

Co-benefits for air-pollution of a zero carbon energy policy in Denmark

Jesper Bak, Aarhus University



Energy plans

First Energy Plan, (Dansk Energipolitik): 1976

- Safeguard against energy supply crises: energy savings, oil to coal and nuclear
- Renewable only marginal role. Energy taxes, R&D for renewable energy

Second Energy Plan (Energiplan81): 1981

- Oil and gas recovery in the North Sea, development of a nationwide grid for natural gas
- Introduction of subsidies for the construction and operation of wind turbines and biomass plants.
- In 1985: decision, no nuclear

Third Energy Plan (Energi 2000), Feed-in tariff: 1990

- Reducing Danish CO₂ emissions by 20% between 1988 and 2005.
- 10% of electricity from wind turbines by 2005. Guaranteed interconnection and purchase of wind

Fourth Energy Plan (Energi 21): 1996

- 12-14%renewable energy in 2005, and 35% by 2030.
- Planning regulations for offshore wind farms, DEA implementing renewable energy policies

Electricity market liberalisation (1999-2008) Abandon feed-in tariff

Rejuvenation and strengthening of the wind sector: 2009-2012, PSO

Energy plan 2012

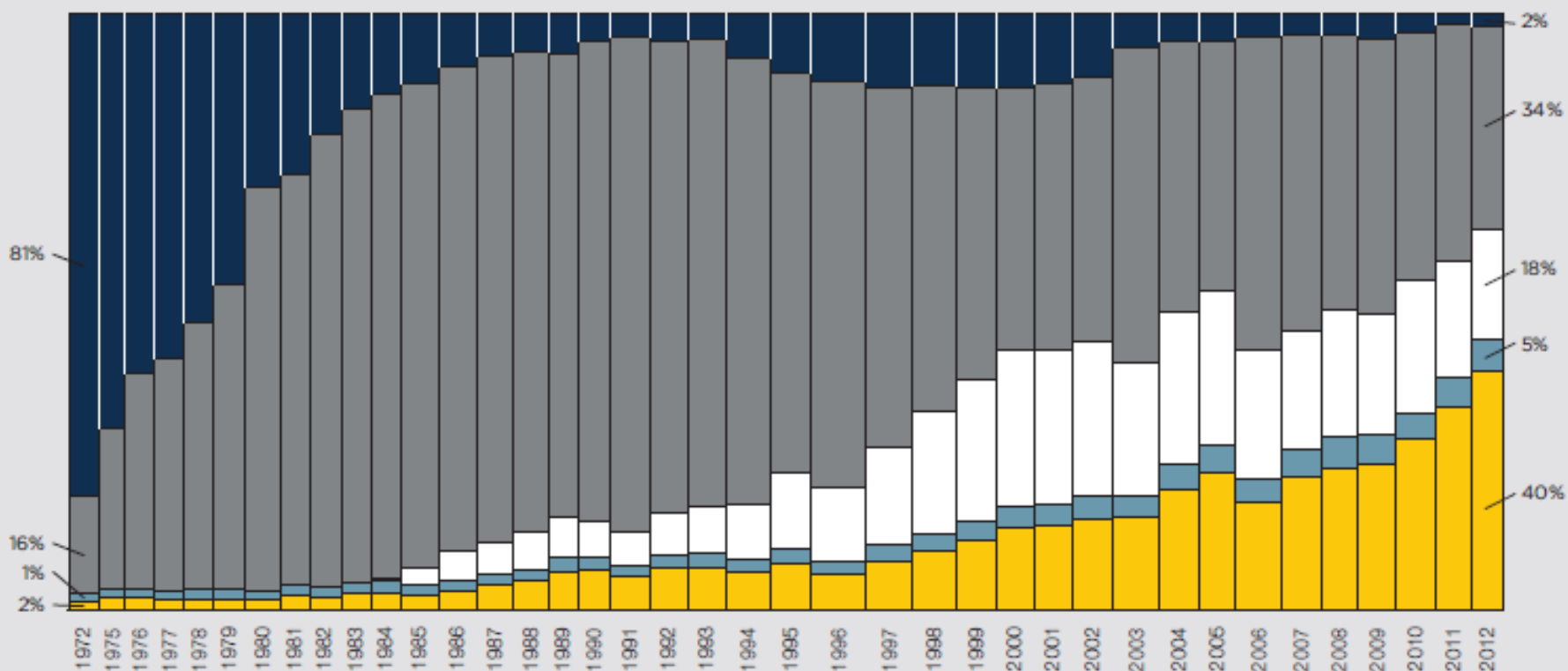
- The electricity and heat sector shall be 100% supplied by renewable energy in 2035.
- Coal will be phased out from power plants and private oil boilers phased out by 2030
- Target of reducing the greenhouse gas emissions by 40% compared to 1990 levels.
- Half of the traditional electricity consumption shall come from wind by 2020.
- A comprehensive new strategy will be developed for creating smart grids.

Under pressure with new government

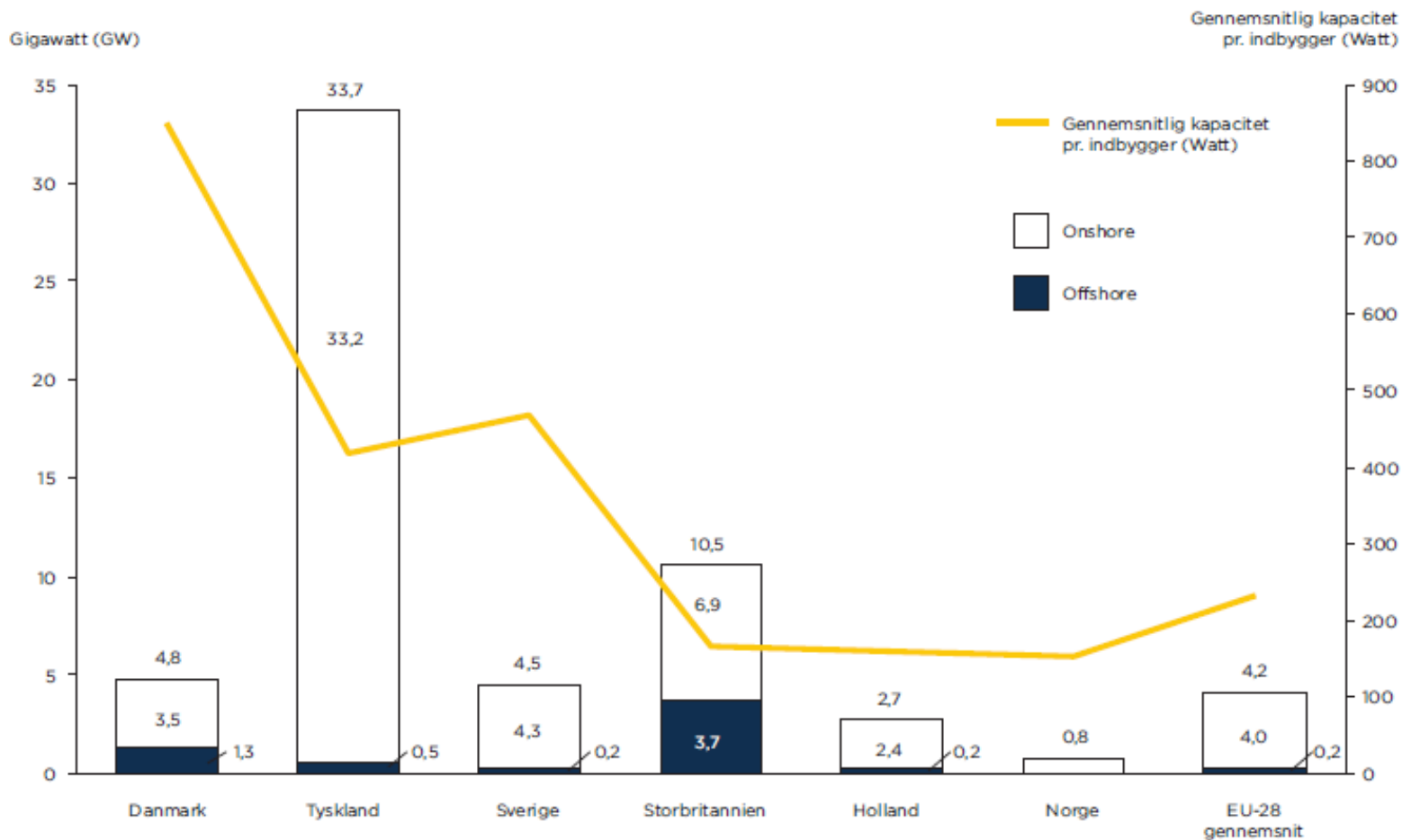
Årligt brændselsforbrug i el- og varmeproduktion*

Procent af samlet brændselsforbrug

Olie
 Kul og koks
 Naturgas
 Affald, ikke-bionedbrydeligt
 Vedvarende energi

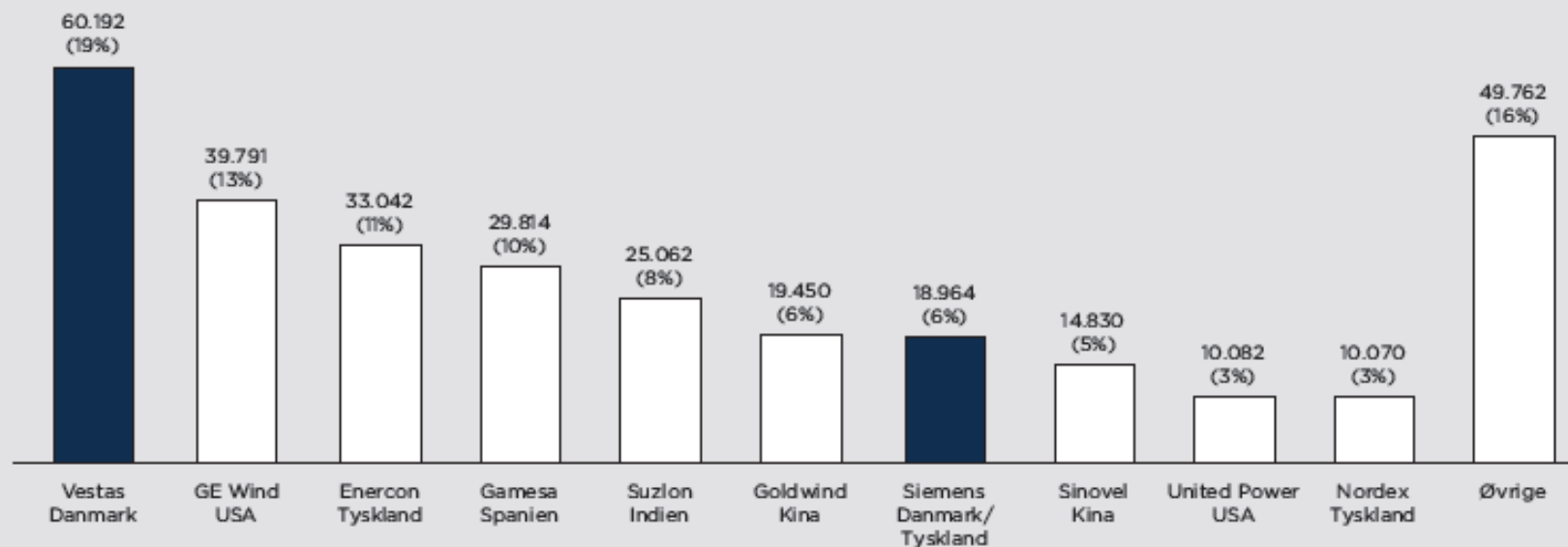


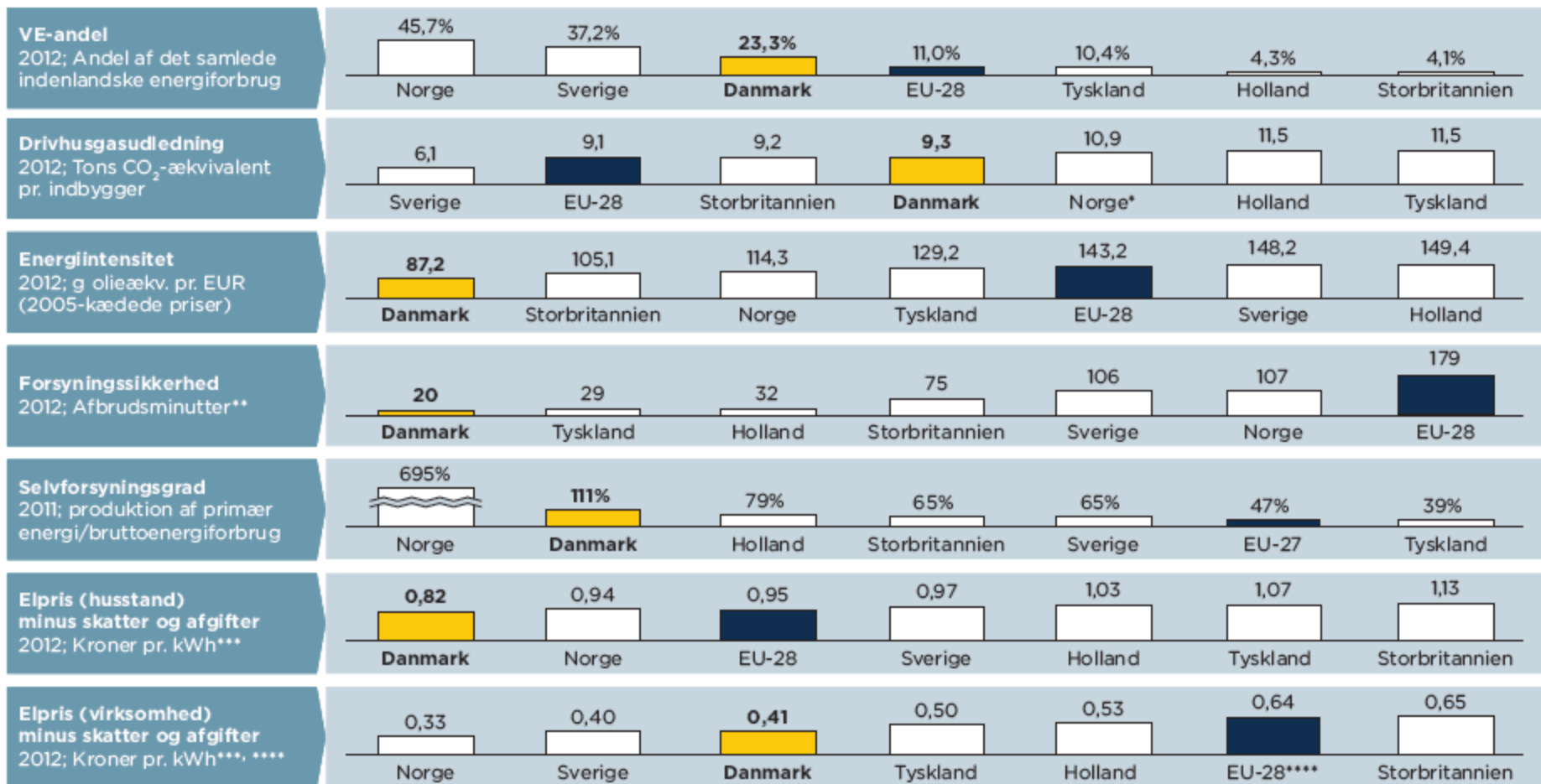
Akkumuleret installeret kapacitet og gennemsnitlig kapacitet pr. indbygger i 2013



Top 10 globale landvindmølleproducenters andel af installeret kapacitet

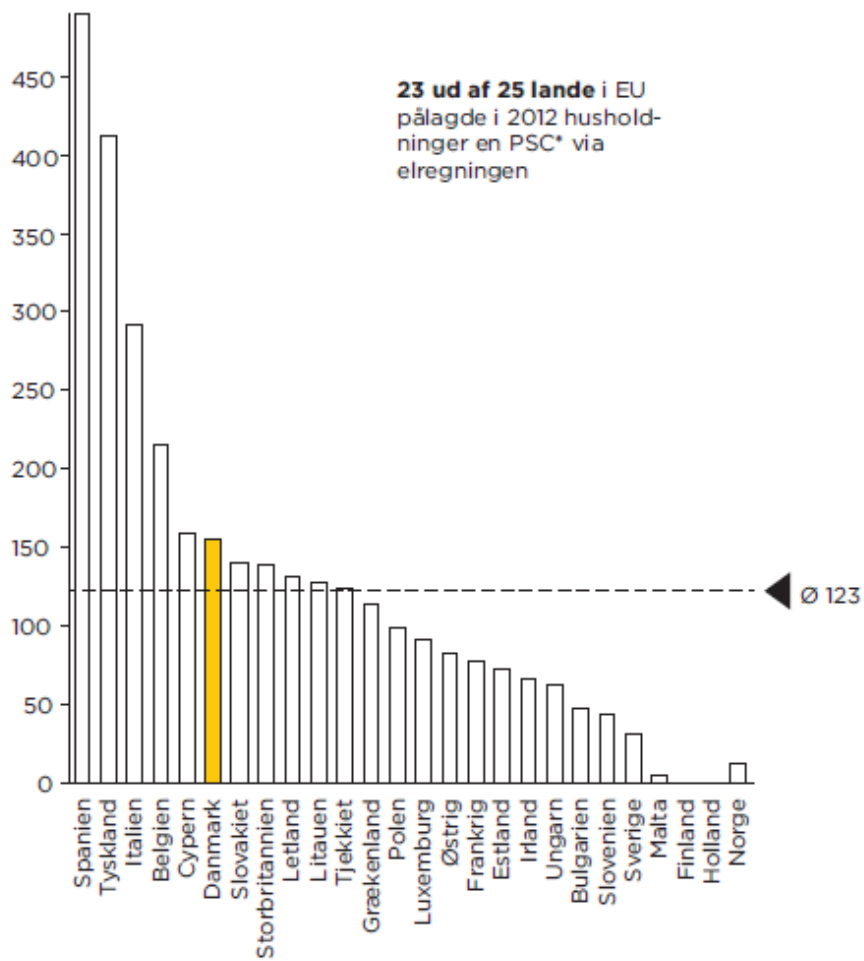
Akkumuleret kapacitet (1980-2013) og HQ
Megawatt (MW), (procent)





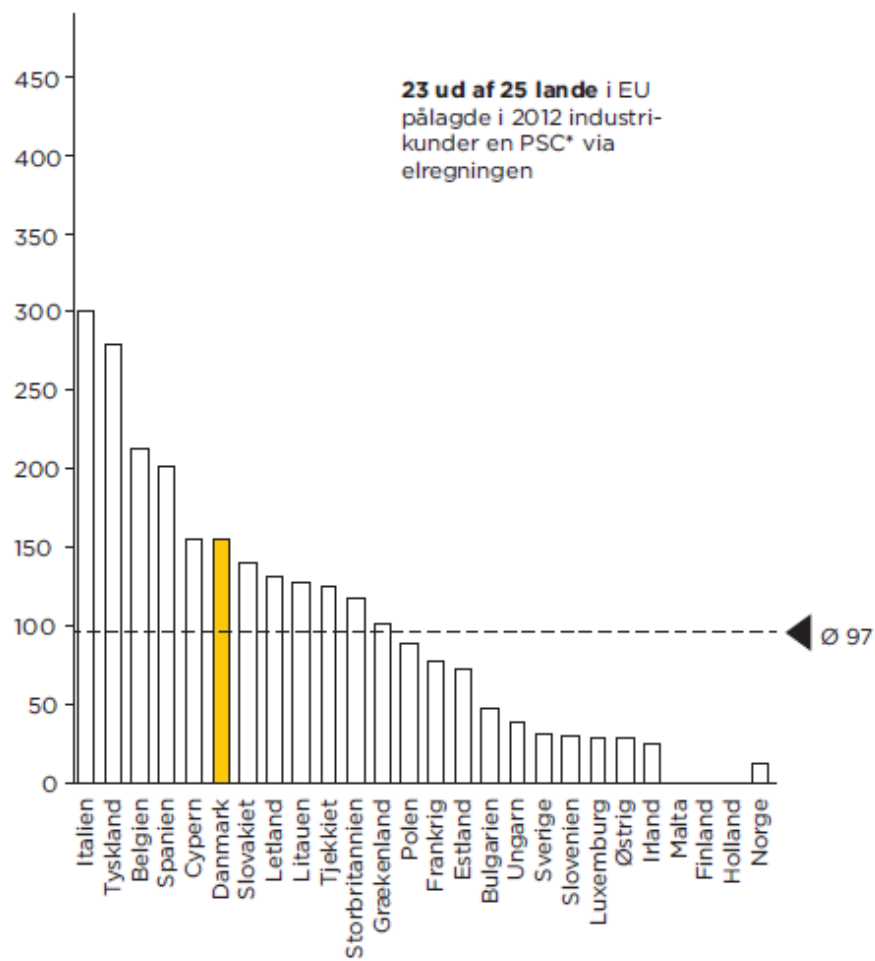
PSC* - husholdninger PSC* (2,5-5 MWh)

Kroner pr. MWh (2012)



PSC* - virksomheder (500-2.000 MWh)

Kroner pr. MWh (2012)



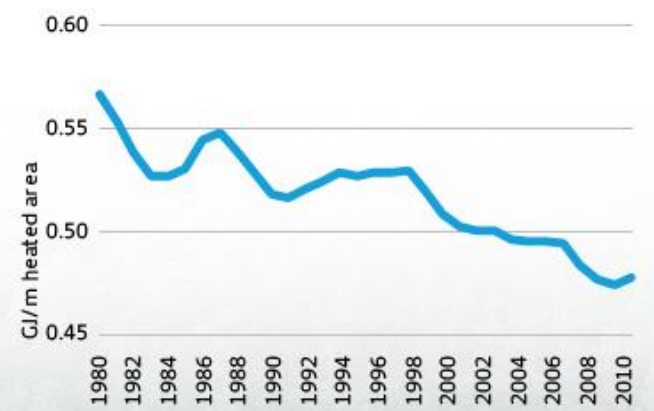
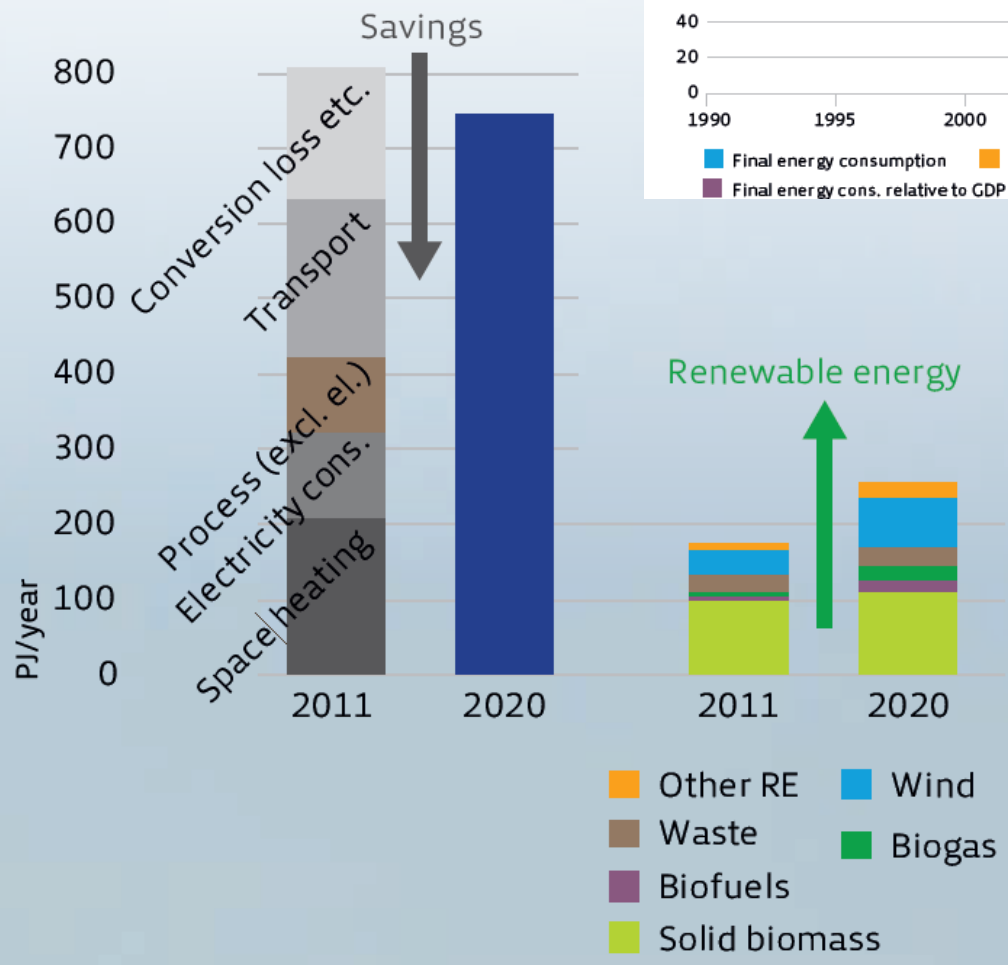
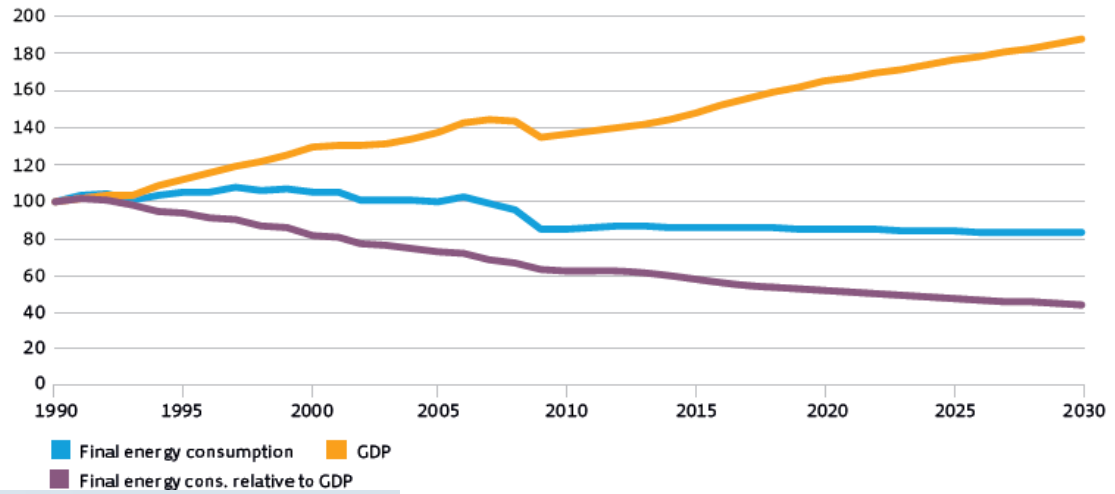
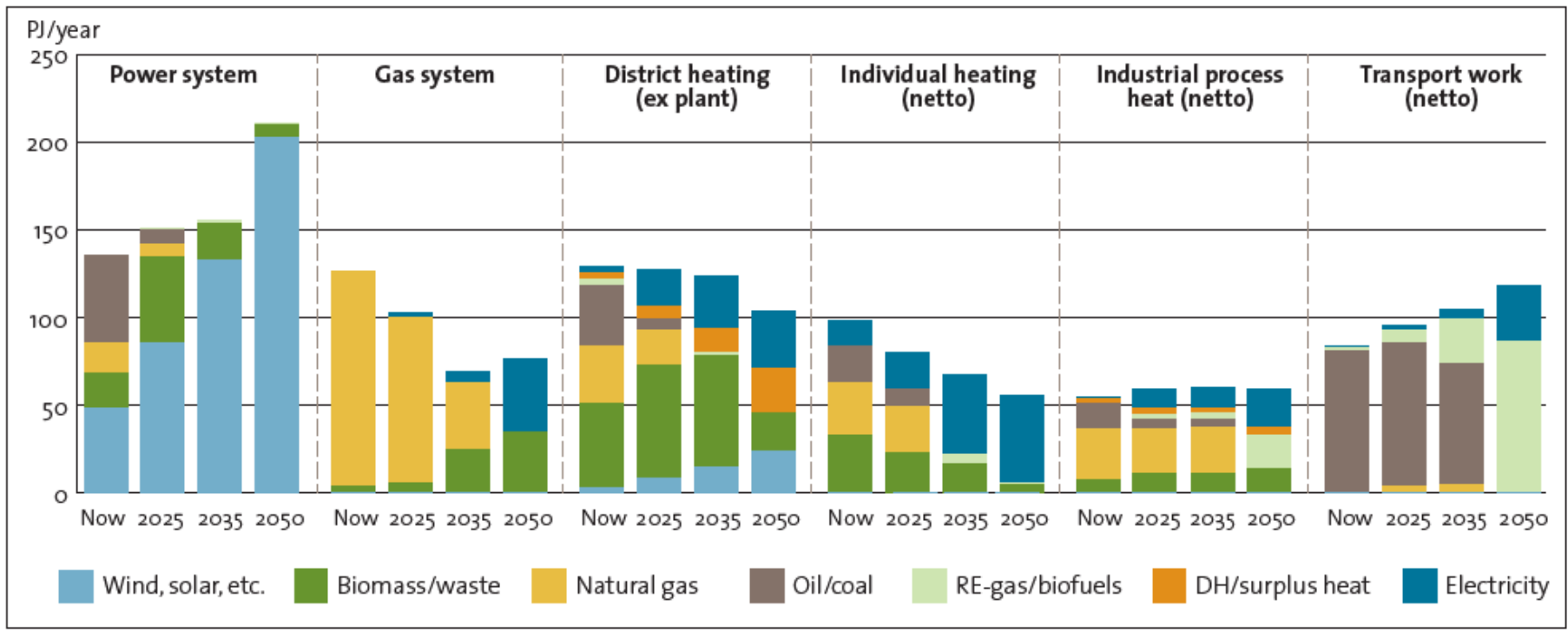
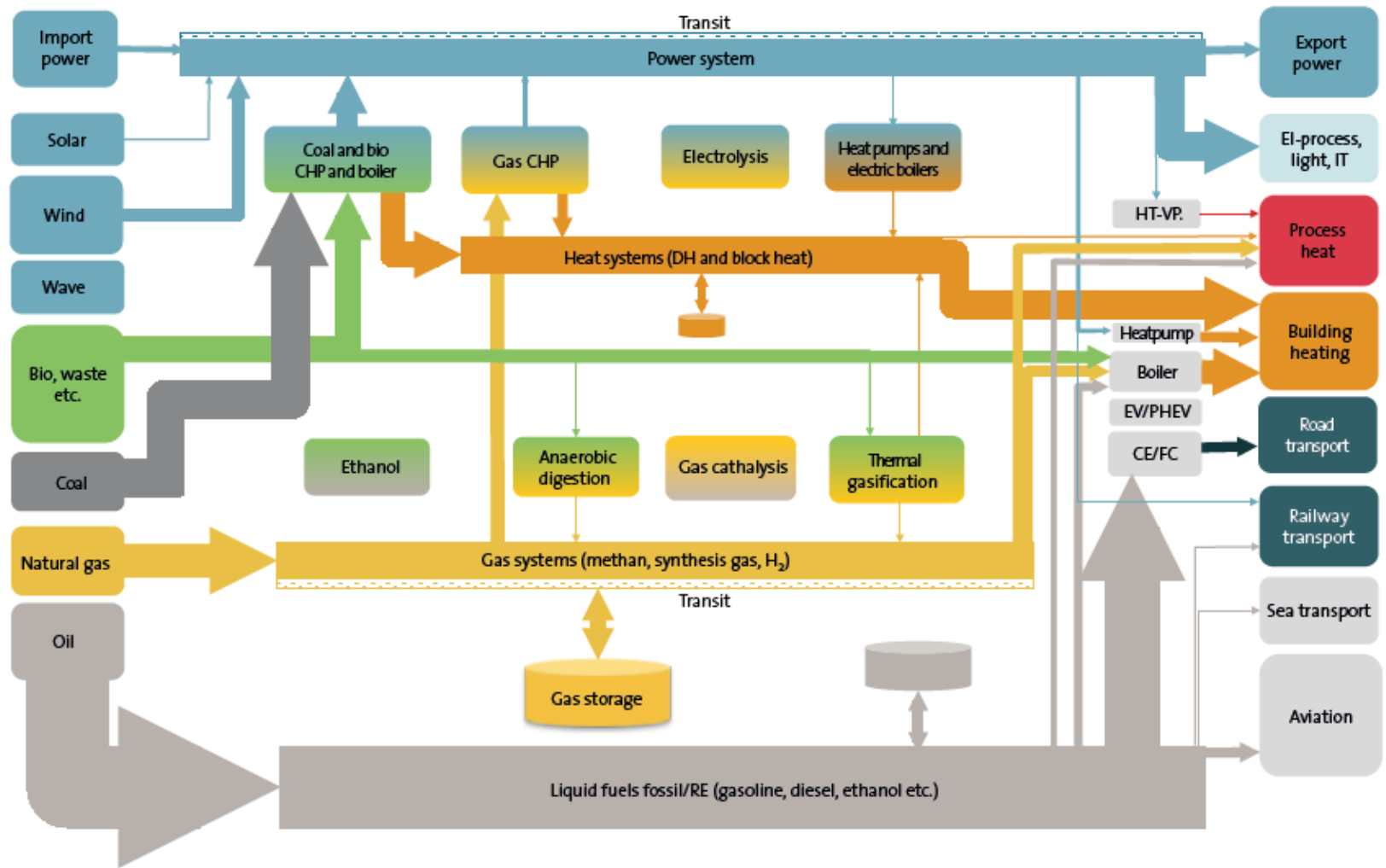
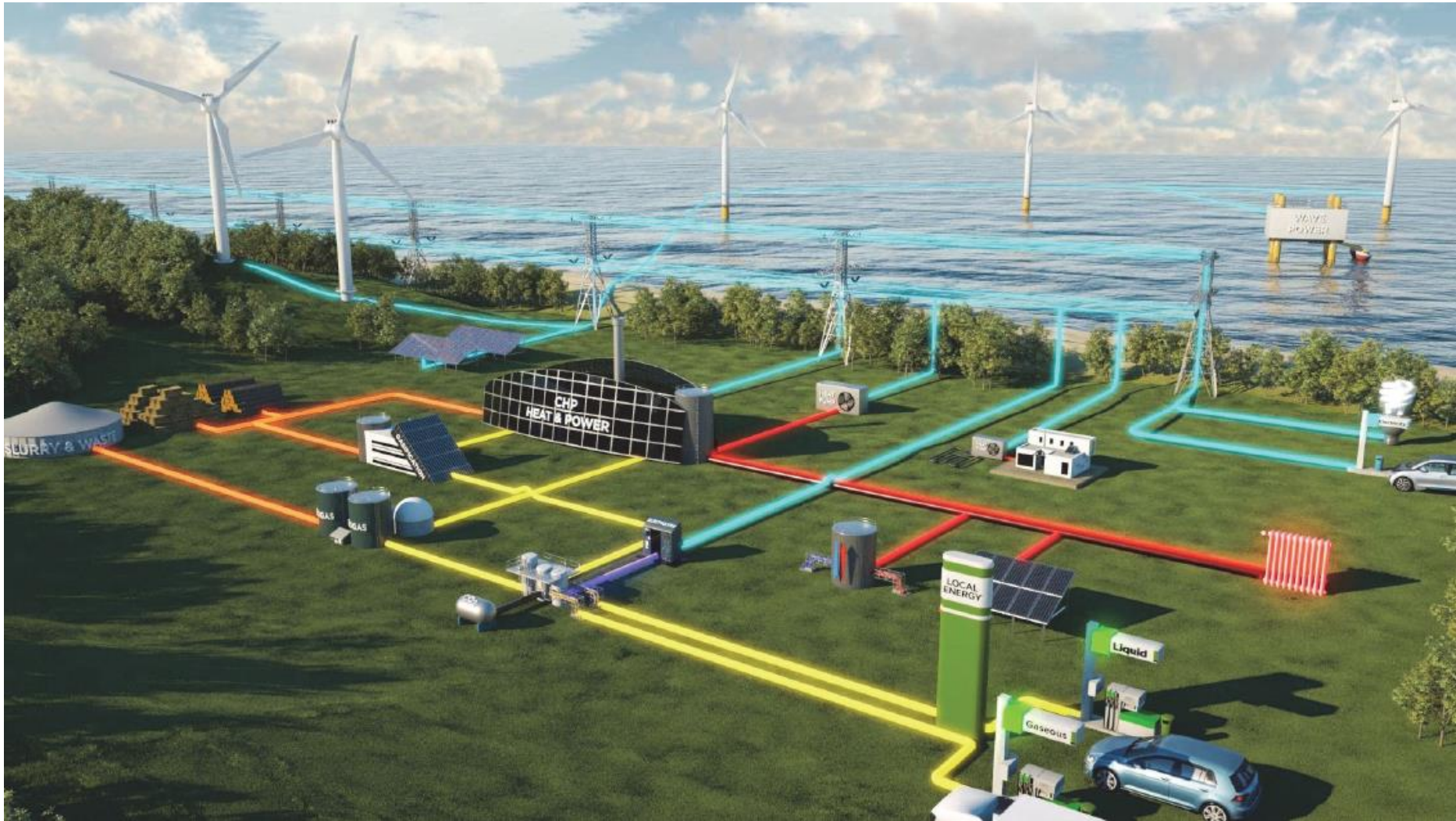


Figure 3: Development in net heat demand per m² of heated area for households. The figures are averages for all Danish households and averages over 3 years.

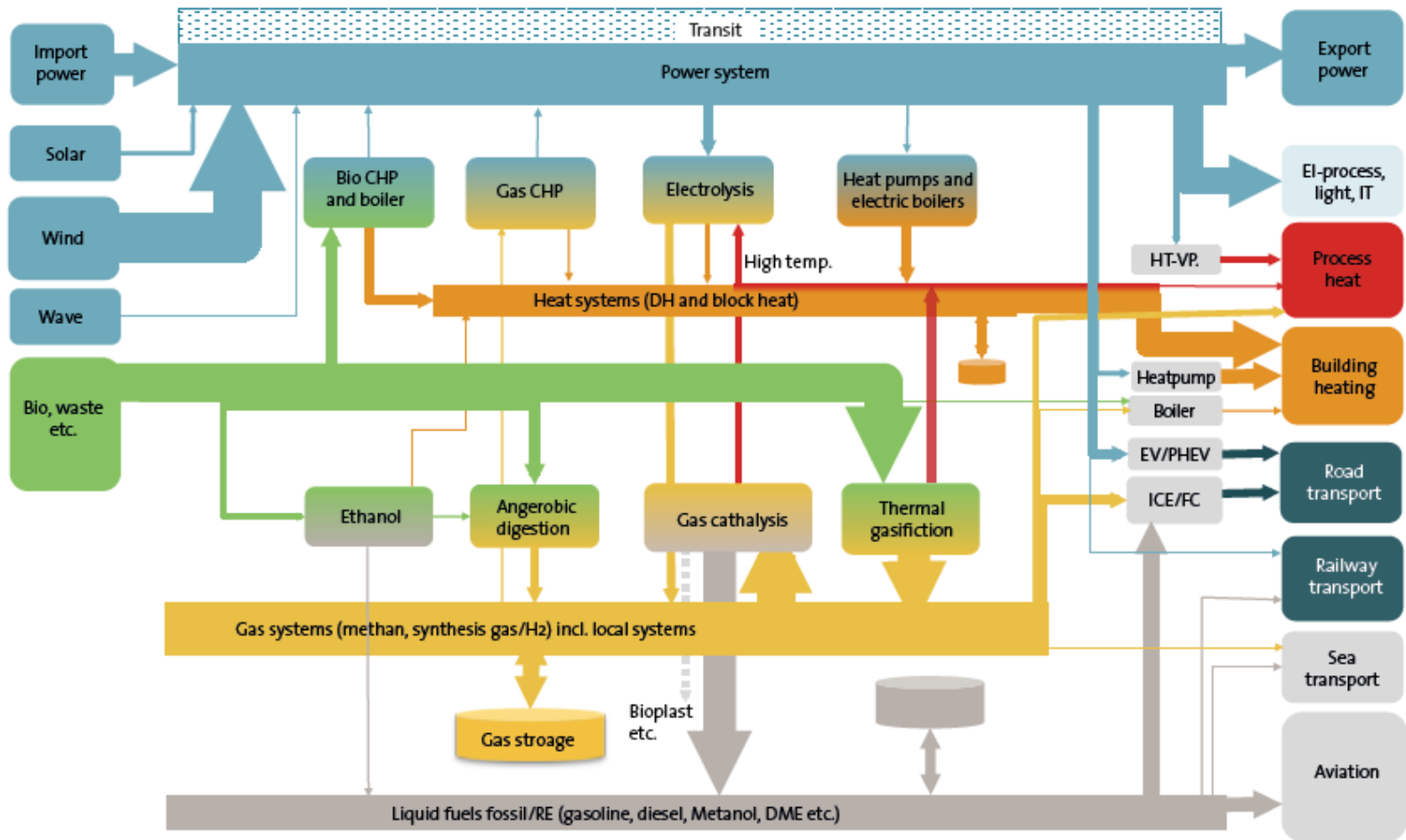


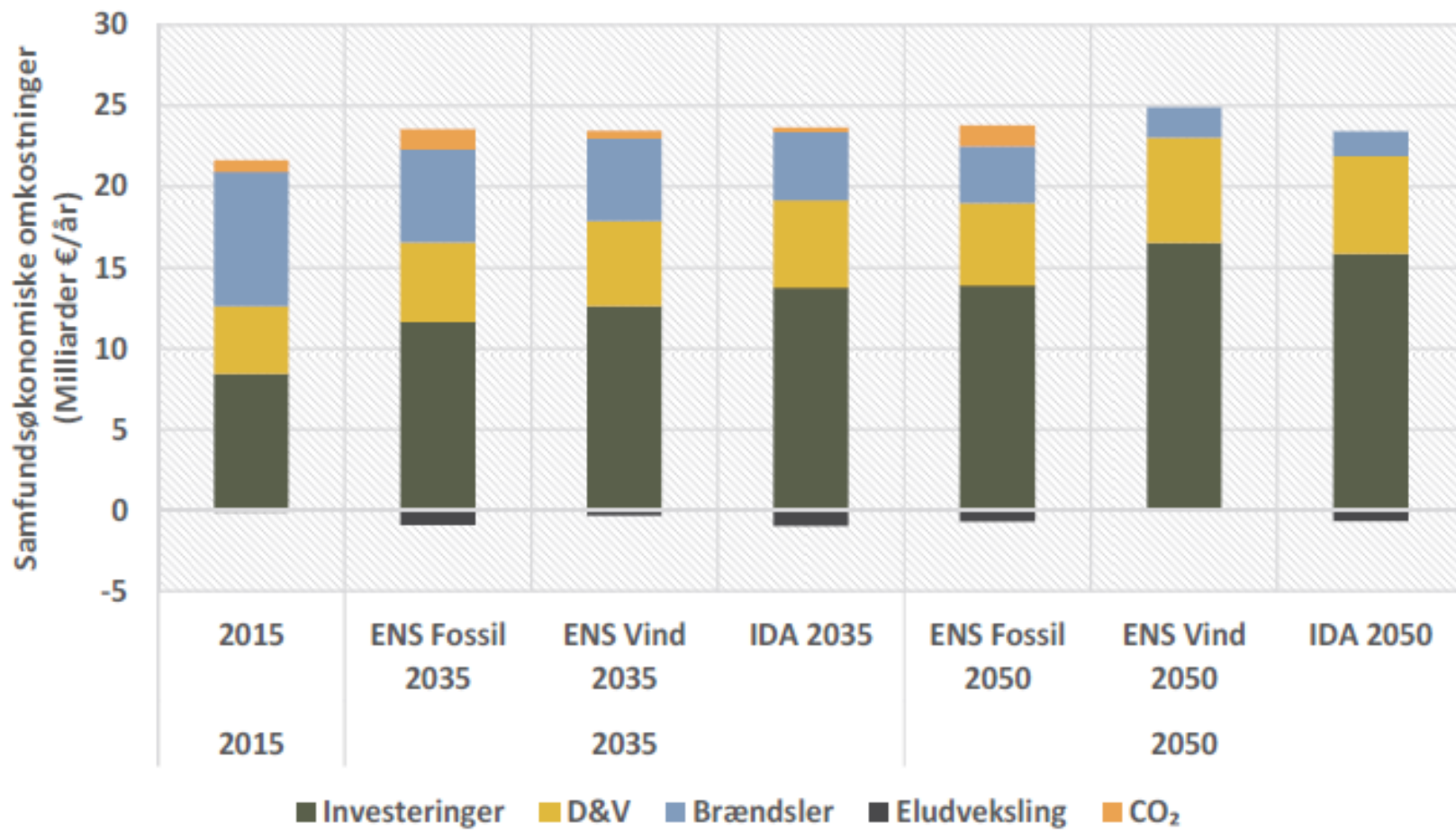
2014



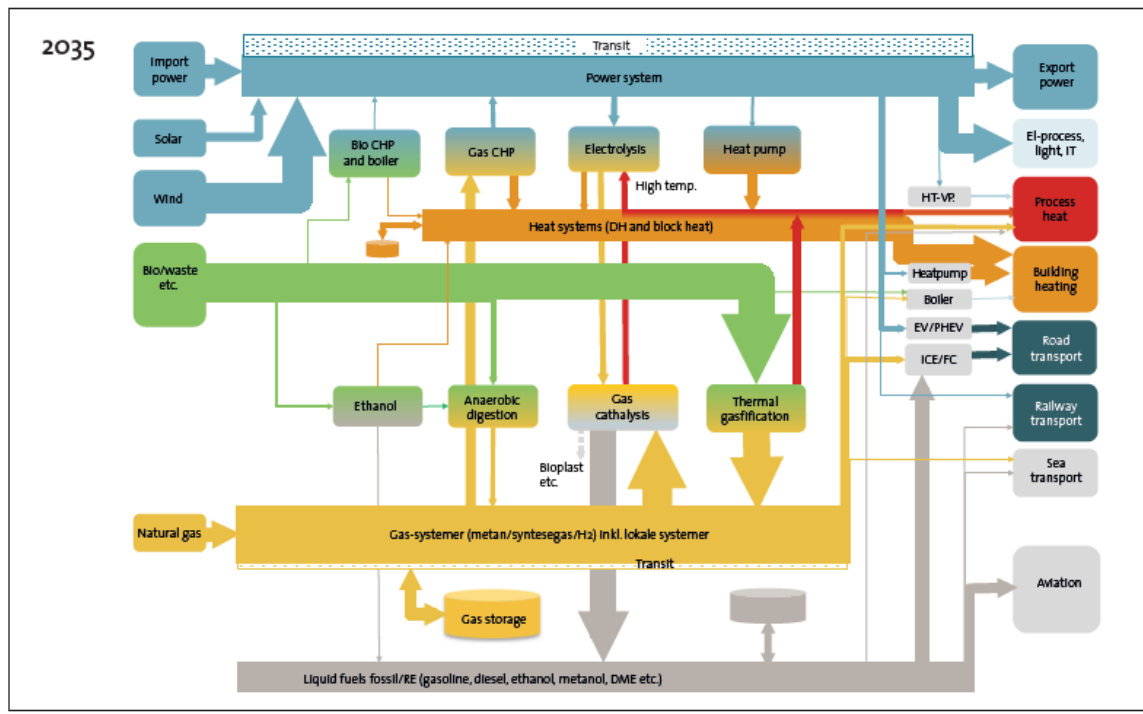
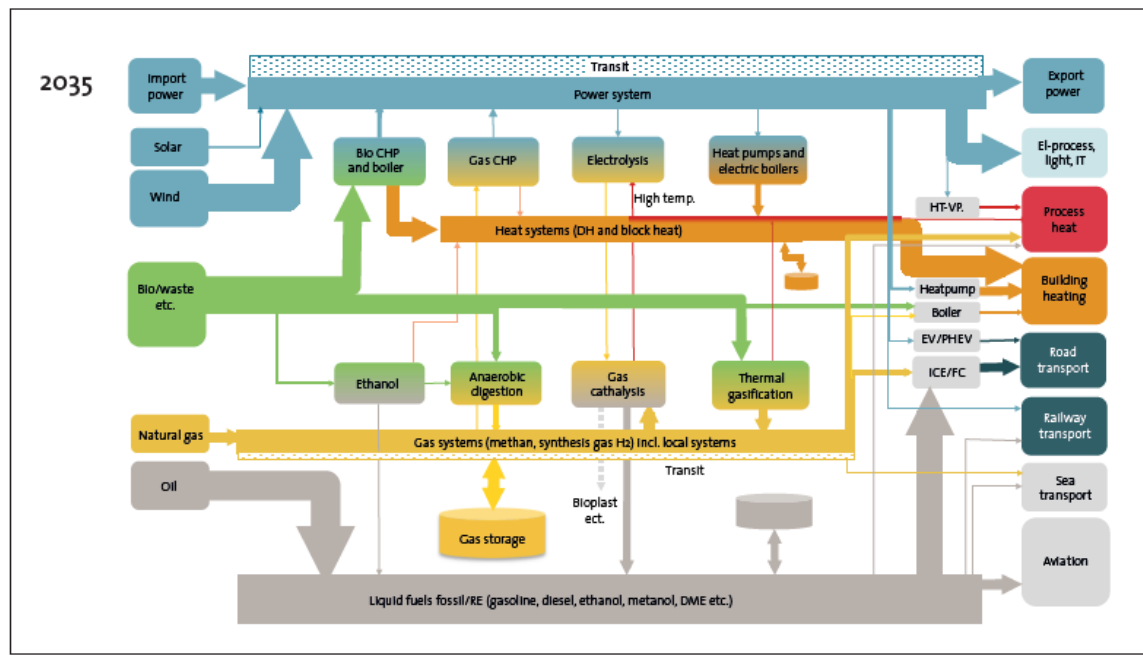


2050

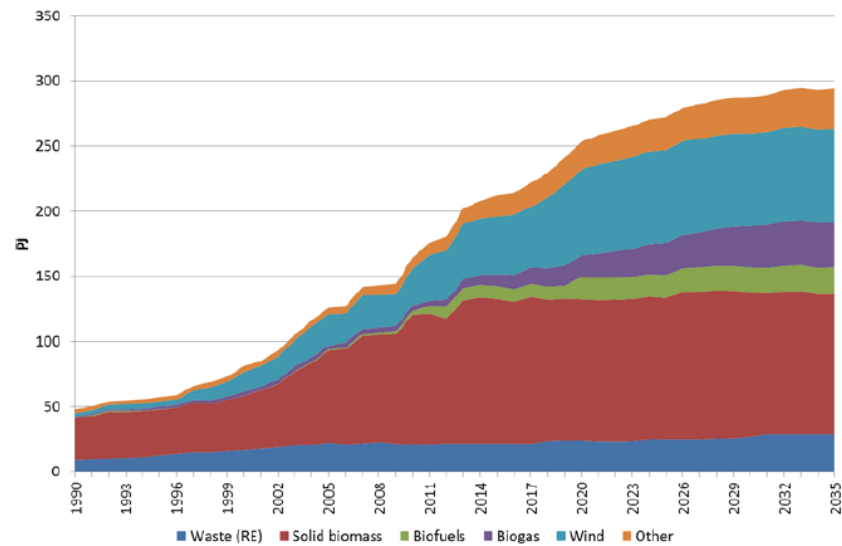
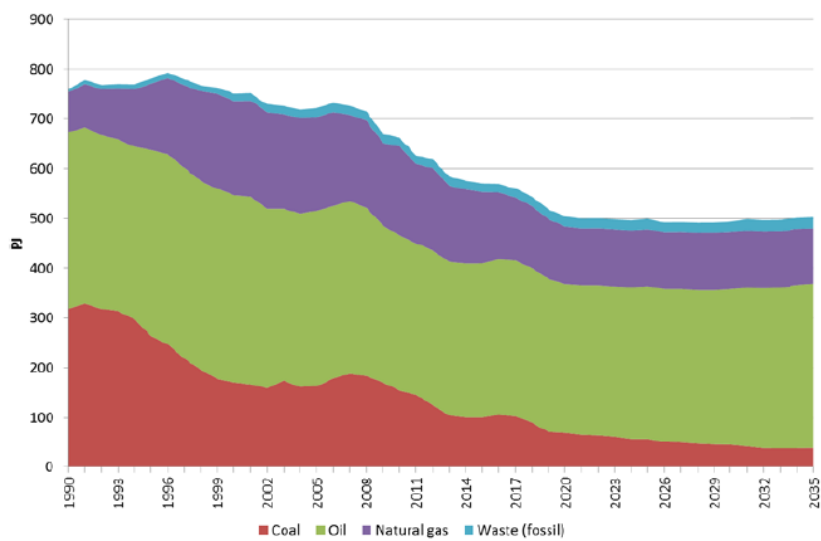




Different pathways to 2050: scenarios for 2035



2035 fuel mix used in emission projections



Lessons from the Danish experience – and projections

Shift from fossile fuels is possible, and desirable for many reasons

The conection to air pollution is not as simple as could be hoped –
Attention to technology (combustion) is needed

Energy efficiency is a key factor

Emission projections are (often) conservative

Air pollution has not been an issue in energy plans

