

Metropolitan Washington Council of Governments

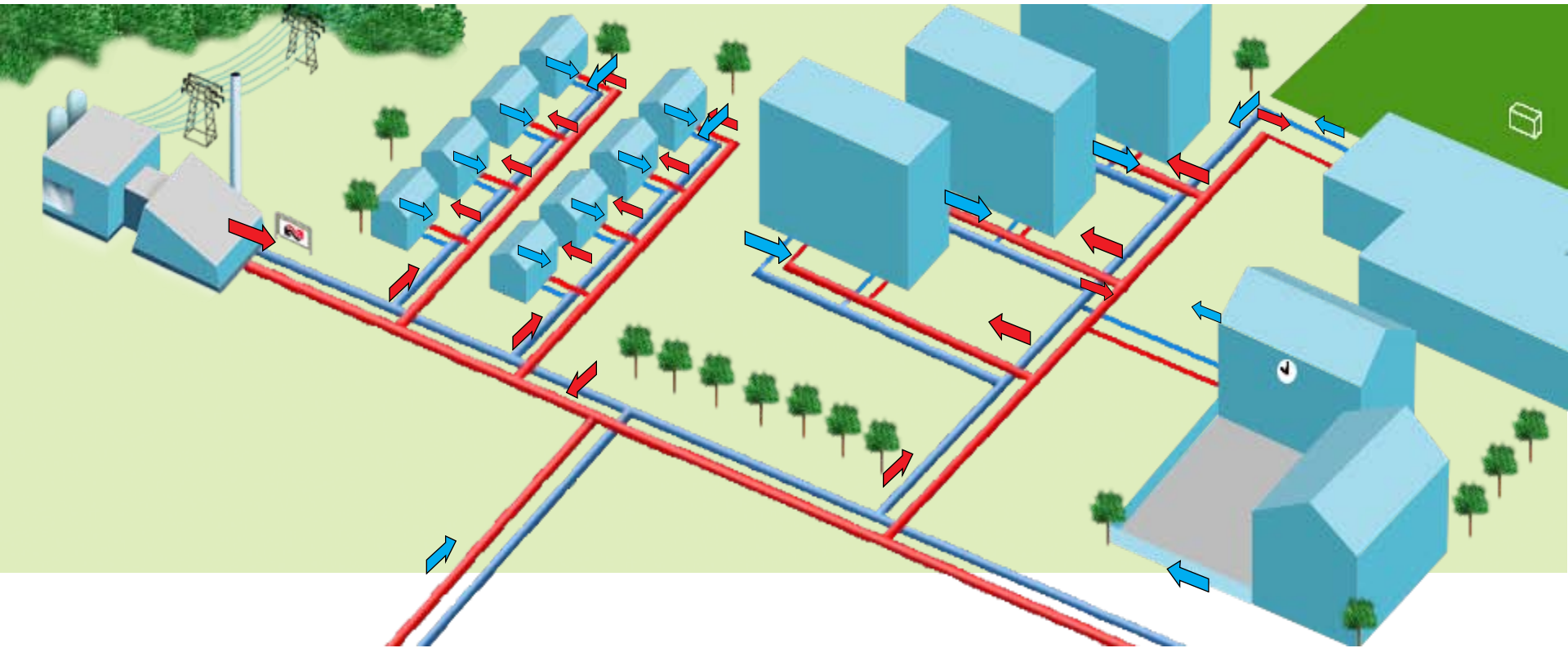
- Climate, Energy and Environment Policy Committee
(Why?) Denmark's District Energy Planning

Washington, DC, January 26th, 2011



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➤ District Heating is under ground



- Nationally exists 30.000 km pipe system
- 62 % of all homes have District Heating
- This is equivalent to approx 50% of the total heat demand

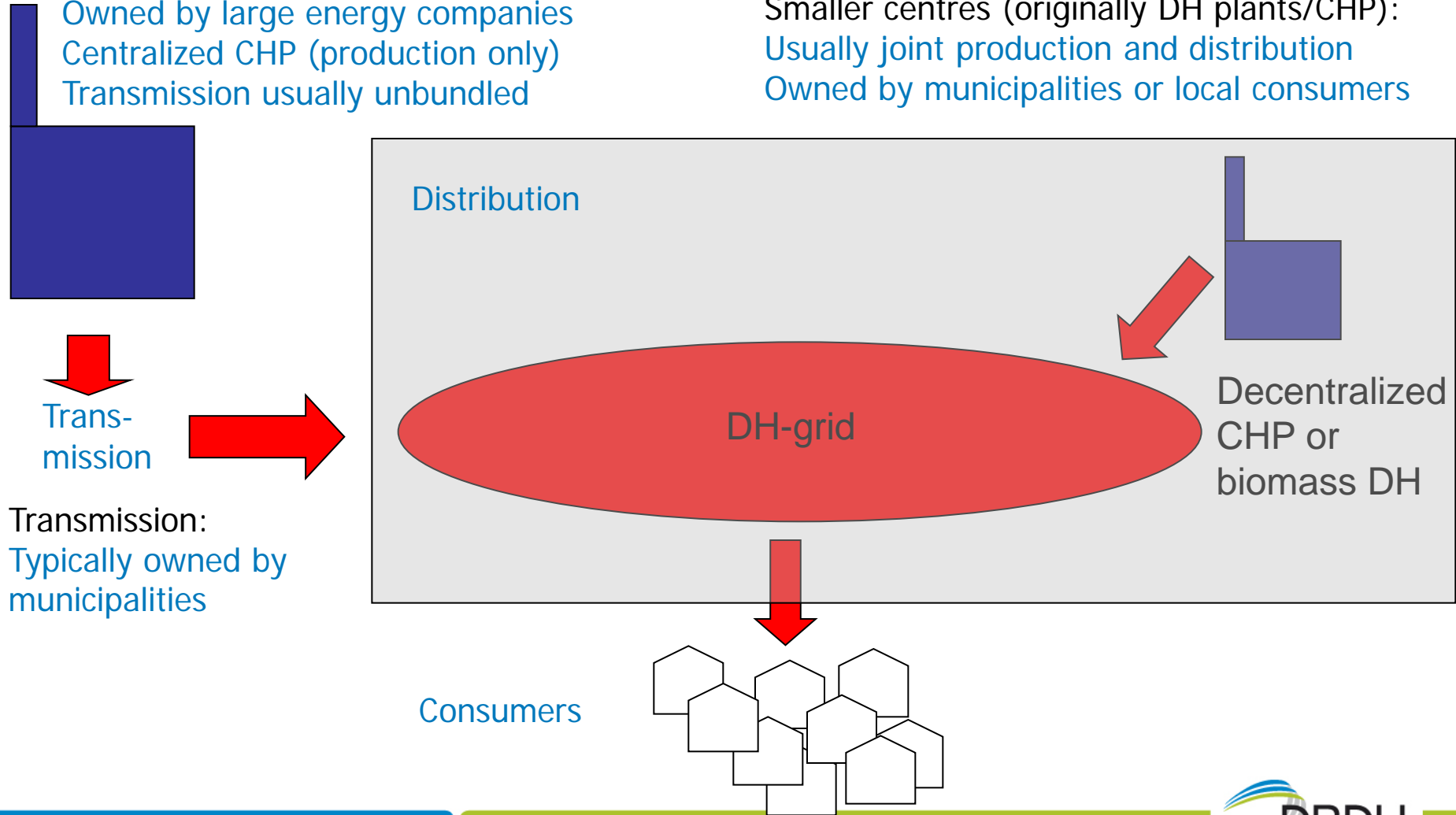
➤ Organizational Set-Up of 2 Types of DH

Large cities (originally power plants):

- Owned by large energy companies
- Centralized CHP (production only)
- Transmission usually unbundled

Smaller centres (originally DH plants/CHP):

- Usually joint production and distribution
- Owned by municipalities or local consumers



➤ What triggered the energy revolution?

- 1973-74 oil crisis
- 2 countries were 98% dependent on imported energy: Japan and Denmark (oil and coal)
- Supply situation exacerbated by inefficient energy use
- Sharply rising oil prices caused severe economic crisis and high unemployment.



A matter of national security and top economic priority to embark on new sustainable solutions



Show car free Sundays in Denmark as a result of the oil crisis in 1973

➤ Political Leadership before anything else

DECIDED THAT WASTED ENERGY IS BAD AND REACTED!

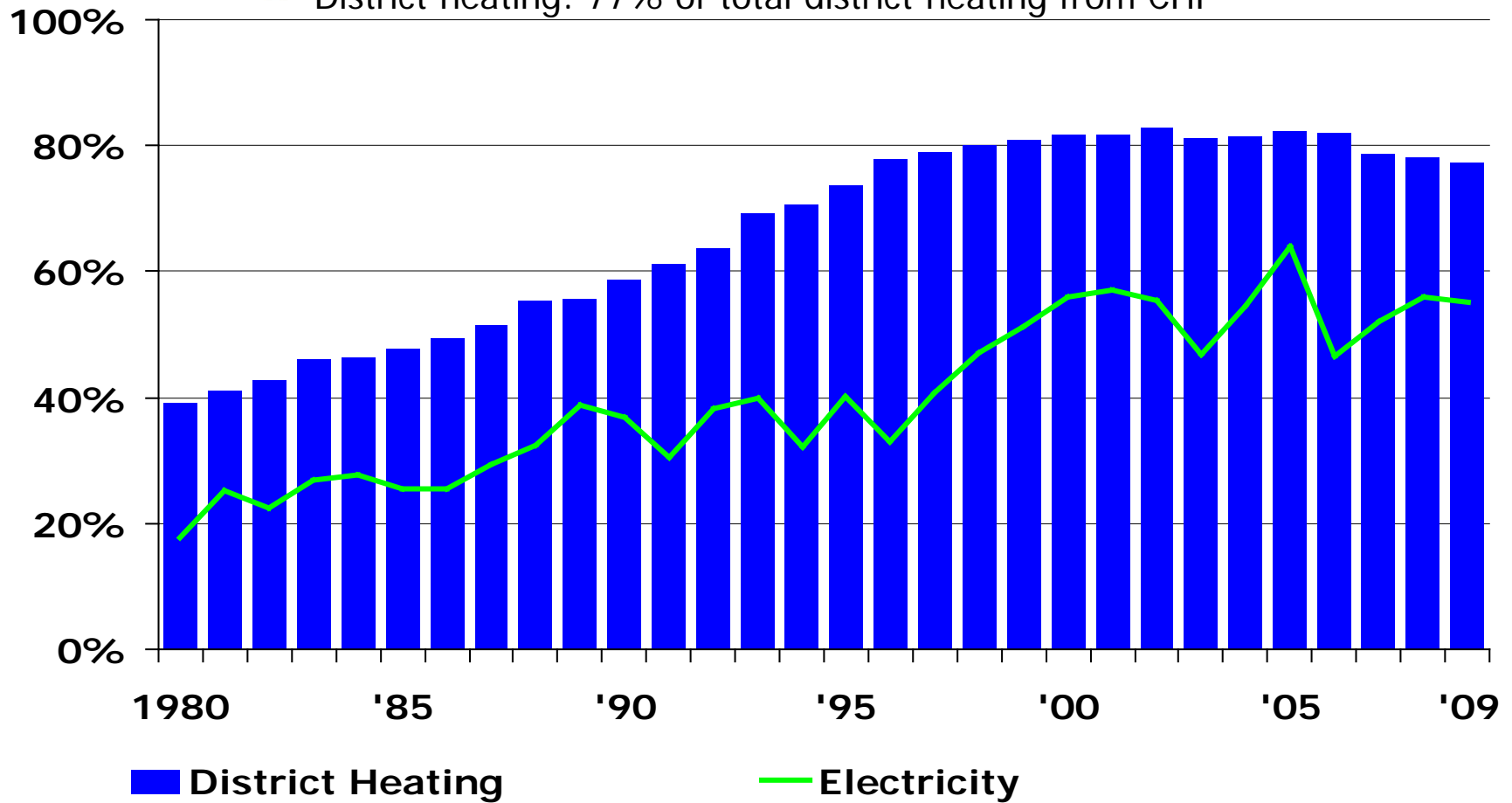
➤ Energy Legislation

- 1976 – Electricity Supply Act
- 1979 – Heat supply act
- 1986 – decentralized CHP to promote domestic fuels, e.g. biomass
- 1990 – increase use of biomass by building new CHP and converting existing coal and oil fired CHP's to e.g. biomass
- 1993 – Concrete measures to increase use of biomass to 20 PJ/Year
- 2008 – Further increase use of biomass by 700.000 tons
- 2011 – Fossil Free Society?



➤ District Heating as Combined Heat and Power

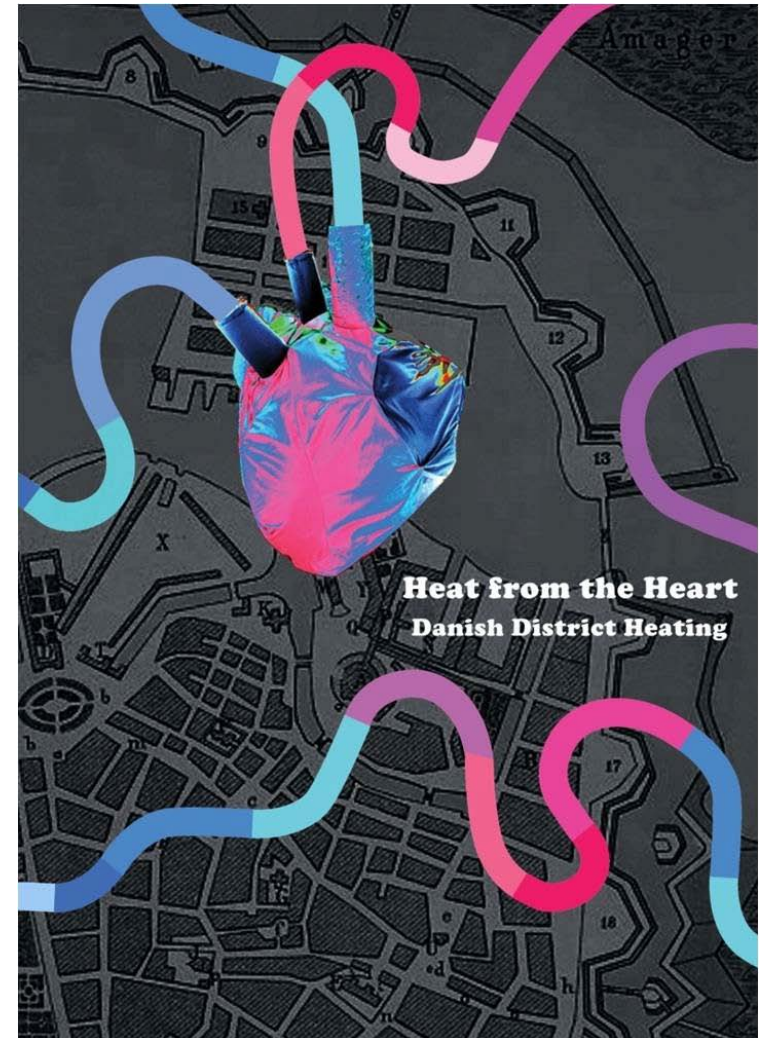
- CHP contribution to total production in 2009:
 - Electricity: 55% of total power from CHP
 - District heating: 77% of total district heating from CHP



Source: Danish Energy Agency

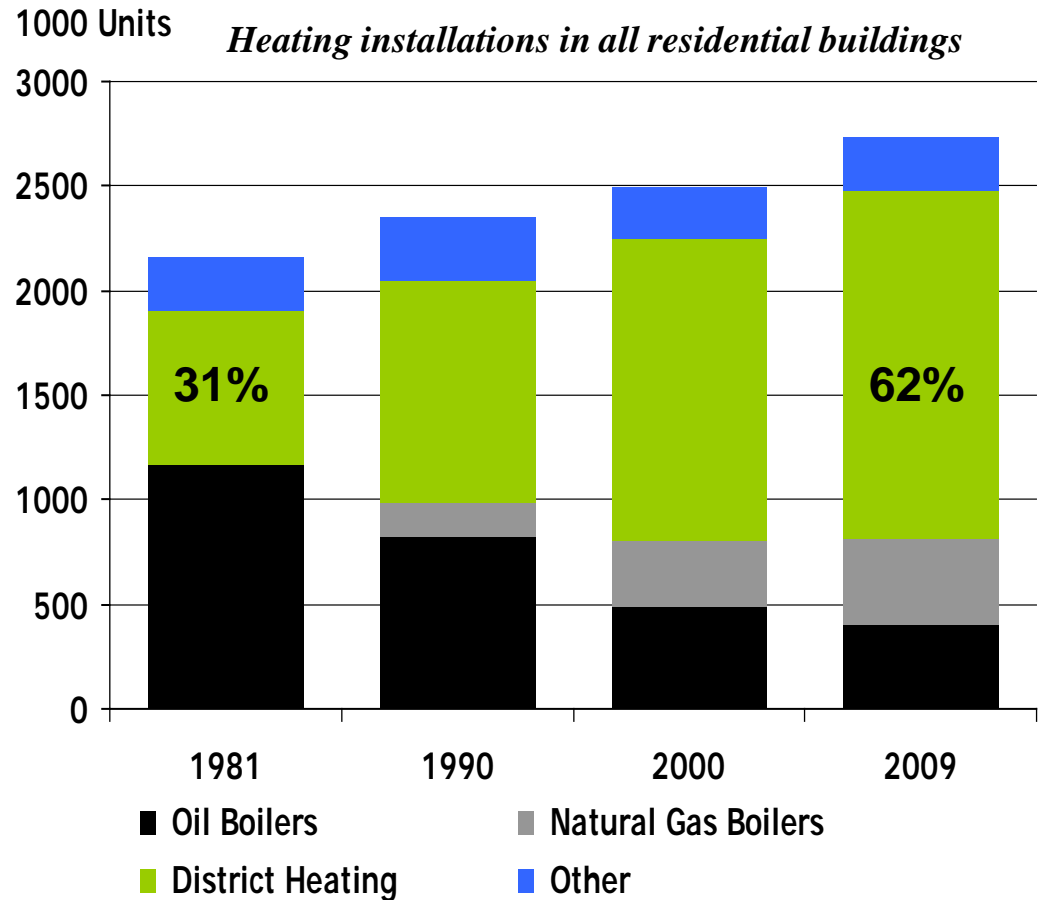
➤ Legal Framework of District Heating

- Heat Supply Act introduces supply zones all over Denmark with the aim of raising DH to 60% in 2000
- Heat Supply Act sets frame for local decisions by typically Municipalities
- All DH companies are non-profit entities
 - **Heat price = True costs** (no local subsidies)
- If CHP: Split of costs between electricity and heat
- All consumers can complaint 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



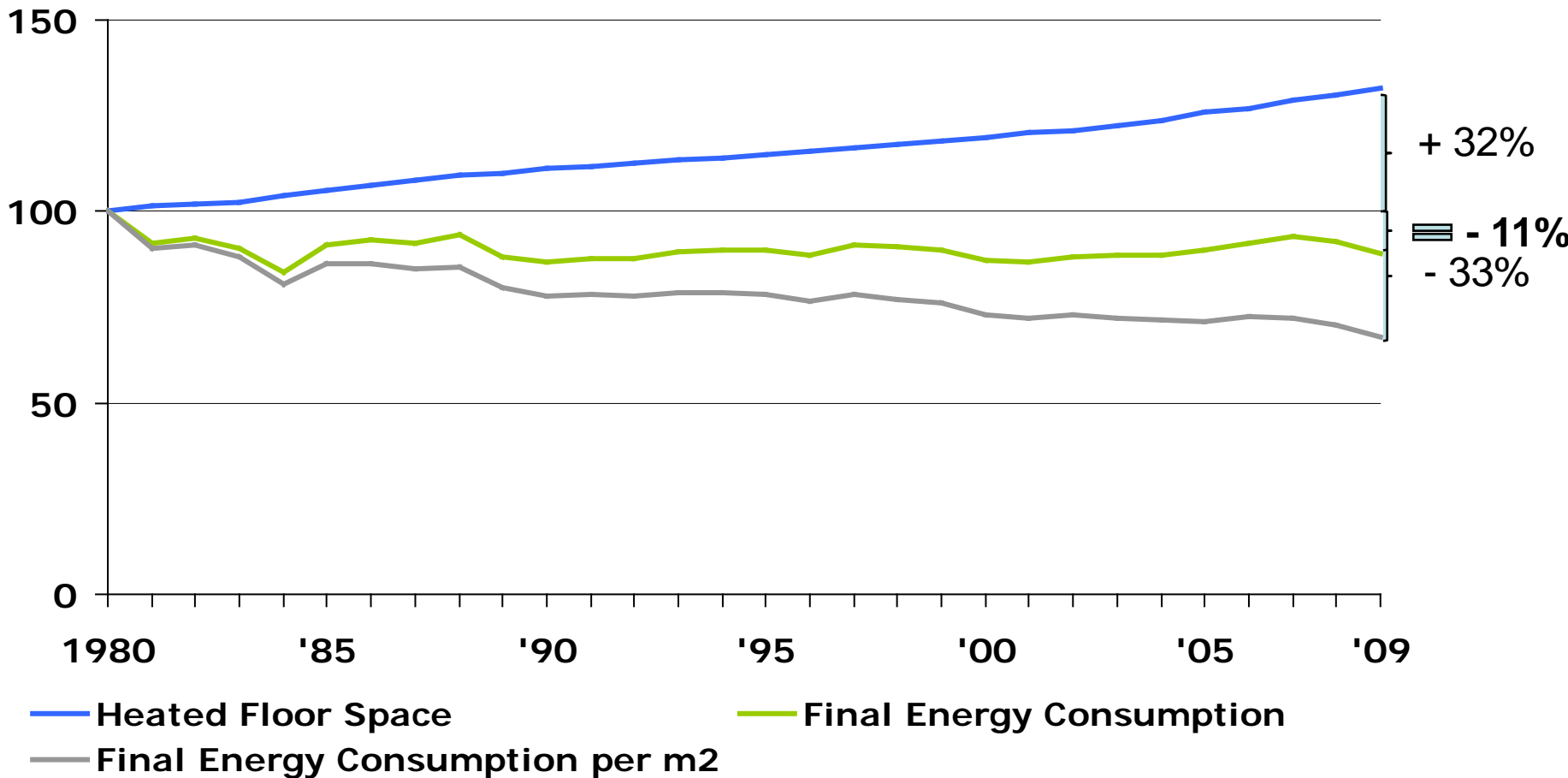
➤ District Heating in Historical Perspective

- Before the 1980's most DH was produced as a by-product from electricity around the cities.
- In the 1980's and -90's most new DH was a main-product. Produced as DH or CHP in towns.
- The share of DH doubled from 1980. Today 1.6 mill. houses supplied with DH.
- Future: 100,000 houses with individual NG → DH – more?
- Oil Furnaces for heating will be banned?



Source: Danish Energy Agency

➤ The Heating Sector after Oil Crisis in 1973



RESULT: Net Reduction in Final Energy Consumption since 1980 in DH Areas

Source: Danish Energy Agency

➤ Today – 35 Years Later

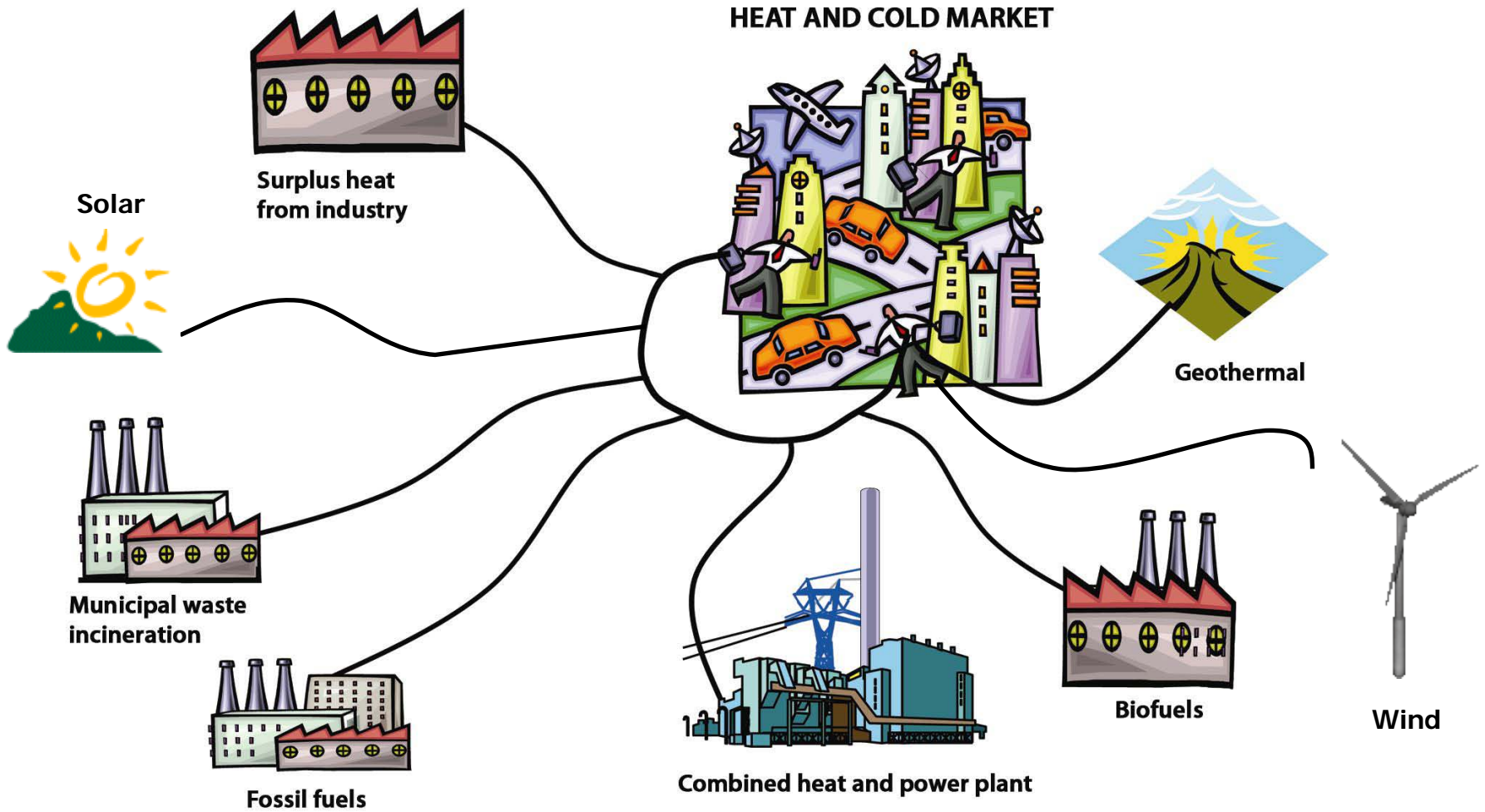
Main Results - Denmark:

- Self-sufficient with energy since 1997 (2009 = 124%)
- Lowest energy consumption per GDP-unit in EU
- Highest contribution to electricity from new renewables (non-hydro RE) in the world
- Most efficient clean coal technology world wide
- Leading nation of advanced energy solutions (**district heating and CHP**, wind turbines, biomass plants, energy saving technologies ...)

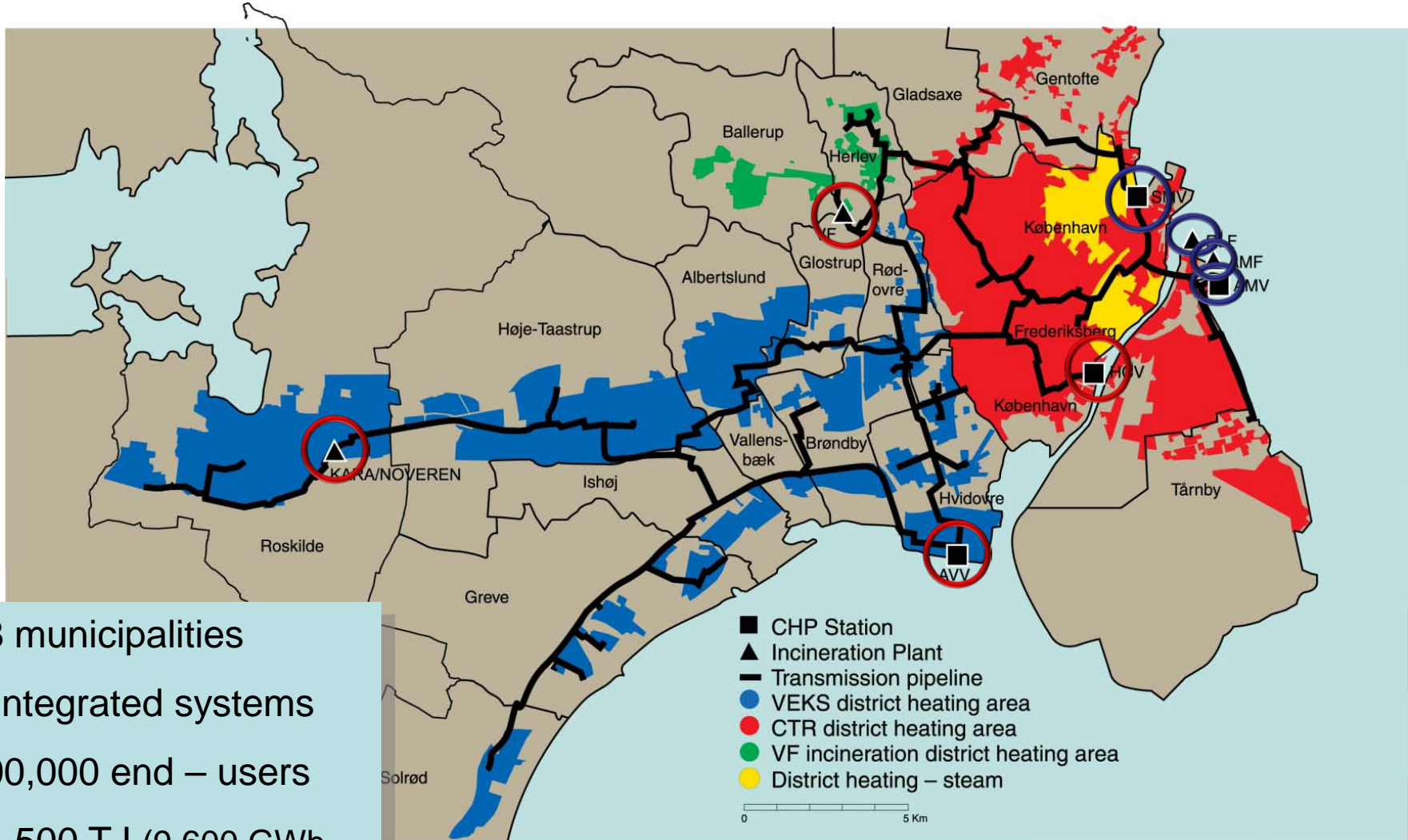


Front Cover of Hot|Cool 3/2009 (Focus: System Integrator on Urban Infrastructure)

➤ Today and Tomorrow's 'Smart Energy' Infrastructure



➤ The greater Copenhagen DH system – ‘real time’



18 municipalities

4 integrated systems

500,000 end – users

34,500 TJ (9,600 GWh,
32,700 GBtu)

➤ Strength of the system - flexibility

More efficient and flexible heat production by optimizing the choice of production unit depending on price on electricity

Heat production from:

- Oil
- Coal
- Natural gas
- Waste incineration
- Wood pellets
- Straw
- Biofuel
- Geothermal energy

Heat production from:

- 27 % - Waste
- 2 % - Geothermal
- 70 % - CHP
- 1 % - Peak load



➤ Consumer Prices for District Heating (2010/11)

District heating is significantly cheaper than alternative supply:

- 98% of all district heating consumers pay less for their heat compared to heat from individual household-based oil stoves
- Compared to the cost of heat from an individual natural gas boiler, 95% of DH customers pay less
- DH consumer price averages 2,650 USD (18.1 MWh/year) = about 4% of HH income.
- Natural Gas = 3,670 USD
- Oil Furnace = 4,590 USD

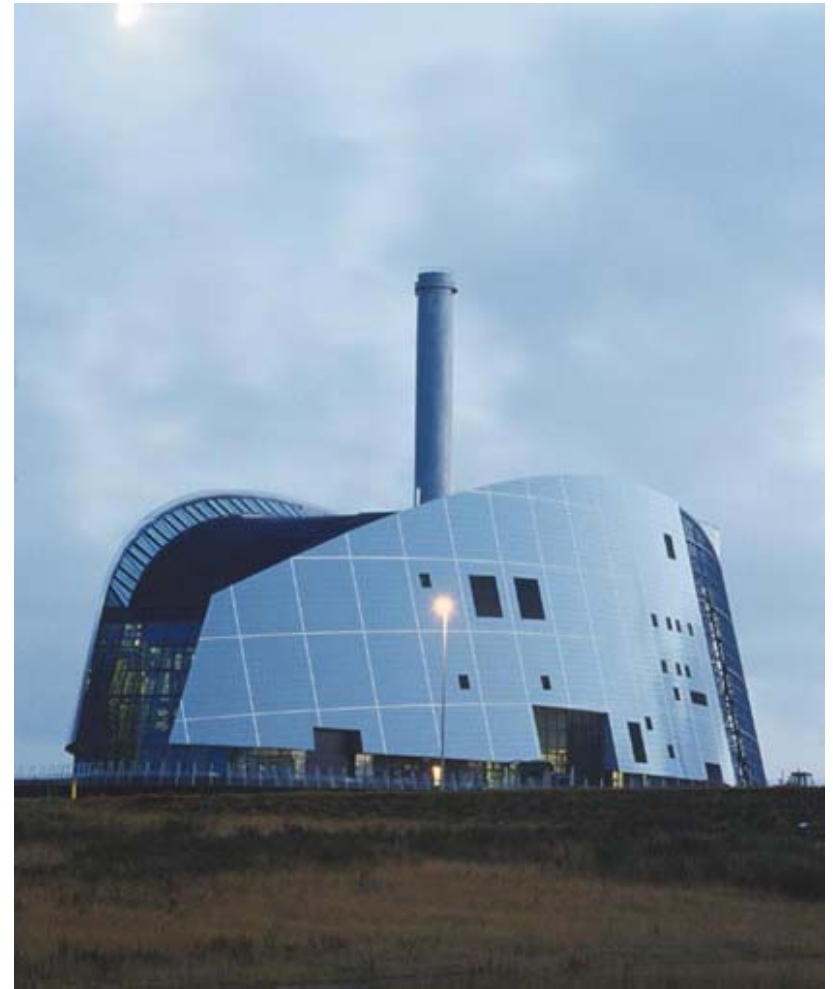


Photo: Energy Viborg District CHP Plant
(Architectural Design Matters)

Source: Danish District Heating Association

➤ Danish Lessons Learned on DH

The Kinder Surprise Effect



- Increased Security of Supply
- Cost-effective energy consumption
- Reduced CO₂-emission

- Feasibility studies with realistic demand assessment ensure equal competition with individual heat supply
- Only DH if feasibility study documents lower consumer prices and economic benefits for DH company and society. Extra safety margin if small communities (villages)
- Consumer prices must reflect real market costs. Subsidies must be transparent and take form as investment grants and kWh-subsidy from the state
- DH can be cost-neutral for the state by CO₂/energy-tax
- Consumers protected against misuse of supply monopoly by independent state authority and complaint board

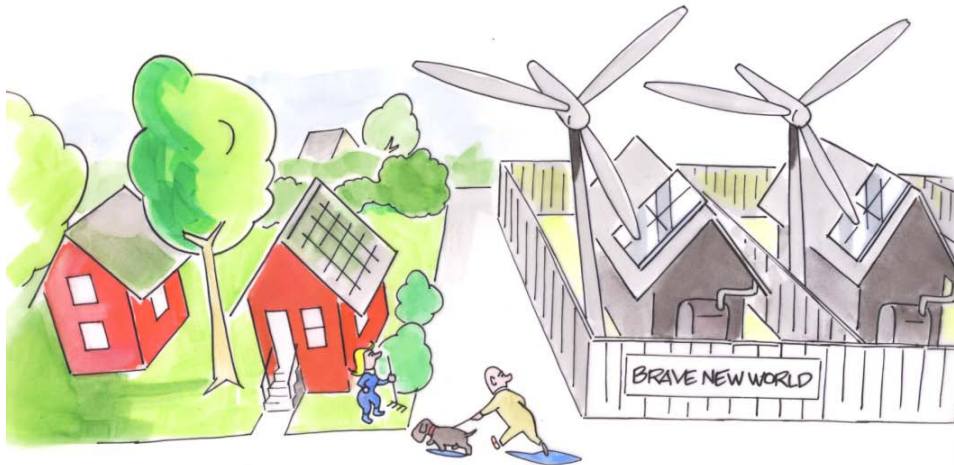


➤ CASE: Køge
A new Large Greenfield
DH system in Denmark
approx. 40 km outside CPH



➤ Overall push for the project

- A broad consensus in the Danish Parliament that **Denmark** in the long term has to be **independent** of **fossil fuels**.
- The EU directives require that the reduction of CO₂-emissions must be done in a cost-effective way.
- The **Renewable Energy Directive** (RE-Directive) requires that **cities must plan for** district heating and cooling (**DHC**) in order to use RE where it is advantageous for heating, preparation of domestic hot water and cooling.



➤ First things first – a Development Plan...

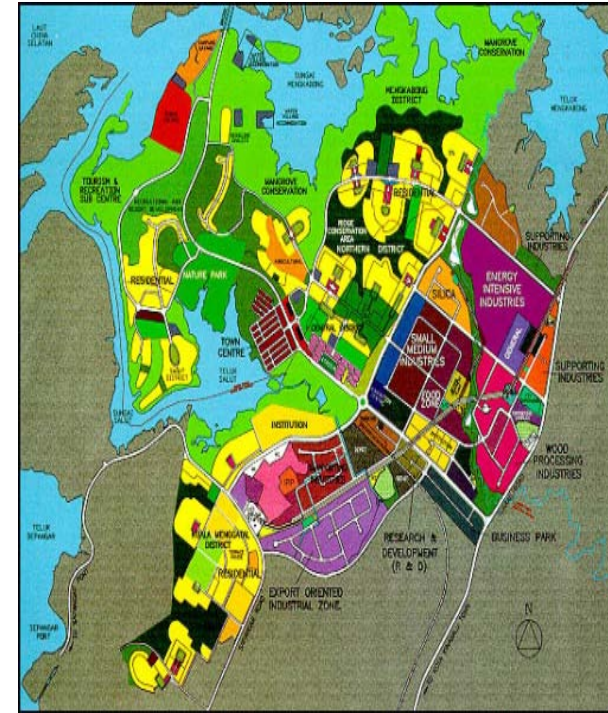
- The Development Plan is a study of the economic, customer-economic and environmental consequences:
 - A positive economy for the society is necessary to subsequently obtain authority approval of the project.
 - A positive customer economy is needed to motivate customers to connect to the DH system.
 - Environmental impact must be known before such a large project begins.



➤ What does the Development Plan?

➤ Preconditions for the Development Plan:

- The main parts of all buildings larger than 300 m², - or approximately 1.8 million m² - are connected to the DH system
- Approximately 600,000 m² of new buildings will be connected during the project period 2011-2031
- From 2016 a natural gas consumption of 15 mill. m³/year will be replaced by DH - 1.4 million m² building area connected to DH
- From 2020 a natural gas consumption of 19 mill. m³/year will be replaced by DH



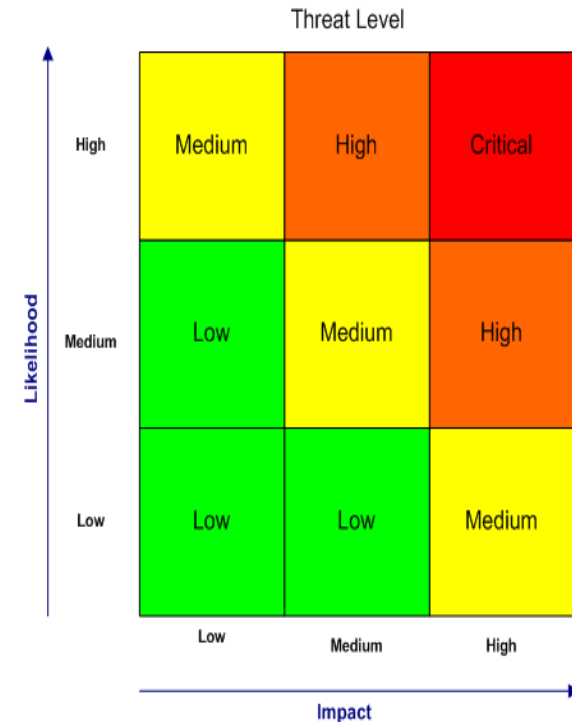
➤ Economics

- A very robust reduction of economic costs over the project period (20 years):
 - The economic cost of fuel purchases and operation and maintenance of the current natural gas supply will be approx. € 128 million
 - The corresponding cost connected to the conversion to DH will be approx. € 105 million or equivalent to a saving (NPV) of € 23 million
 - The internal rate of return (IRR) for the project in relation to a reference with condensing gas boilers and heat pumps are calculated to 10 %



➤ Customer economy

- With the assumed guaranteed reduction in DH price of 10 % for all current natural gas customers, all DH investments will be repaid over the project period
- The largest and most uncertain project risk is associated with future natural gas prices:
 - If natural gas prices are reduced by 5 % throughout the project period, the corresponding lower DH tariff extend the amortization period from 20 to 23 years
 - If natural gas prices are reduced by 10 % throughout the project period the amortization period will be extended to 27 years
 - Since the Danish DH legal framework allows amortization periods up to 30 years, the economy for the project is considered to be robust



➤ Tariff structure – Price Guaranteed

- The project propose a **Price Guaranteed** for DH of **90 %** of the **equivalent** annual cost of heating **based on natural gas**
- Price Guarantee means that customers are not burdened financially with extraordinary one-time costs of converting to DH
- The DH investments to be covered through the guaranteed price



➤ Investments

- The total investment will be remunerated and depreciated by the DH customer via their contribution for the DH supply
- Loans will be taken for financing the investments
- The total DH investments are calculated to approximately DKK 600 million (€ 80 mill.) covering DH network and the associated customer installations



➤ Reduced CO₂ emissions



- The main environmental impact of the project is a large **reduction** in CO₂ emissions of approx. **40,000 tonnes per year**.

➤ Thank you for your attention



“ Every Generation needs a new revolution”

- Mr. Thomas Jefferson