IPCC WG3 2007, Chapter 11: Mitigation from a cross-sectoral perspective

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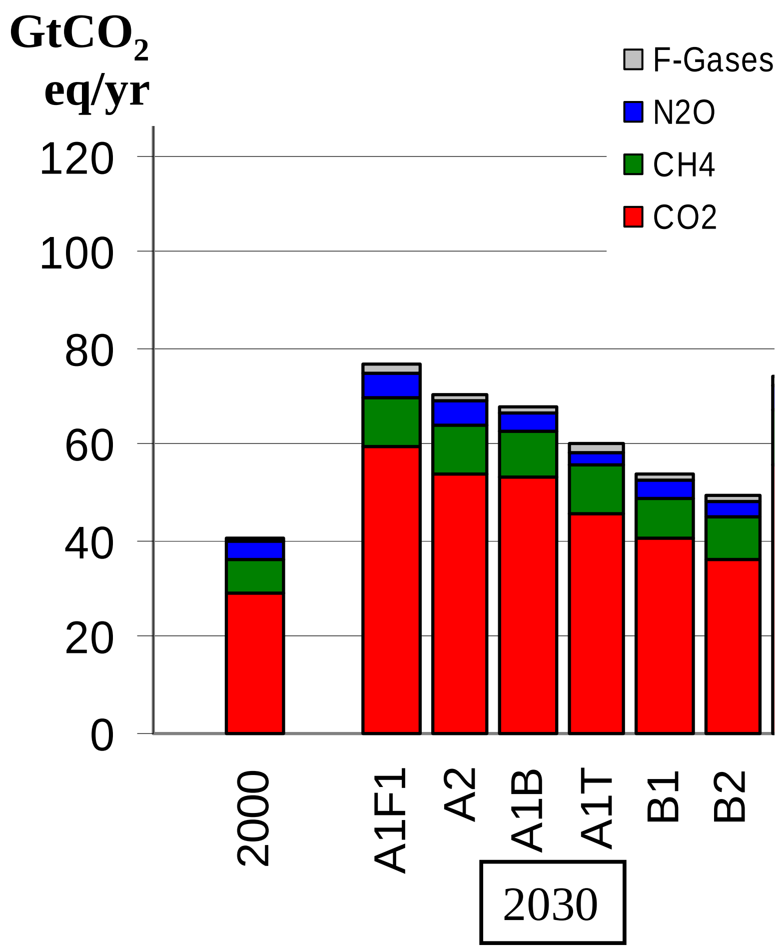
Chapter 11 overview

1. Emission reduction (mitigation) potentials and associated costs:
    - Summarises and aggregates sectoral estimates of the economic potentials and costs of mitigation covered in Chapters 4 to 10
    - extends them to allow for interactions between sectors and technologies and unconventional technologies.
    - Compares bottom-up and top-down estimates at different carbon prices
    - Assesses macroeconomic costs, spillovers and co-benefits of action.
2. Assesses short and medium-term implications of long-term stabilization scenarios covered in Chapter 3
3. Analyses technological change and its relationship to policies including carbon prices
4. Other dimensions (eg. Investment, portfolios, carbon leakage)

With current policies, global GHG emissions will continue to grow over the next few decades

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



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:

- ***Market potential:*** the mitigation potential based on private costs and private 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:*** **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.**

Understanding mitigation potentials

- Measured in Giga tonnes CO_2-equivalent a year ($GtCO_2$-eq/yr)
- World-wide, or for countries or sectors as specified
- Defined for given carbon costs
  - expressed as $(2000 prices) per tonne CO_2-equivalent (US$/$tCO_2$-eq)
- A measure of minimum "social cost" of a given level of GHG reductions
- The potential does not specify anything about the instruments used to implement reduction: could be implemented in various ways, but in a market economy:
  - where markets are well functioning, a carbon price would generally be the most efficient way of implementing such reductions *if there are not other barriers and distortions (see Chapter 13)*
  - Mitigation potential identified at 'zero cost' indicates presence of barriers that would need to be addressed to secure the associated reductions
  - Other policy approaches may increase costs for given level of mitigation
- Most of the potentials discussed are economic potentials, at four illustrative carbon price levels:
  - 0, 20, 50 and 100 US$/$tCO_2$-eq

Memo: Relationship between $50/t$CO_2$ and US fuel prices

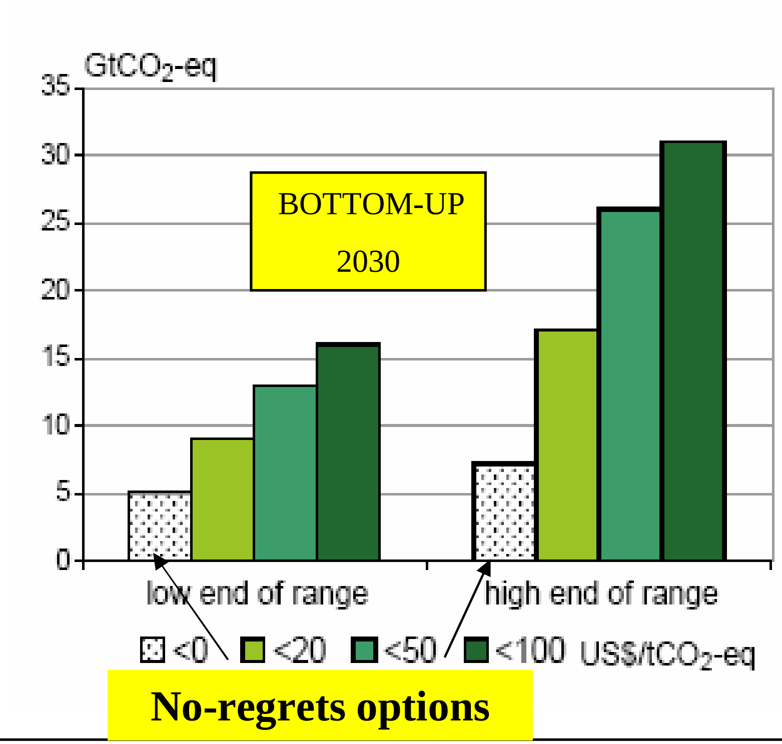
		2005 base	Added cost of $50/t$CO_2$	
		$	$	%
Crude Oil	($/bbl)	60	22.4	37%
Regular Gasoline	($/gal)	2.39	0.48	20%
Heating Oil	($/gal)	2.34	0.53	23%
Wellhead Natural gas	($/tcf)	10.17	2.73	27%
Residential Natural gas	($/tcf)	15.3	2.75	18%
Utility Coal	($/short ton)	32.6	101.4	311%
Electricity	(c/kWh)	9.6	3.23	34%

Source: Derived from Table ES.5, US CCSP, 2006, sourced in turn from Bradley et al. 1991, updated with U.S. average prices for the 4th quarter of 2005 as reported in DOE, 2006.
Note: This table does not include any adjustments in producer prices due to changes in energy demands under stabilization.

Two main modelling approaches to estimating mitigation potentials

- **Bottom-up** syntheses aggregate economic potentials estimated from technology assessments
- **Top-down** studies use economic models to look at response to implicit carbon price; the underlying assumptions may use technology information, and/or econometric data on past responses of energy & emissions to price changes (=> elasticities)
- By construction, most top-down models cannot yield ‘no regret’ (negative cost) options because they assume no-regret options already taken up in ‘baseline’; bottom-up models do not have this underlying assumption

‘No regrets’ options drive greater estimated potentials from ‘high end’ bottom-up models, but other parts of mitigation potentials comparable across approaches



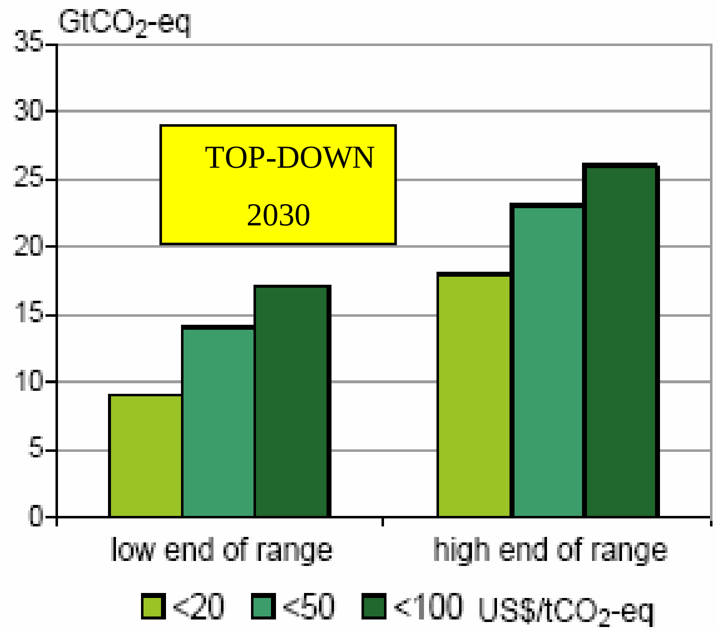
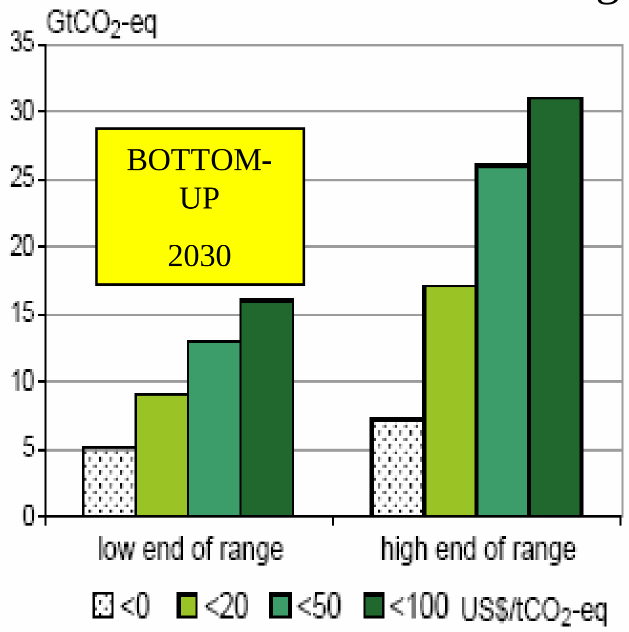


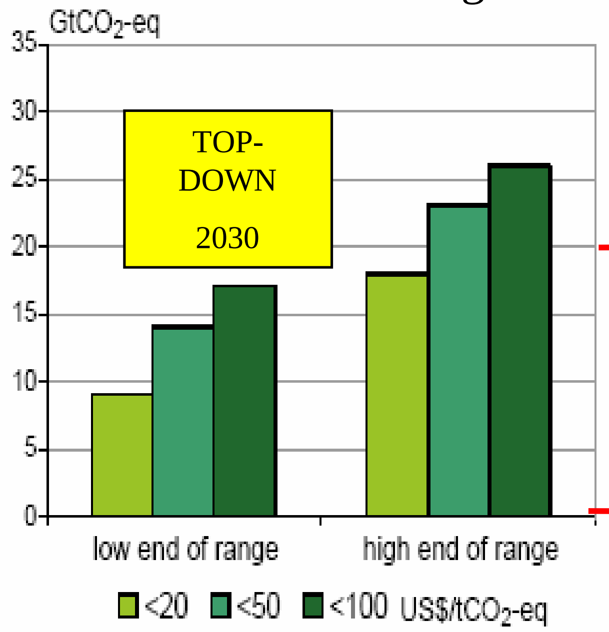
Figure SPM 5A: *Global economic potential in 2030 estimated. Cost categories in US$/tCO2eq.*	***Figure SPM 5B:*** *Global economic potential in 2030 Cost categories in US$/tCO2eq..*

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

Uncertainty about costs of returning emissions to current levels (by 2030) driven by uncertainties in both mitigation potentials and baselines

- eg. 20GtCO2eq sufficient against half the baselines
- Outside 'lower end' ranges, within US$20-50/tCO2 higher end





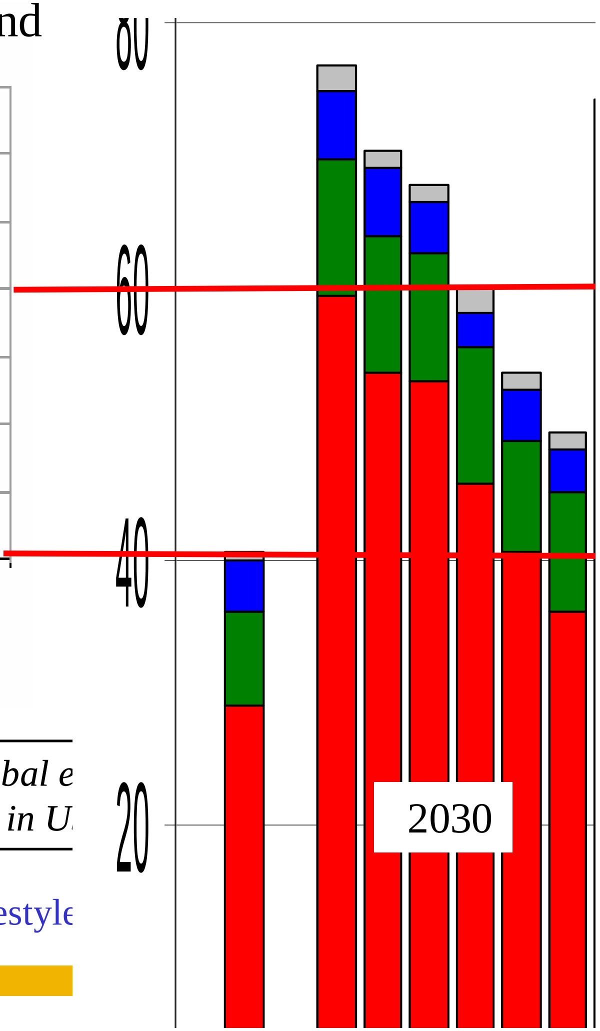
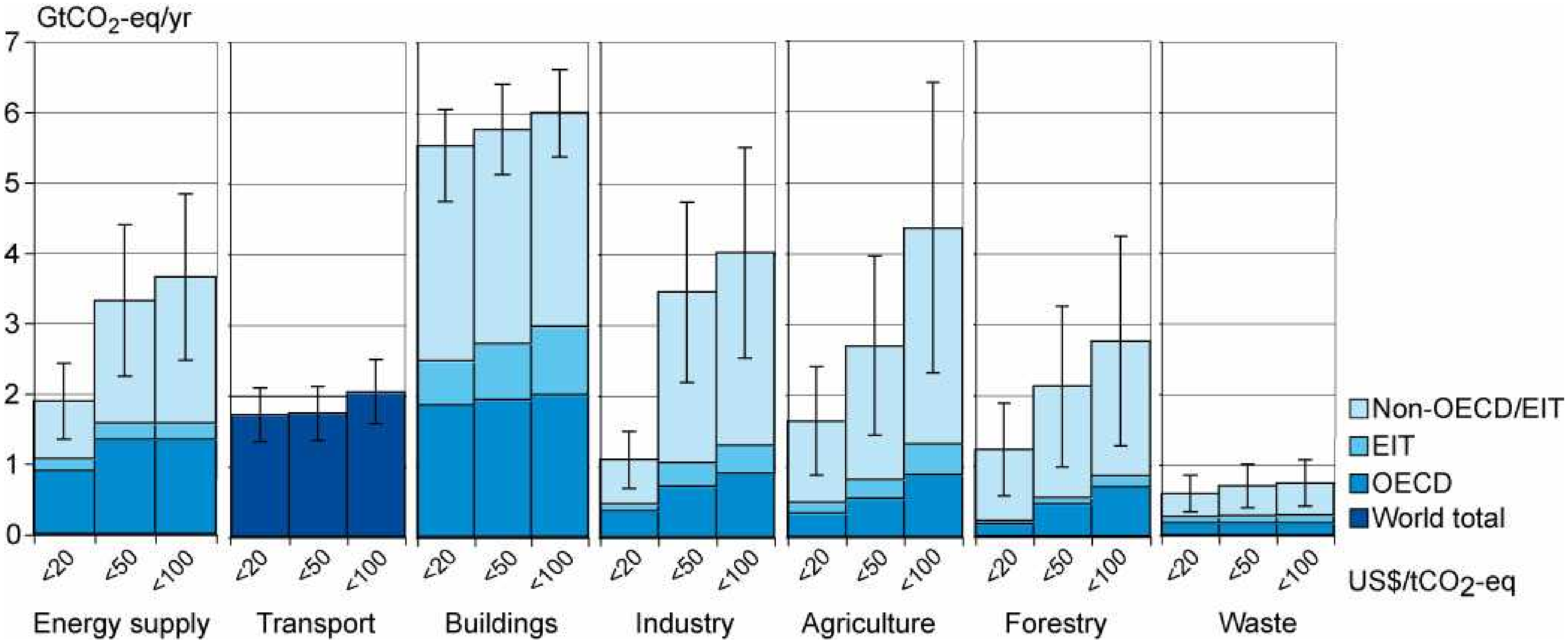


Figure SPM 5A:*Global economic potential in 2030 estimated. Cost categories in US$/tCO2eq.*	***Figure SPM 5B:*** *Global e 2030 Cost categories in U.*

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

All sectors and regions have the potential to contribute (end-use based)

‘no-regret’ potential dominates in buildings



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

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Part II:

- Mitigation in relation to atmospheric stabilisation

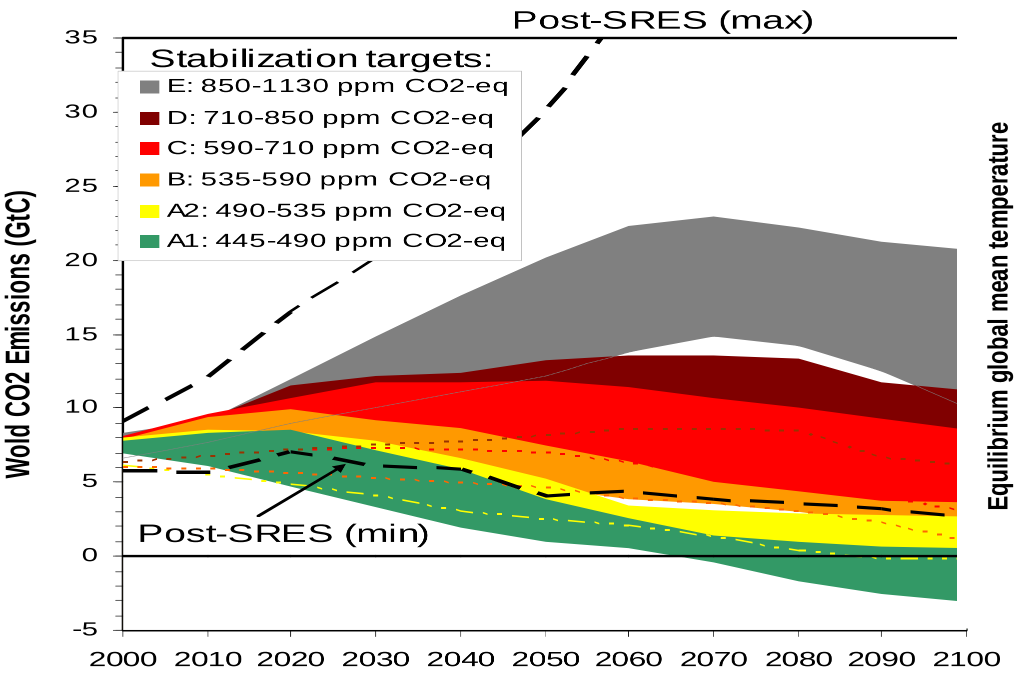
Long-term mitigation

- 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

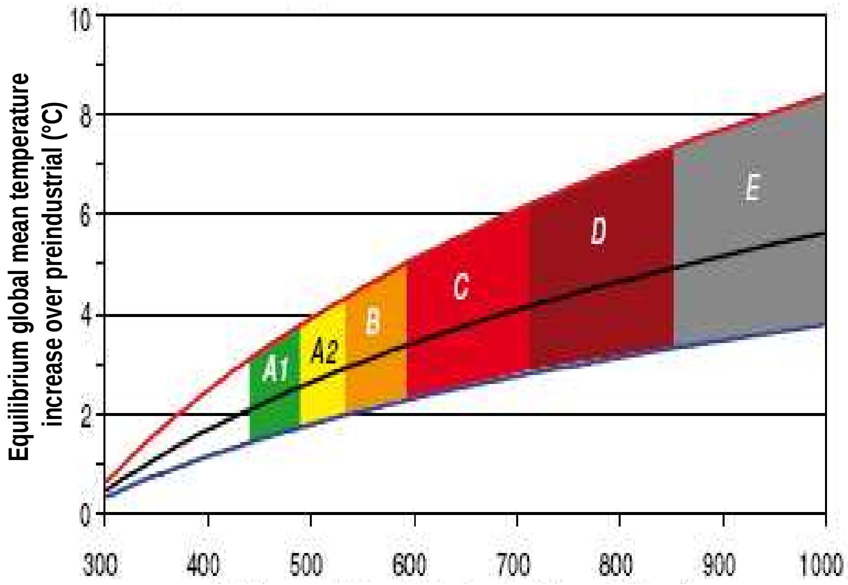
	Stabilization level (ppm CO_2-eq)	Global Mean equilibrium temp.increase°C	Year CO_2 needs to peak	% reduction in 2050 compared to 2000
A1	445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50
A2	490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30
B	535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5
C	590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60
D	710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85
E	855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140

The lower the stabilisation level, the earlier global emissions have to go down

Global CO_2 in GtC



Mean temperatures °C



Multigas and CO2 only studies combined

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

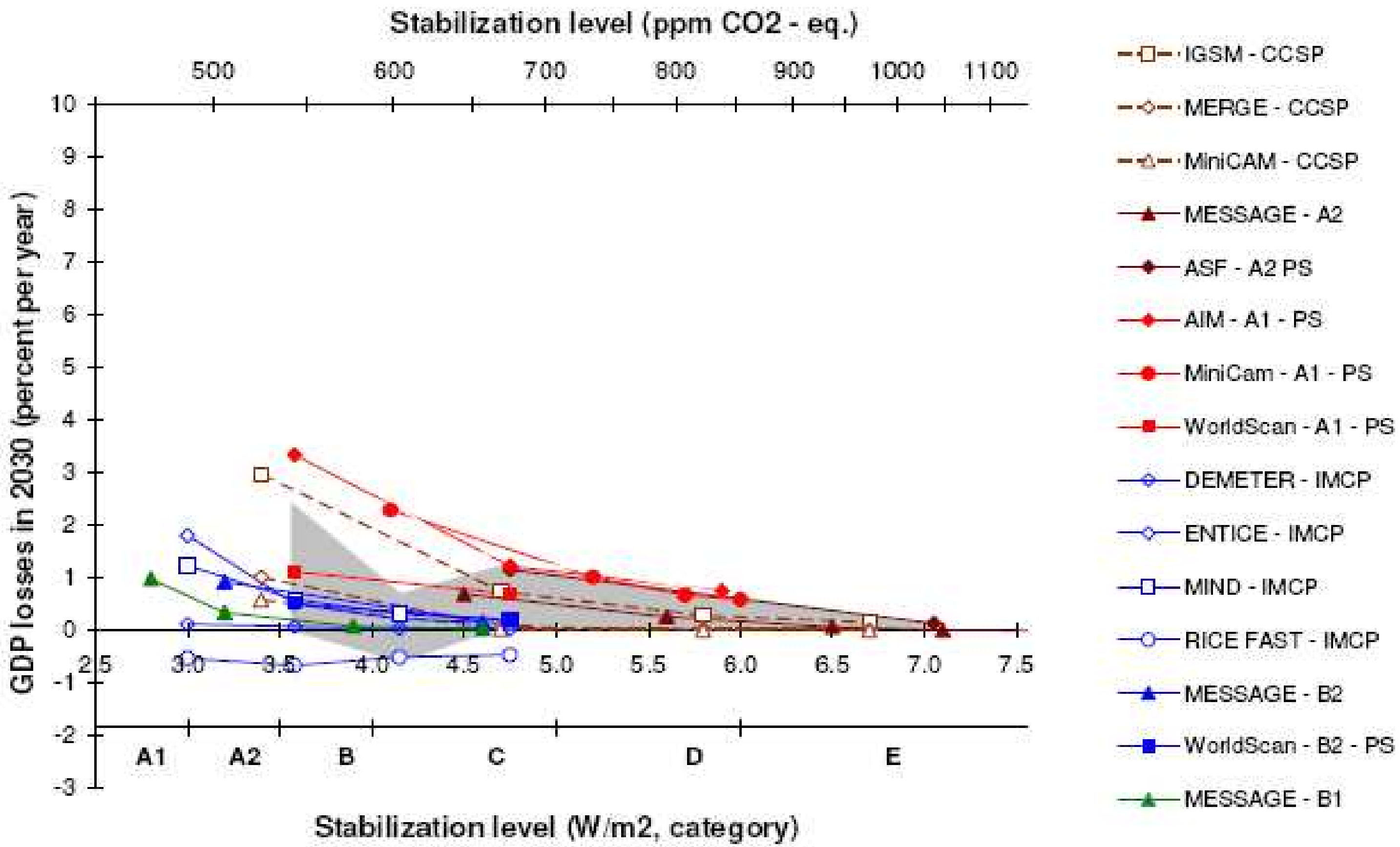
Stabilization levels (ppm CO_2-eq)	Median GDP reduction[1] (%)	Range of GDP reduction [2] (%)	Reduction of average annual GDP growth rates [3] (percentage points)
590-710	0.2	-0.6 – 1.2	< 0.06
535-590	0.6	0.2 – 2.5	<0.1
445-535[4]	**Not available**	**< 3**	**< 0.12**

[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.**

These net costs and ranges come for modeling studies that assume efficient markets etc. They do not include net environmental and other co-benefits, which can be substantial.

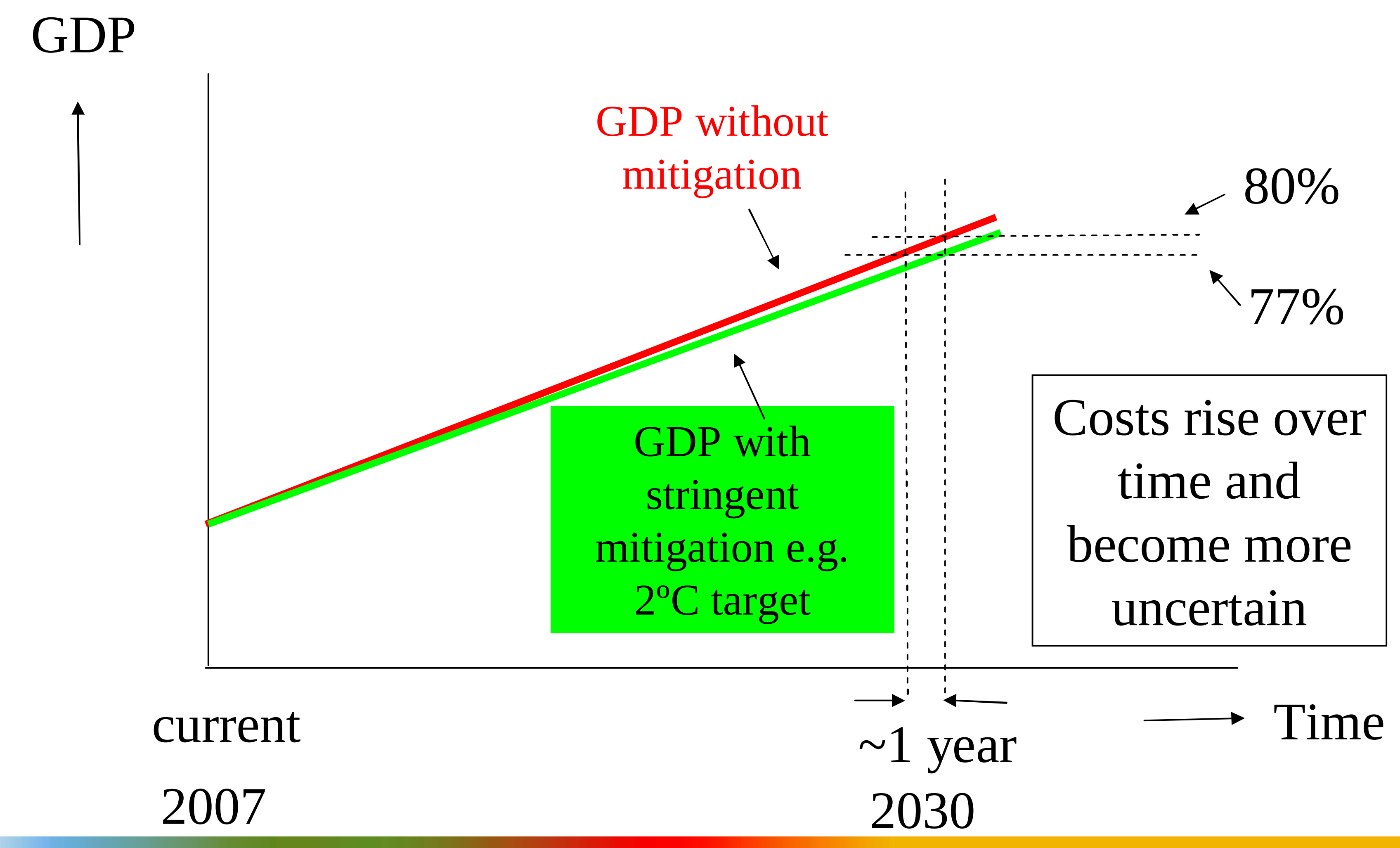
Across a wide range models, costs rise for more stringent stabilisation levels up to c. 3% GDP max by 2030 for A2/B levels

Most studies for stringent stabilization (categories A1 and A2) show costs less than 3%



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

Illustration of the 3% cost number



Part III:

- Technological change and carbon prices

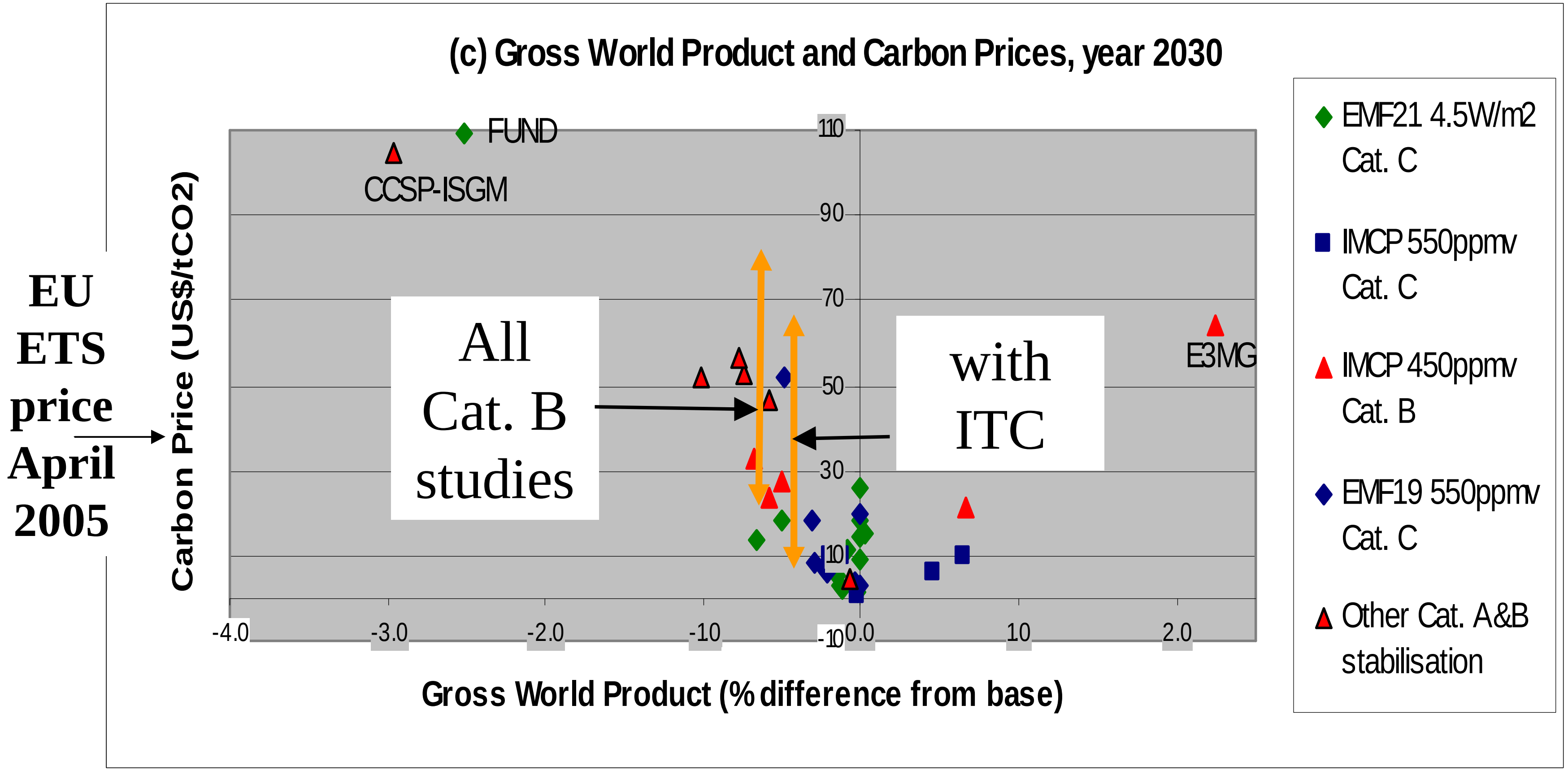
The role of technology policies

- Deployment of low-GHG technologies and RD&D would be required for achieving stabilization targets and cost reduction.
- The lower the stabilization levels, especially 550 ppmCO_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.
- Various incentives including carbon prices will also affect private sector investment in innovation
- Memo:
  - 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.

Representing technological change in global scenarios

- 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.

Macro-economic costs by 2030 in relation to carbon prices



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

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
  - See Chapter 13 for discussion of associated policy instruments

- For stabilisation at around 550 ppm CO_2eq, carbon prices predicted to be required:
  - 'predictable and ongoing increase to reach 20-50 US$/CO2 by 2020-30'
  - '20-80 US$/t$CO_2$eq by 2030'
  - '5-65 US$/t$CO_2$eq by 2030' if more technological change is induced by policies
- At the higher levels in these price ranges, large shifts of investment into low carbon technologies can be expected

Part IV:

- Other cross-sectoral dimensions

There are various potential co-benefits / side-effects 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
  - provision of modern energy services to rural areas and employment
  - spill-overs from development of low-carbon technologies

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" from price changes).

Investment and capital stock

- Analysis of decision-making under uncertainty emphasises that uncertainty tends to increase need for stronger early action, particularly regarding long-lived capital stock and associated innovation
- Energy sector infrastructure *in reference ('business-as-usual')* cases projected to require US$20trillion by 2030:
  - Options for stabilisation will be heavily constrained by the nature and carbon intensity of this investment
- Lower carbon scenarios show a large *redirection* of this investment, with net *additional* investment 'from negligible to less than 5%' *(high agreement, much evidence)*

Policy and options portfolios

- Short term pathways towards lower stabilisation would require many additional measures around energy efficiency low carbon energy supply, avoidance of carbon-intensive long-lived capital stock (eg. in buildings)
- Portfolios of energy options that include low-carbon options will reduce risks and ‘portfolio costs’, because fossil fuel prices are expected to be more uncertain and volatile than alternatives
- Costs will be reduced if policy combines carbon prices with measures to support innovation, for example by using revenues from emission permit auctions to support energy efficiency and low carbon innovations (high agreement, medium evidence)

Competitiveness, carbon leakage and fossil fuel markets

- Model-based estimates of 'carbon leakage' from implementing Kyoto Protocol commitments in range 5-20% (ie. 5-20% of domestic reductions may be offset by displacement abroad) *(medium agreement, medium evidence)*
- Empirical studies on energy-intensive industries under the EU ETS conclude that carbon leakage is 'unlikely to be substantial' due to transport costs , local market conditions, product specialisation of local suppliers, etc *(medium agreement, medium evidence)*
- Not possible to quantify possible benefits of international transfer of low carbon technologies induced by industrialised country action
- Other leakage impacts arising from impact on fossil fuel markets: mitigation will tend to reduce global fossil fuel demand: oil, gas or coal prices may fall, reducing payments by energy importers and consequently revenue to energy exporters *(high agreement, limited evidence)*

Chapter 11: cross-cutting mitigation – some high-level conclusions

- Emission reduction (mitigation) potentials and associated costs
  - Significant potential but spread across wide range of sectors
  - Costs small relative to economic growth (but still big numbers absolute)
- Short and medium-term implications of long-term stabilization scenarios
  - 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
- Technological change and carbon prices
  - Diversity of technology-supporting measures required
  - Improved but still very incomplete understanding of relationship between carbon pricing and technology investment/innovation
- Other dimensions (eg. Co-benefits, investment, portfolios, carbon leakage)
  - Are all significant issues, additional to the pure cost measures
  - *Additional* investment need is small relative to the *reorientation* of investment towards lower carbon pathways and associated innovation
  - Core policy issue is what package of measures, domestically and internationally, (Ch.13) can achieve this consistent with stabilisation scenarios

The Summary for Policy Makers , the Technical Summary and the full Report (subject to editing) can be downloaded from

www.mnp.nl/ipcc

Further information:

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