Some comments on the Stern Review

by
Torstein Bye
Director of Research
Statistics Norway

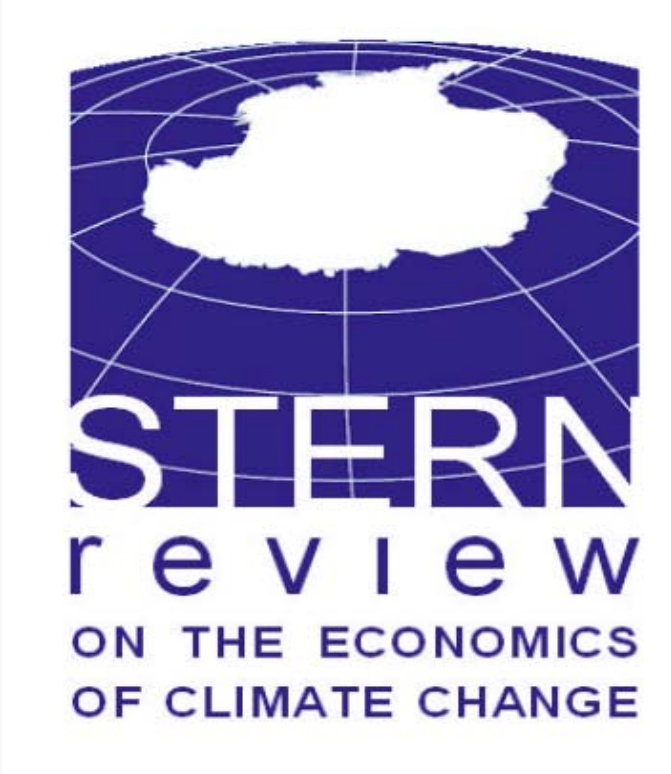

Table of contents

(700 pages-

should have been 200 + appendix?)

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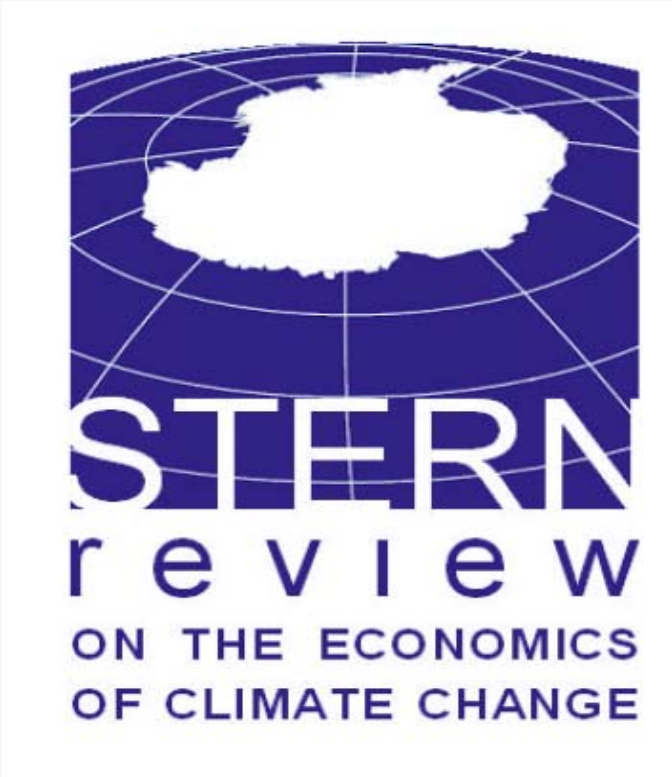


My approach to the report:

Stern Review – in short

temp change, impact, cost impact, cost of abating, cost benefit, instruments

Some dispute about Sterns approach

Tol, Maddison, Lomborg
Nordhaus, Dasgupta, DeLong, Hamilton

What's new in Sterns report ?

Some history

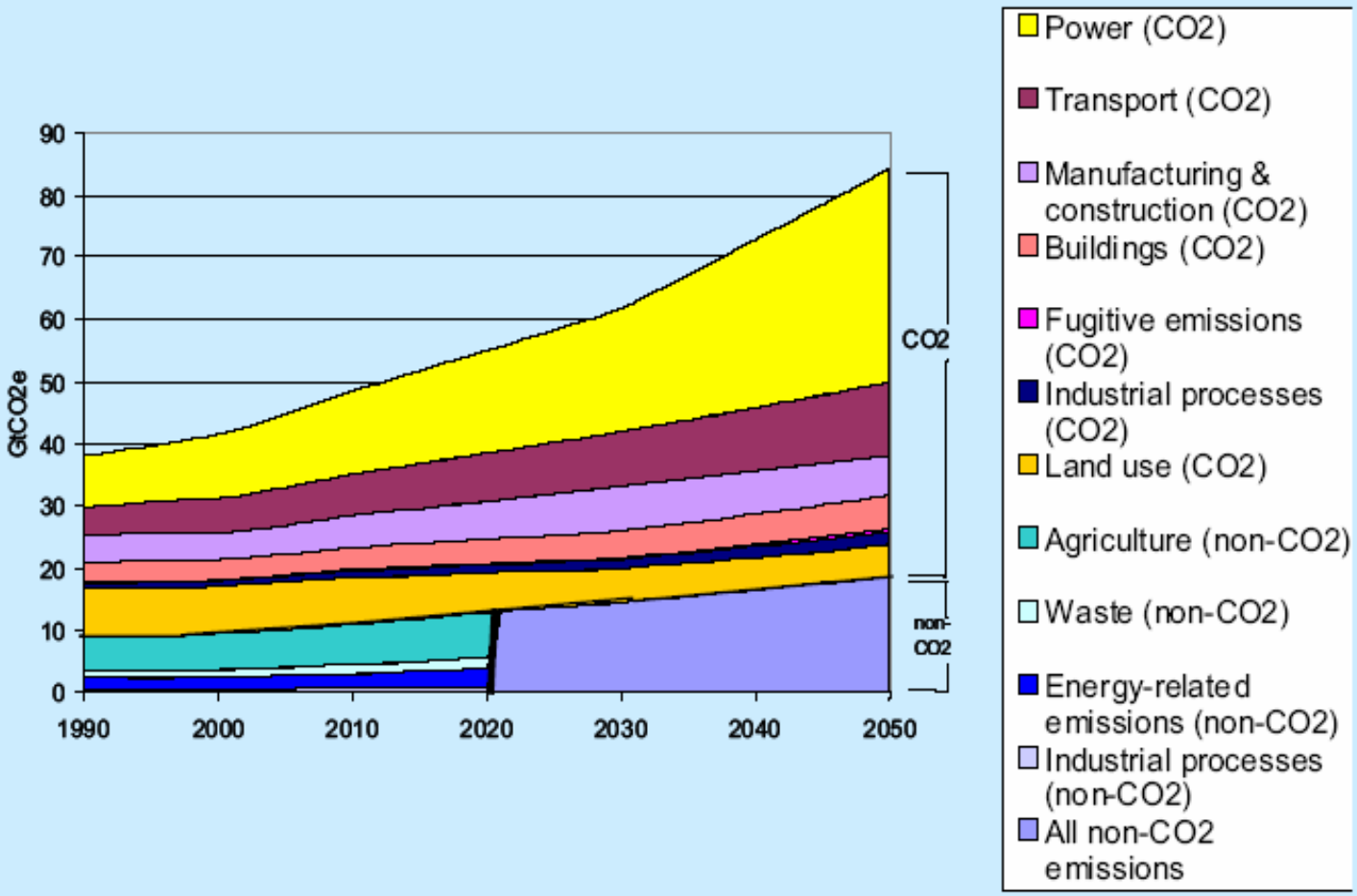
What's really new?

Time preference and displacement

Some summary comments

Historical and projected emissions

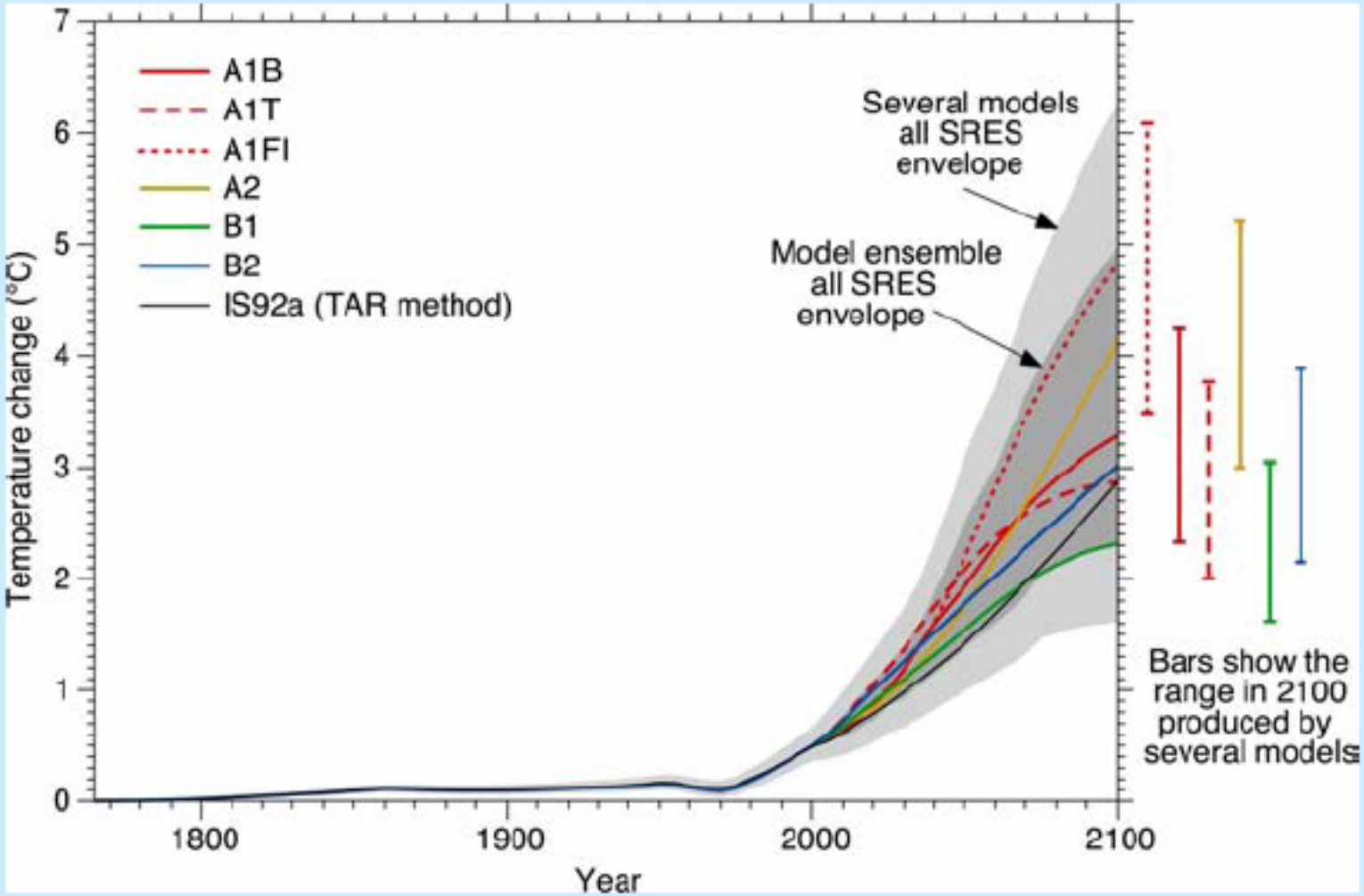
Figure A Historical and projected GHG emissions by sector (by source)



Source: WRI (2006), IEA (in press), IEA (2006), EPA (forthcoming), Houghton (2005).

Temperature projections

Temperature projections for the 21st century



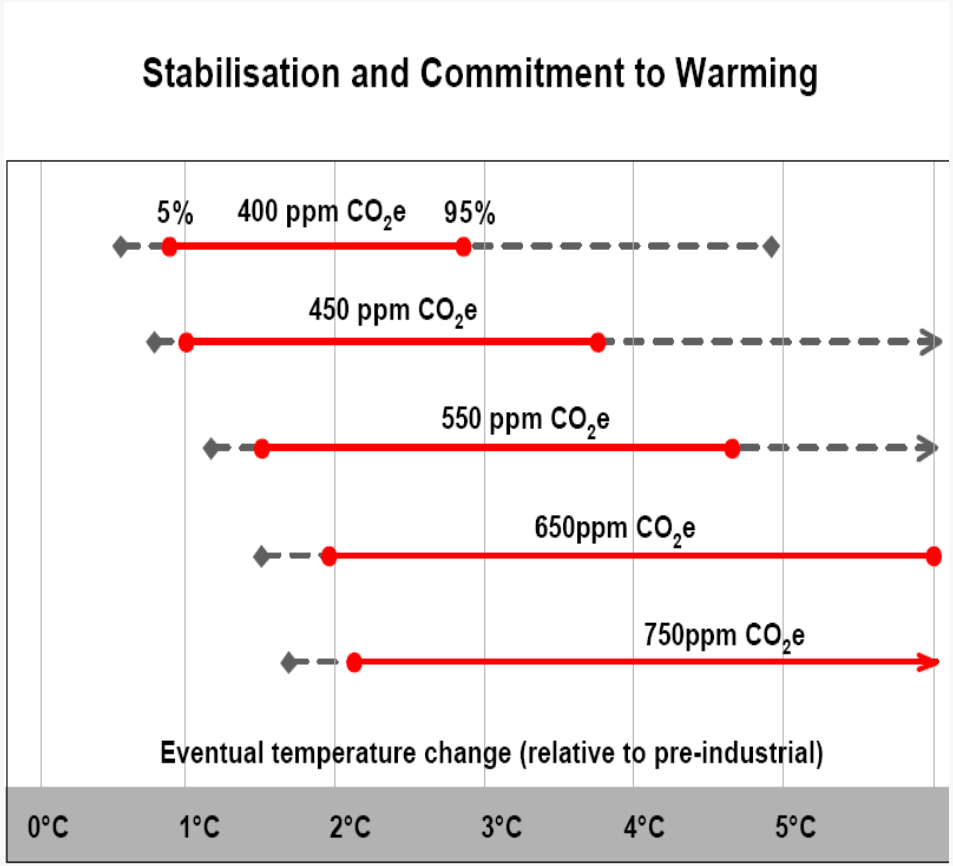
TEMPERATURE

- Carbon emissions have already pushed up global temperatures by half a degree Celsius
- If no action is taken on emissions, there is more than a 75% chance of global temperatures rising between two and three degrees Celsius over the next 50 years
- Average global temperatures could rise by five degrees Celsius
- The NEW IPCC release

434

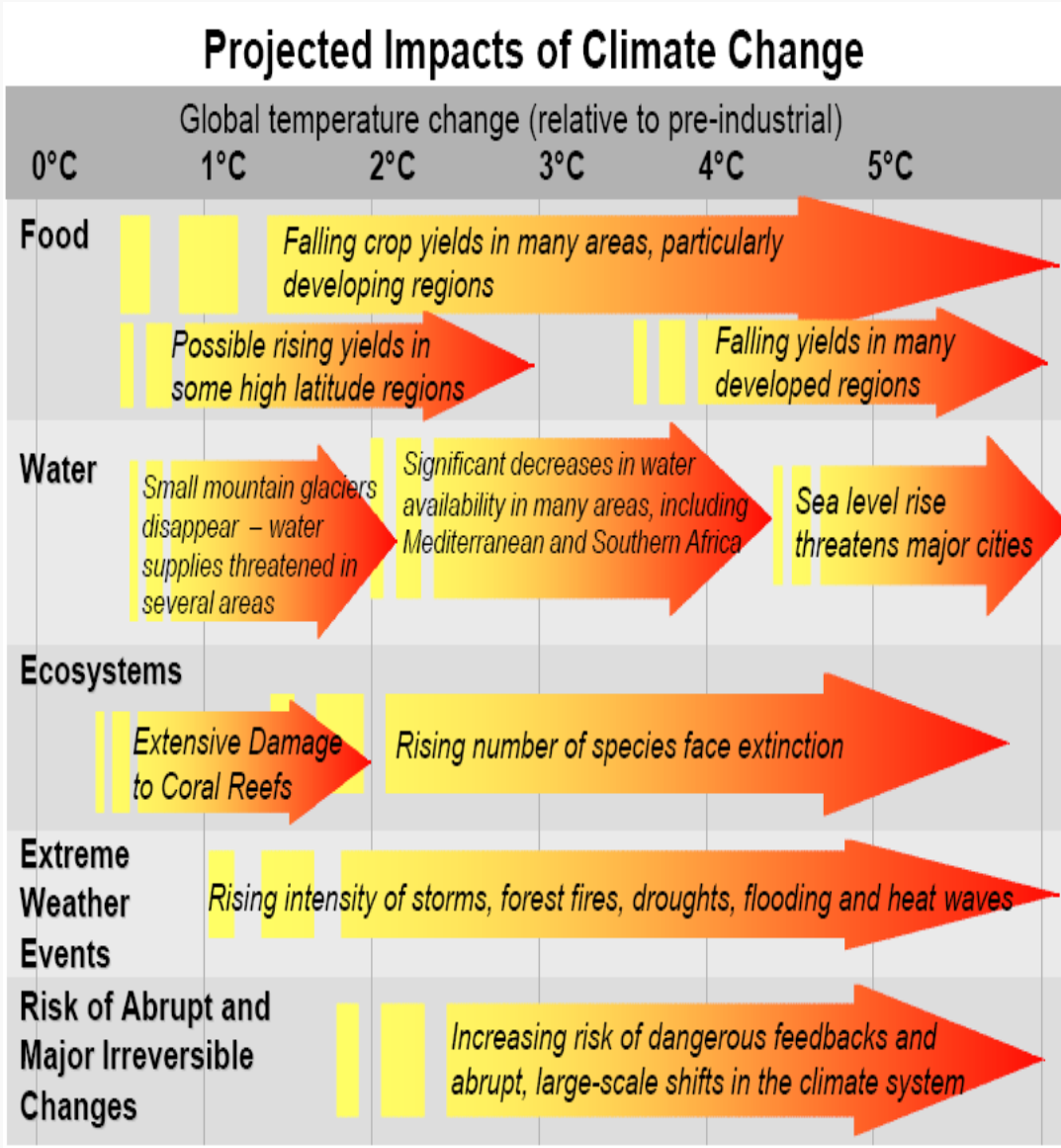
Uncertainty

Stabilisation level (ppm CO_2 equivalent)	Temperature increase at equilibrium relative to pre-industrial (°C)		
	IPCC TAR 2001 (Wigley and Raper)	Hadley Centre Ensemble	Eleven Studies
400	0.8 – 2.4	1.3 – 2.8	0.6 – 4.9
450	1.0 – 3.1	1.7 – 3.7	0.8 – 6.4
500	1.3 – 3.8	2.0 – 4.5	1.0 – 7.9
550	1.5 – 4.4	2.4 – 5.3	1.2 – 9.1
650	1.8 – 5.5	2.9 – 6.6	1.5 – 11.4
750	2.2 – 6.4	3.4 – 7.7	1.7 – 13.3
1000	2.8 – 8.3	4.4 – 9.9	2.2 – 17.1



ENVIRONMENTAL IMPACT

- Melting glaciers will increase flood risk
- Crop yields will decline, particularly in Africa
- Rising sea levels could leave 200 million people permanently displaced
- Up to 40% of species could face extinction
- There will be more examples of extreme weather patterns



Today

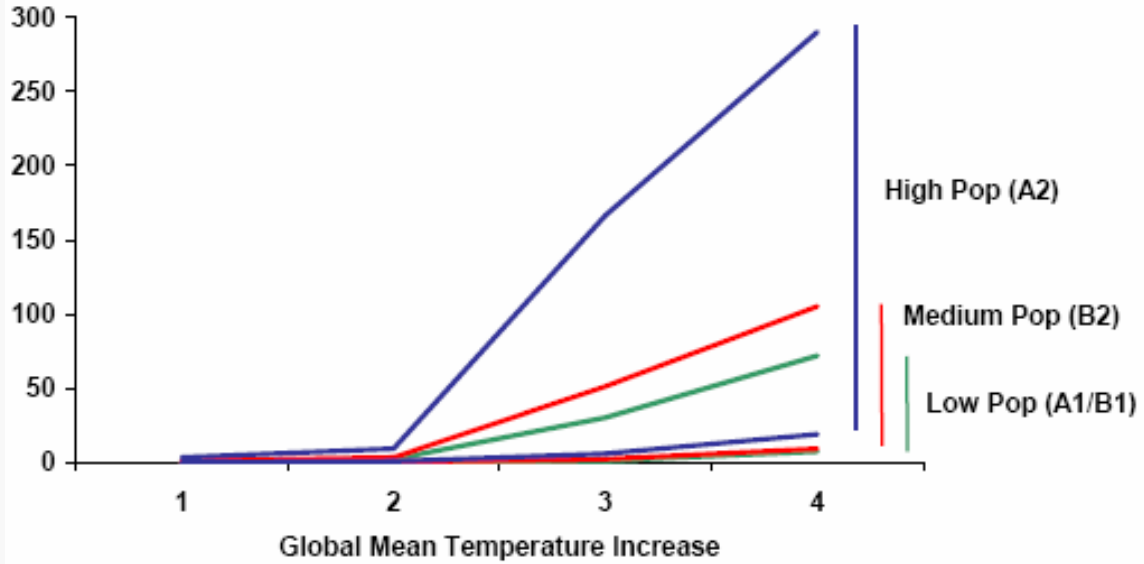
ENVIRON-MENTAL IMPACT

Table 3.1 Highlights of possible climate impacts discussed in this chapter

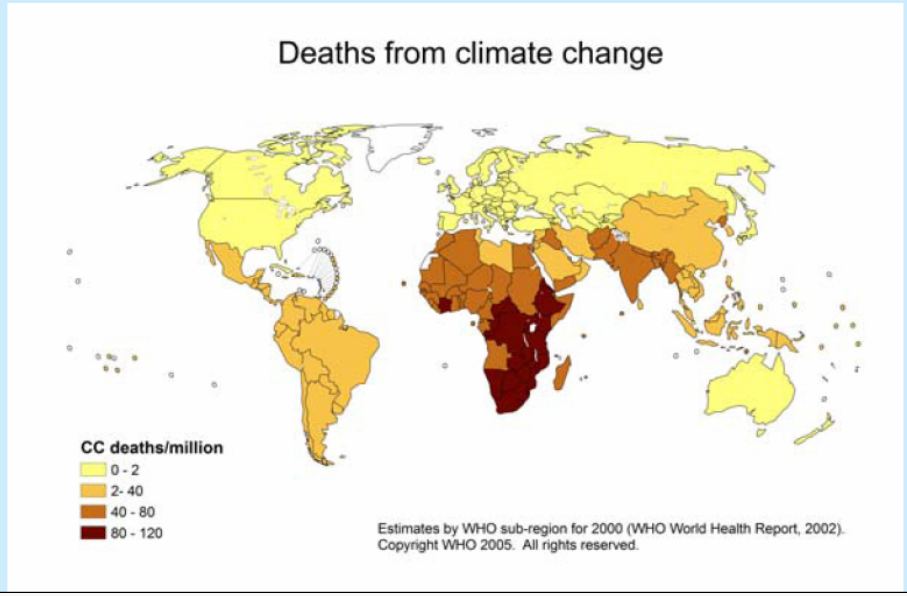
Temp rise (°C)	Water	Food	Health	Land	Environment	Abrupt and Large-Scale Impacts
1°C	Small glaciers in the Andes disappear completely, threatening water supplies for 50 million people	Modest increases in cereal yields in temperate regions	At least 300,000 people each year die from climate-related diseases (predominantly diarrhoea, malaria, and malnutrition) Reduction in winter mortality in higher latitudes (Northern Europe, USA)	Permafrost thawing damages buildings and roads in parts of Canada and Russia	At least 10% of land species facing extinction (according to one estimate) 80% bleaching of coral reefs, including Great Barrier Reef	Atlantic Thermohaline Circulation starts to weaken
2°C	Potentially 20 - 30% decrease in water availability in some vulnerable regions, e.g. Southern Africa and Mediterranean	Sharp declines in crop yield in tropical regions (5 - 10% in Africa)	40 – 60 million more people exposed to malaria in Africa	Up to 10 million more people affected by coastal flooding each year	15 – 40% of species facing extinction (according to one estimate) High risk of extinction of Arctic species, including polar bear and caribou	Potential for Greenland ice sheet to begin melting irreversibly, accelerating sea level rise and committing world to an eventual 7 m sea level rise Rising risk of abrupt changes to atmospheric circulations, e.g. the monsoon Rising risk of collapse of West Antarctic Ice Sheet Rising risk of collapse of Atlantic Thermohaline Circulation
3°C	In Southern Europe, serious droughts occur once every 10 years 1 - 4 billion more people suffer water shortages, while 1 – 5 billion gain water, which may increase flood risk	150 - 550 additional millions at risk of hunger (if carbon fertilisation weak) Agricultural yields in higher latitudes likely to peak	1 – 3 million more people die from malnutrition (if carbon fertilisation weak)	1 – 170 million more people affected by coastal flooding each year	20 – 50% of species facing extinction (according to one estimate), including 25 – 60% mammals, 30 – 40% birds and 15 – 70% butterflies in South Africa Onset of Amazon forest collapse (some models only)	
4°C	Potentially 30 – 50% decrease in water availability in Southern Africa and Mediterranean	Agricultural yields decline by 15 – 35% in Africa, and entire regions out of production (e.g. parts of Australia)	Up to 80 million more people exposed to malaria in Africa	7 – 300 million more people affected by coastal flooding each year	Loss of around half Arctic tundra Around half of all the world's nature reserves cannot fulfill objectives	
5°C	Possible disappearance of large glaciers in Himalayas, affecting one-quarter of China's population and hundreds of millions in India	Continued increase in ocean acidity seriously disrupting marine ecosystems and possibly fish stocks		Sea level rise threatens small islands, low-lying coastal areas (Florida) and major world cities such as New York, London, and Tokyo		
More than 5°C	The latest science suggests that the Earth's average temperature will rise by even more than 5 or 6°C if emissions continue to grow and positive feedbacks amplify the warming effect of greenhouse gases (e.g. release of carbon dioxide from soils or methane from permafrost). This level of global temperature rise would be equivalent to the amount of warming that occurred between the last age and today – and is likely to lead to major disruption and large-scale movement of population. Such "socially contingent" effects could be catastrophic, but are currently very hard to capture with current models as temperatures would be so far outside human experience.					

Other damages

Additional millions at risk from coastal flooding

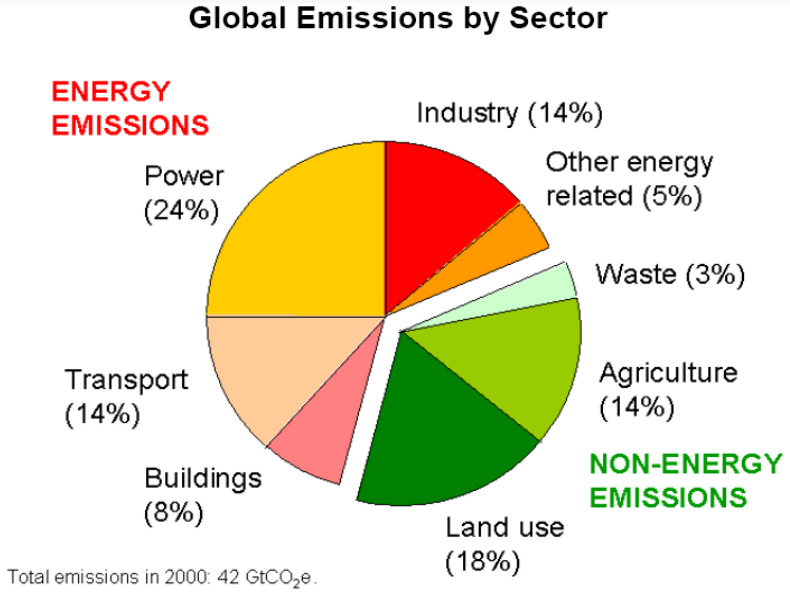


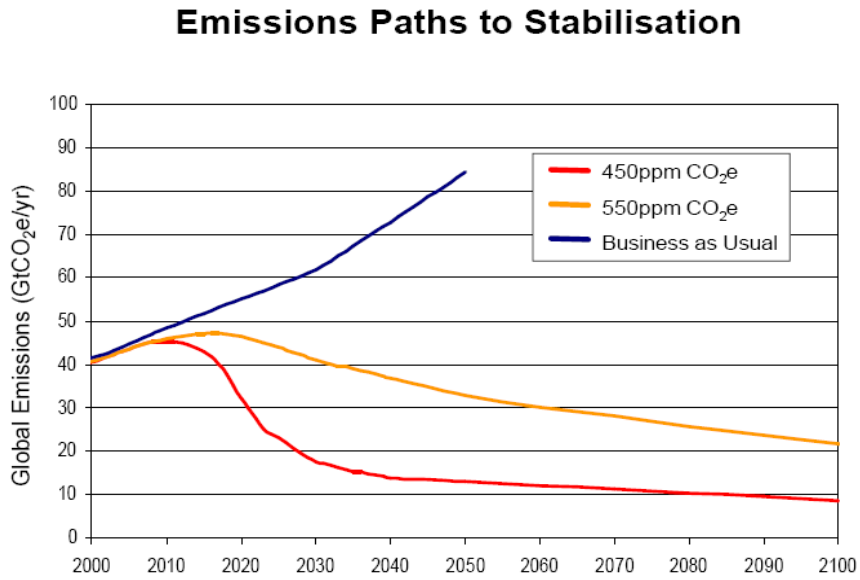
WHO estimates of extra deaths (per million people) from climate change in 2000



ENVIRONMENTAL PATH's

- Business as usual – pluss 1,5% p.a. i 50 år – ζ=1-1,5% p.a
- 550 ppm – max 47 Gt in 2015 with a reduction of 1,0% p.a. over 85 years
- 450 ppm – max 45 Gt in 2012 with a reduction of 3,4% p.a. over 35 years





The Economics of Climate Change - Uncertainty

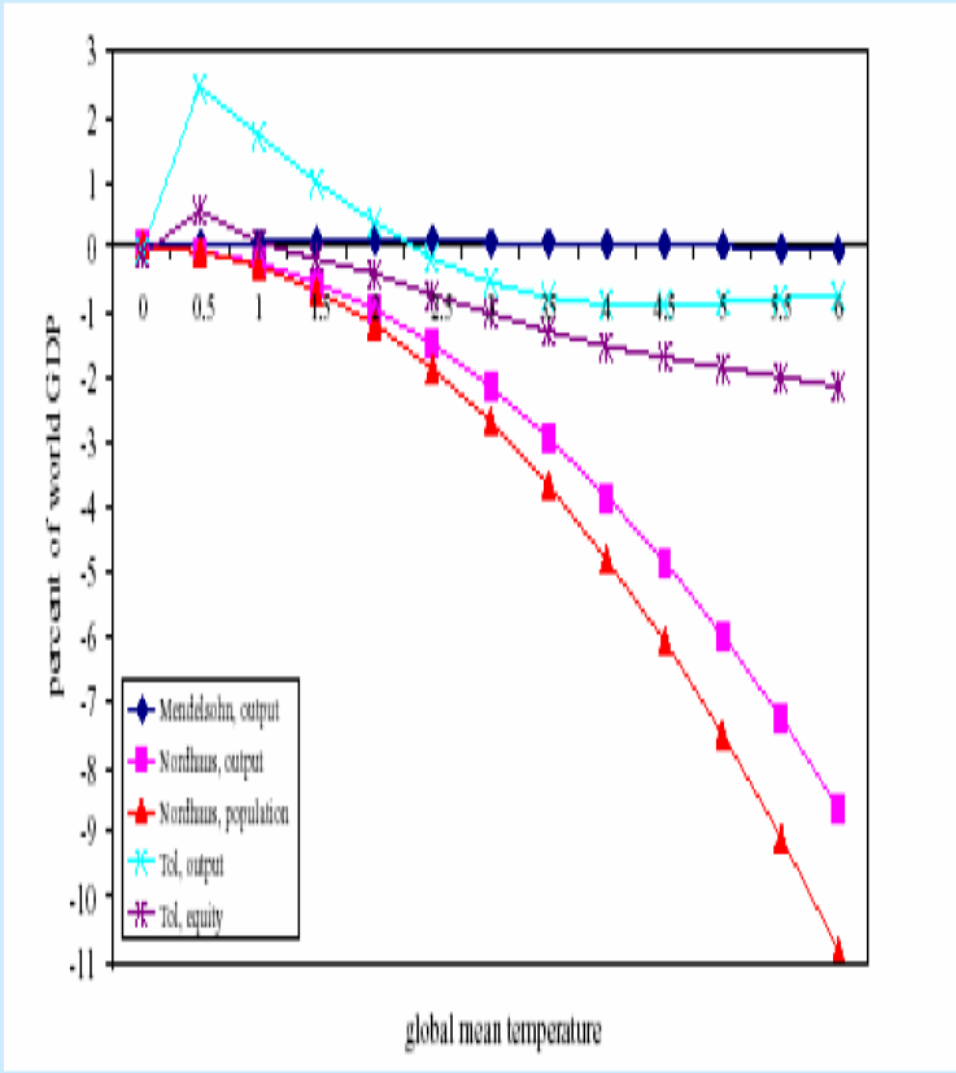
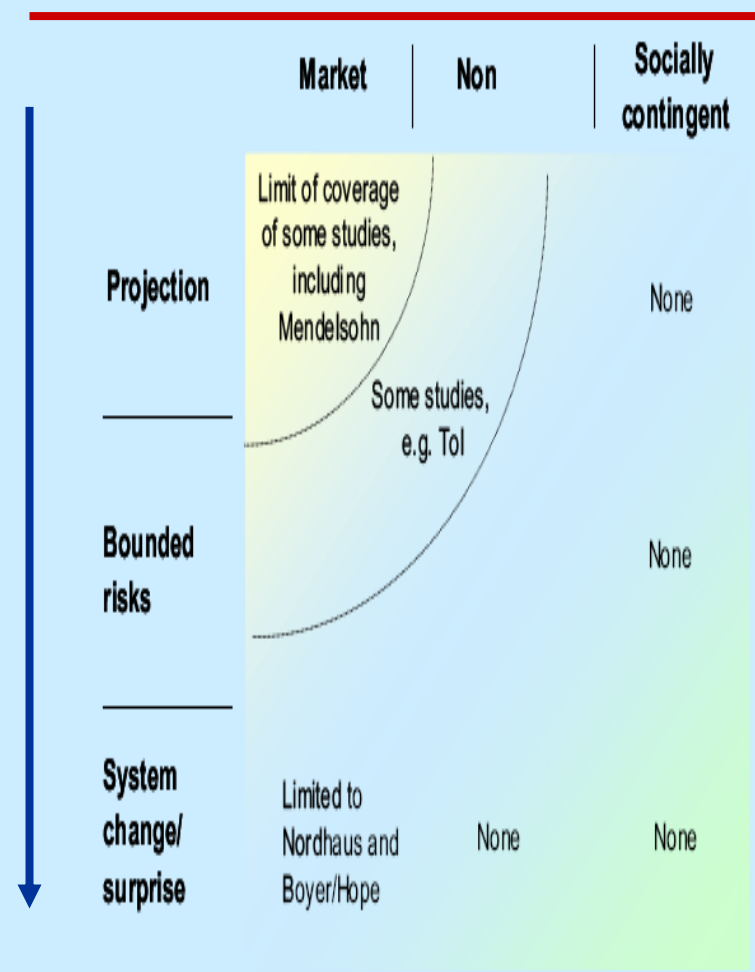


Figure 6.3 Coverage of existing integrated assessment studies.



Source: Watkiss, Downing *et al.* (2005).

The Economics of Climate Change

- Integrated assessment modeling – PAGE2002IAM
  - Probabilistic variation of risk – Monte Carlo simulations
    - Based on earlier work – just adding uncertainty
    - Different climate scenarios (baseline-and high-feedbacks)
  - The cost over the two next centuries to 5% of GDP for now and forever – (up to 13% if feedbacks included) – ΔBGE (balanced growth equivalent)
  - Three left out important costs
    - Non-market impacts (health, environment)
    - Risk for larger impacts
    - Distribution against poor
  - Increase the cost to 20% of GDP
  - Forvirrende – se tabell

Table 6.1 Losses in current per-capita consumption from six scenarios of climate change and economic impacts*.

Scenario		Balanced growth equivalents: % loss in current consumption due to climate change		
Climate	Economic	Mean	5th percentile	95th percentile
Baseline climate	Market impacts	2.1	0.3	5.9
	Market impacts + risk of catastrophe	5.0	0.6	12.3
	Market impacts + risk of catastrophe + non-market impacts	10.9	2.2	27.4
High climate	Market impacts	2.5	0.3	7.5
	Market impacts + risk of catastrophe	6.9	0.9	16.5
	Market impacts + risk of catastrophe + non-market impacts	14.4	2.7	32.6

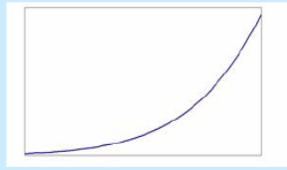
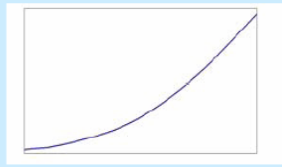
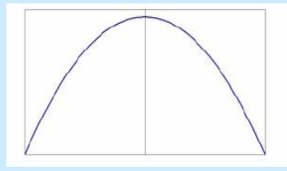
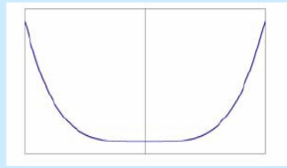
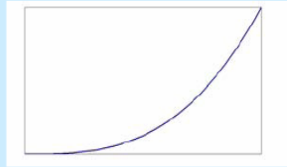
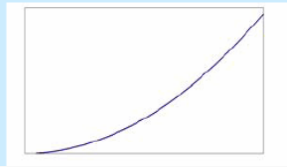
*Utility discount rate = 0.1% per annum; elasticity of marginal utility of consumption = 1.0.

The cases that we would argue are central for the market imports are highlighted. The non-market effects are of great importance but involve difficulties in evaluation.

PAGE: Policy Analysis of Greenhouse Effect

ECONOMIC IMPACT - nonlinear

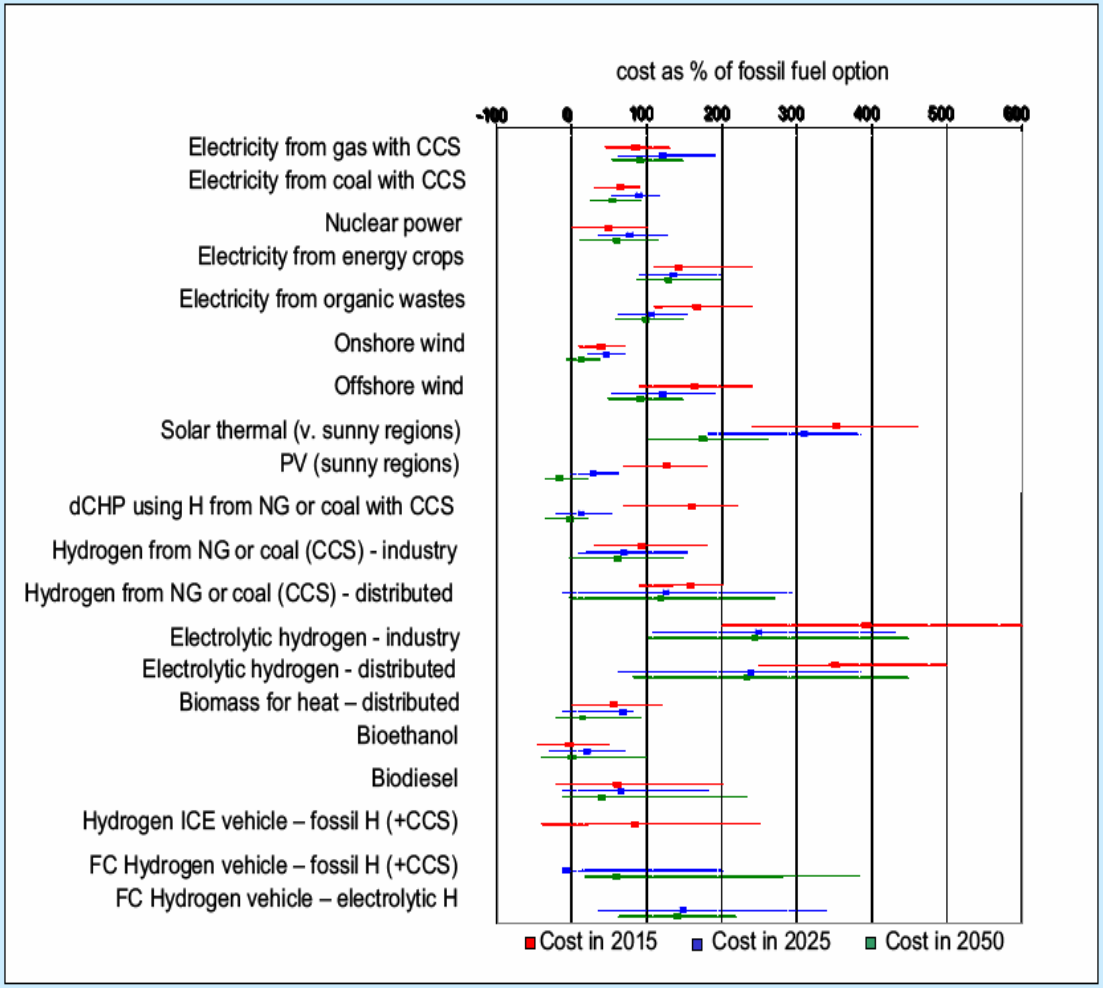
- Extreme weather could reduce global gross domestic product (GDP) by up to 1%
- A two to three degrees Celsius rise in temperatures could reduce global economic output by 3%
- If temperatures rise by five degree Celsius, up to 10% of global output could be lost. The poorest countries would lose more than 10% of their output
- In the worst case scenario global consumption per head would fall 20%
- To stabilize at manageable levels, emissions would need to stabilize the next 20 years and fall between 1% and 3% after that. This would cost 1% of GDP

Type of effect	Sector [location of source]	Proposed Functional Form		Basis
Climate system	Water [Chapter 1]	Exponential $y = e^x$		The Clausius-Clapeyron equation shows that the water holding capacity of air increases exponentially with temperature. This means that the water cycle will intensify, leading to more severe floods and droughts. There will also be more energy to drive storms and hurricanes.
	Extreme temperatures (threshold effects) [Chapter 1]	Convex curve (i.e. gradient increases with temperature)		Because of the shape of the normal distribution, a small increase in the mean dramatically increases the frequency of an extreme event.
Physical impacts	Agricultural production [Section 3.3]	Inverse parabolic ("hill function") $y = -x^2$		In cooler regions, low levels of warming may improve conditions for crop growth (extended growing season and new areas opened up for production), but further warming will have increasingly negative impacts as critical temperature thresholds are crossed more often. Tropical regions may already be past the peak. The shape and location of the curve depend on crop.
	Heat-related human mortality [Section 3.4]	U-shaped		Sharp increase in mortality once human temperature tolerances are exceeded (heatwaves and cold-snaps). Initially mortality will be reduced by warming in cold regions.
	Storm damage [Section 3.6]	Cubic $y = x^3$		Infrastructure damage increases as a cube of wind-speed
Human response	Costs of coastal protection [Section 3.5]	Parabolic $y = x^2$		Costs of sea-wall construction increase as a square of defence height

OPTIONS FOR CHANGE

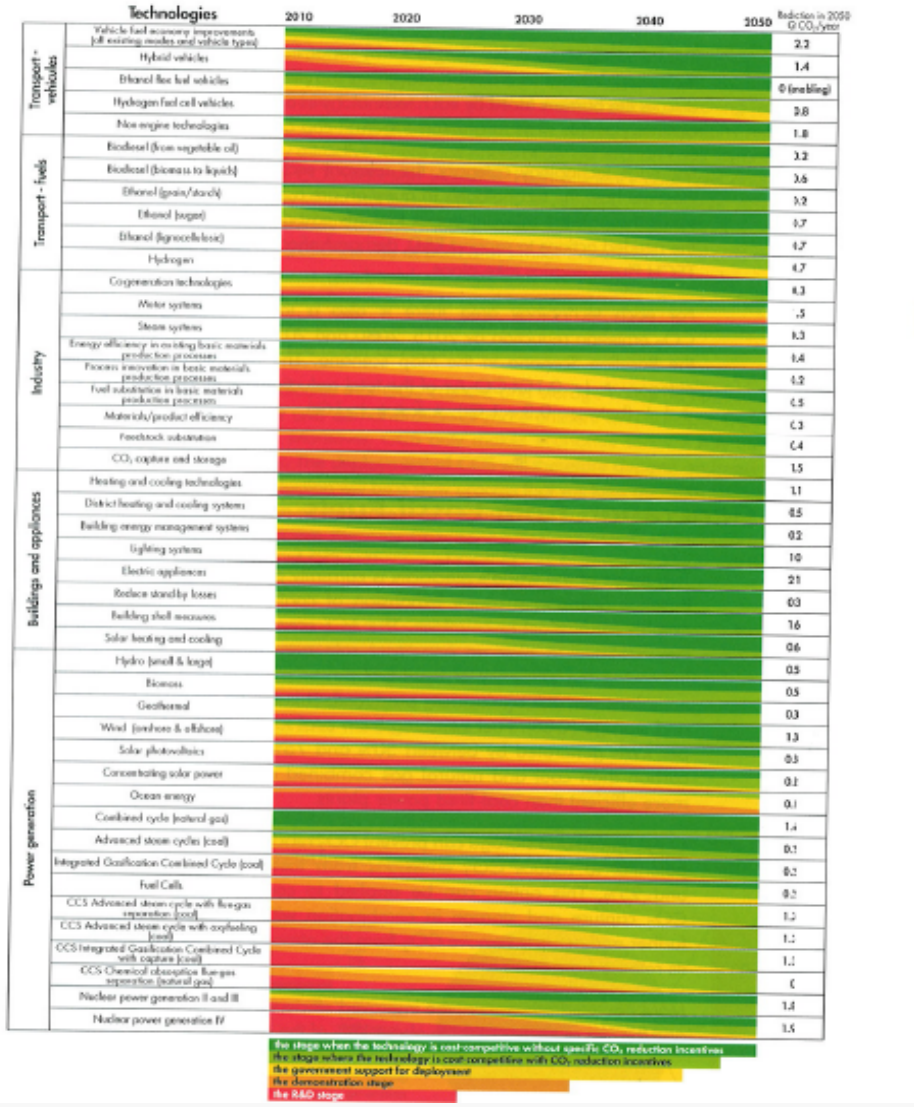
- Reduce consumer demand for heavily polluting goods and services
- Make global energy supply more efficient
- Act on non-energy emissions - prevent further deforestation
- Promote cleaner energy and transport technology, with non-fossil fuels accounting for 60% of energy output by 2050

Unit costs of energy technologies expressed as a percentage of the fossil-fuel alternative (in 2015, 2025, 2050)



OPTIONS FOR CHANGE - IAEE

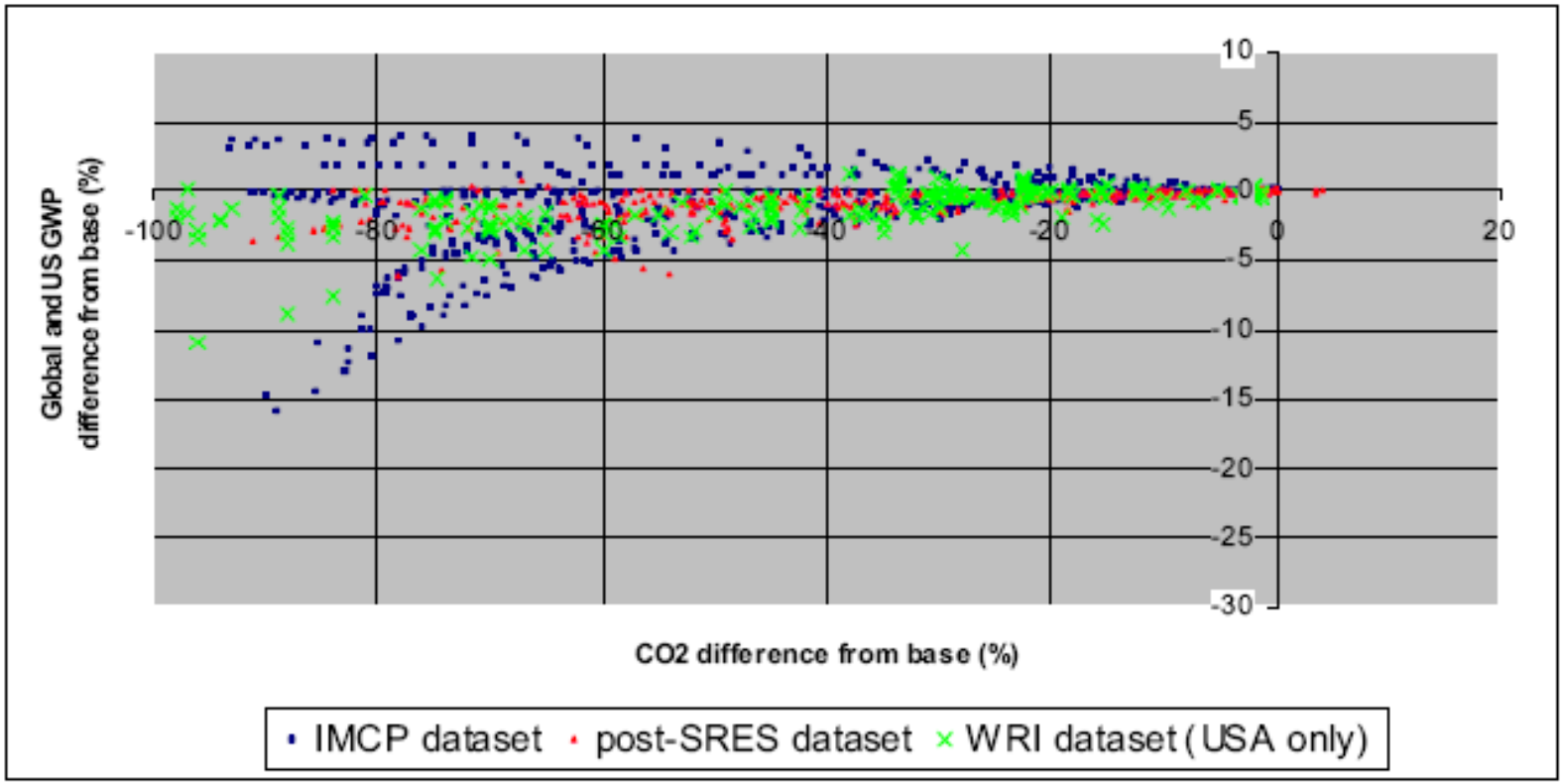
Figure 3.2 ▶ Transition through technology stages towards cost-competitiveness in the ACT scenarios.



The cost of mitigation- macro studies

Figure 10.1 Scatter plot of model cost projections

Costs of CO_2 reductions as a fraction of world GDP against level of reduction



Source: Barker et al. (2006)

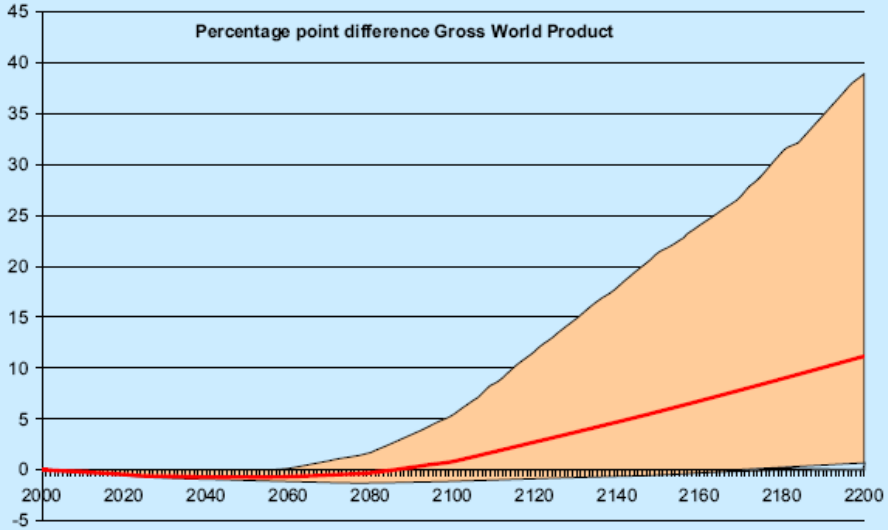
The cost of mitigation - Meta-analysis -Barker et al. (2006)

- **Average impact of model assumptions on world GDP in 2030 for stabilization at 450ppm CO2 (500-550ppm CO2*e*)** (% point levels difference from base model run)

Worst case assumptions	**-3.4**
Active revenue recycling	1.9
CGE model	1.5
Induced technology	1.3
Non-climate benefit	1.0
International mechanisms	0.7
'Backstop' technology	0.6
Climate benefit	0.2
Total extra assumptions	**7.3**
Best-case assumptions	**3.9**

- Average = 1% of GDP from 2050- ppm 500-550
  - **Range +/- 3%**
- **GDP-Growth**
  - From 2.5 annually to 2.49%
- Less than climate cost
- Implications
  - Structural changes
  - Countries competitive advantage - versus the firm

Figure 13.1 'Output gap' between the '550ppm $C0_2e$ and 1% GWP mitigation cost' scenario and BAU scenario, mean and 5th – 95th percentile range

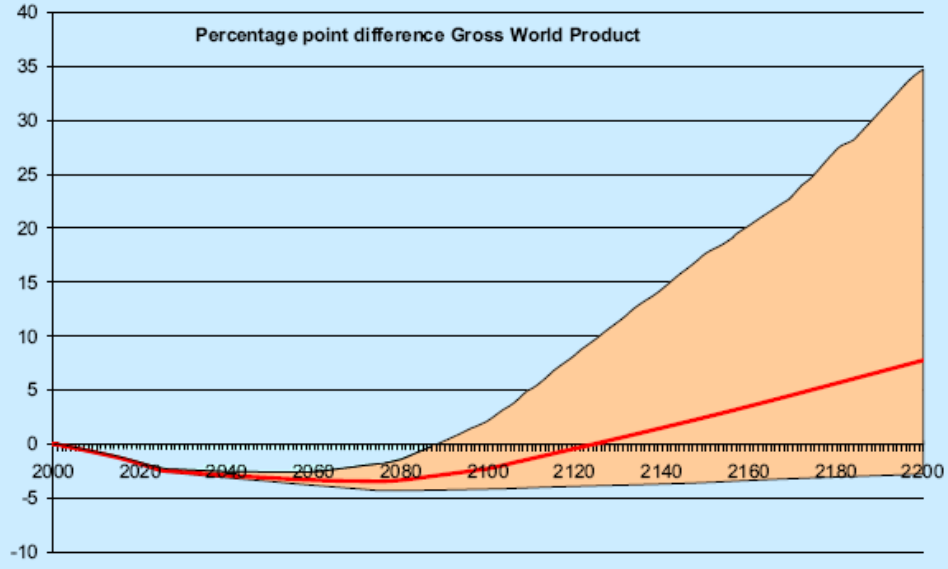


The cost and the benefit

Net profit in average

Net loss in average

Figure 13.2 'Output gap' between the '550ppm $C0_2e$ and 4% GWP mitigation cost' scenario and BAU scenario, mean and 5th – 95th percentile range



GOVERNMENT RESPONSE

- Create a global market for carbon pricing
- Extend the European Emissions Trading Scheme (EETS) globally, bringing in countries such as the US, India and China – Africa ?
- Set new target for EETS to reduce carbon emissions by 30% by 2020 and 60% by 2050
- Pass a bill to enshrine carbon reduction targets and create a new independent body to monitor progress
- Create a new commission to spearhead British company investment in green technology, with the aim of creating 100,000 new jobs
- Former US vice-president Al Gore will advise the government on the issue
- Work with the World Bank and other financial institutions to create a $20bn fund to help poor countries adjust to climate change challenges
- Work with Brazil, Papua New Guinea and Costa Rica to promote sustainable forestry and prevent deforestation
- Adaptation – foreign aid

Policy and instruments - deforestation

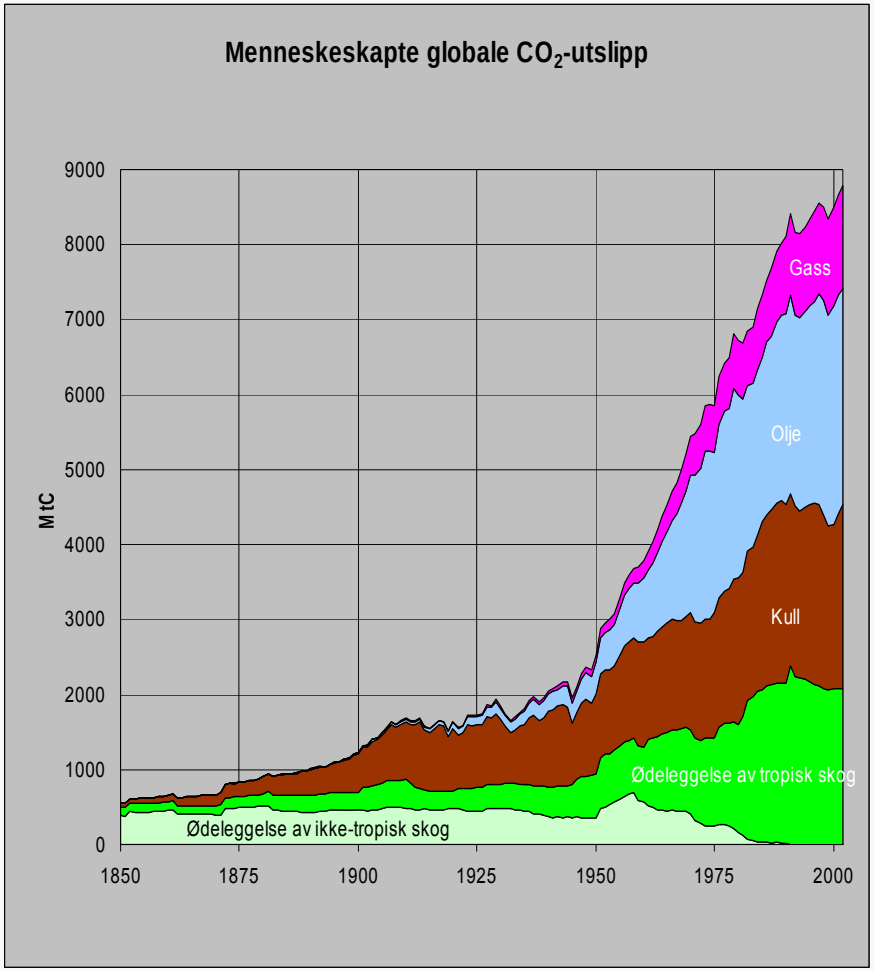
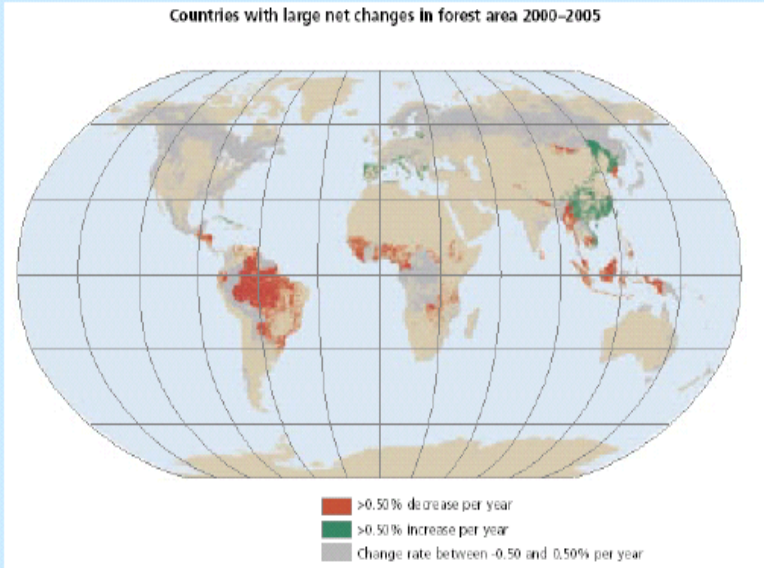


Figure 25.2 Deforestation is currently concentrated mainly in tropical areas



Countries with largest annual net loss in forest area 2000-2005	Annual change (1 000 ha/year)
Brazil	-3 103
Indonesia	-1 871
Sudan	-589
Myanmar	-466
Zambia	-445

Source: FAO (2005a)

Dispute Stern - Tol – Lomborg - Maddison

- B.Lomborg – Cop.Business School – Cop.Cons.Center
- Selective
  - Cherry picking statistics
- Hasty
  - High figures-low figures for the same event
- Discrepancy
  - from other studies
  - Not properly addressed
- Worth reading
- Alternatives to fight poverty

- D.Maddison – Univ. Bermingham
- Selective
- Can't replicate
  - Undocumented
- Relation to other newer studies
- Parameters of uncertainty
- Should have been peer reviewed

- R.Tol – Carnegie Mellon
- Selective in choice of literature
- Damage costs rule out
  - Technical change
  - Adaptation
  - Overestimate cost
  - And then benefit
- Total cost=total benefits
  - Versus
  - Marginal costs=marginal benefits

Nordhaus, Dasgupta, Hamilton - DeLong

$$\rho = \eta \frac{\dot{c}}{c} + \delta$$

- W.Nordhaus - Yale
- Nothing new in economics compared to the literature
- The discount rate drives the results
- Inconsistent with history
- The Dice model

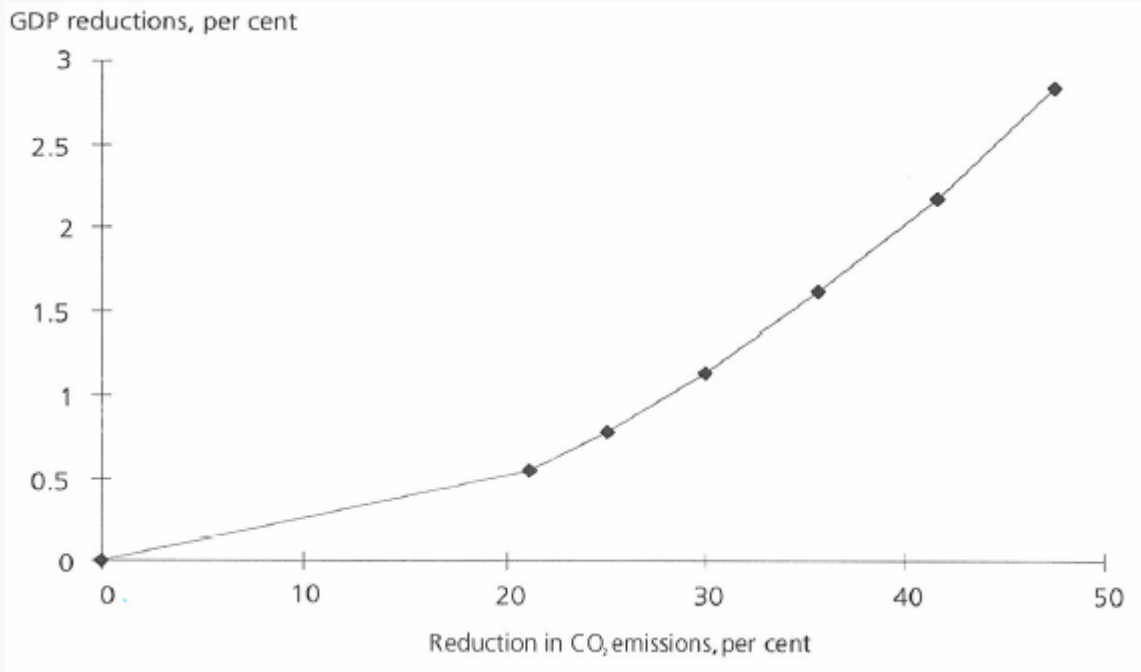
- P.Dasgupta – Un. Cambridge
- The choice of parameters
- The ethical parameter η
- The distribution of well being does not matter?
- Spend huge amount on the future, although they will be richer anyway

- K. Hamilton - WB
- End of calculation
  - Year 2200
  - Zero discounting
  - The end matters

- B.DeLong - Berkeley
- Dasgupta is wrong in calculations
  - GDP versus Haig-Simons output
- But right in conclusion

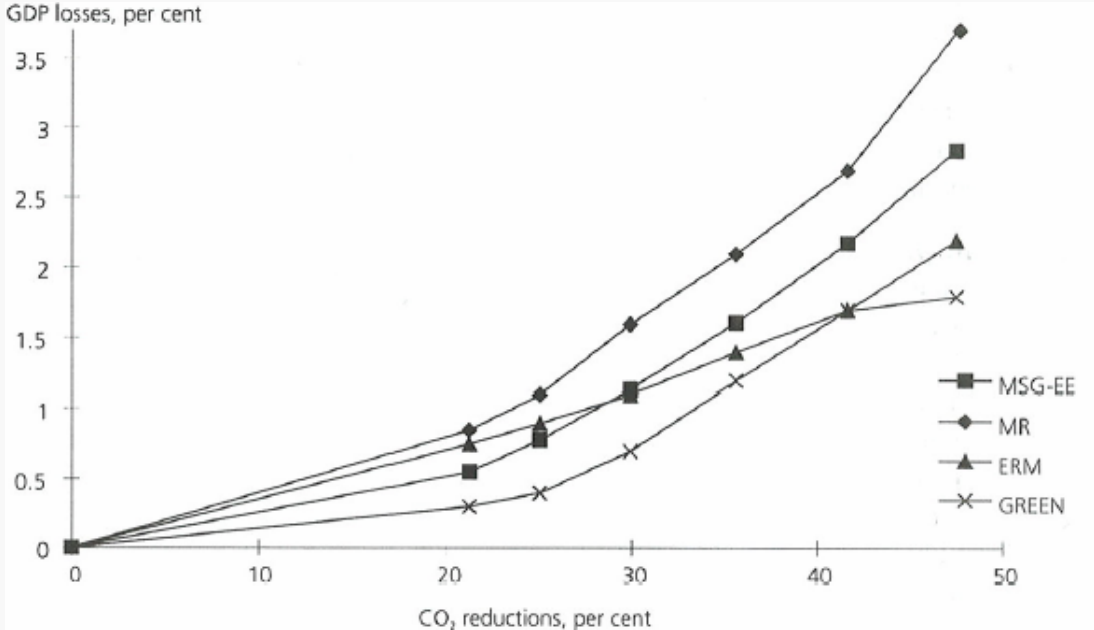
Have we learned anything new?
Norway – 2000-2020

- Simen (1987) - Stabilizing CO_2 by 2000 – 1-2 % GDP
- KLØKT (1991) – ”Klimagruppen” – 2000 og 2025
  - GDP (-0,5 , - 3,2) - lowering crude oil price - GNI (-3,4 , - 6,3)
- Alfsen, Bye and Holmøy (1996): Figure – GDP – 2020
- LUU - < 0,5% of GDP
  - 2050 – 75% reduction



Have we learned anything new?
International - 2020

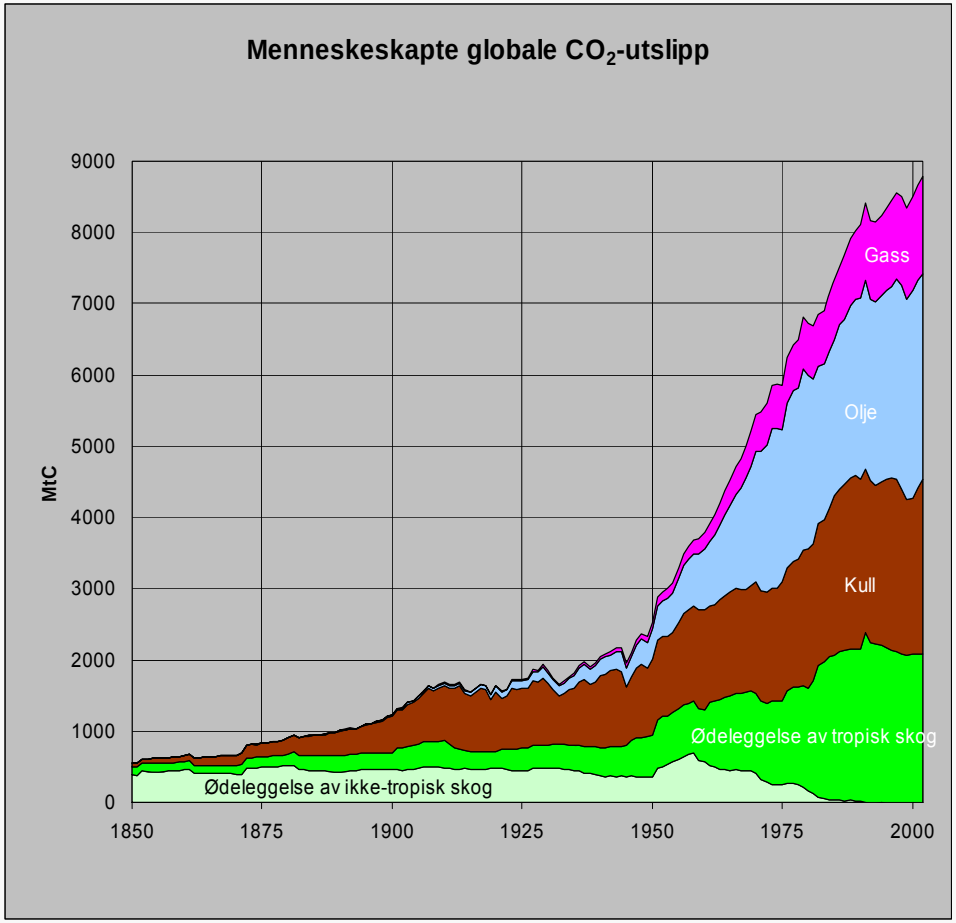
- MR – Manne-Richels Global 2100 – forward looking int.temp
- ERM – Edmunds Reilly – partial model
- Green – recursive dynamic general equilibrium model
- Green Tax Commission 1995
- Stern – 2006
  - 50 % by 2050
- - 1% BNP +/-3
- More detailed
  - More flexible
  - Lower costs
  - Still low



What's really new in it?

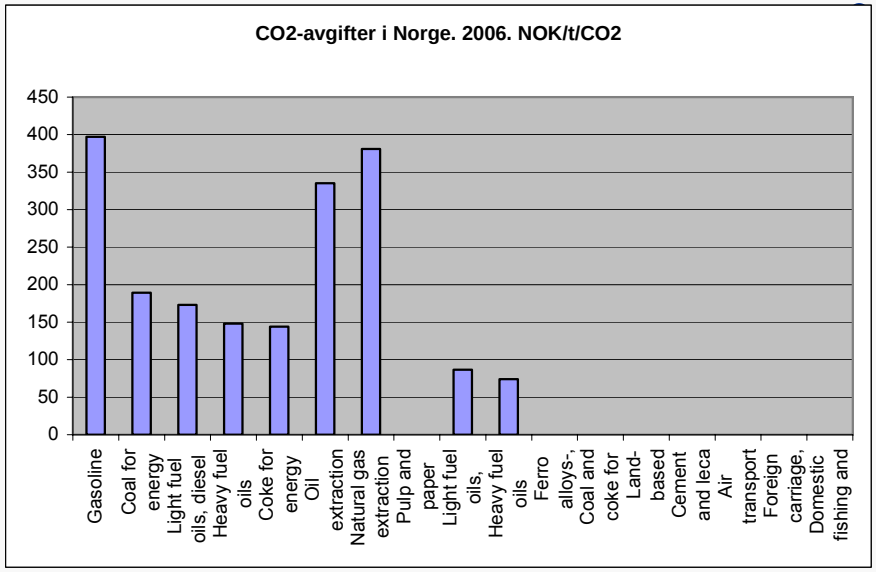
- Temperature increase is higher (and more certain – but…)
- Abatement costs lower – flexibility (but low compared to low)
- Uncertainty counts – and …..
- What is the problem?
  - Distribution of damage costs
    - Poor countries – incentive – but time preference rate high
    - Rich countries – no incentive – unless ethical
  - Distribution of abatement costs
    - Cheap in poor countries
    - "Expensive" in rich countries
  - Displacement
    - You pay – I won't
- The Stern analysis – as most analysis –
  - the social planner consumer preference rate
  - I.e. side payments – income transfer implicit - proposed

International displacement – some examples



- Total 40 Gt – forest 10 Gt
- Stern – 1-30/tonn
- In Norway:
  - ENOVA: 1,6 bill NOK: 260 mt?
  - CO_2 taxes: 7,5 bill NOK
    - 3,7 bill NOK: 600 mt
  - Gas power Mongstad
    - 0,6 bill NOK: 1,3 mt – 100 mt
  - Kårstø: 0,7 bill. NOK
  - Skogn: 2,5 bill. NOK ?
  - >Bruvoll and Larsen – 2% - 1mt
- 6 bill. NOK – ”1 Gt”
  - 2,5% of Global emissions

National displacement – some examples



Sektor	CO_2e - %
Total	100
Energisektorer	30
*Herav olje etc	26
Industri	27
*Metall	11
*Kjemisk	9
Andre	33
*Jordbruk	9
*Landtransport	8
Husholdninger	11

- Just some industries
  - High correlation emission and tax
  - Petro (26%) – small effect from now
  - Manufacturing (27%)
    - metal + chemicals (20%)
    - Large effect – nobody wants
  - Others (33%)
    - Agriculture (9%)
      - Large effect –nobody wants?
    - Land transport (8%) –
      - Small effect from now – district policy
- Large cost for few
  - Weak instruments
- ”Large costs” – no effect
- LUU presumed effects
- The distribution of income and cost

Is climate really an issue?

- From 40 Gt to 85 Gt in 2050 ?
  - ”Assume” average cost of reduction 2$/t = 5 €
    - 20 most wealthy countries – 6 bill NOK a year
    - Makes 120 bill NOK – 20 bill/US$
    - 10 Gt – 25 percent of total world ”emissions” to day
    - 6 bill. NOK < 0,4 % of Norwegian GDP
- EU target: 50 % reduction – 16% of World Emission
  - 6 Gt
  - How much money?
    - –20 countries–1% of GDP–1000 bill NOK-160b$?
  - 2$/t - let us quintuple = 10$/t ---160/10 = 16 GT
- What a waste of money, but most of all –

–What an environmental waste?

Summary and conclusions

- We know what we knew about climate change 20 years ago
- We know what we knew about cost of abatement 20 years ago
- We know something new about the damage
- We know what we knew about distributional effects
  - International and domestic
- Relative to target ”nothing” happens to emissions
- Politicians and environmentalists seem to suffer from misconception ?
  - The total cost is small in MACRO
  - The distribution of cost is uneven
  - The distribution of benefits is uneven
  - The consumer preference rate in poor countries obstructs
  - The total sum of money and necessary early and extensive action
  - Cost efficiency do cost for the affected
- Our Prime Minister seems to change direction? – **RIGHT DIRECTION**