Tyndall°Centre
for Climate Change Research

Achieving the 2°C Target through Carbon Trading

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Royal Society of Chemistry Invited Lecture

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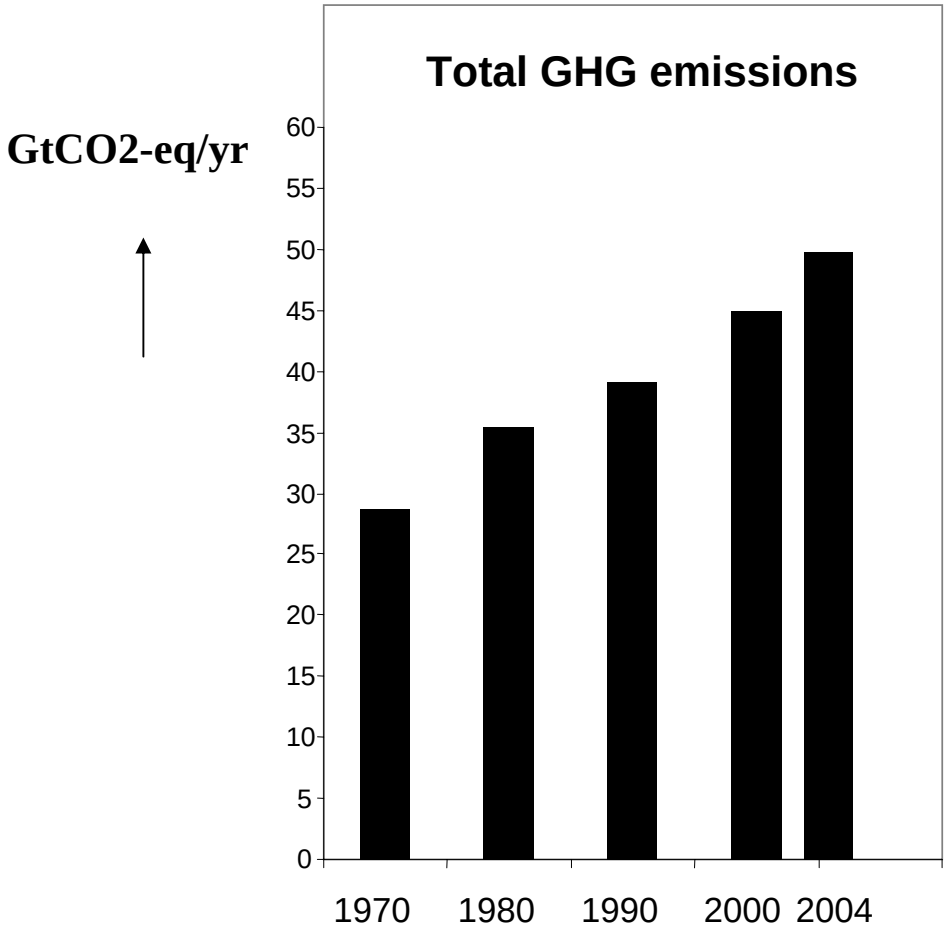
Outline

1. The science and the 2˚C target for climate stabilization
2. Implications for “dangerous” climate change
3. The EU carbon market
4. Carbon trading in policy portfolios
5. Mitigation costs and potentials
6. Costs of achieving the 2˚C target (and benefits)
7. Conclusions for UK action

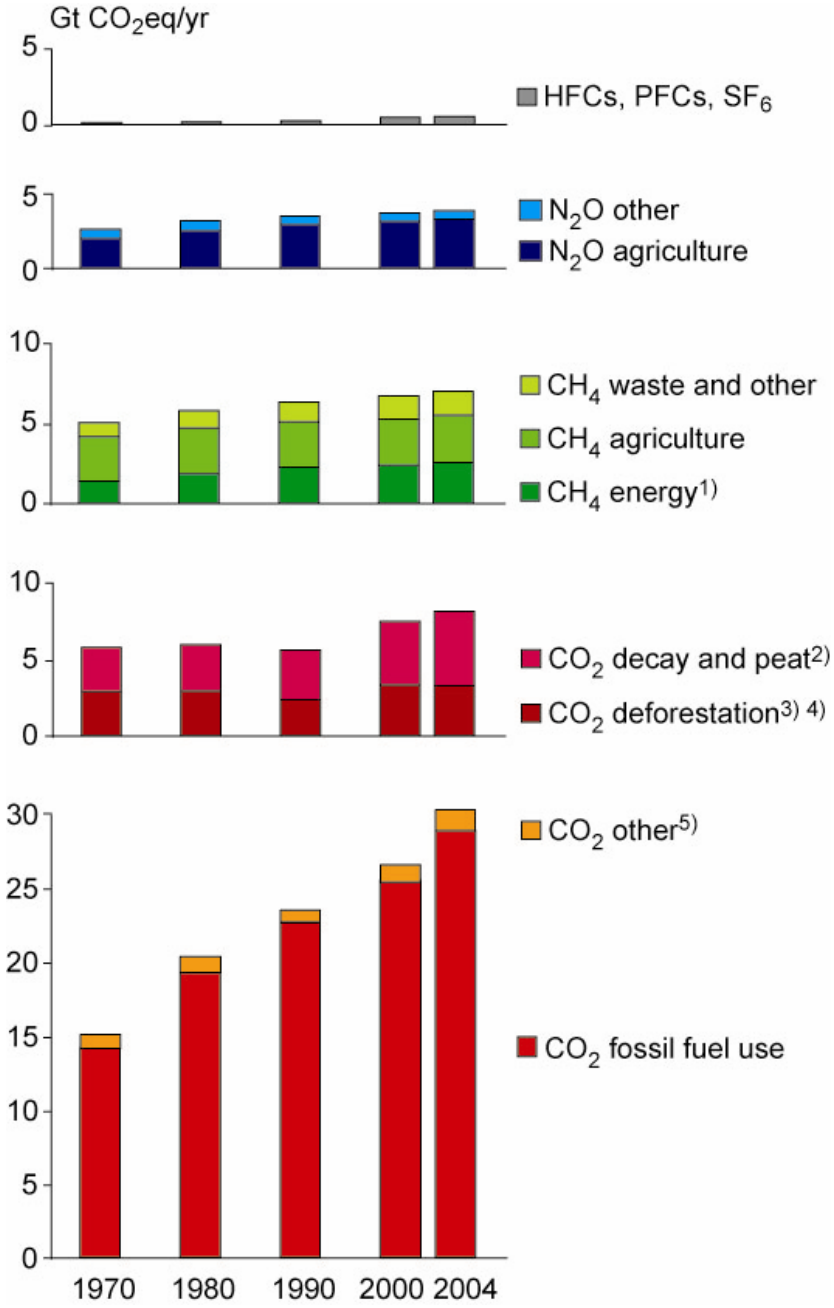
Acknowledgements
Parts of this presentation come from the IPCC WG III Summary for Policy Makers, unless otherwise stated. The comments are my own.

Trends in global GHG emissions



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

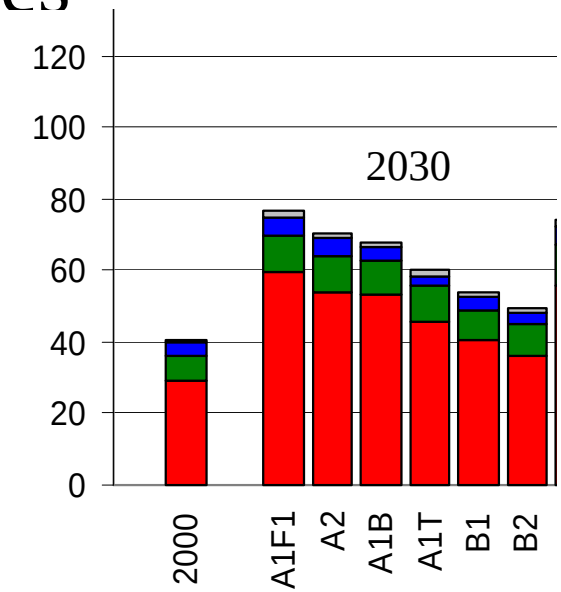
Carbon dioxide is the largest contributor



Future emissions will grow further

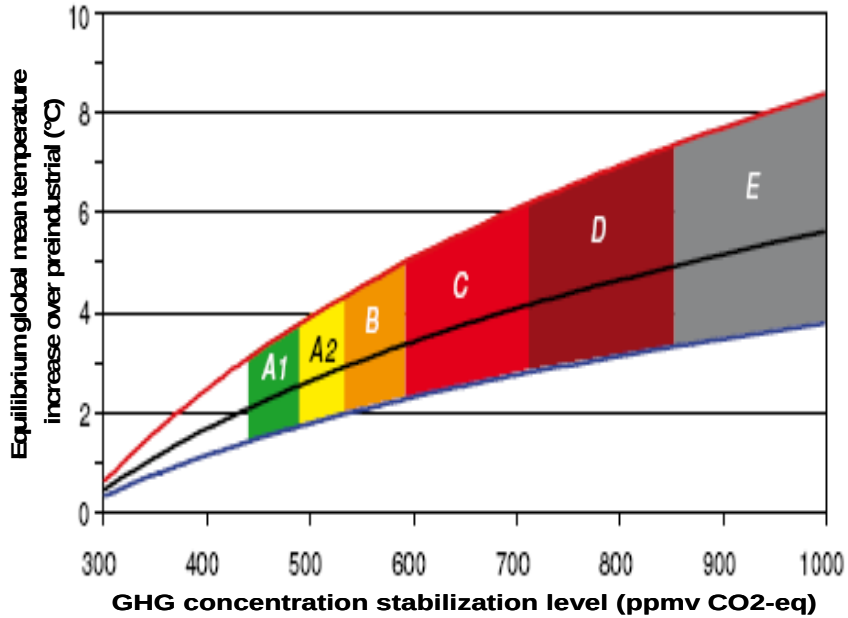
- With current climate-change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades

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



The key question: can “dangerous anthropogenic climate change” be avoided?

EU interpretation:
global mean temperature increase at less than 2ºC above pre-industrial level

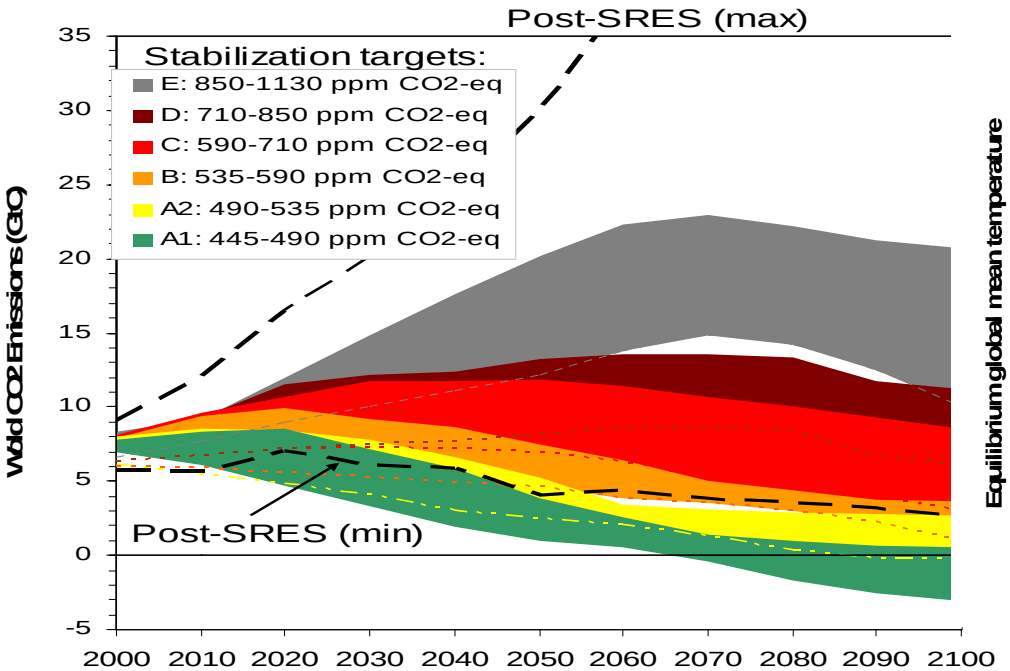


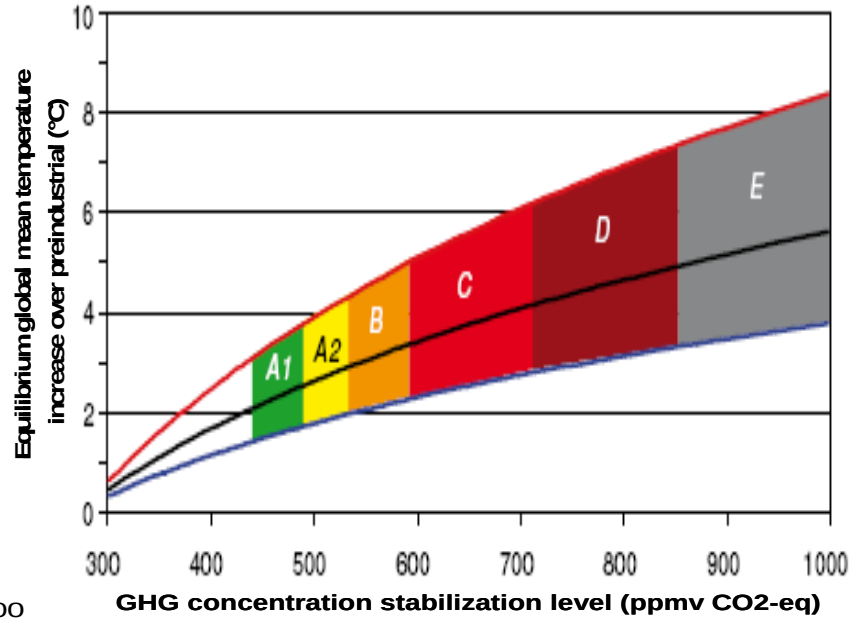
Source: IPCC WG3 SPM 2007

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

Range comes from diferent models

Range comes from alternative estimates of climate sensitivity

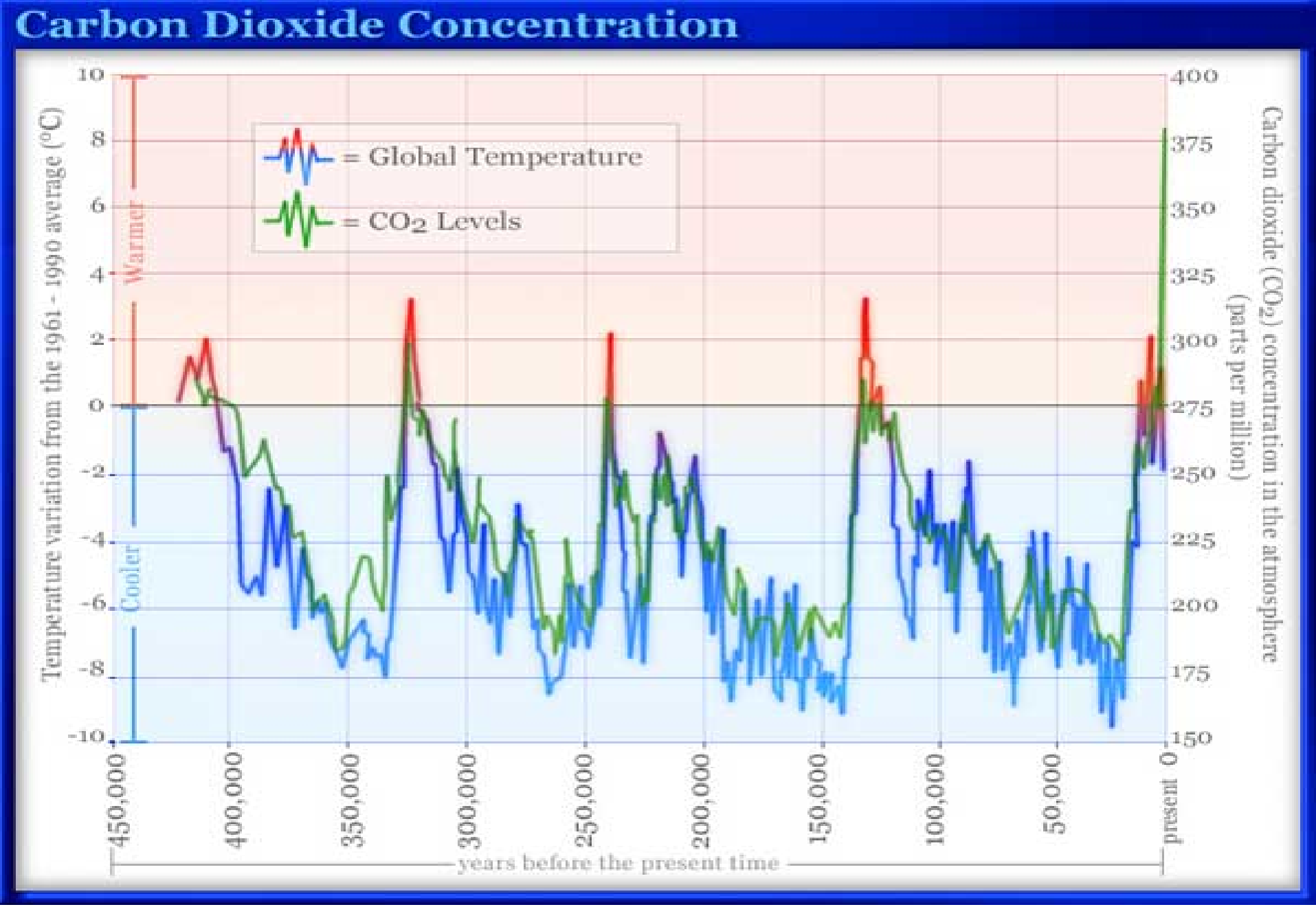




Multigas and CO_2 only studies combined

Note lack of studies below 450ppmv-CO_2-eq

Source: IPCC WG3 SPM 2007



Source: Derived from Petit *et al*, *Nature*, 1999. Shown in Al Gore's "An Inconvenient Truth".

Targets to avoid "dangerous" climate change

- UNFCCC "dangerous" is an ethical and political issue
  - IPCC leaves the definition to governments
  - Stern, p. 284: "The current evidence suggests aiming for stabilisation somewhere within the range 450 - 550ppm CO_2eq. **Anything higher would substantially increase risks of very harmful impacts.."**
  - EU's 2ºC target of a rise in equilibrium temperatures above pre-industrial: **even at this limit, there is a risk of the Greenland ice sheet melting (eventually)**

UNFCCC: stated objective is "to achieve stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system."

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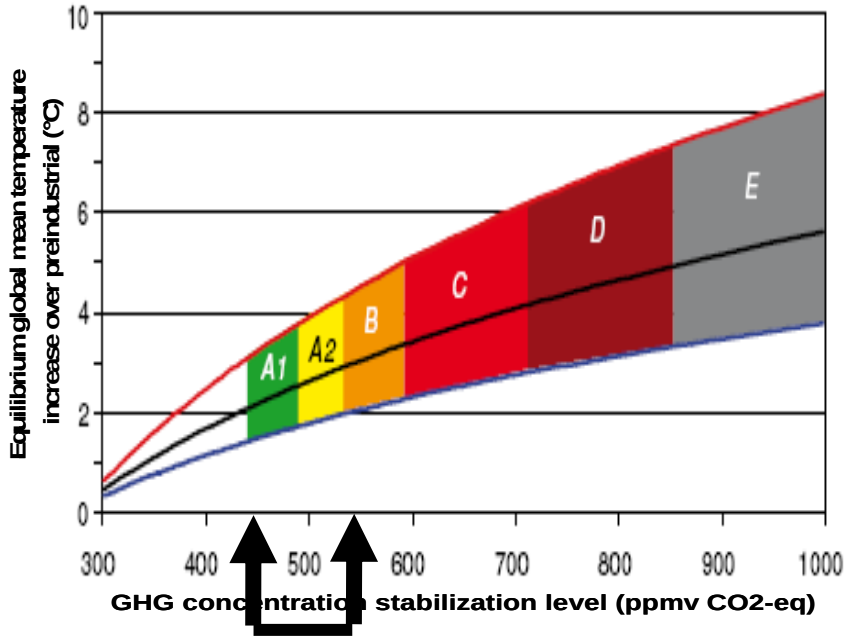

Stern 450-550

Source: IPCC WG3 SPM 2007

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where we are now

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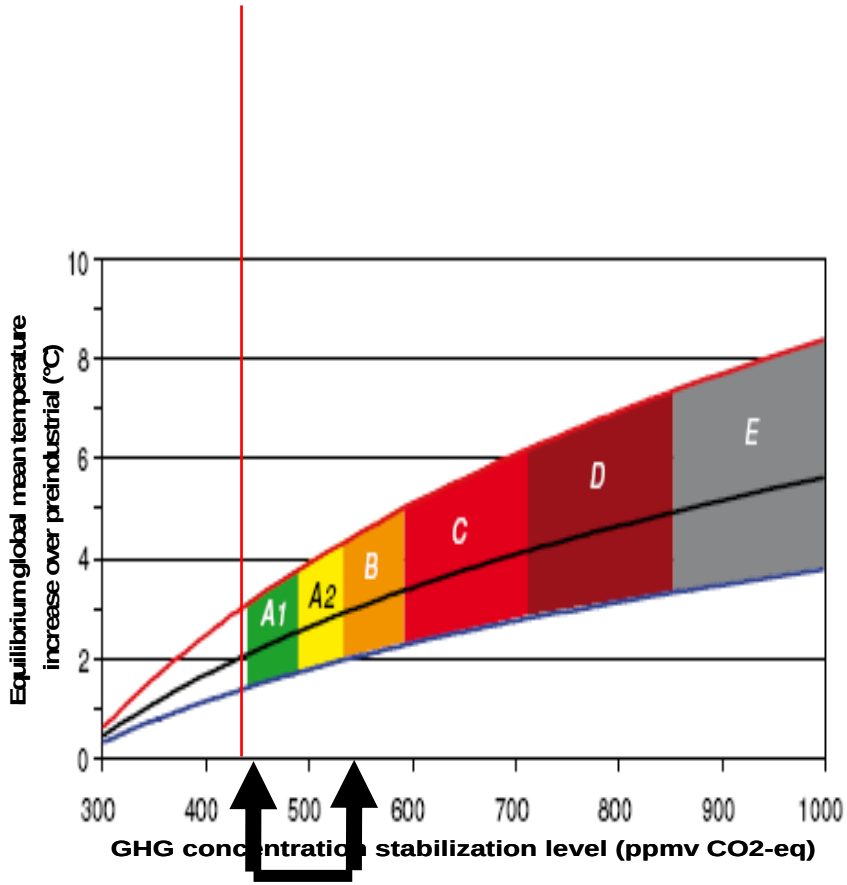

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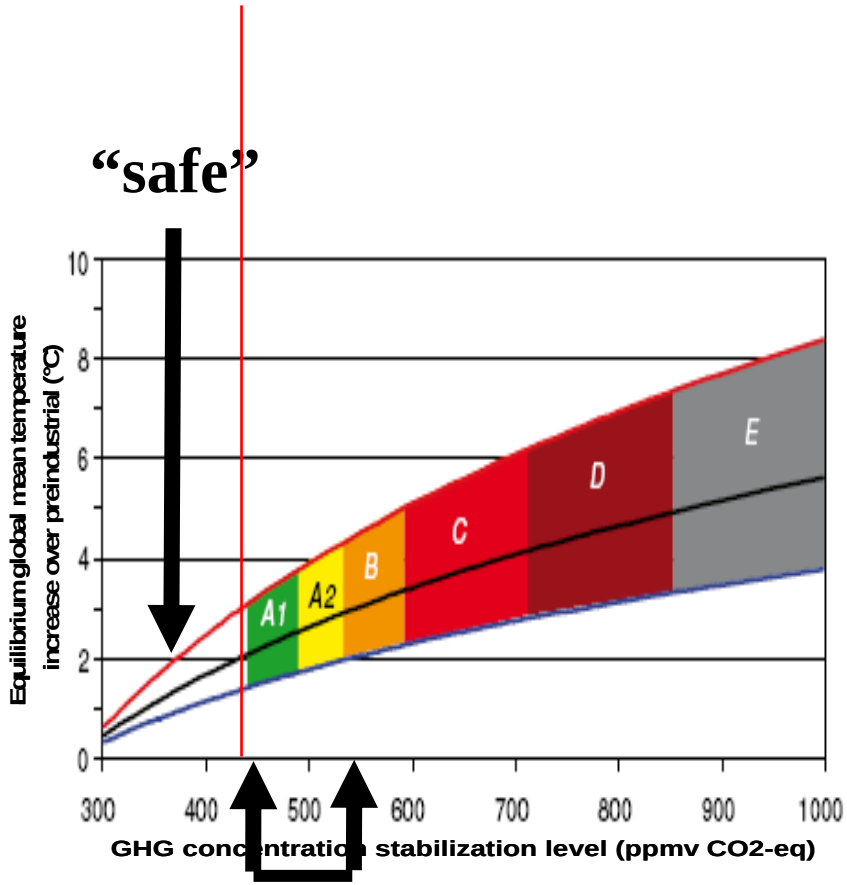

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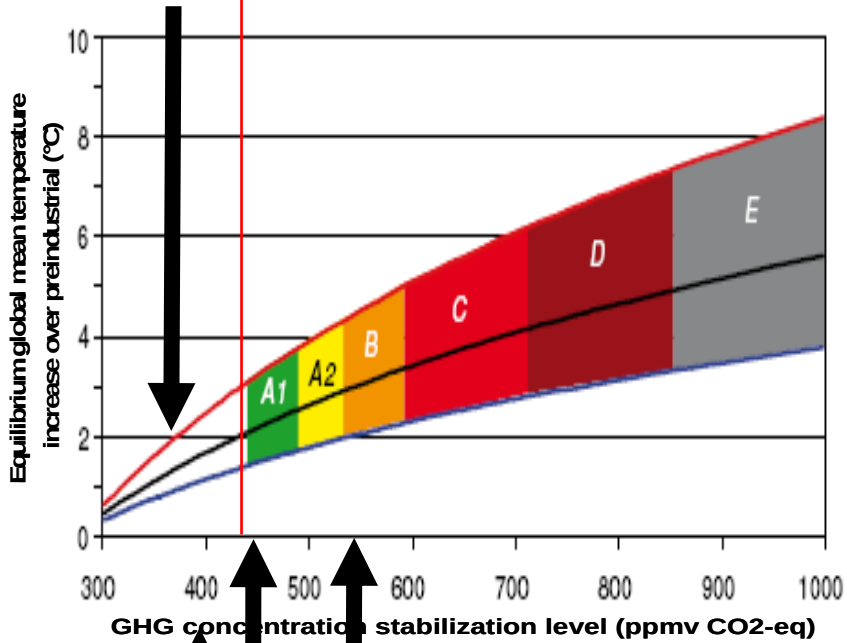


Stern 450-550

“feasible”

Source: IPCC WG3 SPM 2007

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

Implications for avoiding dangerous climate change

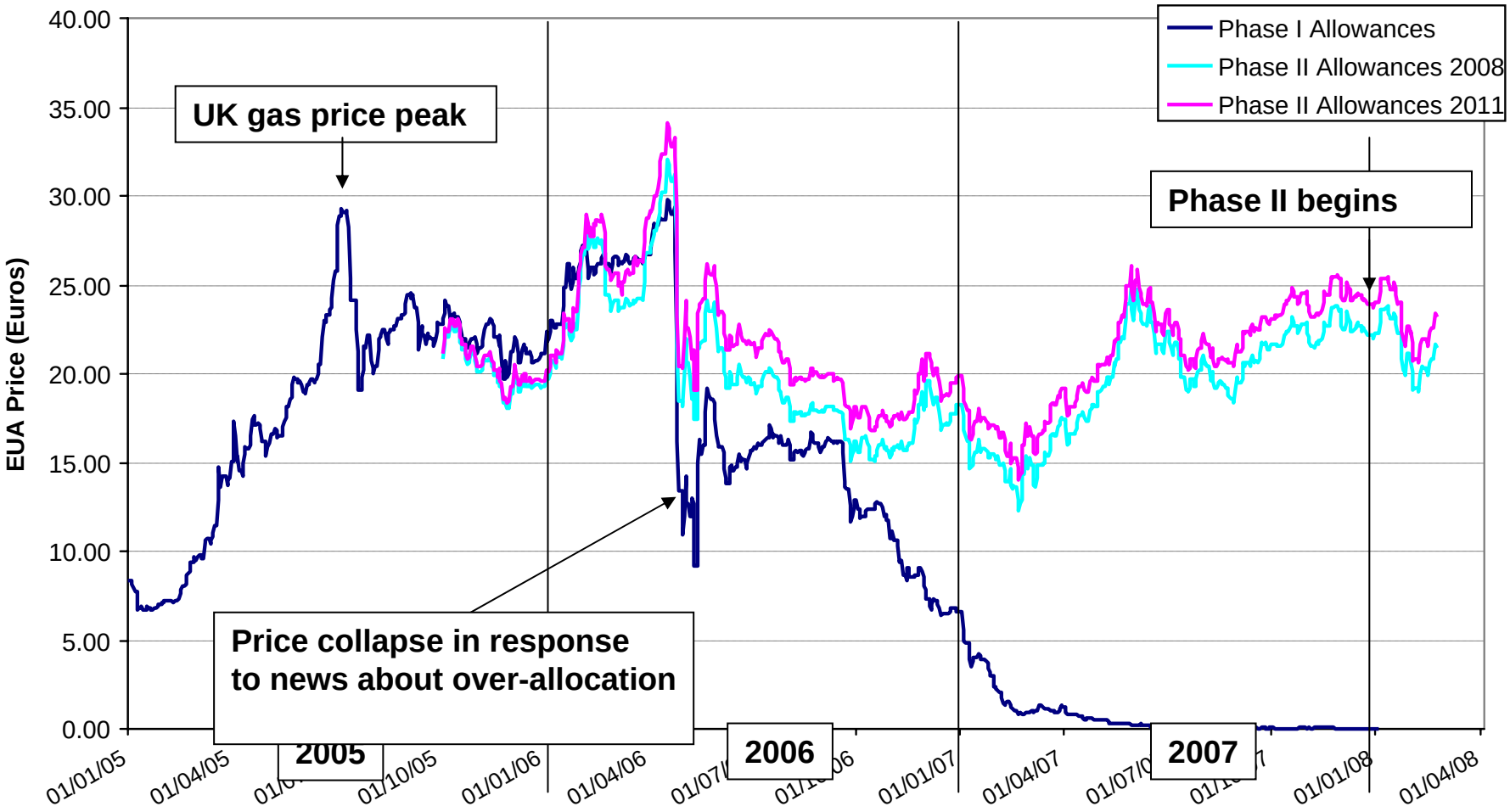
- To have a >50% probability of achieving <2ºC rise
  - CO_2-eq concentrations have to be <450ppm CO_2 eq (c/f c430 now)
  - global GHG emissions have to fall by >70% below business as usual by 2050
  - technologies have to be developed to capture CO_2
- Global warming is a stock problem and industrialized countries are responsible for most of current stocks
  - hence reduction in EU & USA of c90% below BAU/1990 by 2050
- Risks are asymmetric
  - so precaution suggests a zero carbon UK as soon as possible (without excessive costs)
- Eventually all countries & sectors have to decarbonize
  - Turns “How much?” into “When?” for each person, household, business, government

The importance of a "price on carbon"

IPCC, AR4: high agreement, much evidence

- "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 "modelling studies show carbon prices rising to 20 to 80 US$/t$CO_2$eq by 2030" ($5 to 65 if more technological change is induced by policies)
- At these carbon prices, large shifts of investments into low carbon technologies can be expected

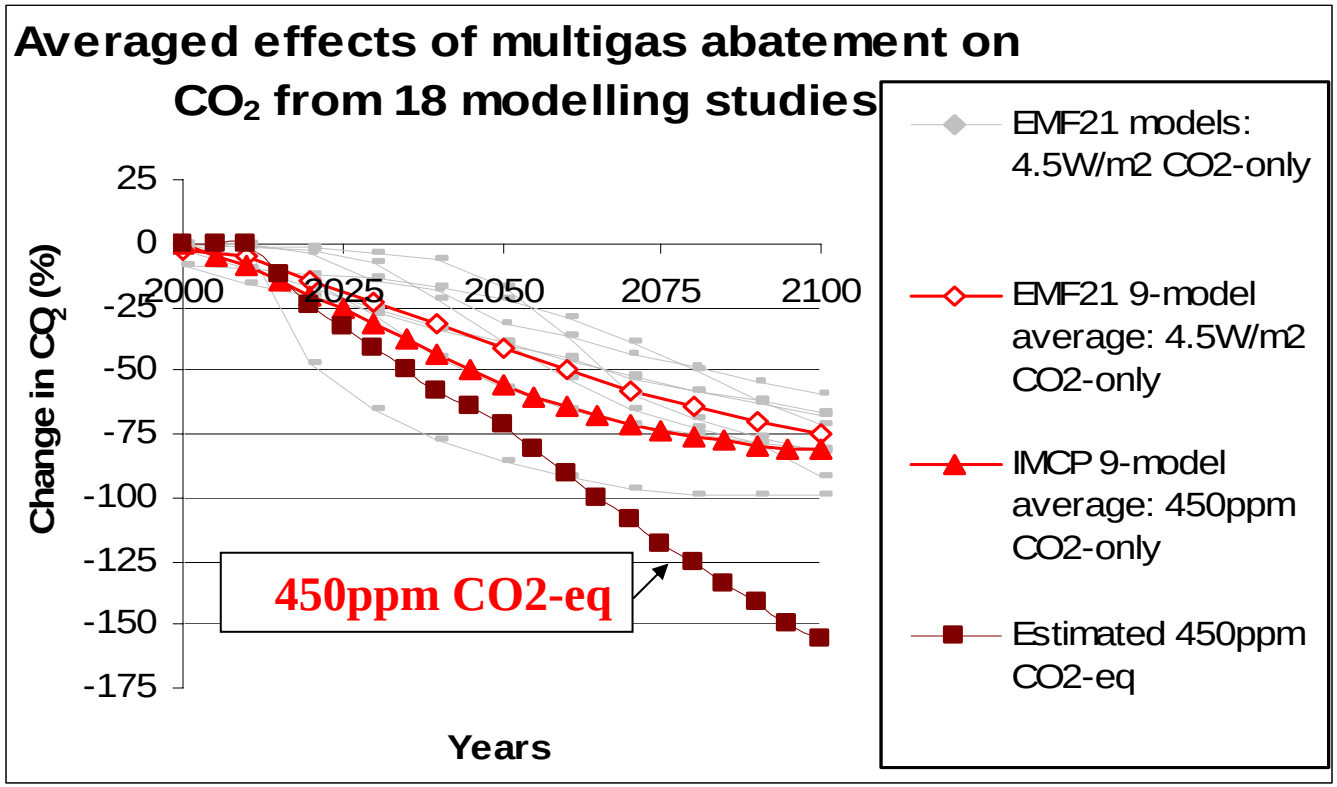
EU Emission Allowance Prices: January 2005 to February 2008 in €/tCO_2



Source: European Energy Exchange (EEX, 2008)

Global CO_2 mitigation for 450ppm CO_2-eq

450ppm CO_2-eq requires - 40% 2030 and - 70% 2050 (or more) from baseline



Source: Barker, T. and K. Jenkins, 2007: The Costs of Avoiding Dangerous Climate Change: Estimates derived from a meta-analysis of the literature. A Briefing Paper for the UN Human Development Report 2007.

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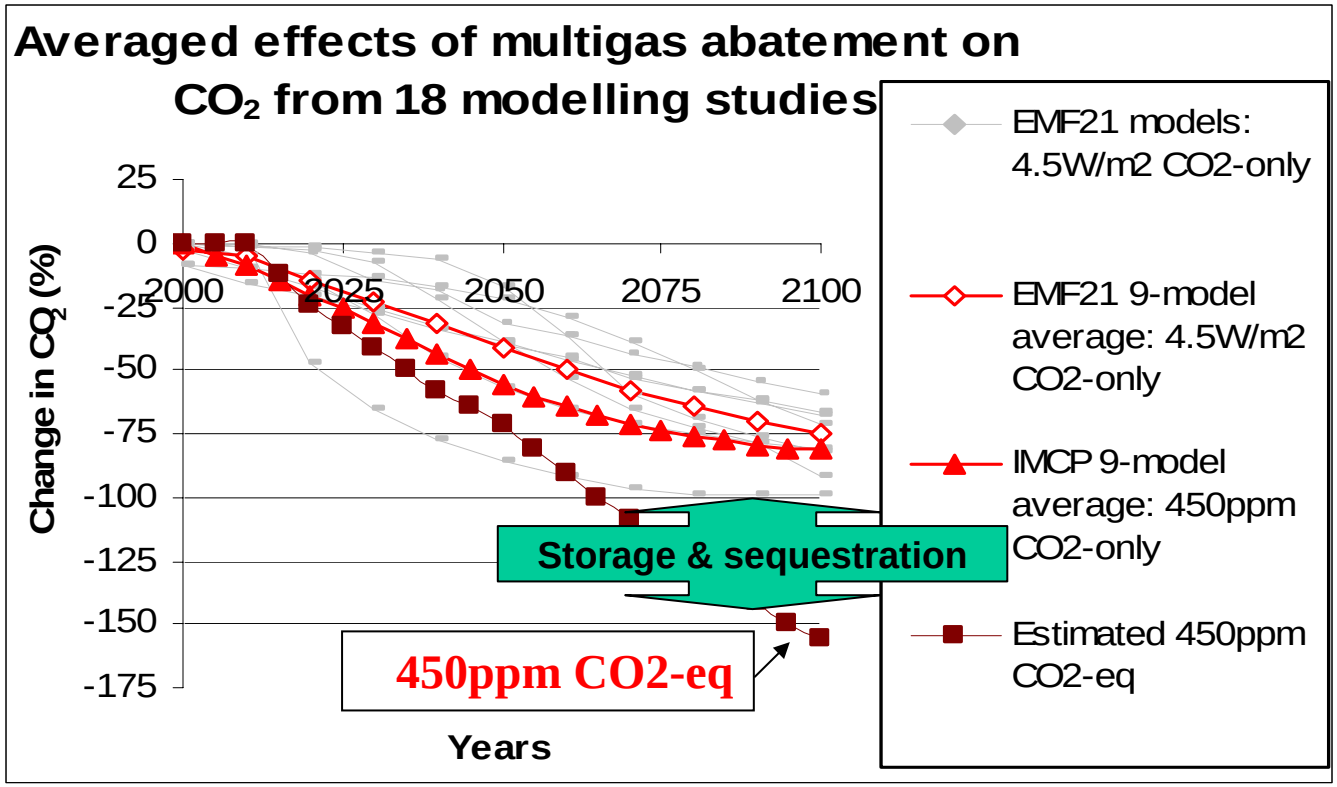

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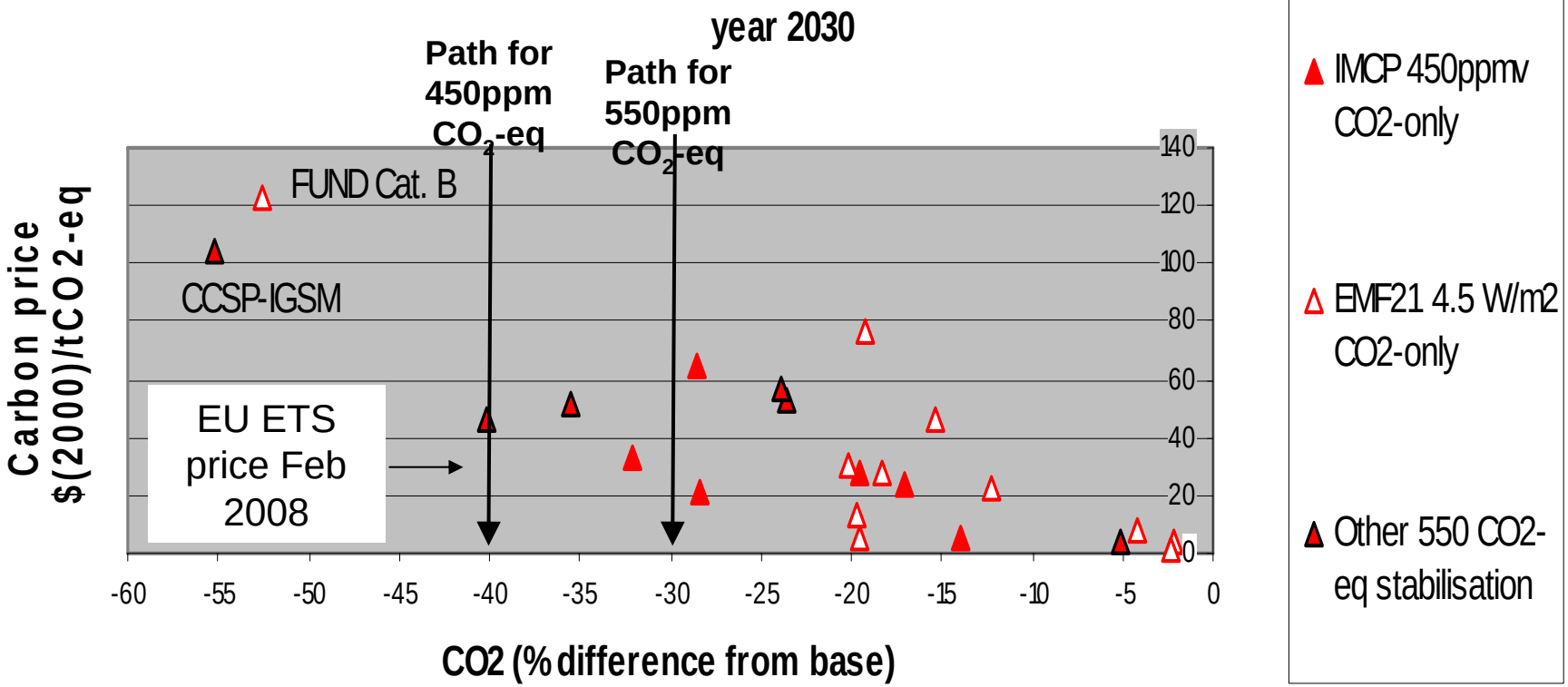
Carbon prices and CO_2 effects for 550ppm CO_2-eq stabilisation from modelling studies



Note that to achieve the stabilisation target, non-CO_2 GHGs are also assumed to be reduced by the CO_2-equivalent prices for all scenarios shown.

Memo: Relationship between $50/tCO$_2$ and US fuel prices

		2005 base	Added cost of $50/tCO$_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.

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.

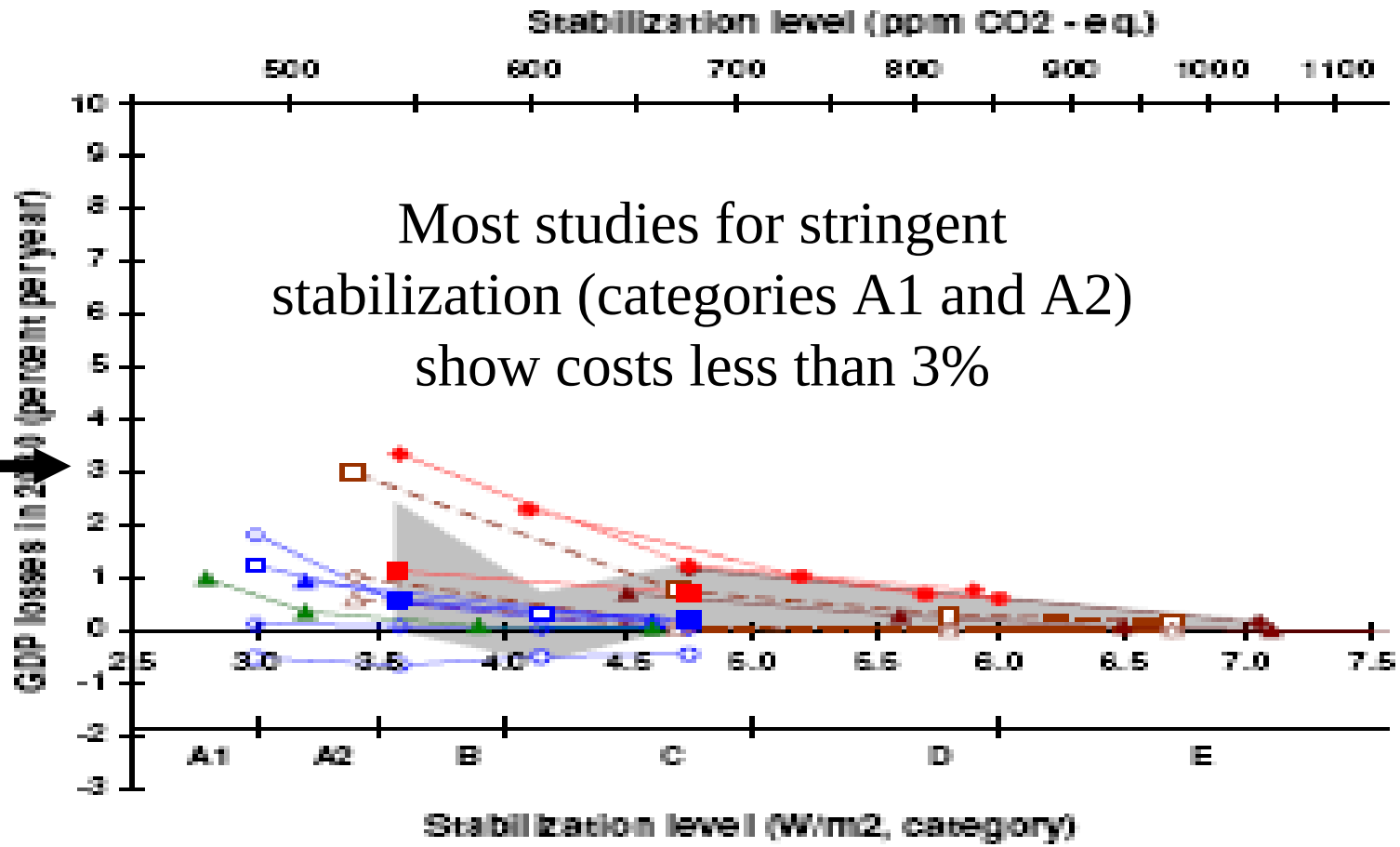
Economic potential: the mitigation potential based on social costs and social discount rates. Direct benefits of for instance energy savings are normally included, while most external costs are generally not.

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**

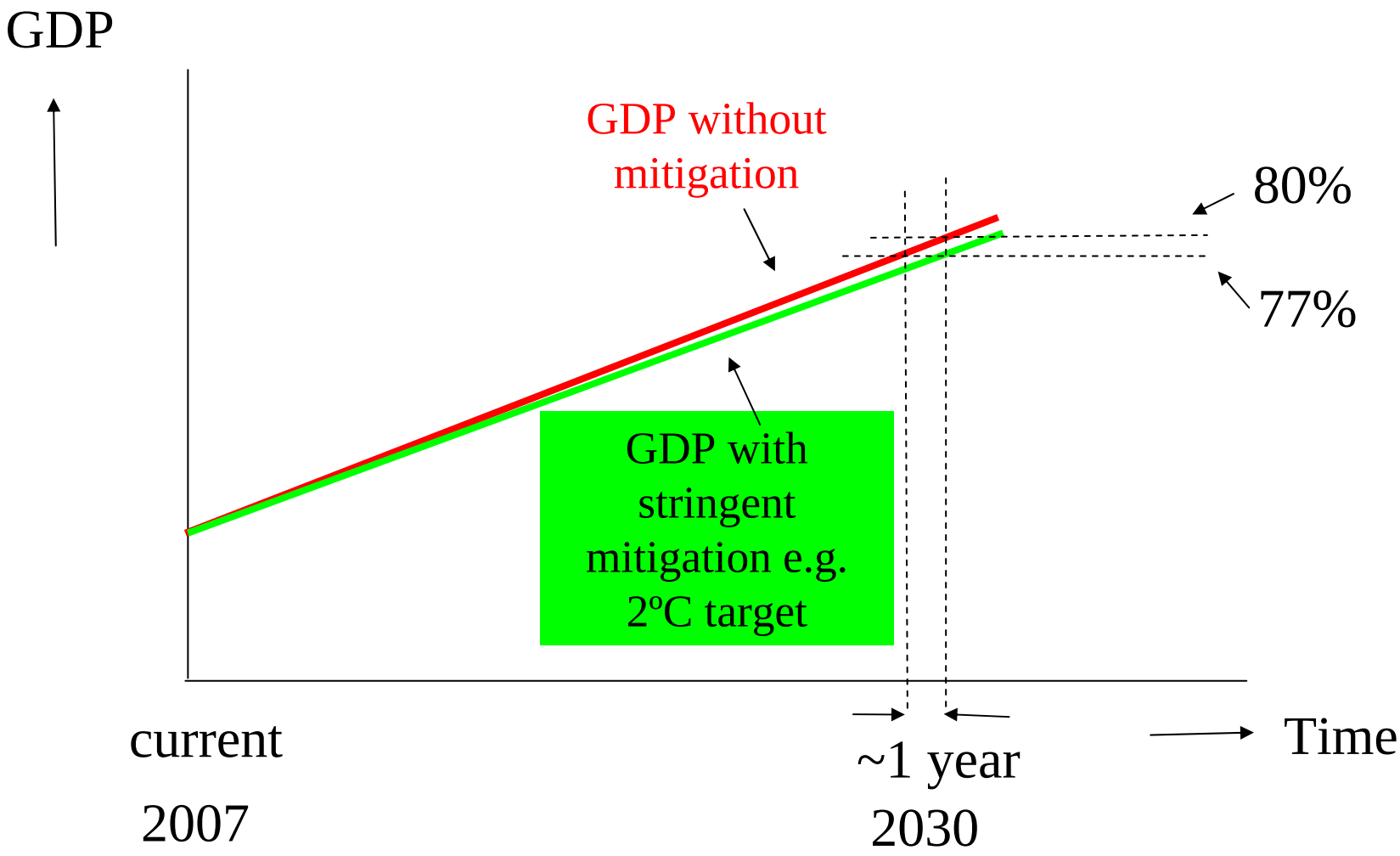
[1] This is global GDP based market exchange rates.
[2] The median and the 10th and 90th percentile range of the analyzed data are given.
[3] The calculation of the reduction of the annual growth rate is based on the average reduction during the period till 2030 that would result in the indicated GDP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

3% maximum global cost by 2030 in context



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

Illustration of the 3% cost number



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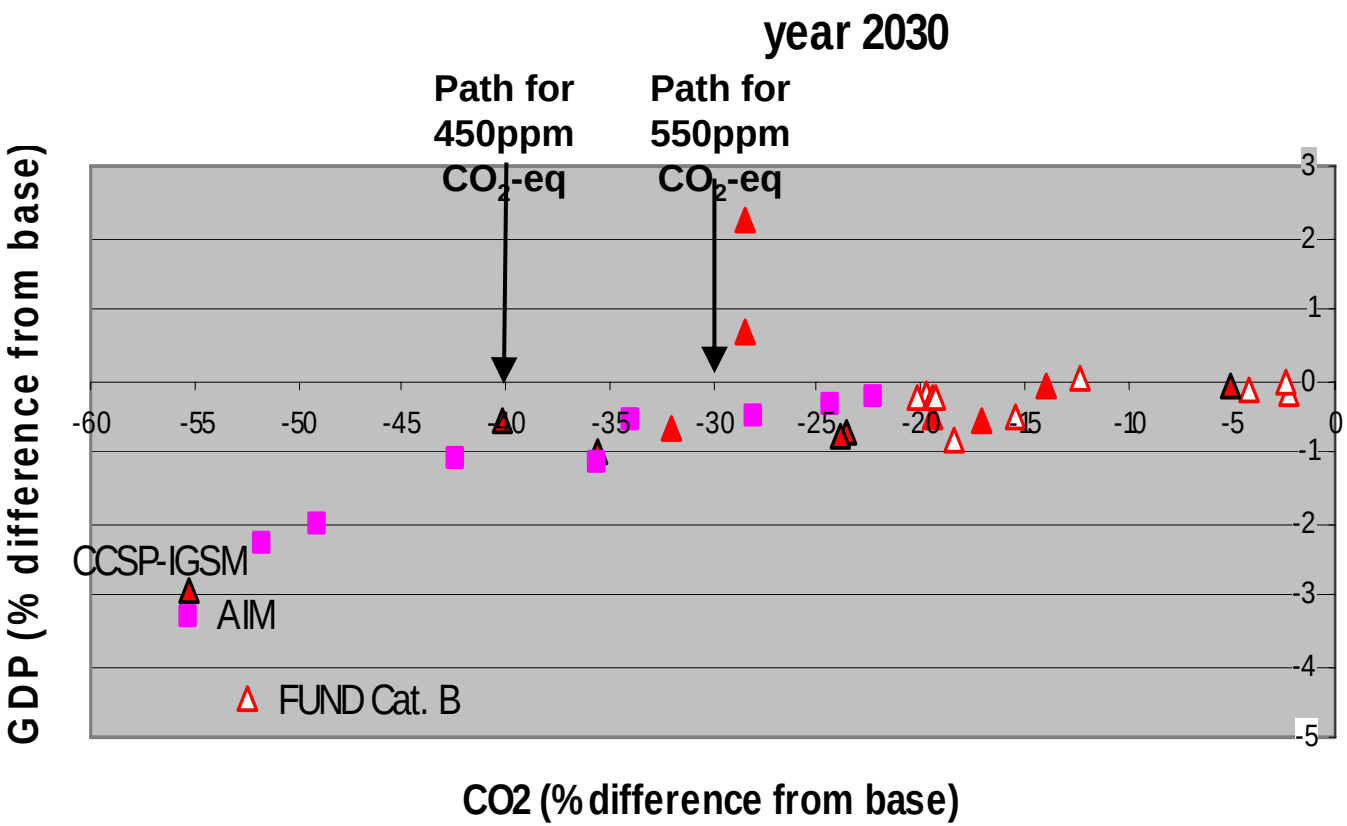

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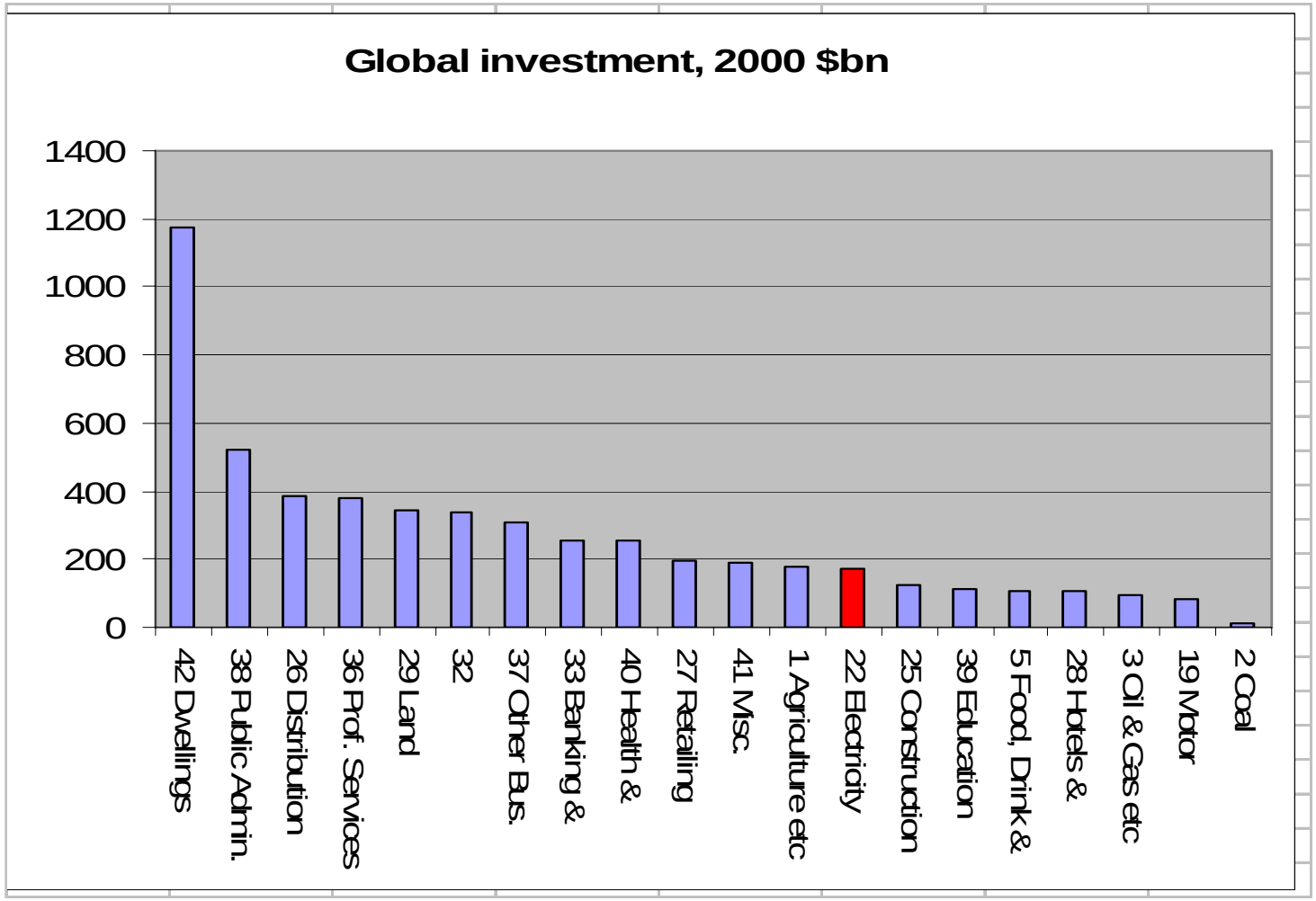
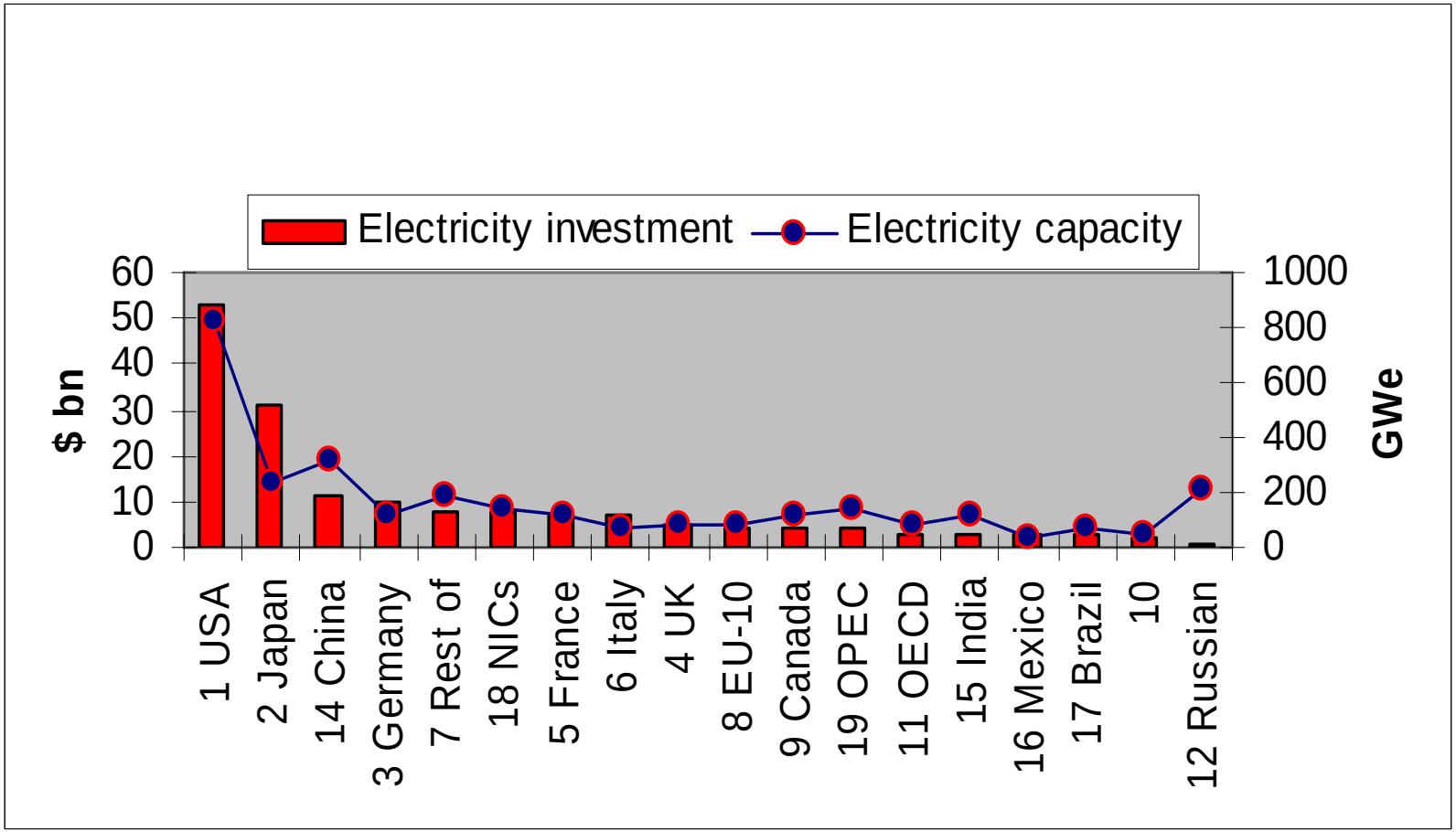
Global investment, 2000 $bn



Global electricity by region, 2000



US GDP costs for accelerated reductions in CO_2 emissions

US Administration EIA study (1999) for effects on US GDP

	2010		2020	
number of years to adjust	3 to 4		13	
trade in emission permits	none	Annex I	none	Annex I
CO_2 change (%)	-30.6	-18.4	-35.1	-23.9
Base GDP effect (%)	- 4.2	-2.0	-0.8	-0.6
Additional effects of:				
non-CO_2+sinks	0.7	0.3	0.1	0.1
revenue recycling	1.9	0.7	0.4	0.2
ancillary benefits*	0.4	0.3	0.4	0.3
Total GDP effects (%) *	-1.2	-0.7	0.1	0.0

note: * ancillary benefits are estimated and are not in original study.

Source: US Energy Information Administration (EIA) (1998). *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*. Washington DC.

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Base GDP effect (%)	high cost	- 4.2	-2.0	-0.8	-0.6
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high cost

low cost

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Source: US Energy Information Administration (EIA) (1998). *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*. Washington DC.

Summary: the costs of achieving the 2º C target

Key conclusion from IPCC AR4: not enough studies on stringent mitigation have been done!

Extrapolating from current studies:

The macro-economic costs of the 2ºC target appear to be negligible (even beneficial) for global GDP and welfare, provided policies are "well-designed"

- Equilibrium models (providing nearly all the cost estimates) *assume* that mitigation will be costly, despite evidence from econometric models and business
- Low-cost, low-GHG technologies are likely to be developed both directly and through rising carbon prices
- But this requires international co-operation on allocation of burdens and benefits

Conclusions for UK policy

- A rising real carbon price is required of about \$100/tCO_2 by 2030 (rising thereafter) to be on the safe side, e.g. by a trading scheme
- The price should be guaranteed by government so as to reduce the risks of investing in low-GHG technologies, e.g. by reserving a % of traded permits
- A portfolio of supporting policies (regulation, ecotax reform, information) will reduce costs and accelerate change
- All sectors should plan for when they can phase out GHG emissions, and secure offsets or carbon capture