Tyndall Centre for Climate Change Research

4CMR Foreseeing Mitigation

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The Mitigation Challenge

IPCC Working Group III

Fourth Assessment Report 2007

Terry Barker, Coordinating Lead Author

25 May 2007, The Pitt Building, University of Cambridge

13 years to turn round global warming

By Fiona Harvey and Gernot Wagner in London
Published: May 5 2007 03:00 | Last updated: May 5 2007 03:00

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Achieving this would reduce the world's annual gross domestic product by 3 per cent in 2030, the UN expert panel concluded. Emissions have been rising for the past 150 years.

If emissions were to peak in 2015, which is viewed as unlikely to be achieved, and thereafter fall by about 50-80 per cent over the next several decades, global warming would be limited to about2° Celsius above pre-industrial levels, the IPCC report found. The world has already warmed by

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Outline of lecture

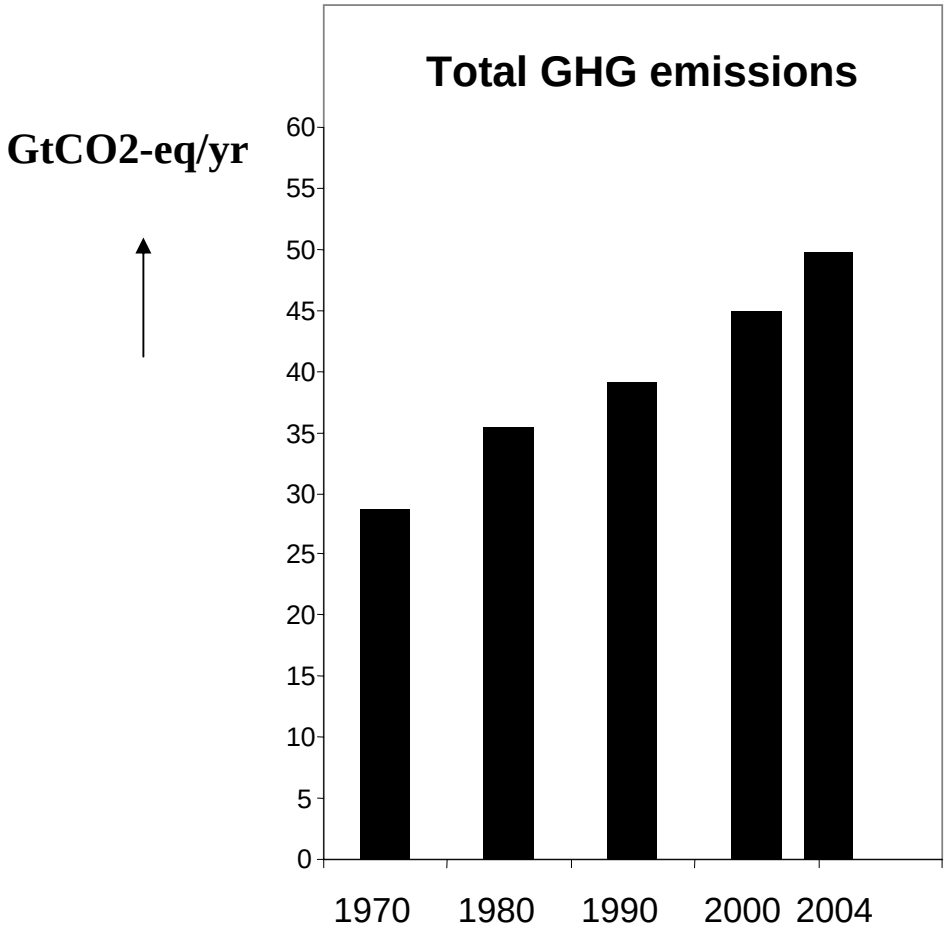
1. The IPCC process
2. Trends in global GHG emissions
3. Establishing the concept of mitigation potential
4. Economic potential for mitigation to 2030
5. Costs of climate stabilization (and benefits)
6. New literature on the role of technological change
7. Conclusions

Acknowledgements
This presentation has been developed from that given to the Press Conference, Bangkok, May 4, 2007, by the Co-Chairs of IPCC AR4, WG III. The text and figures in the presentation come from the WG III Summary for Policy Makers, unless otherwise stated. The comments are my own.

The IPCC process for WG III

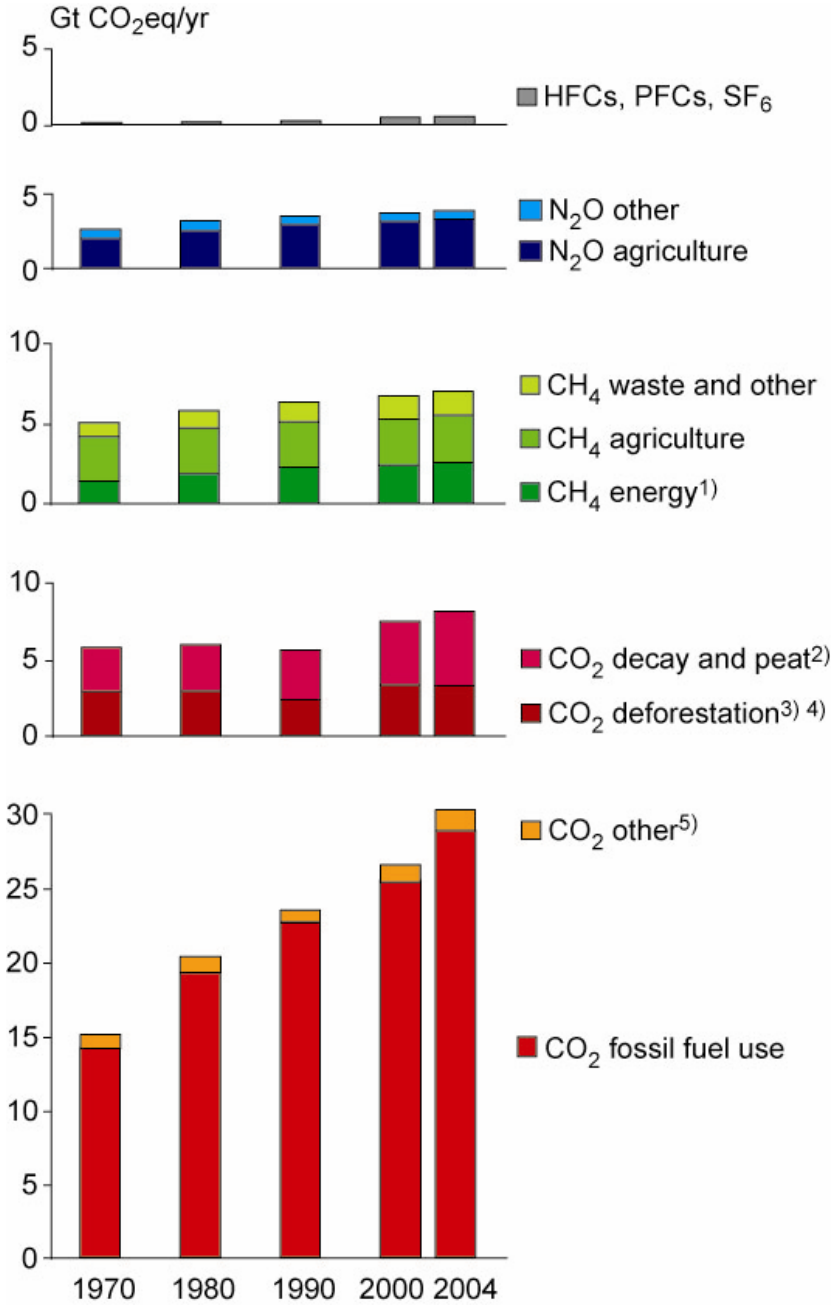
- WG I: the Science. WG II: Impacts. WG III: Mitigation.
- Three-year process 2004 to 2007
- Assessment of published literature (to December 2006)
  - 168 Lead Authors
  - 59 Authors from developing countries
  - 106 Authors from developed countries
  - 84 Contributing authors
  - 485 Expert Reviewers
- Extensive review by independent and government experts
- Summary for Policy Makers approved line-by-line by all 180 IPCC member governments (Bangkok, May 4)
- Full report and technical summary accepted without discussion

Trends in global GHG emissions



Between 1970 and 2004, global GHG emissions have increased by 70 %

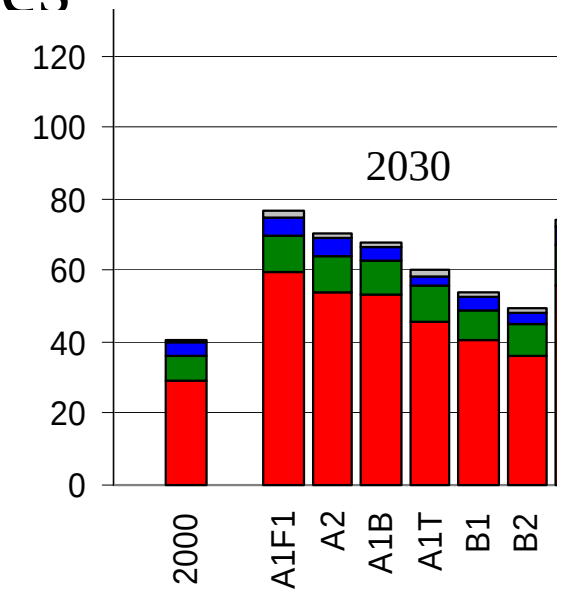
Carbon dioxide is the largest contributor



Future emissions will grow further

- With current climate-change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades

- IPCC SRES scenarios: 25-90 % increase of GHG emissions in 2030 relative to 2000



Establishing the concept of mitigation potential

- There was a need to have a set of definitions
  - acceptable to engineers and economists across WG III chapters (“bottom-up” and “top-down” approaches)
  - encompassing different economic modelling approaches (neo-classical, institutional)
  - applicable to mitigation in all countries & sectors and from one IPCC report to the next
- IPCC Third Assessment Report definitions were unclear and confusing
- Agreed: market, economic, technical and physical mitigation potentials and associated “carbon prices”

Definitions of mitigation potentials

Mitigation potential: the scale of GHG reductions that could be made, relative to emission baselines, for a given level of carbon price (expressed in cost per unit of carbon dioxide equivalent emissions avoided or reduced).

Market potential: the mitigation potential based on private costs and discount rates, which might be expected to occur under forecast market conditions, including policies and measures in place, but with barriers limiting actual uptake.

Economic potential: the mitigation potential based on social costs and social discount rates. Direct benefits of for instance energy savings are normally included, while most external costs are generally not.

My comments on the definitions in the IPCC Report (1)

- The mitigation potentials are quantities, measured in Giga tonnes CO_2-equivalent a year ($GtCO_2$-eq/yr)
- They are world-wide, or for countries or sectors, and usually in the future
- They are defined for given carbon prices expressed as $(2000 prices) per tonne CO_2-equivalent (US$/$tCO_2$-eq)
- Four key prices have been chosen to measure economic potentials: 0, 20, 50 and 100 US$/$tCO_2$-eq
- The market potential at a zero carbon price is basically "business as usual" in the projections
- If a country introduces a carbon tax, the effects become embodied into the market mitigation potential

My comments on the definitions in the IPCC Report (2)

- Most of the potentials discussed are economic potentials
- Any positive carbon price is a “social cost”, meaning it is a price created by policies and measures e.g. the EU’s emissions trading scheme
- Climate stabilization studies provide estimates of required reductions in GHG emissions, globally by year, i.e. the required economic potentials
- The economic models provide estimates of the carbon prices yielding such economic potentials: hence the carbon price ranges in the tables

Two approaches in the Report: their relative advantages

Techno-economic analysis ("bottom-up")

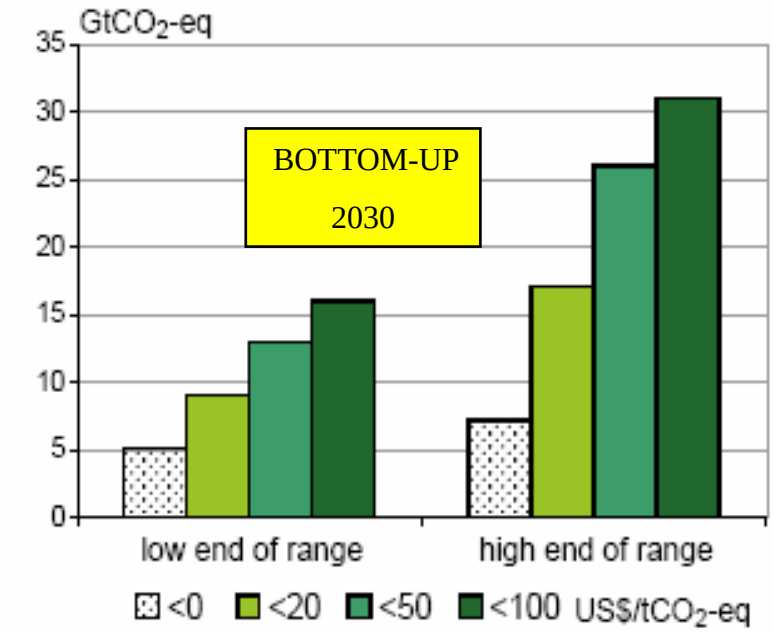
- emphasizes specific technologies and regulations
- has a stronger relation with business practices
- Relates to sectoral policies

Integrated Assessment analysis ("top-down")

- integrates the energy system and the economy
- includes economic and natural system feedbacks
- allows modelling of economy-wide polices and measures, e.g. carbon tax

Economic potential is substantial for the mitigation of global GHG emissions over the coming decades

- Estimates are from both bottom-up and top-down studies



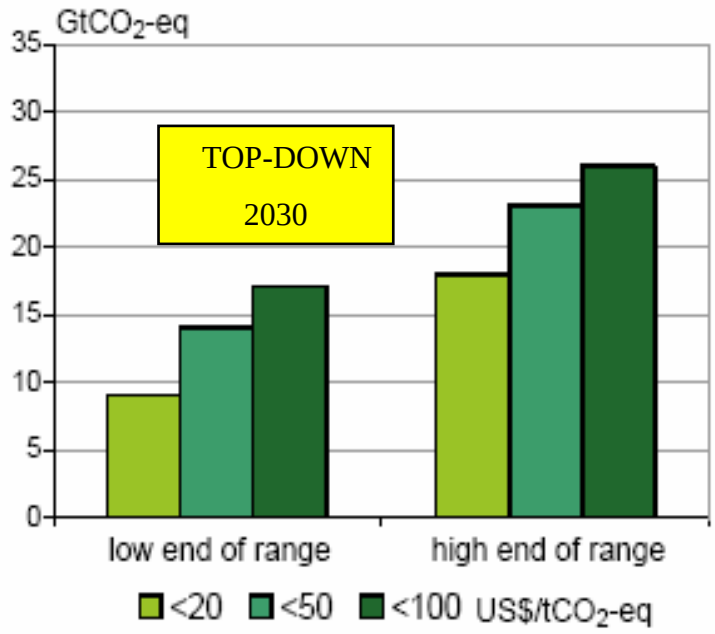


Figure SPM 5A: *Global economic potential in 2030 estimated. Cost categories in US$/tCO2eq.*	***Figure SPM 5B:*** *Global economic potential in 2030 Cost categories in US$/tCO2eq..*

Note: estimates do not include non-technical options such as lifestyle changes

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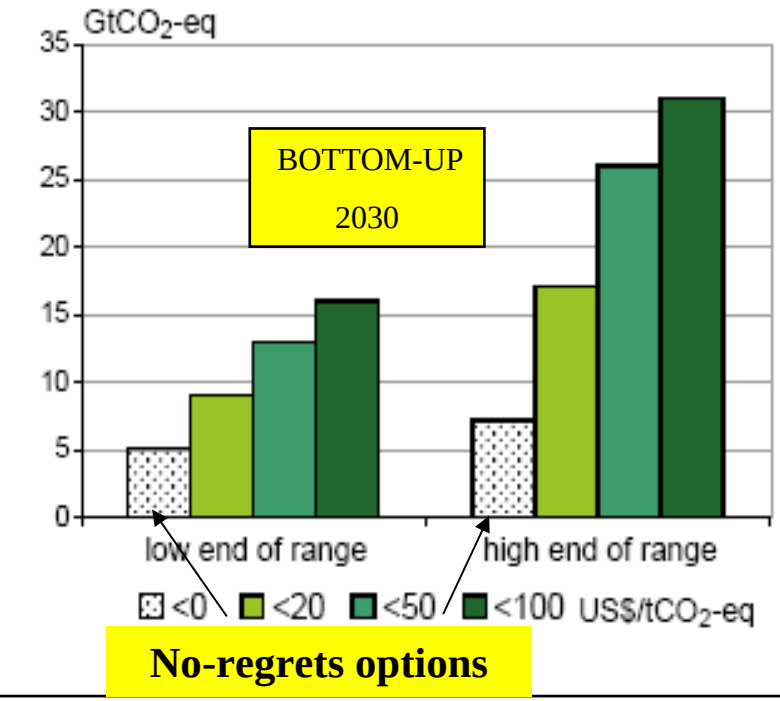

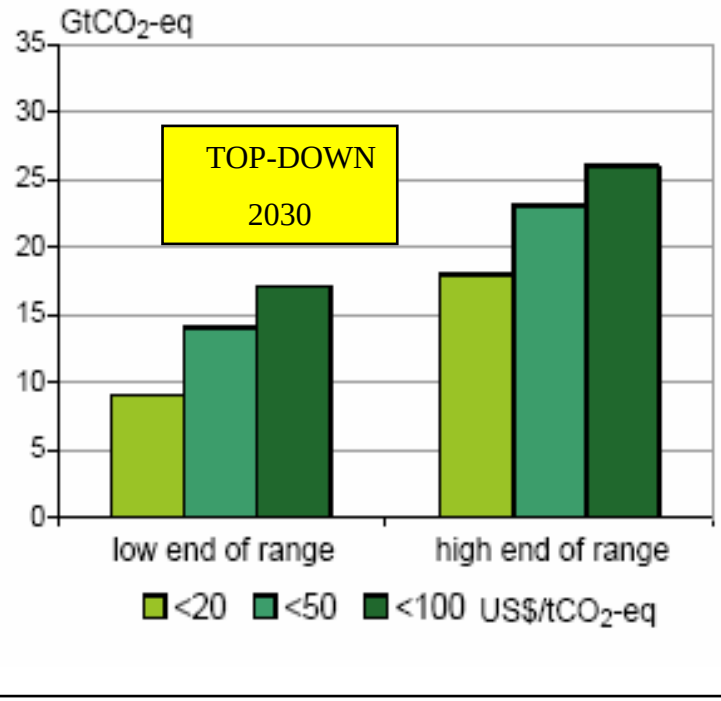

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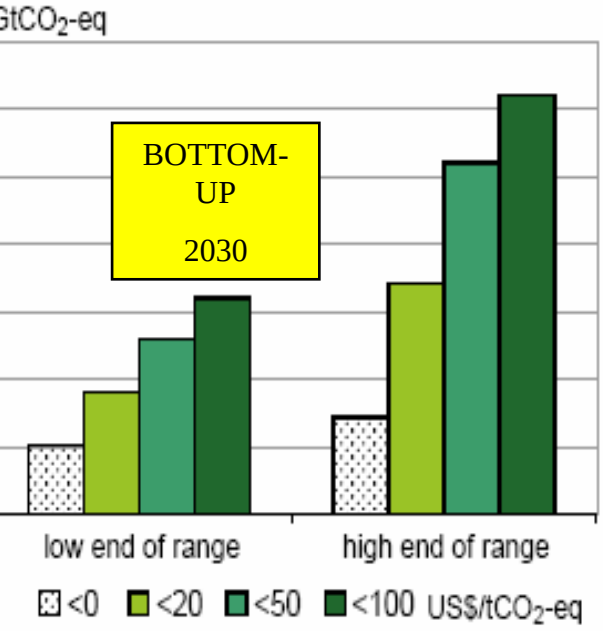

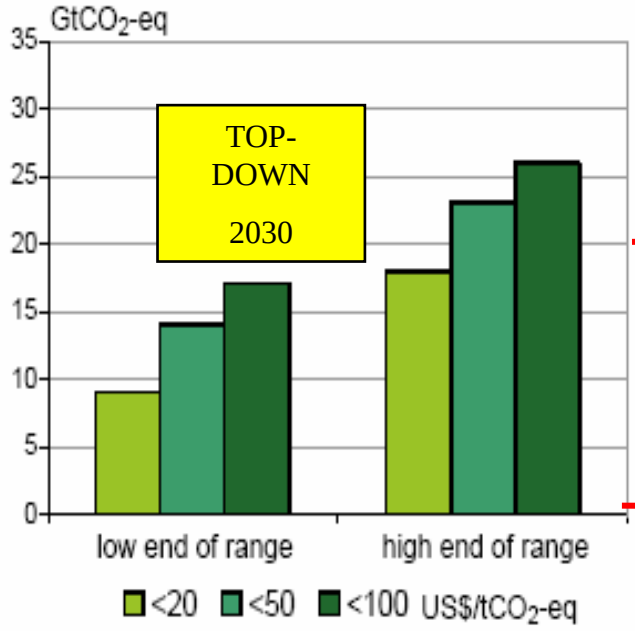

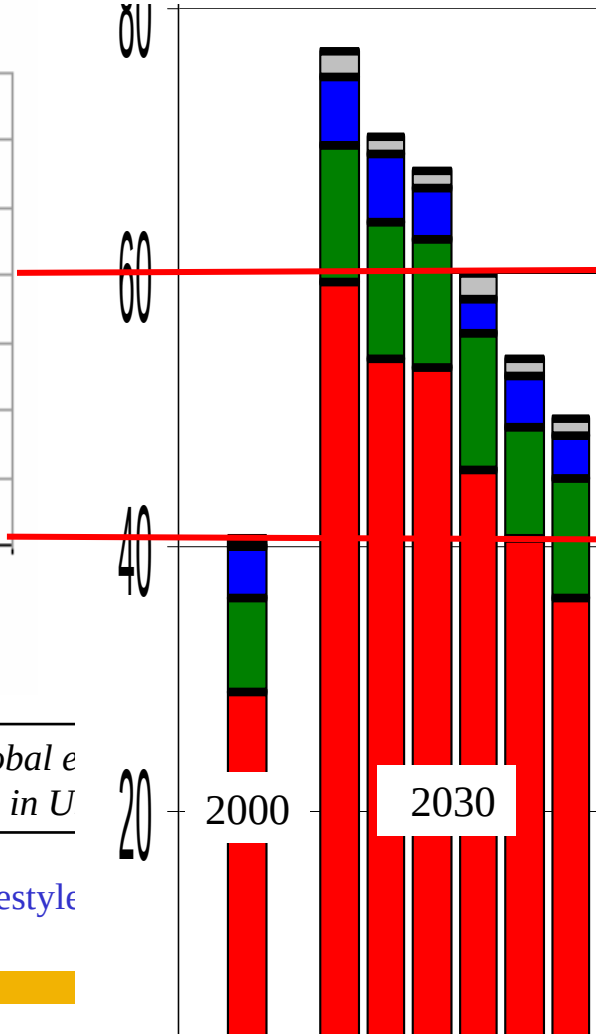

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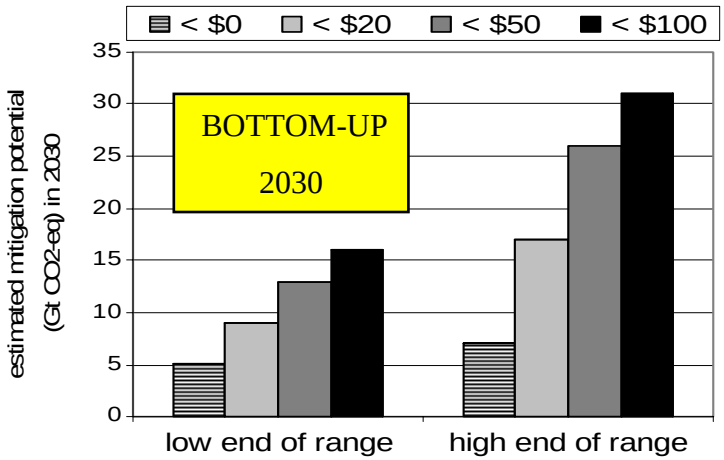

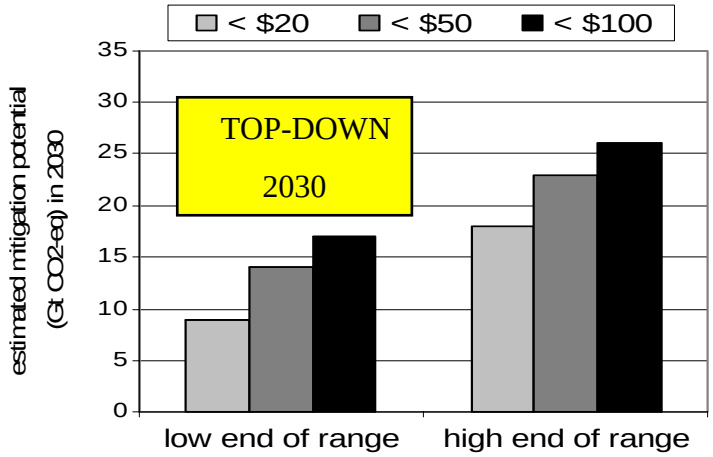

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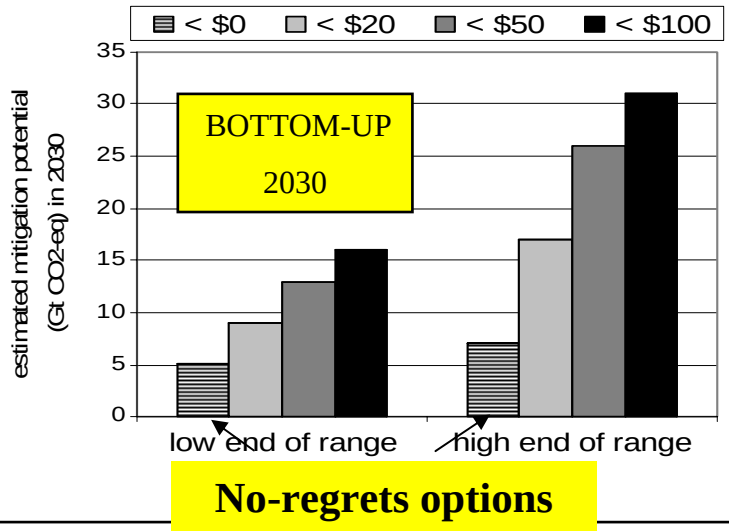

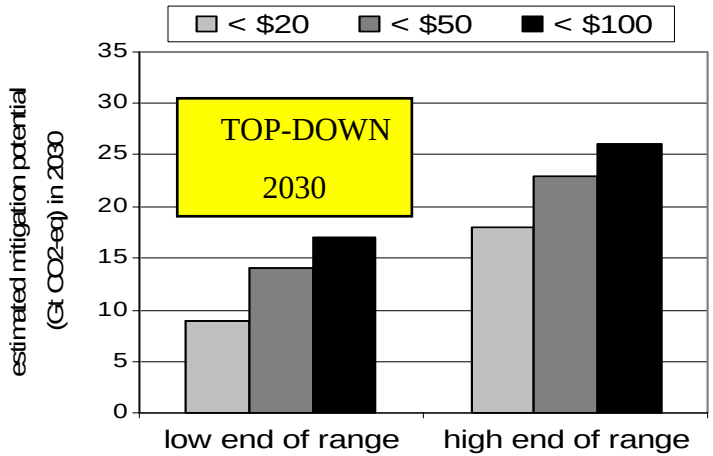

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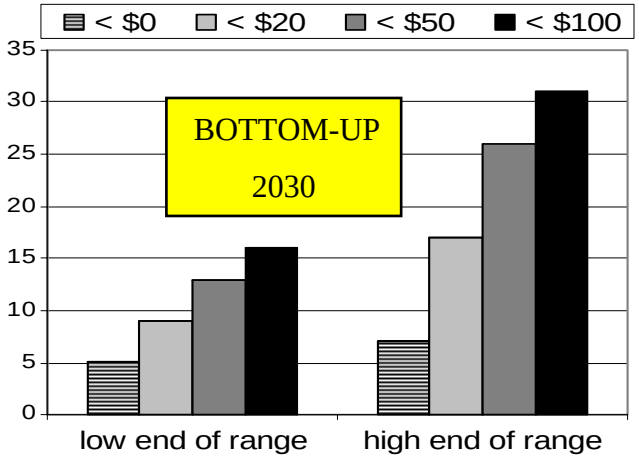
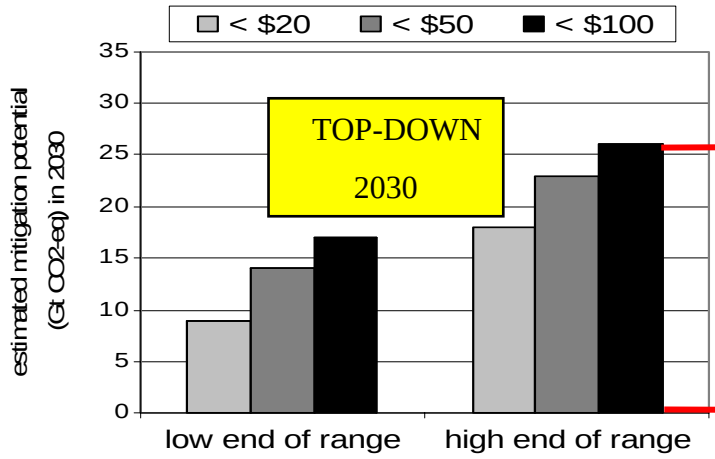
Note: estimates do not include non-technical options such as lifestyle changes

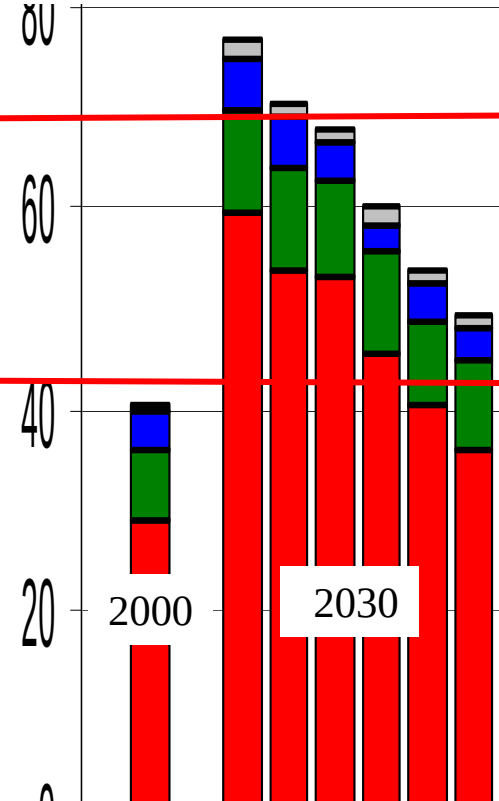
Economic potential is substantial for the mitigation of global GHG emissions over the coming decades

- Estimates are from both bottom-up and top-down studies
- The potentials could offset the projected growth of global emissions, or reduce emissions below current levels





IPCC SRES scenarios



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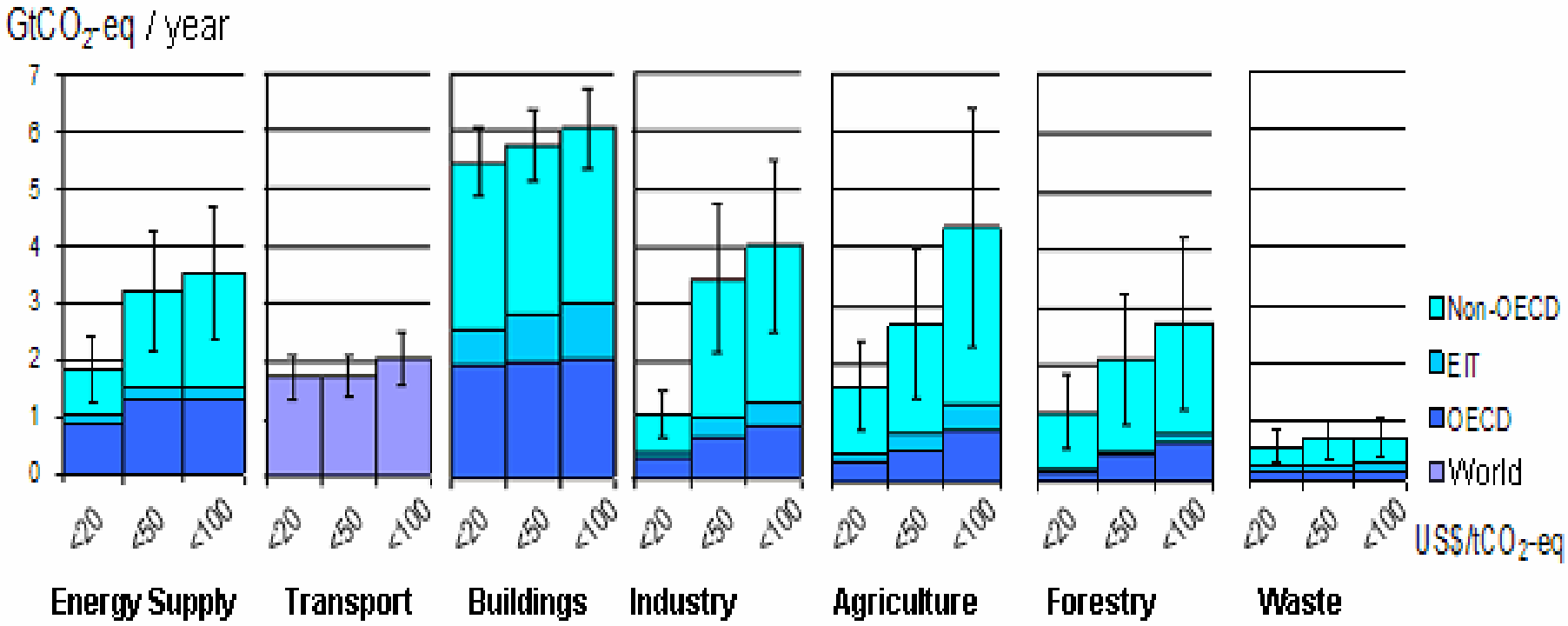
All sectors and regions have the potential to contribute



Note: estimates do not include non-technical options, such as lifestyle changes.

Changes in lifestyle and behaviour patterns can contribute to climate change mitigation: examples

- Changes in occupant behaviour, cultural patterns and consumer choice in buildings.
- Reduction of car usage and efficient driving style, in relation to urban planning and availability of public transport
- Staff training, reward systems, regular feedback and documentation of existing practices in industrial organizations

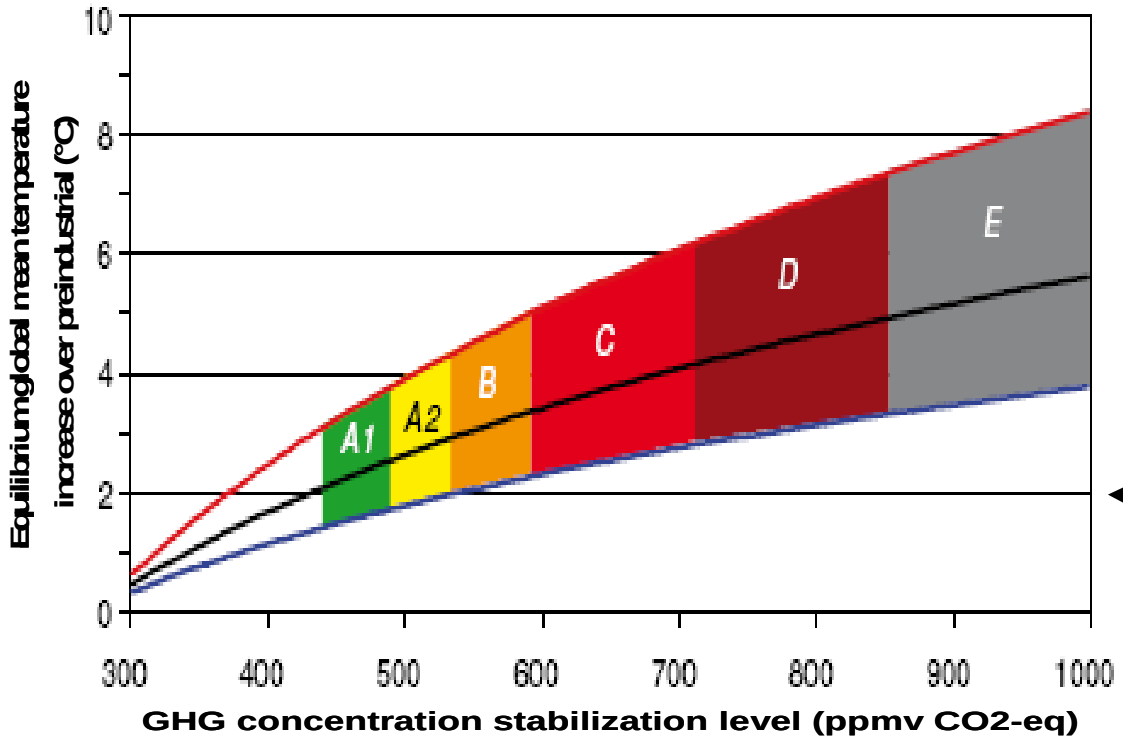
Long-term mitigation

- The lower the stabilization level, the more quickly emissions would need to peak and to decline thereafter
- Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels

Stabilization level (ppm CO_2-eq)	Global Mean temp. increase at equilibrium (°C)	Year CO_2 needs to peak	% reduction in 2050 compared to 2000
445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50
490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30
535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5
590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60
710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85
855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140

Stabilisation levels and equilibrium global mean temperatures

Mean temperatures



2°C
EU target

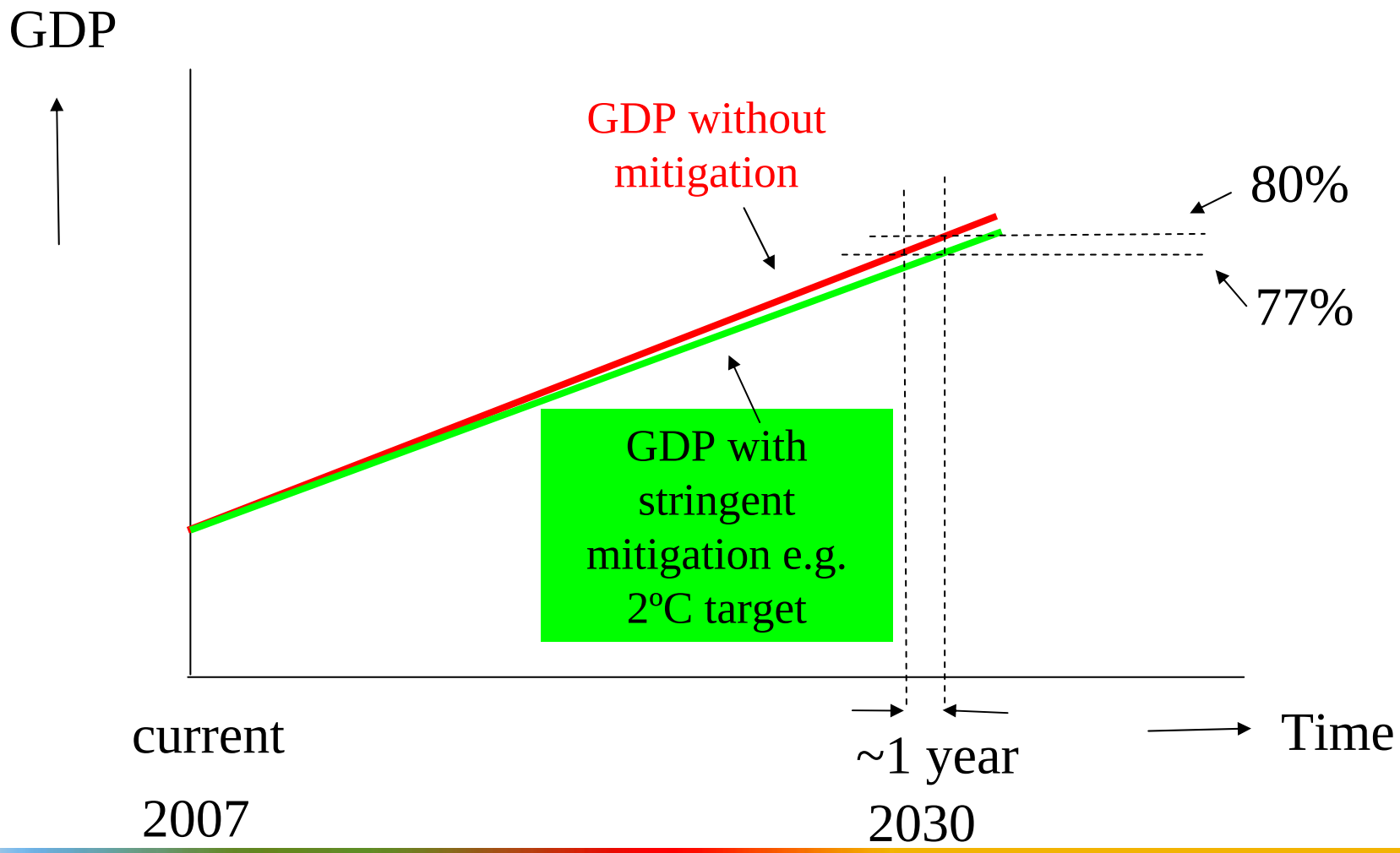
***Figure SPM 8**: Stabilization scenario categories as reported in Figure SPM.7 (coloured bands) and their relationship to equilibrium global mean temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3 ℃ (black line in middle of shaded area), (ii) upper bound of likely range of climate sensitivity of 4.5 ℃ (red line at top of shaded area) (iii) lower bound of likely range of climate sensitivity of 2 ℃ (blue line at bottom of shaded area). Coloured shading shows the concentration bands for stabilization of greenhouse gases in the atmosphere corresponding to the stabilization scenario categories. The data are drawn from AR4 WGI, Chapter 10.8.*

What are the macro-economic costs in 2030 for different stabilization levels?

Stabilization levels (ppm CO_2-eq)	Median GDP reduction [1] (%)	Range of GDP reduction [2] (%)	Reduction of average annual GDP growth rates [3] (percentage points)
590-710	0.2	-0.6 – 1.2	< 0.06
535-590	0.6	0.2 – 2.5	<0.1
445-535[4]	**Not available**	**< 3**	**< 0.12**

[1] This is global GDP based market exchange rates.
[2] The median and the 10th and 90th percentile range of the analyzed data are given.
[3] The calculation of the reduction of the annual growth rate is based on the average reduction during the period till 2030 that would result in the indicated GDP decrease in 2030.
[4] **The number of studies that report GDP results is relatively small and they generally use low baselines.**

Illustration of the 3% cost number



There are also co-benefits of mitigation

- Near–term health benefits from reduced air pollution may offset a substantial fraction of mitigation costs
- Mitigation can also be positive for: energy security, balance of trade improvement, provision of modern energy services to rural areas and employment

BUT

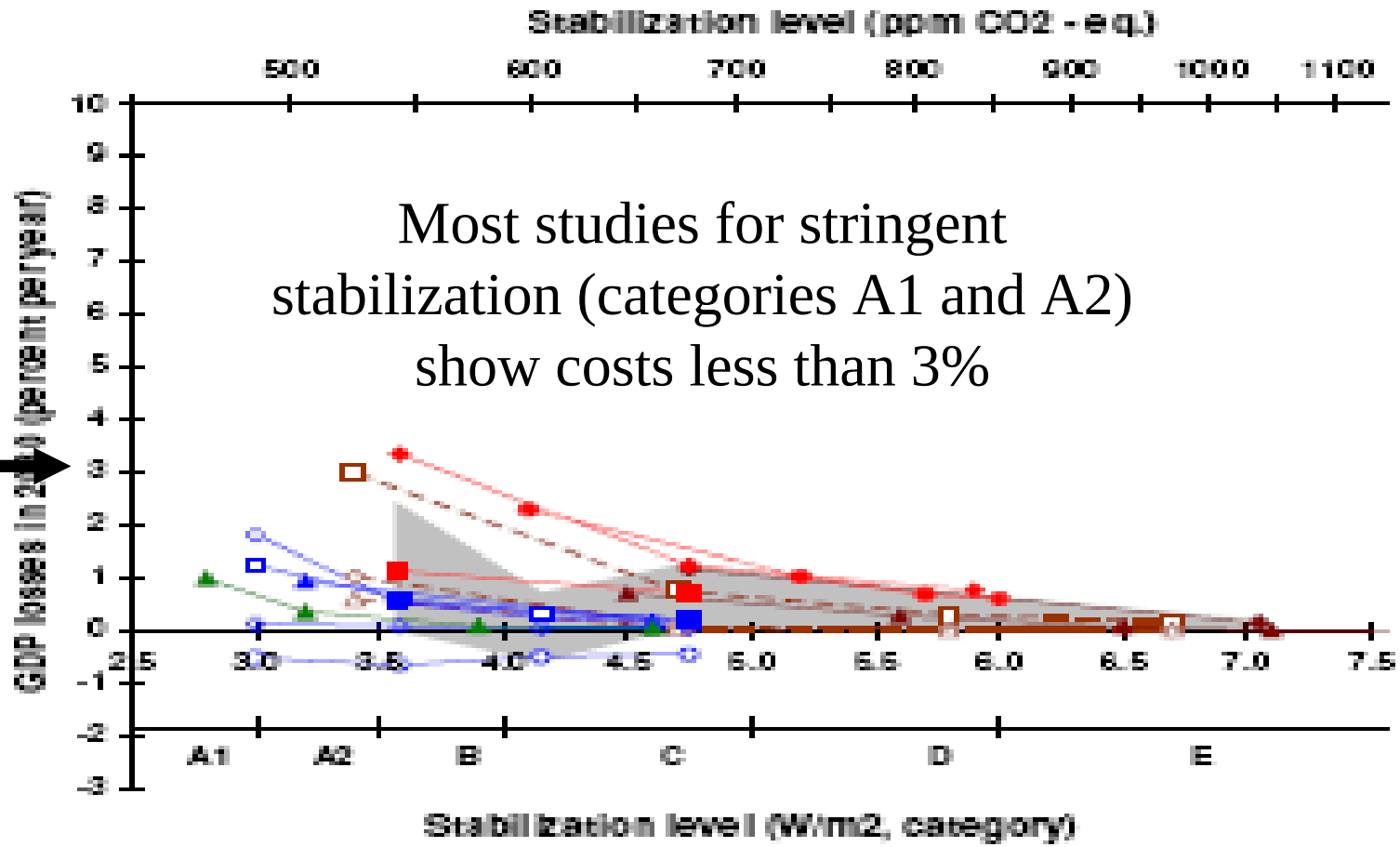
- Mitigation in one country or group of countries could lead to higher emissions elsewhere (“carbon leakage”) or effects on the economy (“spill-over effects”).

What are the macro-economic costs by 2050?

Stabilization levels (ppm CO_2-eq)	Median GDP reduction[1] (%)	Range of GDP reduction [2] (%)	Reduction of average annual GDP growth rates [3] (percentage points)
590-710	0.5	-1 – 2	< 0.05
535-590	1.3	Slightly negative - 4	<0.1
445-535[4]	Not available	< 5.5	< 0.12

[1] This is global GDP based market exchange rates.
[2] The median and the 10th and 90th percentile range of the analyzed data are given.
[3] The calculation of the reduction of the annual growth rate is based on the average reduction during the period till 2050 that would result in the indicated GDP decrease in 2050.
[4] The number of studies that report GDP results is relatively small and they generally use low baselines.

3% maximum global cost by 2030 in context



Source: IPCC AR4, WG III Report 2007, Chapter 3, Figure 3.25 (a)

The importance of a “price of carbon”

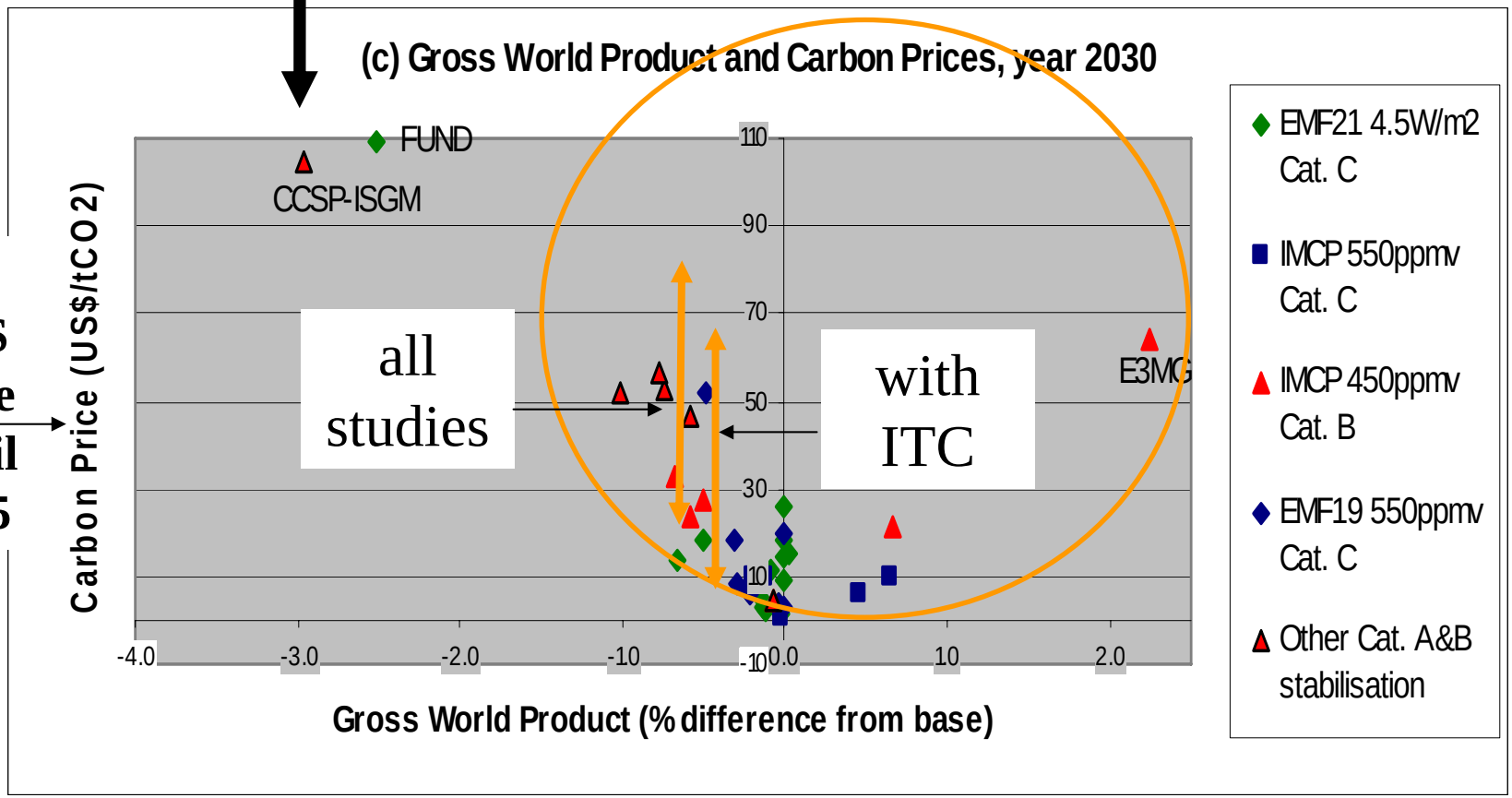
- Policies that provide a real or implicit price of carbon could create incentives for producers and consumers to significantly invest in low-GHG products, technologies and processes.

- Such policies could include economic instruments, government funding and regulation

- For stabilisation at around 550 ppm CO_2eq carbon prices should reach 20-80 US$/t$CO_2$eq by 2030 ($5-65 if more technological change is induced by policies)

- At these carbon prices large shifts of investments into low carbon technologies can be expected

3% maximum global cost by 2030 in context with carbon prices



Source: IPCC AR4, WG III Report 2007, Chapter 11, Figure 11.7

The importance of technology policies

- Deployment of low-GHG emission technologies and RD&D would be required for achieving stabilization targets and cost reduction.
- The lower the stabilization levels, especially those of 550 ppm CO_2-eq or lower, the greater the need for more efficient RD&D efforts and investment in new technologies during the next few decades.
- Government support through financial contributions, tax credits, standard setting and market creation is important for effective technology development, innovation and deployment.
- Government funding for most energy research programmes has been flat or declining for nearly two decades (even after the UNFCCC came into force); now about half of 1980 level.

Scientific consensus on technology and economics

- Third to Fourth Assessment report
  - "remarkable progress has been achieved in applying approaches based on induced technological change to stabilisation studies; however, conceptual issues remain"
  - technology is now responsive to carbon prices in many models
- In the models that adopt these approaches, projected costs for a given stabilization level are reduced
  - the reductions are greater at lower stabilisation levels.
- Although most models show GDP losses, some show GDP gains
  - because they assume that baselines are non-optimal and mitigation policies improve market efficiencies
  - or they assume that more technological change may be induced by mitigation policies.

International agreements

- Notable achievements of the UNFCCC/Kyoto Protocol that may provide the foundation for future mitigation efforts:
  - global response to the climate problem,
  - stimulation of an array of national policies,
  - the creation of an international carbon market and
  - new institutional mechanisms
- Future agreements:
  - Greater cooperative efforts to reduce emissions will help to reduce global costs for achieving a given level of mitigation, or will improve environmental effectiveness
  - Improving, and expanding the scope of, market mechanisms (such as emission trading, Joint Implementation and CDM) could reduce overall mitigation costs

Conclusions: my interpretation of the outcome

- We, collectively, may be able to reduce the risks of run-away warming, but action is urgent
- There are huge gaps in knowledge, particularly of the costs and means of effective action, but the way forward is clear
- The 3% overall economic cost is the top end of a wide range that includes substantial benefits
- The Fourth IPCC assessment report marks a turning point in understanding about technology-economy interaction by both the scientific community and governments

The full SPM can be downloaded from www.ipcc.ch

Further information:

IPCC Working group III

Technical Support Unit:

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Additional slides