



# Zukunft dezentraler Energien am Beispiel Dänemarks

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Berlin, 5. Mai 2008

# The Danish Point of Departure

- 1973-74 oil crisis
- 2 countries 99% dependent on imported energy
  - Japan
  - Denmark (oil and coal)
- Supply situation exacerbated by inefficient energy use
- Pollution caused by fossil fuels

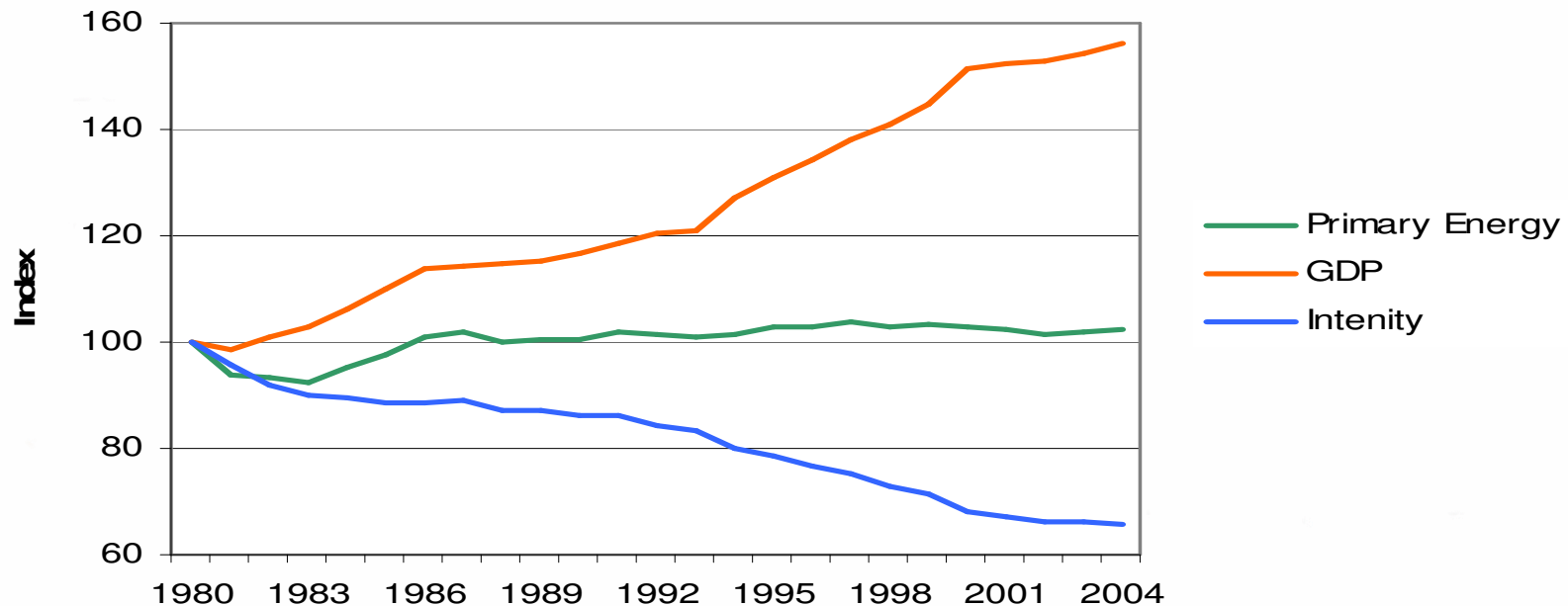
# Today – Some 30 Years Later

## Main Results - Denmark:

- Net exporter of oil and gas
- Lowest energy consumption per unit of GDP in EU (not Switzerland and Japan)
- Highest contribution to electricity from new renewables in EU (world?)
- Most efficient clean coal technology world wide
- Leading nation of advanced renewable energy technologies (wind mills, biomass)

# Today – Some 30 Years Later

- World's most ambitious target for CO<sub>2</sub> reduction (Kyoto)



High economic growth: **GDP +56 % since 1980**

Primary energy consumption constant: **2 % higher in 2004 than in 1980**

CO<sub>2</sub> reduced substantially: **35 % lower in 2004 compared to 1980**

# Danish Energy Production

**Gross Energy Consumption = 830 PJ**

## **Electricity:**

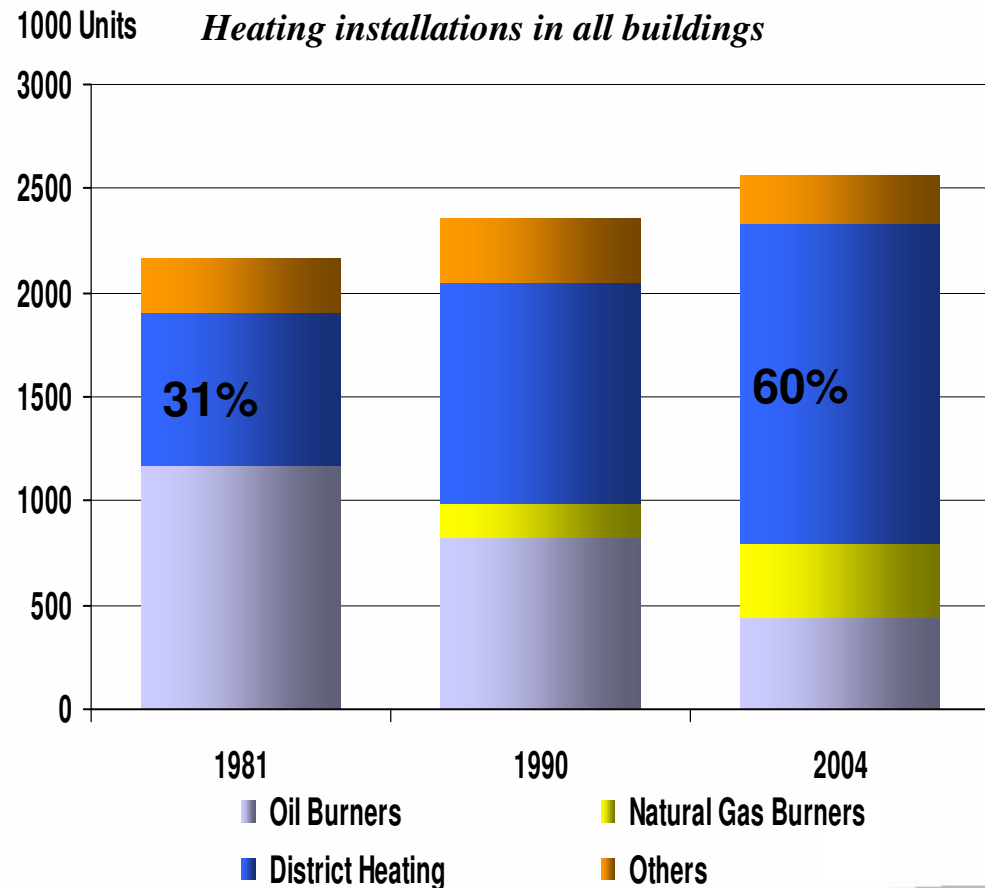
- **Consumption = 127 PJ (35.2 TWh)**
- **Production Capacity = 13,300 MW<sub>el</sub>**

## **District Heating:**

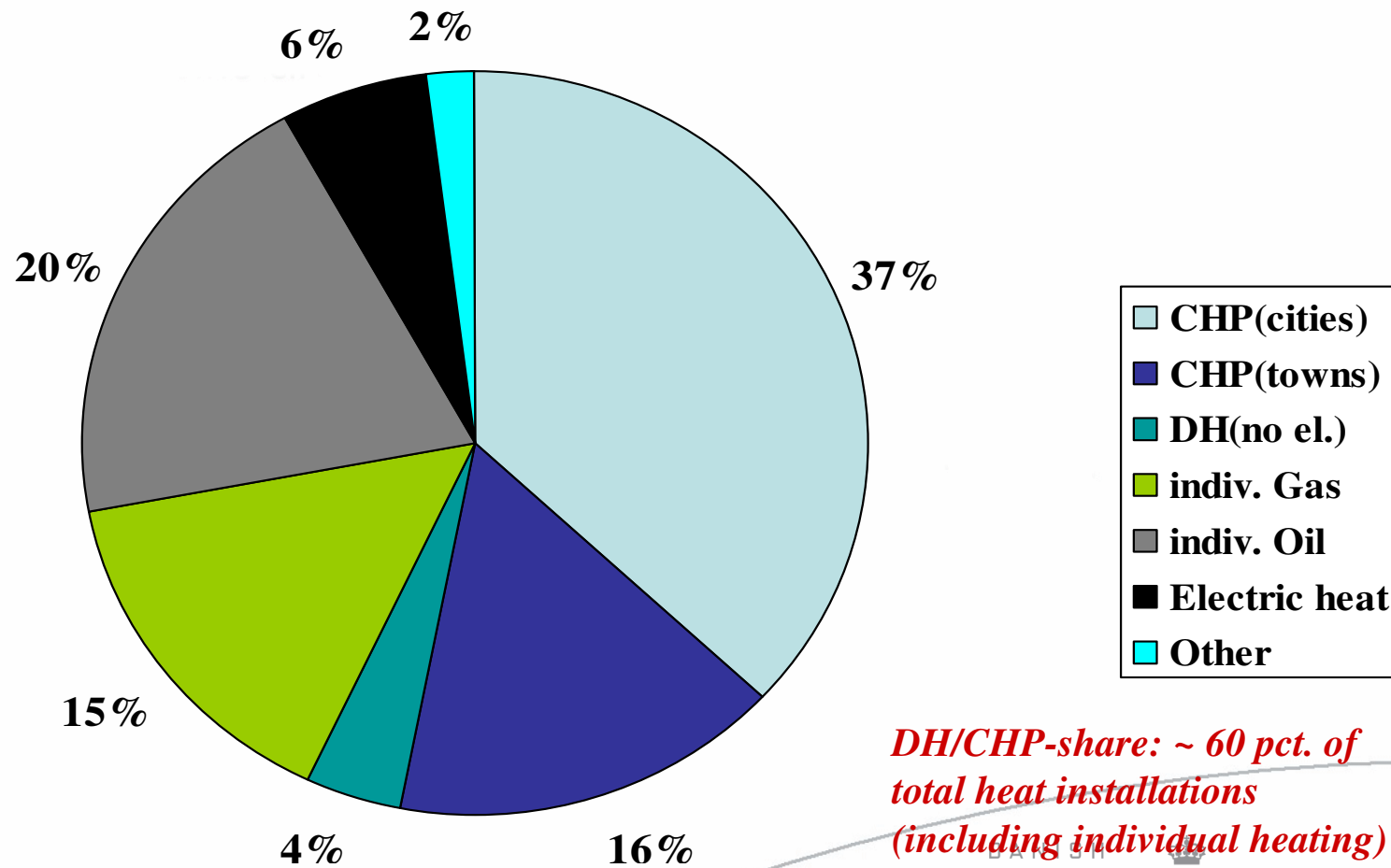
- **Consumption = 126 PJ**
- **Production capacity = 10,600 MW<sub>heat</sub>**

# District Heating in Historical Perspective

- Till the 1970'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 onwards. Today 1.5 mio. buildings (houses, apartment blocks and industries) are supplied by district heating



## Present Heat Supply at 2.5 Mio. Residential Units



*DH/CHP-share: ~ 60 pct. of  
total heat installations  
(including individual heating)*

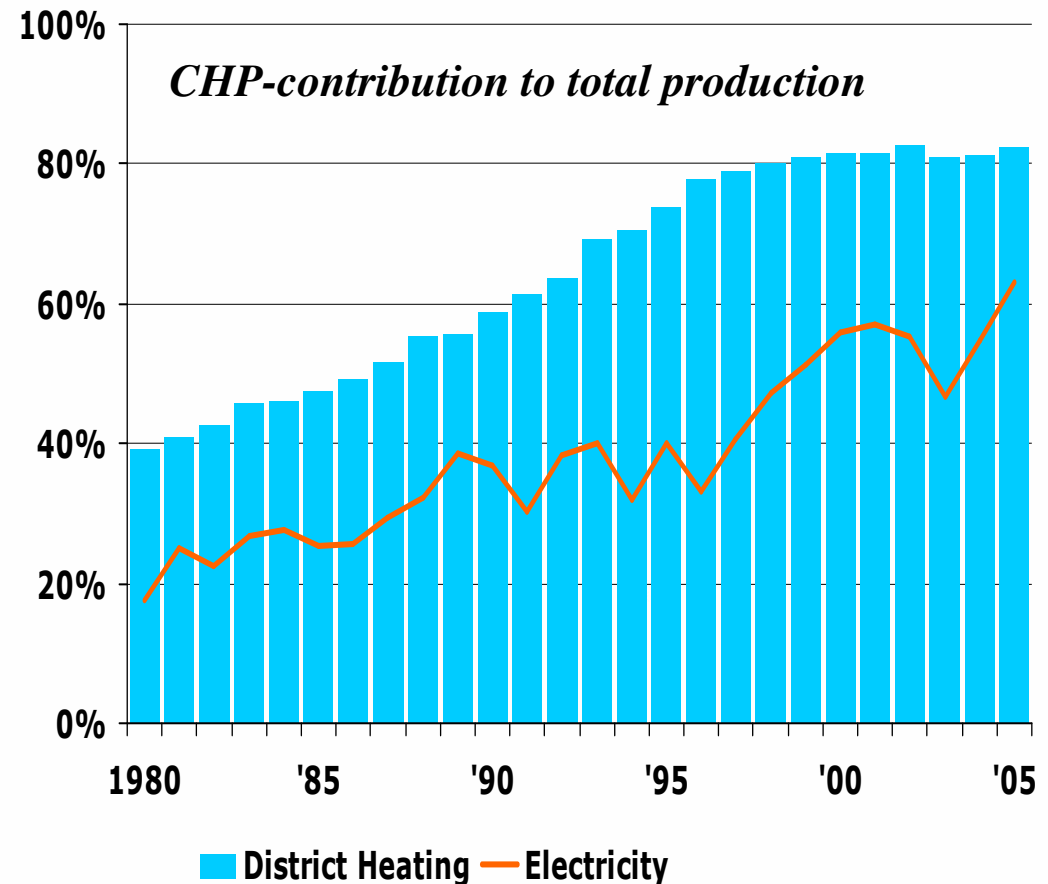
# Combined Heat & Power Production

- First CHP at municipality hospital in 1904
- First large-scale CHP commissioned in 1934
- Conversion of DH to CHP + New small-scale CHP's during 1980's and 1990's



CHP-share:

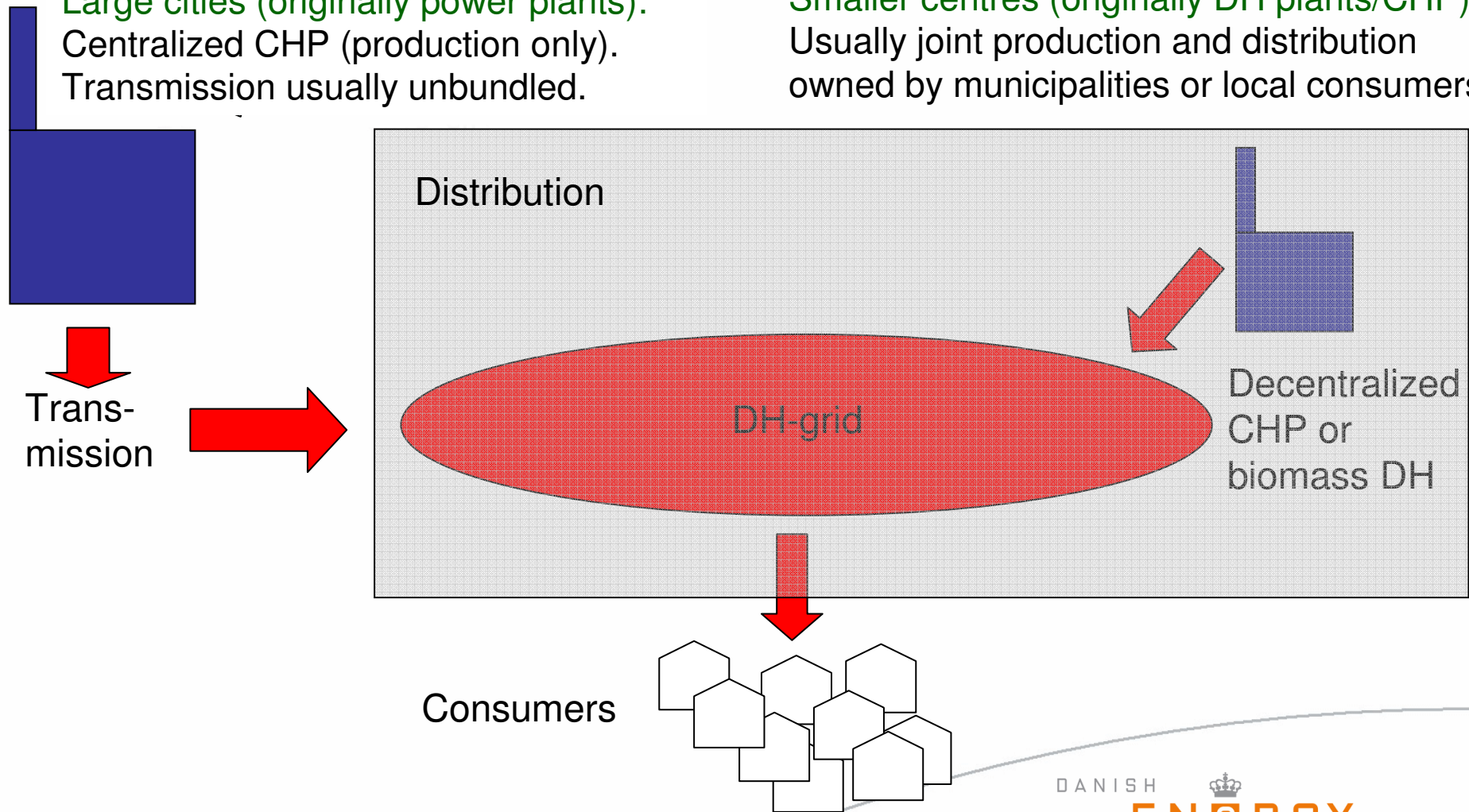
- Electricity: 60%
- District heating: 82%



# Organizational Set-Up of 2 Types of DH

Large cities (originally power plants):  
Centralized CHP (production only).  
Transmission usually unbundled.

Smaller centres (originally DH plants/CHP):  
Usually joint production and distribution  
owned by municipalities or local consumers



# From Centralized to Decentralized CHP

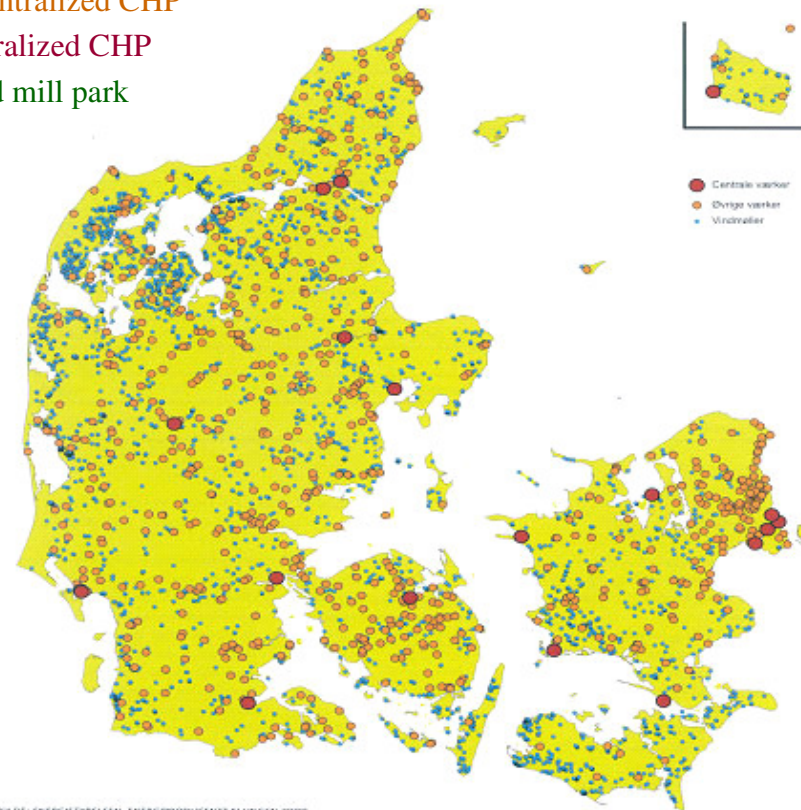
Centralized production in the mid 80's



Legend:

- Decentralized CHP
- Centralized CHP
- Wind mill park

Decentralized production of today



KILDE: ENERGISTYRELSEN, ENERGIPRODUKENTTÆLLINGEN 2000, VINDMØLLERKOORDINATER, KORT & MATRIKELSTYRELSEN 2001

# Reasons behind DH Expansion

- First Heat Supply Act on District Heating (1979)
- Municipalities have right to impose compulsory connection and continuance to DH networks (1982)
- Electric heating is forbidden in DH areas (1988)
- New heat planning system (1990):  
Letters of condition to municipalities
- Financial support to establish or enlarge DH based on bio fuels or CHP on natural gas (1994).

# Reasons behind CHP Expansion

- First political agreement on decentral CHP (1986)
- Political agreement on conversion of existing units to CHP (1990) – 3 phases:
  - 1990-94: Large DH-plants from coal/gas to CHP (gas)
  - 1994-96: Remaining larger coal/gas DH-plants to CHP; small DH-plants outside gas-grid converted to biomass
  - 1996-98: Small gas heat-plants to CHP
- Obligation for municipalities to ensure development of CHP if it is socio-economic viable (1990)

# Reasons behind DH/CHP Expansion

- **Economic incentives**
  - Subsidies for CHP electricity (1984: RE/1992: NG)
  - Investment grants for biomass DH and CHP (1981)
  - Energy tax and CO<sub>2</sub> tax on fossil fuels (1991) = Incentive to co-production + conversion to environmentally friendly fuels
- **Information, R&D**
  - Public support to research, development and demonstration of new technologies (1980)

# Consumer Prices for District Heating

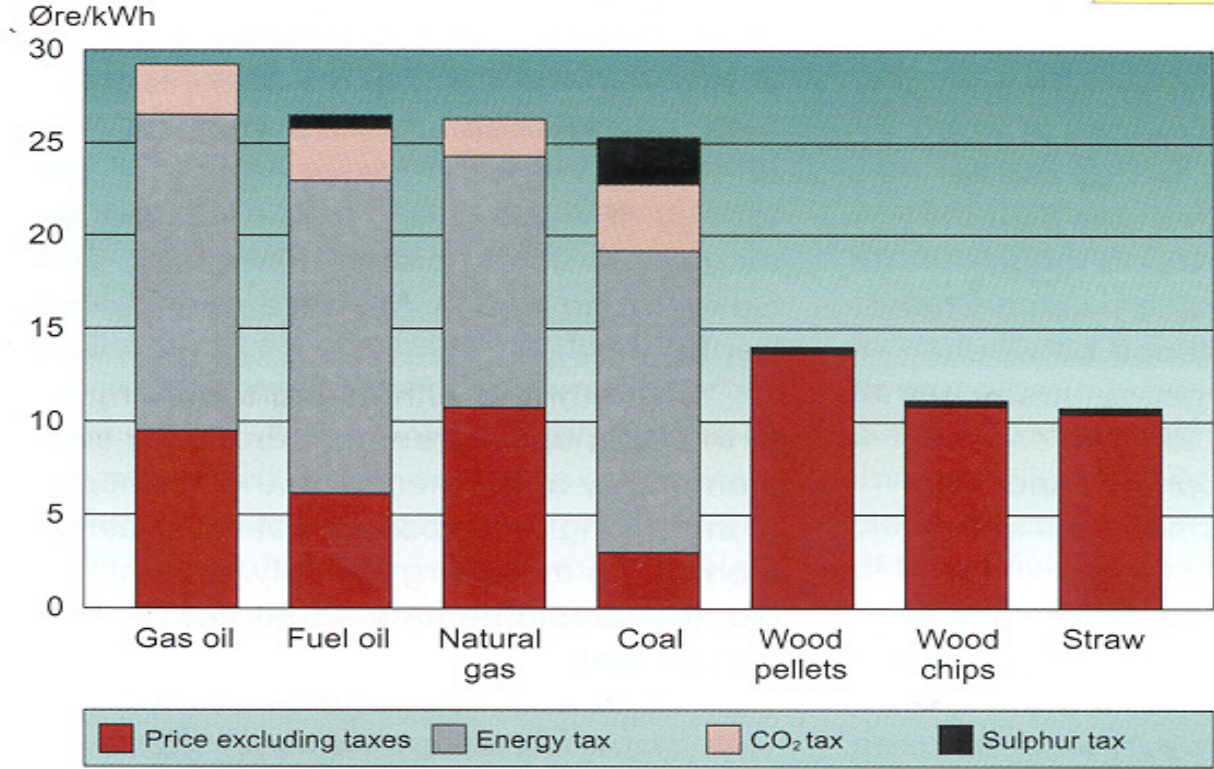
District heating is significantly cheaper than alternative supply



- 97% of all district heating consumers pay less for their heat compared to heat from household-based oil stoves
- Compared to the cost of heat from an individual natural gas boiler, 83% of DH customers pay less (2006).



# Fuel Prices in Denmark



# Organisation of the transmission business

- Energinet.dk
  - State owned TSO
  - operates the +100 kV grid and international interconnectors
  - owns the 400 kV and leases the 132/150 kV grid
- 11 Regional Transmission Grid Companies own the 132/150 kV-grid
  - the State (Energinet.dk) has the right (and obligation) to purchase these grids in case of certain changes in the ownership of the companies

# Size and length of the transmission system

Length of lines

2006	Km total	Cables (%)
400 kV	~1.400	~3
132-150 kV	~5.000	~20
30-60 kV	8.500	33
6-20 kV	61.600	87
0,4 kV	94.100	91

No. of transformers and installed capacity

	#	GVA
132-400 kV	150	29
30-60 kV	850	19
6-20 kV	69.000	24

# Regulation of transmission business

- Construction of new transmission lines above 100 kV to be approved by the Ministry of Climate & Energy (Art. 21 in Electricity Act)
- Substantial changes to existing grid to be approved as well
- Applicant to justify the need for extra capacity or new connection e.g.
  - strengthen the security of supply
  - facilitate the creation of a well functioning electricity market
  - ensure integration of RE (wind) into the electricity system
- To be approved according to the Spatial Planning Act in parallel. This process has proved more difficult during the past 10-15 years due to local opposition against new overhead lines.
- Land owners being compensated according to a voluntary agreement negotiated according to civil law
- New cables below 100 kV only to be approved by the local authorities through a 'digging permit'

# Subsidies for environmentally-friendly generation of electricity

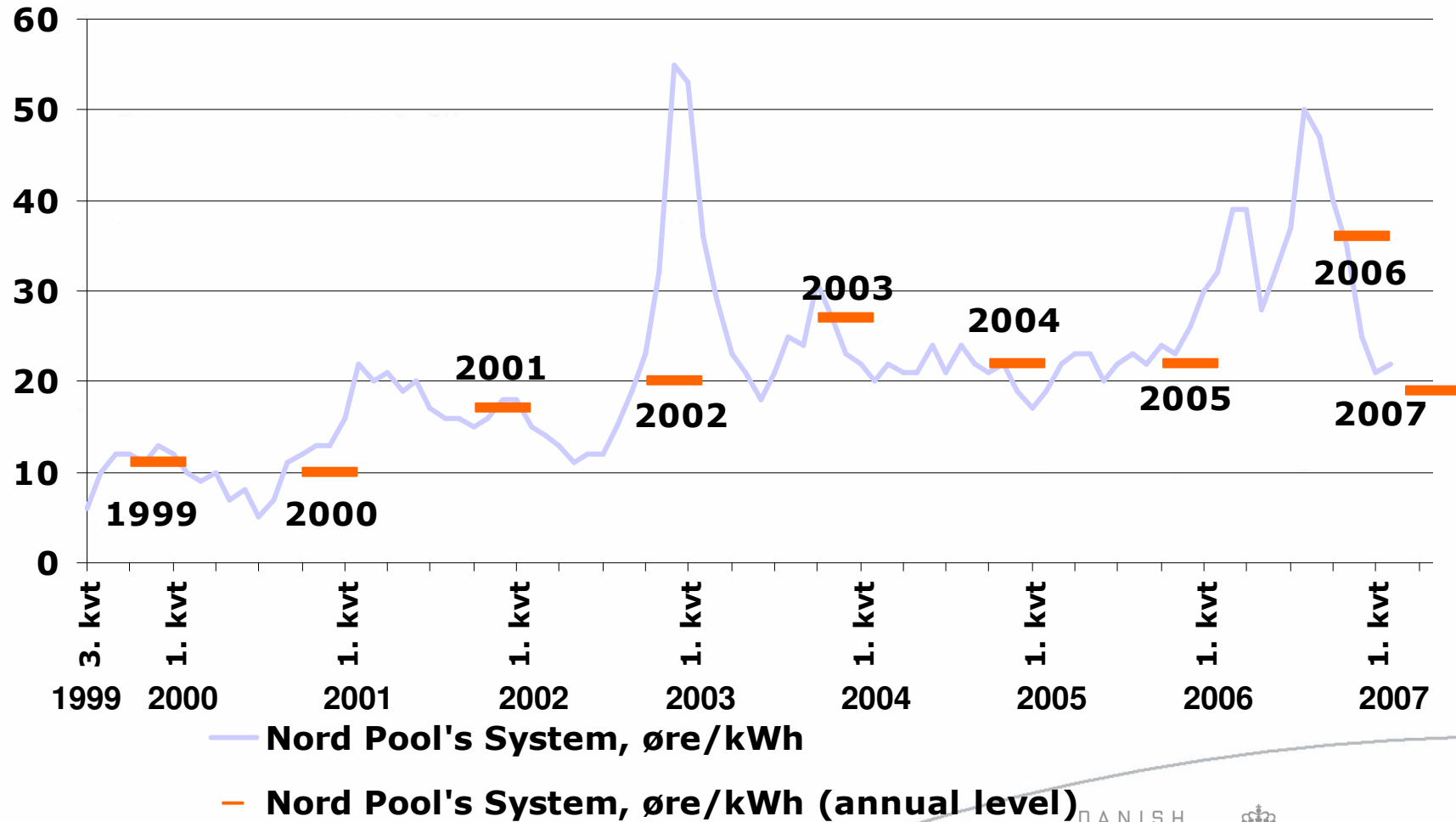
- Existing plants with output **over 5 MW** are eligible for an individual non-production related subsidy corresponding to that received in the period 2001-2003. The subsidy is paid for 20 years from the date of the grid connection and for at least 15 years as from 1 January 2004.
- Plants of or **under 5 MW** are eligible for a subsidy depending on when electricity production takes place. Combined with the market price, the subsidy ensures a tariff called three-tier tariff. At the start of 2005 the tariffs are approx. 22 øre/kWh at low demand, approx. 46 øre/kWh at high demand and approx. 59 øre/kWh at peak demand. Consequently, a typical mean annual tariff of 30-40 øre/kWh is achieved.

# Subsidies for environmentally-friendly generation of electricity (2)

- Additional subsidies for plants under 25 MW established before 1th July 2002
  - 8 øre/kWh for the first 8 mio. kWh

# Spot Market Prices for Electricity

Øre per kWh



Source: Nord Pool

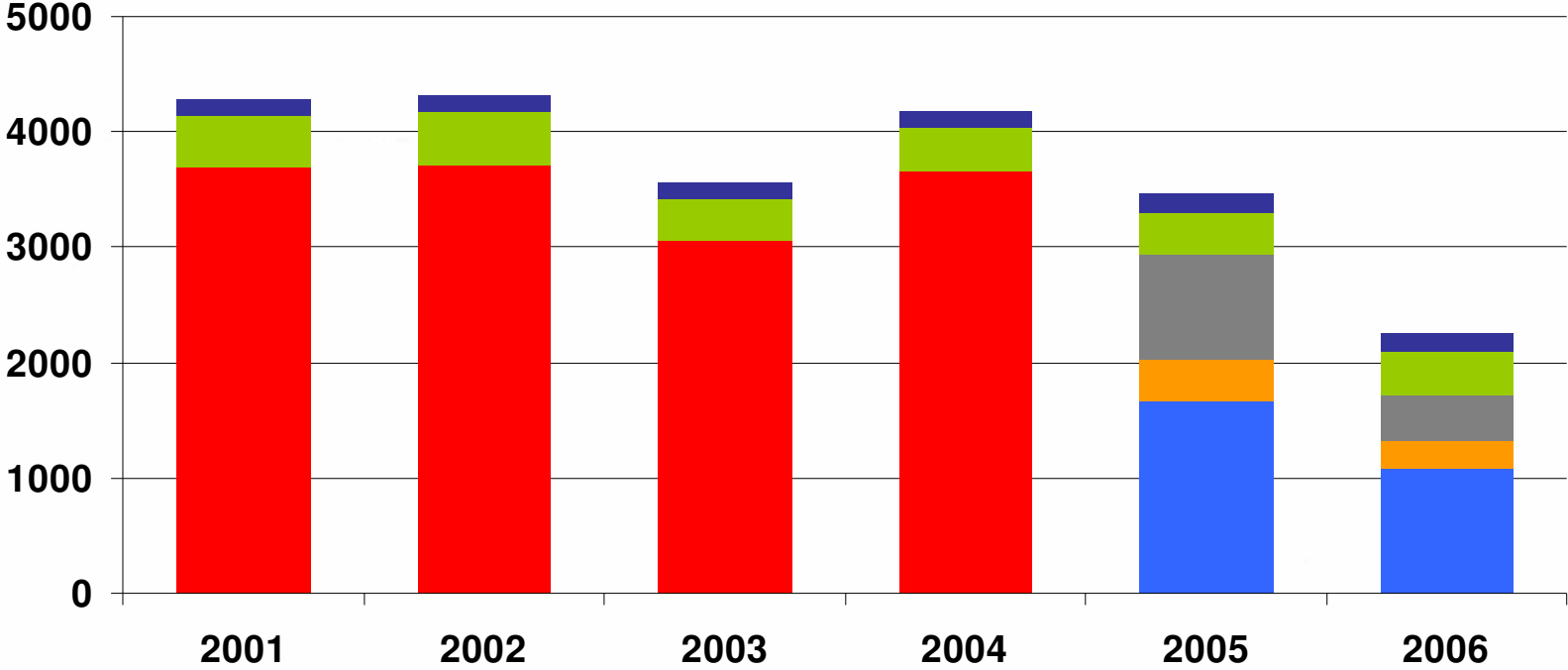
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# Expenditure on Public Service Obligations (PSO) in the Electricity Sector

Million DKK, Current Prices



- Other (R&D, Environmental Research etc.)
- Supply Security
- Payment of Subsidies for Environmentally-friendly Electricity
- Small-scale CHP Units
- Biomasse etc.
- Wind Power

# WWW.ENS.DK

## Facts and figures

- Find the data you need

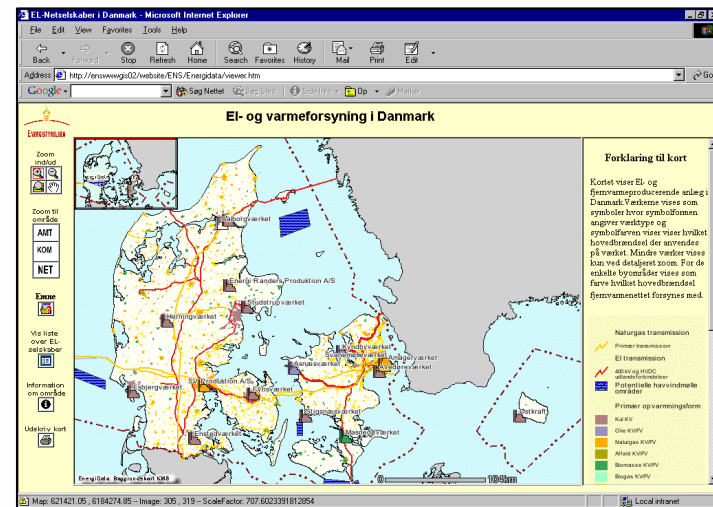
## Energy Statistic

- download data

Energibalancen 2000									
Enhedsenhed (TWh)	Løb	Råolie og kulforsyning	Gas	Naturgas	Kul og olie	Totalt energiforsyning	Udvalgte energiforsyning	Fjernvarme	Andre
Røttok produktion	813.438	356.335	11.552	186.511	165.921	90.580	2.394	144	-
Bæredygtig løb	1169.800	764.506	310.295	-	89.000	-	-	-	-
Fjernvarme produktion	609.940	171.658	244.836	-	161.484	1.520	30.300	144	-
Import	923.452	576.732	193.081	120.678	3.054	-	27.906	-	-
Brænding	50.058	-	56.858	-	-	-	-	-	-
Omsætning	447	-	640	-	-	-	-	-	-
Lagerændring	18.570	2.871	16.119	3.190	9.420	-	-	-	-
Statistisk differens	92	245	1.890	-	937	-	-	-	-
<b>Kraftmængder (MWh)</b>	<b>43.343</b>	<b>356.335</b>	<b>339.285</b>	<b>35.026</b>	-	-	<b>968</b>	<b>299</b>	-
Produktion	354.181	-	354.181	-	-	-	-	-	-
Førelse ved produktion	397.524	356.335	14.892	25.026	-	-	968	299	-
<b>Konvertering</b>	<b>109.525</b>	<b>-</b>	<b>45.717</b>	<b>92.016</b>	<b>153.645</b>	<b>62.216</b>	<b>123.814</b>	<b>117.725</b>	<b>679</b>
Centrale udlæg	81.189	-	20.803	39.950	12.131	-	82.800	25.483	-
Decentrale udlæg	3.636	-	152	46.925	1.004	30.340	37.687	32.003	-
Fjernvarmeudlæg	2.459	-	2.354	2.445	40	9.912	968	12.481	-
Forvare produktion	10.950	-	3.110	12.964	466	22.350	10.073	17.876	-
Produktion	152	-	520	-	-	-	-	-	-

## Energy Data

- print theme maps



## Themes

- Heat supply
- RE and Offshore Wind
- Links to background reports