

Green transition of Danish power production - before and after market reforms of the electricity sector

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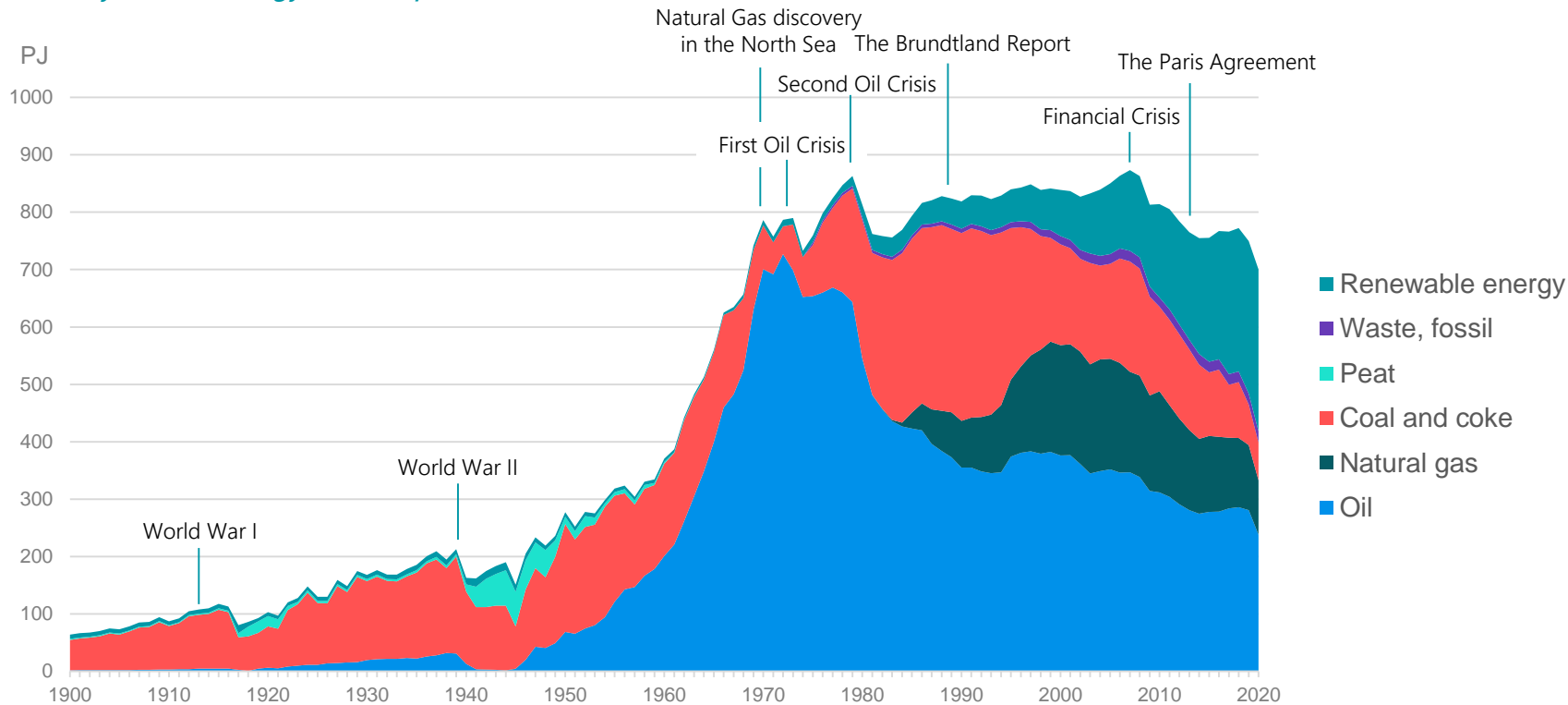
Centre for Global Cooperation





GROSS ENERGY DEMAND OF DENMARK

100 years of energy consumption



Development in power sector in Denmark 1891-1977

Power sector unregulated – but non profit



Power production in Denmark was organized by larger cities and cooperatives on a **non profit basis**.

Power plants were **located close to coasts and close to large cities**.

Typical size of units in later years was **350 MW**. Also two units of 600 MW were decided in 1970'ies.

In larger cities **surplus heat** was used for **district heating**.

Coal was used for fuel up till late 1950'ies, when there was a shift to **fuel oil**. After the energy crisis in 1973/74 the power plants shifted **back to coal**.

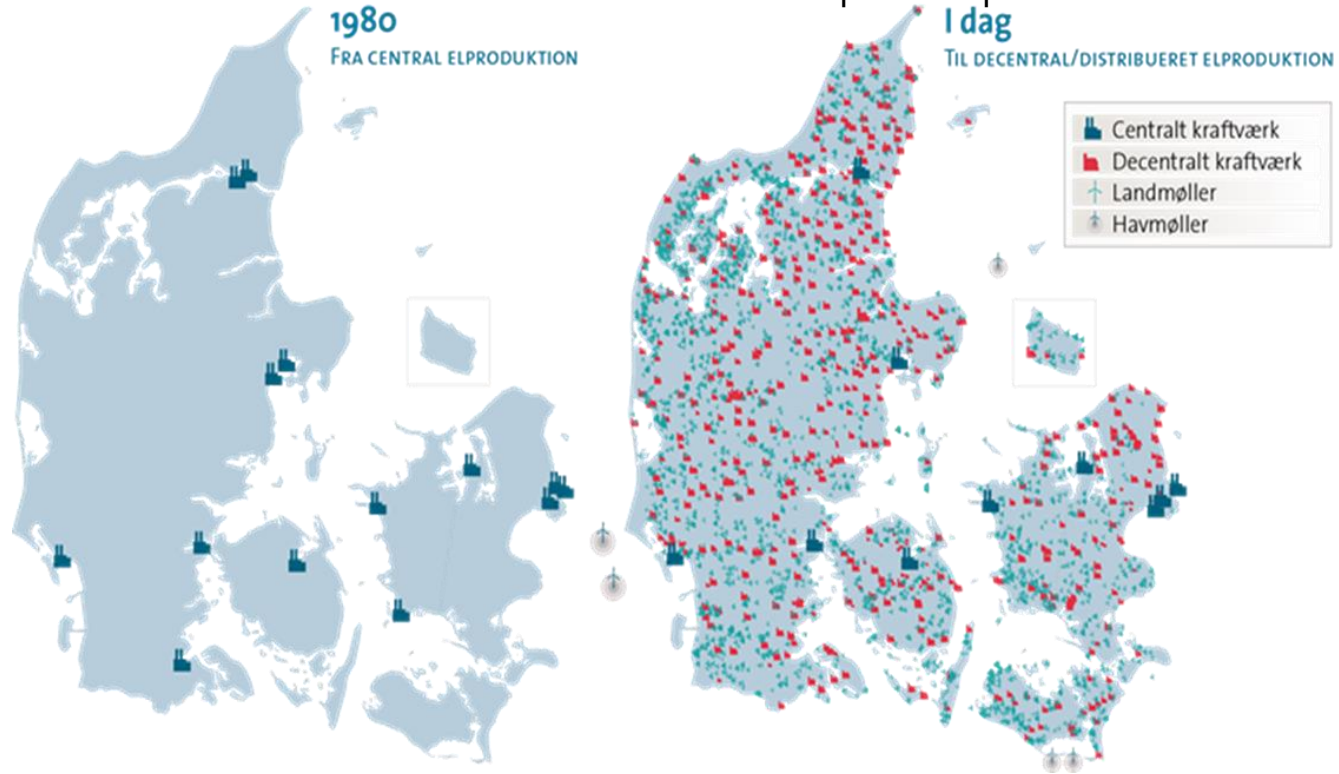
First **interconnector** to Sweden was established in 1915. Several other interconnectors came later to Sweden, Norway, Germany, Netherlands and UK (under construction).

Development in power sector in Denmark 1977-1999

Initiatives to enhance use of combined heat and power and use of renewable energy sources

- 1977 After the energy crisis **Electricity Supply Act** was introduced. New generating capacity over 25 MW should be approved by Danish Energy Agency and prices were regulated (non profit).
- 1979 **Heat Supply Act** was introduced with planning tools to ensure the introduction of **natural gas** and to enhance the use of **surplus heat from the power plants**.
- 1990 Political agreement to promote **combined heat and power plants (CHP)** on natural gas in all towns with district heating.
- 1993 Political agreement to use **biomass** (straw and wood chips) in large power plants.
- 1997 Political decision to establish **5 x 150 MW offshore wind farms**. Power companies asked to build first two wind farms. Next three offshore wind farms cancelled 2002 by new Government.

From centralized to decentralized power production



Development in power sector in Denmark 2000-2008

Market reforms led to new ownership of the power sector

- 2000 **Market reforms unbundled** the Electricity sector. Power production and sale of electricity was liberalized. Transmission, system operation and distribution continued to be monopoly.
- Marked prices were low due to overcapacity. **Aid package** was introduced to help the power companies survive. They had no equity due to non profit regime. Aid included subsidies for using biomass and wind + compensation for being reserve and regulating power.
- 2003-05 Political agreements to **unbundle** the ownership of **transmission and system operation** from the power companies. A Government owned TSO was established. The electricity companies got the right to dispose of their so called free capital from before 1977 when prize regulation was introduced. That gave incentives for municipalities and cooperatives to sell their shares in the electricity sector.
- Swedish state owned power company **Vattenfall** (1/3) and Danish state owned natural gas and oil company **DONG Energy** (2/3) bought all the power plants.
- Political agreement on tender for **2 x 200 MW offshore wind parks**.

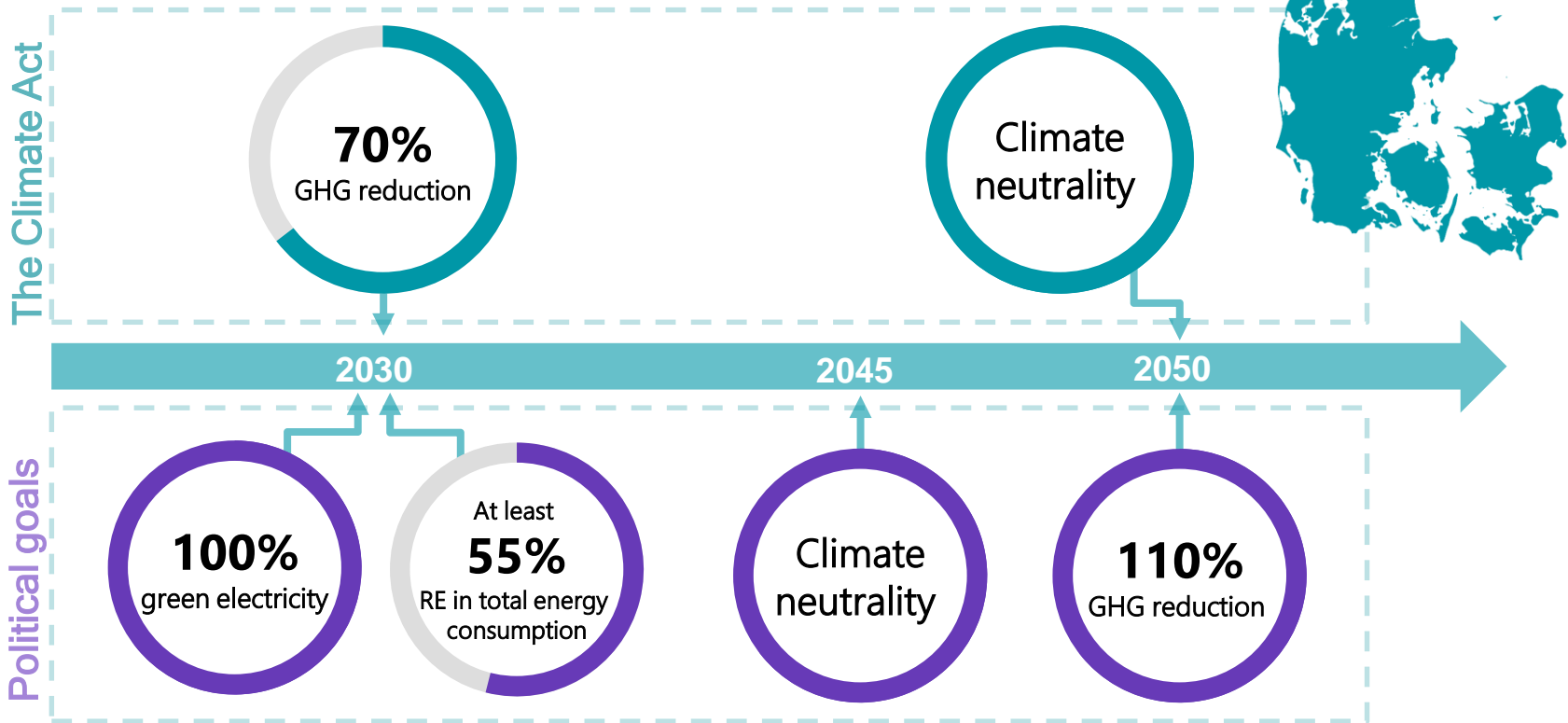
Development in power sector in Denmark 2008-2020

Political agreements on offshore wind parks and biomass

- 2008 Political agreement 2008-2012 **increased subsidies to wind on land and biomass** and decided a tender for an **offshore wind farm** of 400 MW.
- 2012 Political agreement 2012-2020 included **two offshore wind farms** of 600 and 400 MW + 500 MW of **near coast wind parks**. The agreement also included improved calculation methods for the sale of heat from power plants using biomass.
- 2017 DONG Energy decided **phasing out coal** in their power plants by 2023. Vattenfall decided to sell their three power plants to the larger cities Copenhagen, Odense and Aalborg who wanted to secure the supply of surplus heat and to secure the switch from coal to biomass.
- 2018 Political agreement 2020-2024 included an **offshore wind farm** of 800 MW without public subsidies plus two more offshore wind farms before 2030.
- 2020 Political agreement to establish two **energy islands** of 5 GW total.



VISION OF A CLIMATE NEUTRAL SOCIETY



Power sector - summary

- Until 1990'ies the power companies built **350 MW coal fired CHP units**.
- **Small-scale CHPs on natural gas** were established in 1990'ies by order and incentives – for environmental reasons – but primarily to support the natural gas project.
- **Emissions** of CO₂, SO₂ and NO_x reduced by quotas and taxes.
- After **market reforms** (liberalization) in 2000 electricity **market price dropped** – surplus thermal capacity and wind power made the market price drop.
- Several **new transmission lines** to neighboring countries – Norway, Sweden, Germany and Netherlands. **Viking Link** to UK is being constructed 2020-2023 – 750 km – investment of 11 BDKK (1.6 BUSD) – worlds longest DC cable.
- **New thermal electrical capacity** today built only when heat capacity is needed – designed after heat production.
- Several **thermal power units** have been **closed down**. Energy Agency has decided some of them have to be available and power company is compensated by the TSO.
- **Wind farms** increased substantially from the 1990'ies.
- **Offshore wind** and **solar PV** is expanding on a large scale.



Thank you
for your attention

Questions on subsidy schemes

Some main principles. The legislation has changed several times

- Feed in premiums (FIP) have been used from 1984-2018 for electricity from wind turbines on land and from 2000 for biomass used in power plants.
- Feed in tariffs (FIT) have been used for offshore wind after tenders. FIT has also been used for biogas as a fixed FIT.
- Annual net metering has been used for PV until 2012. From 2012 the subsidies have decreased until 2018.
- In 2018 and 2019 there have been (very low) FIP after tenders for wind on land and solar PV. No more subsidy today except for instant net metering for solar PV.

Questions of transformation of subsidy schemes

- Several times subsidies have been reduced – both FIT and FIP. Usually it has had effect for new producers. Existing producers would typically have a period of 10-20 years before subsidies were reduced.
- The small scale CHP's had a fixed price for sale of electricity before market reform. After market reform in 2000 the electricity price dropped. That would have led to increases in heat prices. To avoid that the CHP's received a FIT. Then they did not react to market signals. So the subsidy was changed in 2004 to a fixed sum and then the CHP's could react to the market prices. The subsidy stopped after 15 years.

Spot market prices for electricity

DKK 0.01 per kWh. DKK 10 = USD 1,45

