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/Henrik Lund, Brian Vad Mathiesen, Bernd Möller
- 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
- 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$_2$ 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 CHP and renewable energy

• New additional objectives
  • National obligation to reduce CO₂ emissions outside the CO₂ emission trading scheme
  • Reduce CO₂ emissions for the whole society
  • To be independent of fossil fuels in the long run!
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 supply heat planning with development of 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 CO₂ emissions from 25 to 10 kg/m² since 1980

- The plan shows that this progressive development can continue
  - to achieve a further 50% reduction before 2020 and
  - to achieve an almost CO₂ 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 supply new buildings? individual heating or district heating (DH)?

- EU directive
  - DH should be considered an option for new buildings to reduce the CO$_2$ emission in a **cost-effective** way

- The current Danish building regulations
  - factor 2.5 on electricity, ok
  - factor 1.0 on oil, gas and thermal energy in DH !?
  - an average factor of 0.5 on DH would be more fair

- New building regulations
  - can include renewable energy in block heating from 2010, ok
  - can include a factor 0.8 on DH, but only from 2015 !?

- Our estimates in the plan
  - DH is the least cost solution in all new **planned** urban districts
  - **70% of all new buildings** will be supplied with DH
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 with flue gas condensation

Glass fiber tube inside

Efficient use of all the surplus heat but only in city-wide district heating systems
How to produce the heat?

Biogas CHP

Biogas can substitute natural gas directly in district heating plants - not in individual boilers
How to produce the heat?
Geothermal energy boosted by biomass

70 dgr.C is sufficient for heating and hot tap water - but only via large district heating systems

2 km in DK
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

Difficult fuels can only be utilized in an environmental acceptable way in large boilers.
How to produce the heat?
Surplus wood chip with flue gas condensation

1000 times more environmental friendly than wood stoves – and twice as efficient
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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
Heated floor area and population grows
Heat demand in total and heat demand in kWh/m²

**Case A: Moderately improved building envelope**

Net heat demand in TWh

Specific net heat demand in kWh/m²

- New buildings
- Existing buildings
- Specific average

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The 34th Congress of Euroheat & Power 25-26 May 2009
Heat demand divided on heat sources

Case A: Moderately improved building envelope and expansion of district heating

- Biomass
- Solar heating (individual)
- Heat pumps (individual)
- Stoves, electricity
- Central heating/w natural gas
- Central heating/w oil
- District heating
District heating demand and market share

Case A: District heating market

- Heat distribution losses
- Net heat demand
- Share of district heating

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District heating heat sources

Annual load - Case A
Fuel consumption per unit of district heating delivered to end-user and share of CHP

Case A: District Heating

Share of fuel/energy to cover 1 unit of heat

Waste, biomass etc.
Natural gas
Coal
Oil
Share of combined production

Share of combined heat and power production

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The 34th Congress of Euroheat & Power 25-26 May 2009
CO₂ emission in million tonnes for all heating and in kg/m² floor area

Case A: CO₂ emissions at moderately improved building envelope

- Heat pumps, other
- Stoves, electricity
- District heating
- Central heating/w natural gas
- Central heating/w oil
- CO₂ emissions factor at building
- CO₂ emissions factor outside the quota

Curves show CO₂ per floor area
Columns show the total

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The 34th Congress of Euroheat & Power 25-26 May 2009
Primary Ressource Factor (EuroHeat method) for 420 district heating systems

- Weighthed average in 2006
- Biomass CHP
- Small scale gas CHP and boilers

Heat Plan Denmark:
- 2006 +0.20
- 2020 -0.07
- 2030 -0.26
- 2040 -0.45
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.

- **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$_2$ 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
- Come to Copenhagen and have a look your self
Thank you for your attention!
See you in Copenhagen

Leading the way to Copenhagen November 3 2009
COP 15 December 2009
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