Mitigation of Climate Change

IPCC Working Group III contribution to the

Fourth Assessment Report

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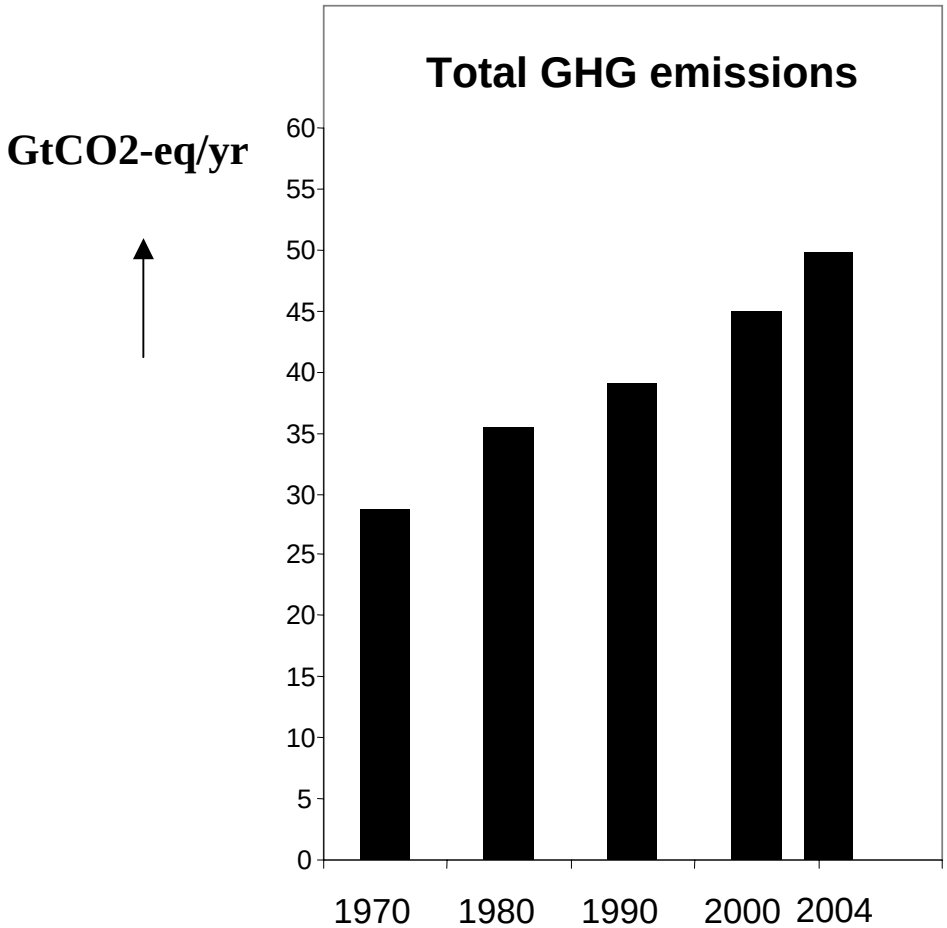
Co-chair IPCC WG III

UNFCCC, Bonn, May 12, 2007

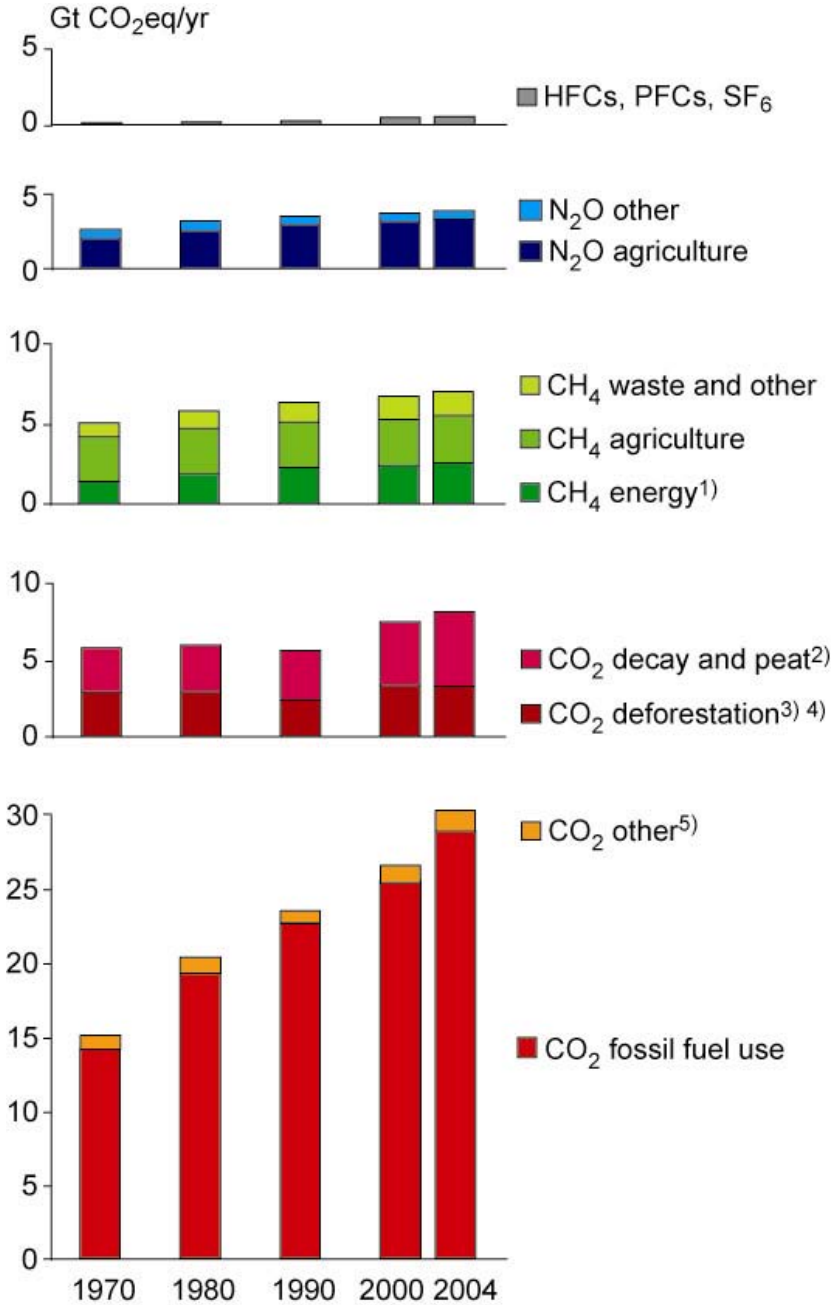
The people

- Lead Authors: 168
  - from developing countries: 55
  - From EITs: 5
  - from OECD countries: 108
- Contributing authors: 85
- Expert Reviewers: 485

Between 1970 and 2004 global greenhouse gas emissions have increased by 70 %

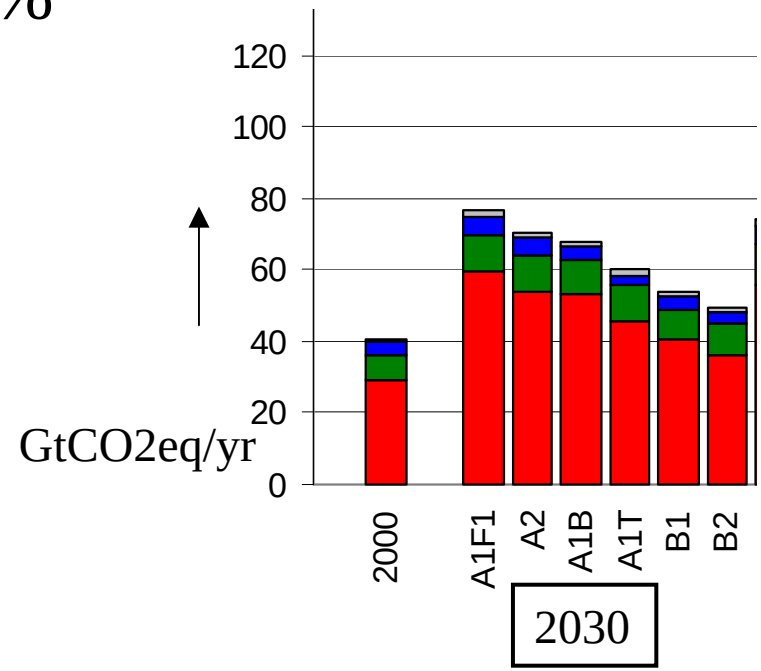


Carbon dioxide is the largest contributor



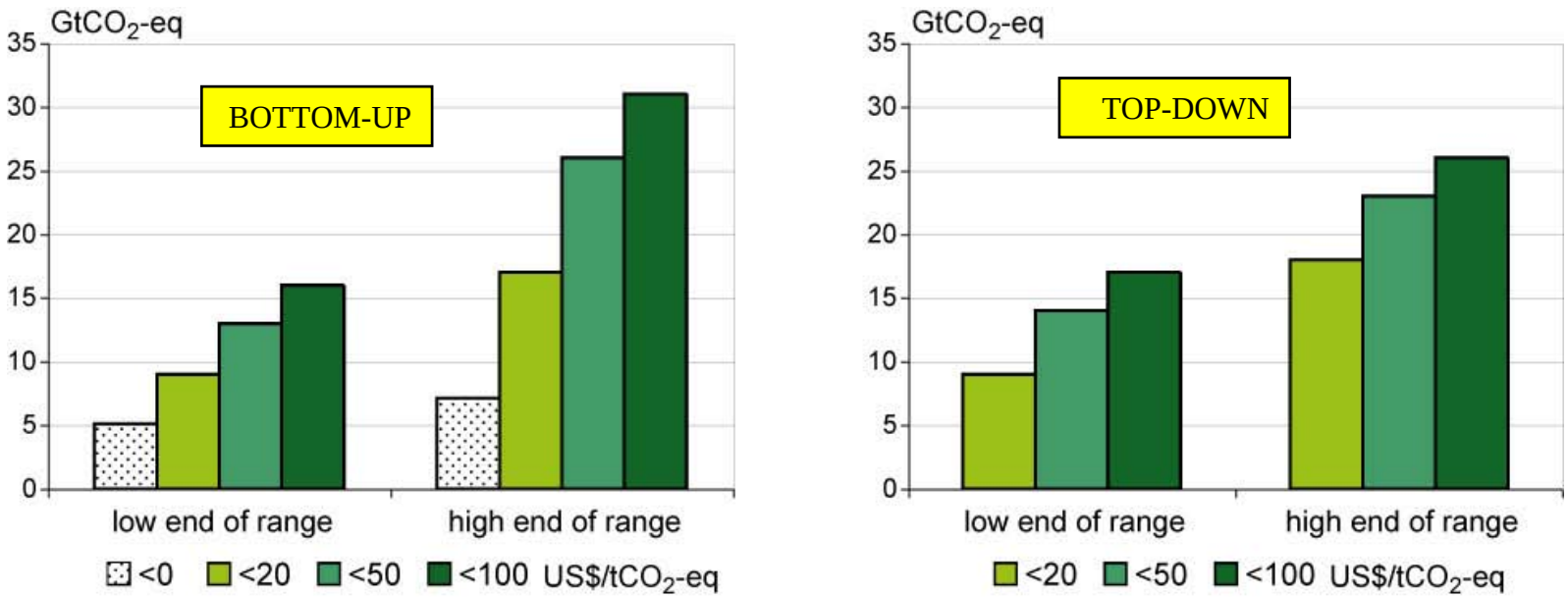
With current climate change mitigation policies *and related sustainable development practices*, global GHG emissions will continue to grow over the next few decades

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



Substantial economic potential for the mitigation of global GHG emissions over the coming decades

- Both bottom-up and top-down studies
- Potential could offset the projected growth of global emissions, or reduce emissions below current levels



Global economic potential in 2030

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

What does US$ 50/ tCO2eq mean?

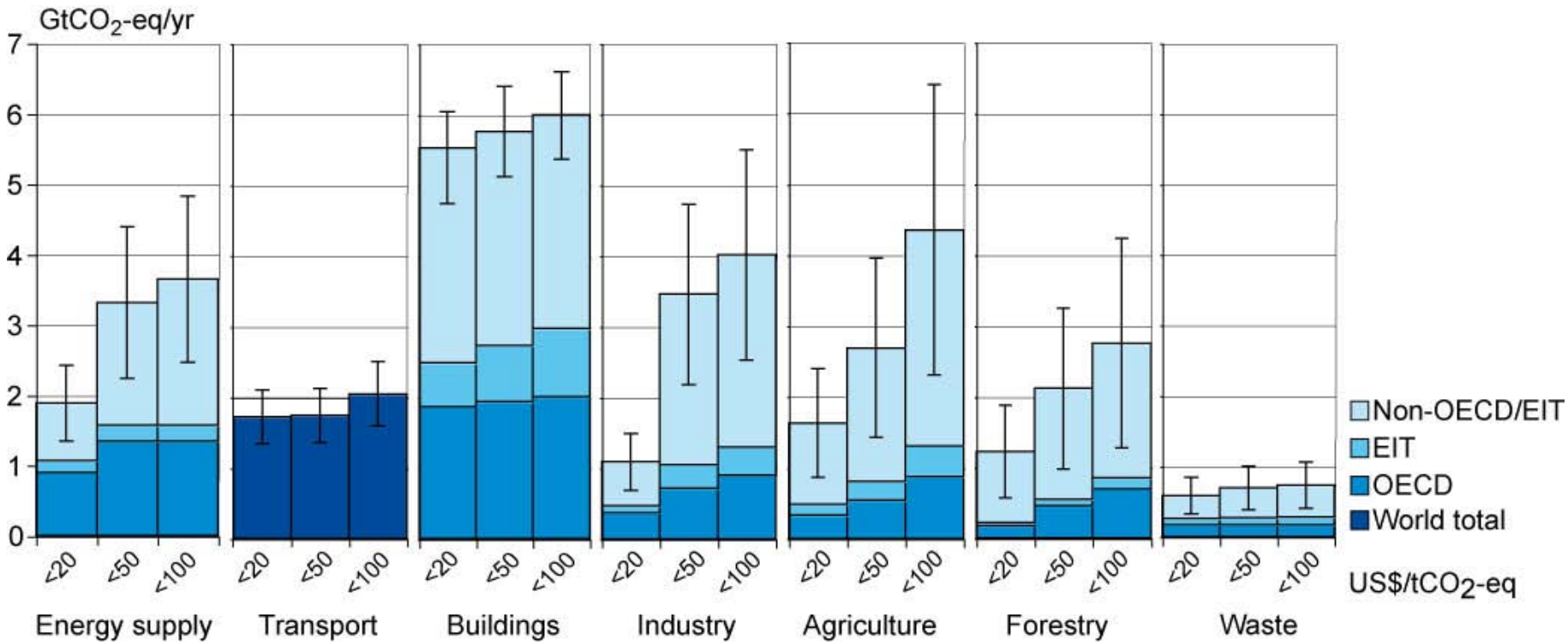
- Crude oil: ~US$ 25/ barrel
- Gasoline: ~12 ct/ litre (50 ct/gallon)
- Electricity:
  - from coal fired plant: ~5 ct/kWh
  - from gas fired plant: ~1.5 ct/kWh

Mitigation potential

- *Economic potential:*
  - takes into account social costs and benefits and social discount rates,
  - assuming that market efficiency is improved by policies and measures and
  - barriers are removed

- *Market potential:*
  - based on private costs and private discount rates
  - expected to occur under forecast market conditions
  - including policies and measures currently in place
  - noting that barriers limit actual uptake

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

- 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
- Behaviour of staff in industrial organizations in light of reward systems

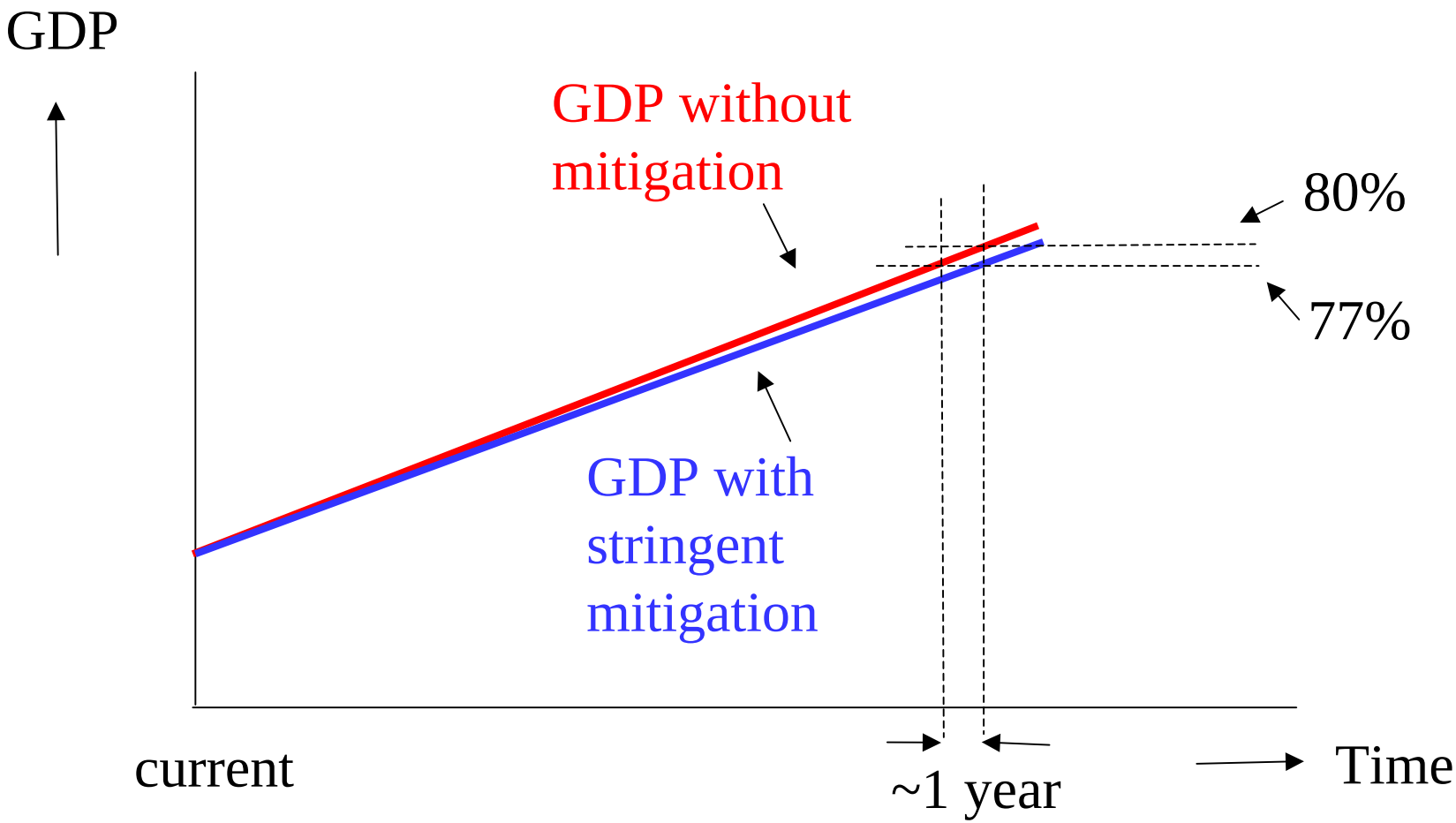
What are the macro-economic costs in 2030?

- Costs are global average for least cost appoaches from top-down models
- Costs do not include co-benefits and avoided climate change damages

Trajectories towards 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 cost numbers



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*, *sustainable agriculture* and *employment*

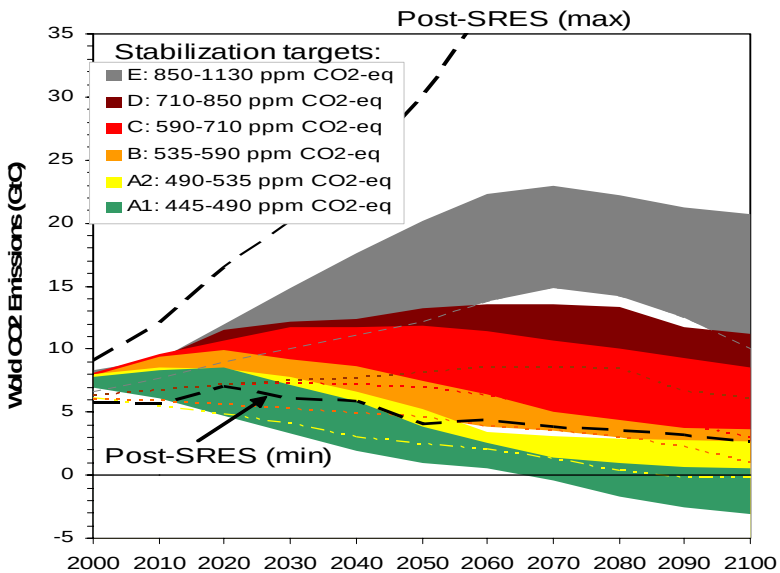
Literature since TAR confirms that there may be effects from Annex I countries action on the global economy and global emissions, although the scale of carbon leakage remains uncertain

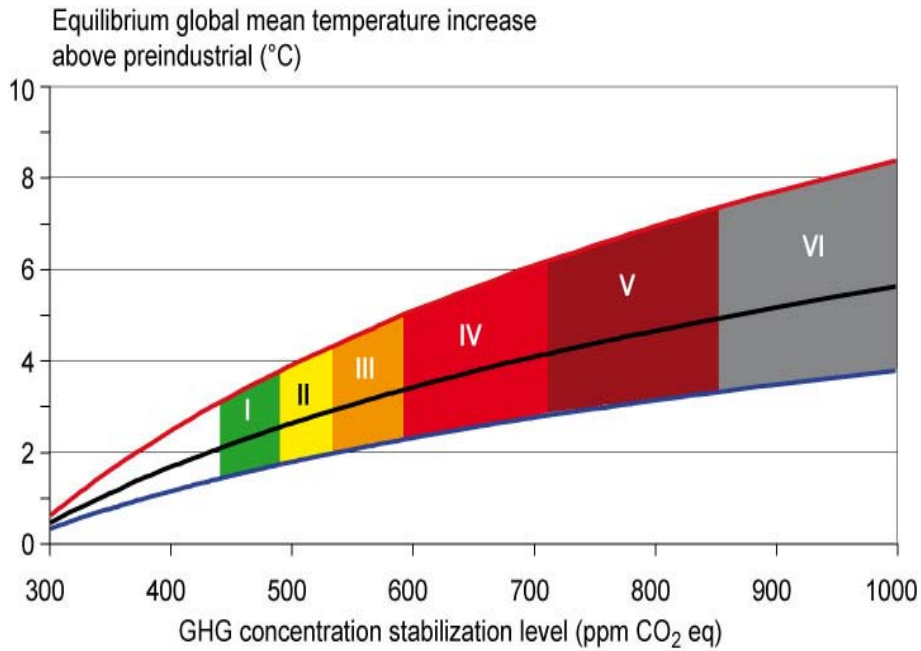
- Fossil fuel exporting nations (in both Annex I and non-Annex I countries) may expect, as indicated in TAR, lower demand and prices and lower GDP growth due to mitigation policies. The extent of this spill over depends strongly on assumptions related to policy decisions and oil market conditions

- Critical uncertainties remain in the assessment of carbon leakage. Most equilibrium modelling support the conclusion in the TAR of economy-wide leakage from Kyoto action in the order of 5-20%, which would be less if competitive low-emissions technologies were effectively diffused.

Long-term mitigation: stabilisation and equilibrium global mean temperatures

- The lower the stabilisation level the earlier global CO2 emissions have to peak





Multigas and CO2 only studies combined

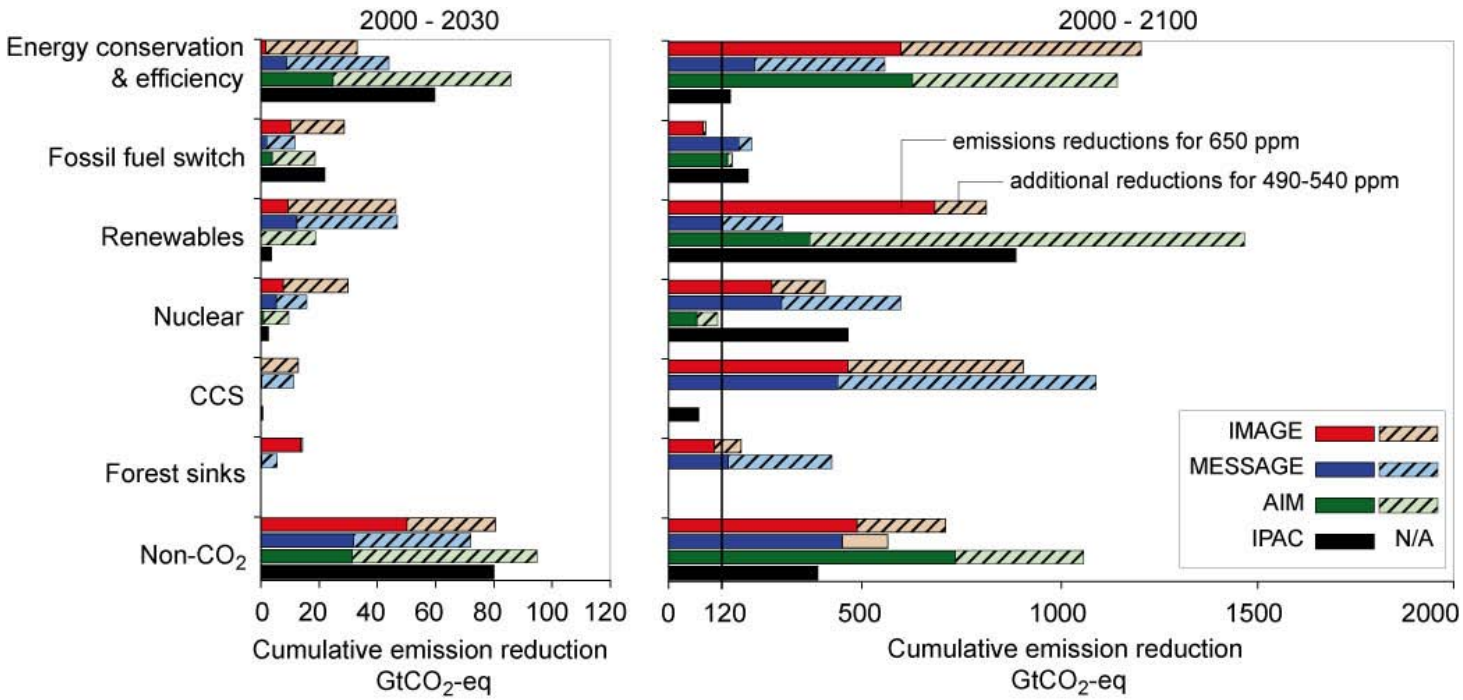
Long term mitigation (after 2030)

•Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels

Stab level (ppm CO2-eq)	Global Mean temp. increase at equilibrium (ºC)	Year CO2 needs to peak	Year CO2 emissions back at 2000 level	Reduction in 2050 CO2 emissions compared to 2000
445 – 490	2.0 – 2.4	2000 - 2015	2000- 2030	-85 to -50
490 – 535	2.4 – 2.8	2000 - 2020	2000- 2040	-60 to -30
535 – 590	2.8 – 3.2	2010 - 2030	2020- 2060	-30 to +5
590 – 710	3.2 – 4.0	2020 - 2060	2050- 2100	+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

Technology

- **The range of stabilization levels can be achieved by**
  - **deployment of a portfolio of technologies that are currently available and**
  - **those that are expected to be commercialised in coming decades.**
- **This assumes that appropriate and effective incentives are in place for development, acquisition, deployment and diffusion of technologies and for addressing related barriers**



What are the macro-economic costs in 2050?

Trajectories towards 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.

A wide variety of policies is available to governments to realise mitigation of climate change

- Studies of economic potentials show what might be achieved if *appropriate new and additional policies* were put into place to remove barriers and include social costs and benefits

- Applicability of national policies depends on national circumstances, their design, interaction, stringency and implementation

- The literature suggests that successful international agreements are *environmentally effective*, *cost-effective*, *incorporate distributional considerations and equity*, and are *institutionally feasible*

An effective carbon-price signal could realise significant mitigation potential in all sectors

- 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 CO2eq carbon prices should reach 20-80 US$/tCO2eq by 2030 (5-65 if “induced technological change” happens)
- At these carbon prices large shifts of investments into low carbon technologies can be expected

Sustainable development and climate change mitigation

- Making development more sustainable by changing development paths can make a major contribution to climate change mitigation
- Implementation may require resources to overcome multiple barriers.
- Possibilities to choose and implement mitigation options to realise synergies and avoid conflicts with other dimensions of sustainable development.

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

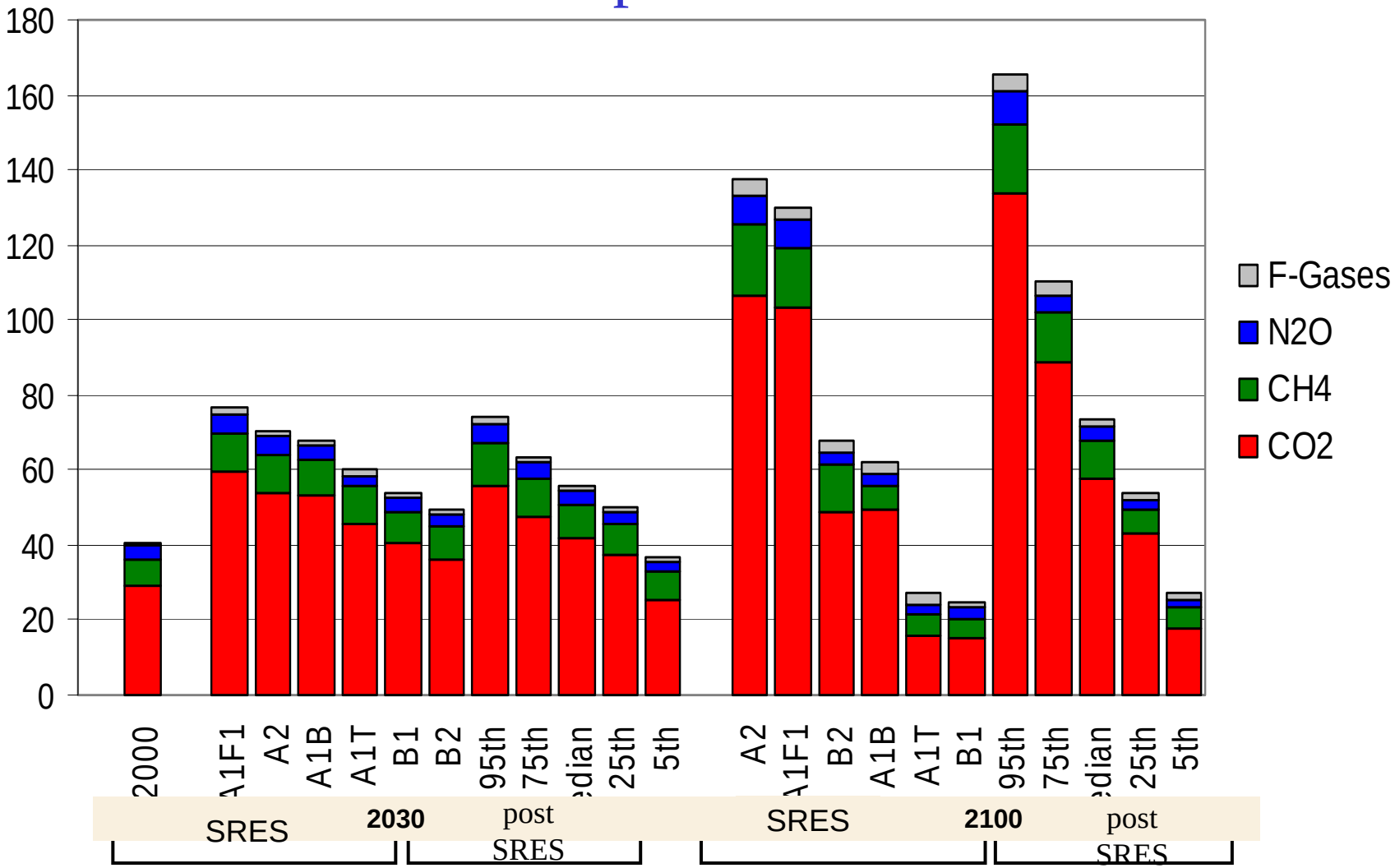
Dealing with uncertainty

High agreement, limited evidence	High agreement, medium evidence	High agreement, much evidence
Medium agreement, limited evidence	Medium agreement, medium evidence	Medium agreement, much evidence
Low agreement, limited evidence	Low agreement, medium evidence	Low agreement, much evidence

Level of agreement
(on a particular finding)

Amount of evidence
(theory, observations, models)

Global GHG emissions for 2000 and projected baseline emissions for 2030 and 2100 from IPCC SRES and the post-SRES literature

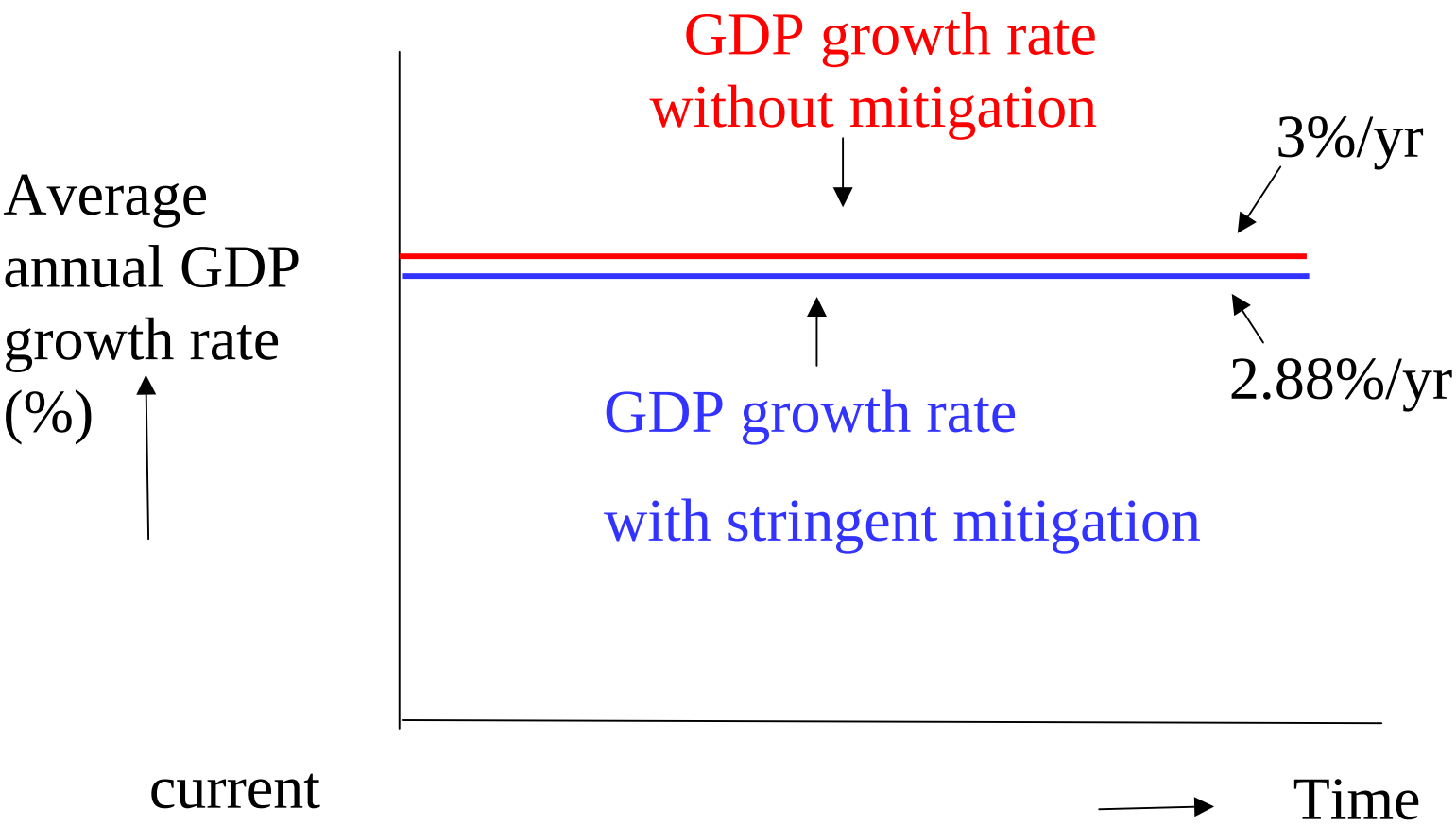


Global economic mitigation potential in 2030 (bottom-up)

Carbon price (US$/tCO$_2$-eq)	Economic mitigation potential (GtCO$_2$-eq/yr)	Reduction relative to SRES A1 B (68 GtCO$_2$- eq/yr) %	Reduction relative to SRES B2 (49 GtCO$_2$- eq/yr) %
0	5-7	7-10	10-14
20	9-17	14-25	19-35
50	13-26	20-38	27-52
100	16-31	23-46	32-63

***Table SPM 1**: Global economic mitigation potential in 2030 estimated from bottom-up studies.*

Illustration of cost numbers



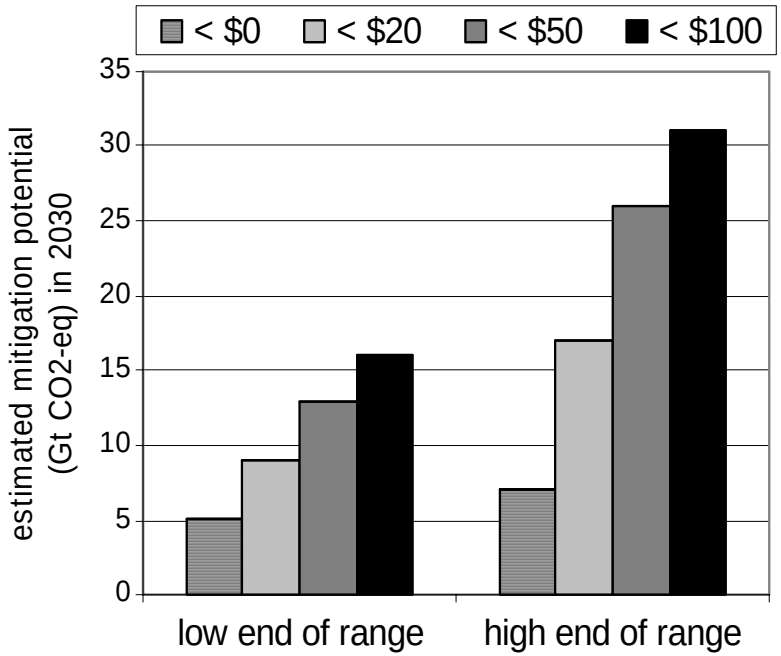
Sectors in WGIII Report

- Energy Supply
- Transport
- Buildings
- Industry
- Agriculture
- Forestry
- Waste Management

Global economic mitigation potential in 2030 (top-down)

Carbon price (US/tCO_2-eq)	Economic potential ($GtCO_2$-eq/yr)	Reduction relative to SRES A1 B (68 $GtCO_2$ eq/yr) %	Reduction relative to SRES B2 (49 $GtCO_2$ eq/yr) %
20	9-18	13-27	18-37
50	14-23	21-34	29-47
100	17-26	25-38	35-53

***Table SPM.2**: Global economic potential in 2030 estimated from top-down studies.*



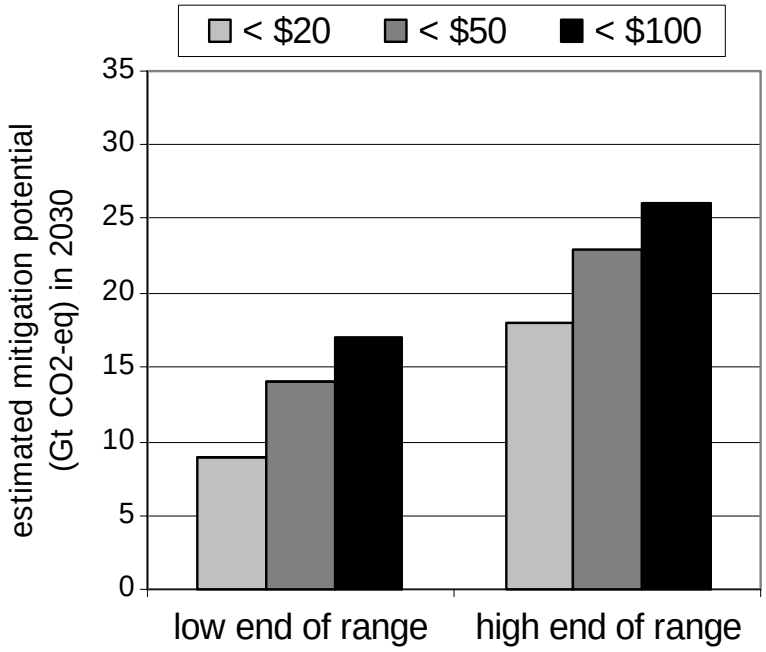
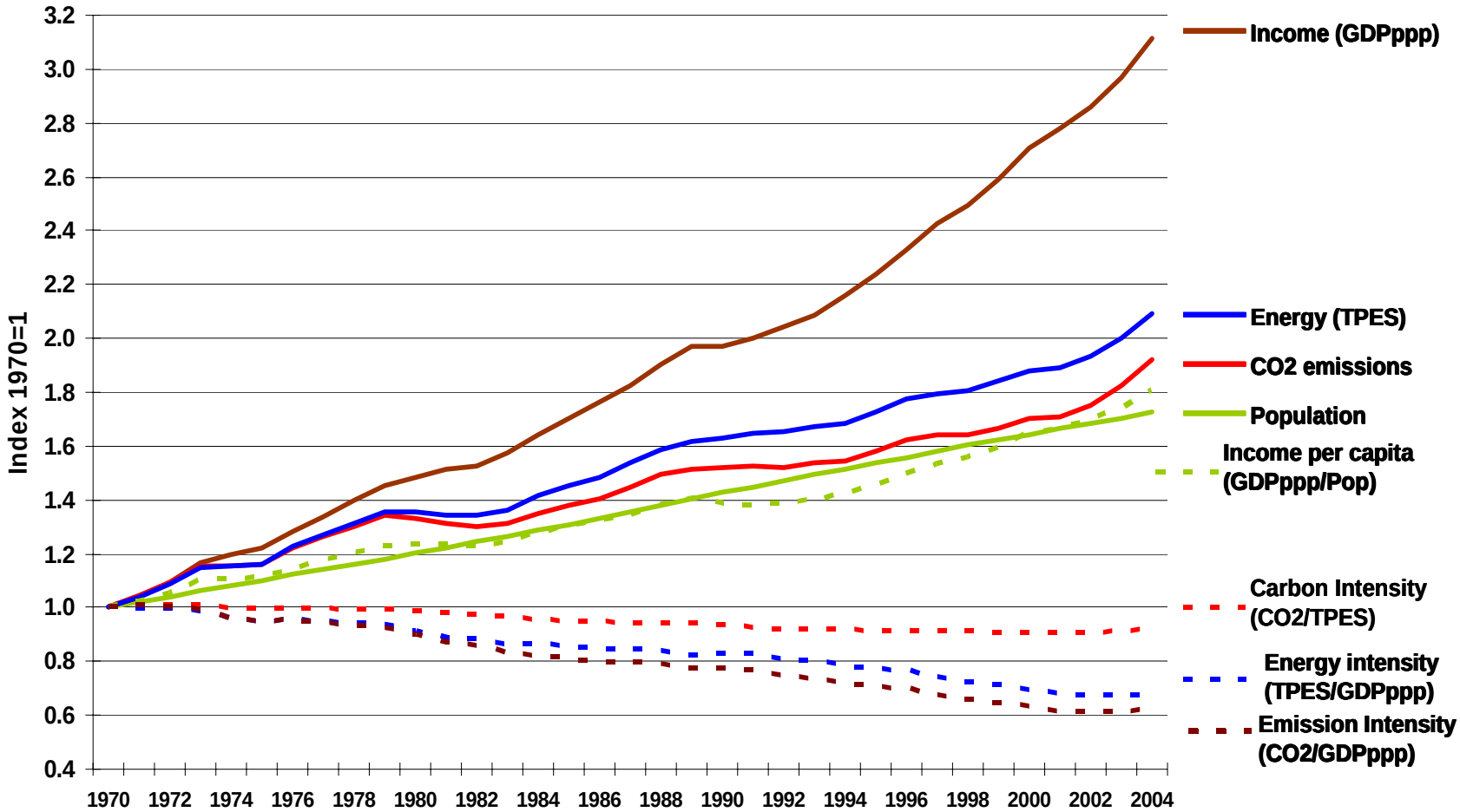


Figure SPM 5A: *Global economic potential in 2030 estimated from bottom-up studies (data from Table SPM 1)*	***Figure SPM 5B:*** *Global economic potential in 2030 estimated from top-down studies (data from Table SPM 2)*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3.2
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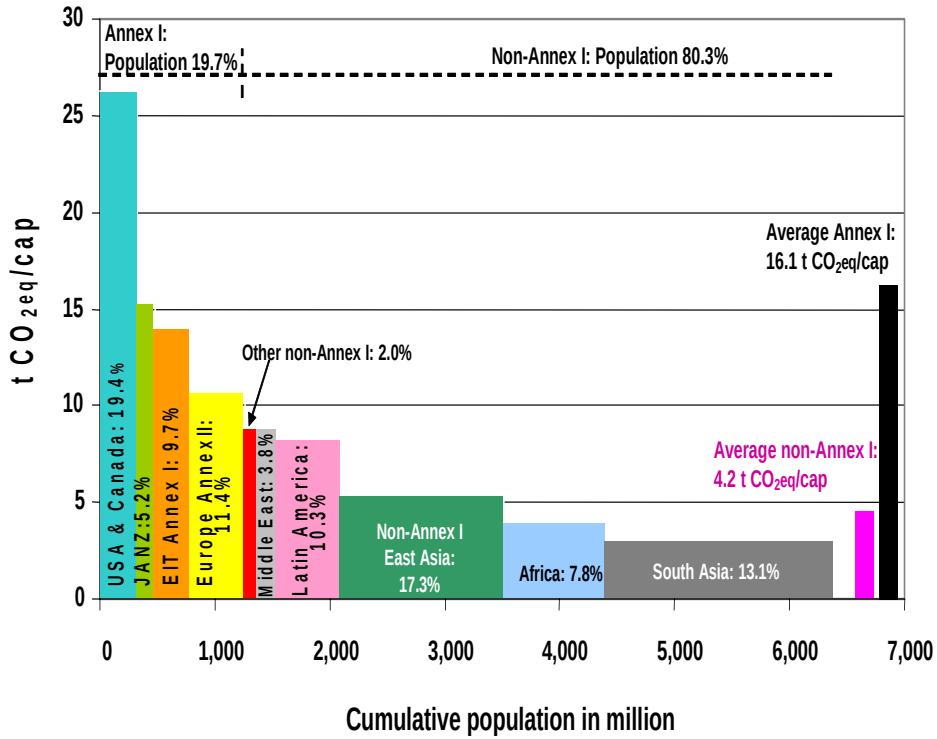
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004
Income (GDPppp)
Energy (TPES)
CO2 emissions
Population
Income per capita (GDPppp/Pop)
Carbon Intensity (CO2/TPES)
Energy intensity (TPES/GDPppp)
Emission Intensity (CO2/GDPppp)



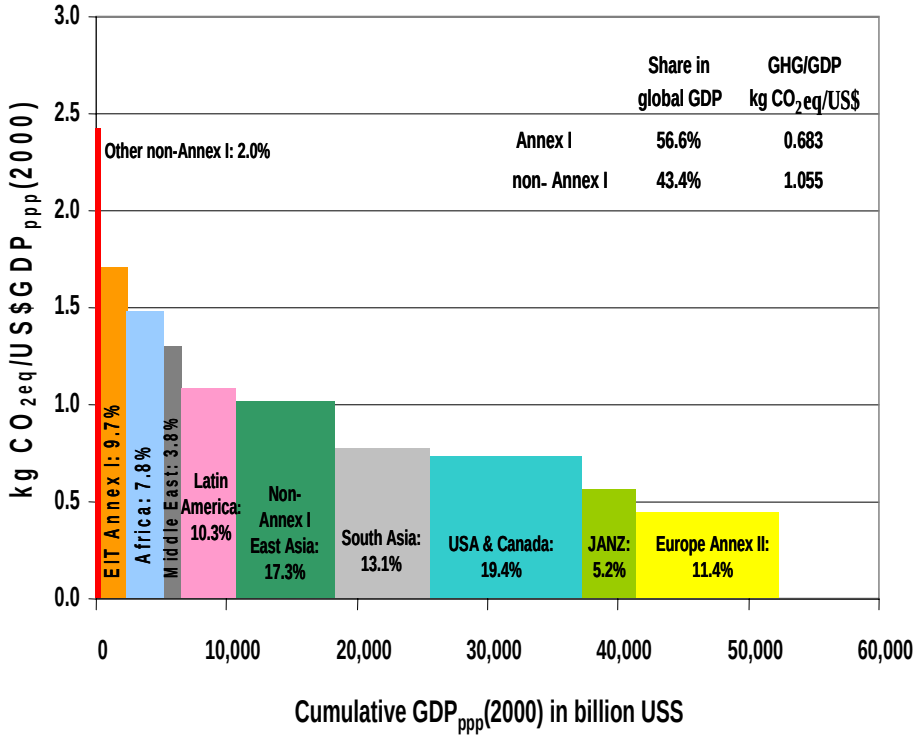


***Figure SPM 3a**: Year 2004 distribution of regional per capita GHG emissions (all Kyoto gases, including those from land-use) over the population of different country groupings. The percentages in the bars indicate a regions share in global GHG emissions [Figure 1.4a].*

***Figure SPM 3b:** Year 2004 distribution of regional GHG emissions (all Kyoto gases, including those from land-use) per US$ of GDP_{ppp} over the GDP_{ppp} of different country groupings. The percentages in the bars indicate a regions share in global GHG emissions [Figure 1.4b].*

Selected sectoral policies, measures and instruments that have shown to be environmentally effective

Sector	**Policies[1], measures and instruments shown to be environmentally effective**	**Key constraints or opportunities**
Energy supply	Reduction of fossil fuel subsidies	Resistance by vested interests may make them difficult to implement
	Taxes or carbon charges on fossil fuels	
	Feed-in tariffs for renewable energy technologies	May be appropriate to create markets for low emissions technologies
	Renewable energy obligations	
	Producer subsidies	

[1] Public RD&D investment in low emission technologies have proven to be effective in all sectors.

Selected sectoral policies, measures and instruments that have shown to be environmentally effective

Sector	**Policies[1], measures and instruments shown to be environmentally effective**	**Key constraints or opportunities**
Transport	Mandatory fuel economy, biofuel blending and CO_2 standards for road transport	Partial coverage of vehicle fleet may limit effectiveness
	Taxes on vehicle purchase, registration, use and motor fuels, road and parking pricing	Effectiveness may drop with higher incomes
	Influence mobility needs through land use regulations, and infrastructure planning	Particularly appropriate for countries that are building up their transportation systems
	Investment in attractive public transport facilities and non-motorised forms of transport	

[1] Public RD&D investment in low emission technologies have proven to be effective in all sectors.

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 CO2-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.

The process

- Three year process
- Assessment of published literature
- Extensive review by independent and government experts
- Summary for Policy Makers approved line-by-line by all IPCC member governments (Bangkok, May 4)
- Full report and technical summary accepted without discussion

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

Stabilisation levels and equilibrium global

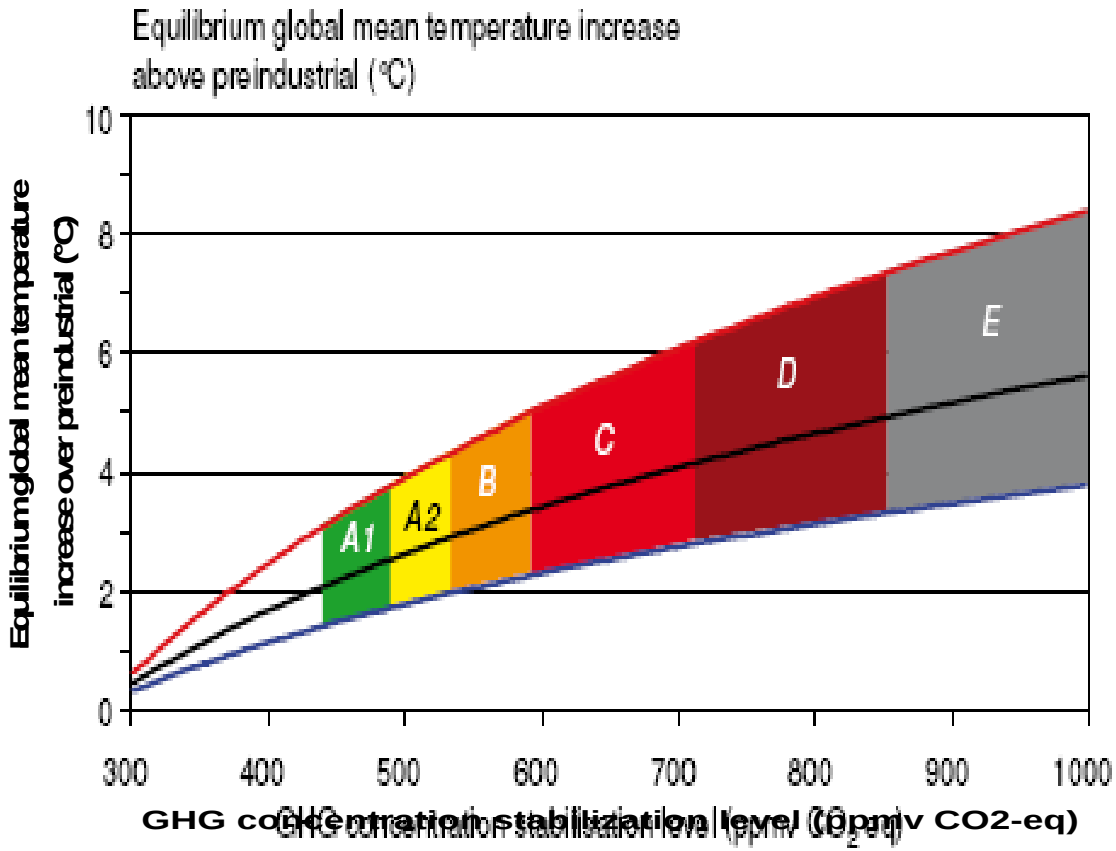


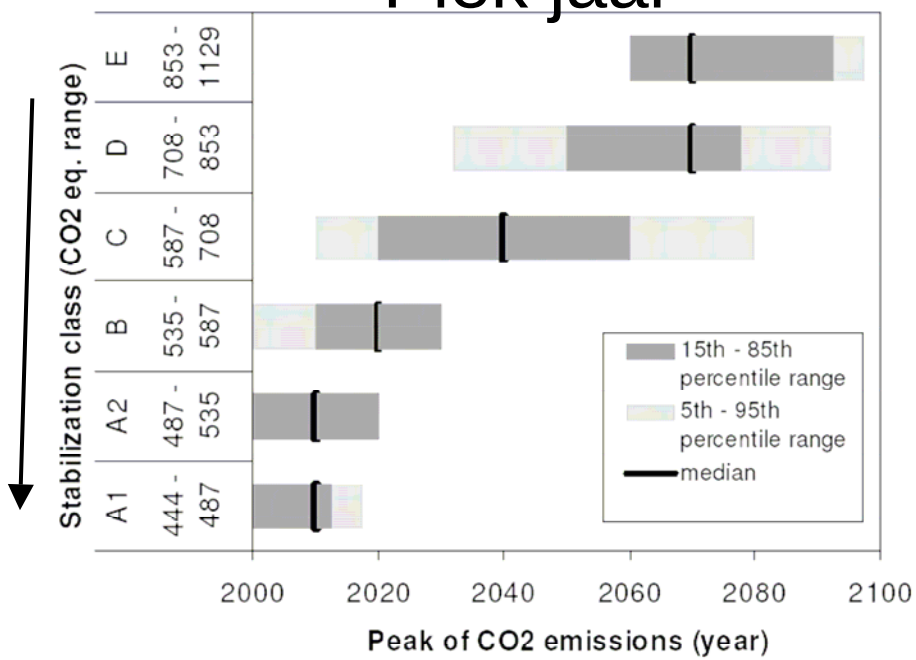
***Figure SPM 8**: Stabilization scenario categories as reported in Figure SPM.7 (coloured bands) and their relationship to equilibrium global mean temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3˚ C (black line in middle of shaded area), (ii) upper bound of likely range of climate sensitivity of 4.5˚ C (red line at top of shaded area) (iii) lower bound of likely range of climate sensitivity of 2˚ C (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.*

How can emissions be reduced?

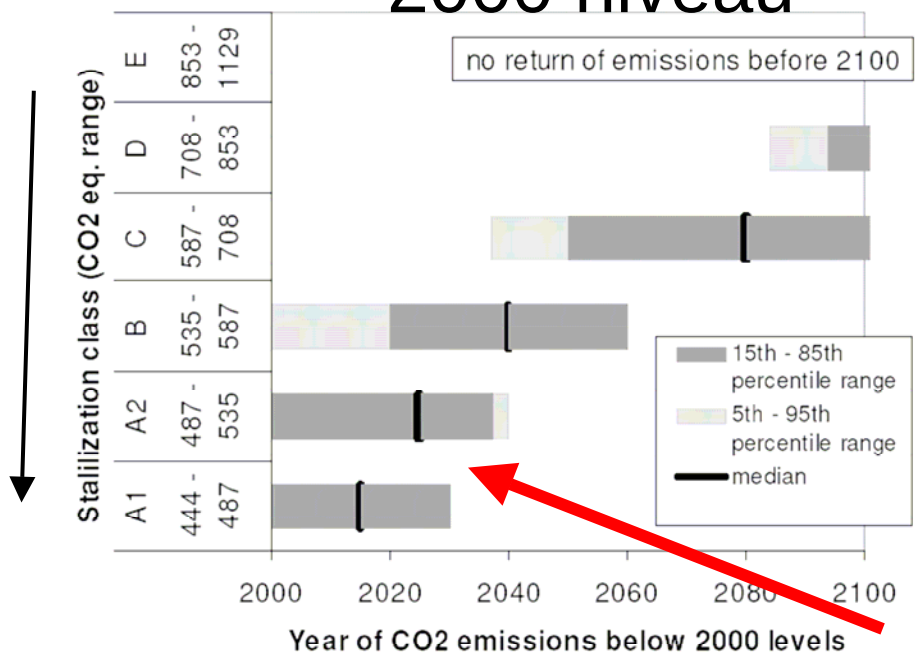
Sector	**(Selected) Key mitigation technologies and practices currently commercially available.**
Energy Supply	efficiency; fuel switching; nuclear power; renewable (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of CO2 Capture and Storage
Transport	More fuel efficient vehicles; hybrid vehicles; biofuels; modal shifts from road transport to rail and public transport systems; cycling, walking; land-use planning
Buildings	Efficient lighting; efficient appliances and airco; improved insulation ; solar heating and cooling; alternatives for fluorinated gases in insulation and aplliances

Emissie reducties voor lange-termijn stabilisatie

Piek jaar



2000 niveau



- Hoe lager het stabilisatie niveau, hoe sneller wereldemissies door een piek moeten gaan – en daarna moeten worden gereduceerd.
- Voor lagere stabilisatieniveau's zijn de reductie activiteiten in de komende 1-2 decennia's cruciaal

How can emissions be reduced?

Sector	**(Selected) Key mitigation technologies and practices currently commercially available.**
Industry	More efficient electrical equipment; heat and power recovery; material recycling; control of non-CO_2 gas emissions
Agriculture	Land management to increase soil carbon storage; restoration of degraded lands; improved rice cultivation techniques; improved nitrogen fertilizer application; dedicated energy crops
Forests	Afforestation; reforestation; forest management; reduced deforestation; use of forestry products for bioenergy
Waste	Landfill methane recovery; waste incineration with energy recovery; composting; recycling and waste minimization