IDA 100 Percent Renewable Energy Plan for Denmark

The Case of Denmark year 2030 and 2050

22nd Catalan Conference for a Sustainable Energy Future Without Nuclear Energy

Professor Henrik Lund
Aalborg University, Denmark

VIDEN DER STYRKER

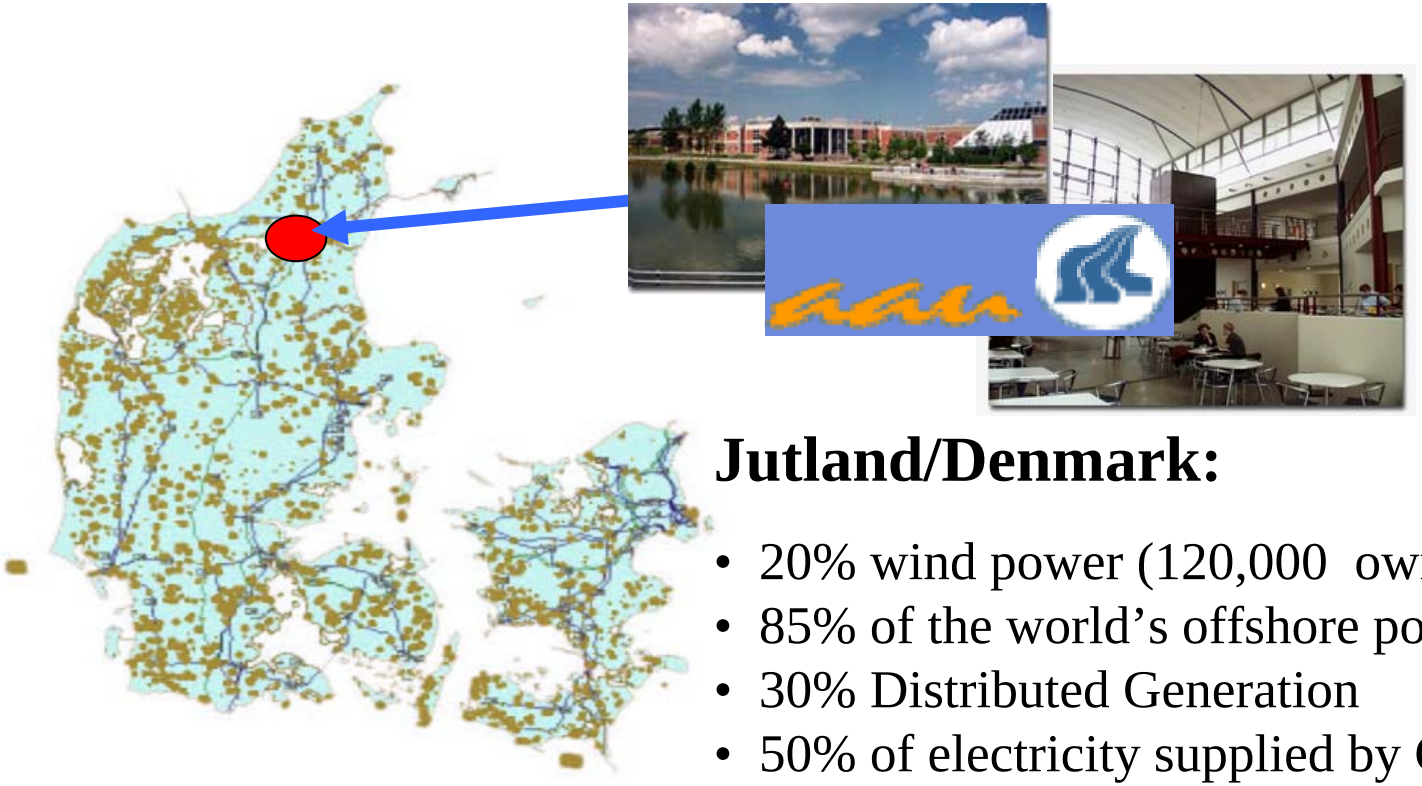
AALBORG UNIVERSITY

Who are we…?

- **The Danish Association of Engineers, IDA:**
  Engineers and other specialist groups working within engineering and technology. IDA has approx. 61,000 members. ***Took the initiative of Energy Year 2006***

- **Aalborg University**
  Henrik Lund and Brian Vad Mathiesen, Energy Planning Research Group. ***Conducted the overall technical and economic analyses.***

Aalborg University, Denmark



Jutland/Denmark:

- 20% wind power (120,000 owners)
- 85% of the world's offshore power (2003)
- 30% Distributed Generation
- 50% of electricity supplied by CHP

Outline

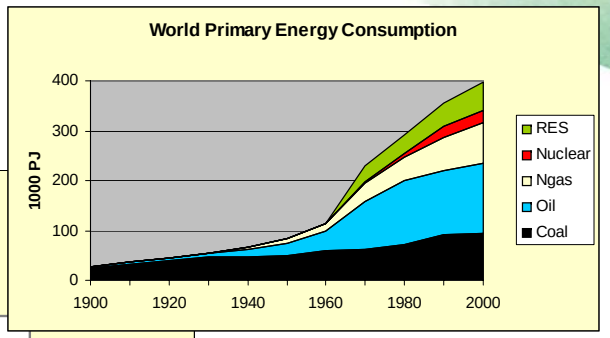
- Political Background and overall targets of IDA Energy Plan 2030
- Work process and Methodology
- Inputs, analyses and results
- Post plan discussions and conclusions

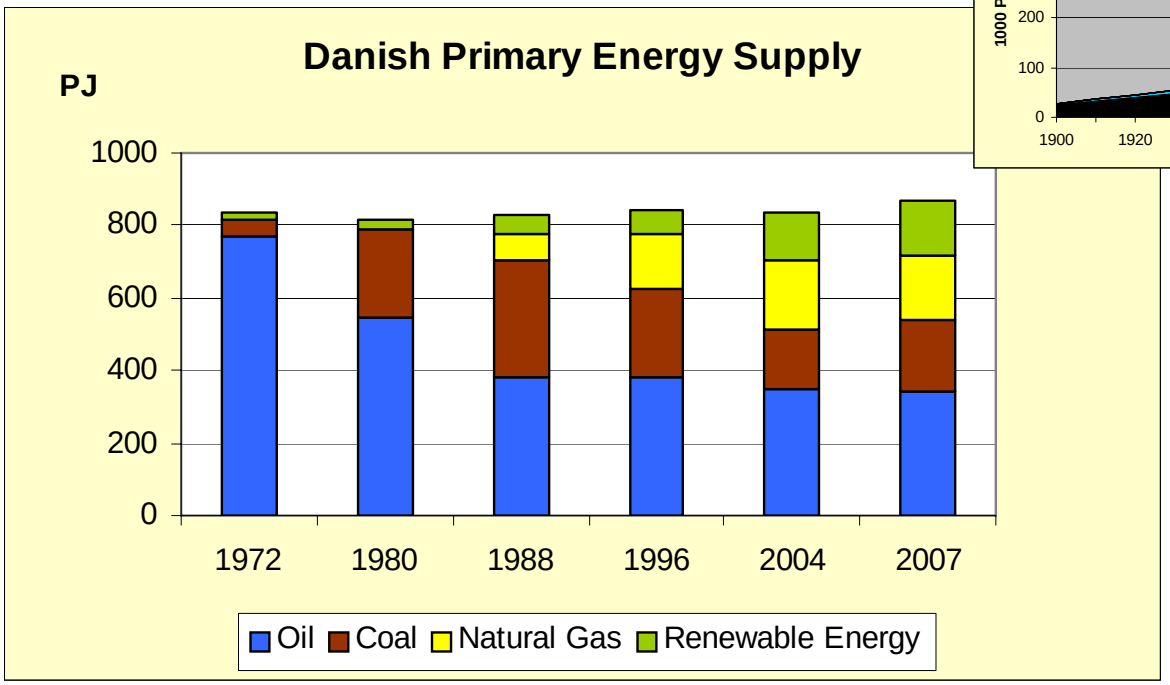
30 Years of active Energy Planning

30 years of active Government and Parliament Energy Policies.

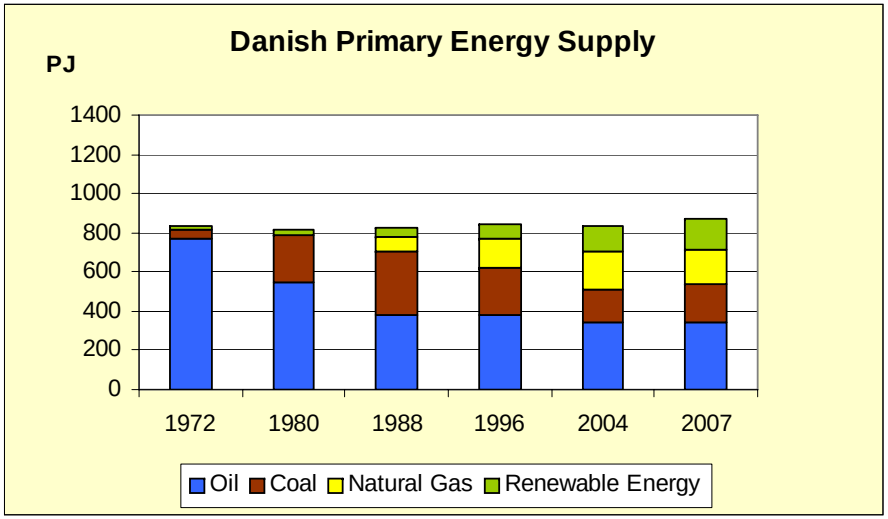
Including NGO alternative strategies and public debate

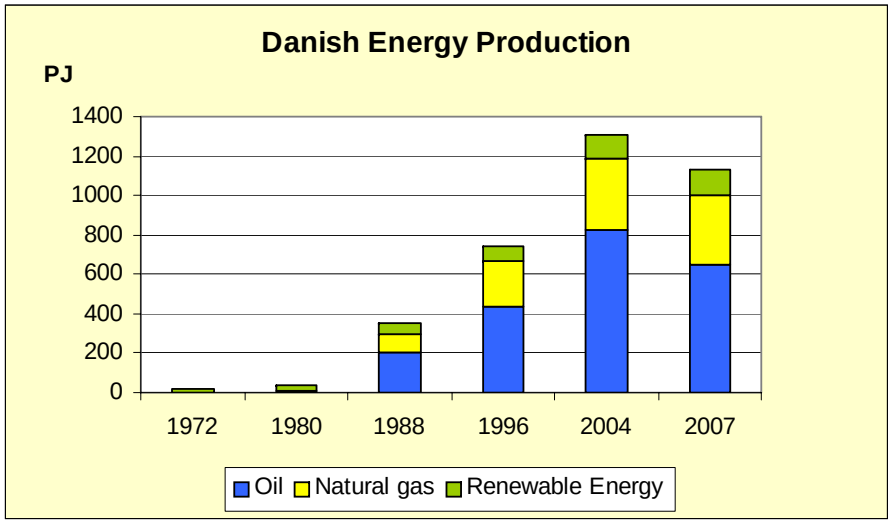
30 years with a stable energy consumption



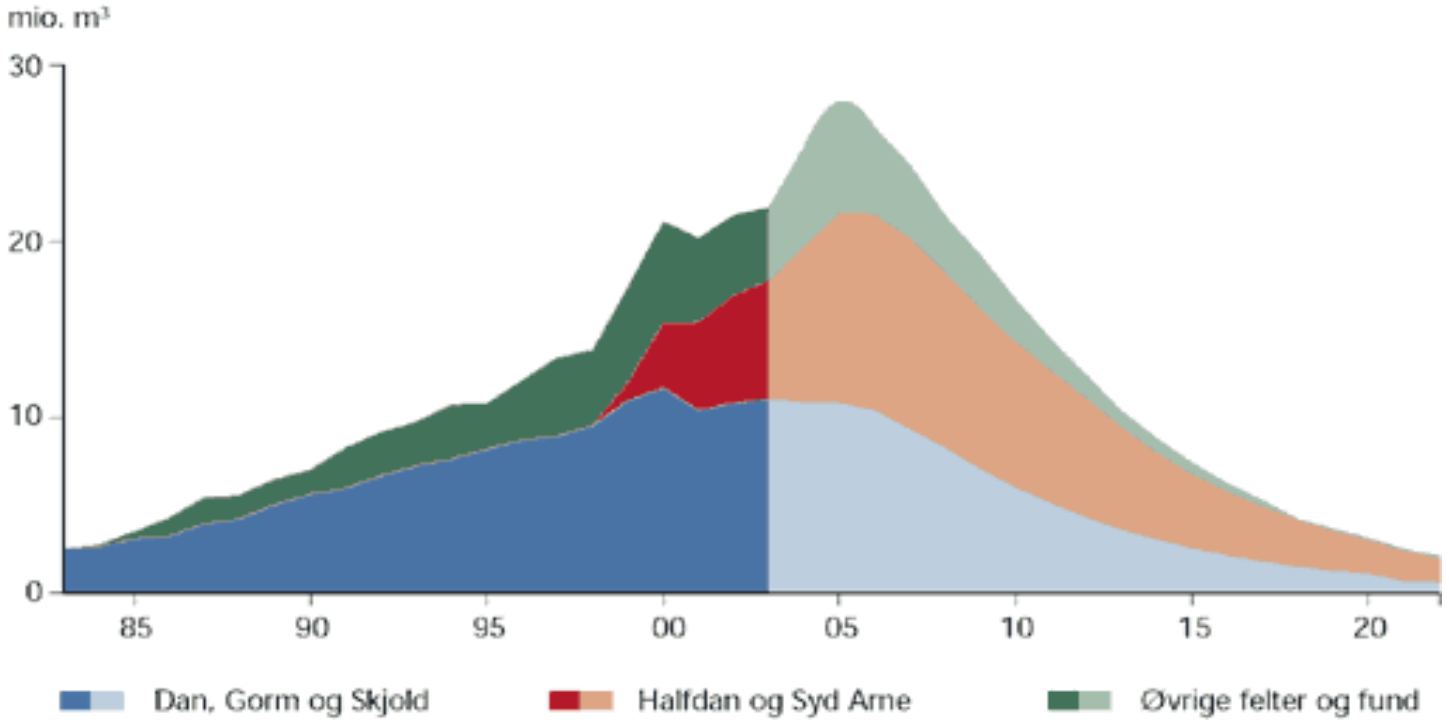


We are more than self-sufficient



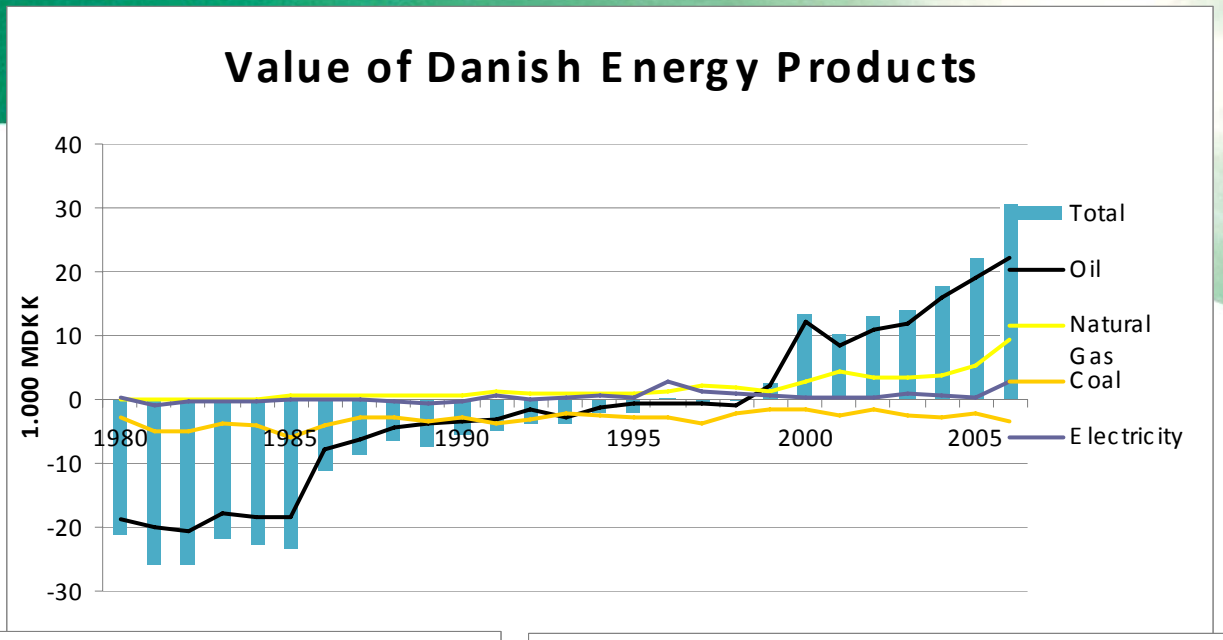


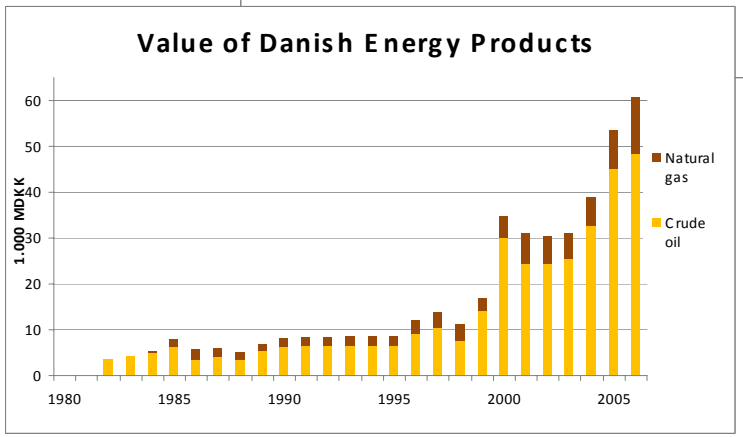
Danish oil production and prognosis

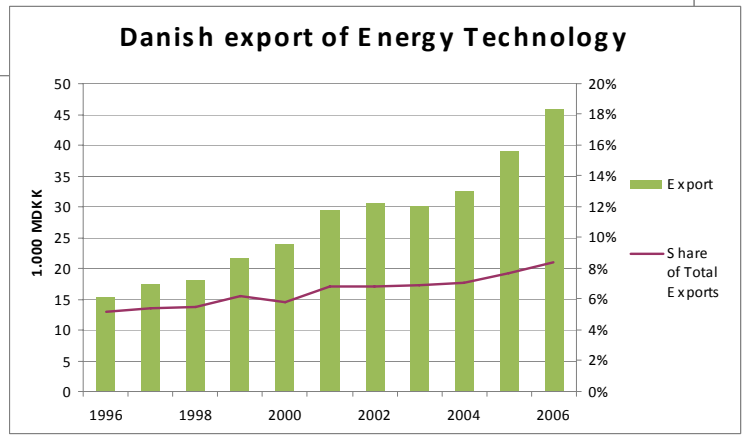


The Danish Energy Authority, 2002

Export of energy technology and fuels

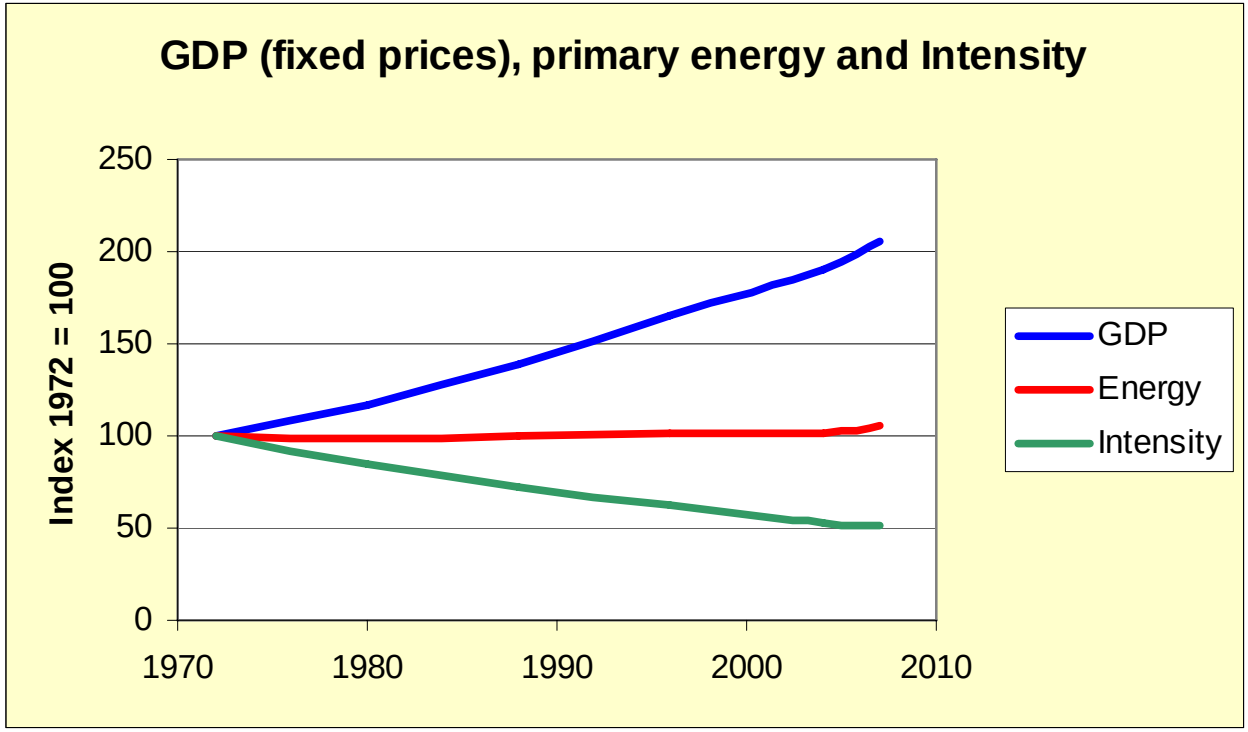






The Danish Energy Authority, 2006

Doubling of energy efficiency

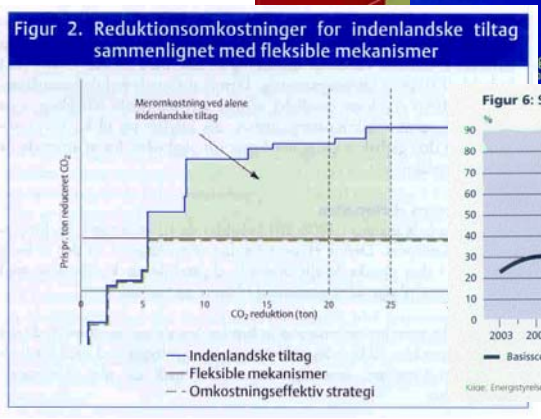


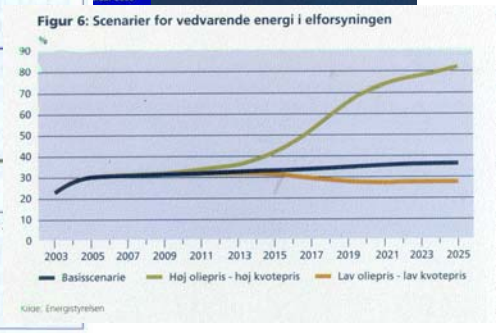
Since 2001…!!

Active Energy Policy put on hold by new government in 2001

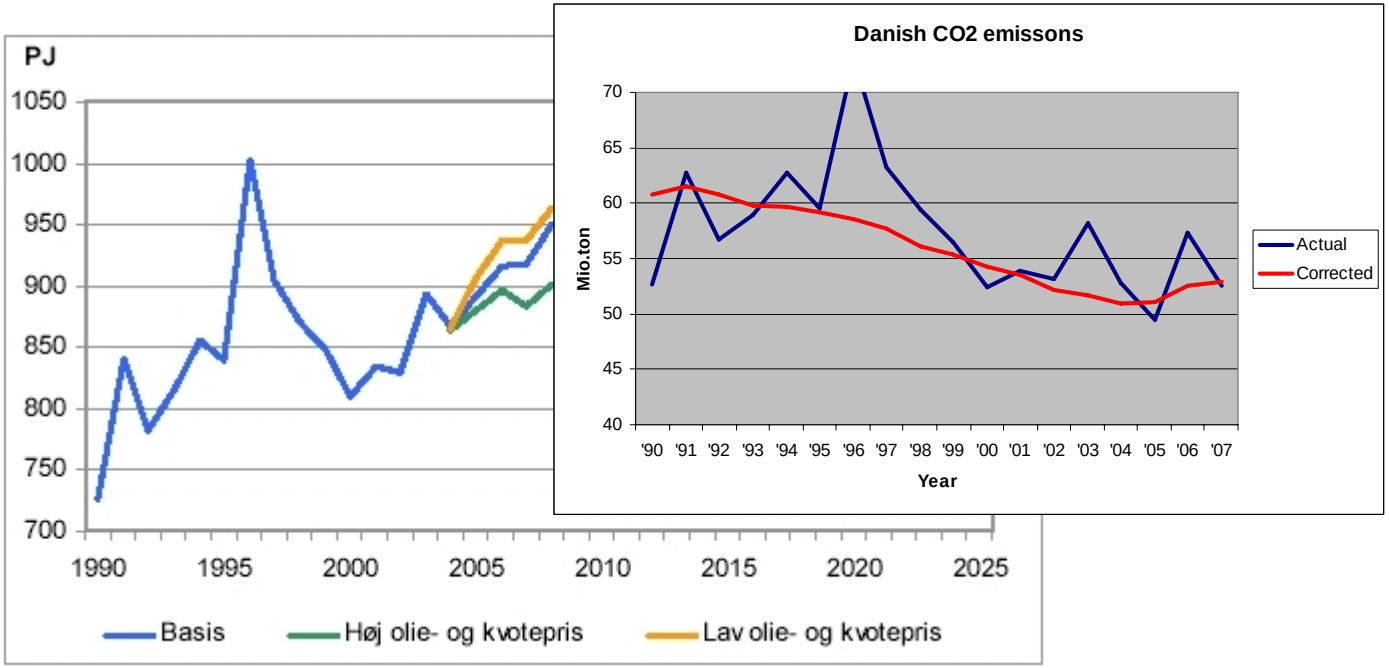
Least cost CDM and JI of climate change

“Leave it to the market” strategy of renewable energy





An increasing energy consumption?



The Danish Energy Authority, 2005

Three targets in the IDA Energy Year 2006

- To maintain security of energy supply
- To cut CO_2 emissions by 50 % by year 2030 compared to the 1990 level
- To create employment and to quadruple the export in the energy industry

New strategy 2006-2007…!

Prime minister in 2006:

- Target of 100 percent Renewable Energy Supply in Denmark year …?? (long-term)

New Energy Strategy were to be negotiated:

Outline

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During the IDA Energy Year 2006

- 40 meetings and seminars by the IDA groups and societies
- More than 1600 participants
- Coordination by the IDA Committee for the environment
- Overall energy system analysis at Alborg University

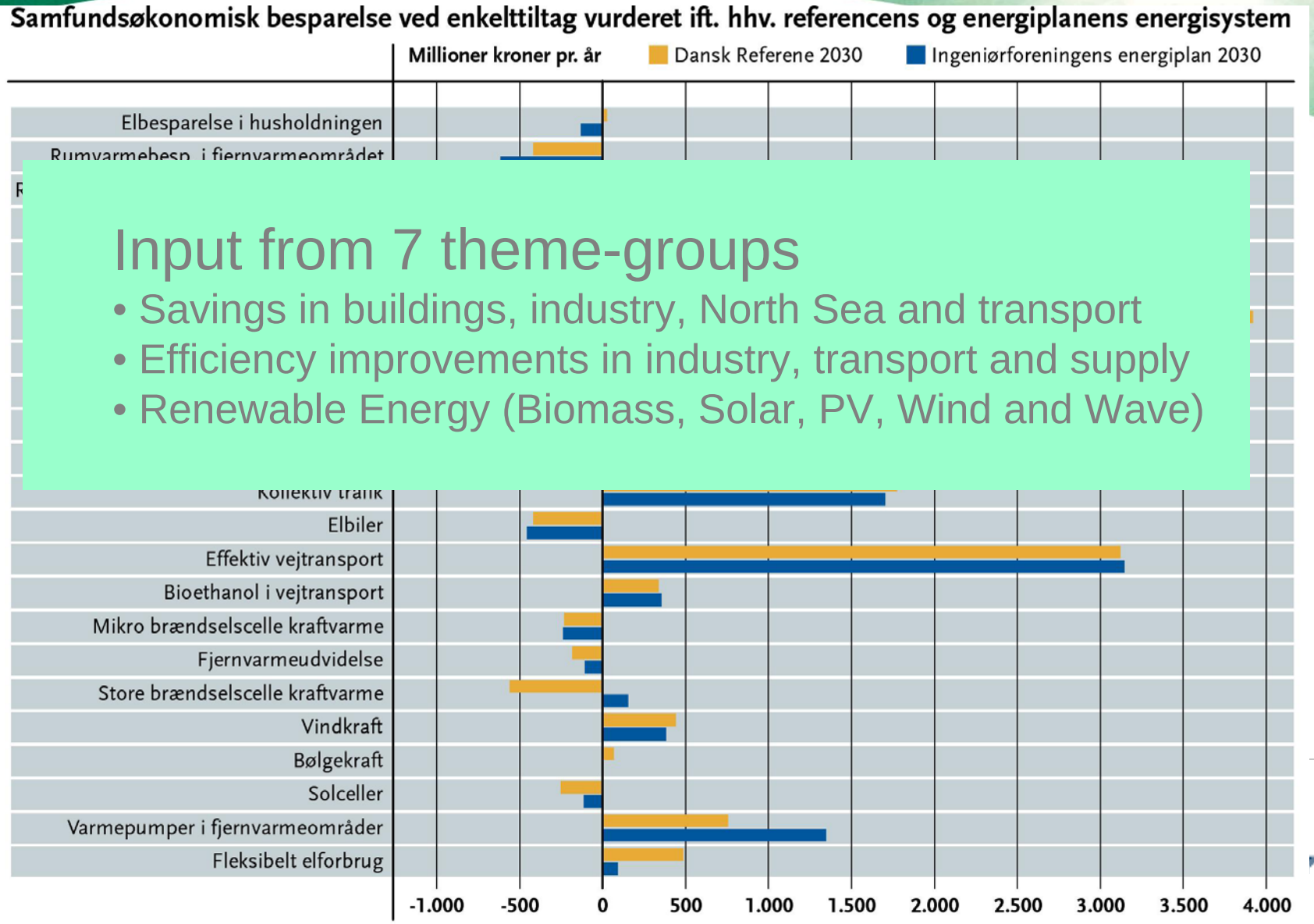
7 themes

- Buildings and solar thermal
- Industry
- Oil and G
- Transpo
- Hydroge
- Wind, Ph
- Energy systems

Biomass

For each theme

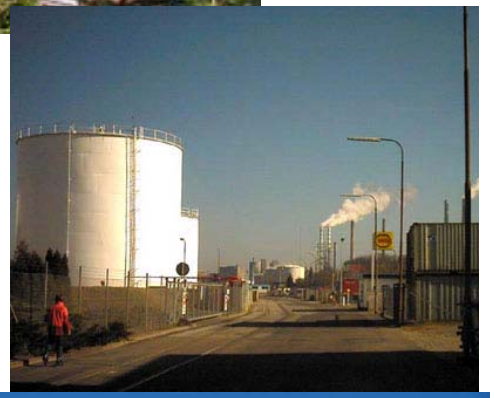
- Knowledge-seminar
- Future-seminar
- Roadmap-seminar



Input from 7 theme-groups

- Savings in buildings, industry, North Sea and transport
- Efficiency improvements in industry, transport and supply
- Renewable Energy (Biomass, Solar, PV, Wind and Wave)

Energy Conservation



- Reduction in the heating demand of 50 %
- 15 % solar thermal share

- 40 % reduction in the fuel consumption in Industry (Efficiency improvements and CHP)

- 45 % reduction in the CO_2 emission from the North sea in comparison to the reference in 2030

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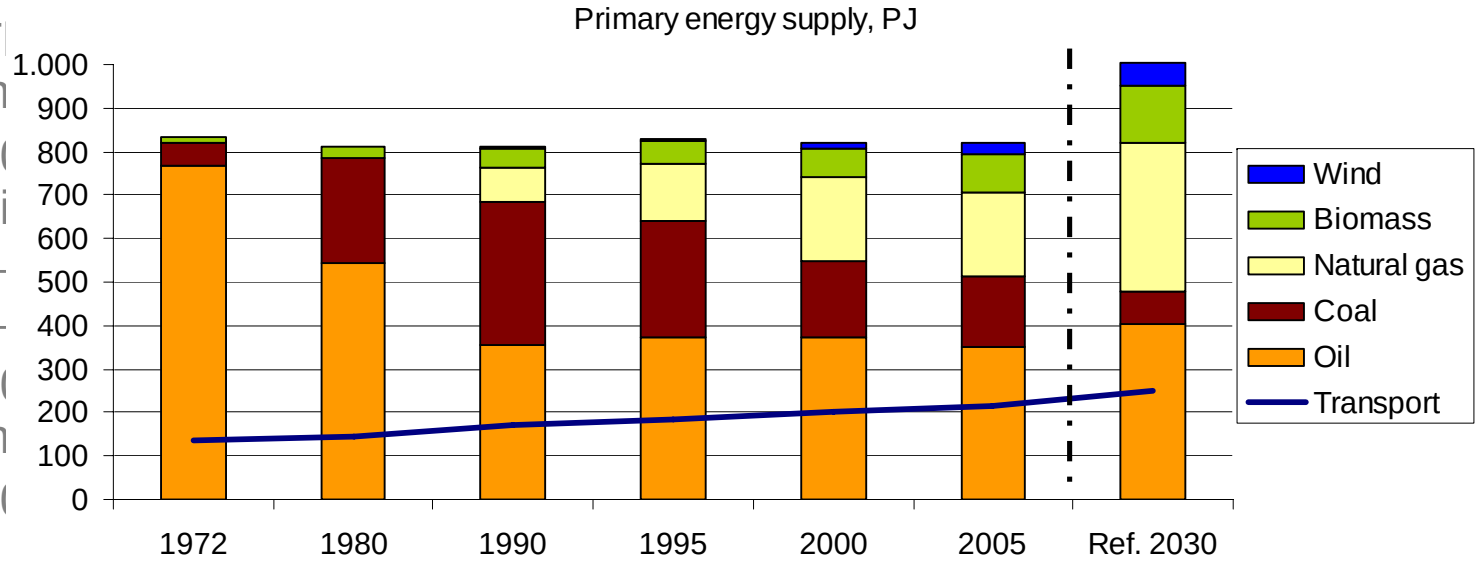
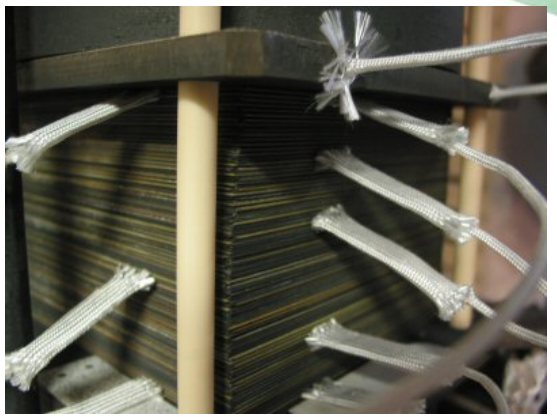


Hydrogen, Fuel cells, Batteries and Biomass (i)

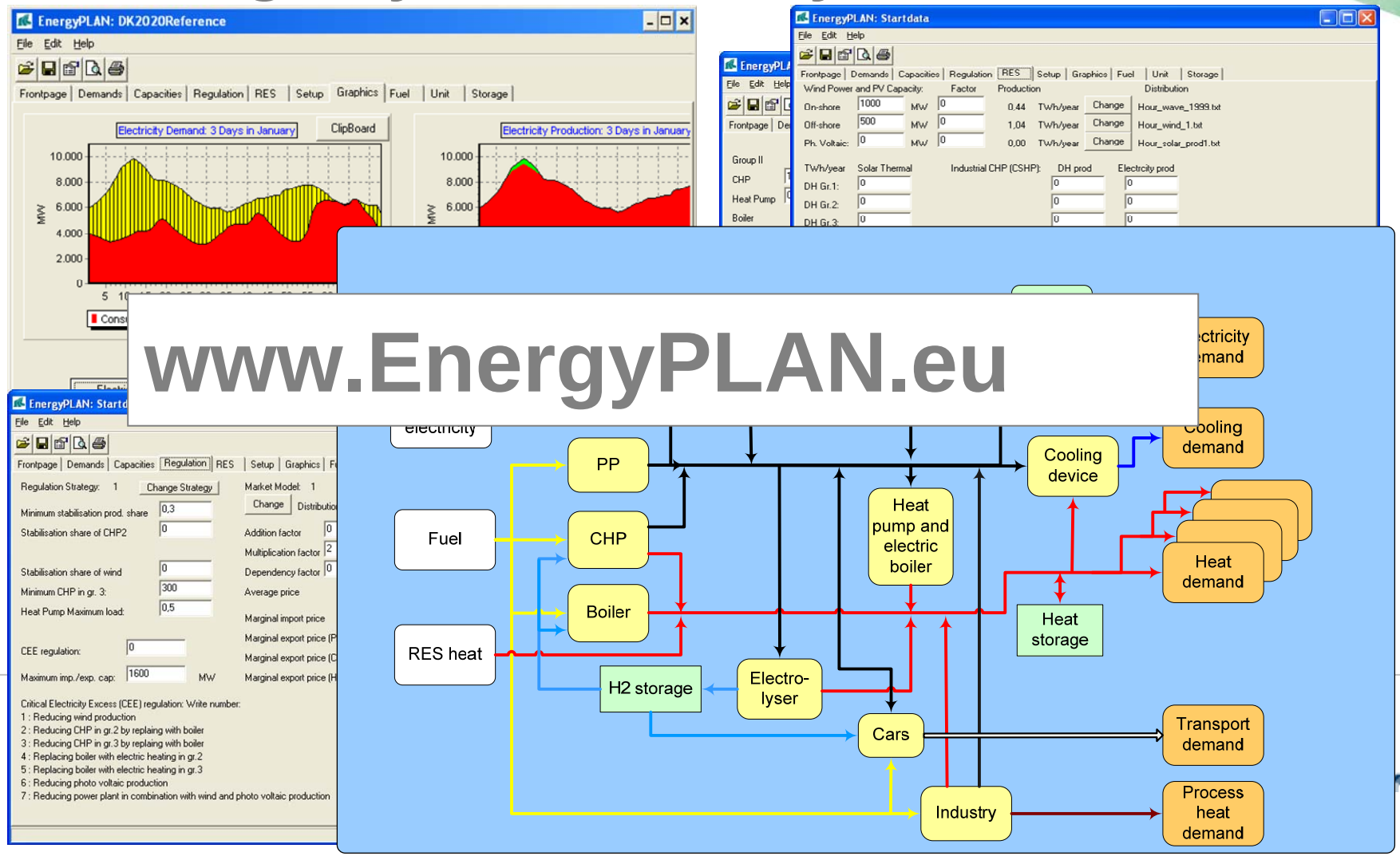
- 10 % of households outside DH is supplied by micro natural gas FC-CHP with eff. of 45 %e and 45 %th.
- From 2015 new small and large FC-CHP are built. In 2030 they are 35 % of all plants. The efficiencies are
  - 66 %e at power plants,
  - 66 %e and 24 %th in central CHP and
  - 56 %e and 34 %th in decentralised CHP



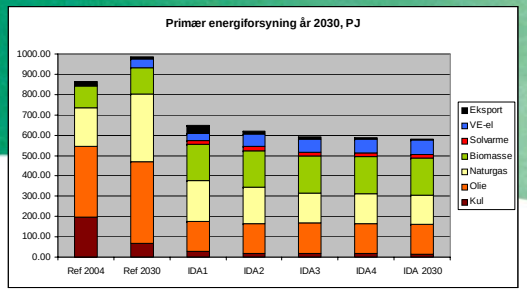
Wind, photo voltaic and wave power

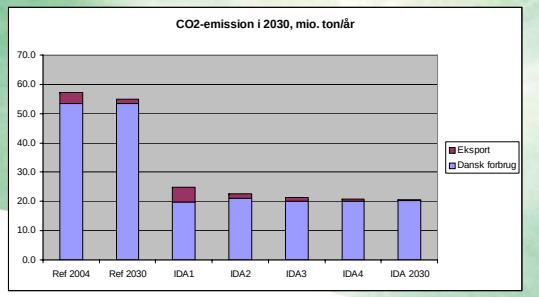
- Doubling the wind power from 3100 MW now to 6000 MW in 2030, half of which is off-shore.
- 5 % of the electricity demand supplied by wave power (500 MW).
- 2 % of the electricity demand supplied by building integrated photo voltaic (700 MW)

Energi System Analyse Model



Technical energy system analyses





	Excess	Boiler share
Step 1: Starting Point	34%	38%
Step 2: CHP regulation	10%	58%
Step 3: Heat Pumps	7%	23%
Step 4: FC regulation	5%	25%
Step 5: Flexible electricity demand	2%	26%

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- Political Background and overall targets of IDA Energy Plan 2030
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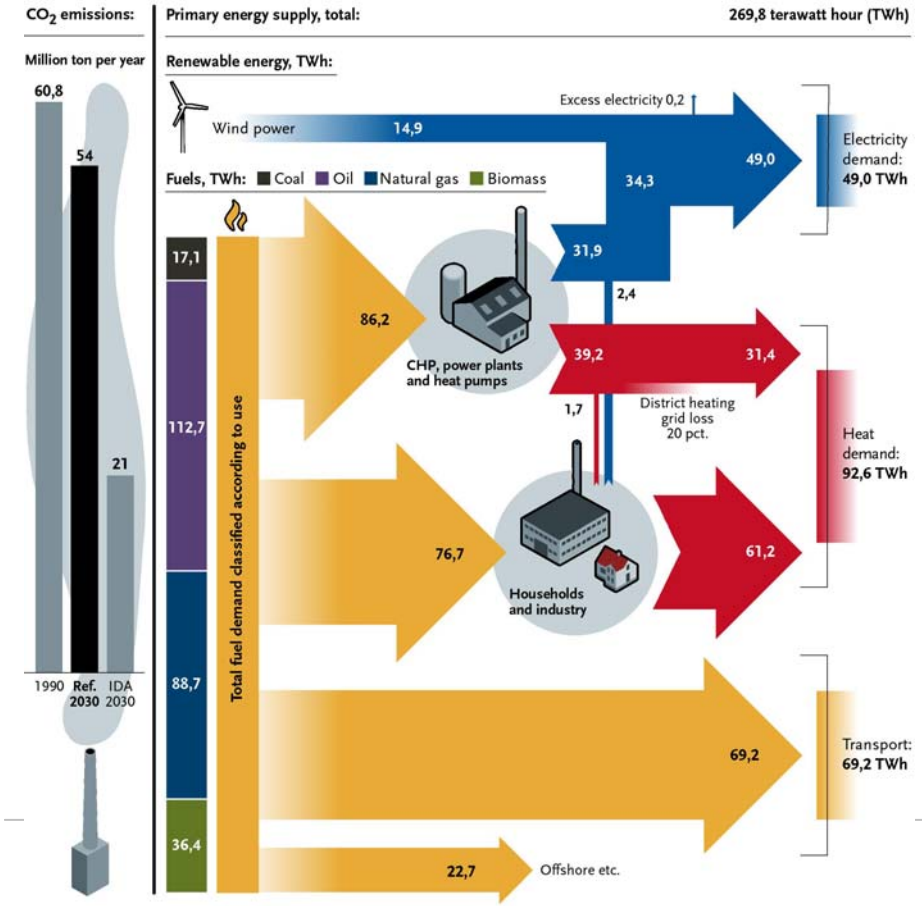
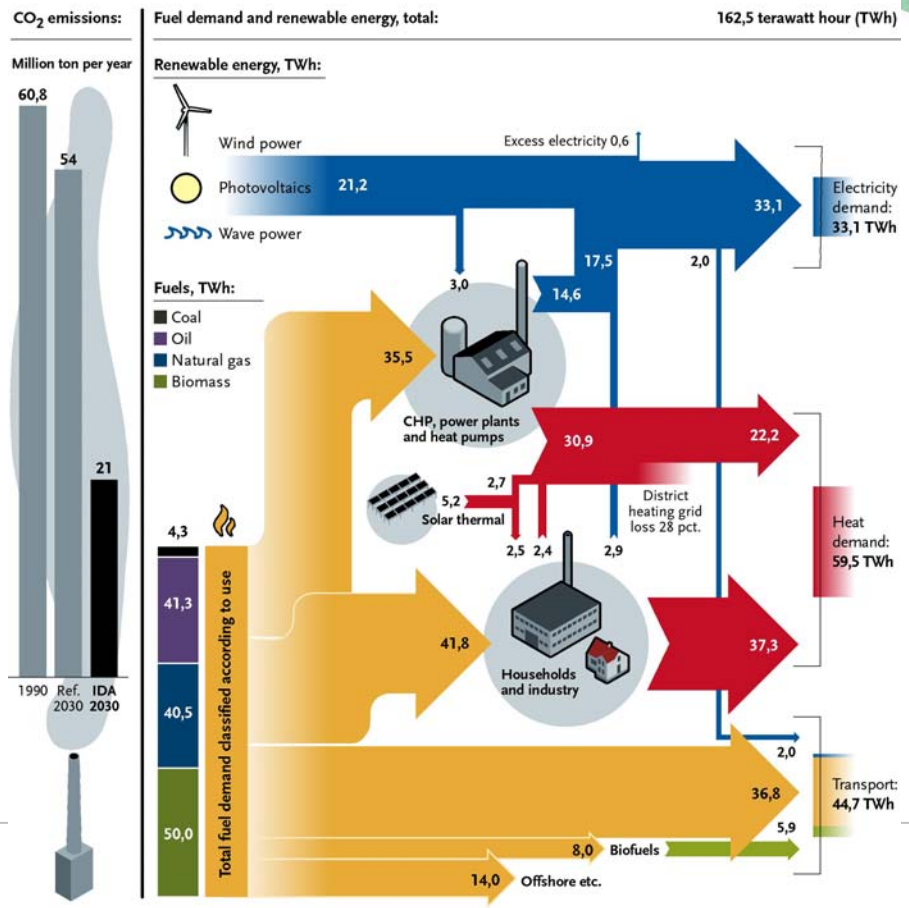
ENERGI TIL FREMTIDEN

Comparisons

DANISH REFERENCE 2030



DANISH SOCIETY OF ENGINEERS' ENERGY PLAN 2030



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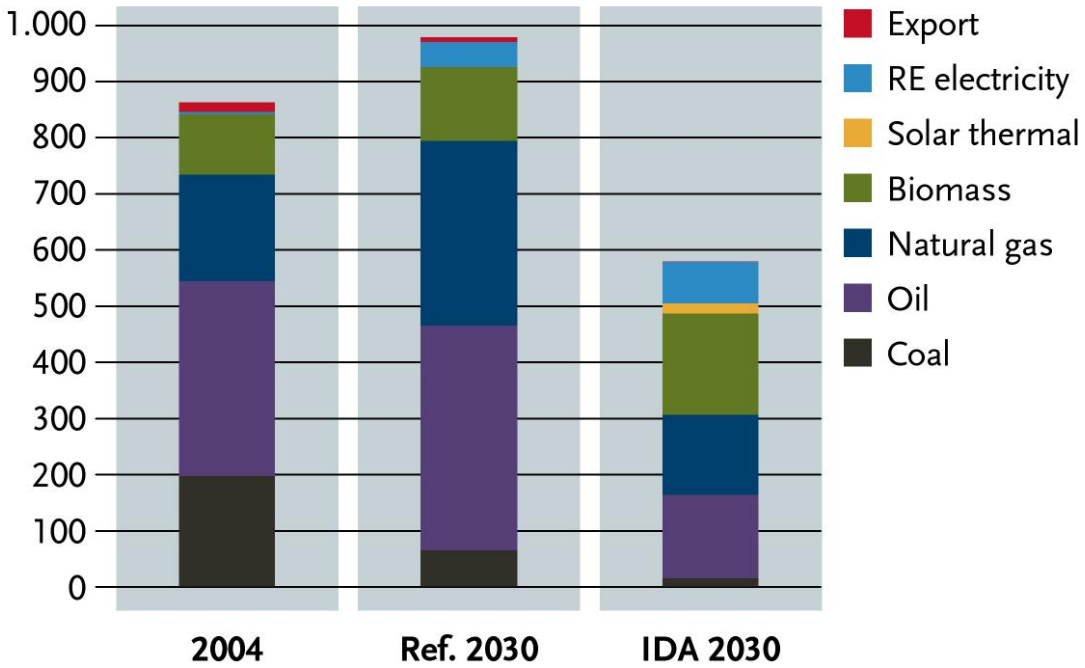
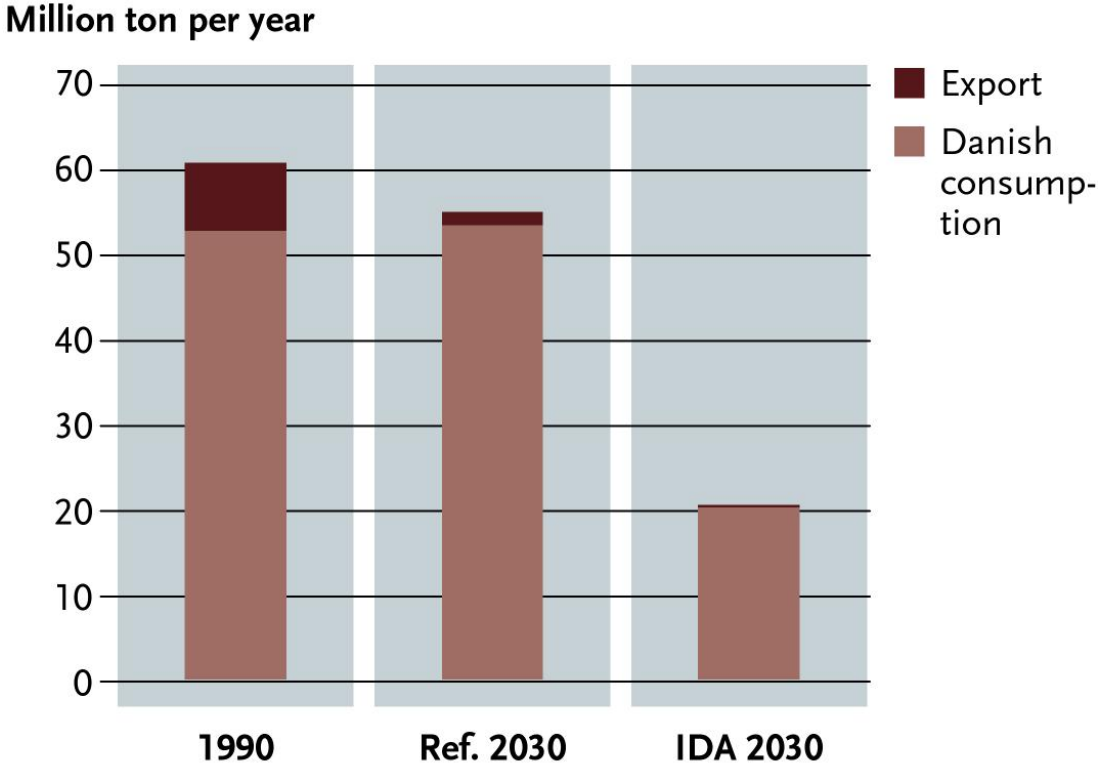
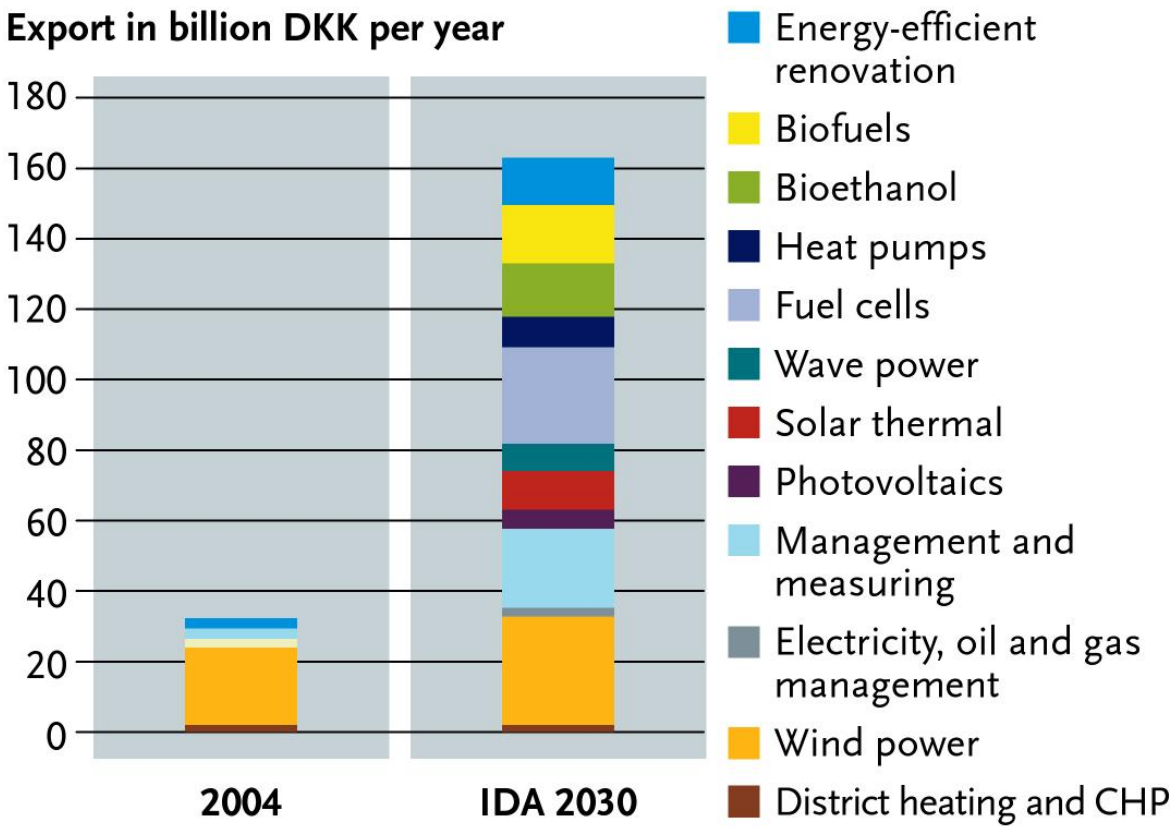
Primary energy supply



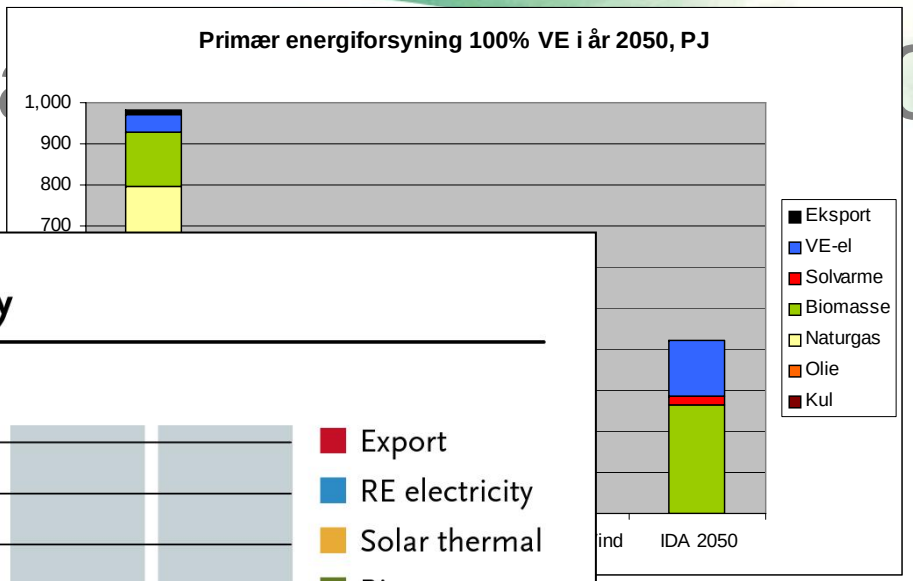
CO_2 emissions

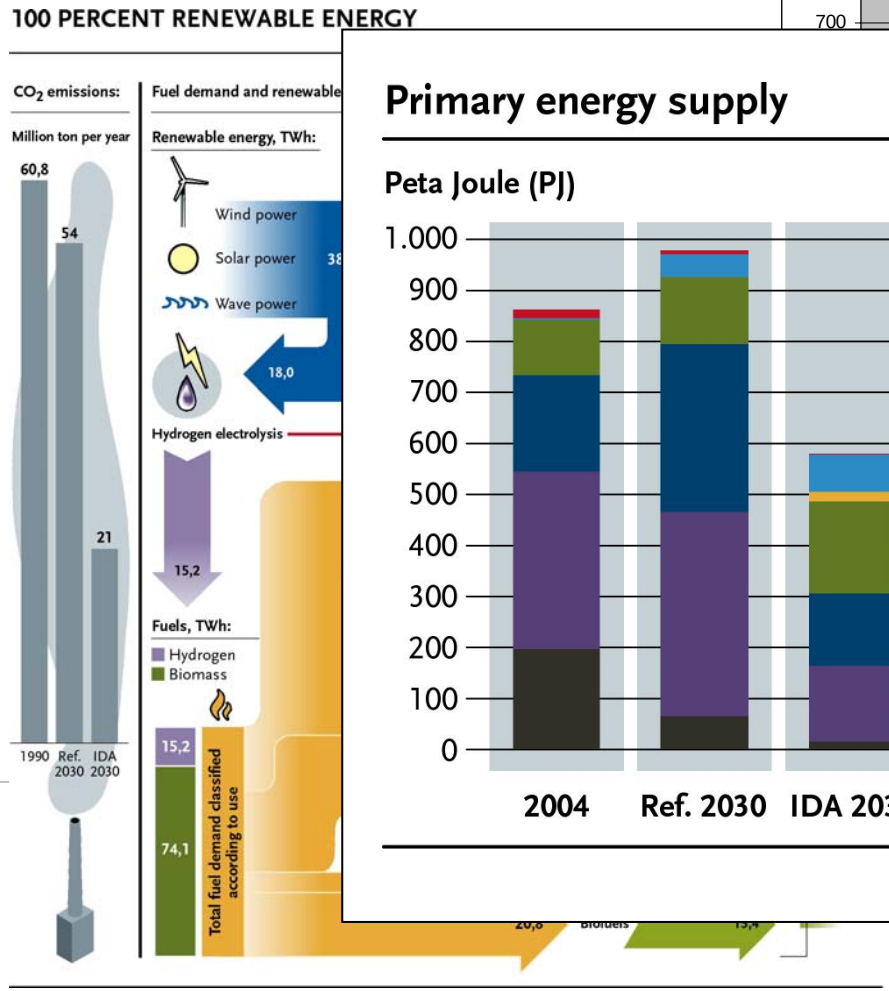


Business potential

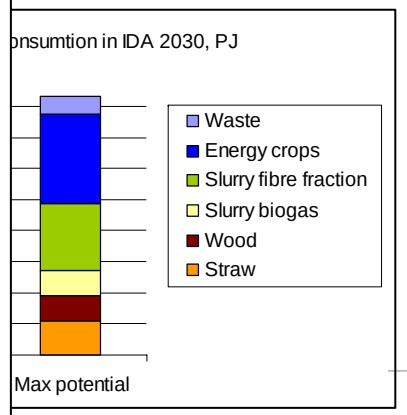


100% Renew


Primær energiforsyning 100% VE i år 2050, PJ
1,000
900
800
700
Eksport
VE-el
Solvarme
Biomasse
Naturgas
Olie
Kul
IDA 2050


100 PERCENT RENEWABLE ENERGY
CO_2 emissions:
Million ton per year
60,8
54
21
1990
Ref. 2030
IDA 2030
Fuel demand and renewable
Renewable energy, TWh:
Wind power
Solar power
Wave power
18,0
Hydrogen electrolysis
15,2
Fuels, TWh:
Hydrogen
Biomass
15,2
74,1
Total fuel demand classified according to use

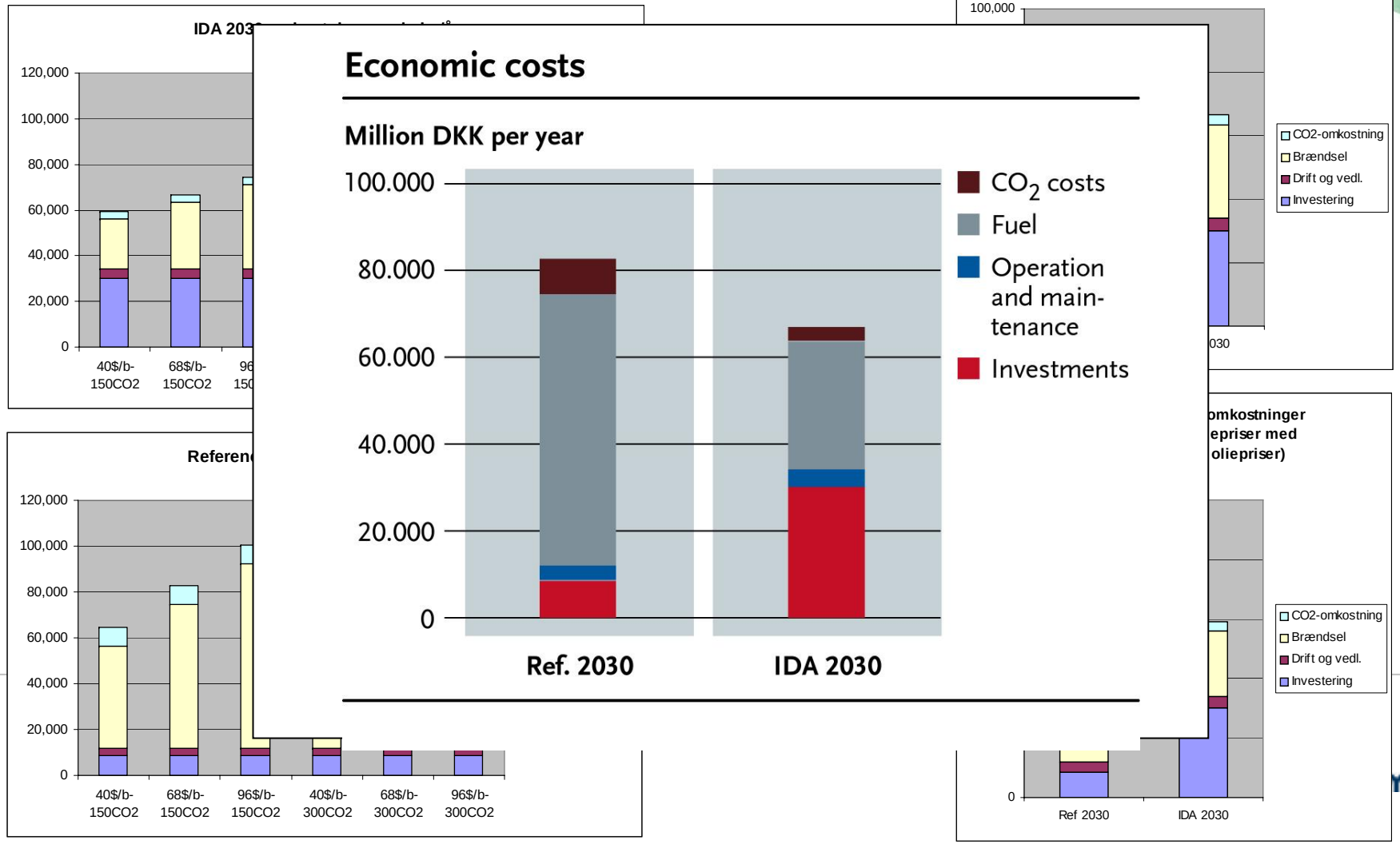
Primary energy supply
Peta Joule (PJ)
1.000
900
800
700
600
500
400
300
200
100
0
2004
Ref. 2030
IDA 2030
IDA 2050
Export
RE electricity
Solar thermal
Biomass
Natural gas
Oil
Coal


onsumtion in IDA 2030, PJ
Waste
Energy crops
Slurry fibre fraction
Slurry biogas
Wood
Straw
Max potential

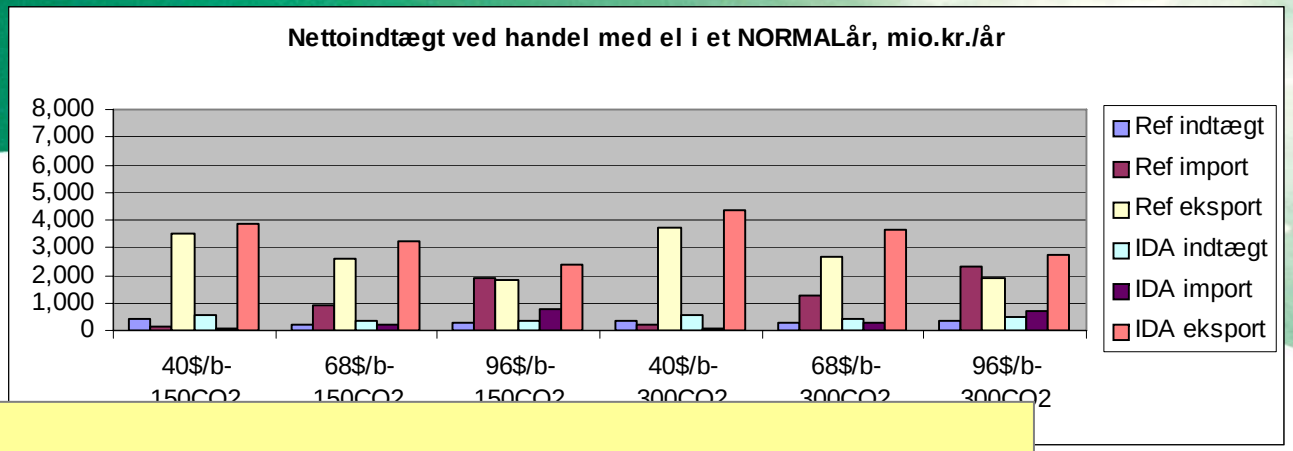
Basic asumptions

- Cost are calculated as Investments, Fuels and Operation&Maintenance.
- Investments are extra costs compared to ”Business as Usual” year 2030 reference
- Oil price vary between 40 and 98 $/barrel with an average of 68 $/barrel (year 2006 price-level)
- Annual investment costs using reel interest of 3%
- Including CO2-qouta-price of 20 EUR/ton

Socio-economic costs and benefits



International electricity trade

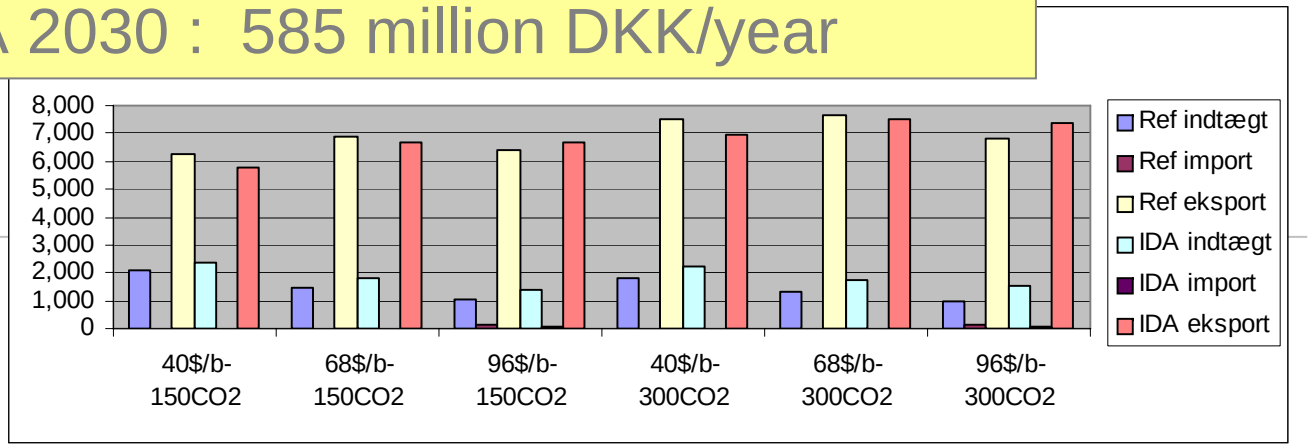


Probabilities:

- Wet-year, Normal-year and Dry-year appears in 3:3:1
- Low, medium and high oil prices appears in 3:4:3
- Low and high CO2-prices appears in 1:1

Reference: 542 million DKK/year

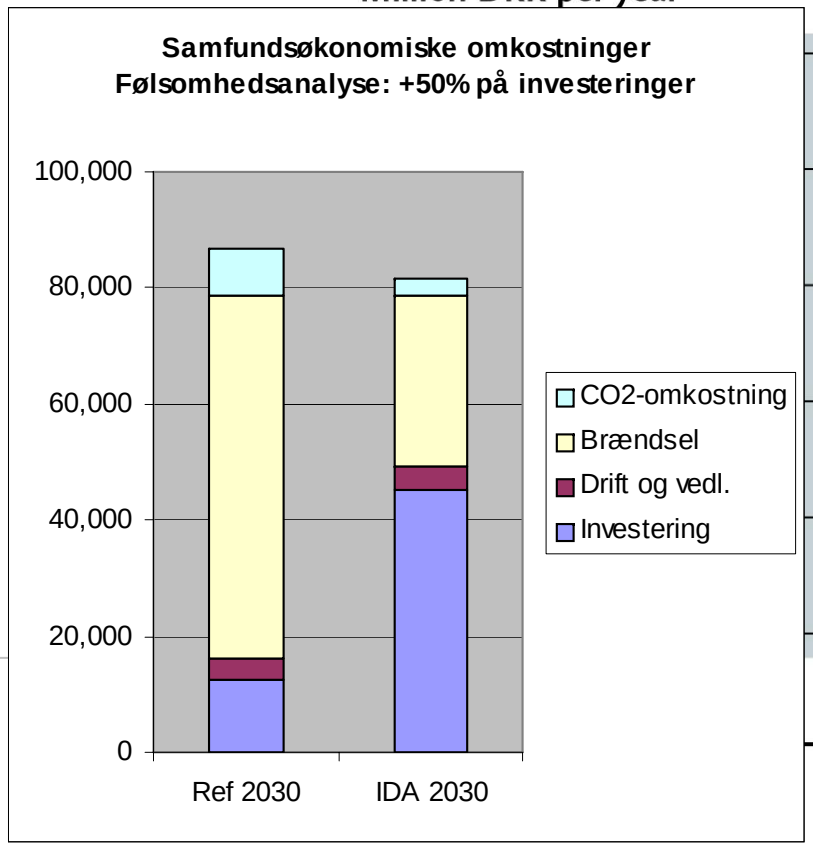
IDA 2030 : 585 million DKK/year

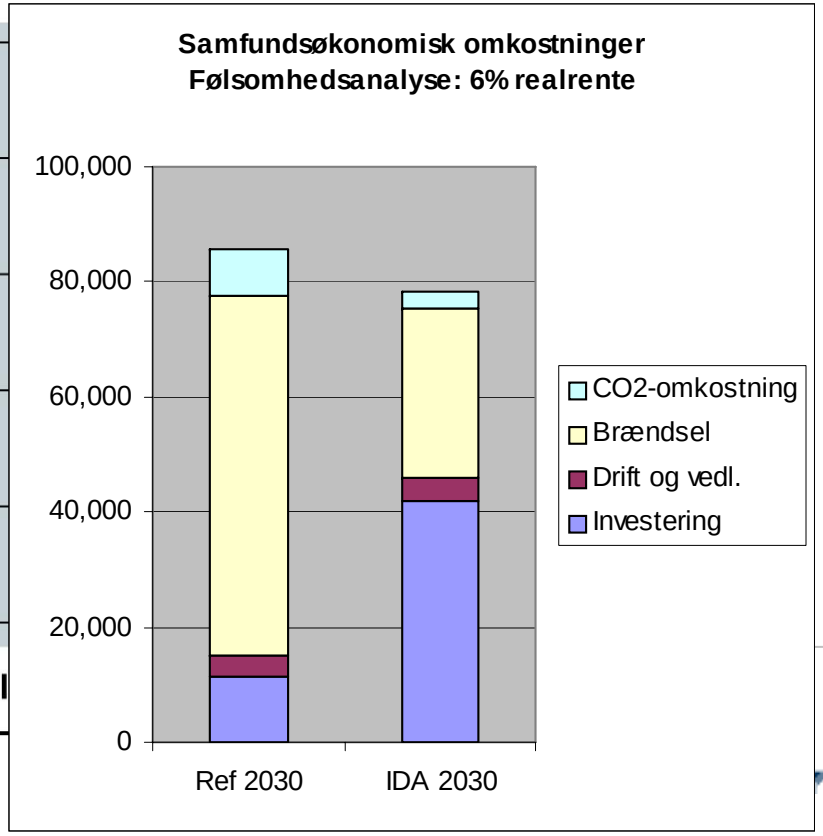


Sensitivity analyses

Economic costs

Million DKK per year





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Post plan discussions

- New energy strategy is being discussed in the Parliament
- IDA Energy Plan is pushing for a more ambiguous target among others in order to implement Danish industrial potentials

11 essential proposals

1. Prolonging the energy savings scheme
2. Foundation for savings in industry
3. Foundation for heat savings
4. Large expansion of rail transport
5. One bn. for research, development and demonstration
6. Initiative for innovation energy markets
7. Feed-in tariffs for renewable energy
8. Resurrection of the public engagement and co-ow
9. CO2 emissions are all auctioned
10. Service-check of the tax and levy structure
11. Establishment of a 100 % renewable energy city

Conclusions

- 100 Percent Renewable is **physically possible** and the first toward 2030 is **feasible** to the Danish Society.

- The methodology of design is a very complex process. The combination of a **creative phase** involving many single experts and **detailed system analyses** seems efficient and can be recommended.

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