Podnebne spremembe:
priložnost za trajnostno rast
Climate Change:
An Opportunity for Sustainable Growth

The Stern review on the economics of climate change

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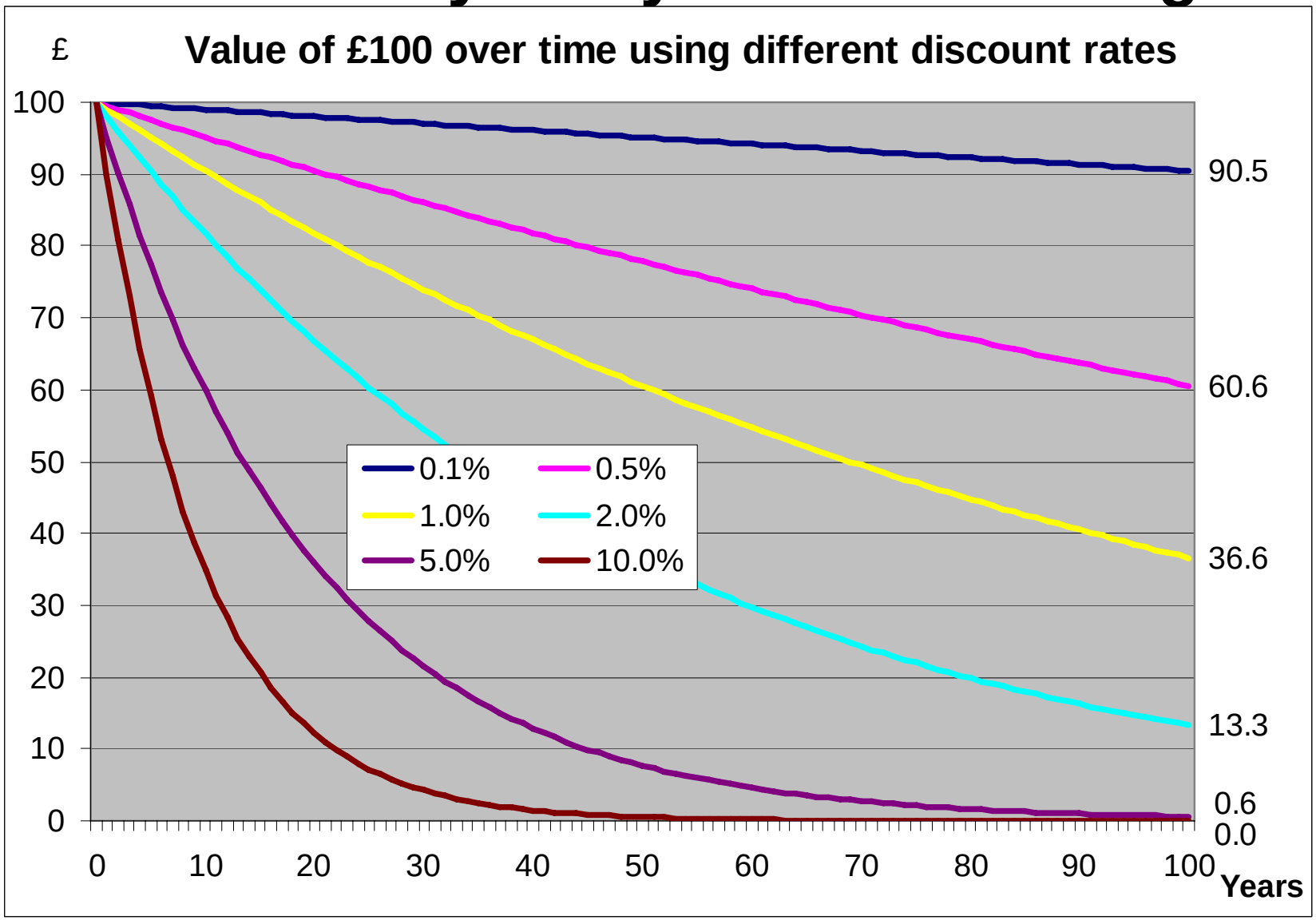
www.brdo-co2nference.net

Sensitivity analysis: discounting



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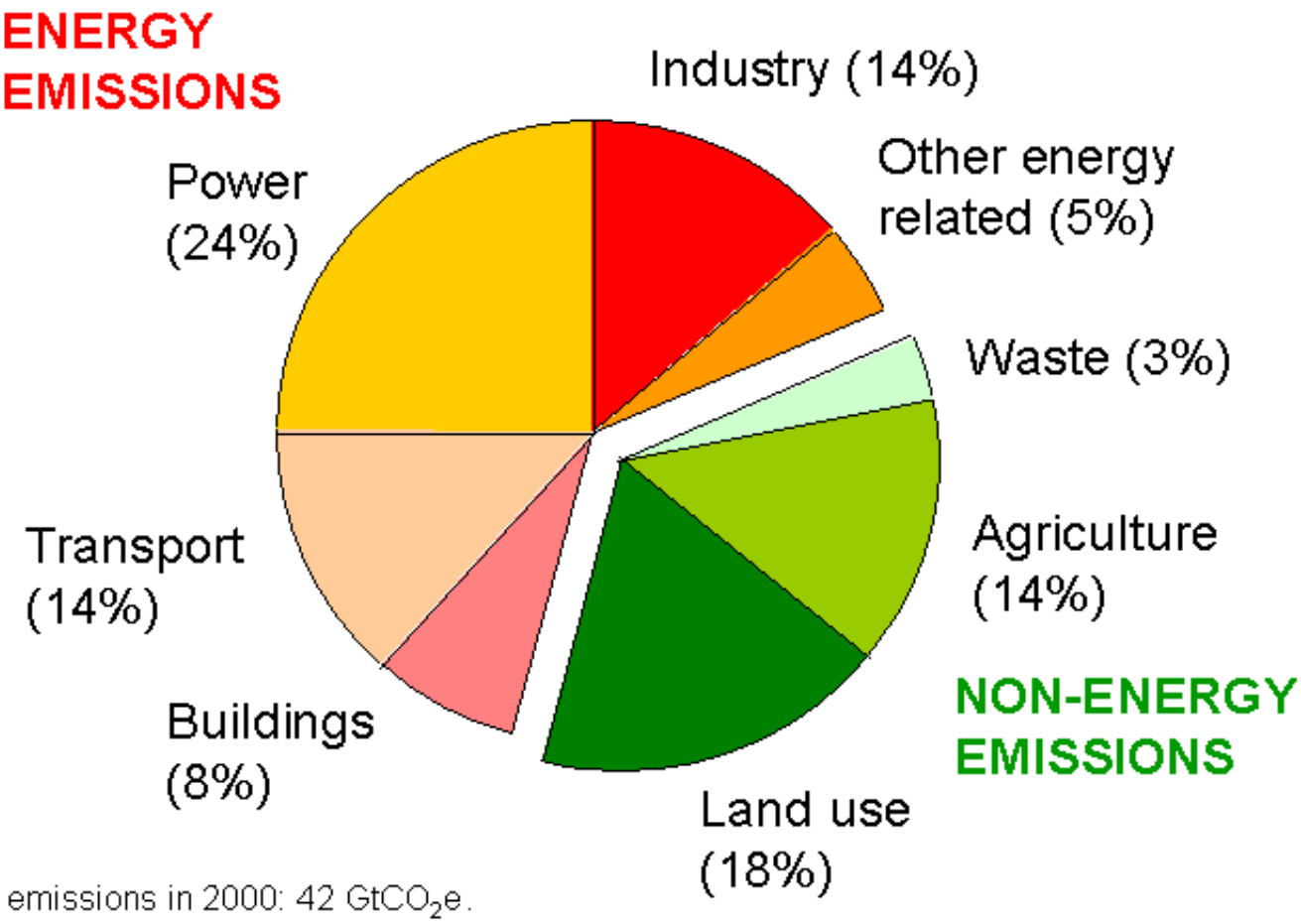
review

ON THE ECONOMICS OF CLIMATE CHANGE

DIMITRI ZENGHELIS

Reducing emissions requires action across many sectors



Total emissions in 2000: 42 $GtCO_2e$.

II Costs

Cost estimates

- Review examined results from bottom-up (Ch 9) & top-down (Ch 10) studies: concluded that world could stabilise below 550ppm CO_2e for around 1% of global GDP

- Subsequent analyses Edenhofer/IPCC top down have indicated lower figures

- So too have bottom-up IEA and McKinsey

- Options for mitigation: McKinsey analysis examines approach of chapter 10 of Review in more detail

Growth, change and opportunity

- Strong mitigation costs around 1% p.a. worldwide
- Strong mitigation is fully consistent with the aspirations for growth and development in poor and rich countries. Business as usual is not.
- Costs will not be evenly distributed:
  - •Competitiveness impacts can be reduced by acting together.
  - •New markets will be created. Investment in low-carbon electricity sources could be over $500bn a year by 2050.
- Mitigation policy can also be designed to support other objectives:
  - •energy - air quality, energy security and energy access
  - •forestry - watershed protection, biodiversity, rural livelihoods

III Mitigation Policy; trading

Mitigation policy instruments

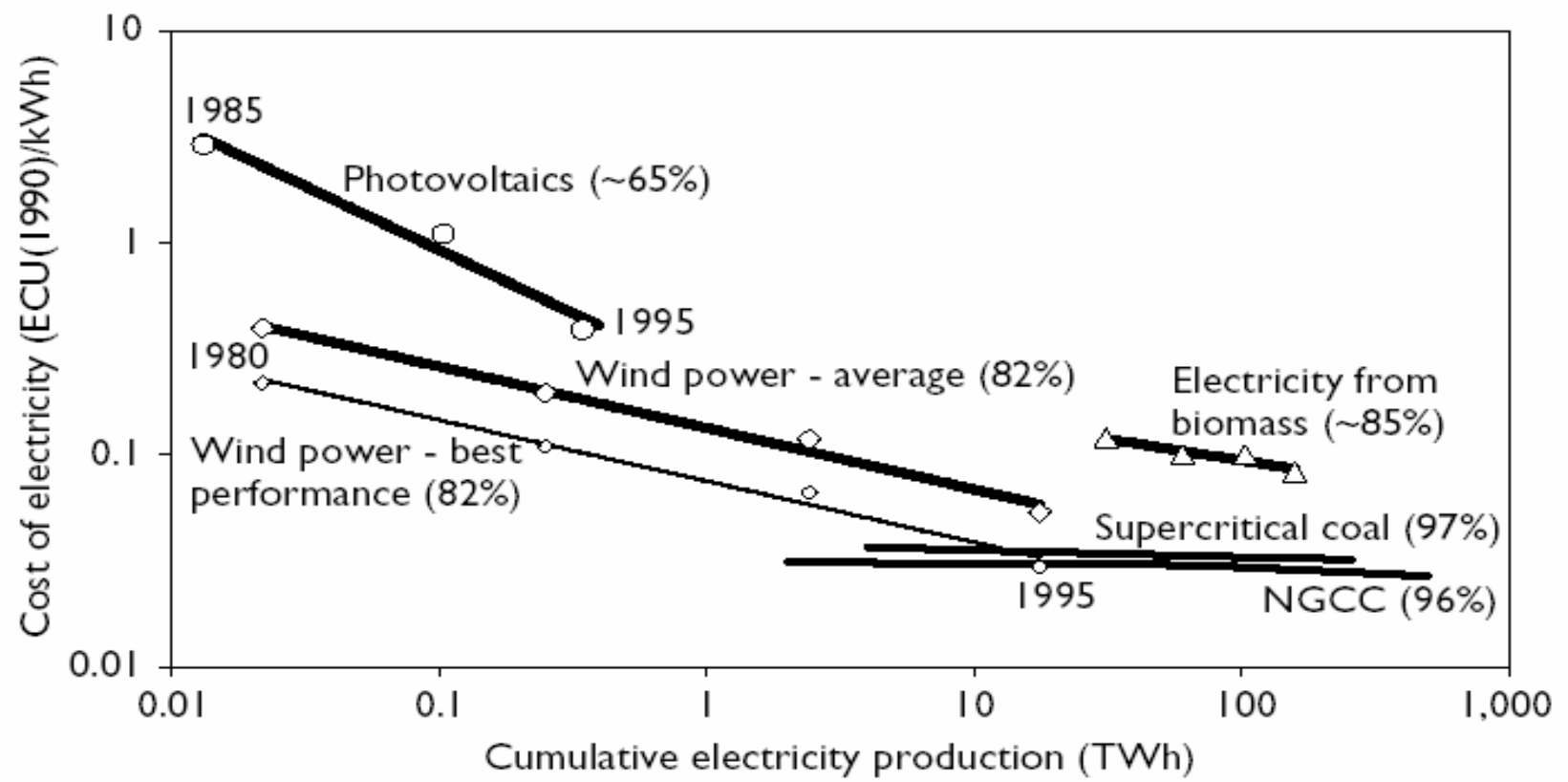
- Pricing the externality- carbon pricing via tax or trading, or implicitly through regulation
- Bringing forward lower carbon technology- research, development and deployment
- Overcoming information barriers and transaction costs– regulation, standards
- Promoting a shared understanding of responsible behaviour across all societies – beyond sticks and carrots

Trade/Tax/Standards

- Trade quotas give greater quantity certainty and incentives to bring in developing countries; ambition, transparency, credibility are key
- Tax may be simpler for some countries and/or sectors
- Tax or Trade: Identify single policy instrument for sector
- Regulation may accelerate change and lower costs by reducing uncertainty and achieving economies of scale
- But complications of interactions e.g. renewables targets and size of carbon market

Trade/Technology

- Some arguments for differential policies given nature of technologies and distance from markets



Trade/Types of markets

- National and regional (EUETS, NE US States, Australia)
- Sectoral
- Voluntary
- Kyoto

Trade/Design (I)

- Auctioning: adjustment issues; path to auctioning
- Price volatility: deep markets (sectors, countries, intertemporal)
- Price volatility: floors/ceilings; put options etc
- Linking markets: trading schemes must be able to interact

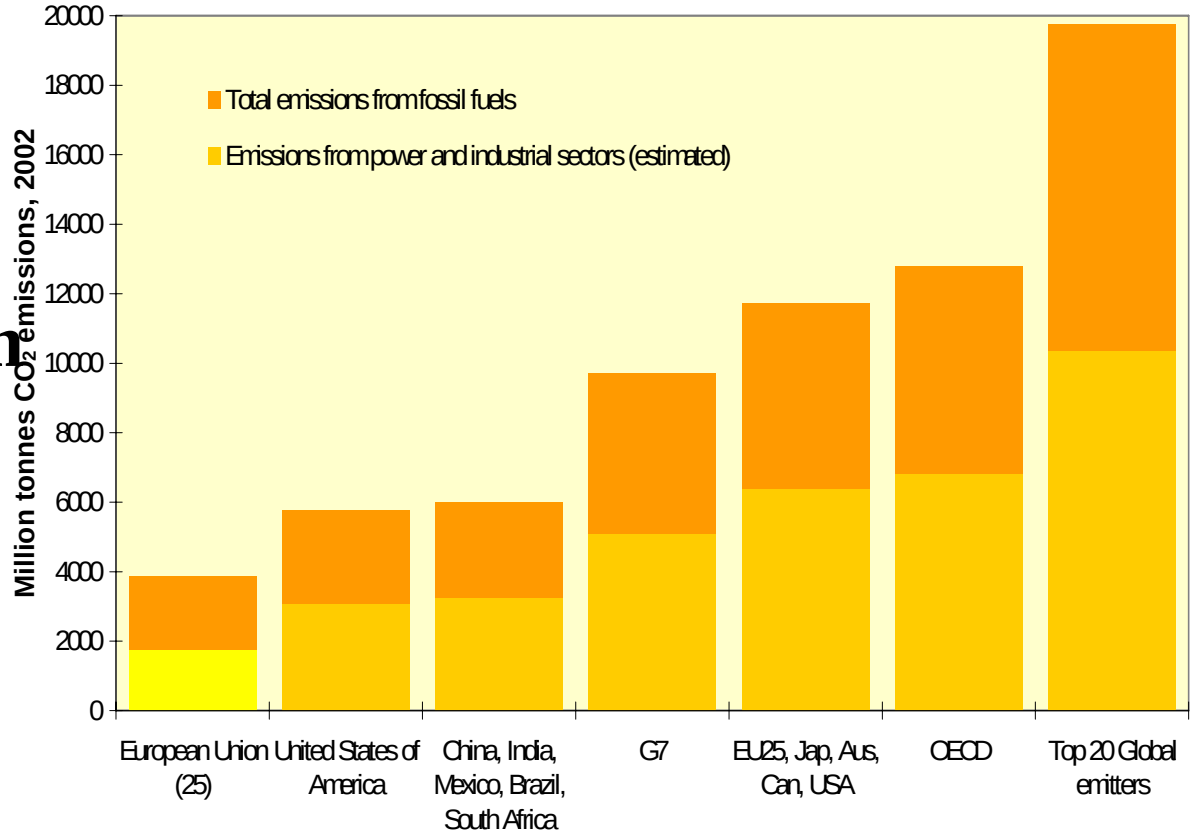
Trade/Institutional structure

- Conventions, types of reduction or transaction admissible
- Simplicity/complexity of certification
- Monitoring of emissions
- Credibility and ratings of instruments

Carbon markets can grow, but to be effective, require good design

Markets need to be based on:

- **Scarcity**
- **Credible, long-term trading periods**
- **Open, deep and liquid markets**
- **Efficient allocation methods**



Estimating Costs of Mitigation

Expected cost of cutting emissions consistent with 550ppm CO2e stabilisation trajectory averages 1% of GDP per year.

- Macroeconomic models: 1% of GDP in 2050, in range +/- 3%.
- Resource cost: 1% of GDP in 2050, in range –1% to +3.5%.

Costs will not be evenly distributed:

- Competitiveness impacts can be reduced by acting together.
- New markets will be created. Investment in low-carbon electricity sources could be worth over $500bn a year by 2050.

Strong mitigation is fully consistent with the aspirations for growth and development in poor and rich countries.

Key principles of policy

Climate change policy:

- Carbon pricing
- R,D&D
- Related market failures and behavioural change

Consistency with other policy goals – growth and energy security

Conclusion from Stern analysis

- Our understanding of the **risks** of climate change has advanced strongly.
- We understand the **urgency and scale** of action required.
- We know that the **technologies and economic incentives for effective action are available or can be created**
- We are in a much better position now to use our **shared understanding** to agree on what goals to adopt and what action to take.

Global Deal (1); targets

Starting point: Carbon dioxide energy emissions

EIA Reference Case, MtCO2 (from energy): 2002-2025				
Country	**2002**	**2025**	**Avg. Annual Growth**	**Total Growth**
World	**24,410**	**38,791**	**2.00%**	**58.90%**
Annex I	14,169	18,258	1.10%	28.90%
non-Annex I	10,241	20,533	3.10%	100.50%
United States of America	**5,752**	**7,980**	**1.40%**	**38.70%**
Western Europe	**3,550**	**3,953**	**0.50%**	**11.40%**
China	3,323	8,134	4.00%	144.80%
India	**1,026**	**1,993**	**2.90%**	**94.30%**
Brazil	341	678	3.00%	98.90%

Source: Climate Analysis Indicators Tool (CAIT) Version 4.0.

(Washington, DC: World Resources Institute, 2007).

Commitments: percentages

- G8 Heiligendamm – 50% by 2050 (consistent with stabilisation around 500ppm Co2e)
- US (under H Clinton) - 80% from 1990 levels by 2050
- France – 75% by 2050 (Factor 4)
- EU Spring Council: 60-80% by 2050 and 20-30% by 2020
- Germany – 40% by 2020

Target: stocks, history, flows

- Current 40-45 GtCO2e p.a. Current stocks around 430ppm; pre-industrial stocks 280ppm
- The United States and the EU countries combined accounted for over half of cumulative global emissions from 1900 to 2005
- 50% reduction by 2050 requires per capita global GHG emissions of 2-3T/capita (20-25 Gt divided by 9 billion population)
- Currently US ~ 20+, Europe ~10+, China ~4, India ~1 T/capita

The GHG ‘reservoir’

- Long-term stabilisation at 550ppm CO_2e implies that only a further 120ppm CO_2e can be ‘allocated’ for emission, given that we start at 430ppm

- Developing country can largely claim this 120ppm given their low emissions in the past. Note that rich countries largely responsible for increase from 280ppm to 430ppm

- Equity requires a discussion of the appropriate use of this reservoir given past history

- Thus convergence of flows does not fully capture the equity story, from emissions perspective

- Equity issues arise also in adaptation, given responsibilities for past increases

Global Deal (2); package

Key elements of a global deal: I

Targets and Trade

•Rich countries to take on ***strong individual targets,*** creating demand side for reductions

•Rich country reductions and trading schemes designed to be ***open to trade with other countries***, including developing countries

•***Supply side from developing countries*** simplified to allow much bigger markets for emissions reductions, ***through sectoral or technological benchmarking***

Key elements of a global deal: II

Funding Issues

- Strong initiatives, with public funding, on **deforestation** to prepare for inclusion in trading
- Demonstration and sharing of **technologies**
- Rich countries to deliver on Monterrey and Gleneagles commitments on **ODA** in context of extra costs of development arising from climate change

Combination of the above can, with appropriate market institutions, help overcome the inequities of climate change and provide **incentives for developing countries to play strong role** in global deal, eventually **taking on their own targets.**

Conclusion from Stern analysis

Unless emissions are curbed, climate change will bring high costs for human development, economies and the environment

- Concentrations of 550ppm CO_2e and above - very high risks of serious economic impacts
- Concentrations of 450ppm CO_2e and below - extremely difficult to achieve *now* and with current and foreseeable technology

Limiting concentrations within this range is possible. The costs are modest relative to the costs of inaction.

Decisive and strong international action is urgent: delay means greater risks and higher costs

Mitigation Policy Instruments

- **Pricing** the externality- carbon pricing via tax or trading, or implicitly through regulation

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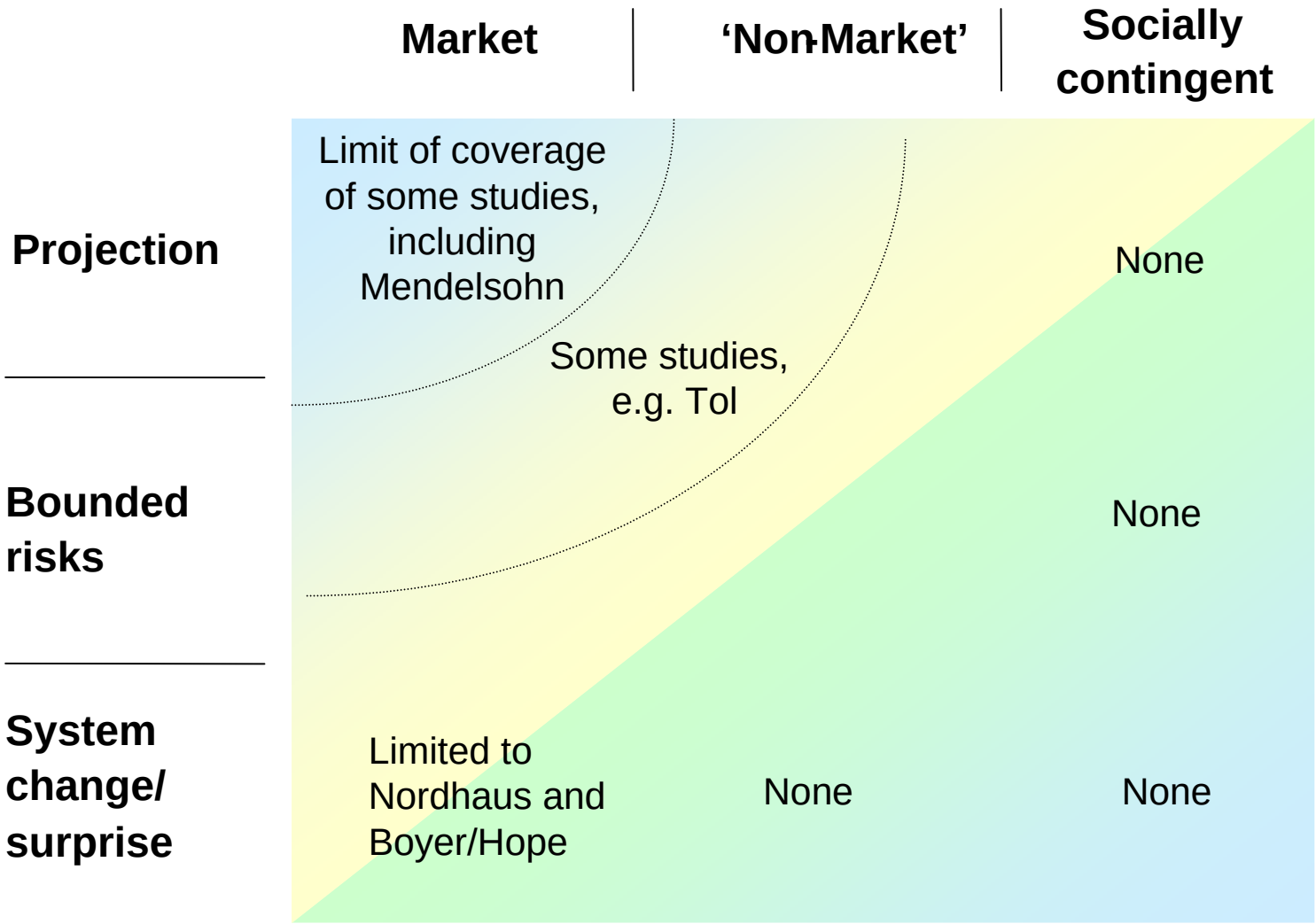
- Promoting a **shared understanding** of responsible behaviour across all societies – beyond sticks and carrots

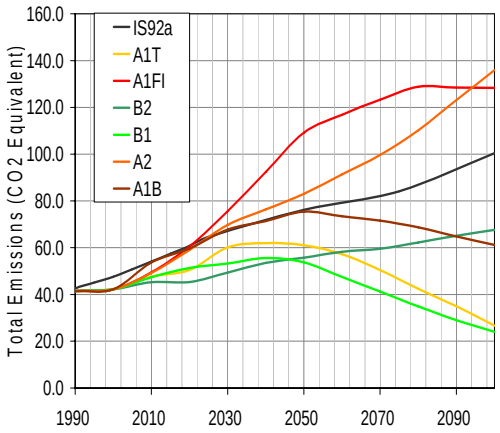


Models only have partial coverage of impacts

Values in the literature are a sub-total of impacts

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

Working with Uncertainty



Population, technology, production, consumption

Emissions

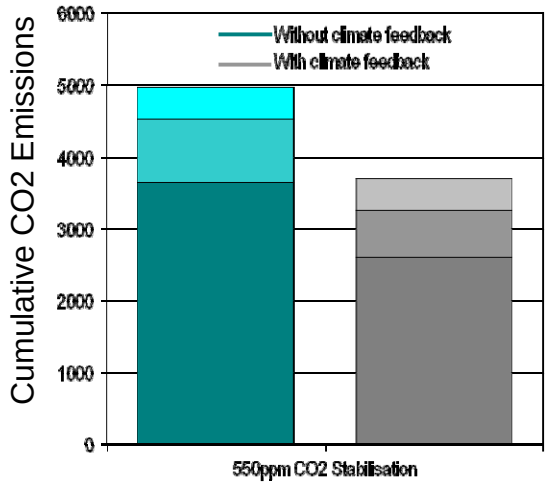
Atmospheric concentrations

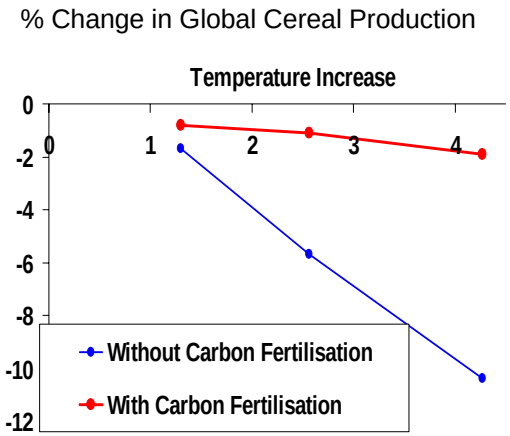
Radiative forcing

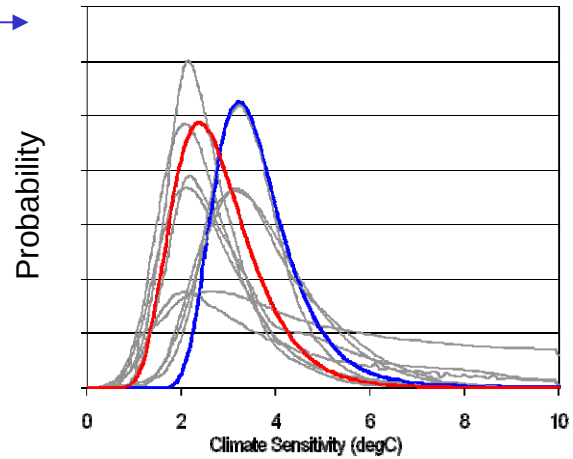
Temperature rise and global climate change

Direct impacts (e.g. crops, forests, ecosystems)

Socio-economic impacts







Aggregate Impacts Matrix

- Essential to take account of **risk and uncertainty**
- Models do **not** provide **precise** forecasts
- Assumptions on **discounting, risk aversion and equity** affect the results

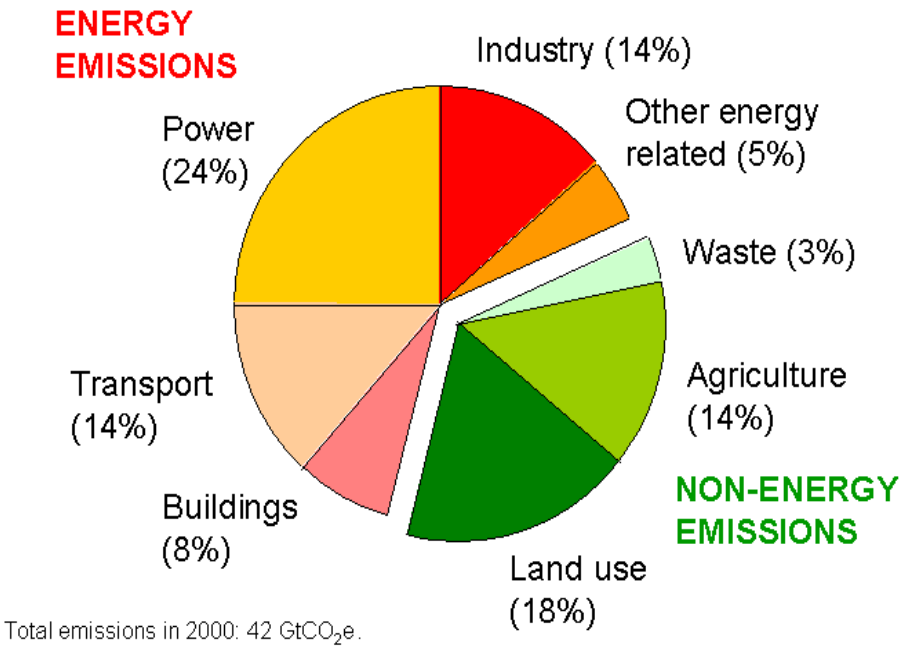
	Market impacts	Broad impacts
Baseline climate	5% (0-12%)	11% (2-27%)
High climate	7% (1-17%)	14% (3-32%)

Rough estimate of equity weighting: 20%

STABILISATION

MITIGATION COSTS

Strategies for Emission Reduction

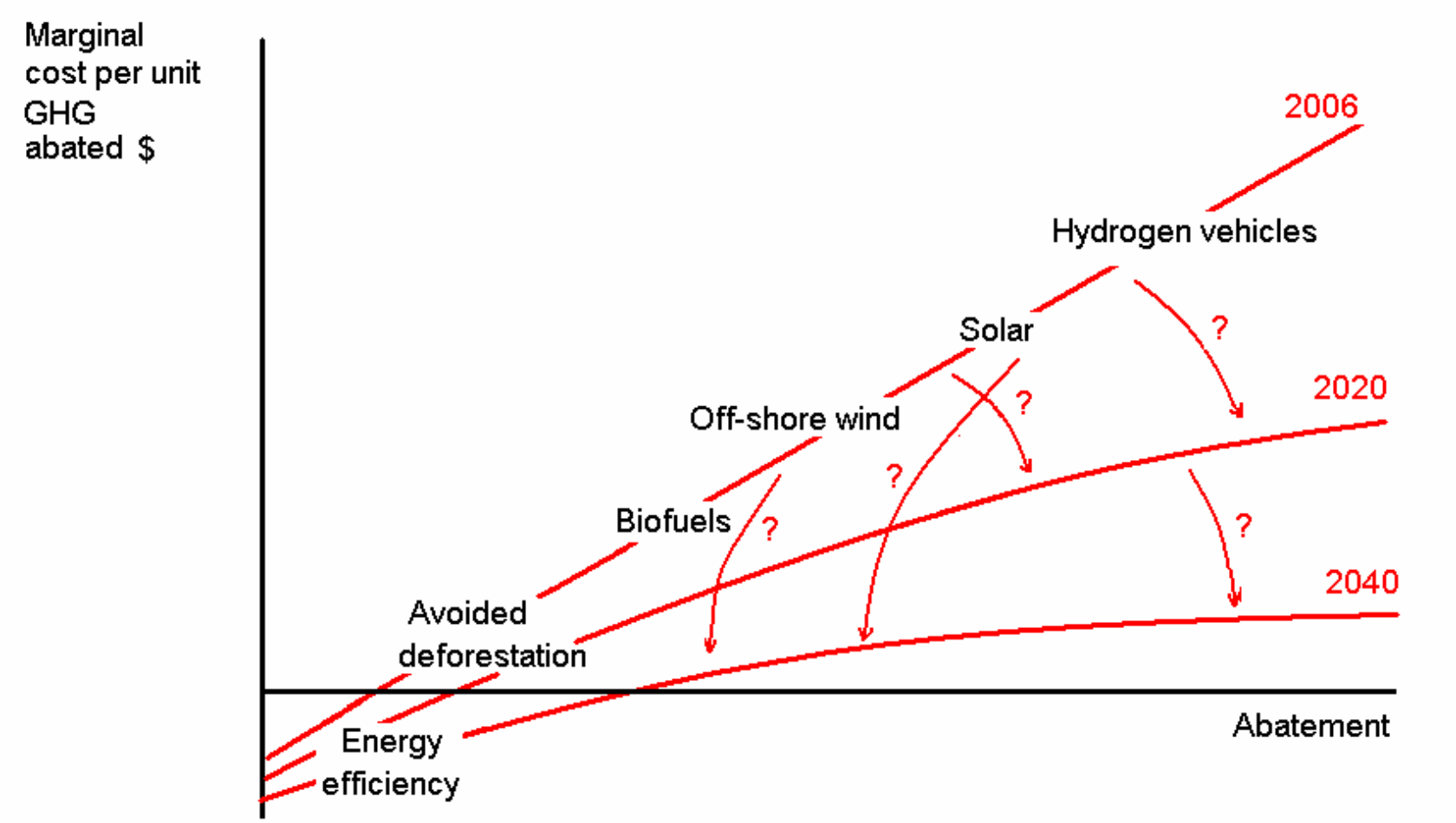


Total emissions in 2000: 42 $GtCO_2e$.

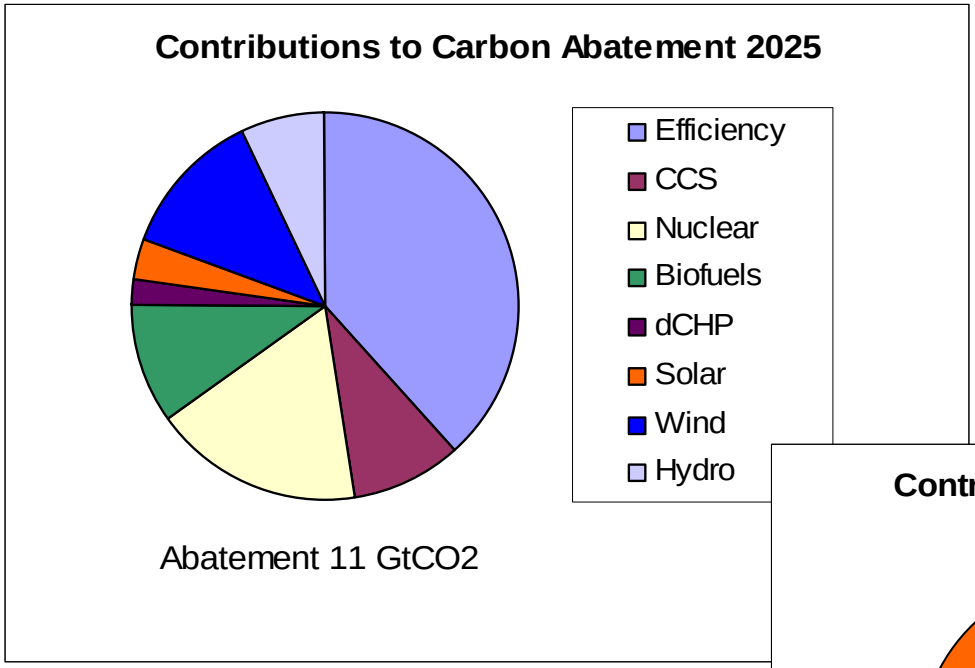
Four ways to cut emissions:

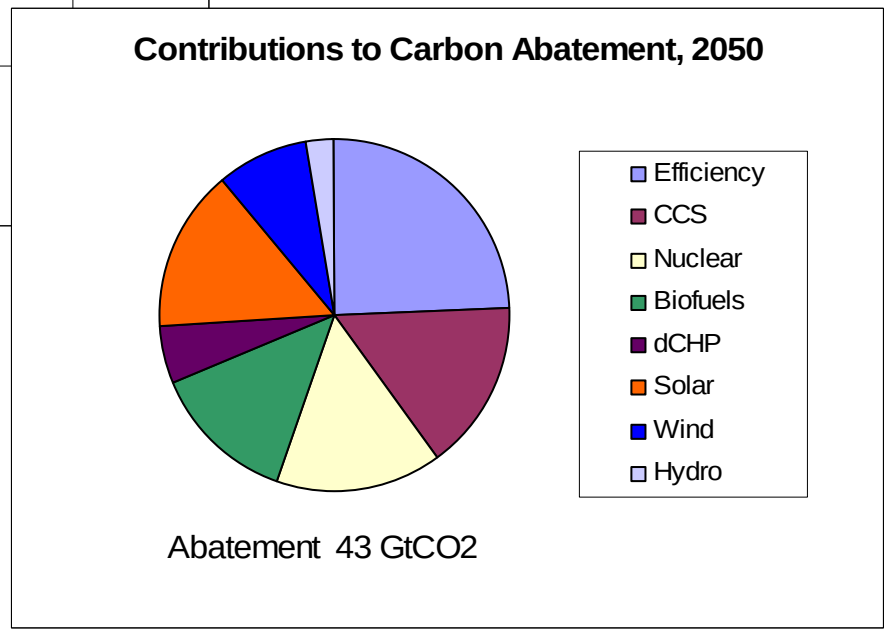
- reducing demand
- improving efficiency
- lower-carbon technologies
- non-energy emissions

Illustrative Marginal Abatement Option Cost Curve



Illustrative Distribution of Emission Savings by Technology





Average Cost of Reducing Fossil Fuel Emissions to 18 GtCO2 in 2050

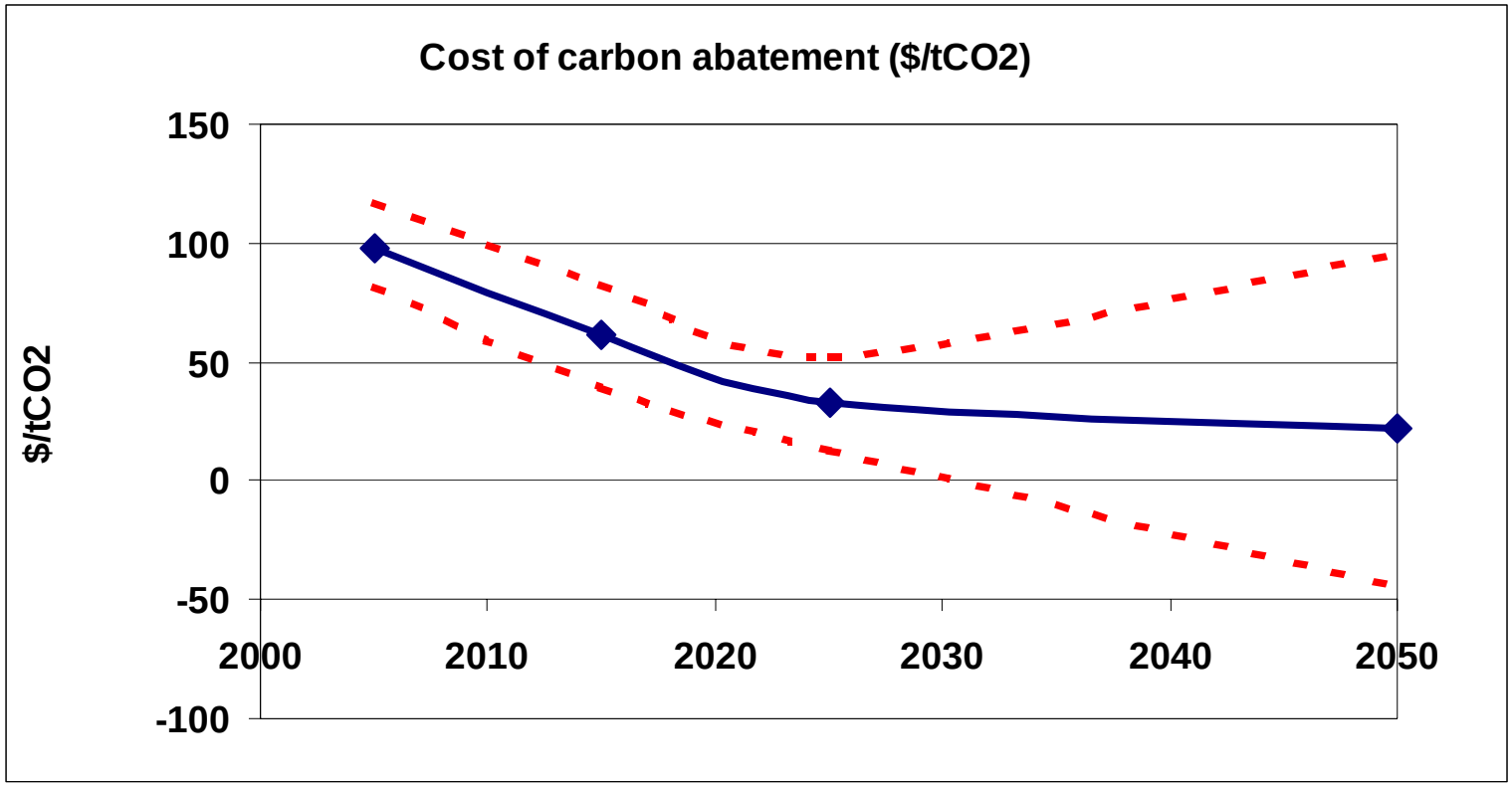


Table 9.1 Annual total costs of reducing fossil fuel emissions to 18 $GtCO_2$ in 2050			
	2015	2025	2050
Average cost of abatement, \$/t CO_2	61	33	22
Emissions Abated $GtCO_2$ (relative to emissions in BAU)	2.2	10.7	42.6
Total cost of abatement, \$ billion per year:	134	349	930

POLICY

Adaptation

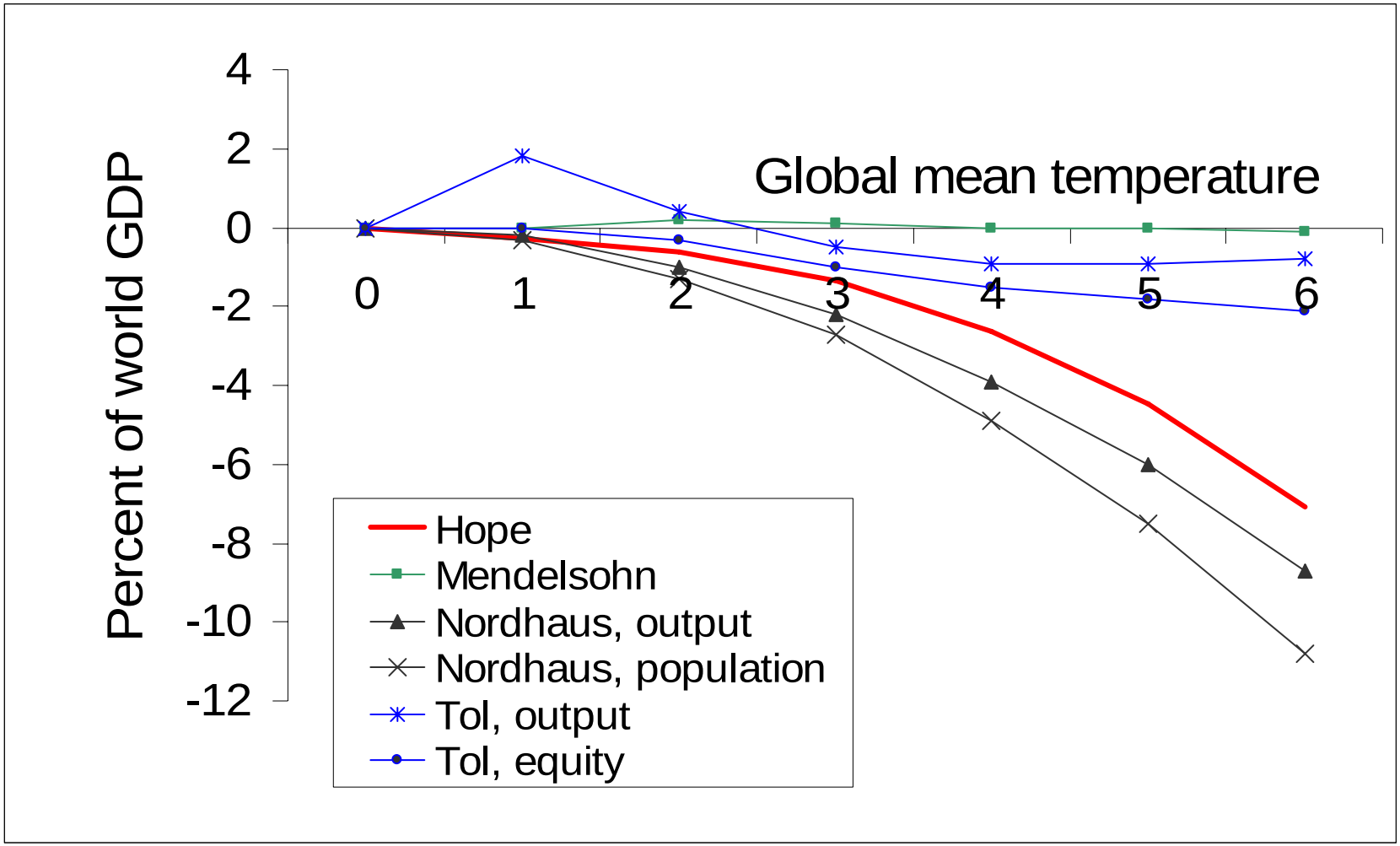
Adaptation is inevitable: climate change is with us and more is on the way

Adaptation cannot be a substitute for mitigation

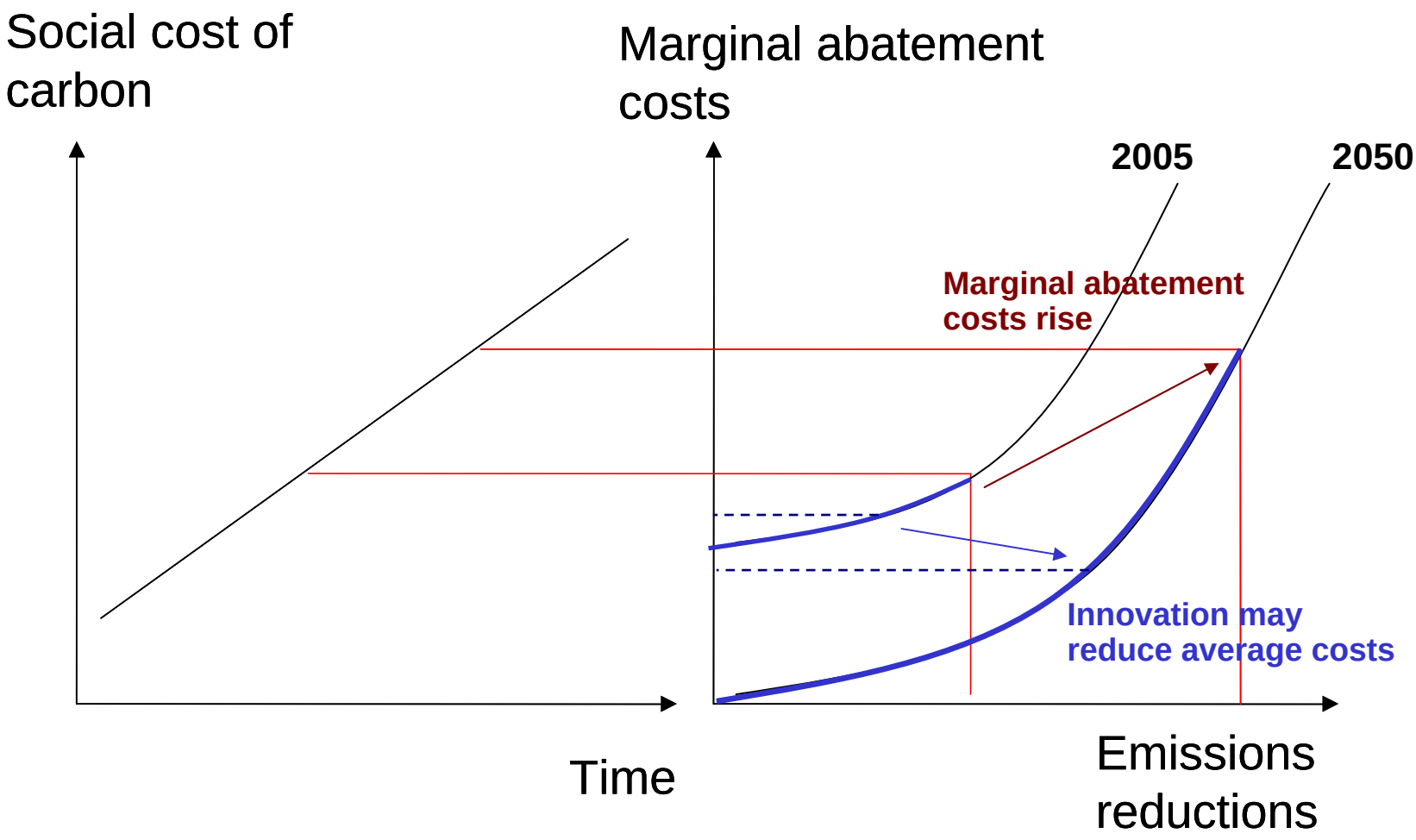
- only reduce the costs of climate change...
- ...but these are rising rapidly
- for severe impacts there are limits to what adaptation can achieve
- Doesn't address risks and uncertainty

Adaptation crucial in developing countries

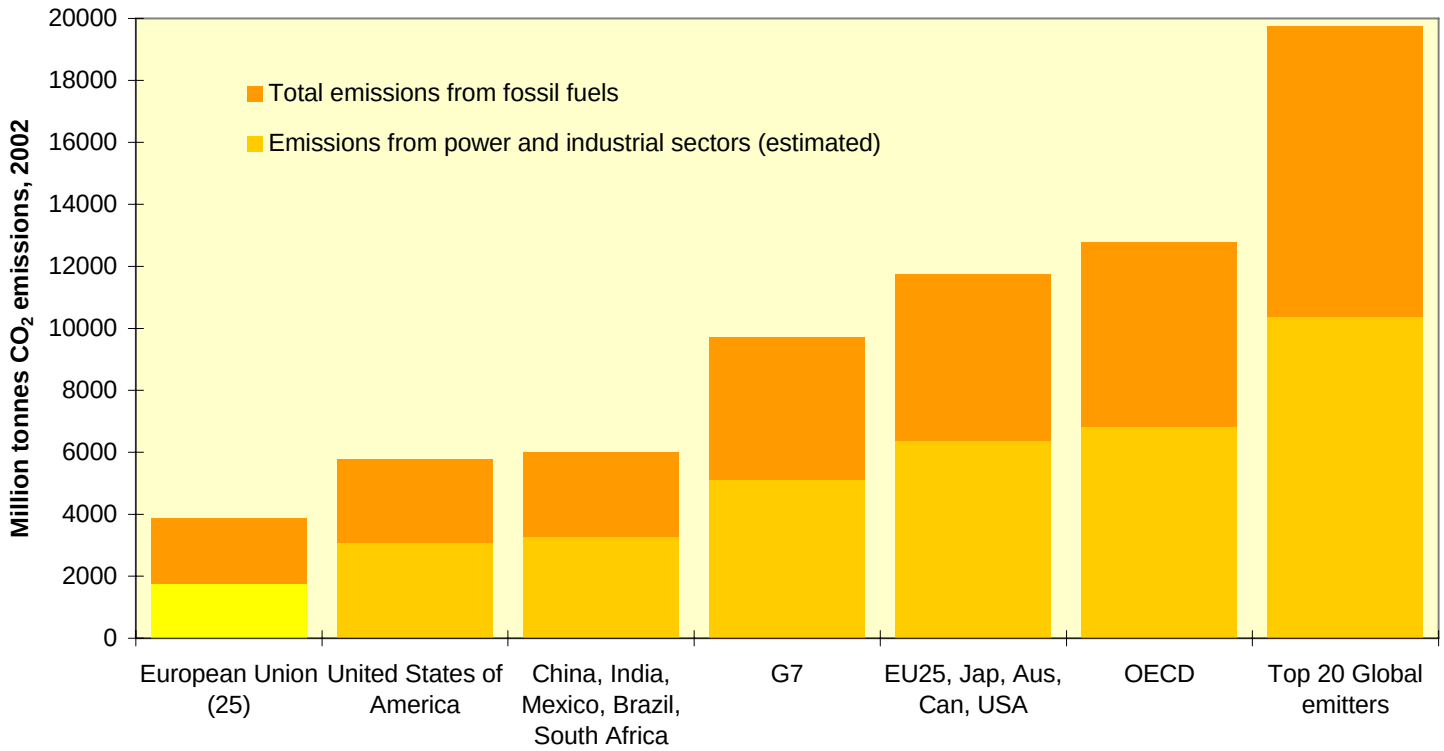
The PAGE model and other Integrated Assessment models



The Relationship Between the Social Cost of Carbon and Emissions Reductions



Global carbon markets can be expanded



- Increasing the size of global carbon markets – by expanding schemes to new sectors or countries, or linking regional schemes – can drive large flows across countries and promote action in developing countries

Additional points in critiques:

- Alarmist science
- IPCC emission scenarios (high with implausible population assumptions)
- Double counted risk
- Adaptation will dramatically reduce costs
- Confuse income and consumption
- Comparability of mitigation costs and impacts
- Bias/underestimation of mitigation costs
- High optimal tax rate
- No peer review

Key principles of international action

Effective action requires:

- Long-term quantity goals to limit risk; short-term flexibility to limit costs
- A broadly comparable global price for carbon
- Cooperation to bring forward technology
- Moving beyond sticks and carrots
- Equitable distribution of effort
- Transparency and mutual understanding of actions and policies

Spreading awareness of other countries actions

- EU – Strategic Energy Review – rejection of national plans
- US – State/City level action and technology support
- China – overall and firm level efficiency targets, standards, reforestation, export duty on energy efficient good

Much more to be done but positives elsewhere

Building international co-operation – a 6 point plan

- Agree stabilisation level – resultant emissions pathway
- Determine equity consideration
- National emissions targets (2050 60-80% developed countries – on course by 2020)
- Reducing costs through global carbon price (transfers through trading building coalitions)
- Addressing deforestation and technology policy
- Enforcement mechanism is the will of the domestic population – responsible behaviour

Conclusion

- Our understanding of the **risks** of climate change has advanced strongly.
- We understand the **urgency and scale** of action required.
- We know that the **technologies and economic incentives for effective action are available or can be created**
- We are in a much better position now to use our **shared understanding** to agree on what goals to adopt and what action to take.

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What is the economics of climate change and how does it depend on the science?

Climate change is an externality with a difference:

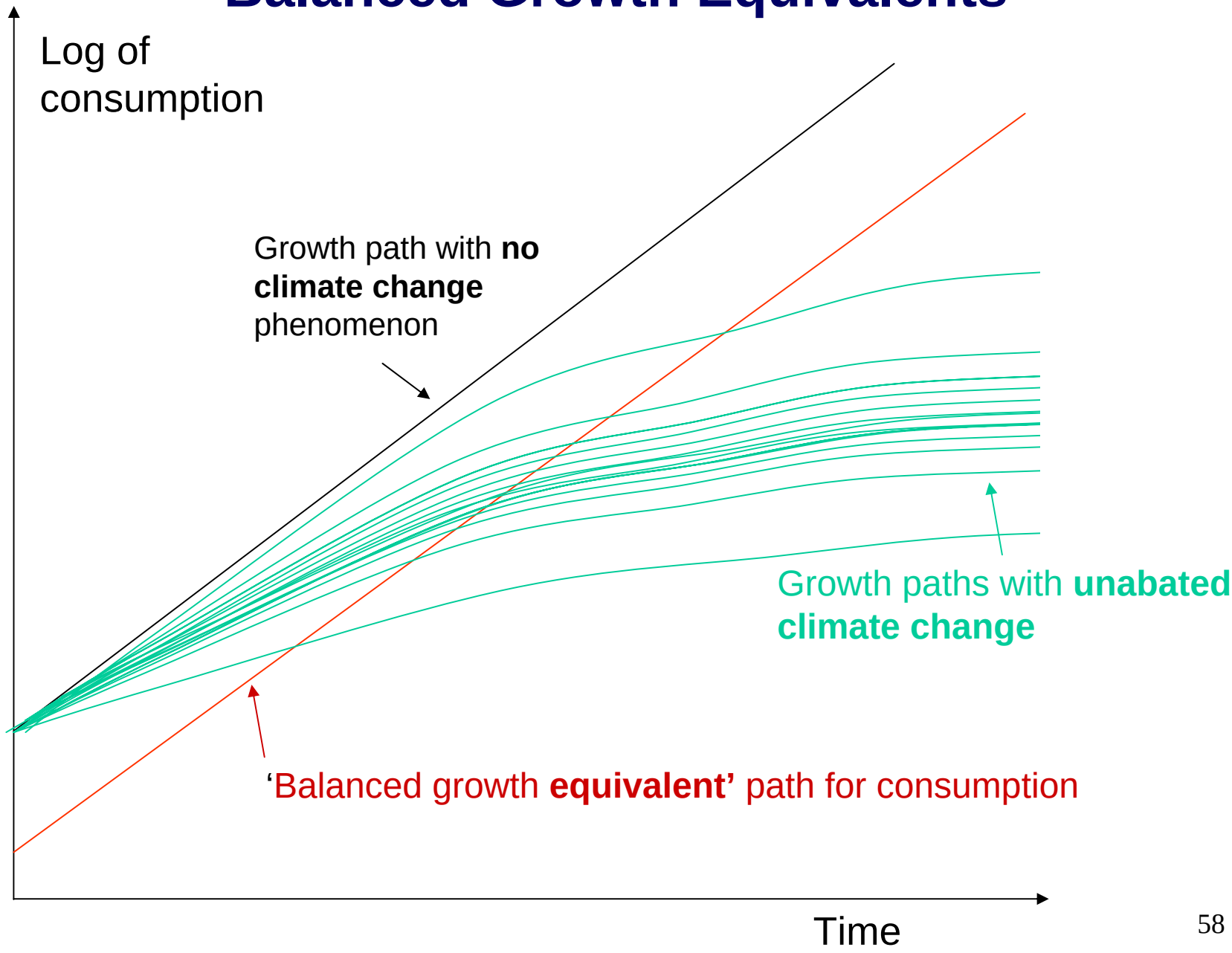
- Global
- Uncertain
- Long-term
- Potentially large and irreversible

Understanding Disaggregated Impacts

- **Developing countries** (especially vulnerable)
  - Rising water stress
  - Falling agricultural yields/incomes
  - Malnutrition and disease
  - Migration and conflict

- **Developed countries** (not immune)
  - Water stress in S. Europe and California
  - Costs of extreme weather events
  - Sea level rise
  - Higher insurance costs

‘Balanced Growth Equivalents’

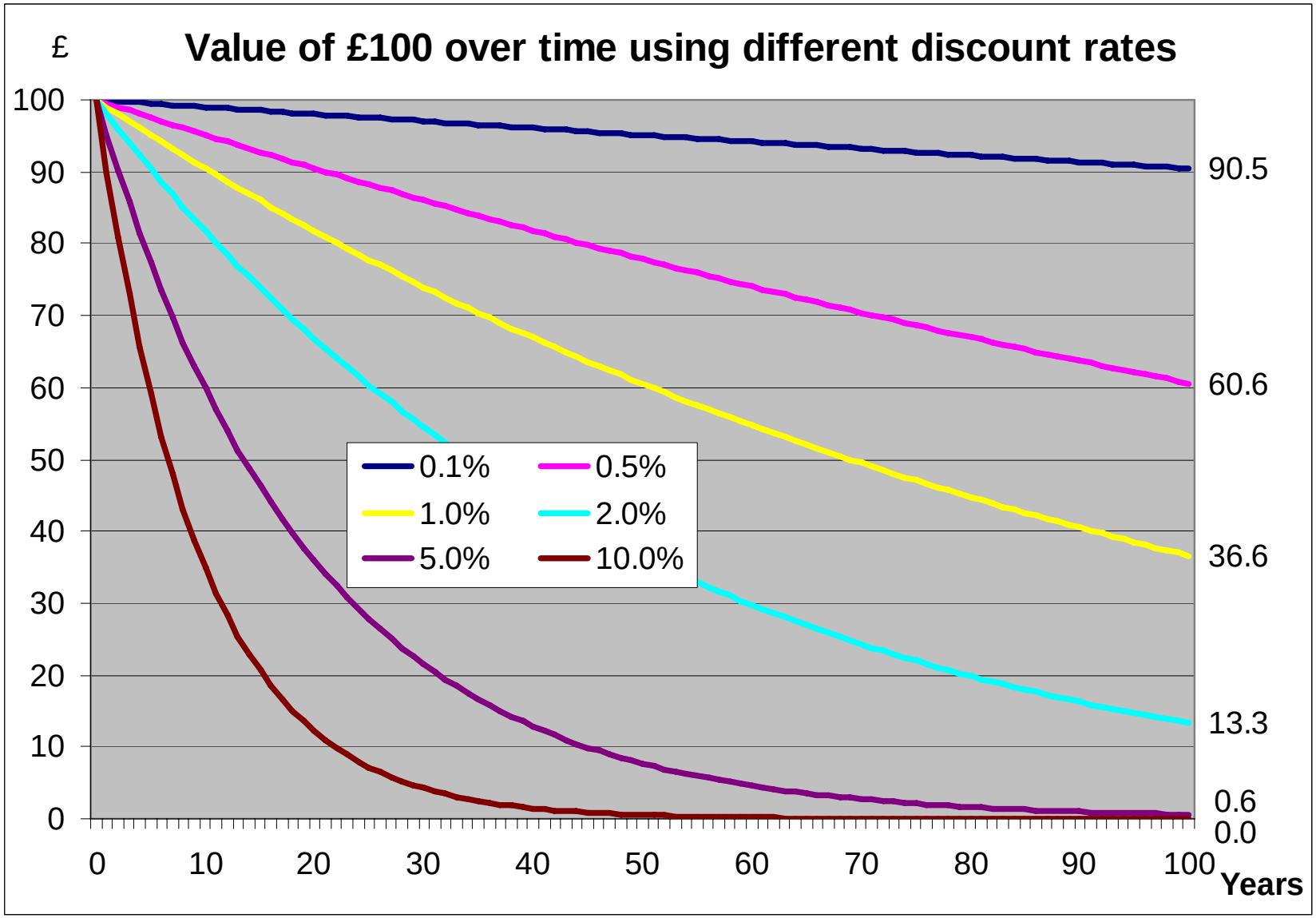


Discounting

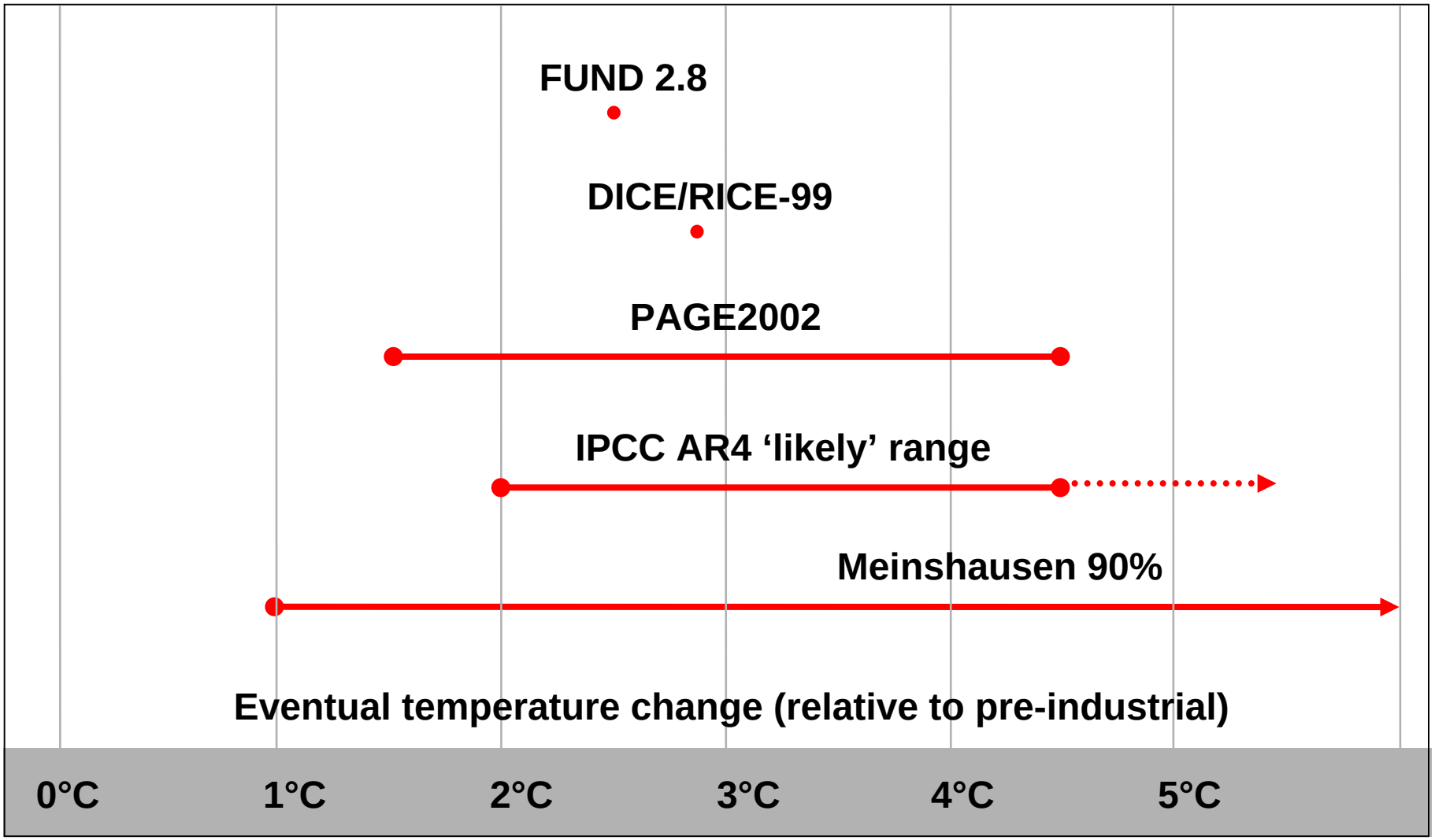
Pure time discount rate (%) δ	Probability of human race surviving 100 years
0.1	0.905
0.5	0.607
1.0	0.368
1.5	0.223

Discount Rate: η x GDP growth rate + δ

Sensitivity analysis: discounting



Estimates of climate sensitivity from IAMs compared to GCMs



Key research questions for policy

- Linking and expanding emissions trading schemes
- Developing and deploying CCS and other key technologies globally
- Planning for adaptation

Sensitivity analysis of cost estimates – model structure

	Variation	Change in % consumption damages (BGE)
Emissions scenario (population)	40% lower	-4
Increasing the damage function exponent	**Stochastic - 3**	**+20**
Growth	1% higher	+
Terminal conditions	Continued growth past 2200 or decline	High Sensitivity ++
Incorporating further risk and uncertainty	More parameter and baseline uncertainty	+3
Aversion to irreversibilities		+
Rise in price of environmental goods relative to consumption goods	Equivalent loss in consumption	++

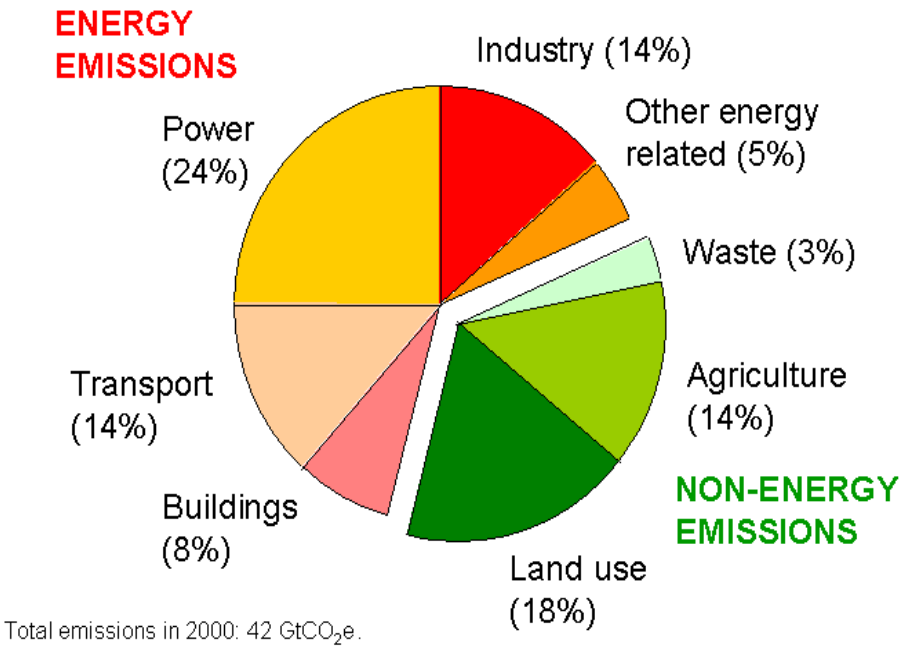
Bold – direct calculation (others are from other studies or 'back of the envelope')

Sensitivity analysis of cost estimates – value judgements

	Variation	Change in % consumption damages (BGE)
Increasing the elasticity of marginal utility of consumption (inequality and risk aversion)	**1-2**	**-7**
Increasing the pure rate of time preference	**0.1-1.5%**	**-8**
Intra-generational income distribution/regional equity weighting	Regional distribution	+6

Bold – direct calculation (others are from other studies or 'back of the envelope')

Strategies for Emission Reduction



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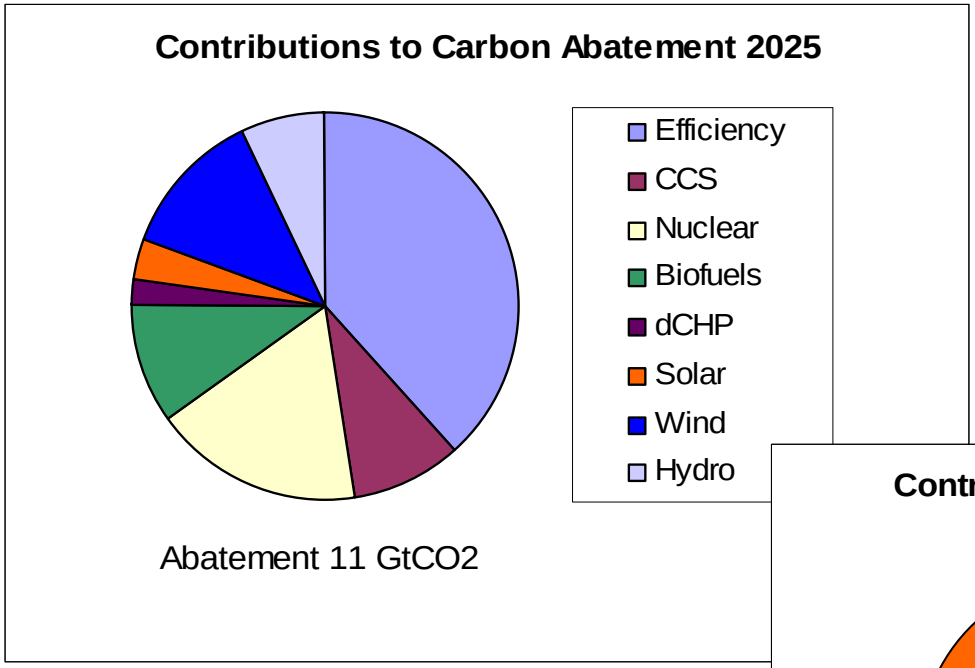
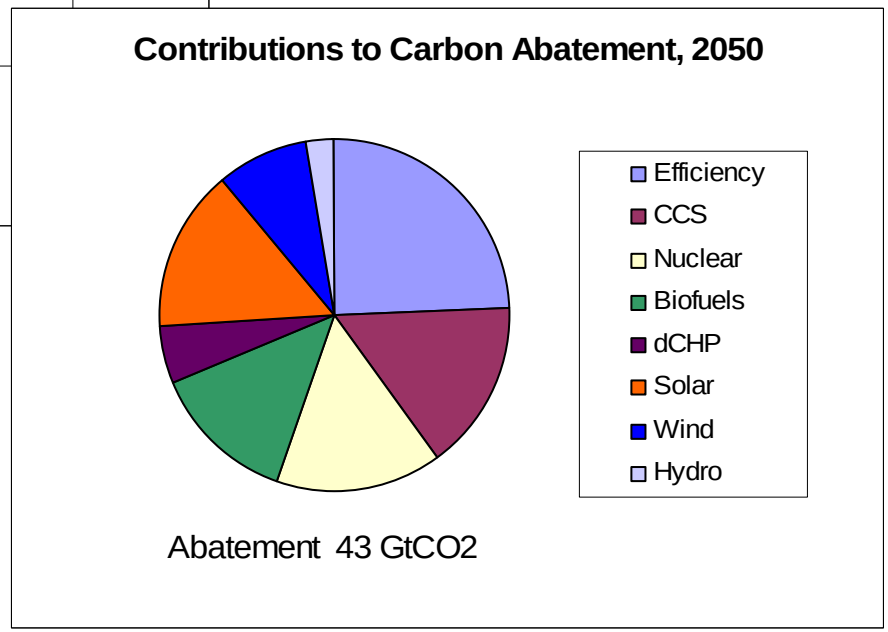
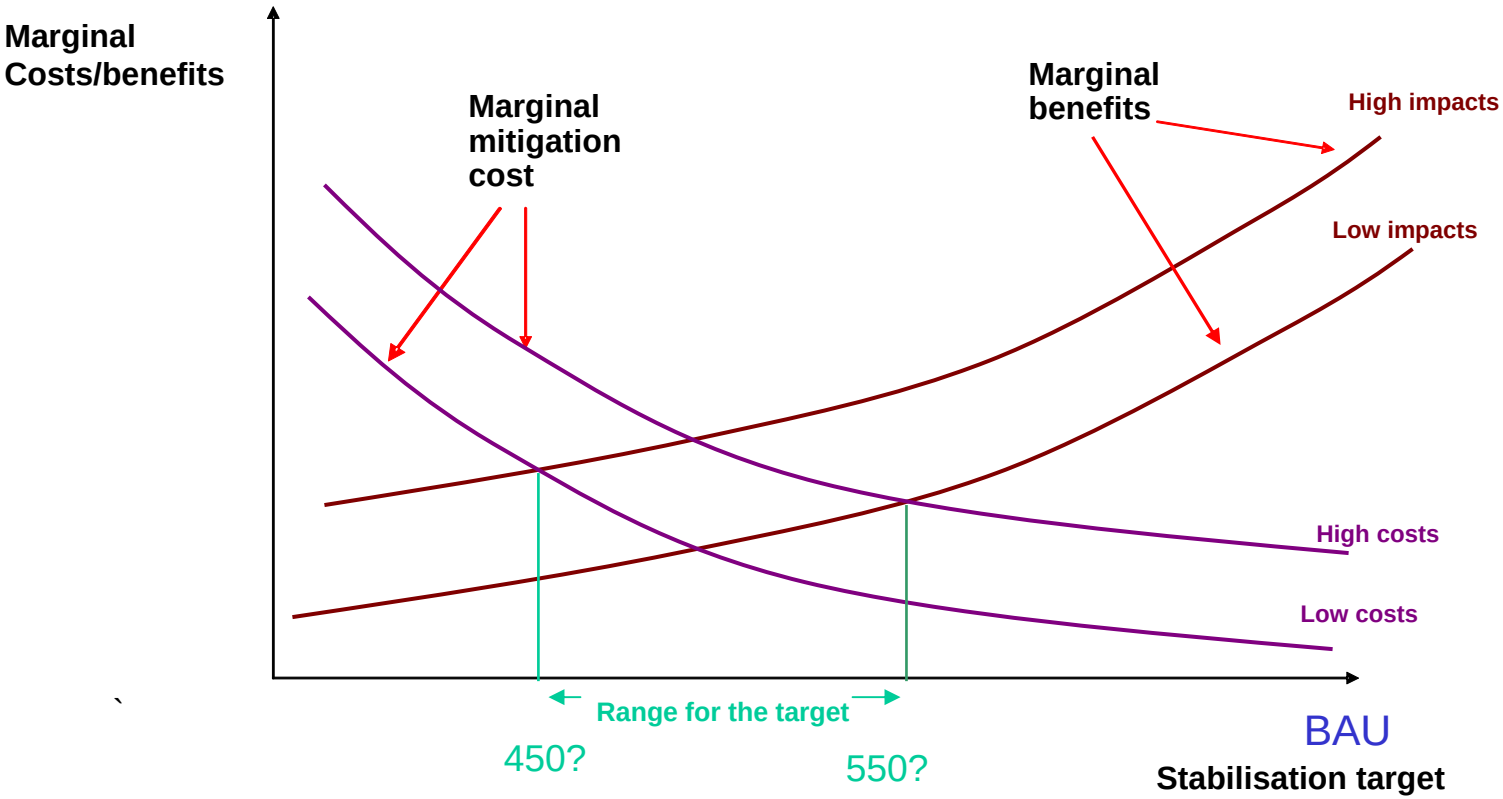




Schematic Representation of How to Select a Stabilisation Level



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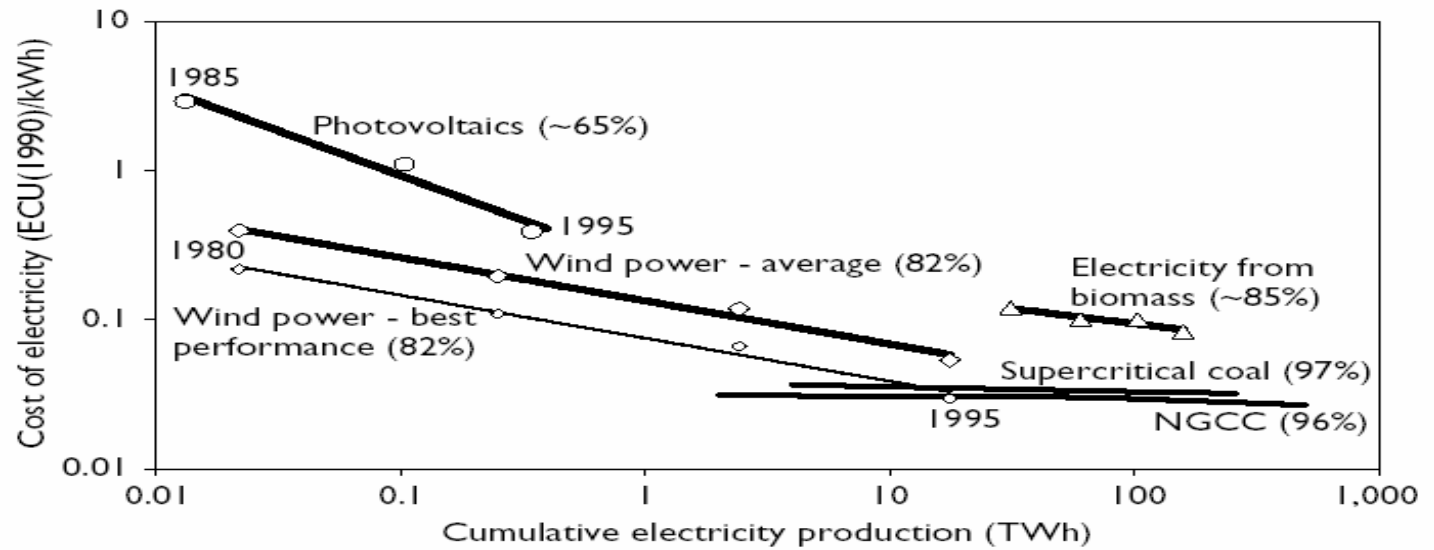
- Equitable distribution of effort
- Informing and mobilising public opinion

Technology needs more than a carbon price



Carbon price alone not enough to bring forward the technologies we need

One way of doing this is through global public funding for technologies:

- –R&D funding should double, to around $20 bn
- –Deployment incentives should increase 2 to 5 times, from current level of $34 bn

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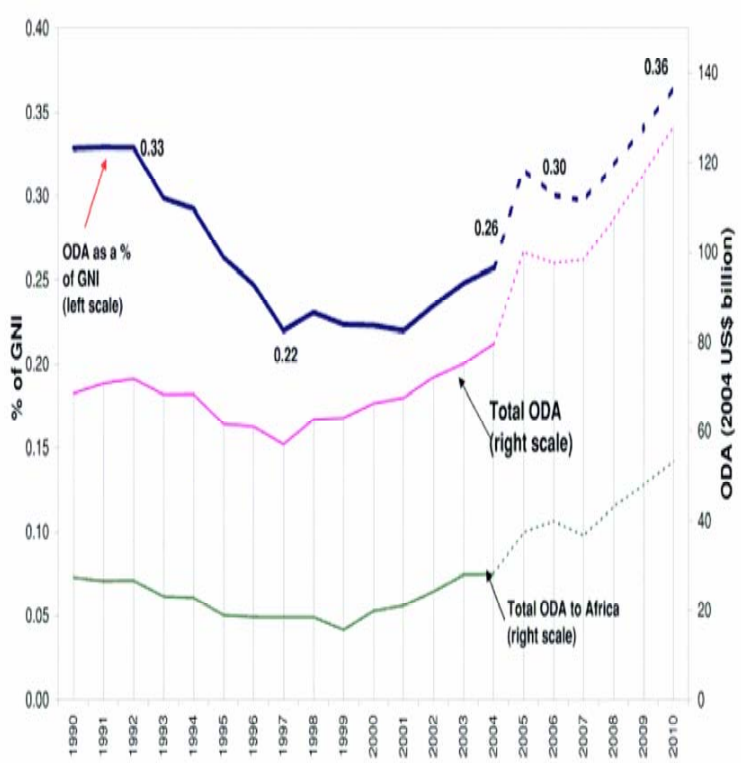
Adaptation crucial in developing countries

Adaptation

- Development increases resilience
- Adaptation will put strong pressure on developing country budgets and ODA: essential to meet 2010 and 2015 commitments
- International action also has a key role in supporting global public goods for adaptation
  - Disaster response
  - Crop varieties and technology
  - Forecasting climate and weather



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International finance flows should be scaled up for effective and equitable mitigation; arrangements such as the Clean Development Mechanism must be transformed to support much larger flows.

Carbon finance works best where national policies and programmes support low carbon development, and where a range of financial instruments for foreign and domestic investment are combined

The IFIs can play a very strong role in shaping investment frameworks and piloting new approaches – eg through the World Bank Energy Investment Framework

Policy for mitigation:
Establishing a carbon price

Price signals can be established in different ways: greenhouse gas taxes; capping emissions and setting up a market in permits; or implicitly through regulation.

Emissions trading is one powerful route to support international co-operation.

Credibility, flexibility and predictability are key if policy is to influence investment decisions by companies.

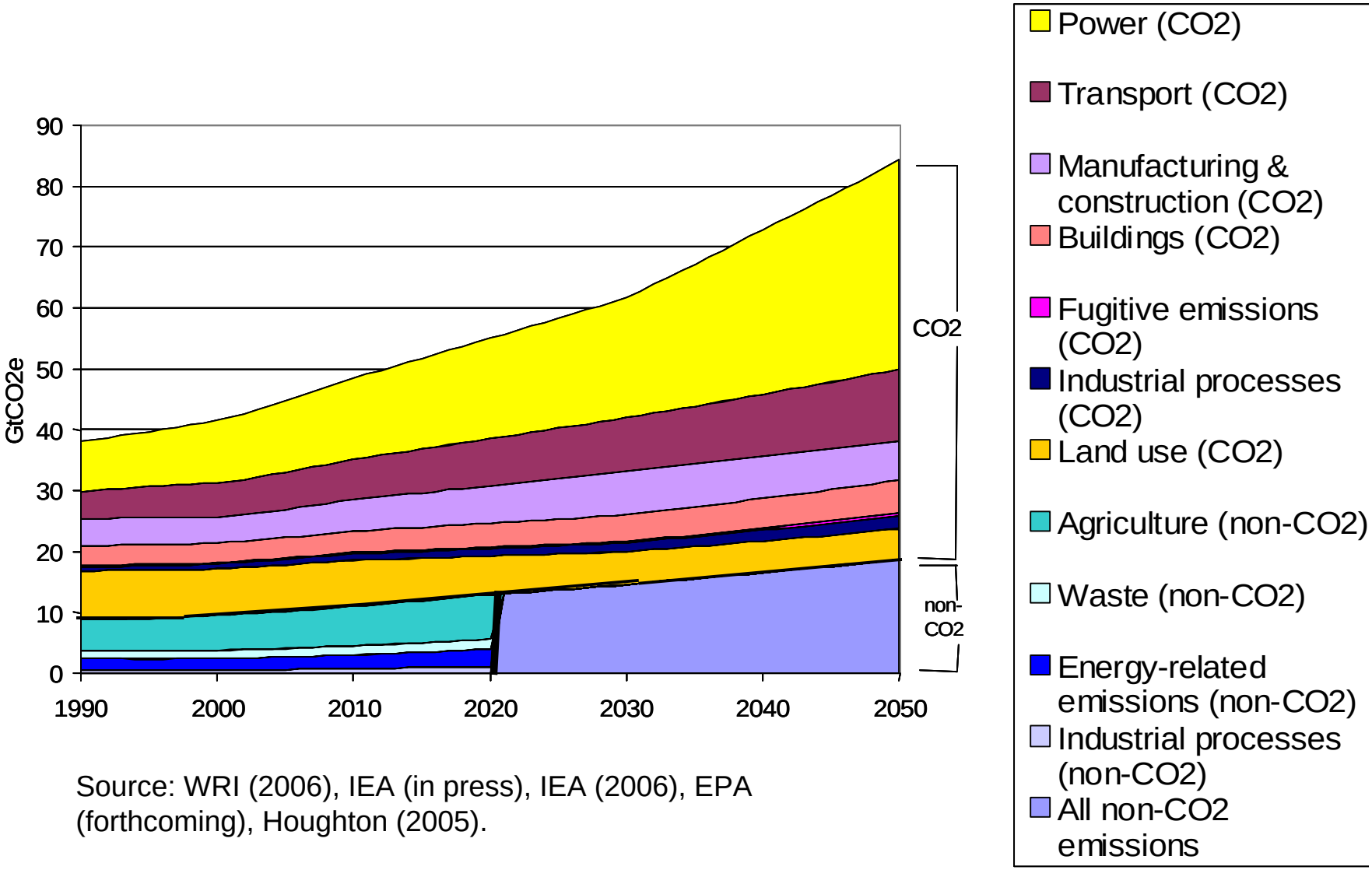
Sensitivity analysis: discounting

Damage function exponent	Utility discount rate	Baseline climate; market impacts + risk of catastrophe	Base climate; market impacts + risk of catastrophe + non-market impacts	High climate; market impacts + risk of catastrophe + non-market impacts
Low range	***0.1***	*5.0*	*10.9*	*14.4*
	0.5	3.6	8.1	10.6
	1.0	2.3	5.2	6.7
	1.5	1.4	3.3	4.2
High range	***0.1***	*6.0*	*14.2*	*21.9*
	0.5	4.3	10.2	15.8
	1.0	2.7	6.4	9.8
	1.5	1.7	4.0	5.9

Sensitivity analysis: damage function and elasticity of marginal utility of consumption

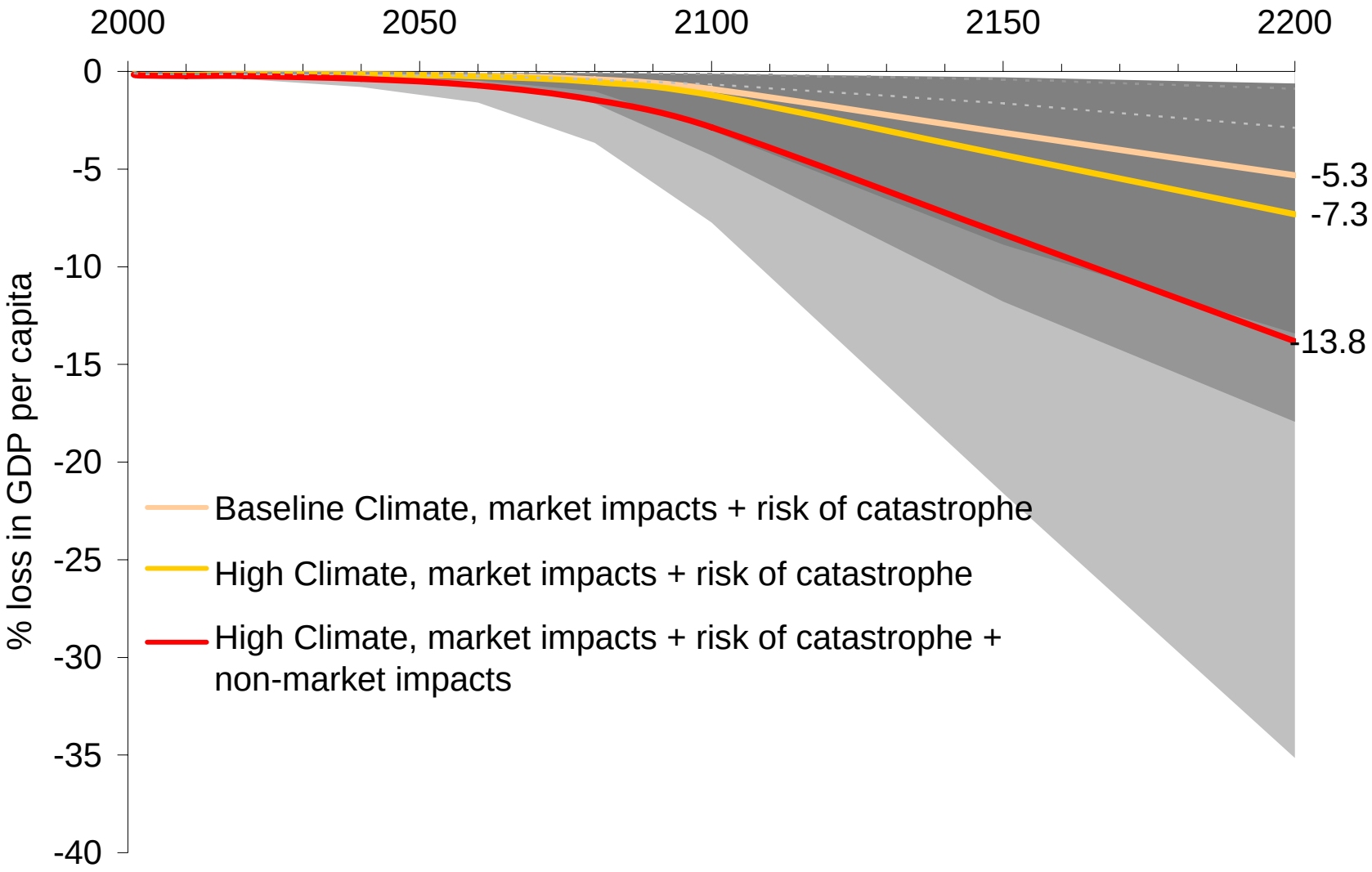
Damage function exponent	**Elasticity of marginal utility of consumption**	**Baseline climate; market impacts + risk of catastrophe** **Mean (5th percentile, 95th percentile)**	**Baseline climate; market impacts + risk of catastrophe + non-market impacts** **Mean (5%, 95%)**	**High climate; market impacts + risk of catastrophe + non-market impacts** **Mean (5%, 95%)**
Low range	***1.0***	*5.0 (0.6-12.4)*	*10.9 (2.2-27.4)*	*14.4 (2.7-32.6)*
	1.25	3.8 (0.6-9.6)	8.7 (2.2-21.7)	12.1 (2.7-26.0)
	1.5	2.9 (0.5-7.1)	6.5 (1.7-16.5)	10.2 (2.0-20.0)
High range	**1.0**	6.0 (0.8-15.5)	14.2 (2.8-32.2)	21.9 (3.7-51.6)
	1.25	4.6 (1.8-12.0)	11.3 (2.6-25.2)	18.2 (3.8-41.9)
	1.5	3.4 (0.3-9.0)	8.7 (1.8-19.2)	15.3 (2.8-33.1)

Historical and projected GHG emissions by sector (by source)

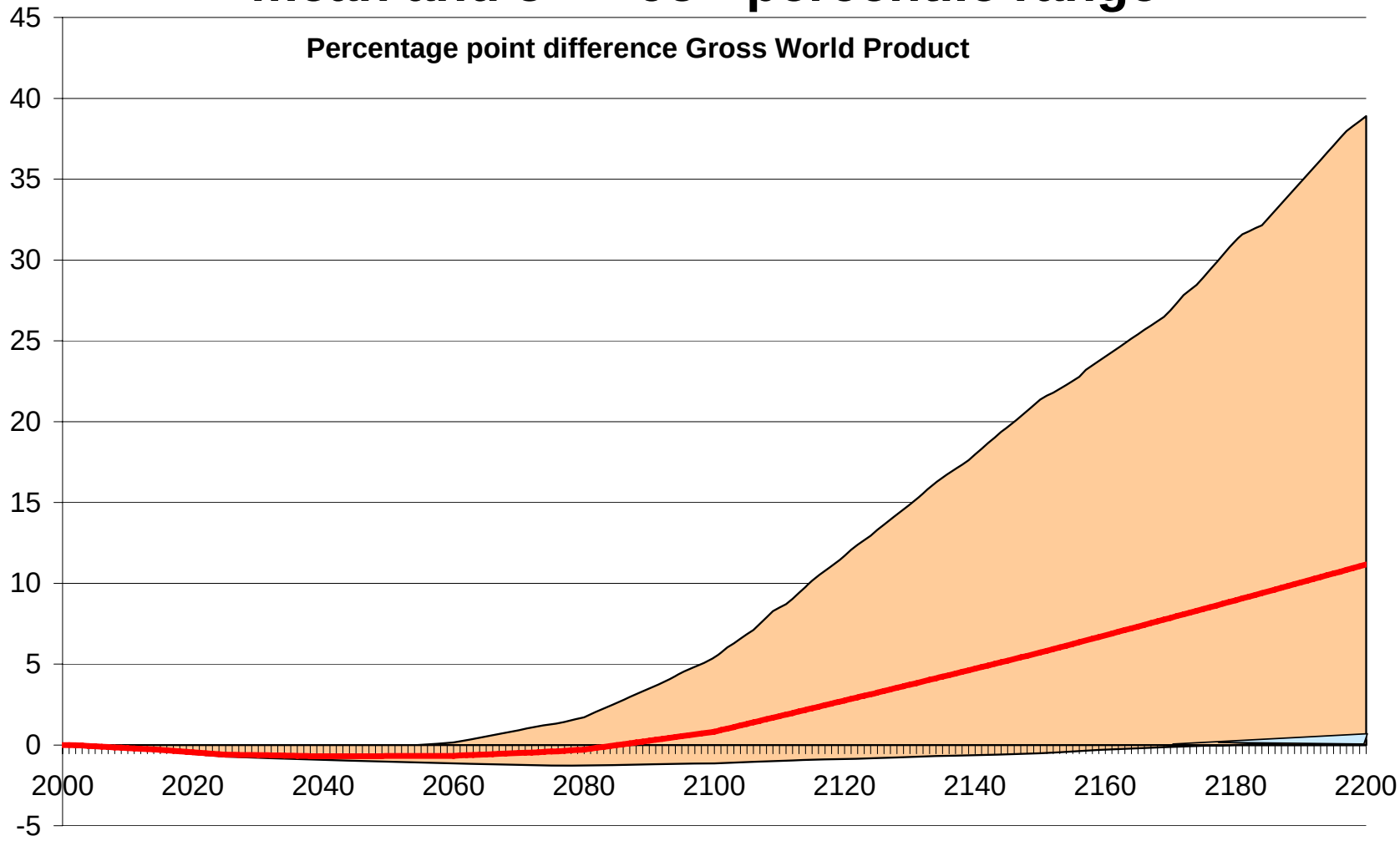


Source: WRI (2006), IEA (in press), IEA (2006), EPA (forthcoming), Houghton (2005).

Damages


2000
2050
2100
2150
2200
0
-5
-10
-15
-20
-25
-30
-35
-40
% loss in GDP per capita
-5.3
-7.3
-13.8
Baseline Climate, market impacts + risk of catastrophe
High Climate, market impacts + risk of catastrophe
High Climate, market impacts + risk of catastrophe + non-market impacts

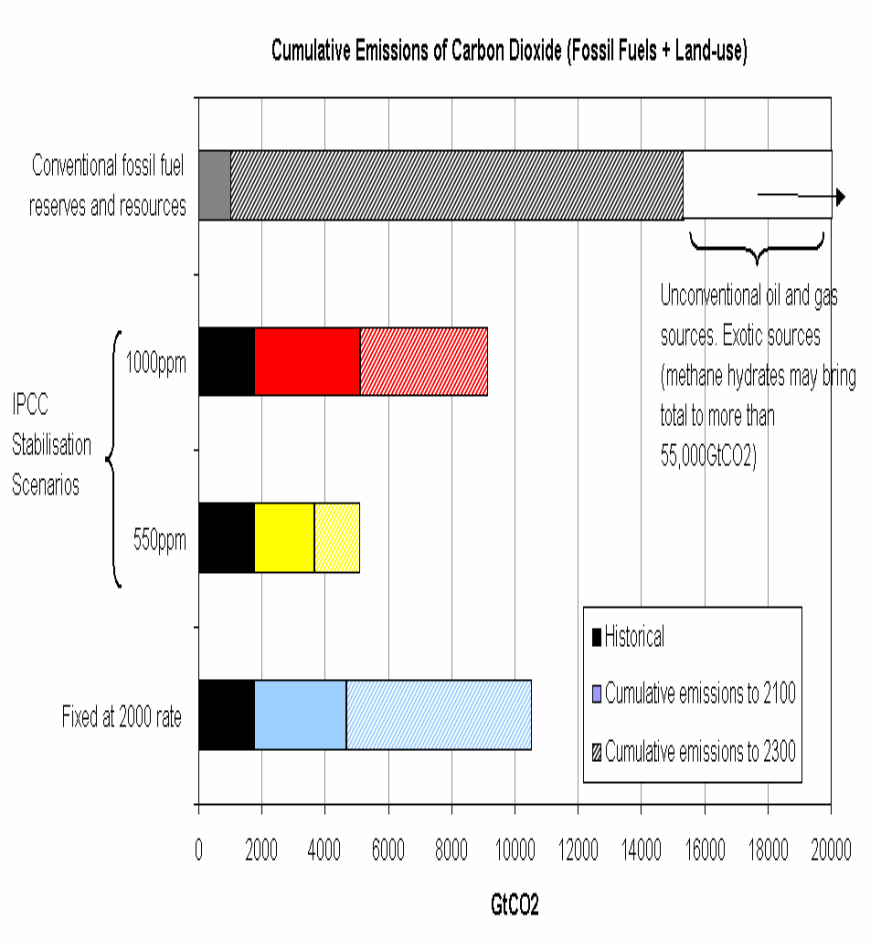
‘Output gap’ between the ‘550ppm $C0_2e$ and 1% GWP mitigation cost’ scenario and BAU scenario, mean and 5th – 95th percentile range



There are more than enough proven reserves to get to 1000ppm CO_2

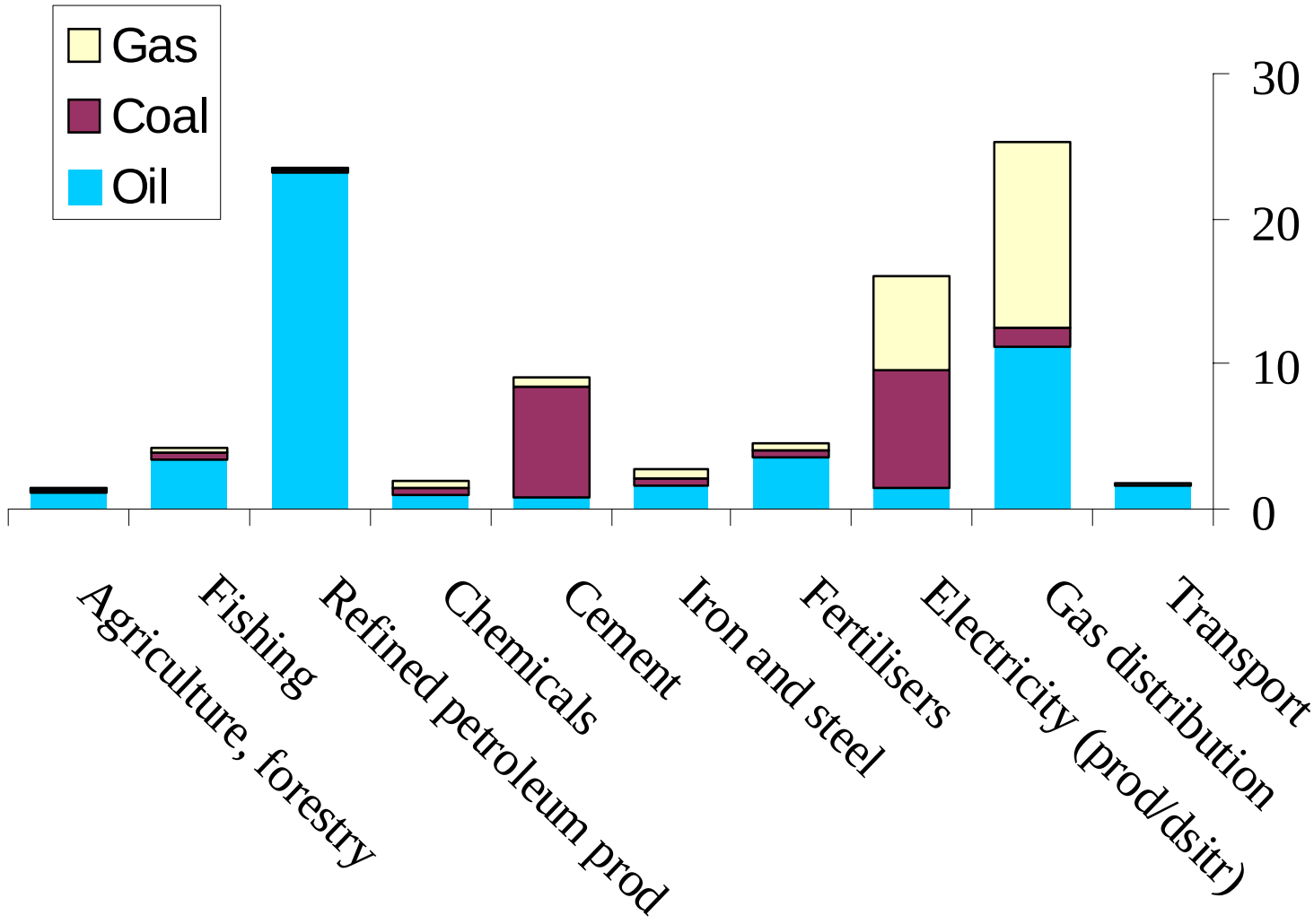
Peak oil is not the answer… Non-conventional sources of oil (tar sands, coal liquefaction etc) are far more carbon intensive than conventional oil deposits

Large reserves of coal available for cheap and reliable energy in many large and fast-growing economies

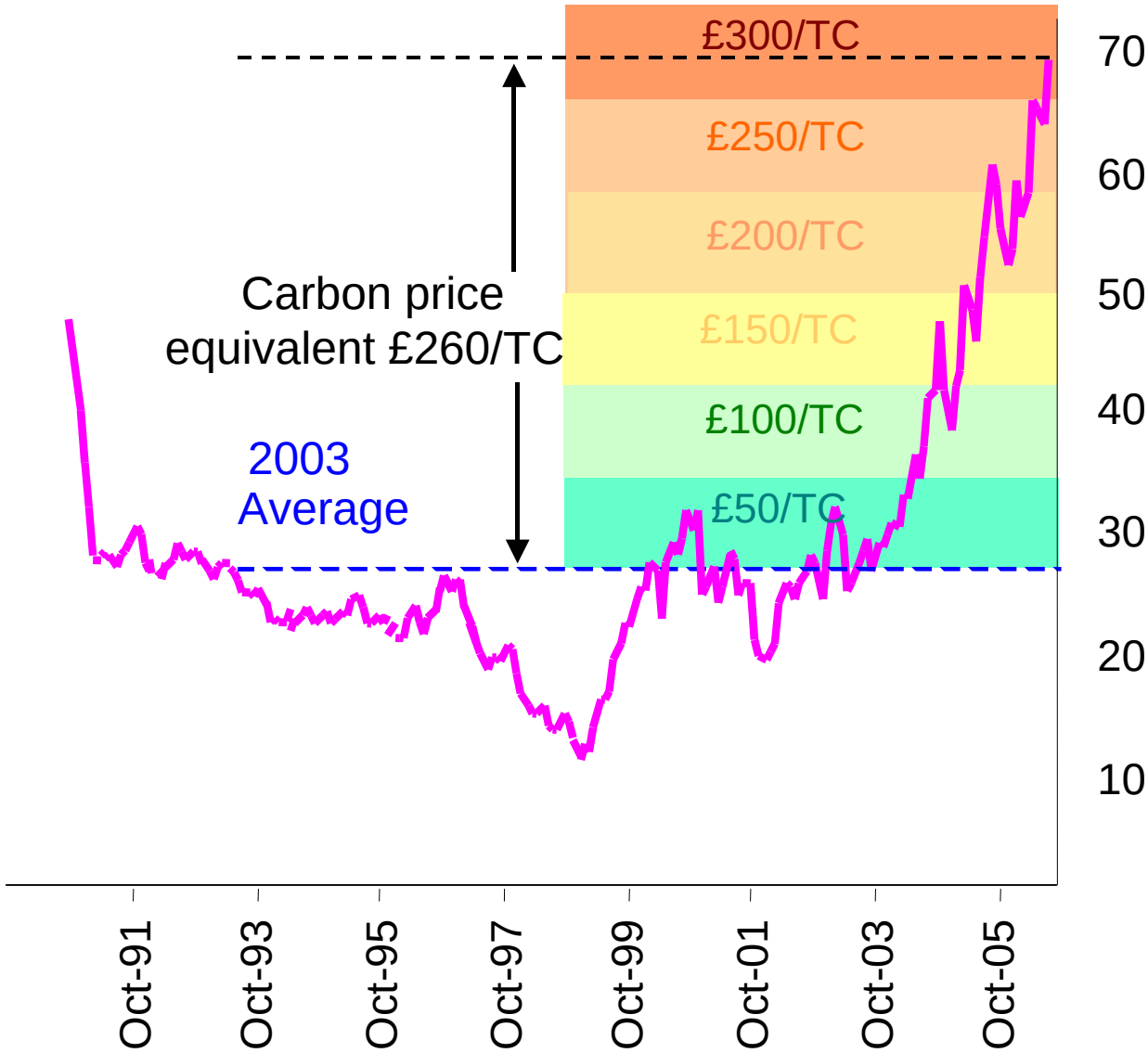


Source: Lenton et al (2006), IPCC

Product price increases from £70/tC pricing (full pass-through), percent



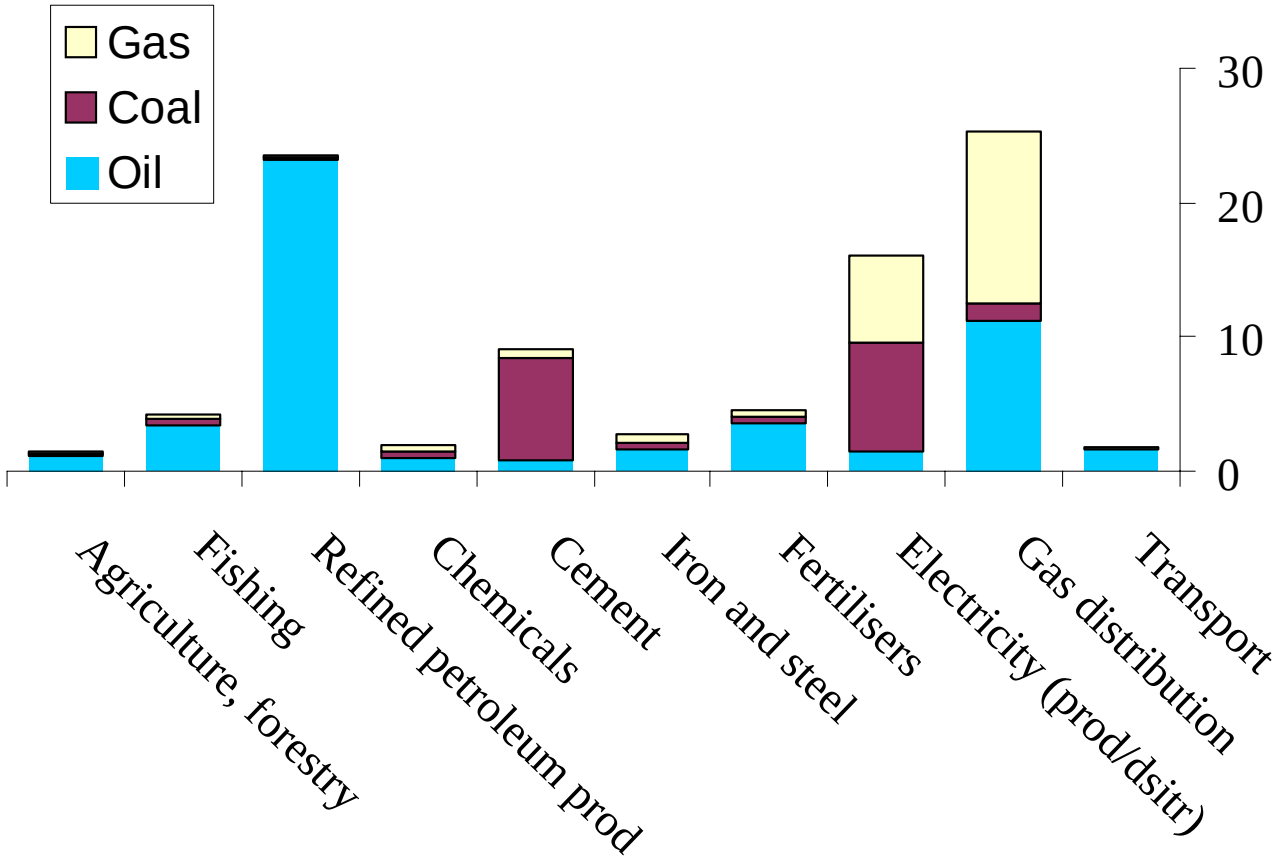
The recent rise in the Brent spot price, US $ per barrel (2003 prices)



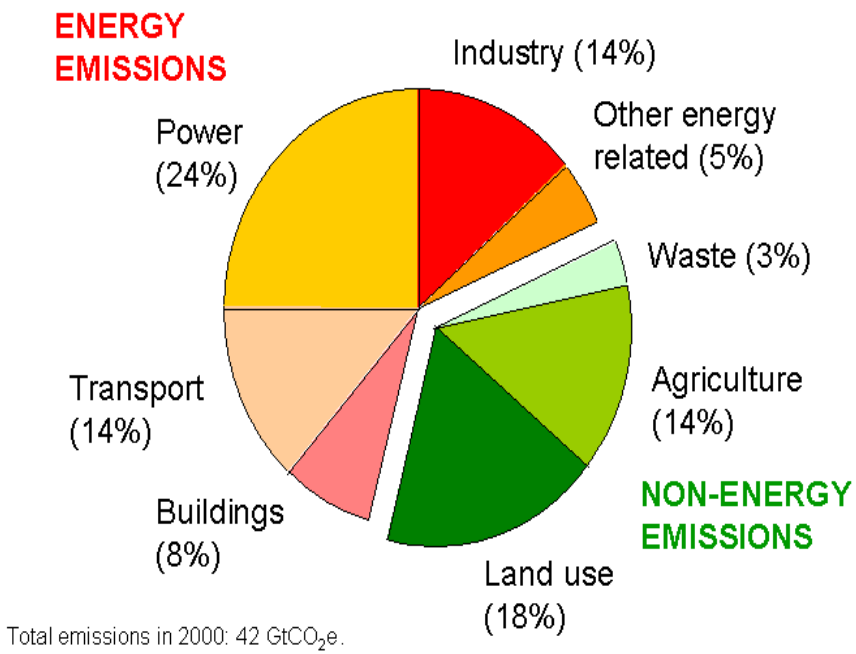
Competitiveness - key messages

- Main objective of mitigation is to change relative prices of carbon-intensive goods; reallocate resources away from carbon-intensive activities!
- The challenge will be managing the transition to coordinated international action; acting at the EU level will be vital
- Total fossil fuel energy costs account for 3% of variable costs in UK production; introducing a £10/tC carbon price would have a similar size of impact on economy as a 6% rise in oil and gas prices
- UK Input-Output tables tables & empirical studies suggest carbon-intensive tradable industries are unlikely to divert trade significantly or relocate if action is taken at an EU level
- Action may boost long-term growth for economies/firms that anticipate change, have the skills, flexibility and technological capacity to take advantage of them

Carbon intensity
Product price increases from £70/tC pricing (full pass-through), per cent



Avoiding deforestation



- Curbing deforestation is highly cost-effective, and significant
- Forest management should be shaped and led by nation where the forest stands
- Large-scale pilot schemes could help explore alternative approaches to provide effective international support

Has energy policy risen to meet the climate change challenge?

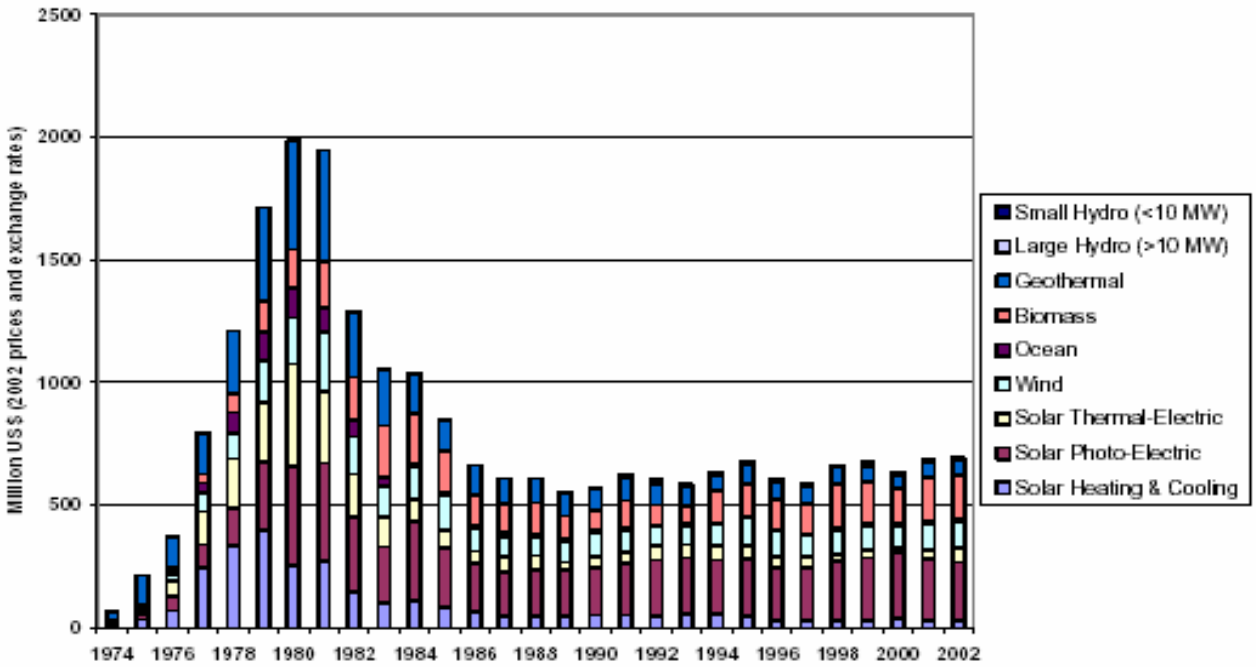
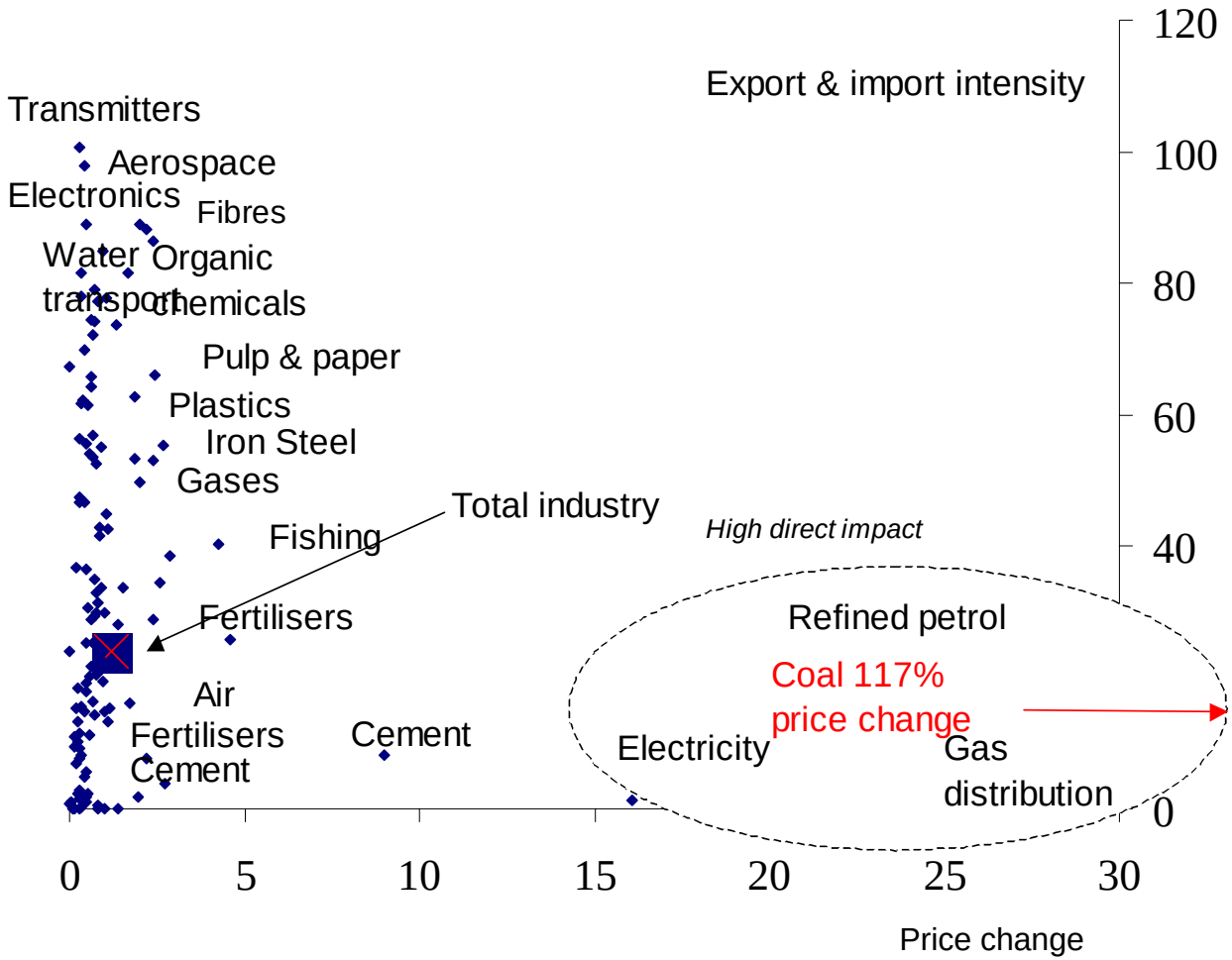


Figure 11 Renewable Energy Technology RD&D (IEA, 2004)

Energy RD&D more generally shows a similar pattern

Renewable energy RD&D remains at around 8% of total energy RD&D

Vulnerable industries
Price sensitivity and trade exposure, per cent



Export and import intensity is defined as exports of goods and services as a percentage of total supply of goods and services, plus imports of goods and services as a percentage of total demand for goods and services. Output is defined as gross, so the maximum value attainable is 200.

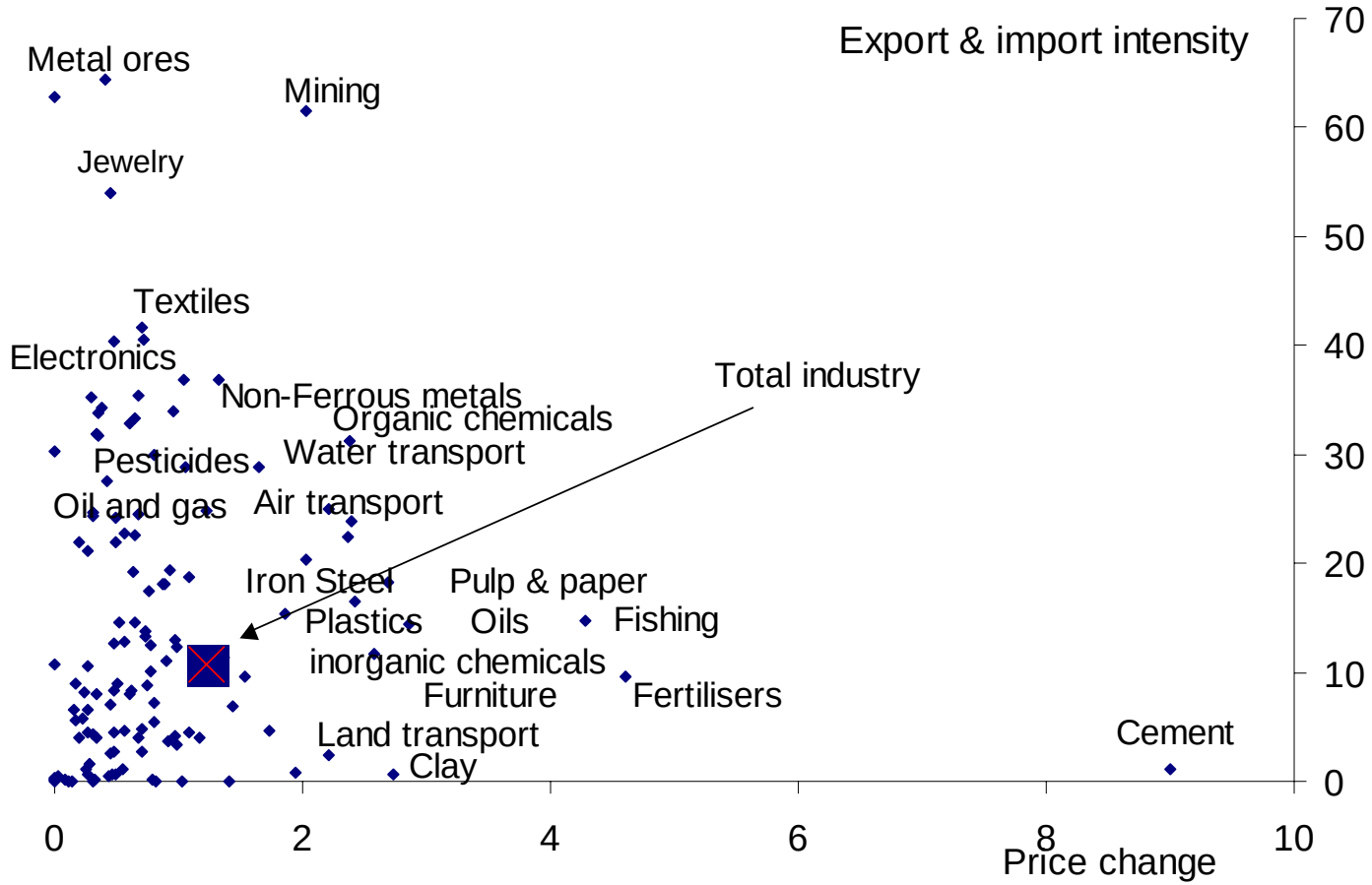
Action at EU level

Key aim is multilateral agreement, but managing the transition argues for EU proceeding ASAP, and ahead of the pack if necessary:

- key step in getting the institutions in place to build a global consensus for climate action
- promoting trust; improving the chances of bringing others in
- avoiding replacing obsolescent capital with long-lived, high-carbon plant and machinery, which would have to be replaced later;
- developing a comparative advantage in ‘clean tech’, potentially high-growth, areas; and
- ancillary benefits such as clean air and energy security

Vulnerable industries

Price sensitivity and non-EU trade exposure, per cent



Export and import intensity is defined as UK exports of goods and services to non-EU as a percentage of total supply of goods and services, plus UK imports of goods from non_EU and services as a percentage of total demand for goods and services. Output is defined as gross, so the maximum value attainable is 200.

Expectations of collective action

- Trade diversion & relocation are less likely, the stronger the expectation of global action
- Iceland has used clean energy to attract energy-intensive sectors
- Aluminium firms settling In Iceland in anticipation of global carbon pricing
- Not acting alone: action has been taken in many countries including China and the US:
  - Energy efficiency;
  - R&D in low-carbon technologies;
  - Carbon trading schemes

Whole-economy competitiveness

- Energy-intensive industries account for a small and falling proportion of UK output
- When the illustrative carbon price of £70/tC is applied, whole economy production and consumer goods prices might be expected to rise by just over one per cent.
- The 19 (out of 123) most carbon intensive UK sectors account for less than 5% of total output & would see variable costs increase of more than 2%
- Only 6 would undergo an increase of 5%+:
  - Gas supply and distribution (28%); Refined petroleum (24%); Electricity production and distribution (19%); Cement (9%); Fertilisers (5%); Fishing (5%)

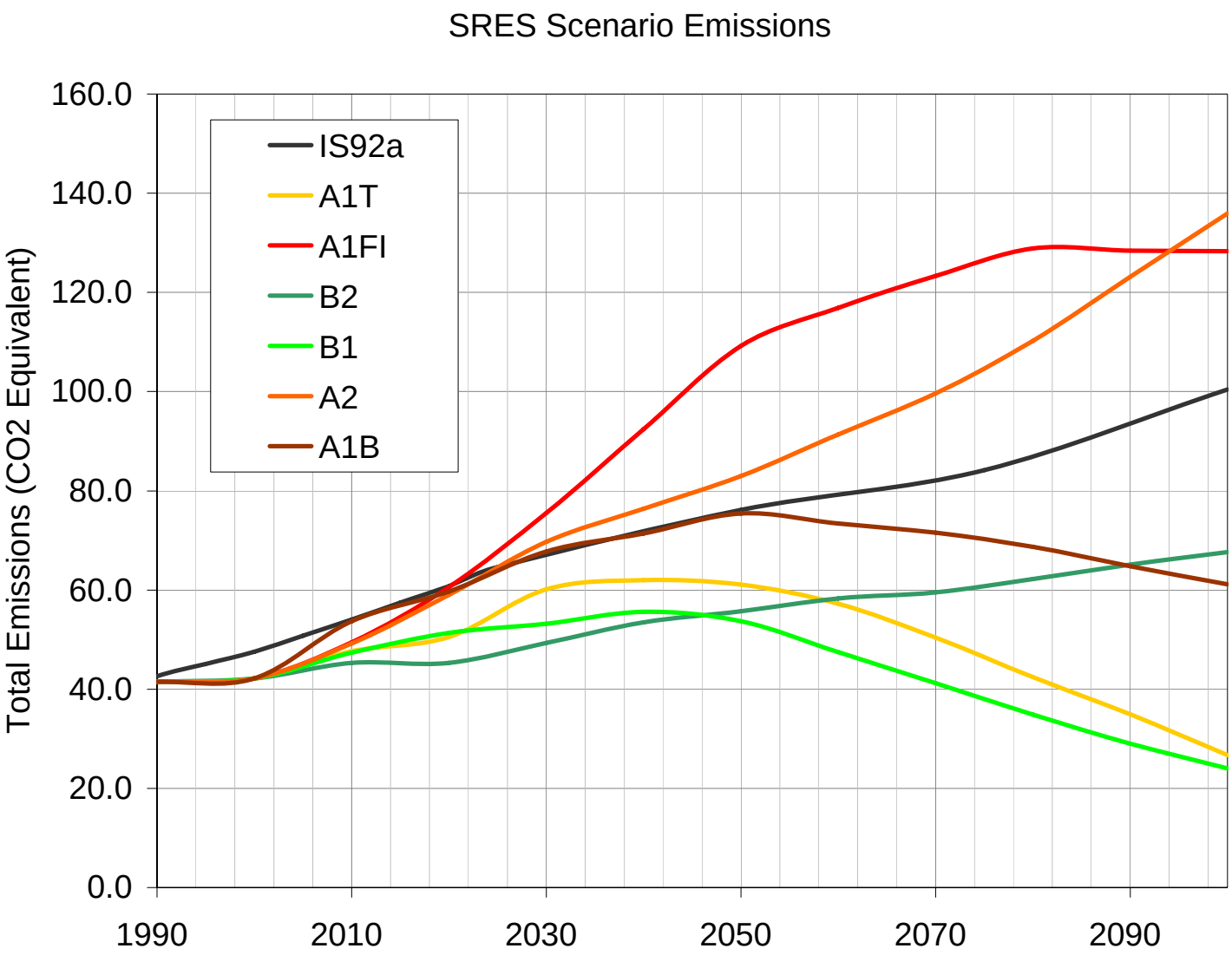
Whole-economy competitiveness

- Whole-economy competitiveness depends on factors that determine productivity growth
- Economies with high skills, technological capacity and flexible markets and governments that anticipate trends will manage the transition best
- Mitigation can promote innovation in clean technology & steer comparative advantage into ‘clean’ income elastic sectors, with potentially large knowledge externalities
- The gains from carbon mitigation in terms of energy efficiency and innovation may be diffuse, spread across the economy, and hard to identify (unlike the costs), but their net effect can be large

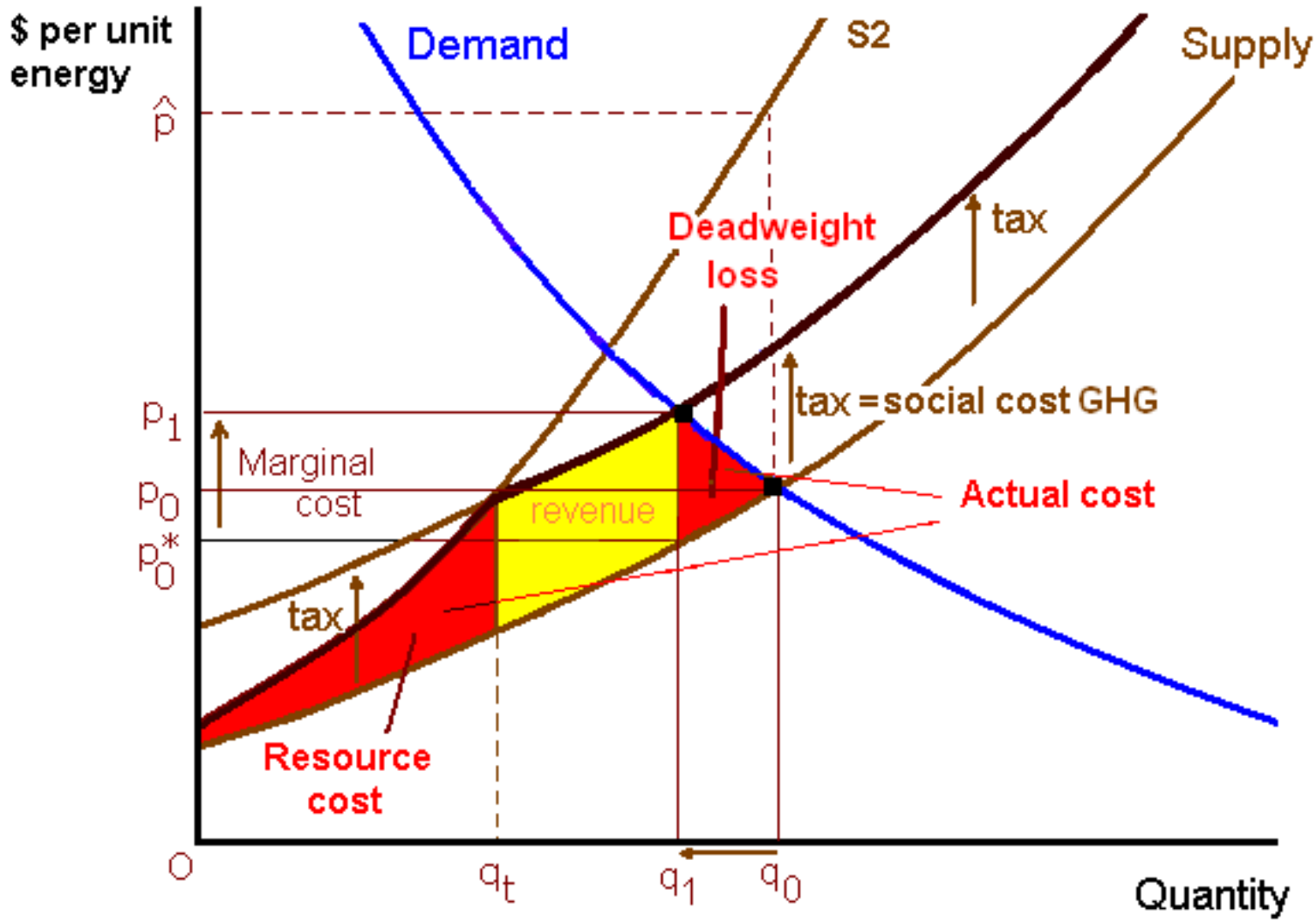
Competitiveness - Conclusion

- Main objective of mitigation is to reallocate resources away from carbon-intensive activities
- The challenge will be managing the transition to coordinated international action
- Total fossil fuel energy costs account for a small part of whole economy costs
- Carbon-intensive tradable industries are unlikely to divert trade significantly or relocate, especially if action is taken at an EU level (which is vital), but important not to exaggerate threat if UK acted unilaterally
- Action may boost long-term growth for economies that anticipate change, have the skills, flexibility and technological capacity to adapt

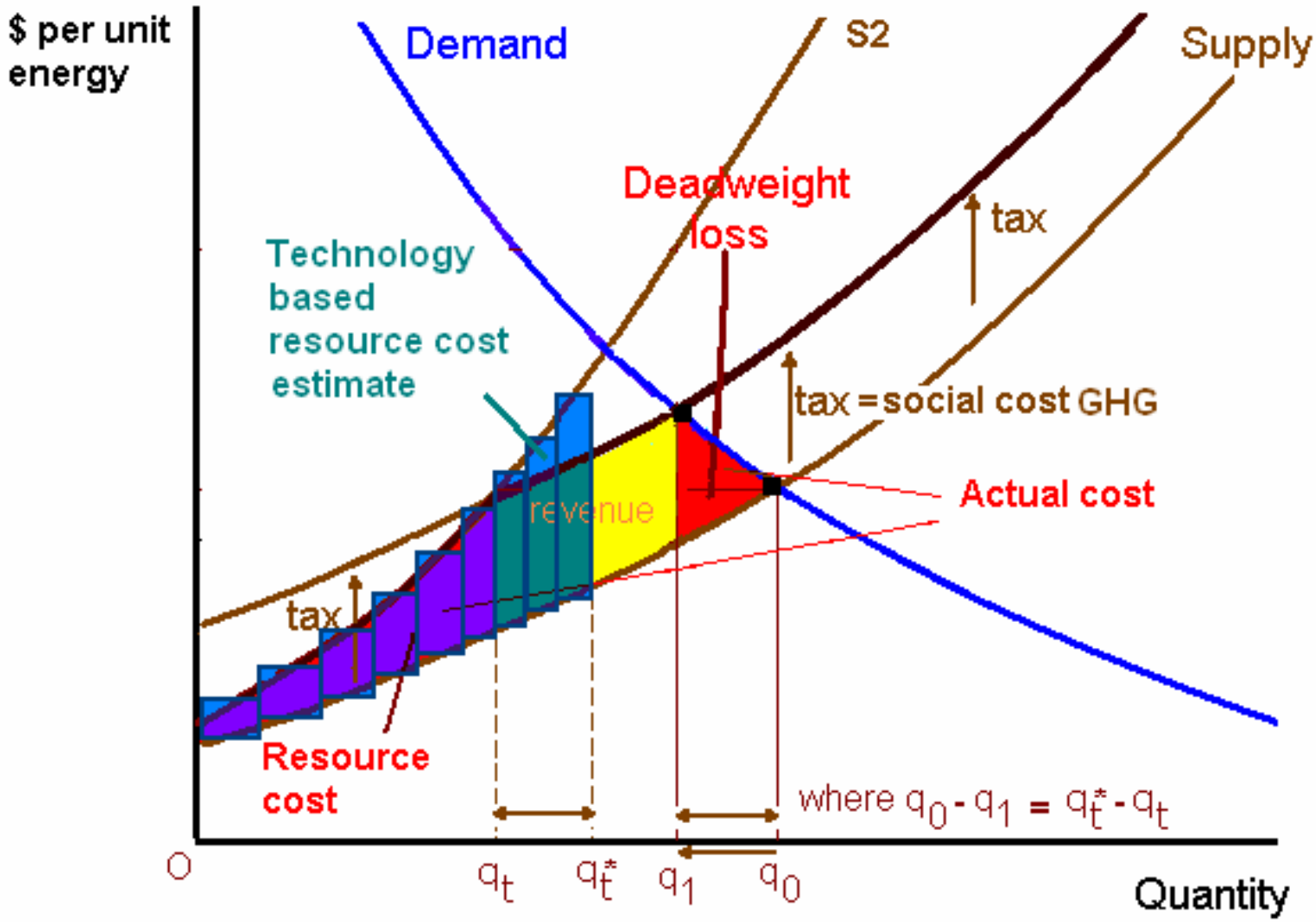
Stabilisation scenarios



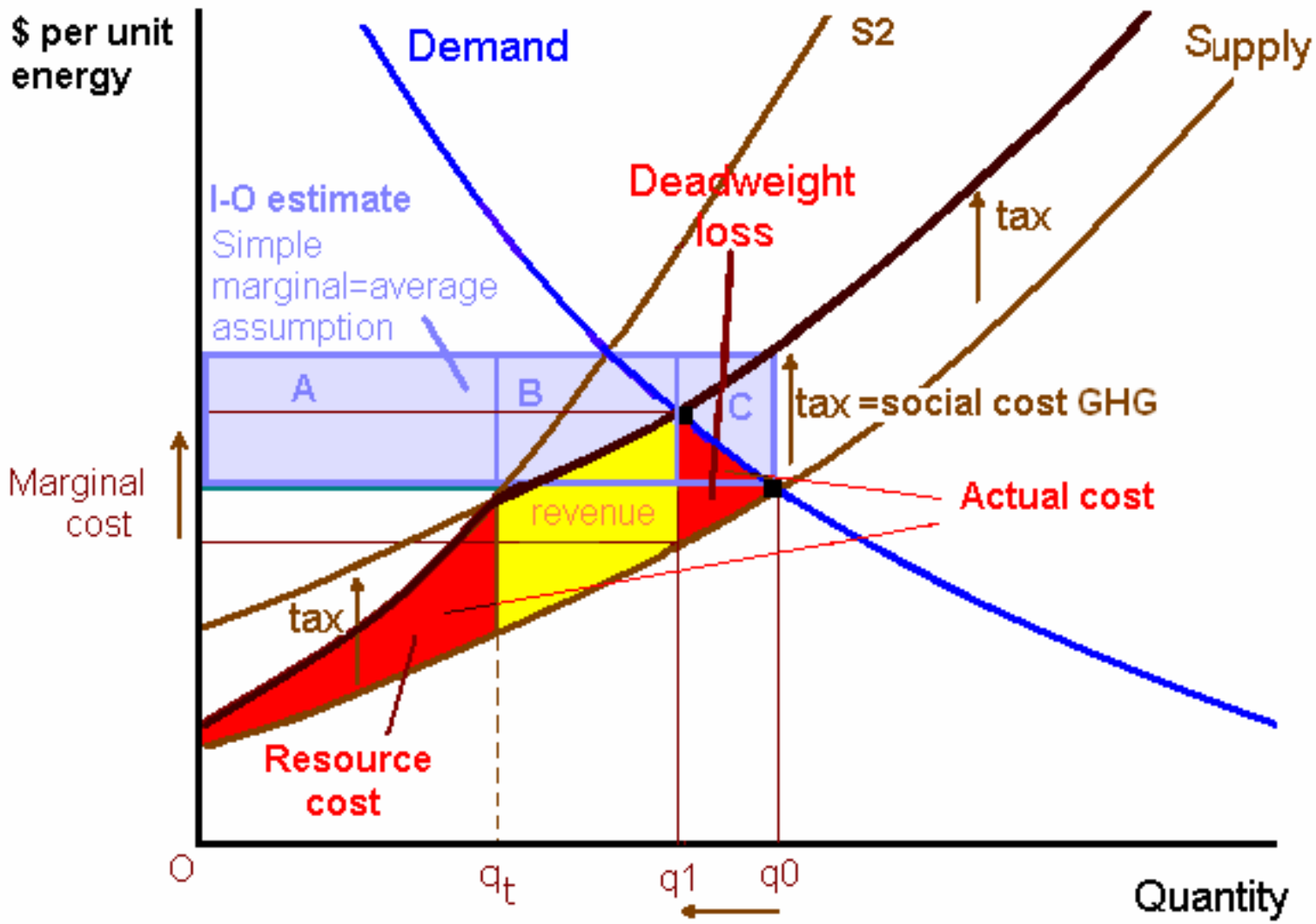
Costs


$ per unit energy
Demand
S2
Supply
$\hat{p}$
Deadweight loss
tax
tax = social cost GHG
p_1
Marginal cost
p_0
revenue
Actual cost
p_0^*
tax
Resource cost
O
q_t
q_1
q_0
Quantity

Costs


$ per unit energy
Demand
S2
Supply
Deadweight loss
tax
Technology based resource cost estimate
tax = social cost GHG
revenue
Actual cost
tax
Resource cost
where $q_0 - q_1 = q_t^* - q_t$
O
q_t
q_t^*
q_1
q_0
Quantity

Costs


$ per unit energy
Demand
S2
Supply
I-O estimate
Simple marginal=average assumption
Deadweight loss
tax
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tax =social cost GHG
Marginal cost
revenue
Actual cost
tax
Resource cost
O
q_t
q1
q0
Quantity

II Costs

Cost estimates

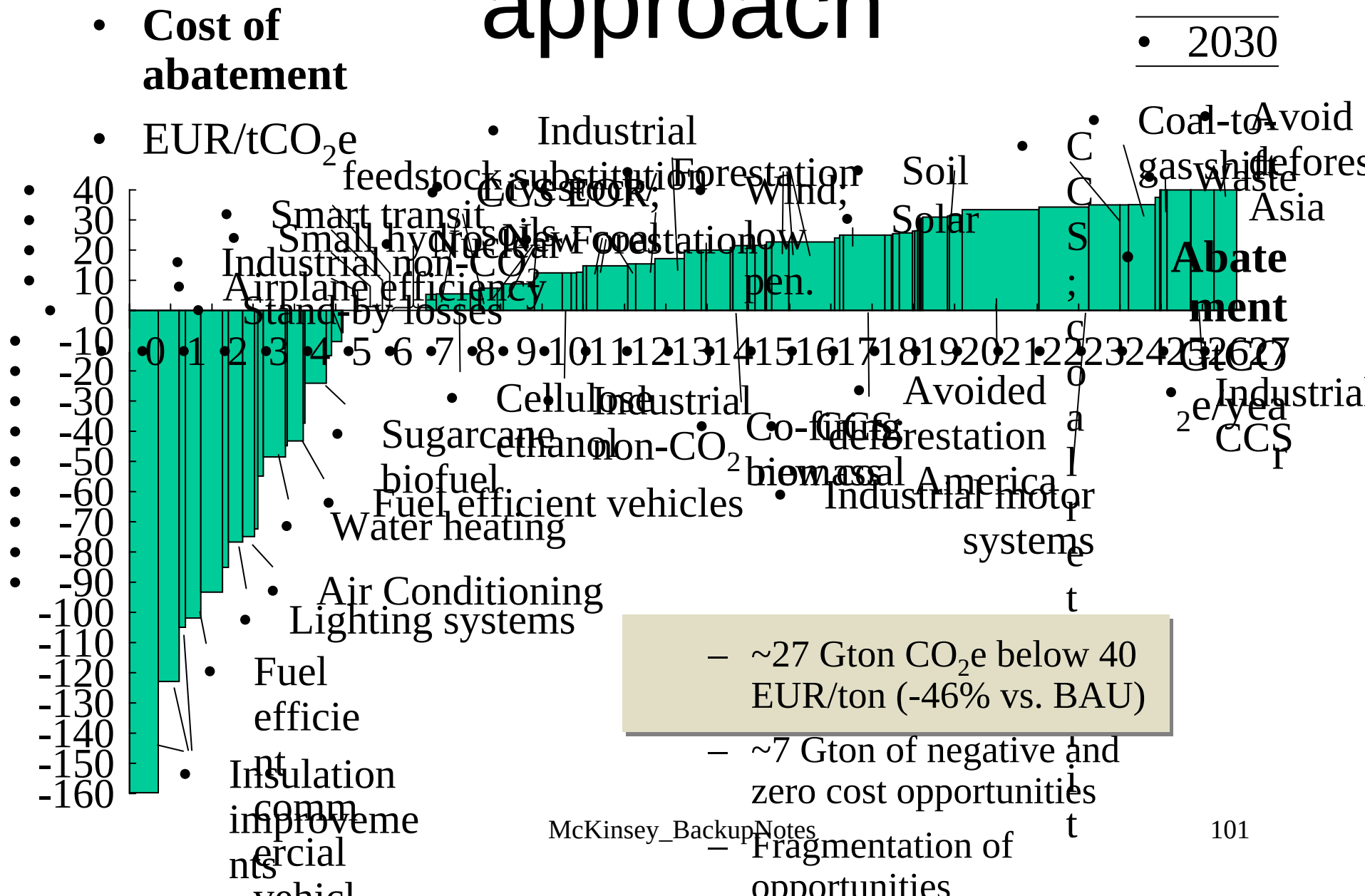
- Review examined results from bottom-up (Ch 9) & top-down (Ch 10) studies: concluded that world could stabilise below 550ppm CO_2e for around 1% of global GDP

- Subsequent analyses Edenhofer/IPCC top down have indicated lower figures

- So too have bottom-up IEA and McKinsey

- Options for mitigation: McKinsey analysis examines approach of chapter 10 of Review in more detail

McKinsey bottom-up approach



- ~27 Gton CO_2e below 40 EUR/ton (-46% vs. BAU)
- ~7 Gton of negative and zero cost opportunities
- Fragmentation of opportunities

Growth, change and opportunity

- Strong mitigation costs around 1% p.a. worldwide
- Strong mitigation is fully consistent with the aspirations for growth and development in poor and rich countries. Business as usual is not.
- Costs will not be evenly distributed:
  - •Competitiveness impacts can be reduced by acting together.
  - •New markets will be created. Investment in low-carbon electricity sources could be over $500bn a year by 2050.
- Mitigation policy can also be designed to support other objectives:
  - •energy - air quality, energy security and energy access
  - •forestry - watershed protection, biodiversity, rural livelihoods

III Mitigation Policy; trading

Mitigation policy instruments

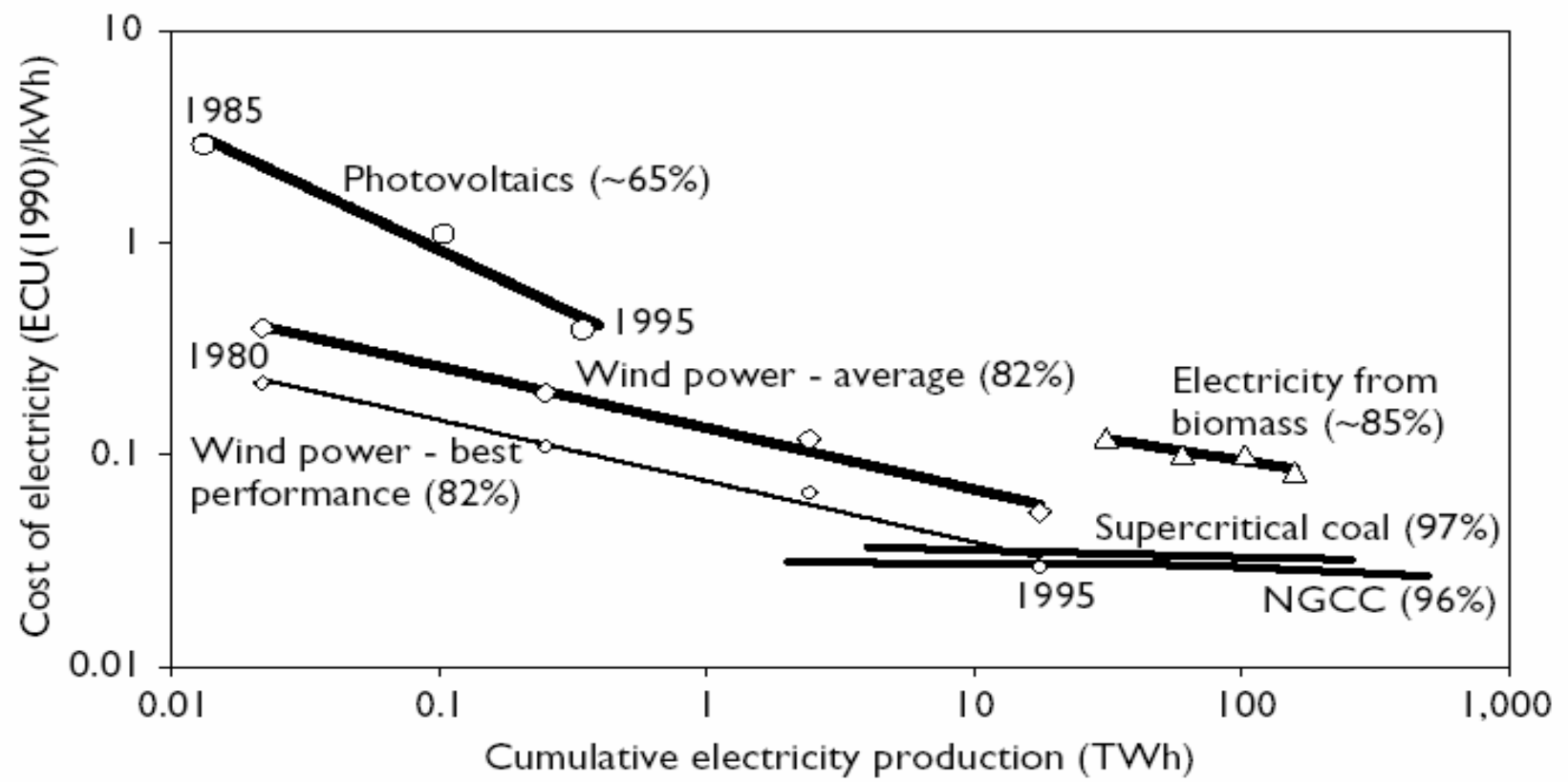
- Pricing the externality- carbon pricing via tax or trading, or implicitly through regulation
- Bringing forward lower carbon technology- research, development and deployment
- Overcoming information barriers and transaction costs– regulation, standards
- Promoting a shared understanding of responsible behaviour across all societies – beyond sticks and carrots

Trade/Tax/Standards

- Trade quotas give greater quantity certainty and incentives to bring in developing countries; ambition, transparency, credibility are key
- Tax may be simpler for some countries and/or sectors
- Tax or Trade: Identify single policy instrument for sector
- Regulation may accelerate change and lower costs by reducing uncertainty and achieving economies of scale
- But complications of interactions e.g. renewables targets and size of carbon market

Trade/Technology

- Some arguments for differential policies given nature of technologies and distance from markets



Trade/Types of markets

- National and regional (EUETS, NE US States, Australia)
- Sectoral
- Voluntary
- Kyoto

Trade/Design (I)

- Auctioning: adjustment issues; path to auctioning
- Price volatility: deep markets (sectors, countries, intertemporal)
- Price volatility: floors/ceilings; put options etc
- Linking markets: trading schemes must be able to interact

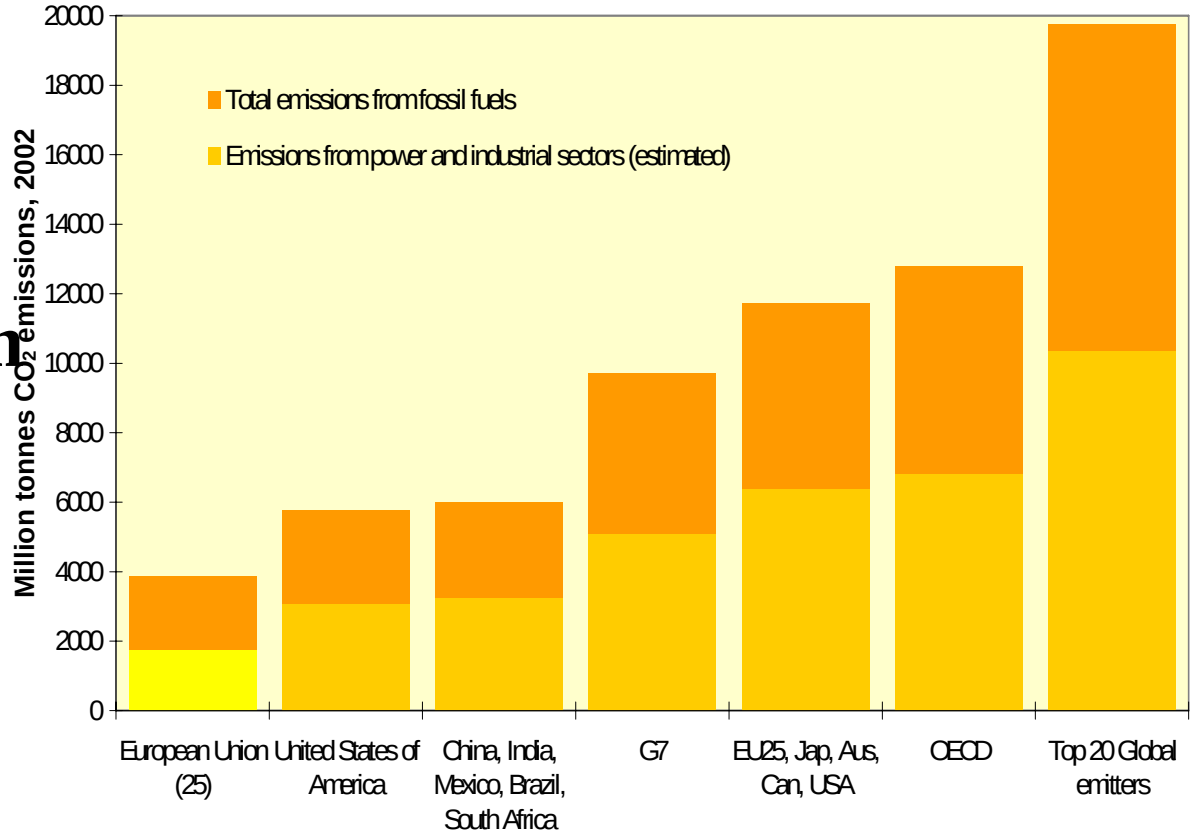
Trade/Institutional structure

- Conventions, types of reduction or transaction admissible
- Simplicity/complexity of certification
- Monitoring of emissions
- Credibility and ratings of instruments

Carbon markets can grow, but to be effective, require good design

Markets need to be based on:

- **Scarcity**
- **Credible, long-term trading periods**
- **Open, deep and liquid markets**
- **Efficient allocation methods**



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