A wide-angle photograph of an industrial facility, likely a power plant or refinery, situated along a body of water. The facility features several tall, white smokestacks emitting plumes of white smoke. In the foreground, two large white wind turbines stand on a grassy area. To the left, a small white lighthouse is visible on a small island. The sky is filled with soft, white clouds, and the water in the foreground is calm. A blue rectangular box is overlaid on the bottom left of the image, containing white text.

# Heat Plan Denmark

## Low Carbon Urban Heating

Anders Dyrelund, market manager  
Rambøll Denmark

# Heat Plan Denmark

## a small study with a significant impact

- Bottom-up R&D study financed by the district heating consumers
- Prepared by an independent team of experts from
  - Rambøll Denmark and
  - Aalborg University
- The first study in Denmark, really to integrate the energy and building sectors – to combine the supply and the demand side
- An eye-opener for the Danish politicians
- Could be a model for other countries

# We focus on the overall energy policy objective in the European Union

- The main objective is to reduce the fossil fuel consumption and the CO<sub>2</sub> emission in a cost effective way



- Important EU directives to implement this objective
  - Strategic environmental assessment
  - Combined Heat and Power (CHP)
  - Energy performance of buildings
  - Renewable energy

# Most important objectives in the energy policy in Denmark since 1976

- Objectives since 1976
  - Develop the most economic heat supply projects for the society of Denmark
  - Reduce the dependency on oil
  - Promote Combined Heat and Power (CHP)
  - Promote renewable energy



- New additional objectives
  - National obligation to reduce CO<sub>2</sub> emissions outside the CO<sub>2</sub> emission trading scheme
  - Reduce CO<sub>2</sub> emissions for the whole society
  - **To be independent of fossil fuels in the long run ! (2050?)**

# Important Danish legislation to implement the policy

- Electricity supply act from 1976
  - all new power capacity since 1976 has been CHP
- Heat supply act from 1979
  - municipal heat supply planning, a new natural gas infrastructure and a substantial increase of district heating
  - optimal zoning of district heating and natural gas networks based on overall economic evaluation for the society of Denmark
  - district heating shifts from fossil fuel boilers to CHP and renewable energy
- This legislation ensures unique least cost integration of power, heat, gas and waste sectors in Denmark
- However, the building sector is not yet fully co-ordinated with the other sectors

# Heat plan Denmark

## focus on the heating sector

- The plan shows how the Danish heating sector has reduced CO<sub>2</sub> emissions from 25 to 10 kg/m<sup>2</sup> since 1980
- The plan shows that this progressive development can continue
  - to achieve a further **50%** reduction before 2020 and
  - to achieve an **almost CO<sub>2</sub> neutral** society before 2030
- The plan is based on an integrated approach, combining
  - optimal end-user heat demand reductions - additional 25% or more?
  - a lower return temperature from building installations – <35°C
  - more district heating (DH) - from 46% up to 63-70% of the market
  - energy efficient use of renewable energy in district heating
  - individual heat pumps, solar heating and wood pellets

# How to produce the heat?

## CHP and surplus wind energy via heat pumps combined with large heat accumulators

District heating which combines

- Large and small CHP
- Electric boilers
- Heat pumps and
- Heat accumulators

Is a precondition for integration of large share of wind energy in Europe

In Denmark the share of wind is growing from 20% towards 70%



# How to produce the heat? Waste to energy CHP

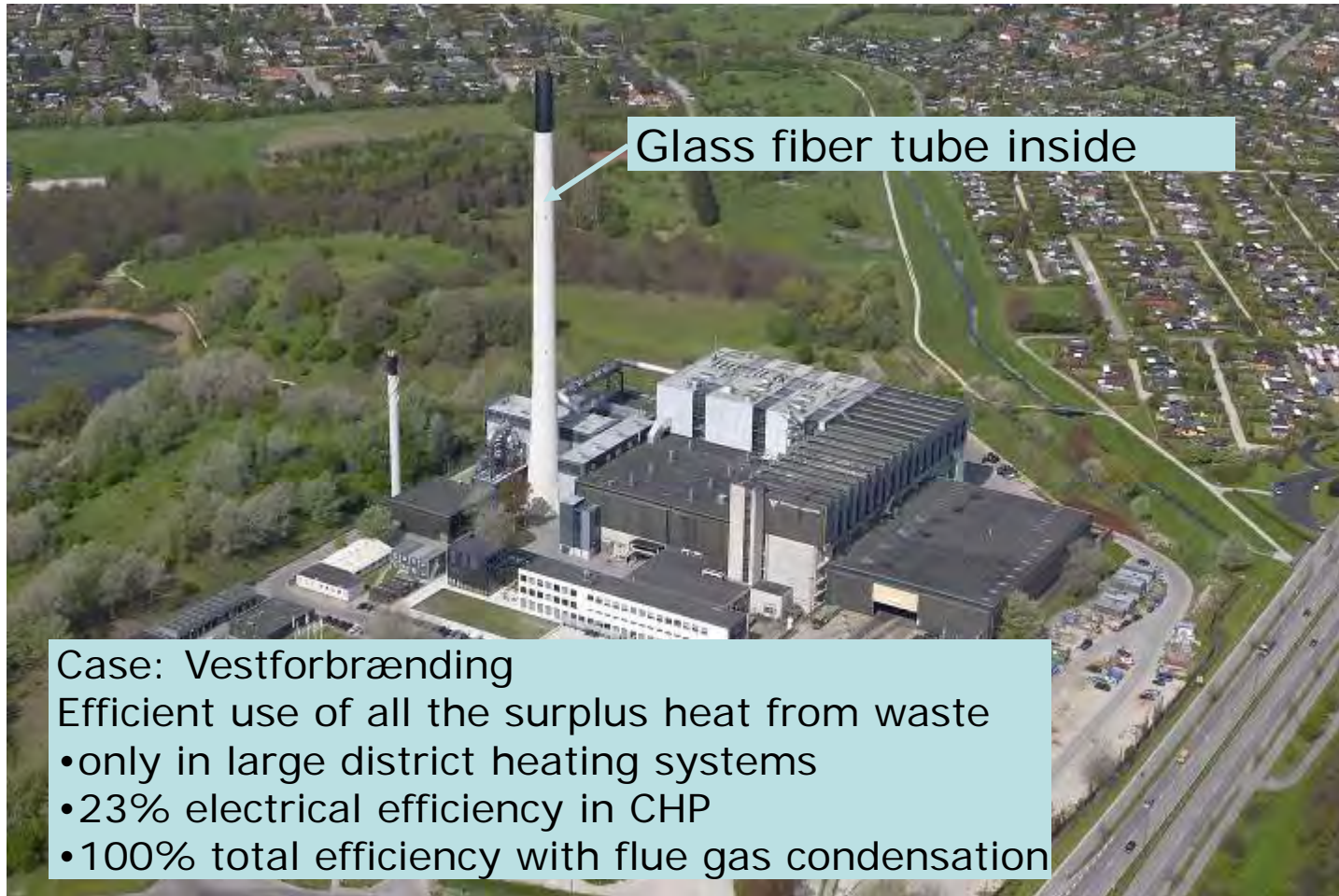


## Case: Amagerforbrænding

- the first 100% utilization of waste
- tunnel to Zealand

# How to produce the heat?

## Waste to energy with flue gas condensation



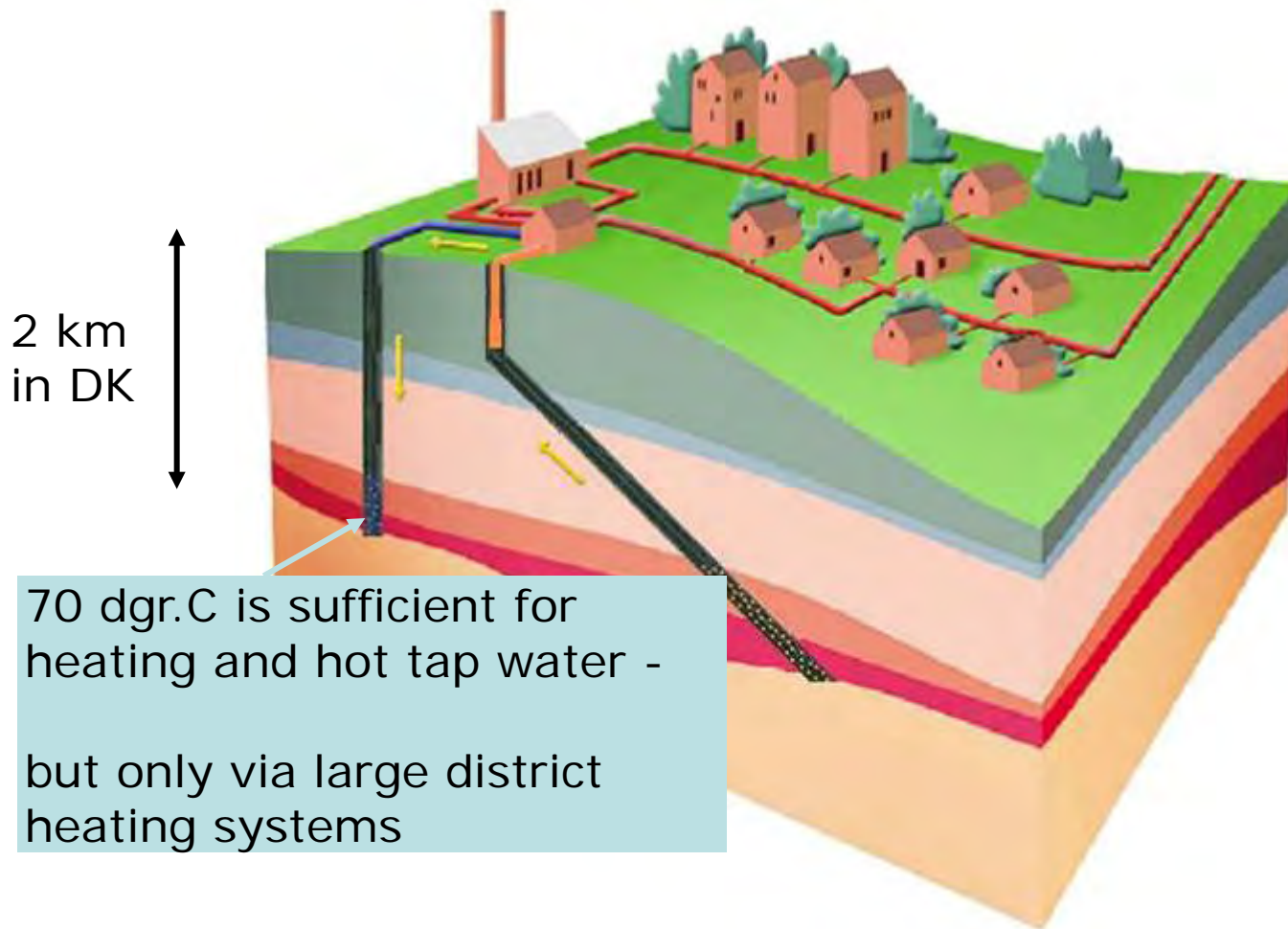
Case: Vestforbrænding  
Efficient use of all the surplus heat from waste

- only in large district heating systems
- 23% electrical efficiency in CHP
- 100% total efficiency with flue gas condensation

# How to produce the heat? Biogas CHP



# How to produce the heat? Geothermal energy boosted by biomass



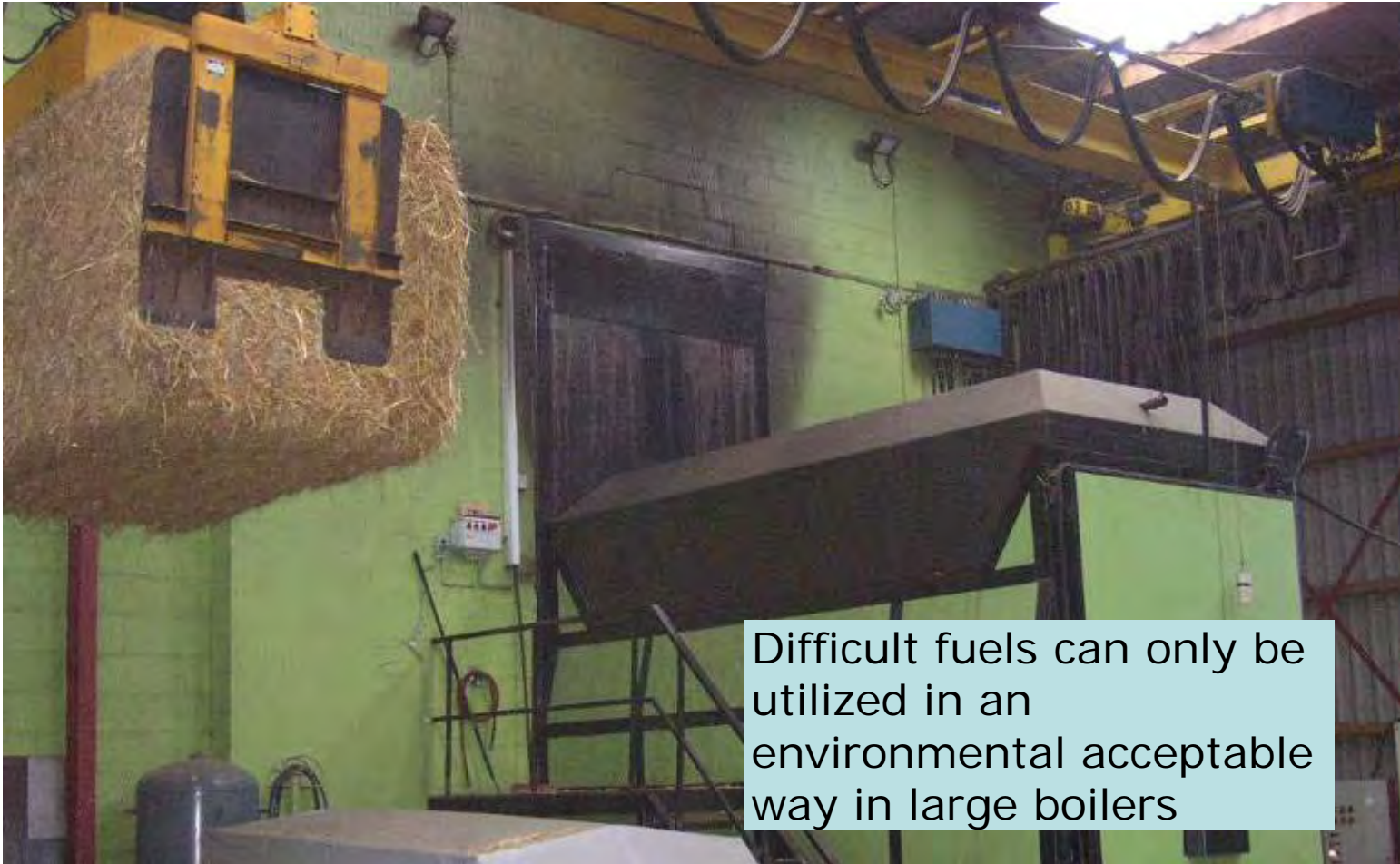
# How to produce the heat?

## Large scale solar thermal plants



6 times more cost effective  
than  
individual solar heating

# How to produce the heat? Straw



# How to produce the heat?

## Surplus wood chip with flue gas condensation

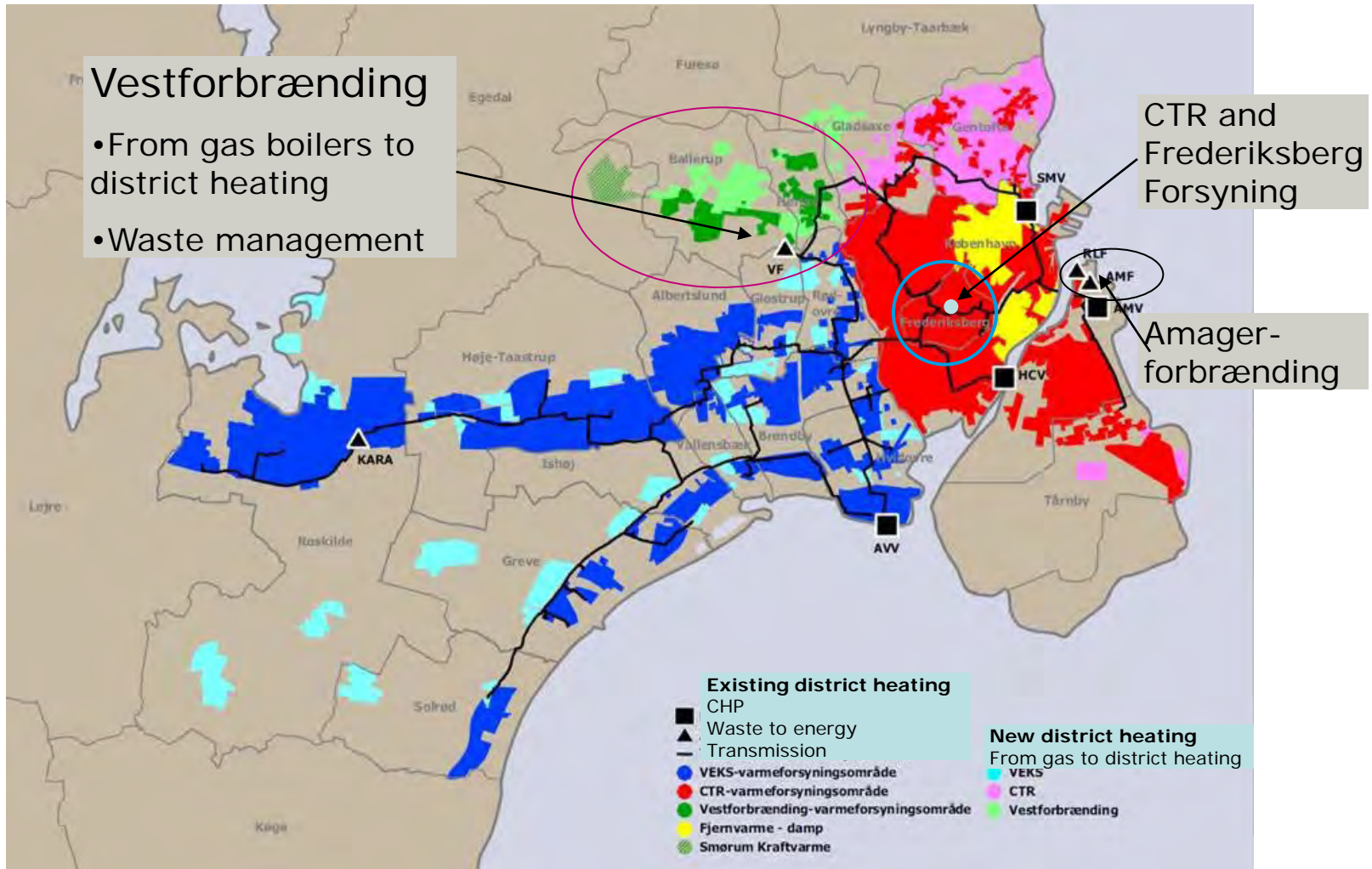


1000 times more environmental friendly than wood stoves – and twice as efficient



# Integrated district heating systems

## Case: Greater Copenhagen, 2009



# New sustainable buildings interact with the energy infrastructure

## Case: New Ramboll office in Kolding:

- Close to public transport
- District heating with
- Waste to energy CHP with flue gas condensation
- "District Cooling" from near by water
- Low temperature floor heating down to 25 dgr. C
- High temperature free cooling through the same floor tupe system

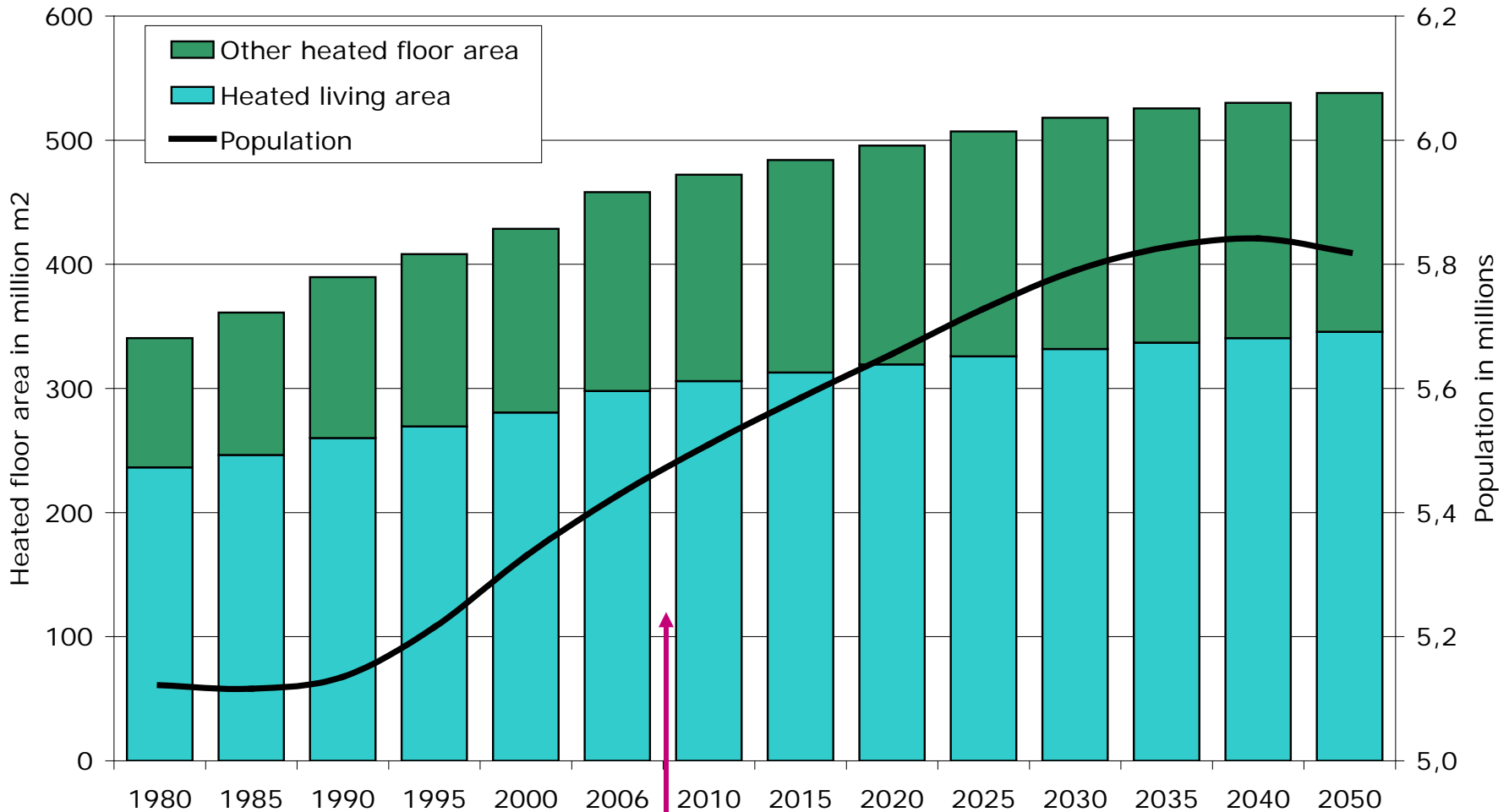


# Heat Plan Denmark

## statistics from 1980–forecast to 2050

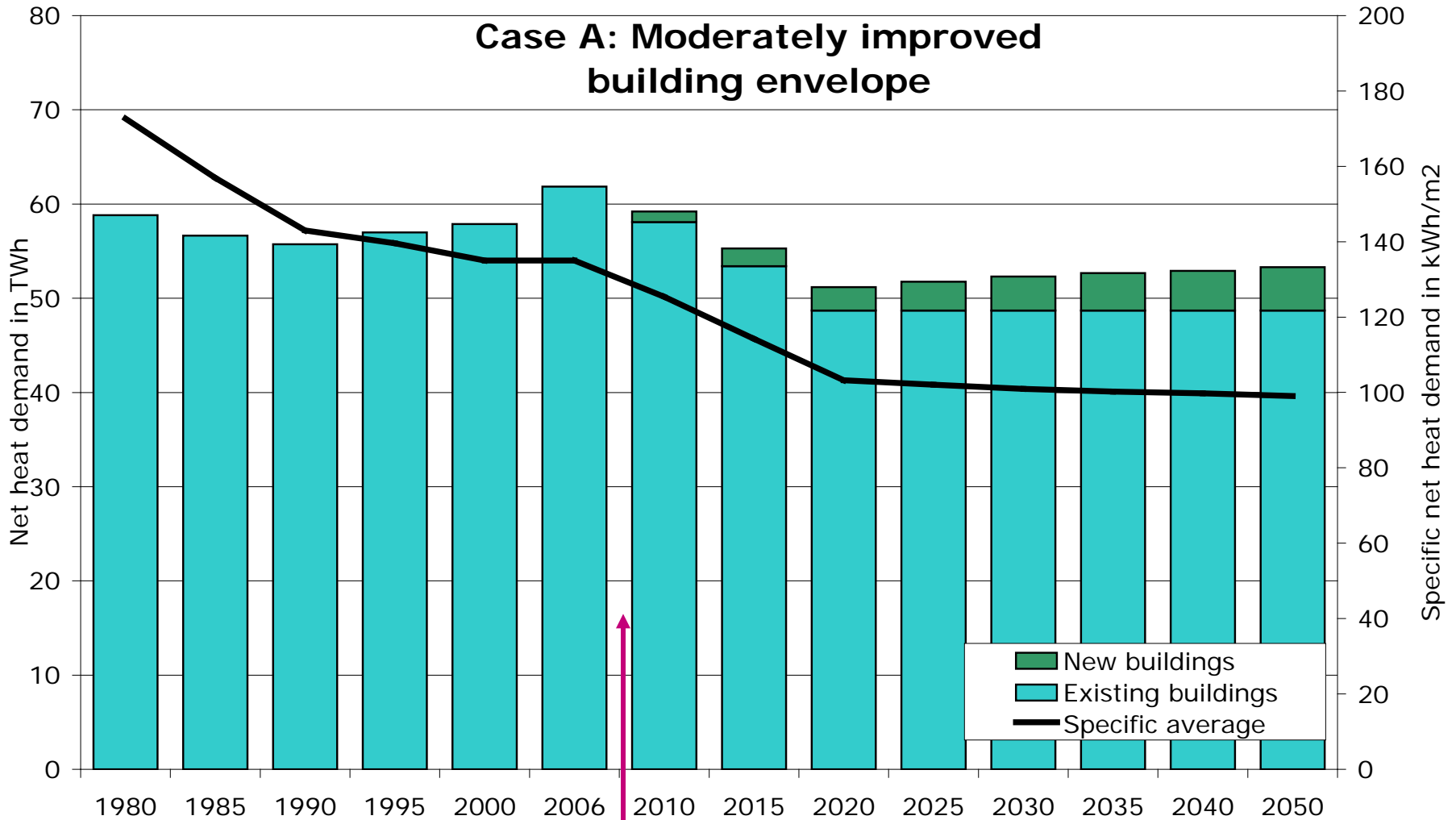
- Statistics from 1980–2006
  - Danish Energy Authority
  - More specific information from 430 district heating companies
- Forecast 2006-2050 based on bottom-up analysis for all 420 DH companies grouped in 10 clusters, which reflects the average
  - DH from 46% to 63% in 2020
  - DH up to 70% before 2050
  - 25% heat demand reduction
  - return temperature down to 35 °C in 2030
- State of the art of to-days technologies

# Heated floor area and population grows

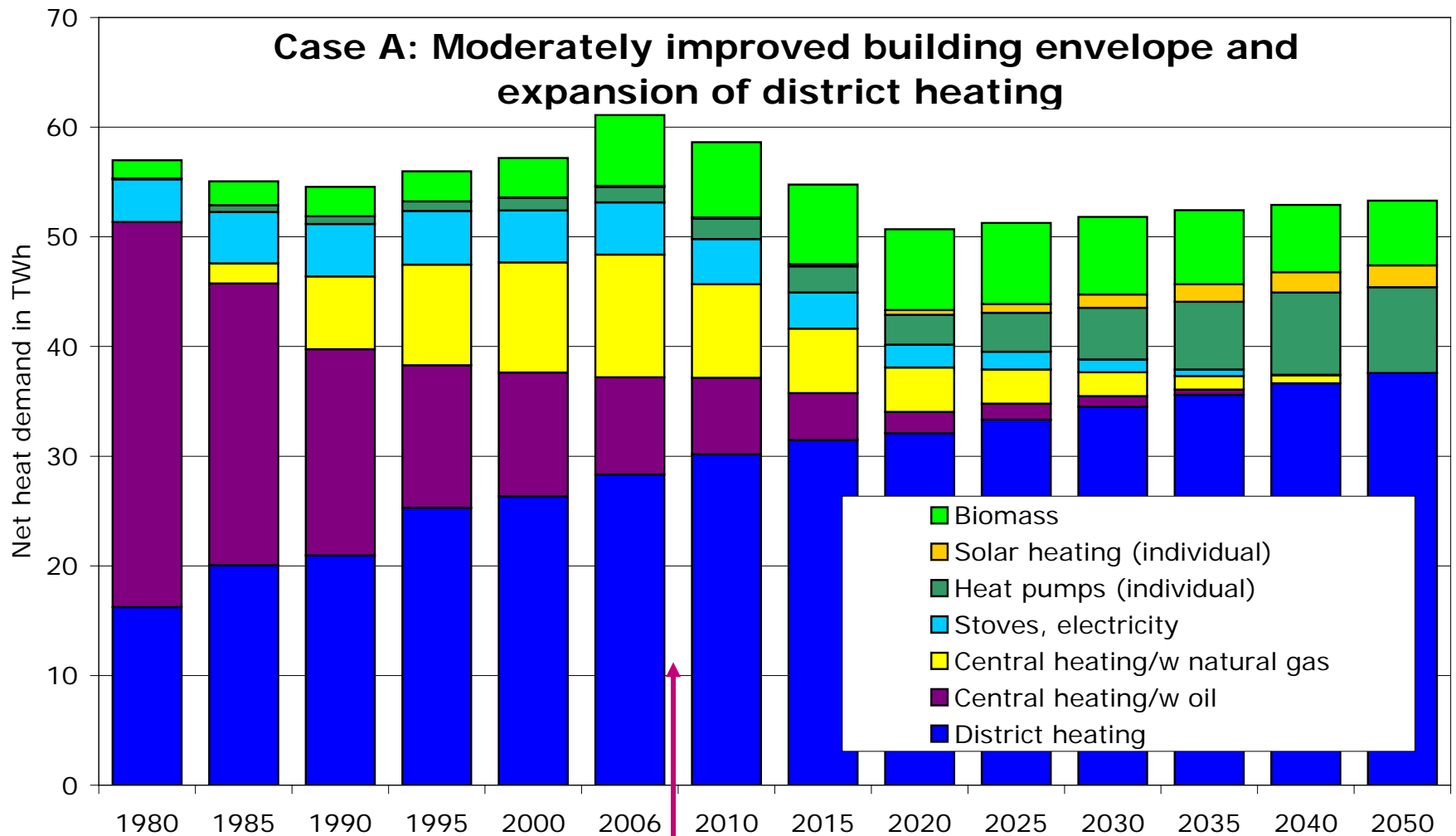


# Heat demand in total and heat demand in kWh/m<sup>2</sup>

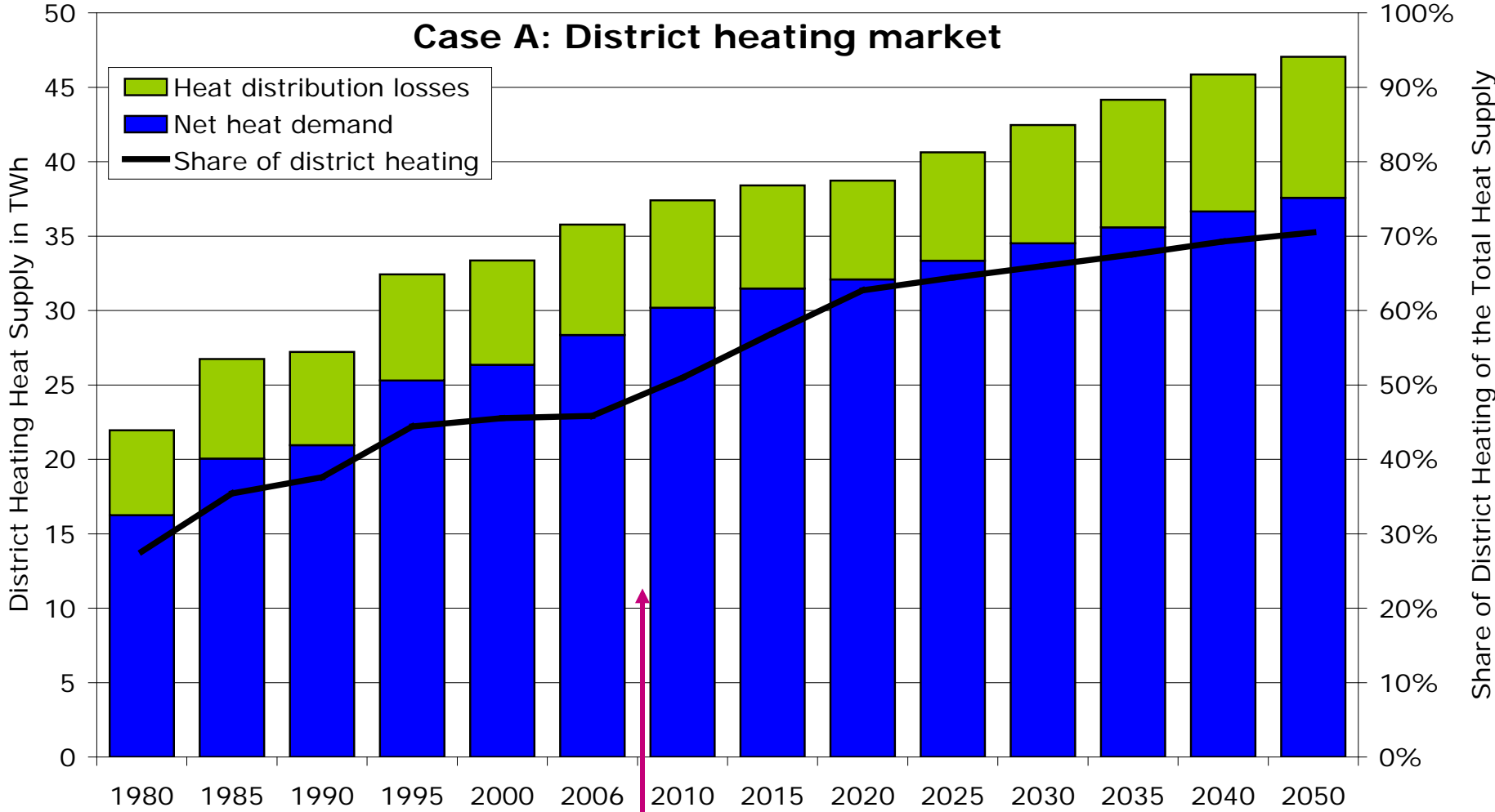
Case A: Moderately improved building envelope



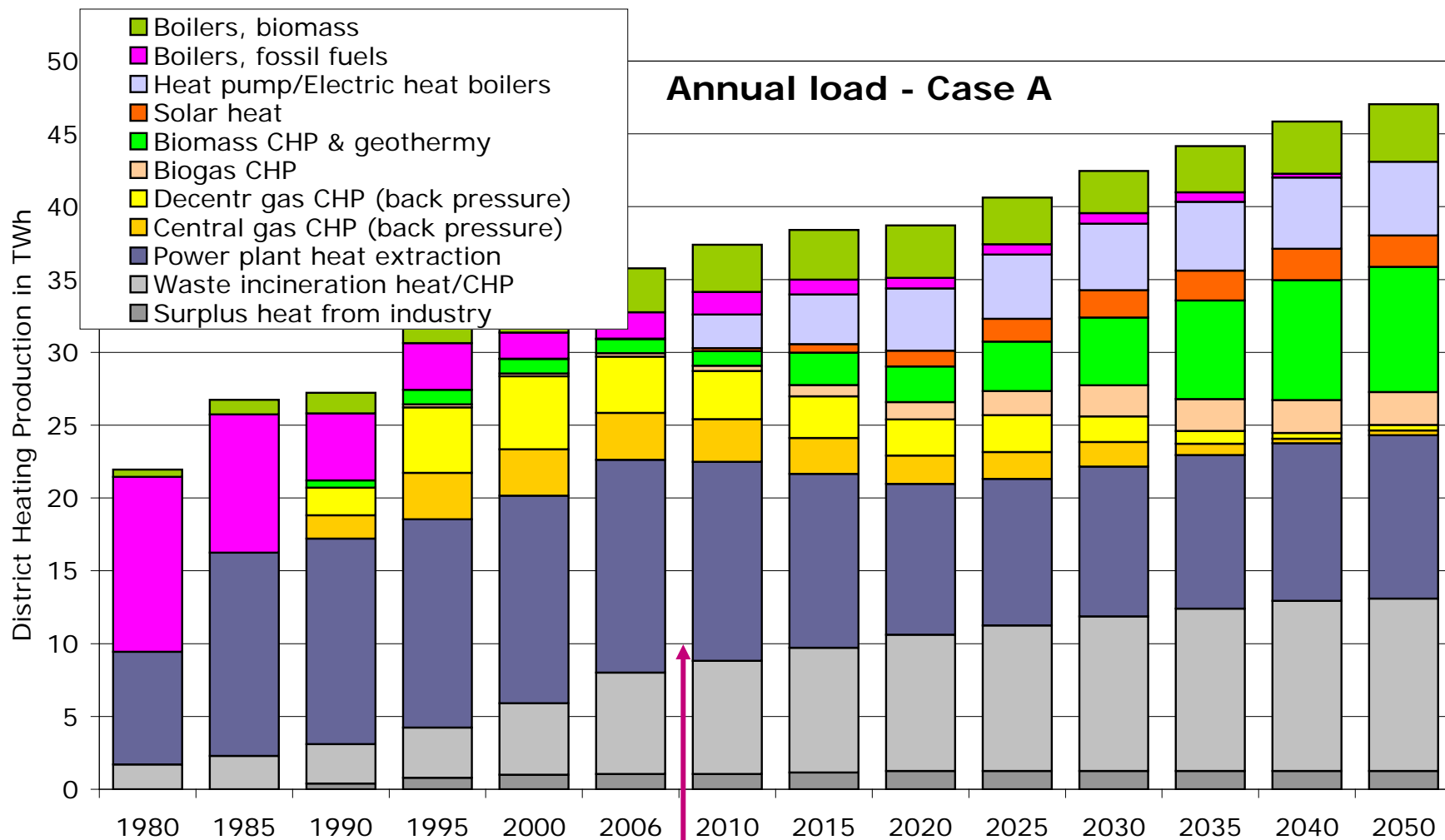
# Heat demand divided on heat sources



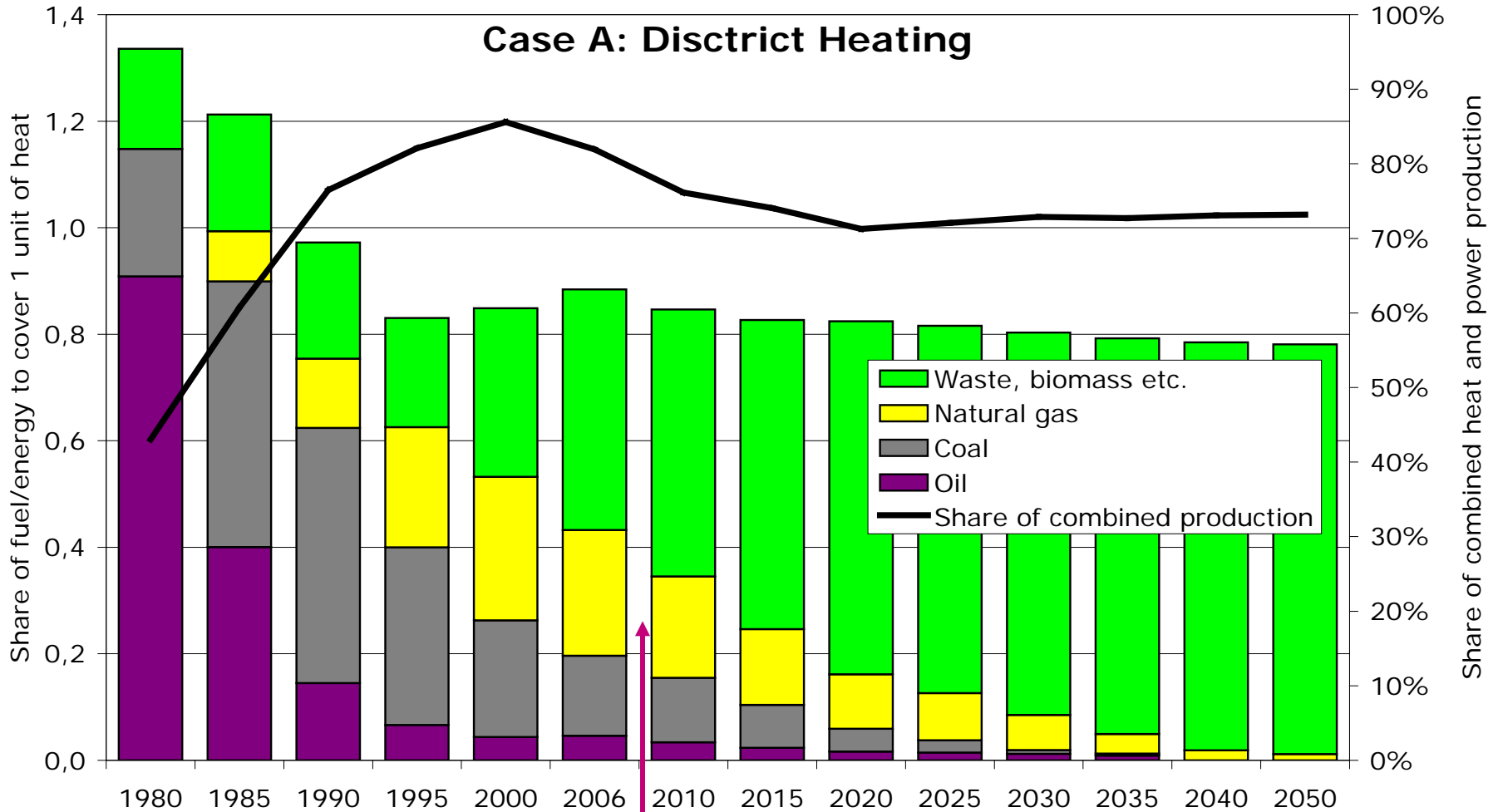
# District heating demand and market share



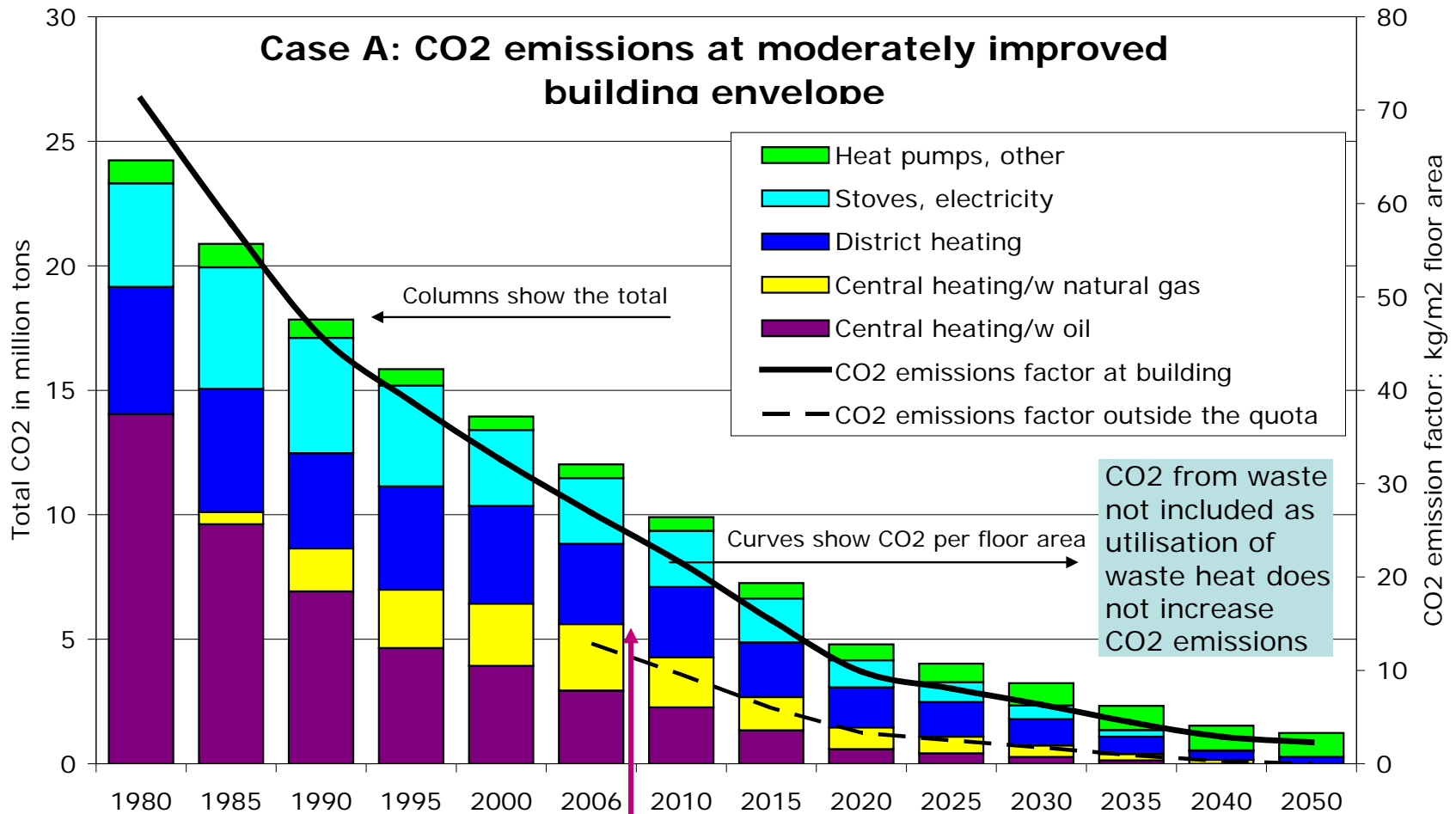
# District heating heat sources



# Fuel consumption per unit of district heating delivered to end-user and share of CHP



# CO<sub>2</sub> emission in million tonnes for all heating and in kg/m<sup>2</sup> floor area



# Heat plan Denmark - Statements

- It is important to focus on **integrated solutions**, including building envelope, building installations, district heating and power system
- **District heating** is a natural part of the urban infrastructure in modern cities
- District heating is a **precondition** for efficient, flexible and cost-effective use of renewable energy and CHP for urban heating, not least waste-to-energy and wind
- **District cooling** is a natural part of the urban infrastructure in districts with sufficient cooling load
- A stable energy policy since 1976, municipal planning and a tradition for **co-operation in the society** have been important preconditions for CO<sub>2</sub> emission reductions in Denmark

# Heat Plan Denmark

## Message to COP 15 in Copenhagen

- Do not worry about signing the Copenhagen Climate Agreement
- It is not a problem to develop a zero carbon heating sector
- You just have to co-operate at all levels in the society
  - a stable and strong national energy policy
  - municipalities take responsibility for the infrastructure
  - well functioning co-operatives in the housing and heating sectors
- Even Danes can do it
- Have a look your self in Copenhagen

# Thank you for your attention!

[ad@ramboll.dk](mailto:ad@ramboll.dk)

[www.ramboll.dk](http://www.ramboll.dk)

[www.auc.dk](http://www.auc.dk)

[www.danskjernvarme.dk](http://www.danskjernvarme.dk)

See our climate solutions at

[www.energymap.dk](http://www.energymap.dk)

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