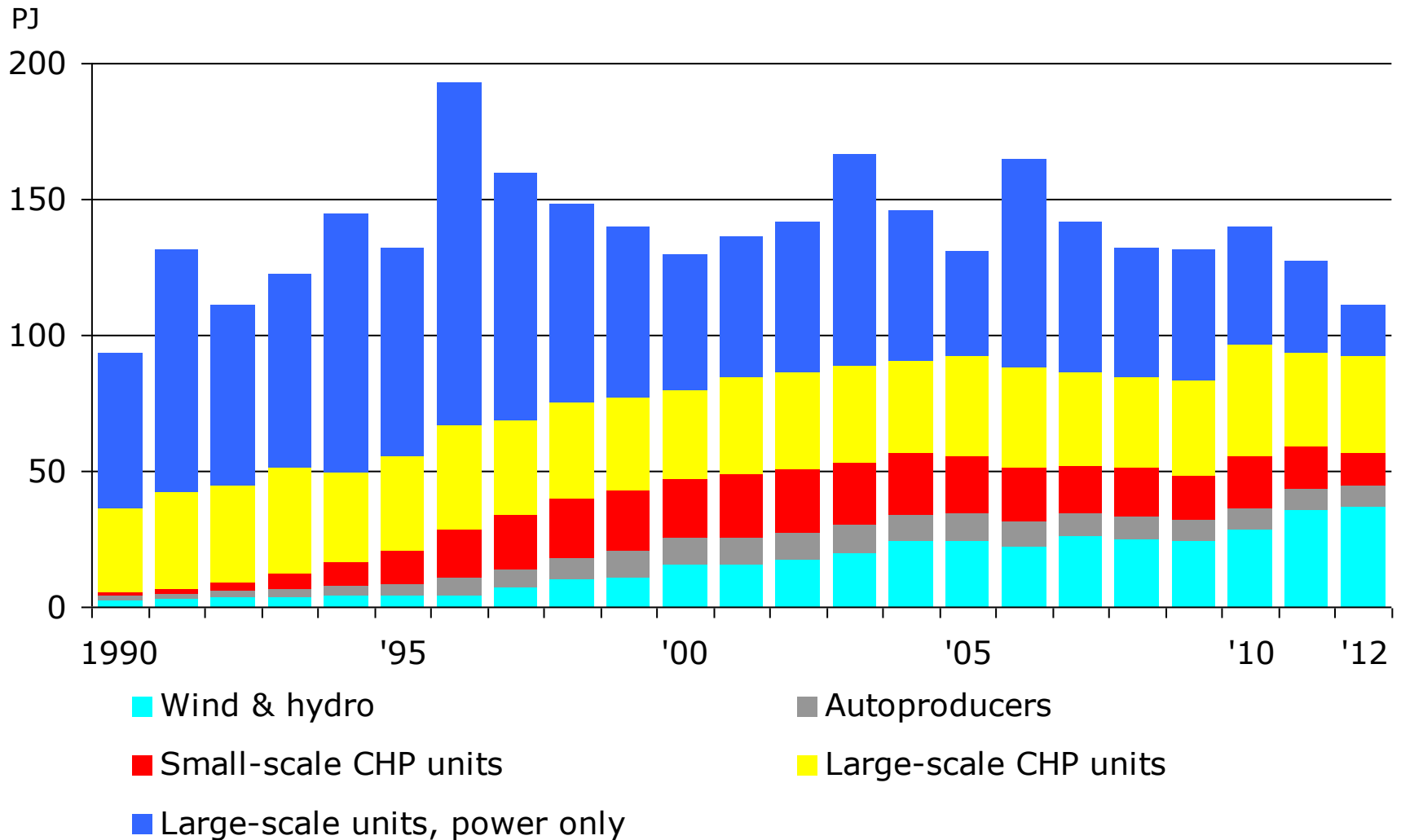


# Energy Situation in Denmark

## Power and heat

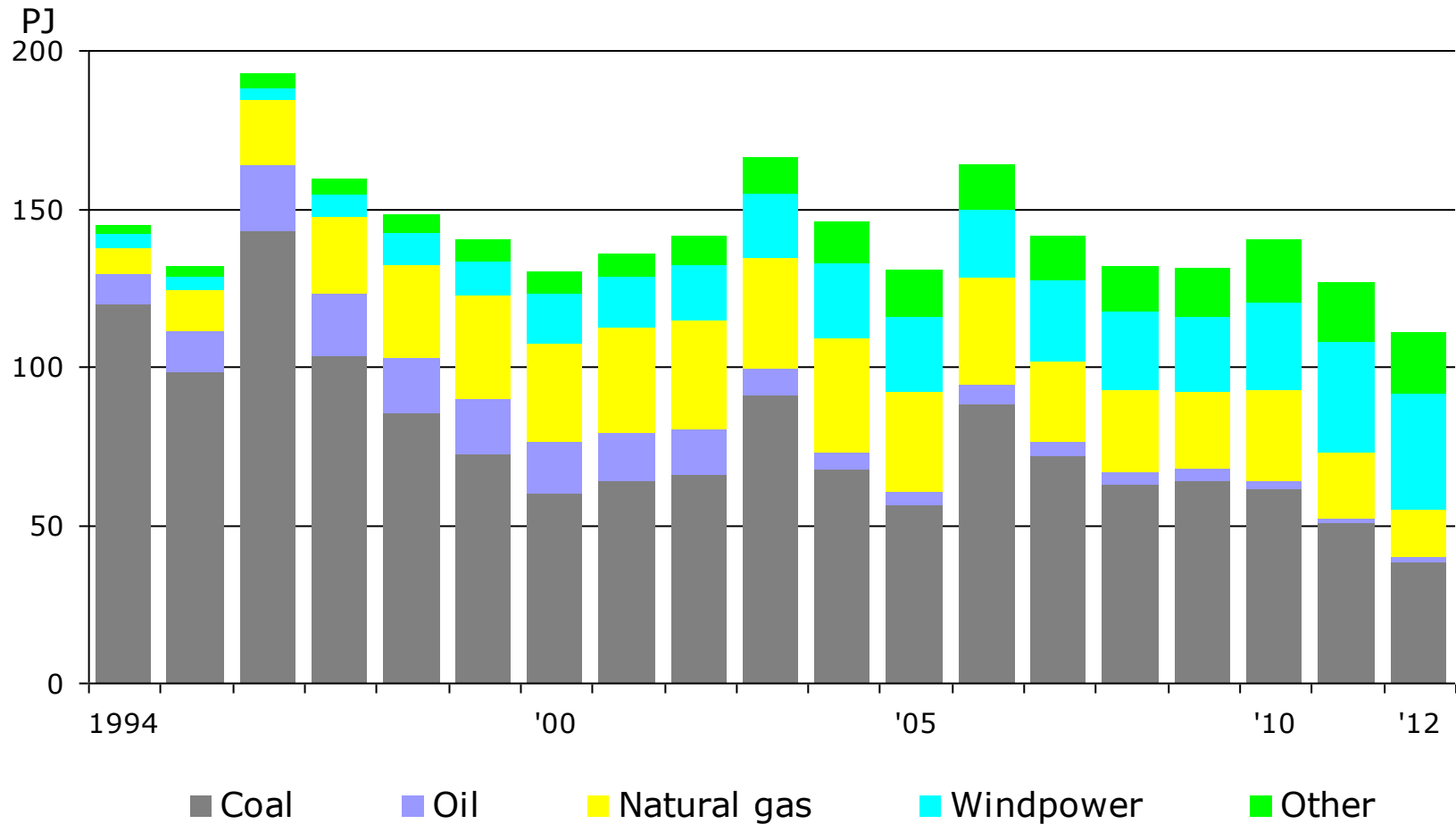


# Electricity production by type of producer

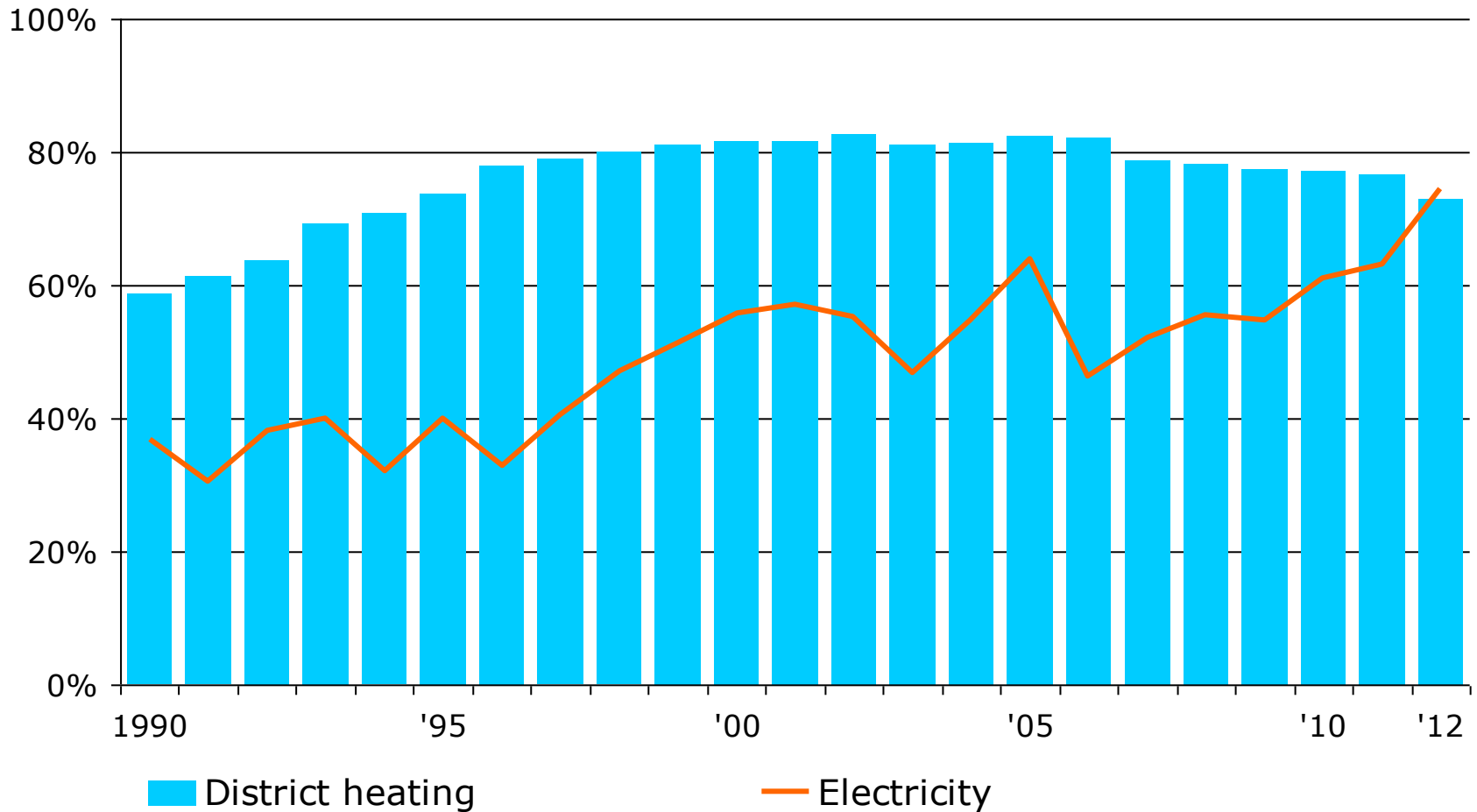




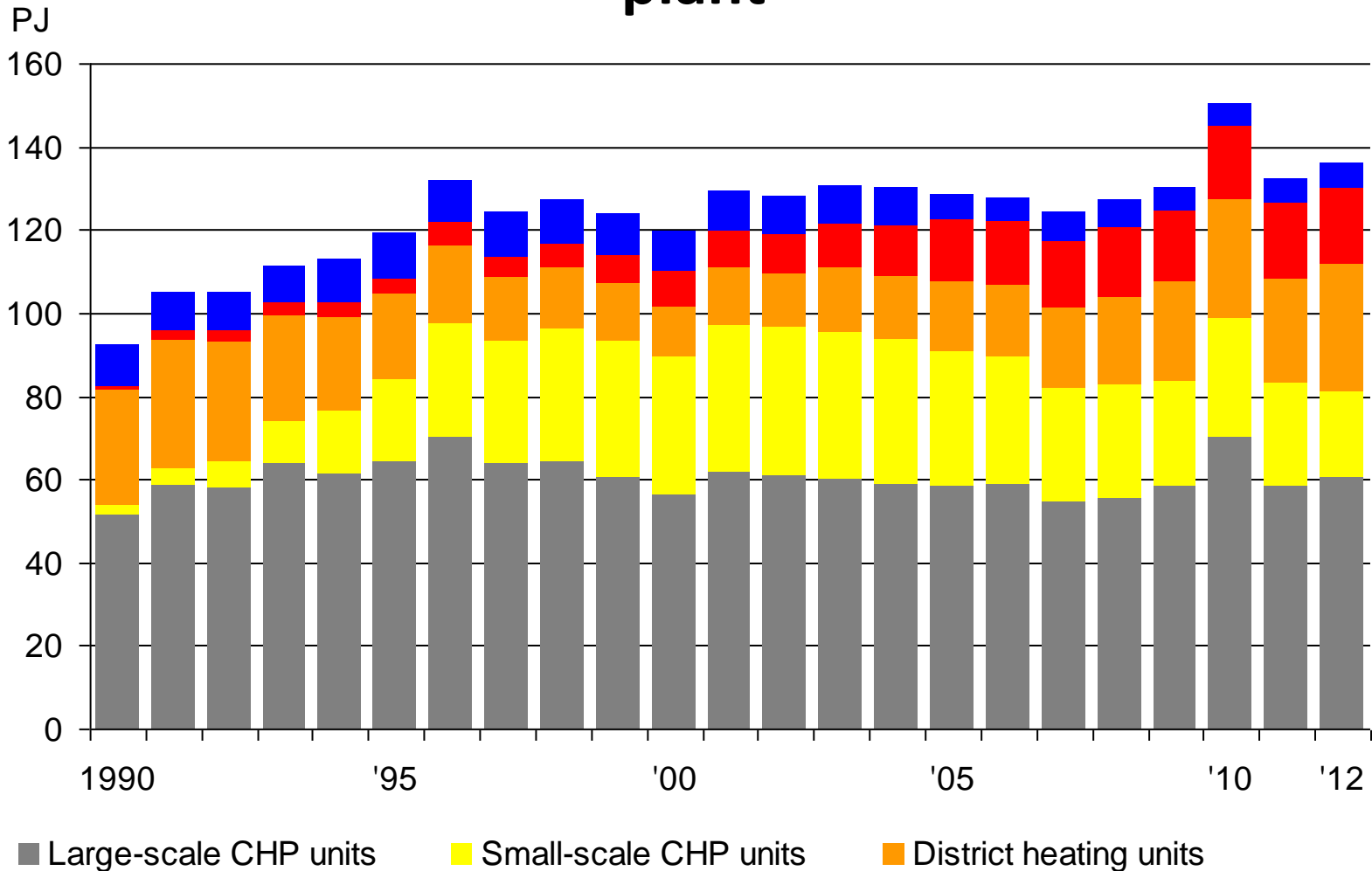
# Electricity production by fuel



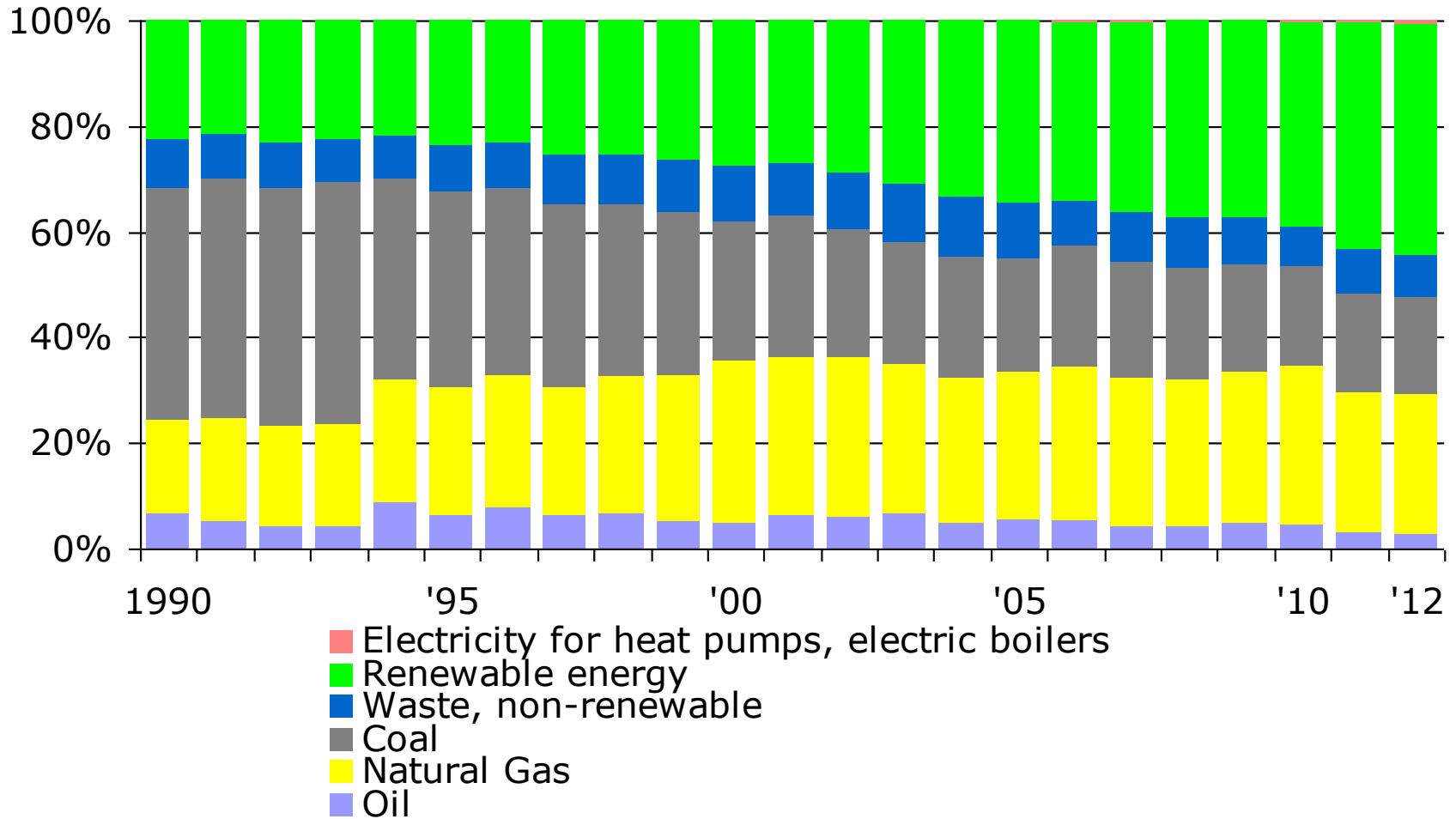
# CHP share of thermal power and district heating production



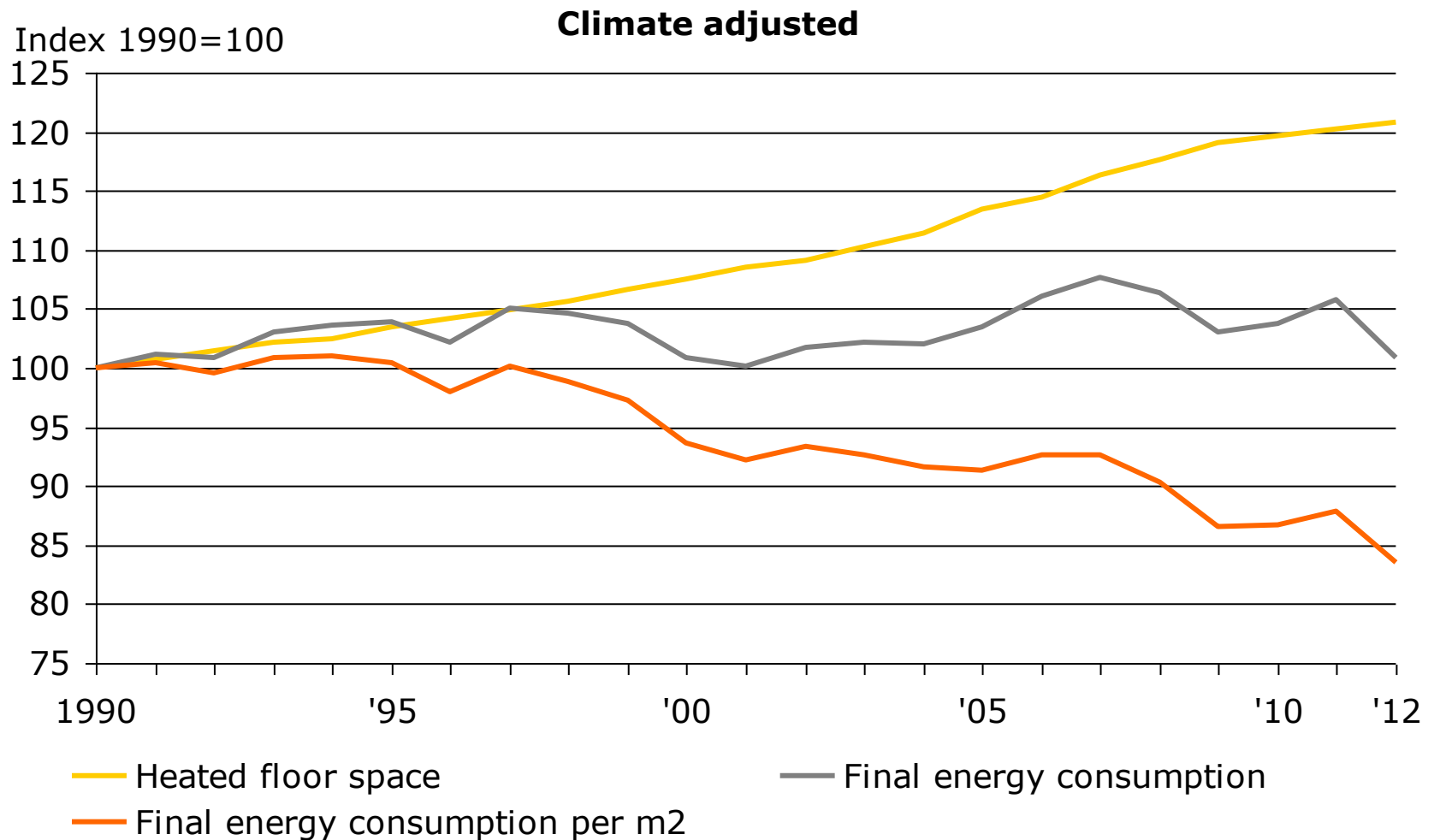
# District heating production by type of production plant



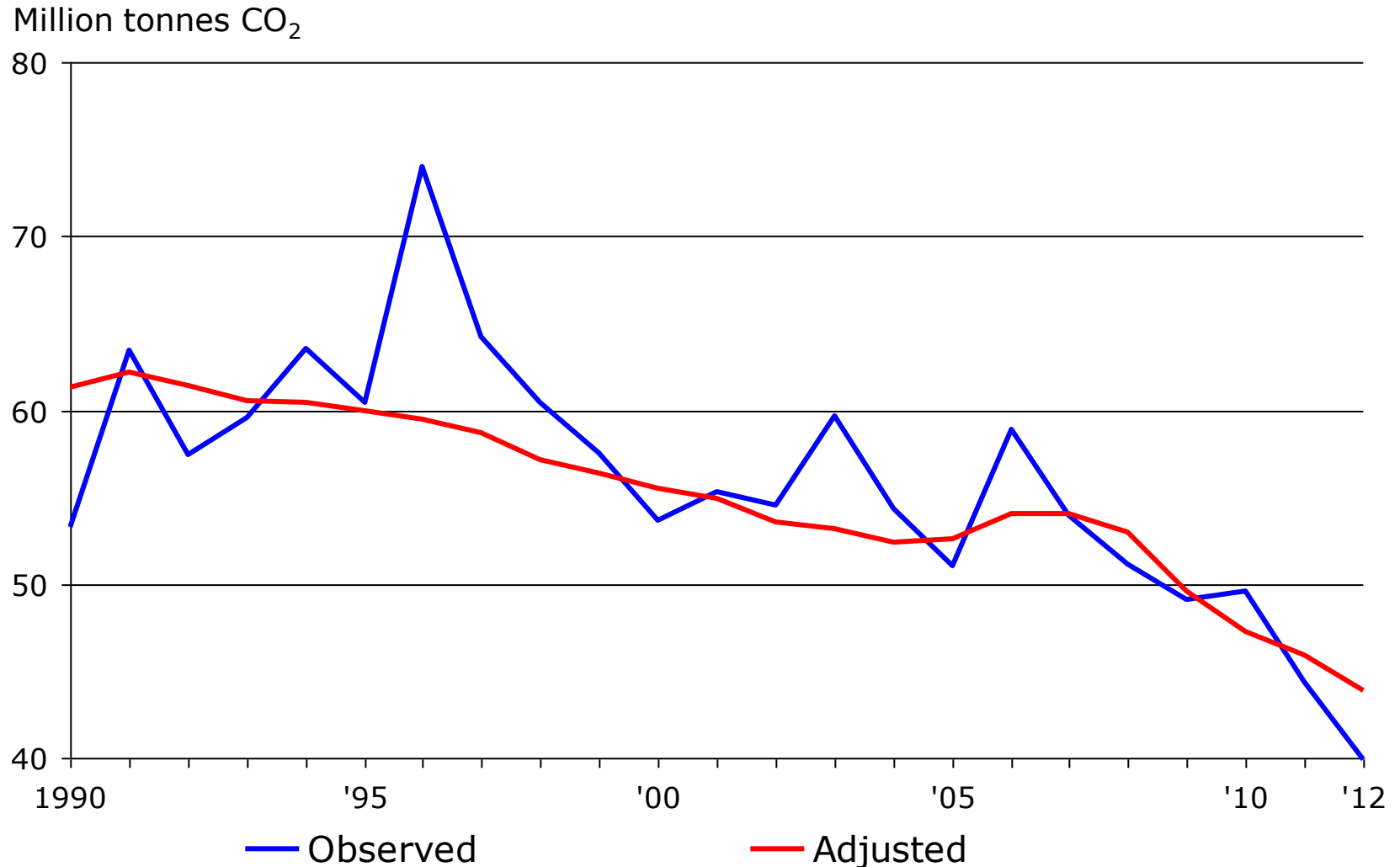
# Fuel consumption for district heating production, percentage distribution



# Energy consumption for heating in households

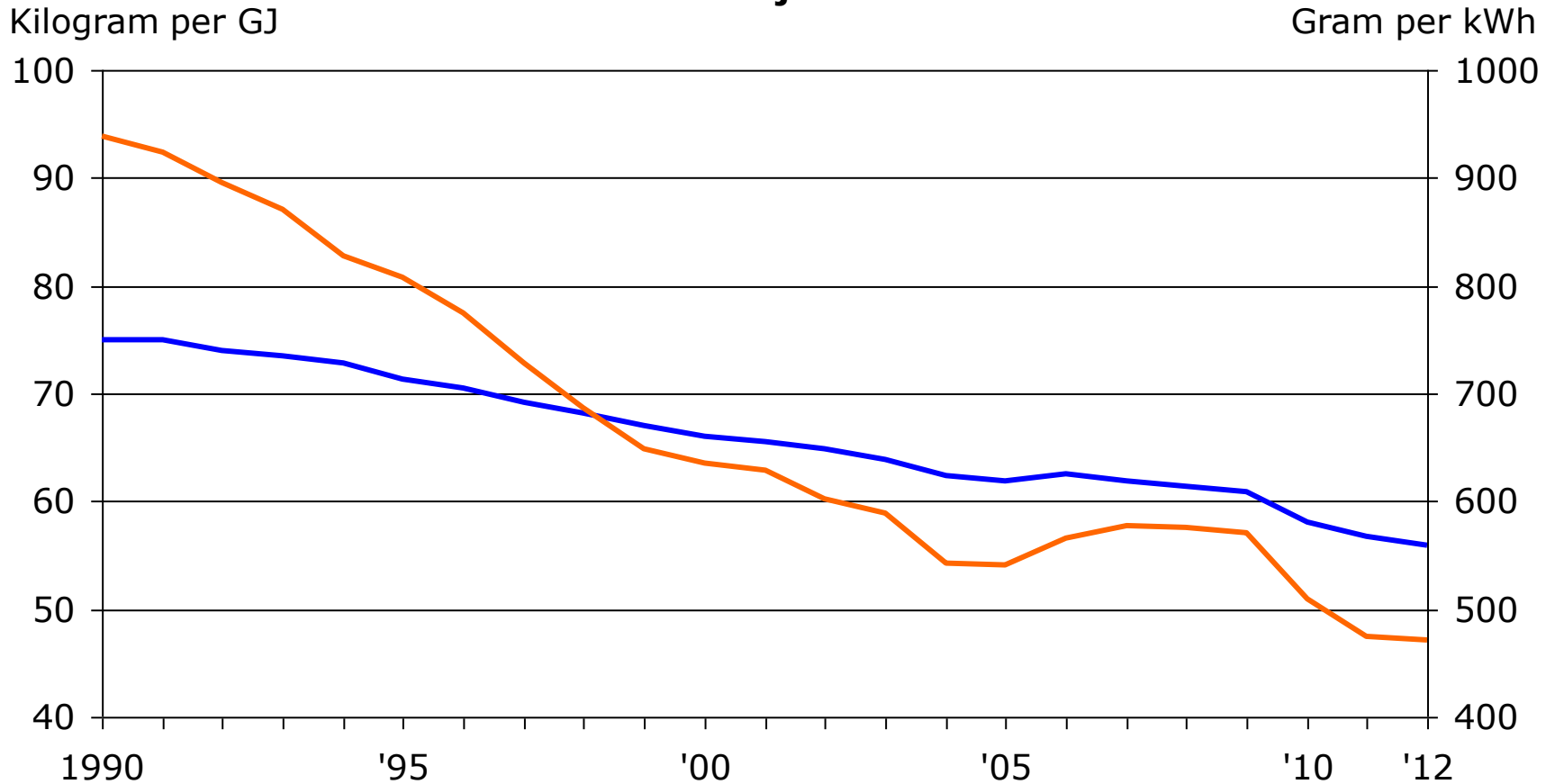


# CO<sub>2</sub> emissions from energy consumption



# CO<sub>2</sub> emissions per fuel unit and kWh electricity

Adjusted



- CO<sub>2</sub>-emissions per fuel unit
- CO<sub>2</sub>-emissions per kWh electricity (right axis)