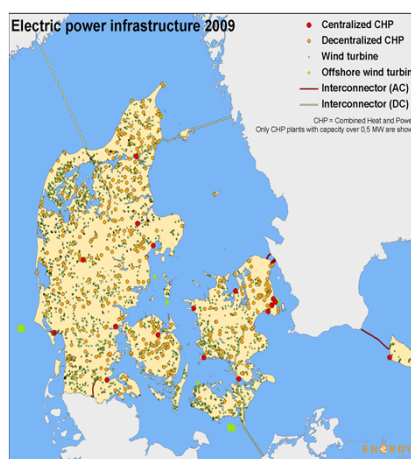


Savings are essential

- Electricity savings (25%)
- Heat savings (42%) (From 132 kWh/m² to about ca. 80 kWh/m² in 2050)
- Savings in industry
- Transport growth but modal shift to more efficient transport Technologies.



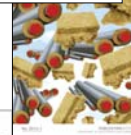
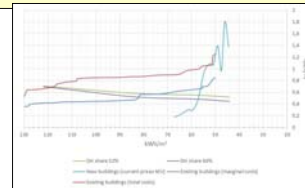
Buildings in 100% renewable energy systems

- Ambitious heat savings essential (also in operational phase)
- Heat savings together with renovations.
- Buildings (new and old) should be seen as part of the system and not be optimised on-site or as a local group.
- District heating to be expanded to cover 66%.
- Focus on shift to lower temperature sources.
- Ground-source heat pumps should primarily be used outside district heating areas (supplemented with solar thermal & biomass)
- Implement district cooling where possible,



Year (prime)	1970	1980	1990	2000	2010
Total heated area (Million m ²)	185.1	246.7	278.0	298.3	331.7
Total heat demand (TWh/year)	27163	34155	36793	38466	40327
Specific demand (kWh/m ²)	147	138	132	129	122
10-year growth factor		1.33	1.13	1.07	1.11

Table 3: Historical development in the main parts of the Danish building stock.

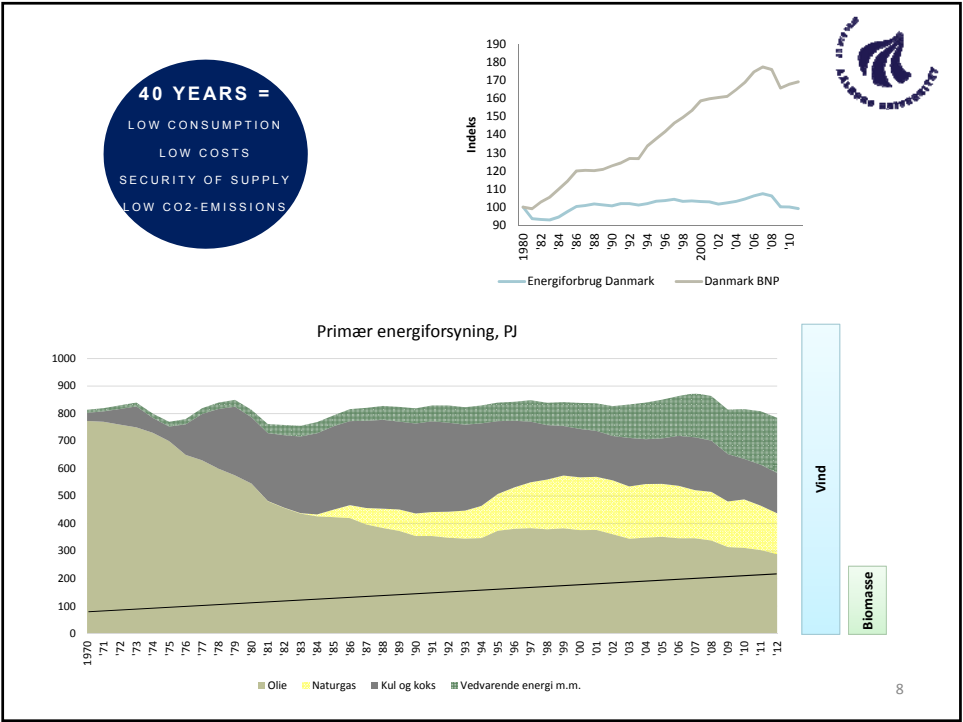
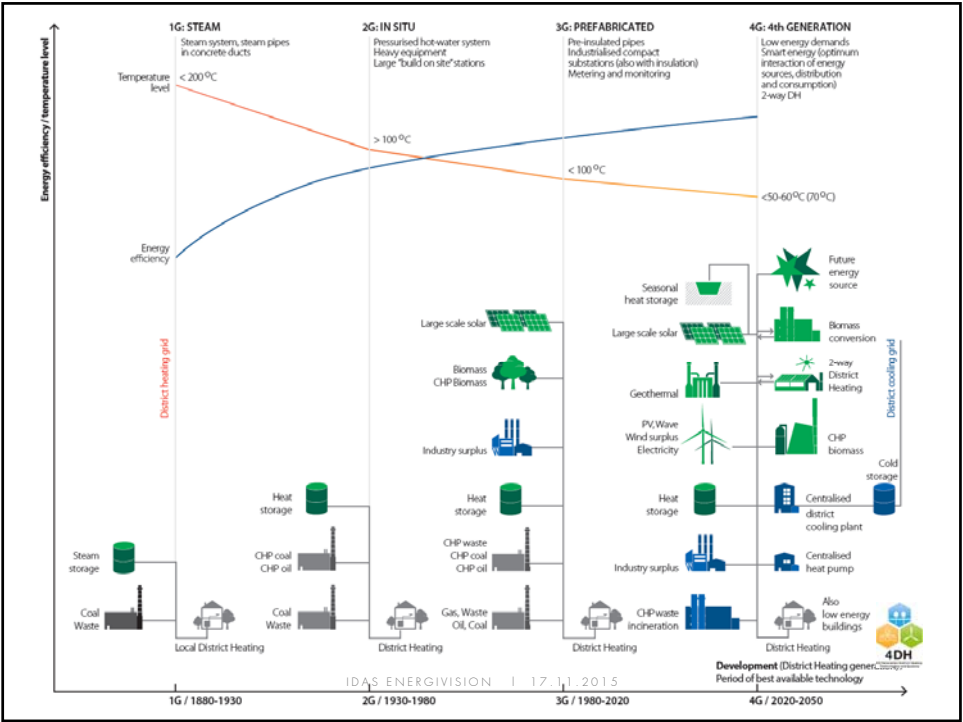


Strategisk forskningscenter for
ENERGINEUTRALT BYGGERI



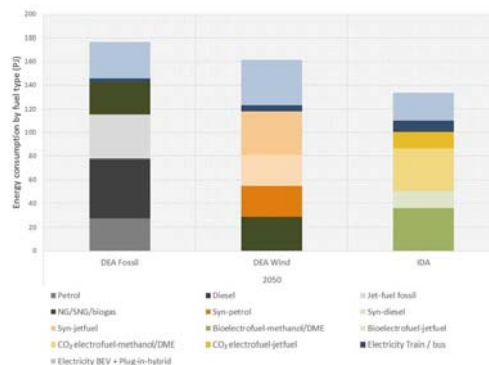
Industry

- Growth in demands (40%)
- Priority:
 1. Savings
 2. More district heating and district cooling for industry
 3. Replace fossil fuels with electricity consumption
 4. Replace fossil fuels with solid biomass
 5. Replace fossil fuels with biogas
 6. Replace fossil fuels with green gas (synthetic fuels)
- Larger use of low temperature sources for district heating in nearby heat networks.



Transport

- More public transport and direct use of electricity
- Personal transport in electric vehicles and plug-in electric vehicles
- Heavy transport on electrofuels. The key to sustainable biomass consumption.



The future gasses

- Phase out of natural gas (from 37 TWh/year)
- Replace fuels in industry and flexible power plants/CHP with biogas and biomass gasification
- Hydrogen for electrofuels with gasified biomass
- Use of existing gas storages
- Use of new storages (CO2, hydrogen, synthetic gas etc.)

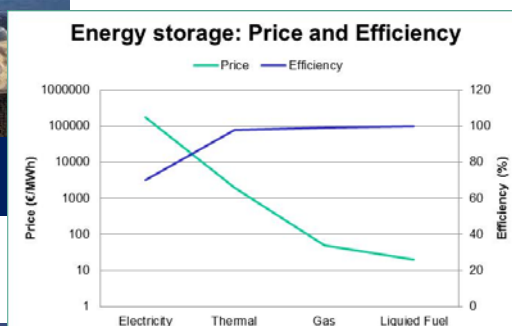
Wind, solar, PV and wave power

- 5.000 MW Onshore Wind, 14.000 MW Offshore Wind
- 5.000 MW PV, 300 MW bølgekraft (Plan B: More wind or PV)
- 2,3 TWh large solar thermal (0,3 TWh today)
- 2,2 TWh individual solar thermal (0,1 TWh today)
- 4,6 TWh geothermal

ENERGY STORAGE



PUMP HYDRO STORAGE
175 €/KWH



THERMAL STORAGE
1-4 €/KWH



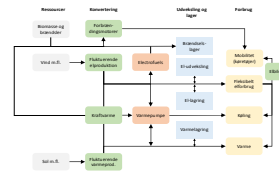
NATURAL GAS UNDERGROUND STORAGE
0.05 €/KWH



OIL TANK
0.02 €/KWH

How to use storages long term..

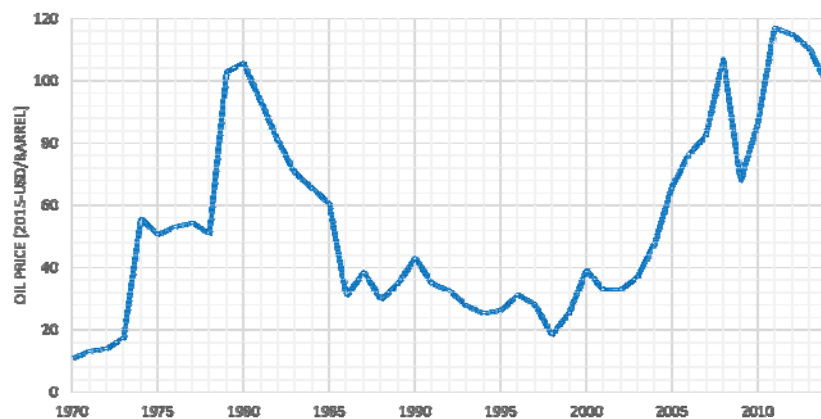
- Three crucial grids in Smart Energy Systems
 - Smart electricity grids
 - Smart thermal grids
 - Smart gas grids
- High capacity electrolyses (Power-to-gas)
- More district heating and district cooling
- Large and small-scale heat pumps (Power-to-heat)
- CHP, solar thermal, etc.
- Electricity storage in transport (batteries and electrofuels)
- Production of green gasses and synthetic fuels



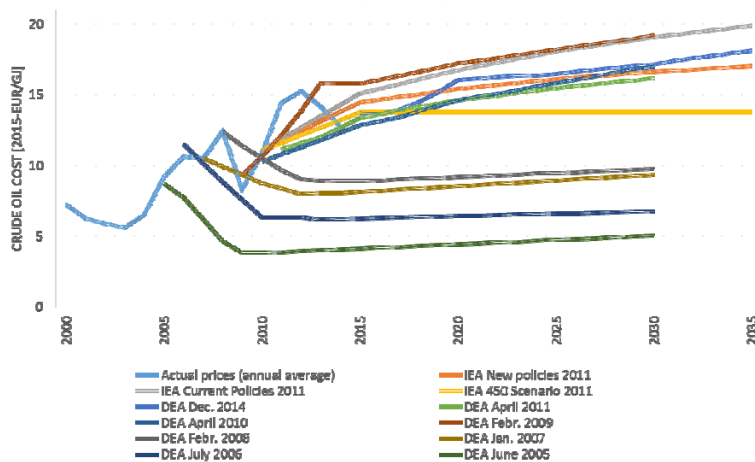
WWW.SMARTENERGYSYSTEMS.EU

World oil prices

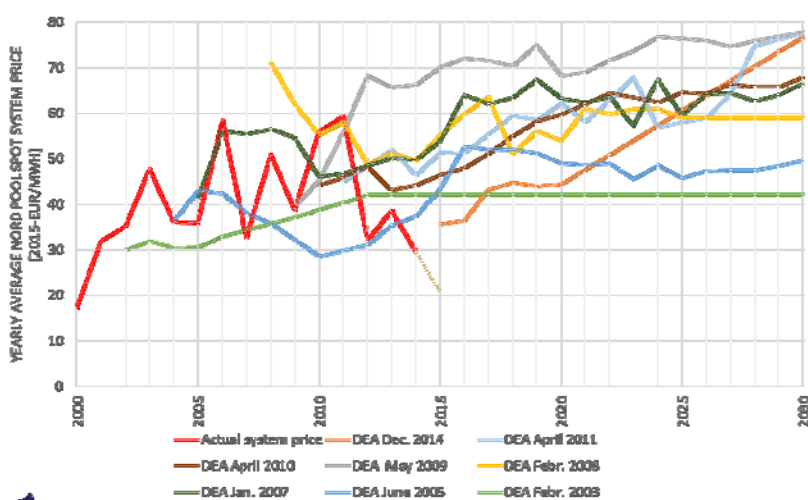
Yearly Brent crude oil price



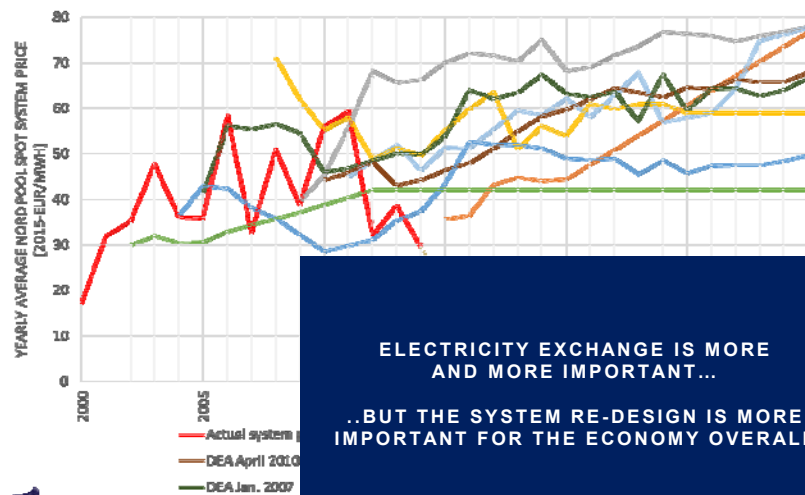
Oil price projections



Electricity prices in Denmark



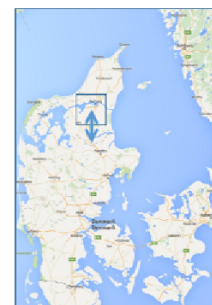
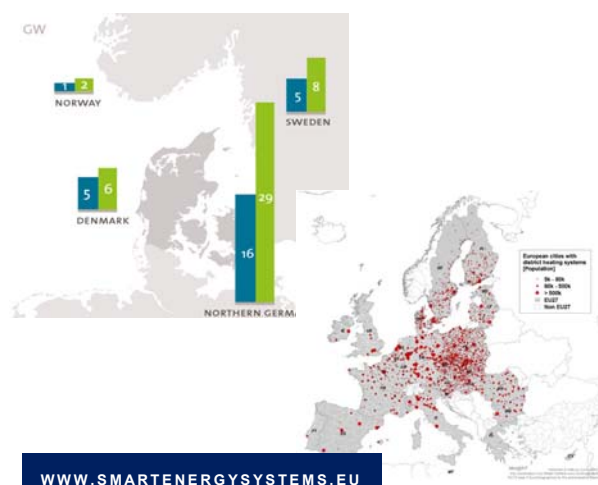
Electricity prices in Denmark



ELECTRICITY EXCHANGE IS MORE
AND MORE IMPORTANT...

..BUT THE SYSTEM RE-DESIGN IS MORE
IMPORTANT FOR THE ECONOMY OVERALL

System – Re-design



Main conclusions

- 100% is possible technically and feasible
- Future need to focus on transmission between the sectors instead of only between countries
- A flexible system is robust with regards to costs and biomass consumption. It uses storages intelligently
- It provides more jobs and lower health costs than fossil fuel systems

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