

District Heating and Integration of Wind Power in Denmark

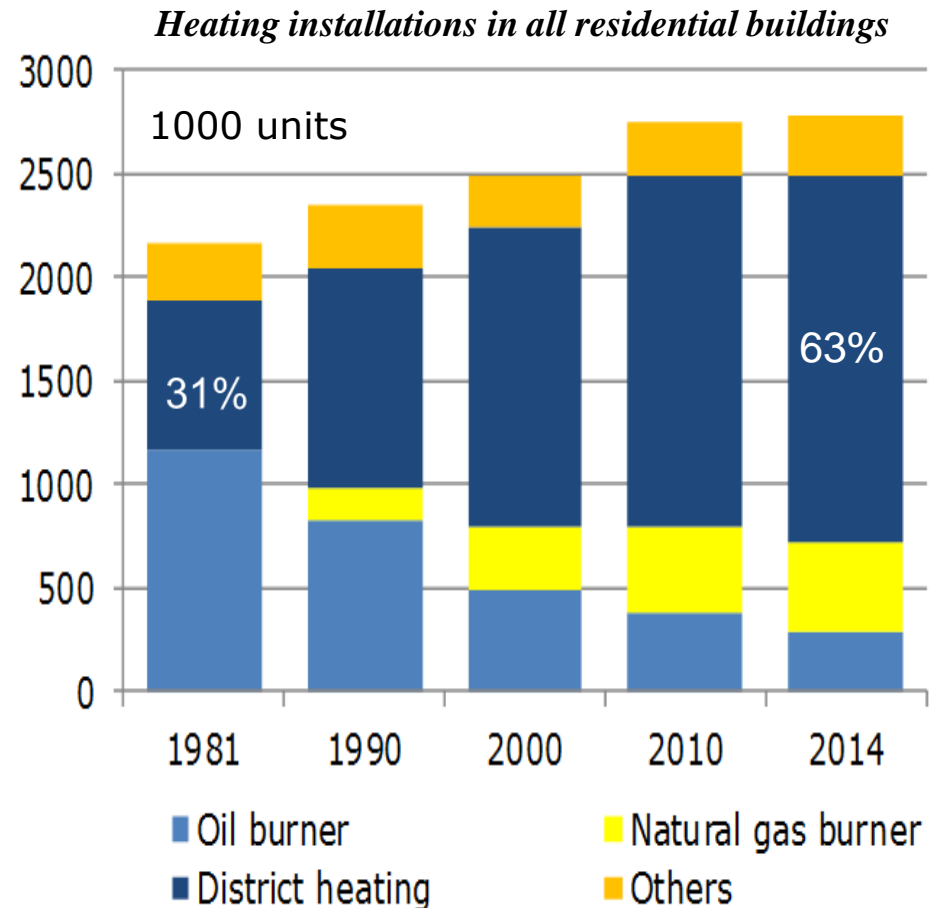
- From green fuels to green electricity

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Nationwide District Heating

- Till the 1980's most DH located around the cities.
- In the 1980's-90's new DH established in rural towns. The share of DH doubled in 30 years.
- Future: Development of electricity-based DH.
- **HOW? Past and future means and measures?**



Heat Supply Zones

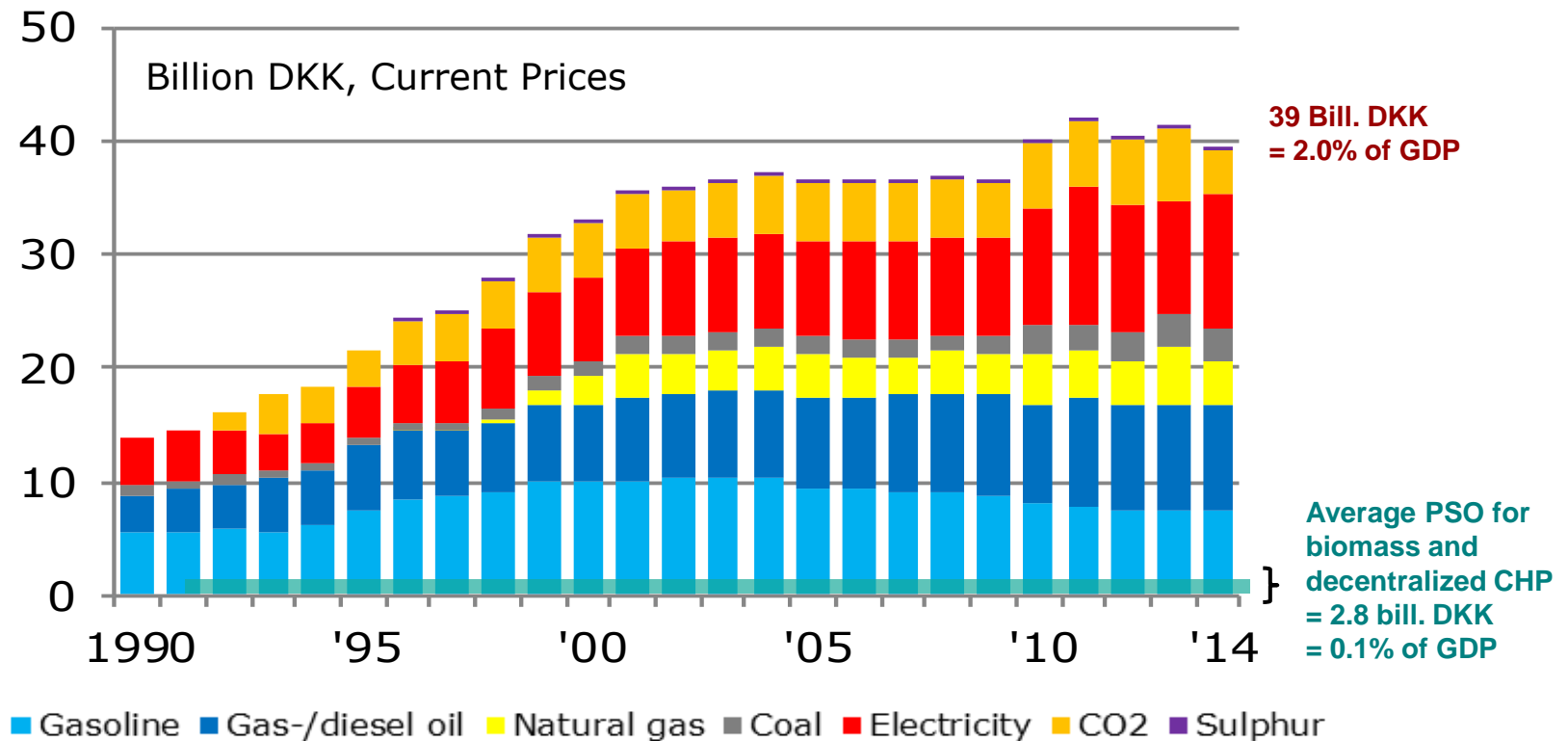
- First Heat Supply Act on District Heating (1979) introduces a national heat plan. Municipalities assigned a key role.
- First Heat Supply Act on District Heating (1979) introduces supply zones all over Denmark. Secures economy of scale and optimal use of capacity.
- Heat zones after 1990: New decentralised CHP + conversion of existing decentralised DH units by administrative orders in 1990-98:
 - From oil and coal → natural gas and biomass
 - From DH-plants → CHP, whenever possible
- Contributed $\frac{3}{4}$ of new power capacity from 1990-97.

Incentives for decentralised DH/CHP

- Investment grants for biomass DH and CHP (1981)
- Subsidies for CHP electricity (1984: RE/1992: NG)
- Financial support to establish or enlarge DH based on bio fuels or CHP on natural gas (1994).
- High energy tax (1977) and CO₂ tax on fossil fuels for DH (1992) = Incentive to energy-efficient DH and co-production + conversion to environmentally friendly fuels.
- All subsidies via state budget. The subsidies can be cost-neutral for the state due to energy/CO₂-taxes.

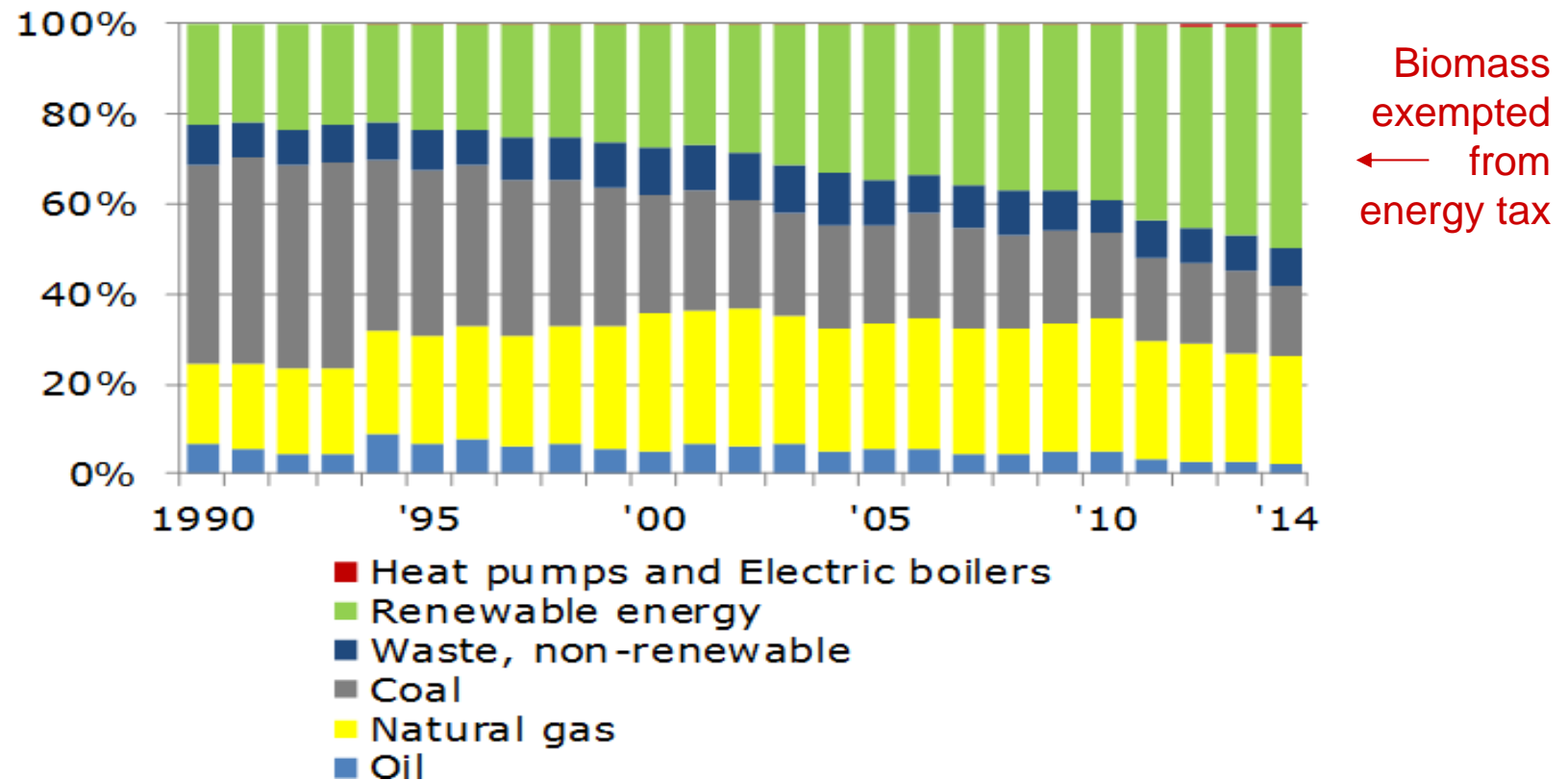


Revenues from Energy and CO₂-Taxes etc. can finance subsidies for DH and CHP



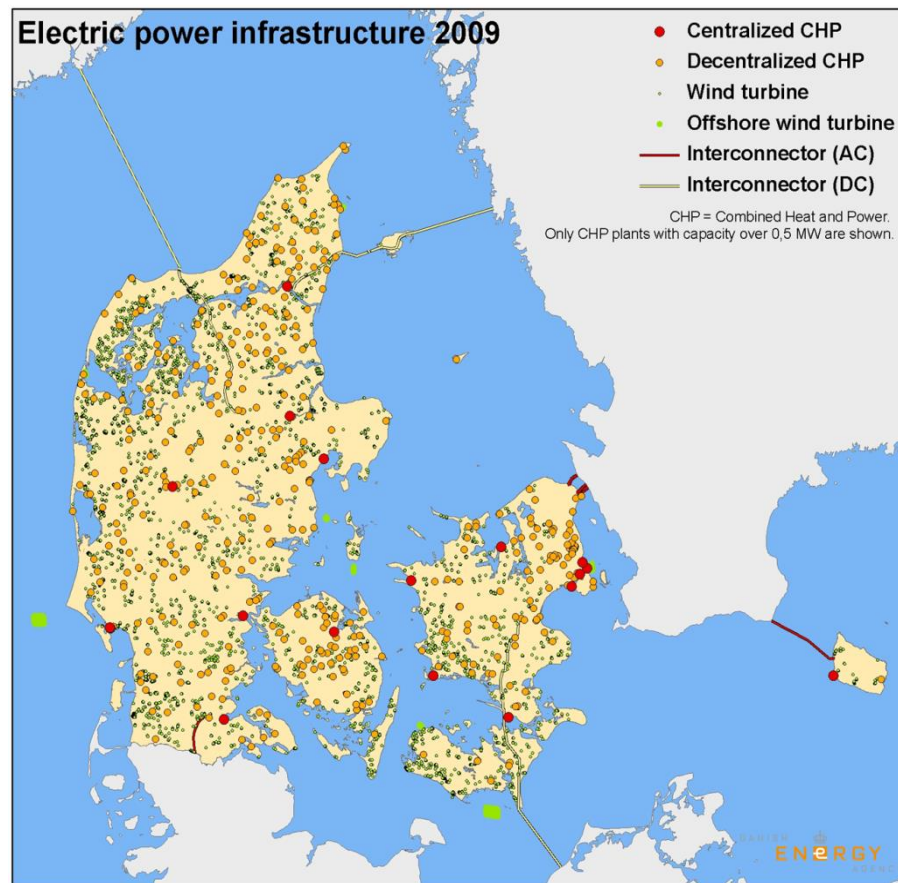
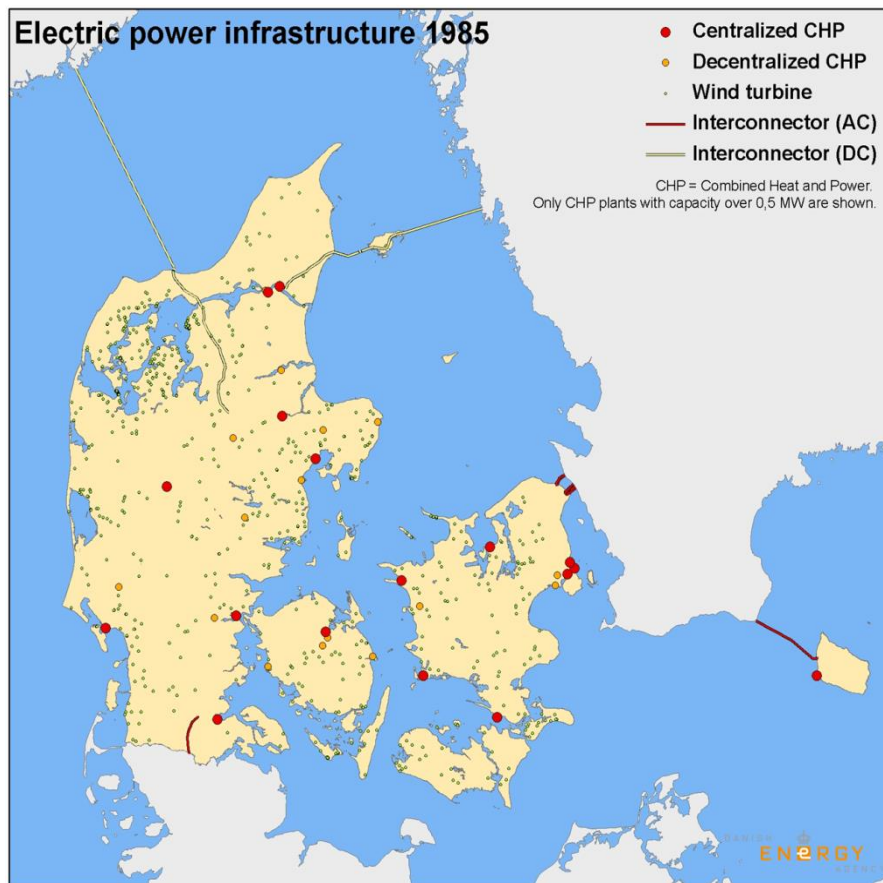
PSO was financed by the state budget until 1999, where the PSO was financed via the electricity bill. The size of the PSO vis-a-vis state revenues is shown in the above figure.

District Heating Production by Fuel



CHP: From Cities to Nationwide Coverage

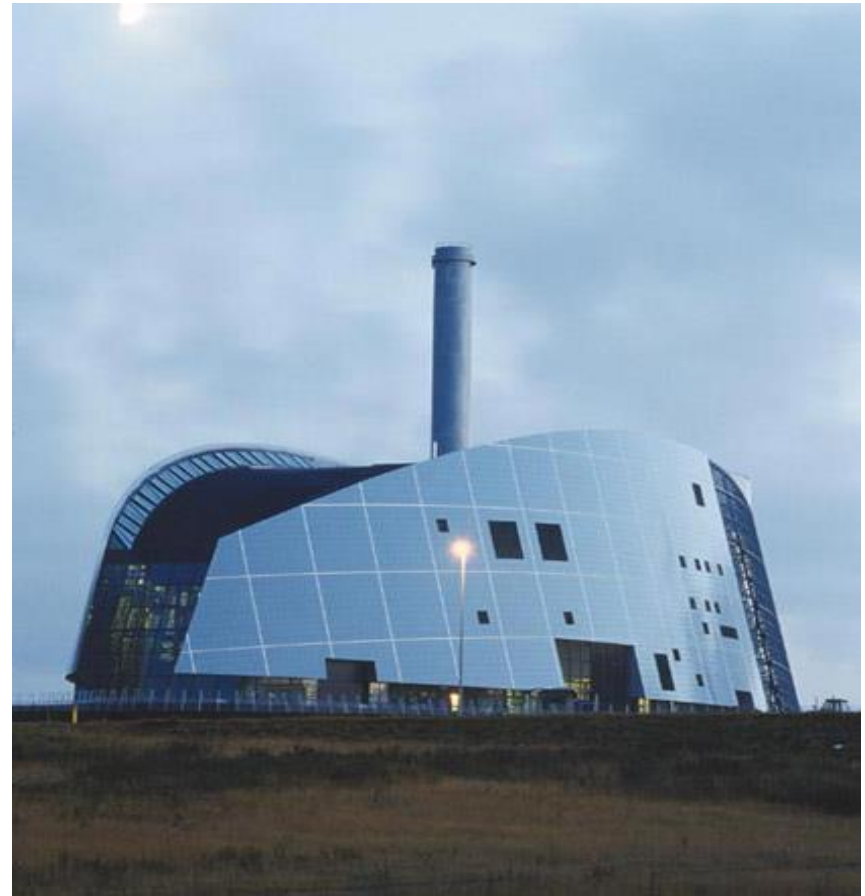
Changes in the generation layout during 25 years



Wind Power replaces Electricity from Combined Heat and Power Plants

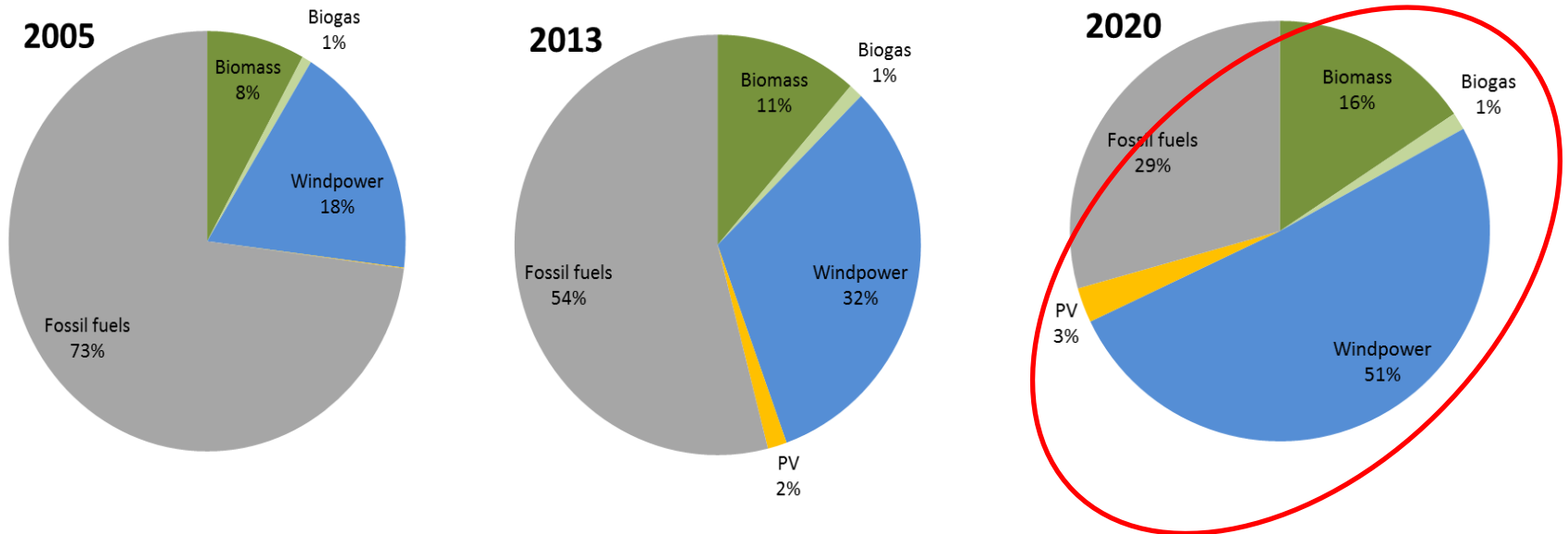
Electricity Production, 2000-2014:

- **Wind turbines:**
From 12 % → 39 % of national power supply.
- **Combined Heat and Power Plants:**
From 41 % → 30 % of national power supply.



Denmark's Electricity Mix in 2020

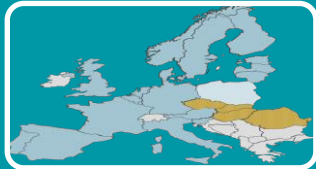
Latest forecast: 54 pct. fluctuating green electricity by 2020



The Danish Toolbox for Efficient Balancing



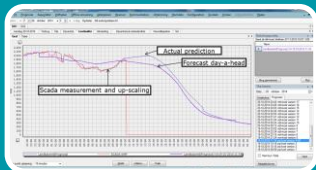
Strong transmission grids and interconnectors



International electricity markets



Flexible generation system



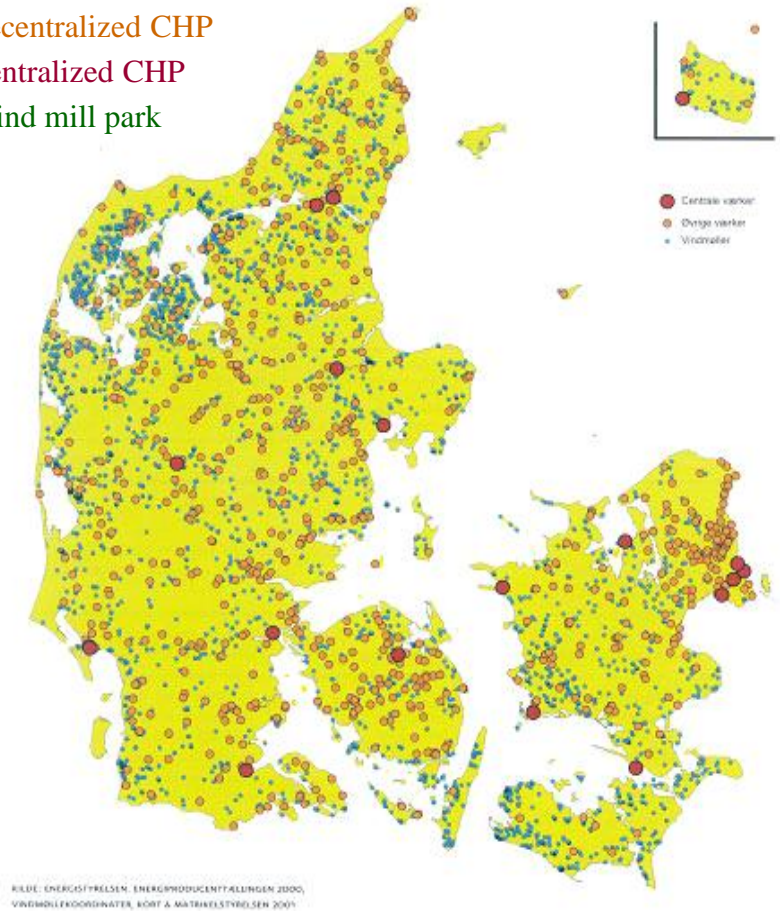
Specialized forecasting and operational planning tools

CHP's and Fluctuating Wind Power Today

- Natural gas turbines = quickest response to market signals (higher el prices)
- Coal fired power units are required to operate down to 35% of rated power. Some are now capable to operate down to 10%
- Heat accumulators decouple electricity and heat demand
- Electric boilers for district heating provide flexible demand (2½ % of total DH capacity and increasing).

Legend:

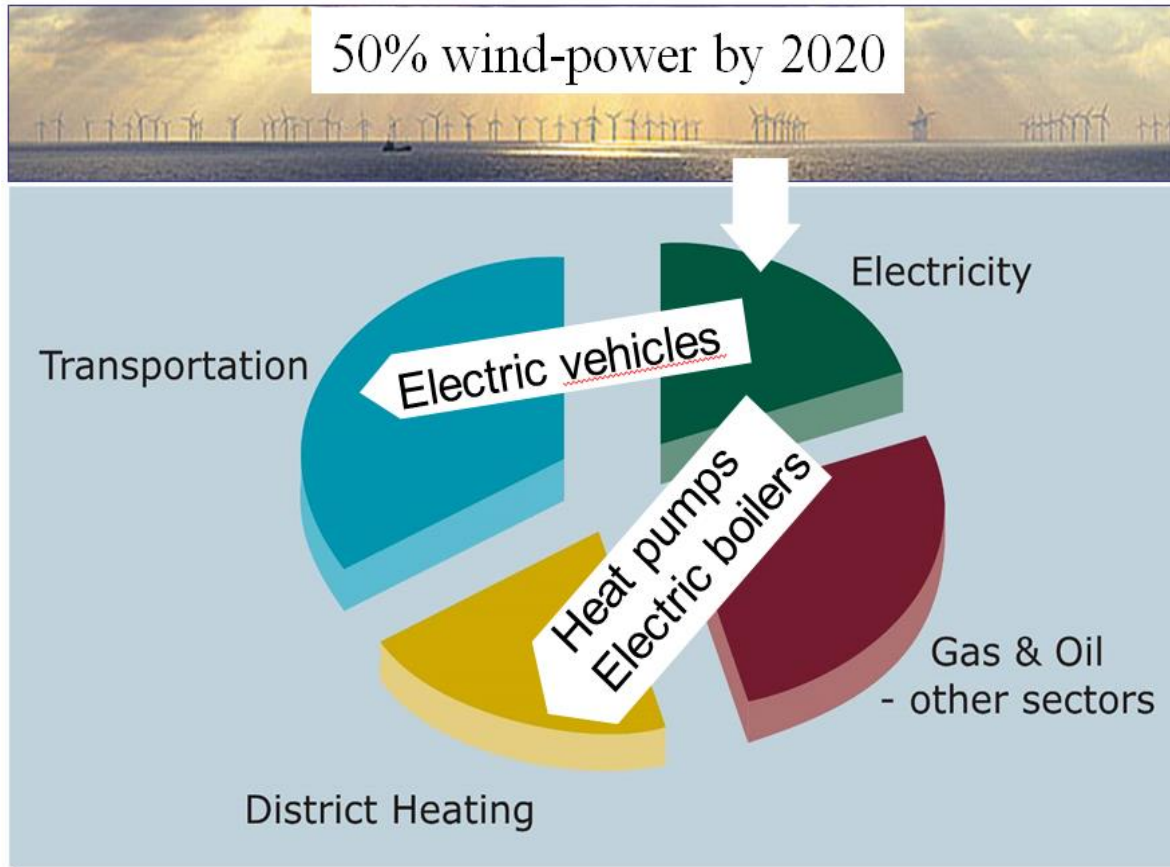
- Decentralized CHP
- Centralized CHP
- Wind mill park



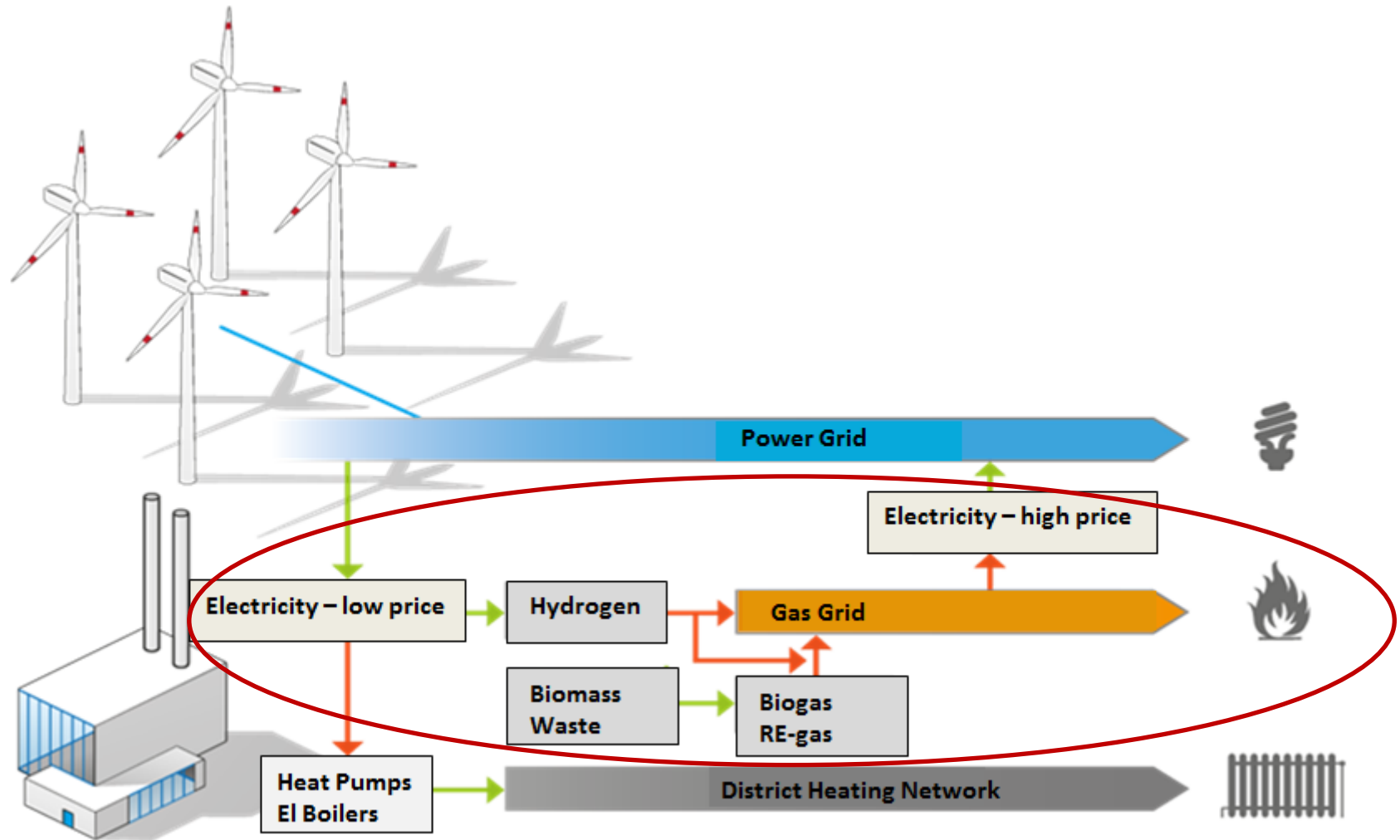
Future District Heating in Denmark

From green fuels to green electricity:

Green electricity will become a main energy carrier, also in the heating sector

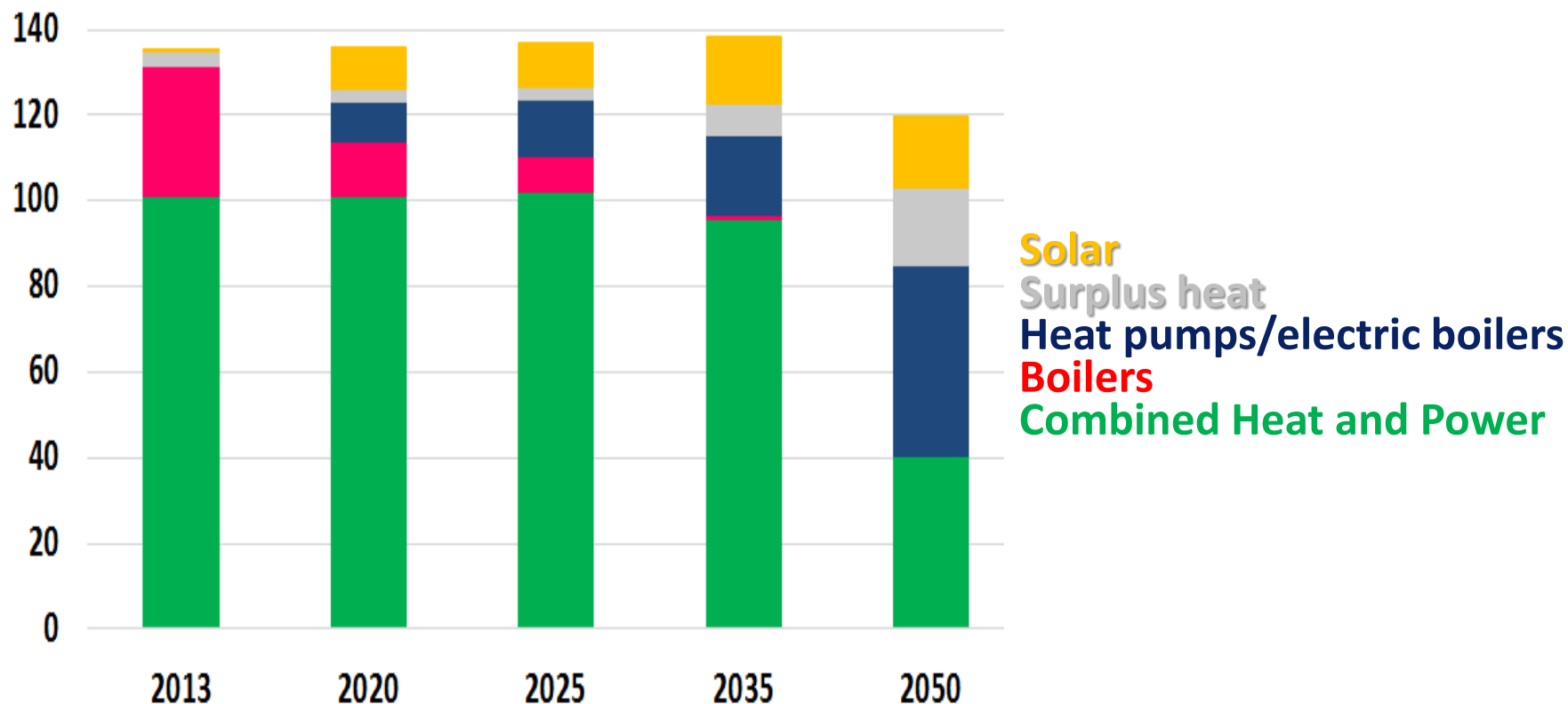


Flexible Use of Wind Power in Future



Green Fuels and Green Electricity

Production of future District Heating (PJ)



New policies to Expand Electricity-Based DH

Long term solution:

Smart energy systems and new technologies etc.



Present solutions and suggestions:

- Demonstration programme for use of large heat pumps in CHP plants
- Lower energy taxes on electricity for heating considered
- Capacity tariff for use of grid system is considered = Incentive to use wind power, when supply exceeds demand, as local use of wind power for DH helps to overcome transmission and distribution bottlenecks.

Energy Statistic

- download data

	AP	AQ	AR	AS	AT	AU	AV	AW
Final Energy Consumption								
Main Menu								
Direct Energy Contents [TJ]	2007	2008	2009	2010	2011	2012	2013	2014
Climate Adjusted								
Heating, Total	213 786	211 347	204 512	204 001	207 389	197 227	198 244	197 347
Oil	25 181	23 609	21 473	19 649	18 969	16 018	15 062	12 583
Natural Gas	37 881	37 210	35 988	35 968	35 202	34 335	34 675	32 611
Coal and Coke	9	19	21	28	30	24	18	0
Waste, Non-renewable	478	325	187	163	277	239	225	372
Renewable Energy	46 845	45 364	43 377	40 935	43 655	40 582	41 720	44 661
Electricity	6 385	6 414	6 478	6 967	6 709	6 569	6 787	6 749
District Heating	96 697	98 099	96 648	99 955	102 164	99 176	99 431	100 009
Gas Works Gas	309	307	338	337	383	285	326	362
Commercial and Public Service	46 794	46 767	45 488	44 804	44 776	44 372	44 751	43 839
Wholesale	5 930	5 801	5 074	4 962	4 900	4 858	4 887	4 679
Retail Trade	4 213	4 039	4 457	4 492	4 387	4 324	4 355	4 204
Private Service	20 247	21 053	19 532	19 557	19 661	19 436	19 572	19 159
Public Service	16 405	15 874	16 426	15 793	15 828	15 754	15 937	15 797
Wholesale								
Oil	371	319	192	203	191	206	204	186
Natural Gas	1 251	1 166	1 000	884	787	825	849	682
Renewable Energy	-	-	-	-	-	-	-	-
Electricity	125	122	115	115	114	111	109	107
District Heating	4 183	4 195	3 766	3 761	3 808	3 716	3 724	3 704
LPG	13	8	6	7	7	6	7	4
Other Kerosene	3	2	2	1	1	0	1	0
Gas-/Diesel Oil	347	299	184	195	183	199	196	179
Fuel Oil	0	0	0	0	0	2	1	2
Petroleum Coke	8	10	0	0	0	-	-	1
Natural Gas	1 251	1 166	1 000	884	787	825	849	682
Total Consumption (adj.)	1 166	1 166	1 000	884	787	825	849	682
Gross Energy Consumption (adj.)	1 166	1 166	1 000	884	787	825	849	682
Commercial and Public (adj.)	46 794	46 767	45 488	44 804	44 776	44 372	44 751	43 839

Heat Supply in Denmark

- download publications →

