Towards CO_2 reduction without nuclear power in the Nordic countries

23. September 2005
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It is a clear Greenpeace objective to combat both climate change and nuclear power. Nuclear power - with all its unsolved and unacceptable problems – should certainly not be part of the solution in the fight for avoiding dangerous climate change.

It is therefore a central question to ask how - and how quickly - nuclear power in the Nordic area - Sweden and Finland – can be phased out in parallel with achieving the substantial reductions in CO_2 emission necessary to keep the global warming below 2 degree C compared to pre-industrial time. For industrial countries this means reductions in CO_2 and other greenhouse gases of at least 30% in 2020 and 80% in 2050 .

Greenpeace have for a couple of years worked closely with energy consultant Klaus Illum on a project

the Nordic Energy Systems Analysis project

to get reliable answers to this question through scenarios made by an extended version of Illums SESAM model to include also Sweden, Norway and Finland.

The aim of the project is to explore a range of different scenarios, so as to find possibilities of developing a Nordic energy system which can satisfy the future energy needs of these countries with low CO_2 emissions and without nuclear power.

Before I present a Nordic scenario giving answer to the question some few words about the model used – a detailed description of the SESAM model have been given by Klaus Illum in several reports.

Slide 1 (the SESAM model of the Nordic.....)

Slide 2 (the SESAM model is a multi…)

Now to the scenarios:

Growth assumptions made:
Slide 3 (material growth assumptions)

Assumption re oil price:
Slide 4 (Crude oil…)

Two scenarios made:
Slide 5a and 5b (two scenario examples..)
The A-scenario
The B-scenario

Transport in scenario B:
Slide 6

Power generation
Slide 7

Nuclear phase-out in Sweden
Slide 8

Nuclear phase-out in Finland:
Slide 9

Phase-in of wind

The assumed phase-in of wind in this scenario is not extremely ambitious. We talk about 200-400 MW pr. year in each of the 4 Nordic countries in the next 25 years – with the highest rate in the last 15 years of the period. I 2030 in total 29 GW installed producing 85 TWh/year.

That means for Denmark that wind in 2015 deliver 35% of the electricity consumption – the same as recommended by Danish Wind Industry Association in "Vind eller forsvind".

And for all 4 Nordic countries together that wind cover well 15% in 2020 – a little more than projected for OECD Europe in Windforce12.

Electricity consumption: Slide 11

Conversion of electric heating

**The amount of electricity used in the 4 Nordic countries to electric heating
- at least 73 TWh/year –
equals around 83% of all electricity produced by nuclear power in the Nordic.**

Electric heating is especially widespread in Norway and Sweden – and is one of the head reasons why the electricity use per capita in households in Norway is 4.2 and in Sweden 2.5 times higher than in Denmark.

To use electricity to heat up houses is like cutting butter with a chainsaw, as A. Lovins have put it.

(It is worth remembering that “Linie 2” that won the Swedish nuclear referendum back in 1980 on their vote list promised that direct electric heating in new houses will be stopped. In spite of this electric heating in Sweden increased 100% in the next 10 years in parallel with putting on line the last 4 reactors (F2, R4, O3 and F3))

So one important change in scenario B is a gradual conversion of electric heating – especially in Norway and Sweden.

Heat generation
Slide 12

Heat consumption
Slide 13

Fuel use
Slide 14a

Fuel use in each country
Slide 14b

CO_2 emission
Slide 15

CO_2 emission in relation to goals
Slide 16

Scenario B illustrates that IT IS technically possible to phase-out nuclear power in Sweden and Finland within 20-25 years – and at the same time reduce Nordic CO_2 emissions from the energy and transport sector in accordance with both Kyoto-targets in 2008-12 and the much more substantial reductions needed in 2020 and 2030.

In addition it leads in 2030 to nearly 60% reduction in Nordic oil use – and 55% reduction in the use of diesel and gasoline in vehicles compared to now.

Slide 17 (investments and reinvestments in B)

Slide 18 (total costs in 2005-2030)

Slide 19 (total costs table)

I guess it may be surprising to many that total costs – investments, maintenance and depreciation costs and fuel costs - needed in the next 25 years (2005-2030) in scenario B are a little less than the total costs needed in scenario A – with moderate oil price growth (price case 2: 60 to 90 $/barrel).

Slide 20

In addition the accumulated capital in 2005-30 is 3 times higher in scenario B – and the annual costs in 2030 clearly lower even in the low oil price case! In other words scenario B is a much more both environmental and economical sustainable energy system than B.

Conclusions:

What actually happens in the future depends on whether or not our societies exploit the technological opportunities for the development of a sustainable energy system.

If the transition to a sustainable energy system does not take place in a goal-directed manner in accordance with an appropriate development strategy, it will take place in an unforeseeable and probably disastrous manner.

This is not to say that economy and the market is not important for the implementation of a certain development strategy. It is indeed.

But only when a certain strategy has been politically decided can new particular markets for infrastructure investments be opened.
Also the market regulation mechanisms appropriate for the implementation of the strategy (e.g. energy efficiency standards for electric appliances and vehicles; CO_2 taxation and other environmental taxation) should be assessed and implemented in a goal directed manner.

It is vital to understand that the so called market forces – oil price, CO2 price and electricity price – will NOT secure that the investment flow in the energy sector will lead to real CO2 reductions. And if it do it will not be large enough reductions.

The Danish government "Energy strategy 2025" from June this year illustrates this clearly:

In their low-low projection
– with assumed oil price of 20 $/barrel and CO2 price of 6.5 euro/ton –
CO2 emission from the energy sector (including transport) will INCREASE nearly 10% in 2008-12 compared to 1990 – and will in 2020 still be nearly 8% MORE than in 1990.

Even in their high-high projection
- with oil price increasing to 50$/barrel and CO2 price increasing to 40 euro/tonnes in 2025 –
CO2 emission will in 2008-12 be THE SAME as in 1990 - and only 18% below 1990 emission in 2020.

In conclusion I will appeal to politicians to use the sort of scenarios that presented today to explore and analyze possible road maps and investment plans to secure development of low CO2 emitting, nuclear free and sustainable energy systems in the Nordic countries.

Nordic cooperation and coordination in this respect is clearly beneficial.

Sitting back and leave it to the market forces is completely irresponsible.
We need politicians that take back energy planning power, set up targets and timetables, and decide on the measures and market regulations needed.

There is no time to waste.

Thank you!


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The SESAM Model

The SESAM model of the Nordic energy system is a comprehensive, completely integrated physical model of:

The end-use system:

- **Buildings with inventories of electrical appliances.**
- **Industries and production processes.**
- **Means of transportation.**

The energy conversion and transmission system:

- **Power and cogeneration stations of various types.**
- **Boiler stations and individual boilers.**
- **Units for the conversion of electric power to chemical energy for use in vehicles, e.g.. electrolyses units.**

The system of energy sources:

- **Hydropower, windmills, PV-panels, biomass, fossil fuels etc..**

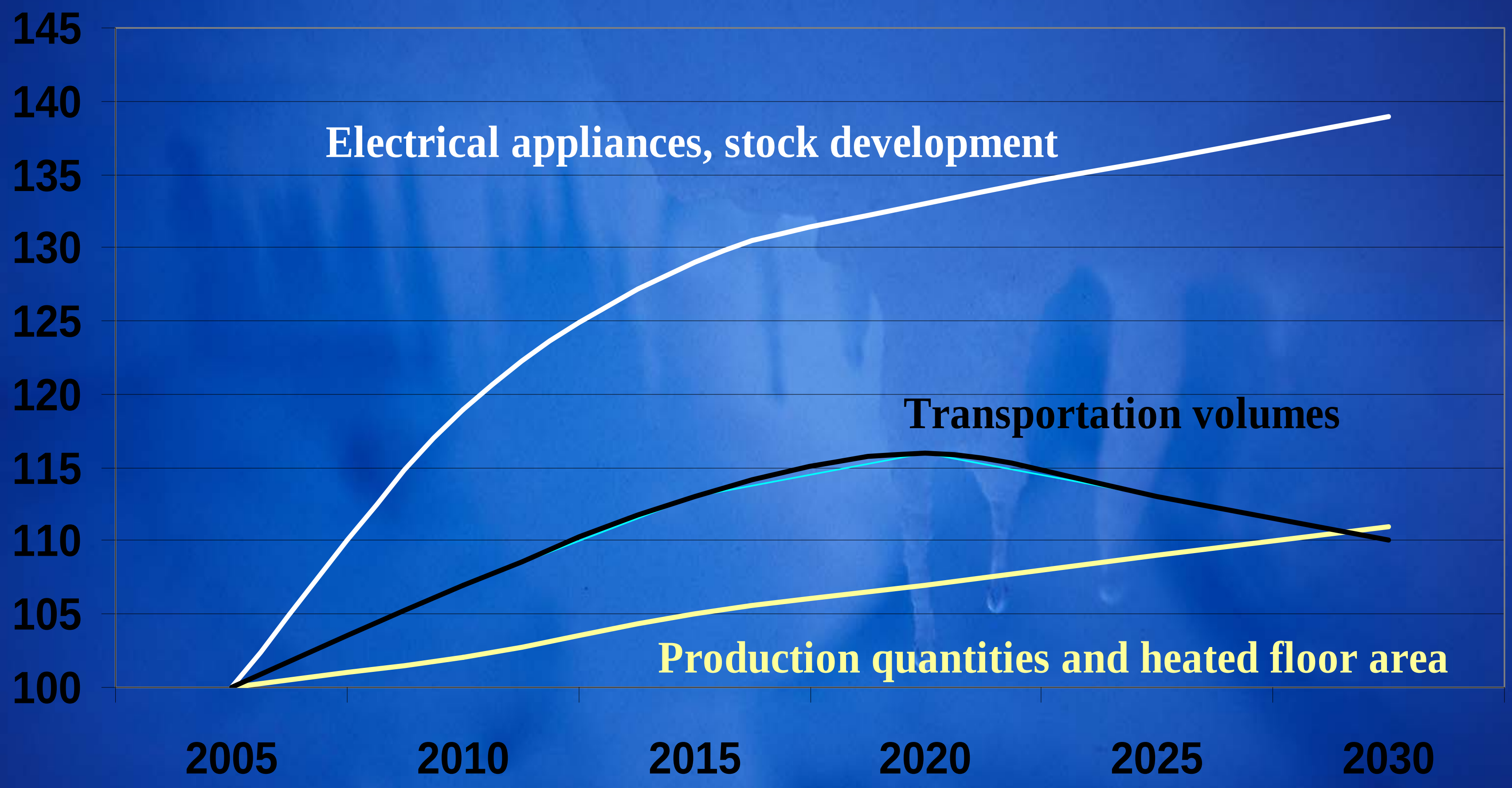
The SESAM Model

The SESAM model is a multi-scenario model.

It facilitates the comparative analysis of a wide spectrum of alternative scenarios for the future development of the energy system in question.

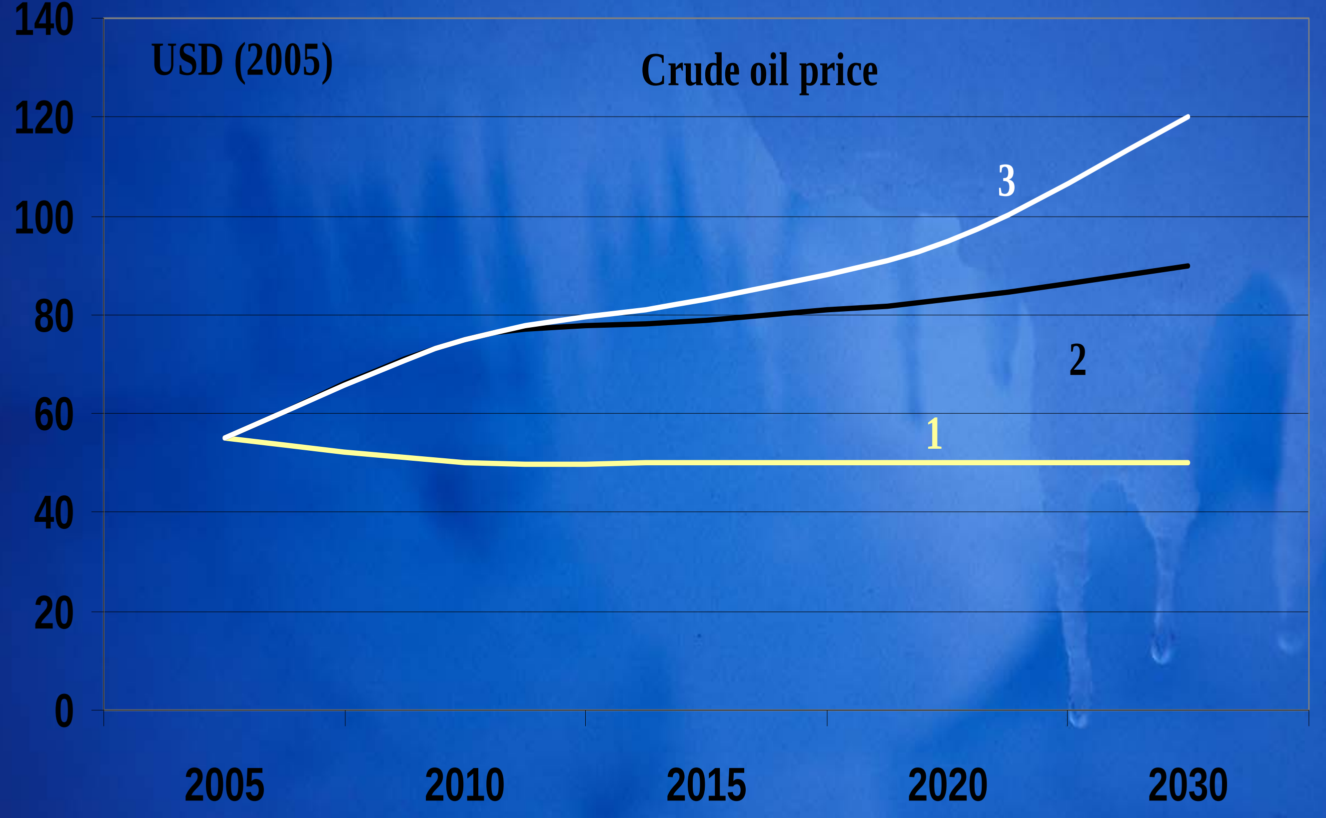
The system consists of a multitude of local systems (big and small), interconnected by a common electric grid.

Growth assumptions



These growth assumptions are made in both scenarios

Crude oil price development in case 1,2 and 3



The price of natural gas and coal is assumed to follow the crude oil price.

Two scenario examples are shown in this presentation:

The A-scenario:

- No investments other than regular reinvestments in worn out equipment are made.
- Nuclear power stations remain in operation.
- Only electrical appliances are replaced by more energy efficient models along the way.

This is a fictional scenario because it results in growth in CO2-emission and oil consumption.

The B-scenario:

•Extensive investments are made in the energy system infrastructure, renewable energy sources, improved weathering of buildings, etc. Nuclear power is phased out.

•The Kyoto/EU-obligations regarding CO2-emission for 2010 and 2020 are met. Substantial CO2-reductions are achieved by 2030.

•Oil consumption is substantially reduced.

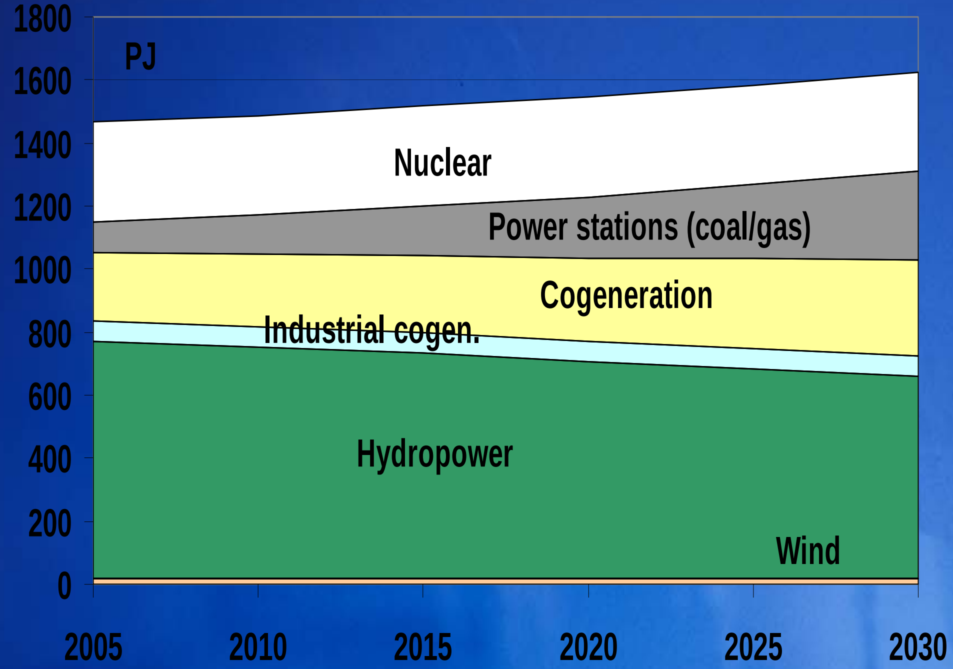
Transport in scenario B

The changes in transportation technology and means of transportation specified in scenario B comprise:

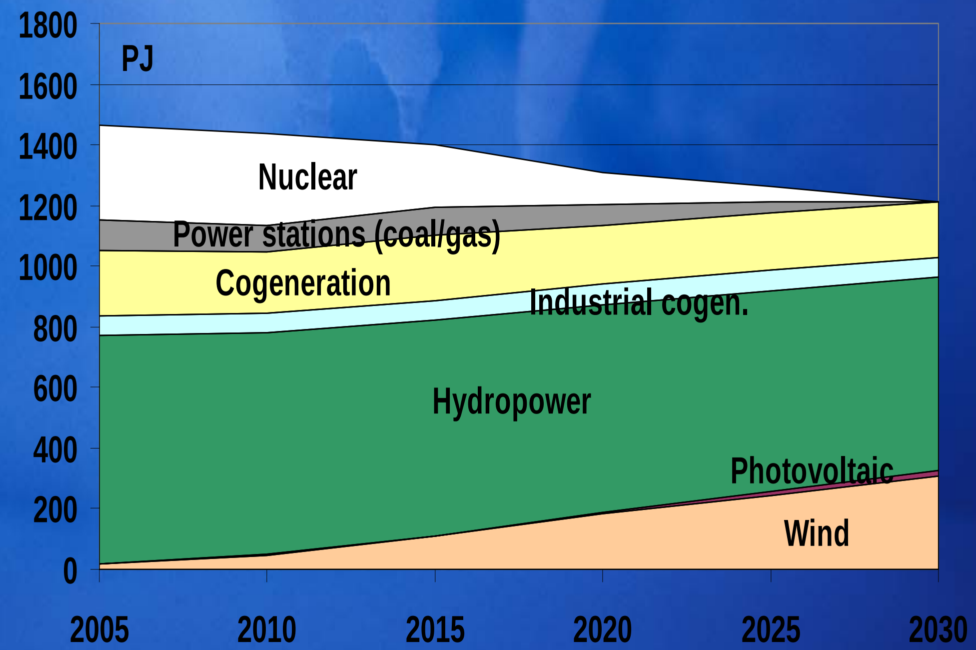
- **Lighter vehicles, more energy-efficient engines.**
- **Electric public transport (trams, trolley buses, trains, etc.).**
- **Electric battery driven cars.**
- **Fuel cell driven buses and cars (electric power converted to chemical energy, e.g. hydrogen, for fuel cells)**
- **More public transport by modern, comfortable means More goods transported by rail and ship.**

Power generation

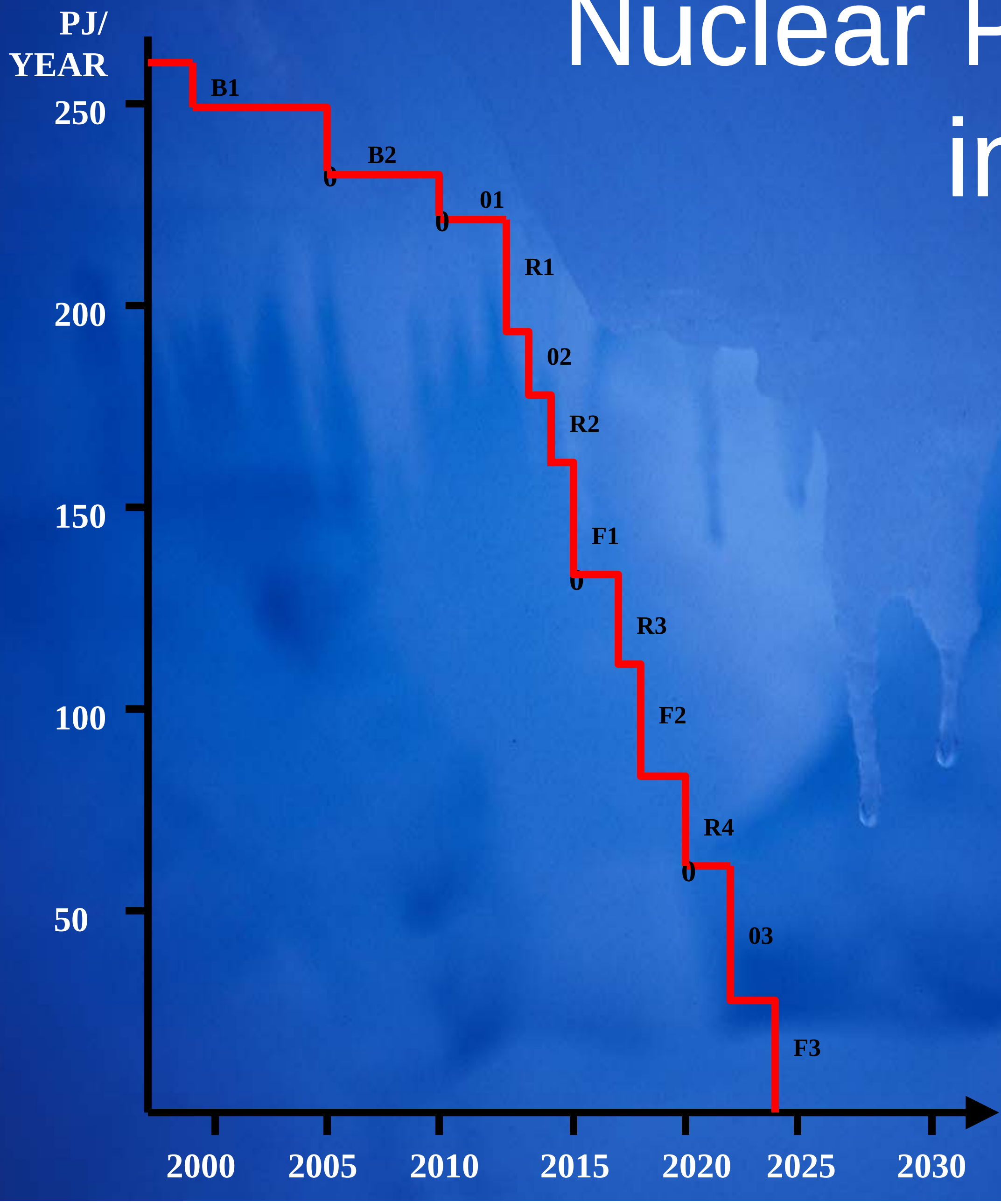
Scenario A



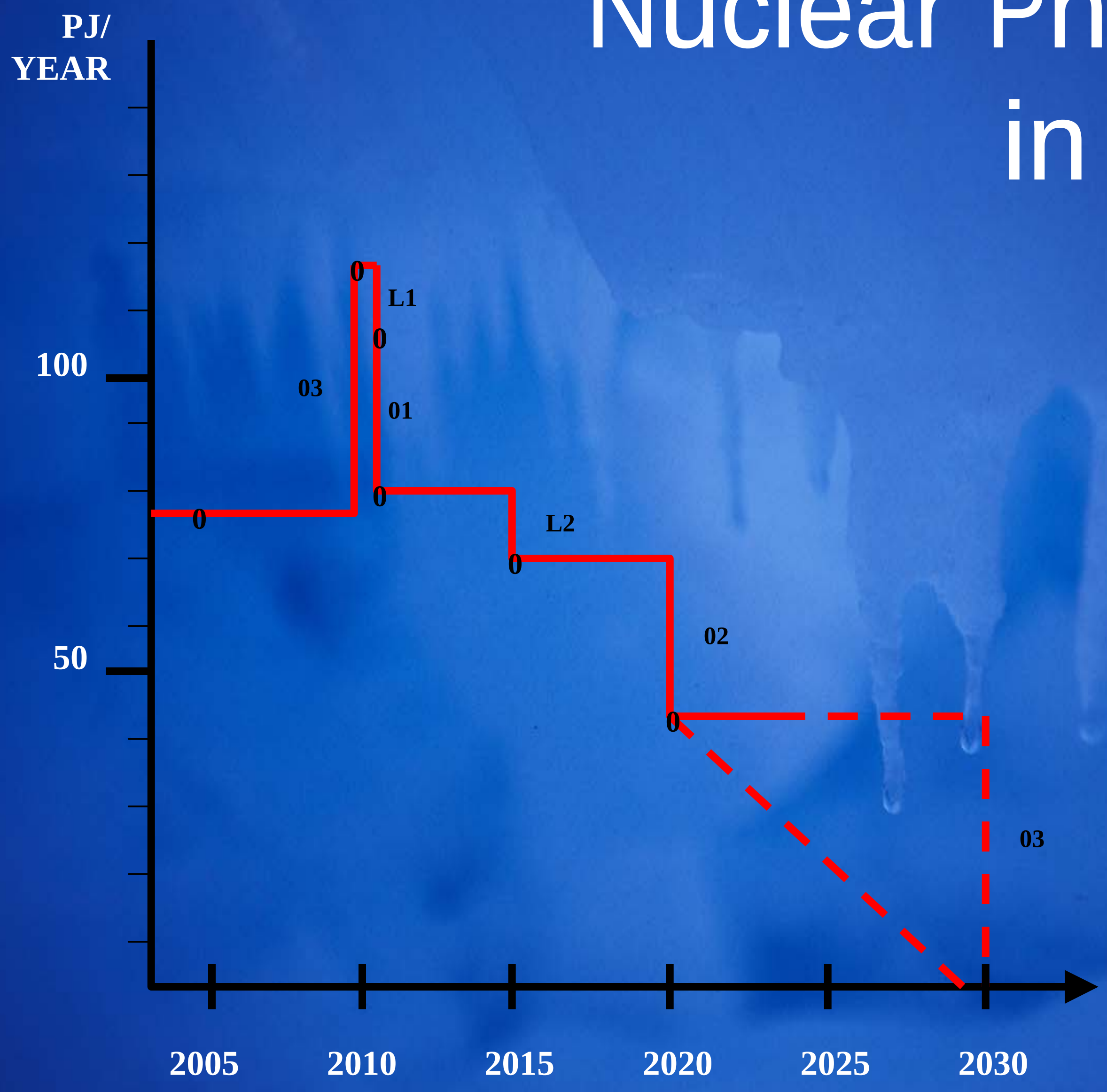
Scenario B



Nuclear Phase-out in Sweden



Nuclear Phase-out in Finland



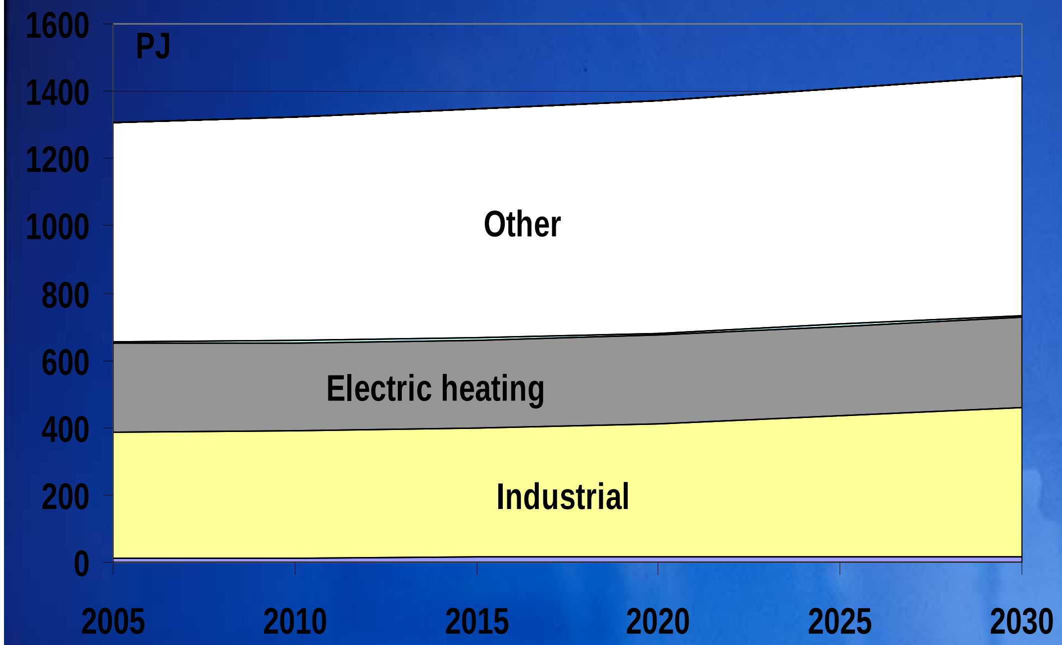
Wind phase-in

Wind phase-in[1]	Denmark	Norway	Sweden	Finland	Nordic
Wind power increase 2005-2015 in TWh	8.2	5.6	4.6	6.0	24.4
MW per year in 2005-20015	302	205	170	220	900
Wind power increase 2015-2030 in TWh	11.7	11.3	14.4	18.1	55.6
MW per year in 2015-2030	287	277	354	444	1365

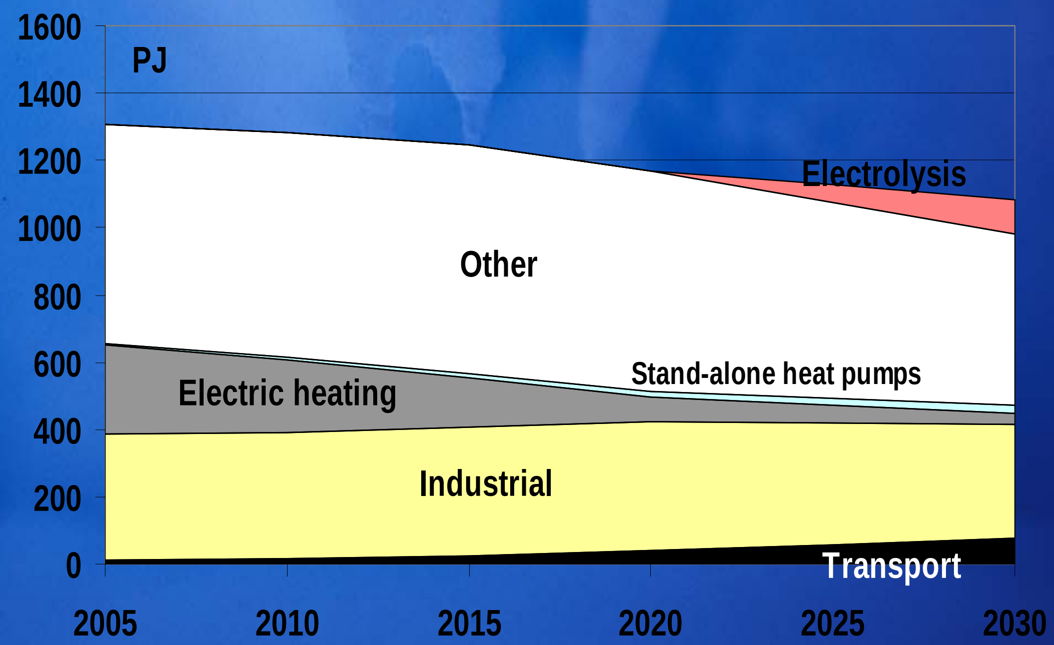
[1] With an assumed mean capacity factor for wind of 31%.

Electricity consumption

Scenario A

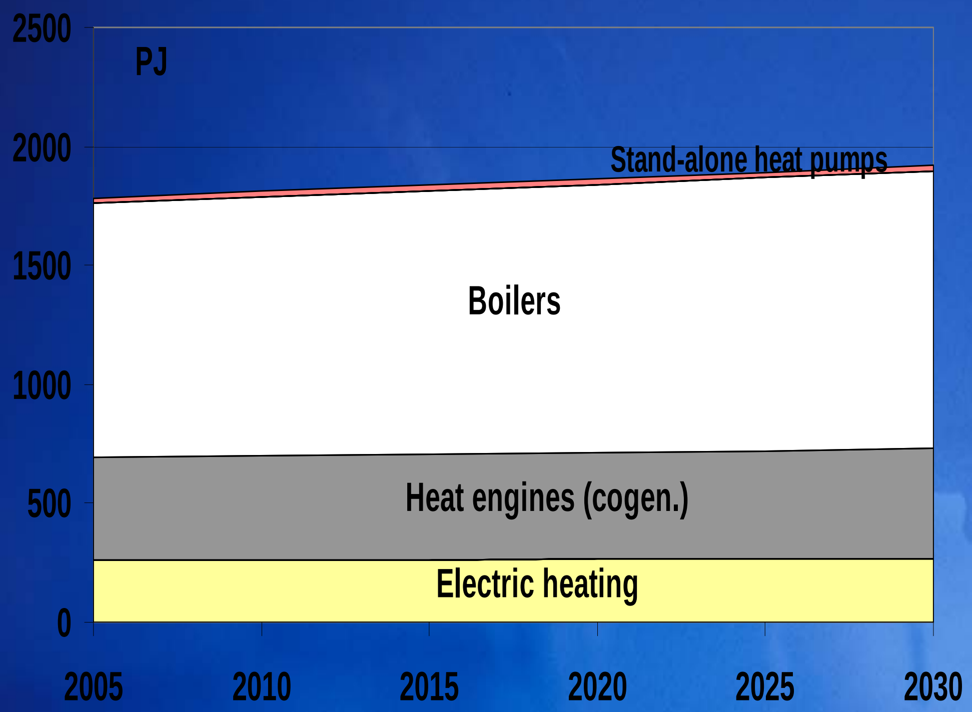


Scenario B

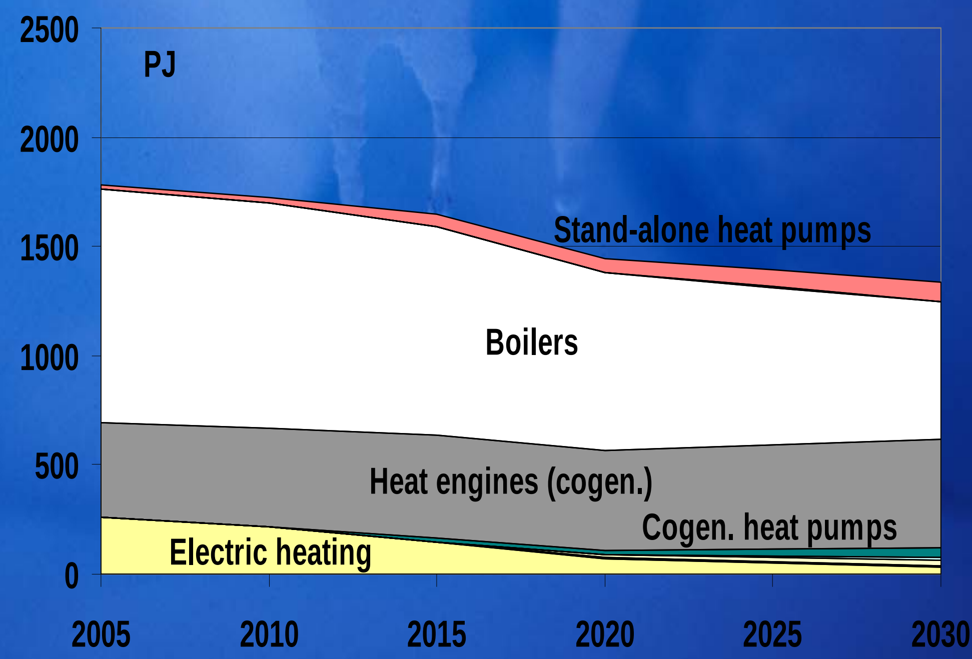


Heat generation

Scenario A

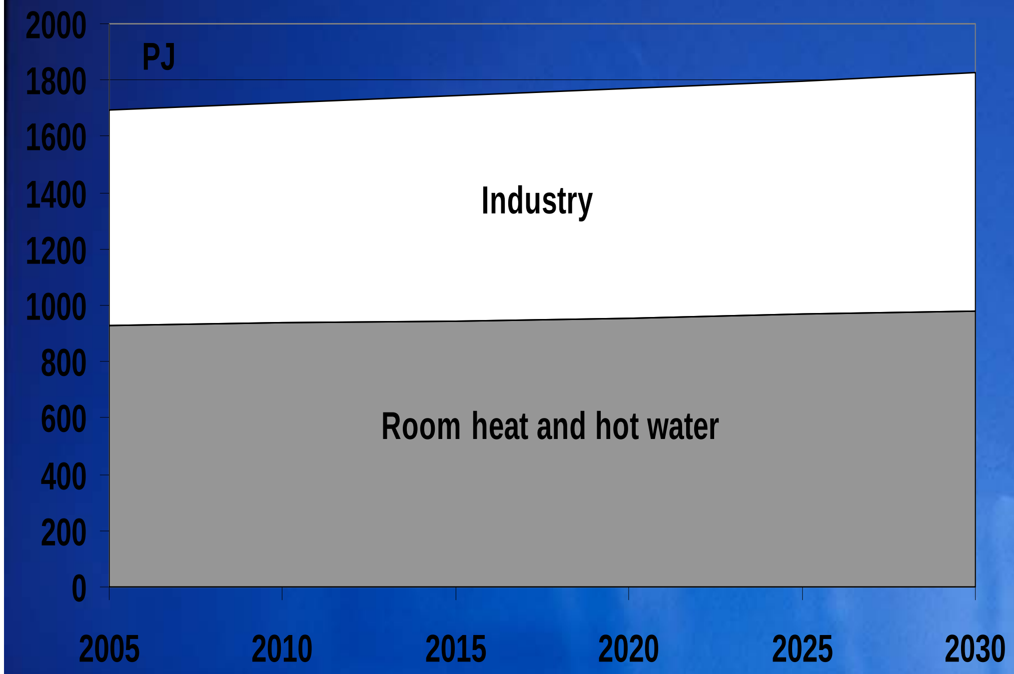


Scenario B

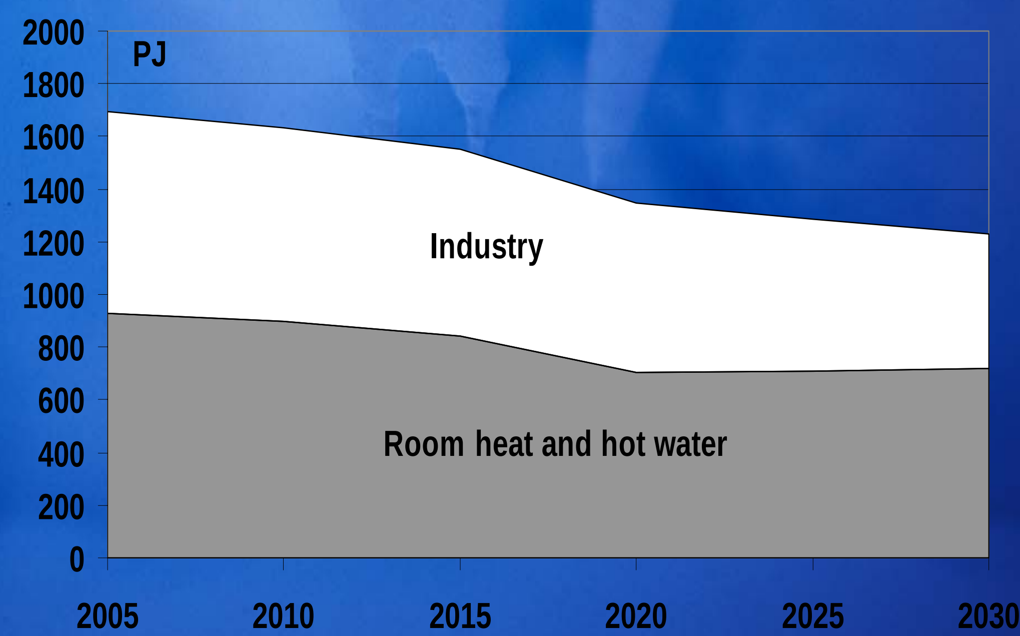


Heat consumption

Scenario A

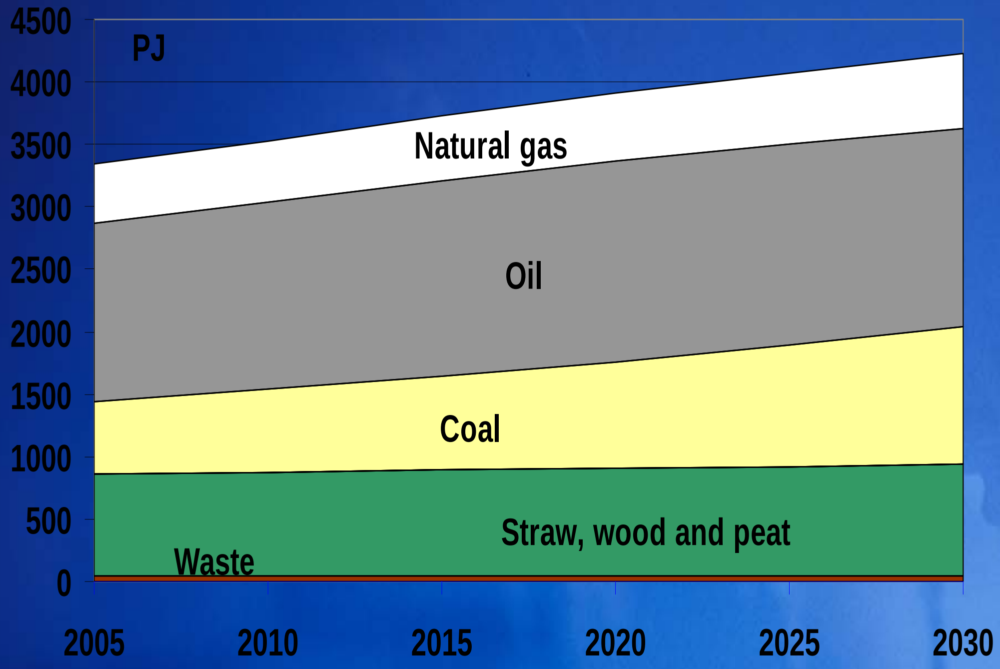


Scenario B

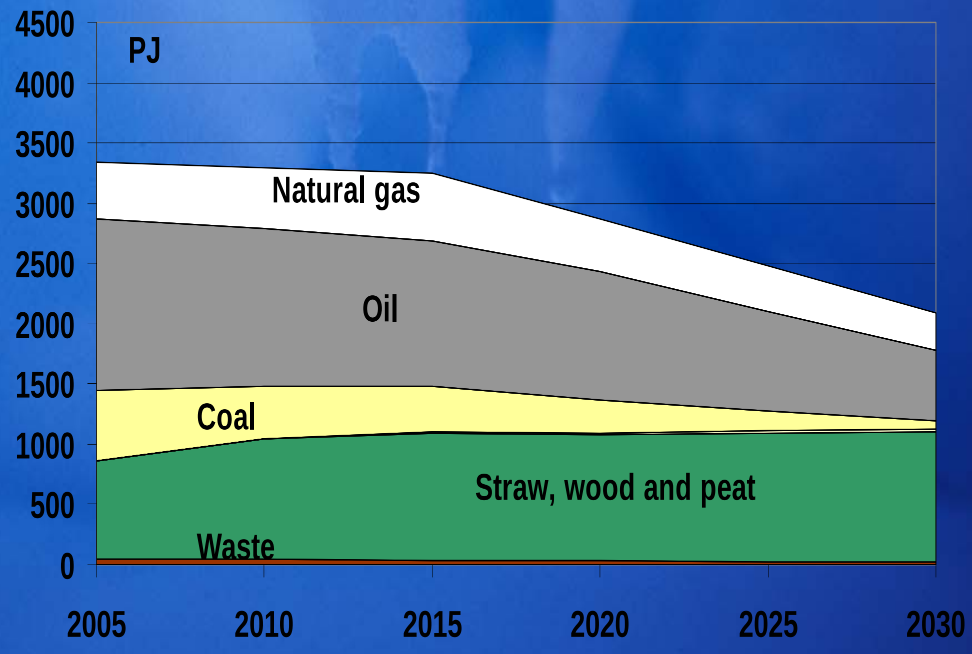


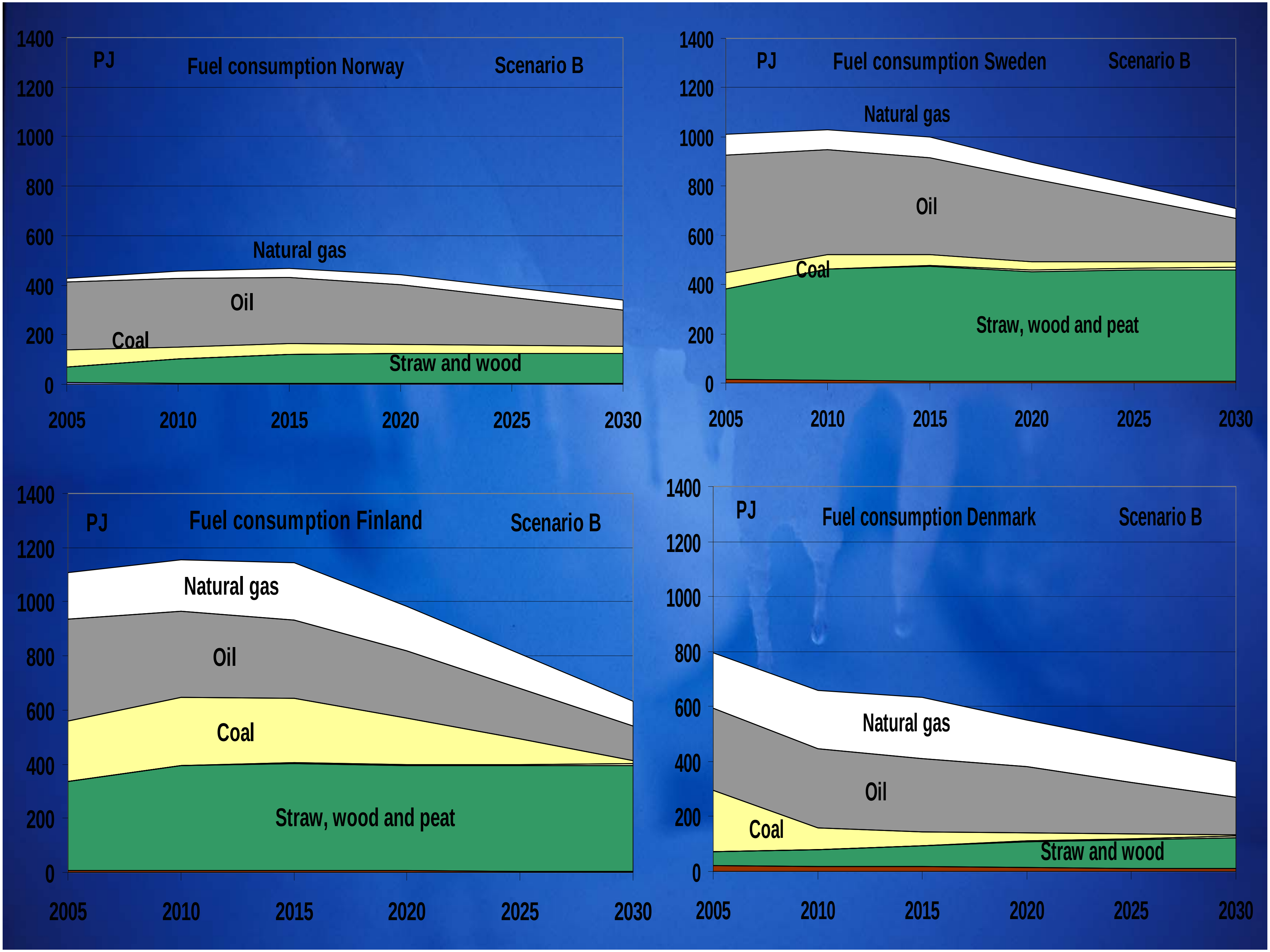
Fuel consumption Nordic

Scenario A



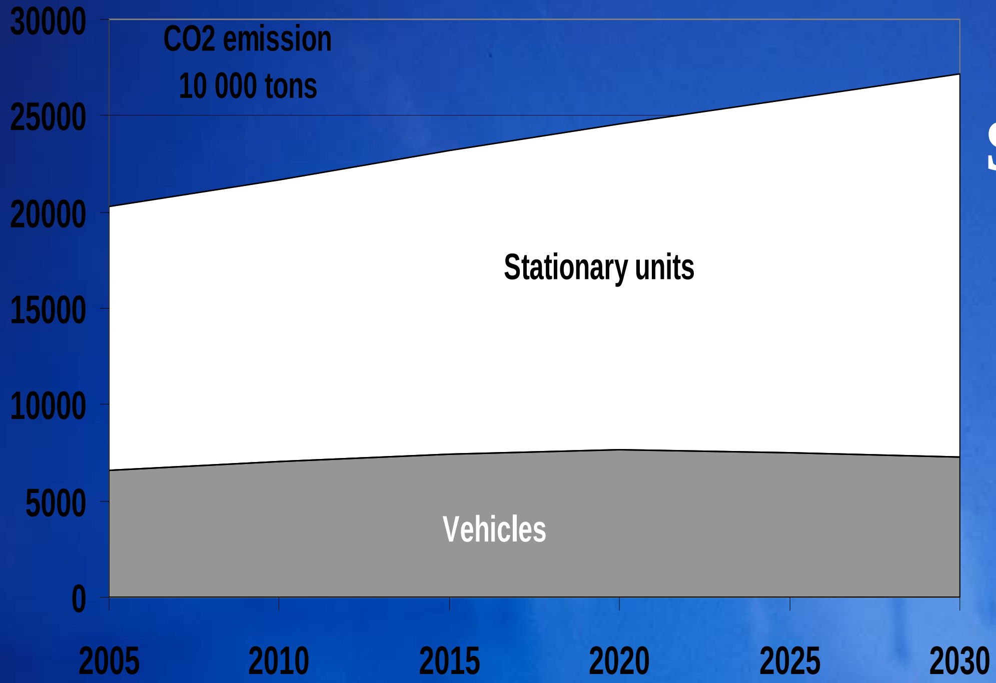
Scenario B



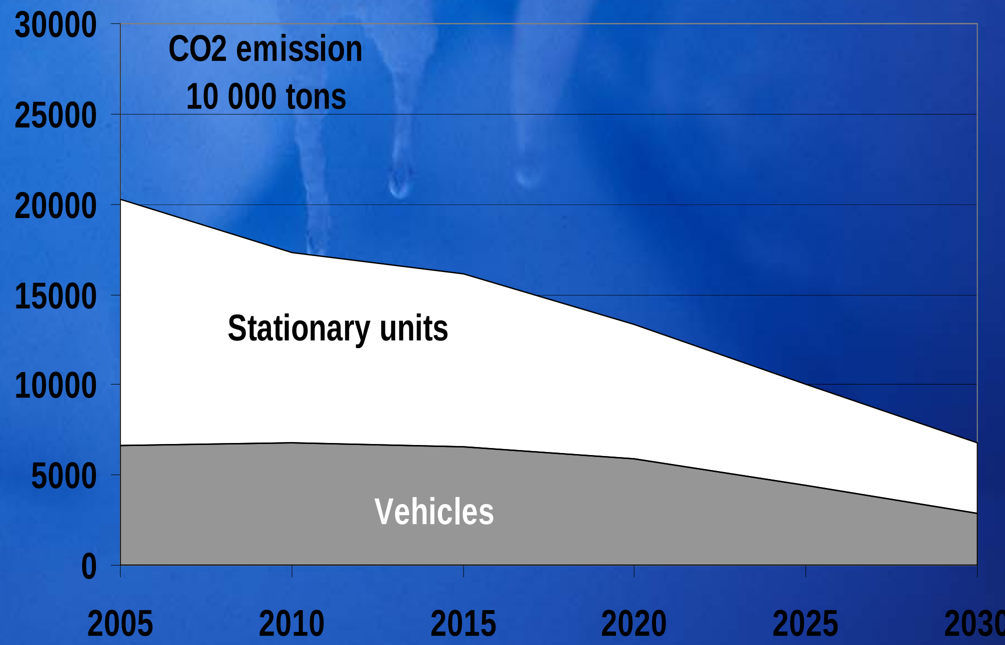

PJ
Fuel consumption Norway
Scenario B
Natural gas
Oil
Coal
Straw and wood
0
200
400
600
800
1000
1200
1400
2005
2010
2015
2020
2025
2030
PJ
Fuel consumption Sweden
Scenario B
Natural gas
Oil
Coal
Straw, wood and peat
0
200
400
600
800
1000
1200
1400
2005
2010
2015
2020
2025
2030
PJ
Fuel consumption Finland
Scenario B
Natural gas
Oil
Coal
Straw, wood and peat
0
200
400
600
800
1000
1200
1400
2005
2010
2015
2020
2025
2030
PJ
Fuel consumption Denmark
Scenario B
Natural gas
Oil
Coal
Straw and wood
0
200
400
600
800
1000
1200
1400
2005
2010
2015
2020
2025
2030

CO2 emission

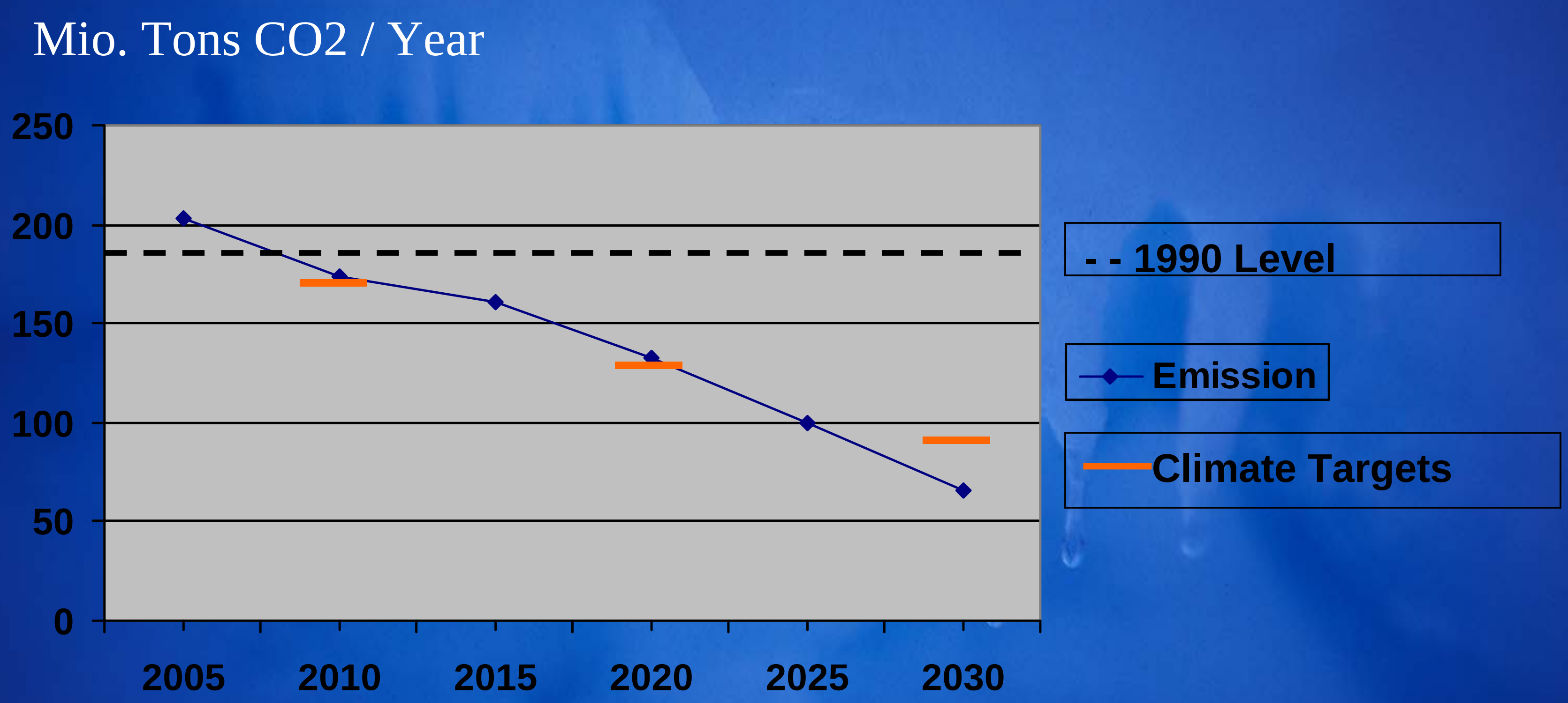
Scenario A



Scenario B



CO2 Emission in the 4 Nordic Countries



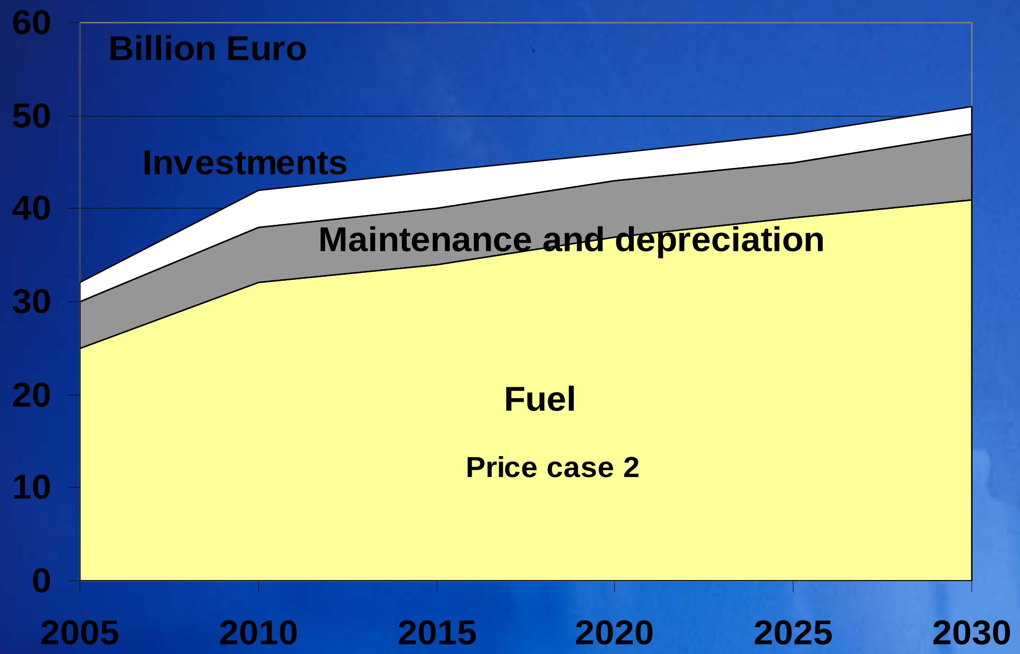
Investments and reinvestments made in the B-scenario

Windmills	32
Photovoltaic	18
Solar absorbers / Biogas plants	8
Cogeneration stations (some with heat pumps), and individual mini-cogeneration	91
Conversion of electric power to chemical energy, e.g. by electrolysis	5
District heating networks	10
New heating installations in buildings (including the replacement of electric radiators)	64
Improved insulation of buildings	63
Total	**291**

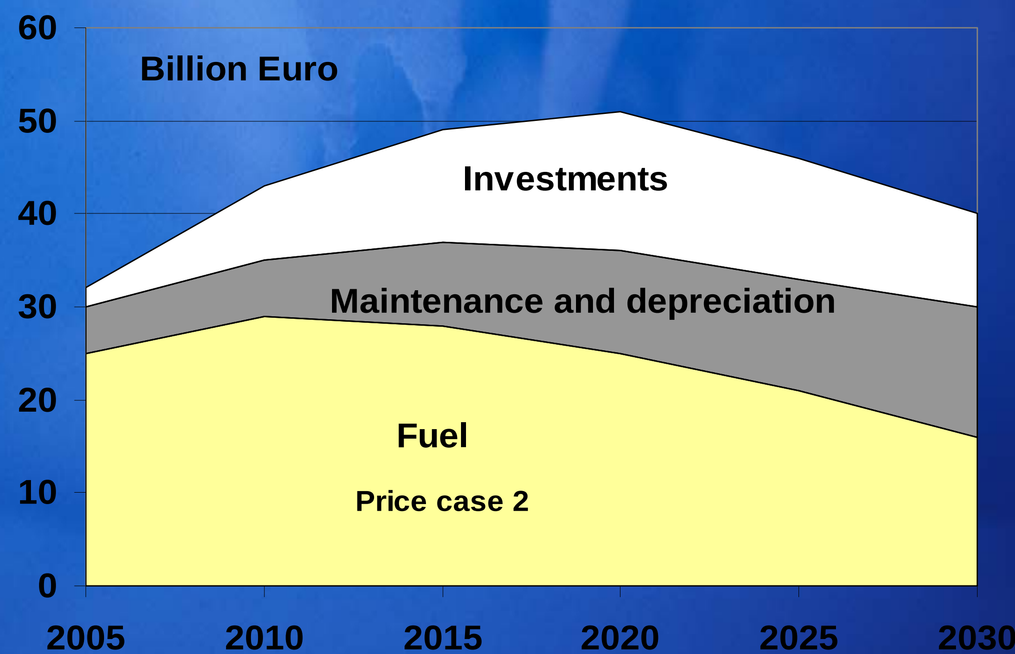
Numbers in Billion Euro

Total costs

Scenario A



Scenario B



Total costs 2005 – 2030

Growth in fuel prices

	None	Moderate	Higher
Fuel price case	1	2	3
Scenario A	920	1130	1240
Scenario B	970	1100	1170

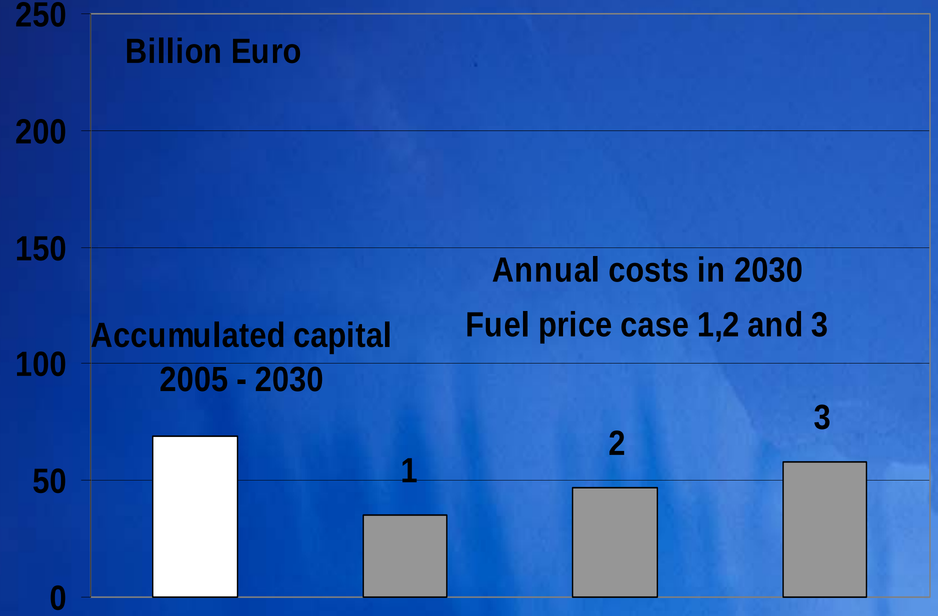
Numbers in Billion Euro

Including:

- Fuels
- Investments and reinvestments
- Depreciation of capital
- Maintenance

Total costs

Scenario A



Scenario B