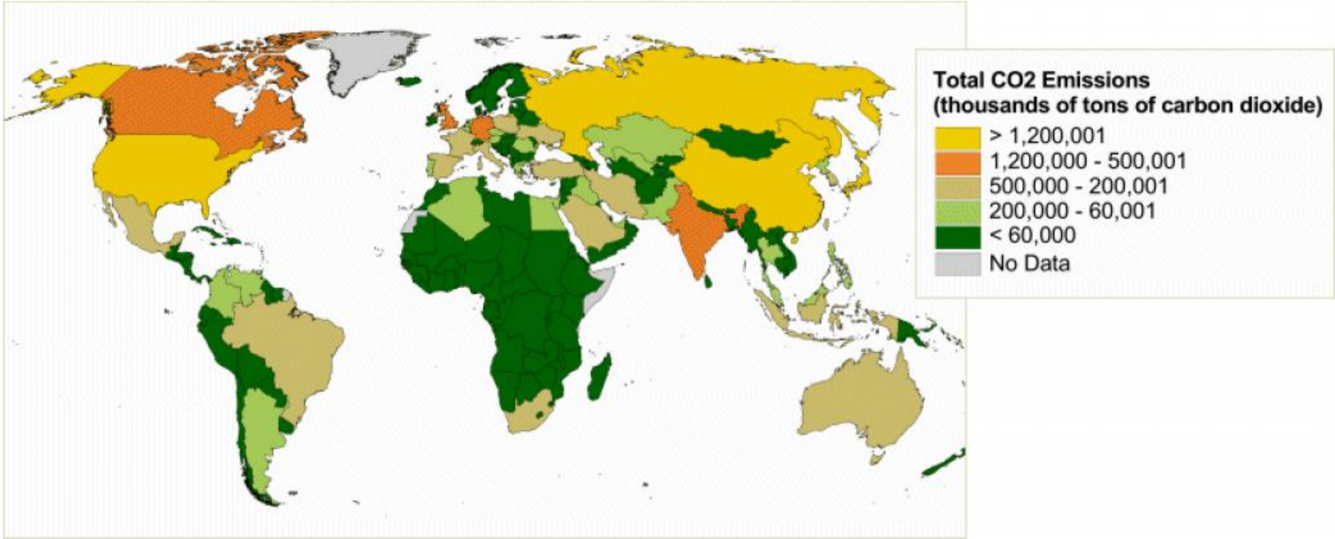
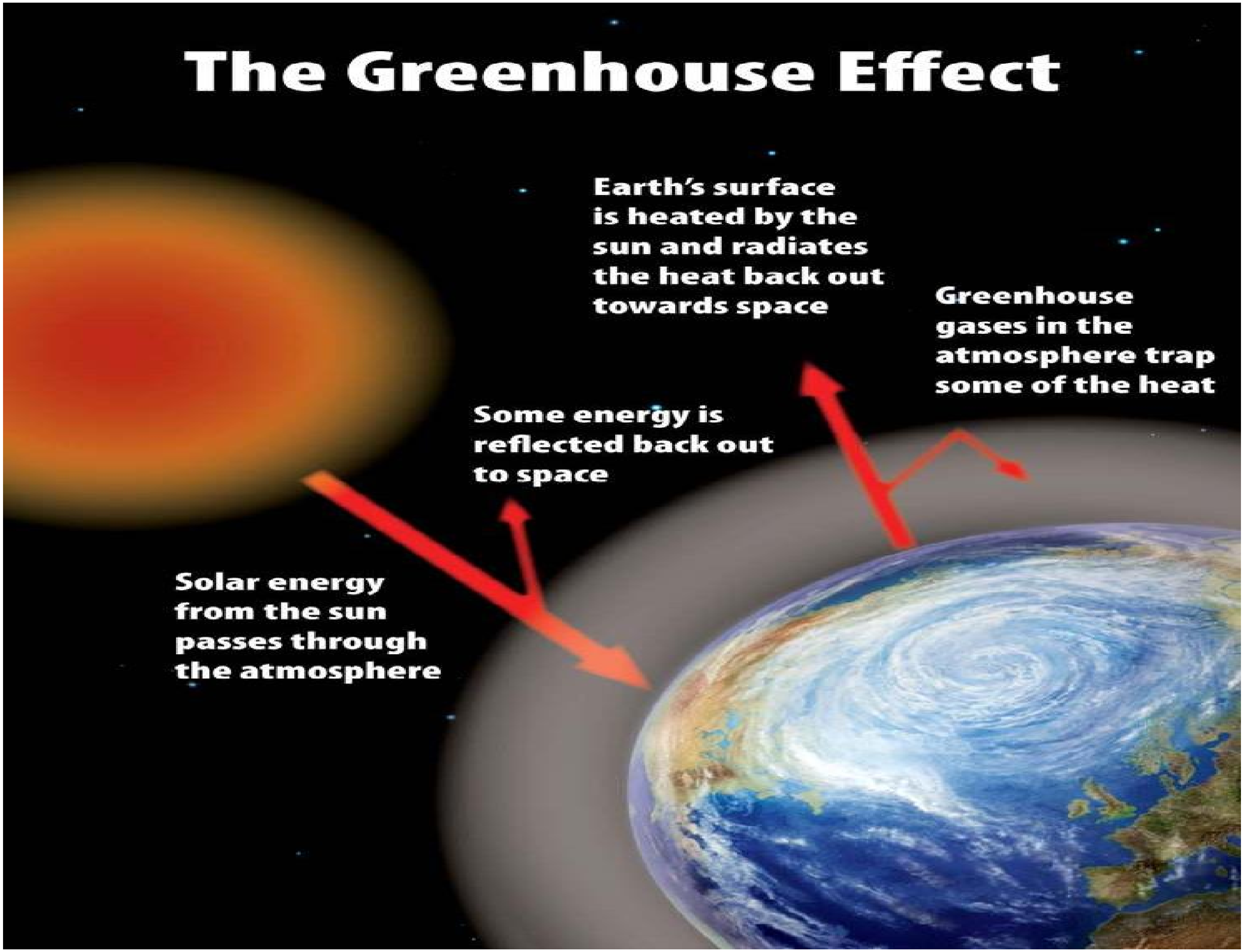
The Economics of Climate Change



Climate Change

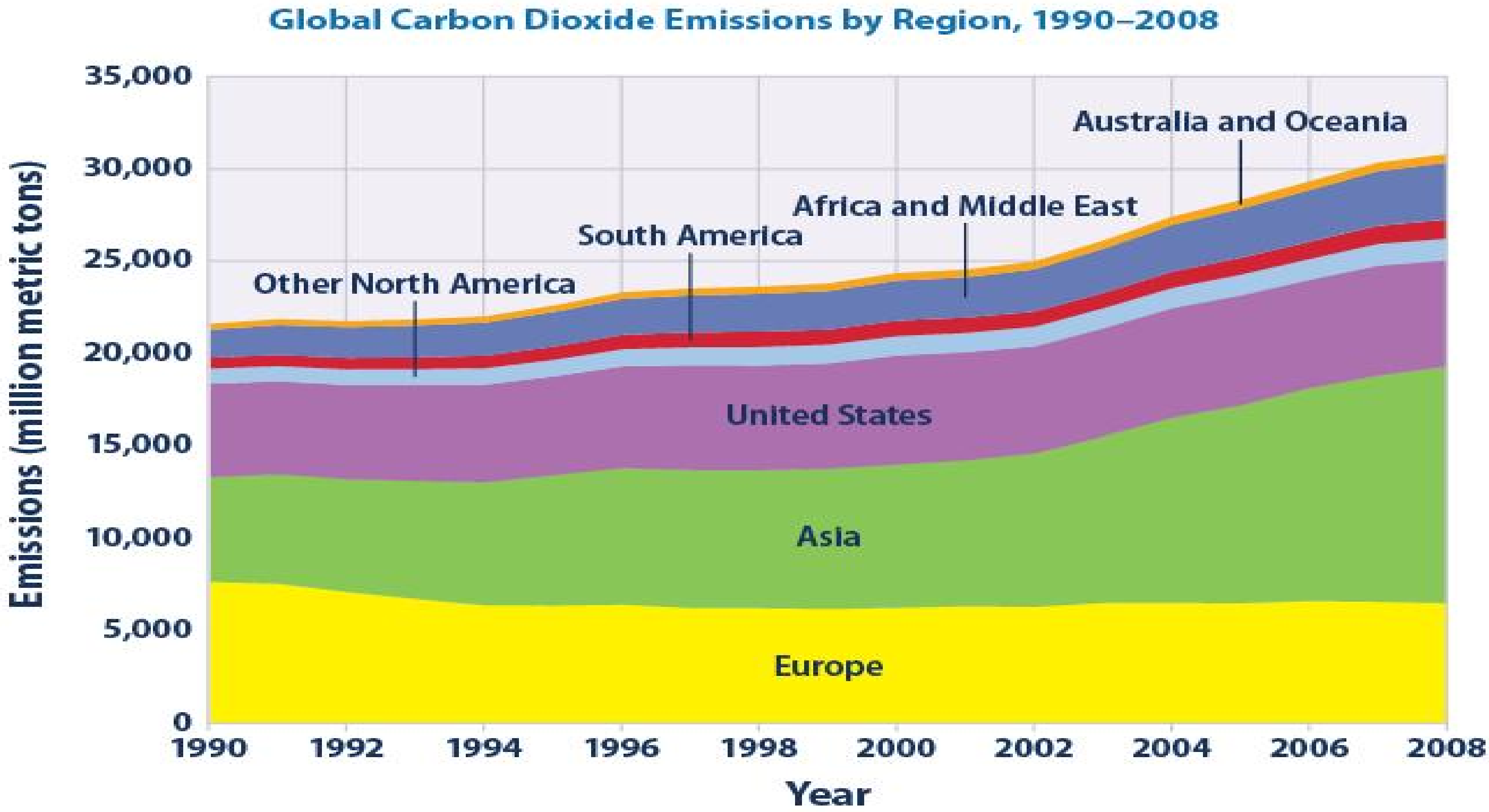
- ‘Climate’ is the long-term atmospheric conditions, ‘weather’ varies constantly
- Changes in climate are natural: e.g. after the last ice age (11,500 years ago) global temperatures were 5°C lower than now
- BUT we are now experiencing temperature rises at unprecedented speed
- Scientists believe that human activities are responsible (Anthropogenic global warming)


The Greenhouse Effect
Earth's surface is heated by the sun and radiates the heat back out towards space
Greenhouse gases in the atmosphere trap some of the heat
Some energy is reflected back out to space
Solar energy from the sun passes through the atmosphere

Greenhouse Gas (GHG)

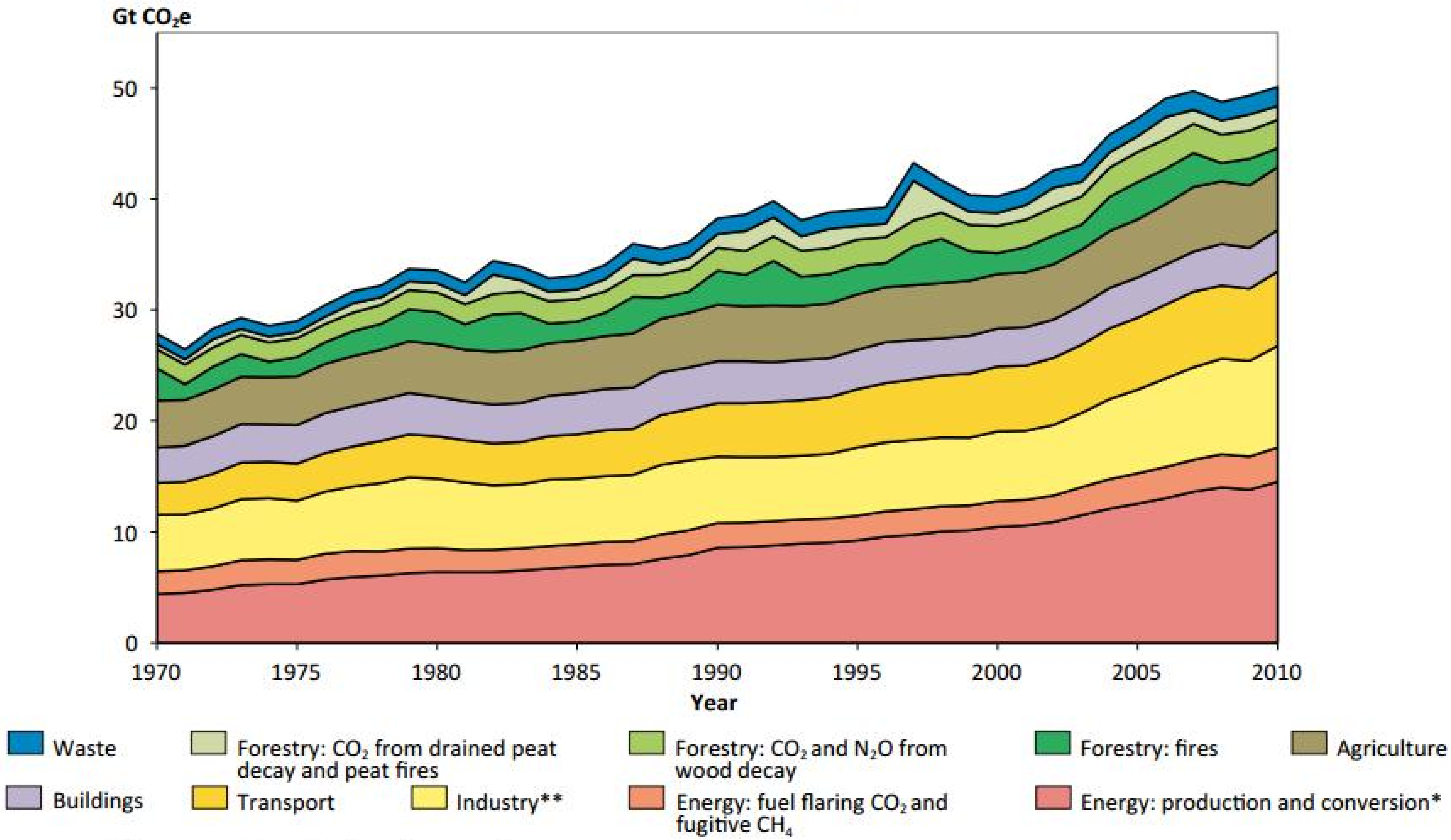
Carbon dioxide (CO_2)	– burning coal, oil and gas for energy, transport and heat
Nitrous oxide (N_2O) Methane (CH_4)	– waste disposal sites, agriculture and cattle
Hydrofluorocarbons (HFCs) Perfluorocarbons (PFCs) Sulphur hexafluoride (SF6)	– used in fridges, air-conditioning and even shoes

CO_2 emissions



Data source: World Resources Institute. 2012. Climate Analysis Indicators Tool (CAIT). Version 9.0. Accessed May 2012. http://cait.wri.org.

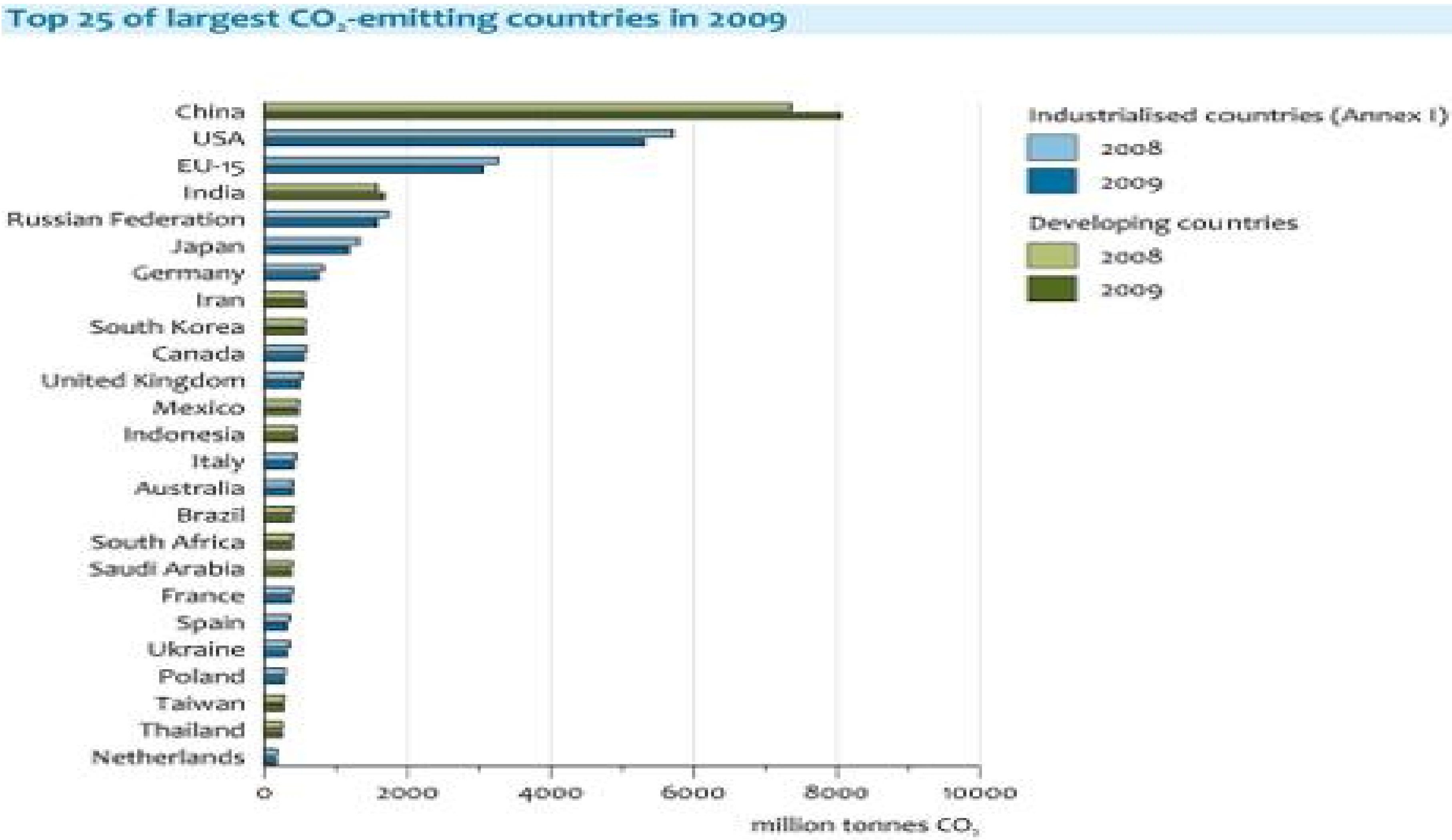
GHG emissions



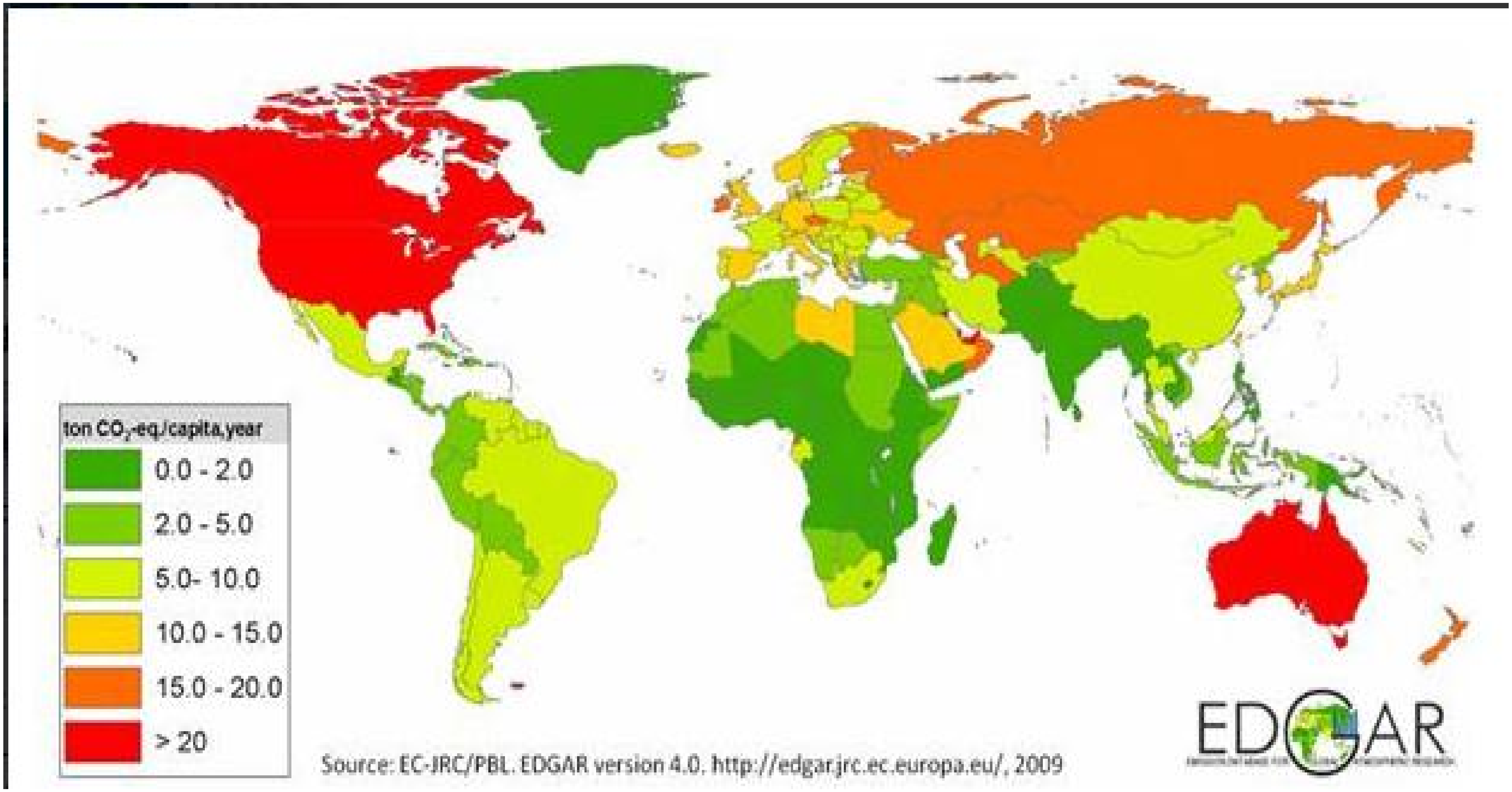
* Power generation, refineries, coke ovens, etc.

** Including non-combustion CO_2 from limestone use and from non-energy use of fuels and N_2O from chemicals production.

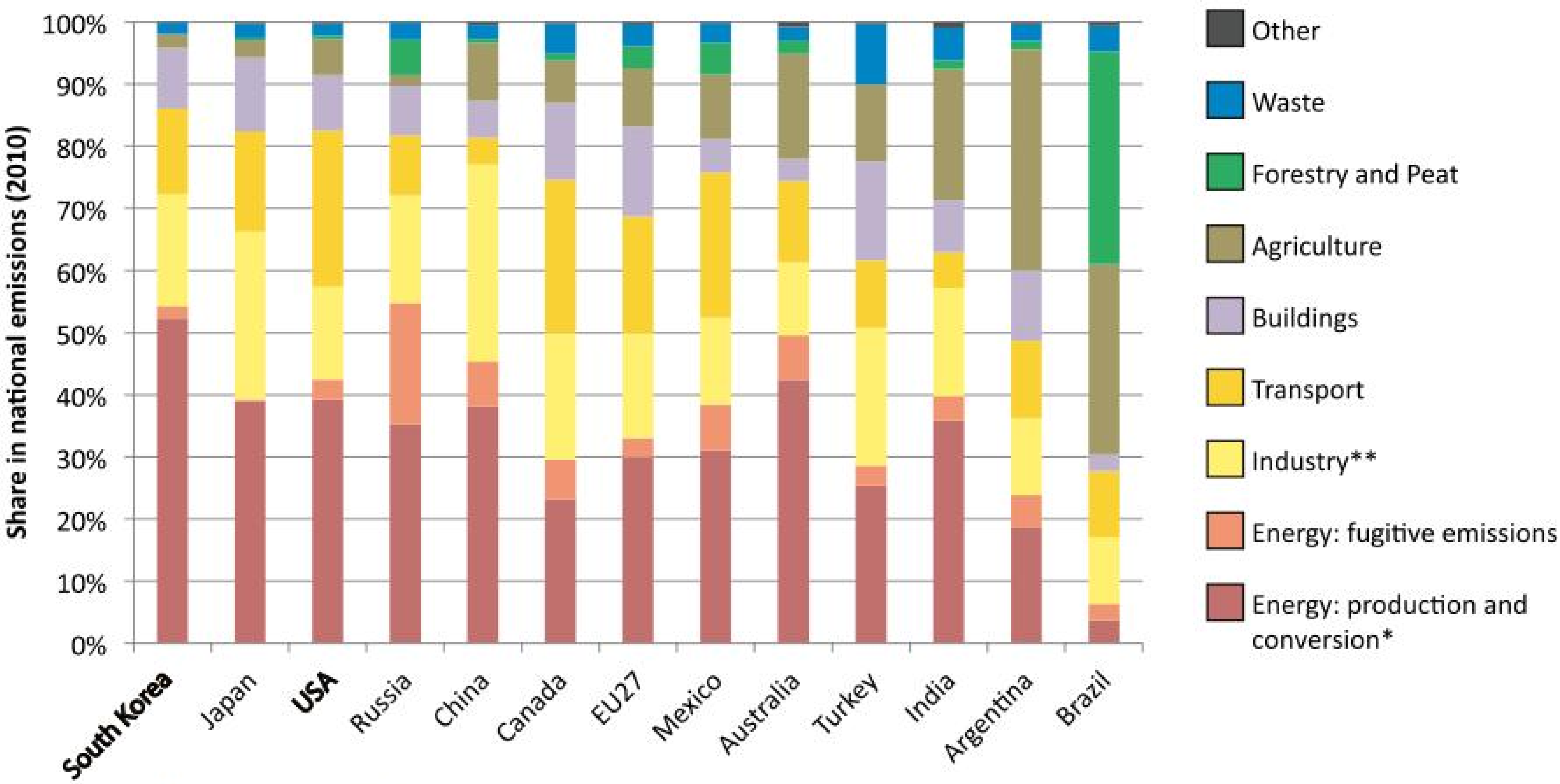
CO_2 emissions



Per capita CO_2 emission



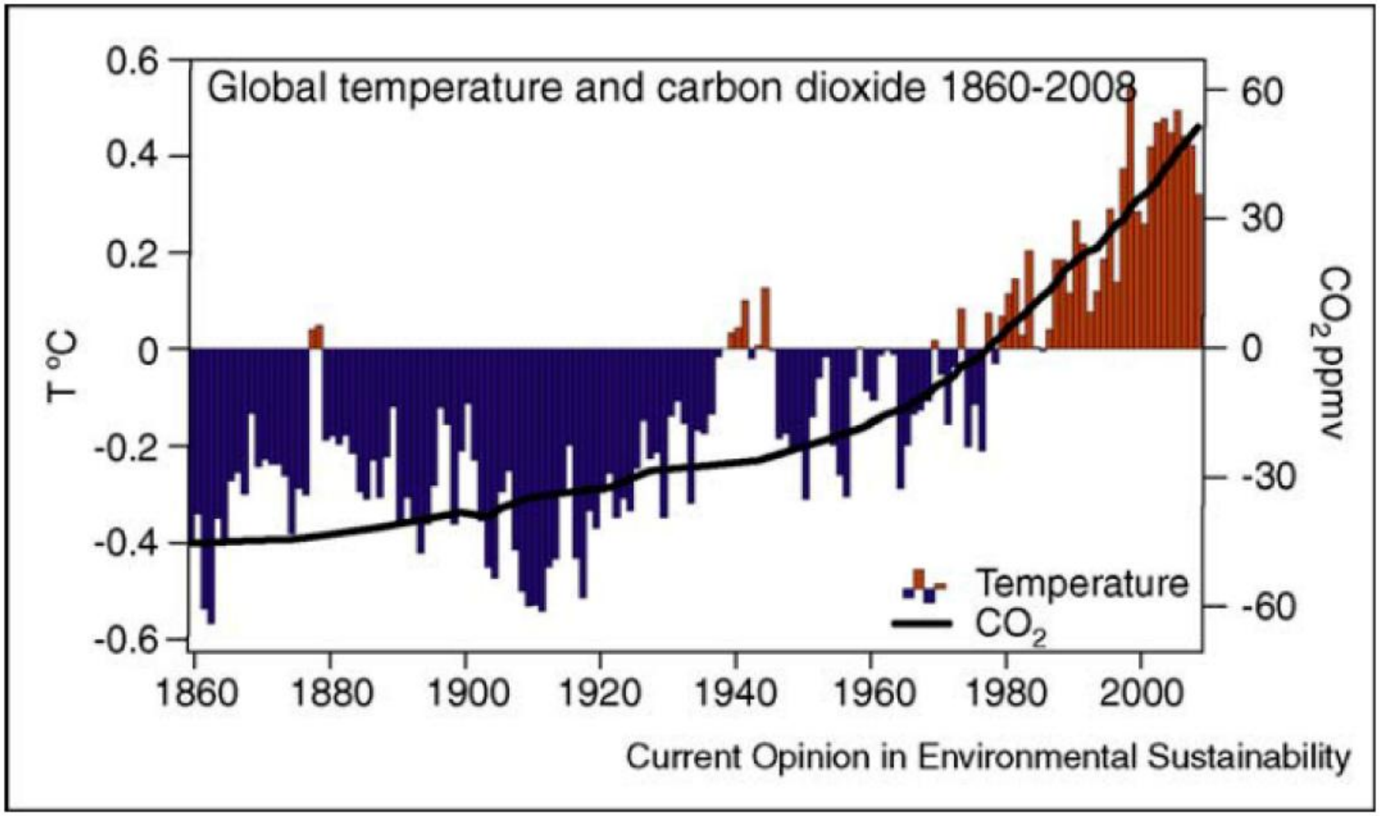
GHG emissions



* Power generation, refineries, coke ovens.

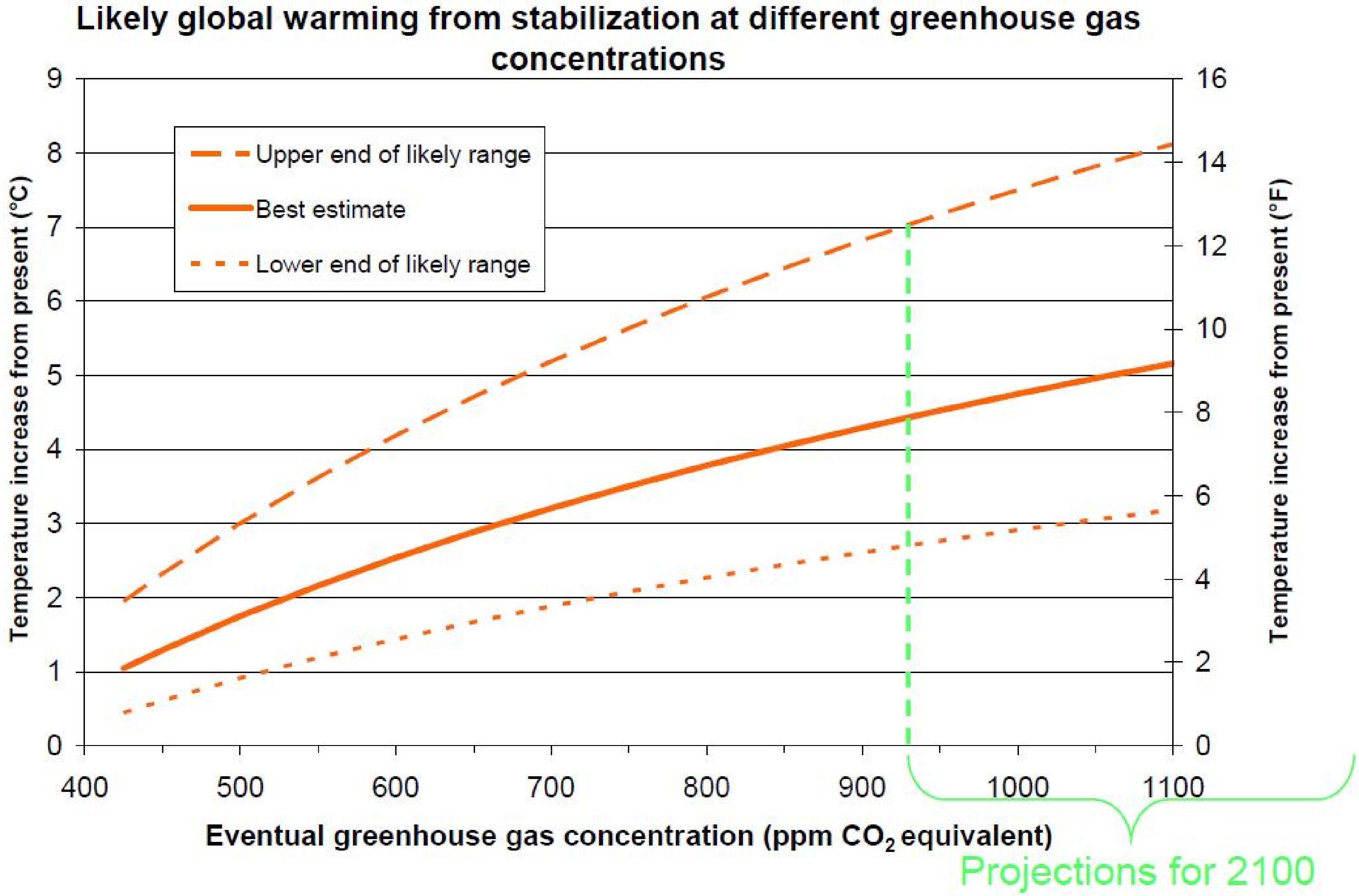
** Including non-combustion CO_2 from limestone use and from non-energy use of fuels and N_2O from chemicals production.

Figure 2.4. Sectoral shares of national greenhouse gas emissions in 2010 for countries included in the G20 with a pledge, taking European Union as a group. *Source: JRC/PBL (2012); EDGAR 4.2 FT2010.*



Time series of annual global mean temperature departures for 1861–2008 from a 1961–1990 mean (bars), left scale, and the annual mean carbon dioxide from Mauna Loa after 1957 linked to values from bubbles of air in ice cores before then. The zero value for 1961–1990 for temperature corresponds to 14 °C and for carbon dioxide 334 parts per million by volume (ppmv). Updated from Karl and Trenberth [16], original data from HADCRUv3 http://www.cru.uea.ac.uk/cru/data/temperature/#datdow, and http://www.esrl.noaa.gov/gmd/ccgg/trends/.

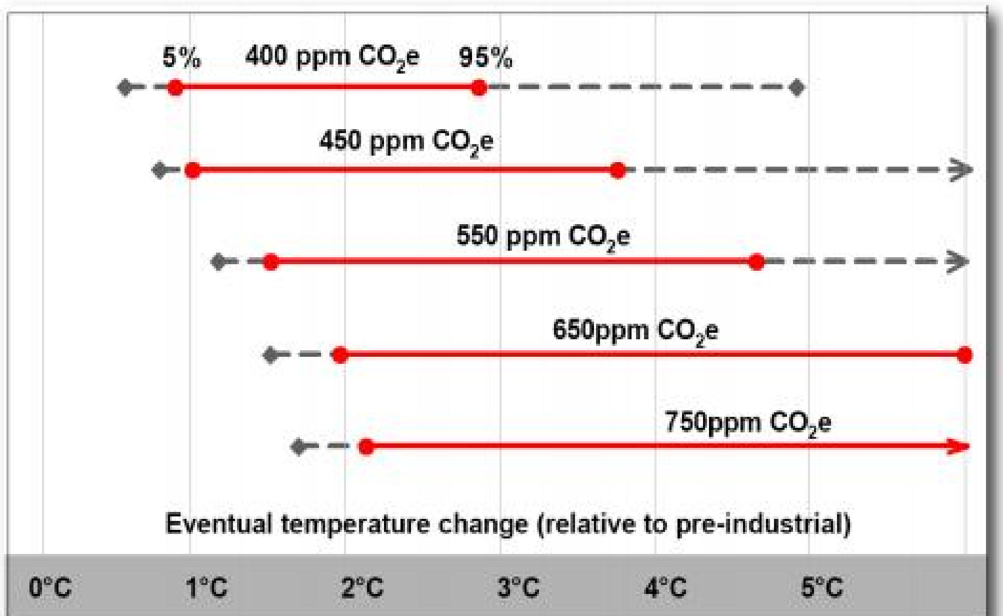
Temperature as function of GHG



Note: "Likely" is defined as greater than a 66% probability of occurrence. Source: IPCC Fourth Assessment Report.

RESOURCES FOR THE FUTURE

- Greenhouse gas concentrations or stocks have increased from around 285ppm in the 1800s to over 430ppm CO_2e today.
- We are adding at a rate of over 2.5ppm per year (likely to accelerate with little or weak action). BAU likely to take us over 750ppm by the end of the century.
- This level of concentration would result in a large probability, perhaps 50%, of an eventual temperature increase of more than 5˚C compared with the pre-industrial era. This would be enormously destructive.



Probability distribution of possible temperature increases presented as 5-95% ranges. As a *rough* approximation, the distribution for 450ppm is centred around 2℃, for 550 around 3℃, for 650 around 4℃, and 750 around 5℃.

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Source: Stern Review (2007), Table 1.1

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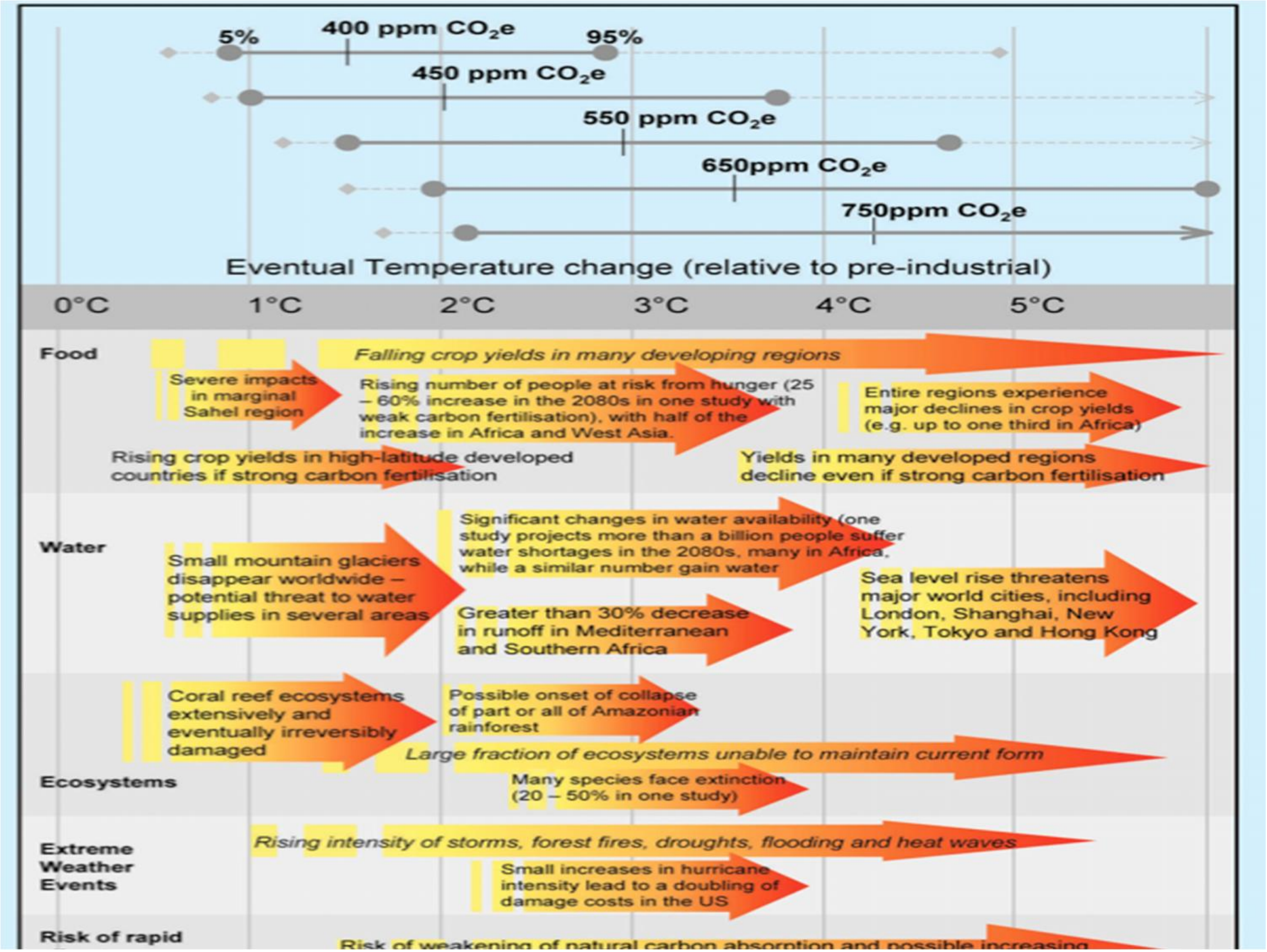
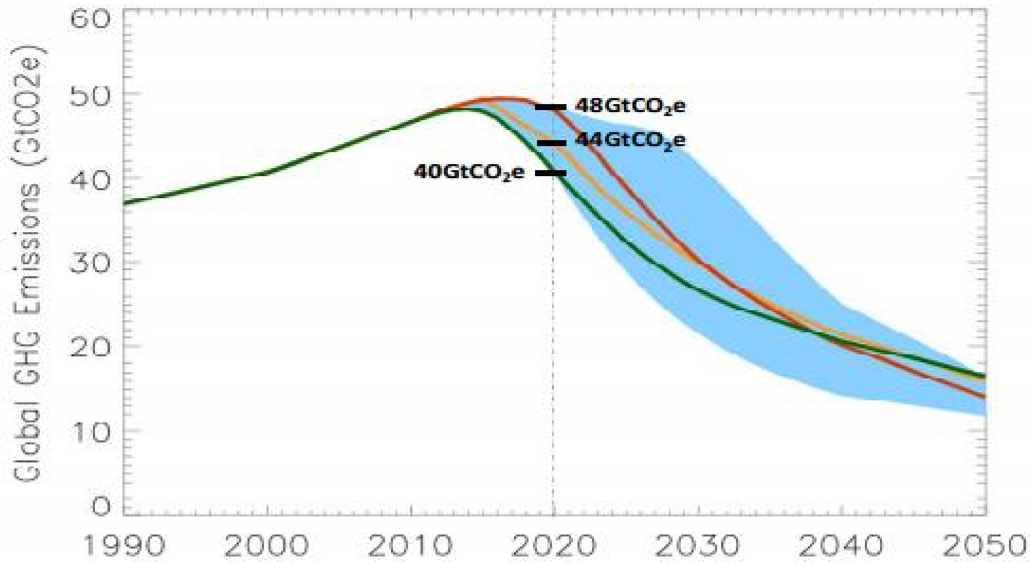


5%
400 ppm CO2e
95%
450 ppm CO2e
550 ppm CO2e
650ppm CO2e
750ppm CO2e
Eventual Temperature change (relative to pre-industrial)
0°C
1°C
2°C
3°C
4°C
5°C
Food
Falling crop yields in many developing regions
Severe impacts in marginal Sahel region
Rising number of people at risk from hunger (25 – 60% increase in the 2080s in one study with weak carbon fertilisation), with half of the increase in Africa and West Asia.
Entire regions experience major declines in crop yields (e.g. up to one third in Africa)
Rising crop yields in high-latitude developed countries if strong carbon fertilisation
Yields in many developed regions decline even if strong carbon fertilisation
Water
Significant changes in water availability (one study projects more than a billion people suffer water shortages in the 2080s, many in Africa, while a similar number gain water
Small mountain glaciers disappear worldwide – potential threat to water supplies in several areas
Sea level rise threatens major world cities, including London, Shanghai, New York, Tokyo and Hong Kong
Greater than 30% decrease in runoff in Mediterranean and Southern Africa
Coral reef ecosystems extensively and eventually irreversibly damaged
Possible onset of collapse of part or all of Amazonian rainforest
Large fraction of ecosystems unable to maintain current form
Ecosystems
Many species face extinction (20 – 50% in one study)
Extreme Weather Events
Rising intensity of storms, forest fires, droughts, flooding and heat waves
Small increases in hurricane intensity lead to a doubling of damage costs in the US
Risk of rapid
Risk of weakening of natural carbon absorption and possible increasing

The 2°C target: implications for emissions



Source: Bowen and Ranger (2009)

- Holding below 500ppm CO_2e, and reducing from there, is necessary to give a reasonable (say 50-50) chance of staying below 2℃. This requires bringing emissions down from 47Gt CO_2e today (reduced by economic slowdown – might have been 50) to below **20Gt CO_2e** (approx. 50% of 1990 levels) by 2050.
- A plausible emissions path is around **47Gt** CO_2e in 2010, **44Gt** in 2020, **under 35Gt** in 2030, and **under 20Gt** in 2050. Likely to have to go **'well under'.** Clearly necessary to 'peak' before 2020.

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*These results are based on the Hadley Centre climate model MAGICC. Thanks to Jason Lowe and Laila Gohar for running these trajectories through the model.
Gt ≡ gigatonnes ≡ billion tonnes

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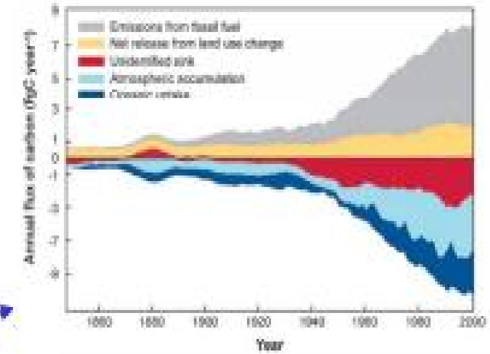
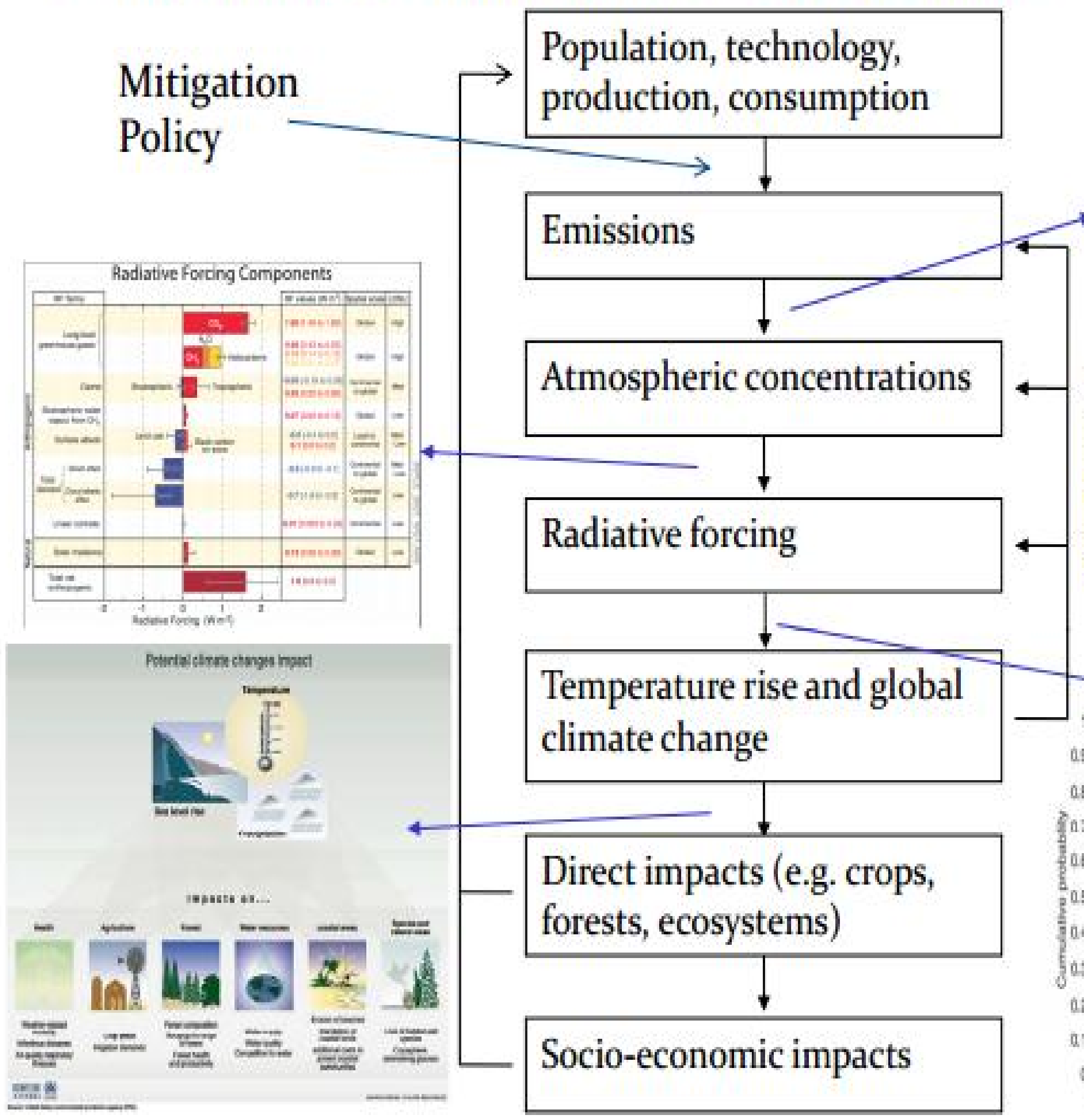
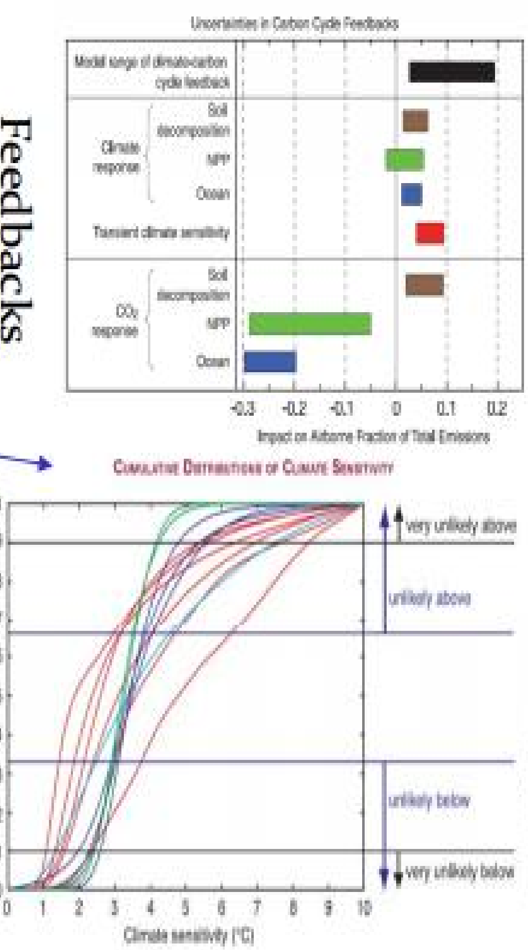
Integrated Assessment Model

- The science of climate change addressing the relation between GHG emissios, temperature and climate change, and their impacts
- The economics of policies addressing GHG emissions
- An integrated assessment model (IAM) combines scientific and socio-economic aspects of climate change for the purpose of assessing impacts and policies.

Components of an Integrated CC Assessment







Integrated Assessment Model

- Why is such a combined model useful for assessing climate change?
  - GHG emissions affect climate change
  - Climate change affects economic production and welfare
  - Economic production and welfare affect GHG emissions
  - ➔ continuous interaction between the economy, welfare and climate system

Dynamic Integrated model of Climate and the Economy (DICE) (Nordhaus, 1997)

- We analyze the most important equations determining
  - Production, Investment and Emissions
- And equations describing how
  - Capital
  - GHG concentrations
  - Temperatures

  evolve over time
- Finally, a welfare function is to be maximized adhering to these equations

Dynamic Integrated model of Climate and the Economy (DICE)
(Nordhaus, 1997)

- Production

$$Y_t = \frac{1 - \Lambda_t}{D_t} A_t K_t^{\gamma} L_t^{1-\gamma}$$

- Labor $\boldsymbol{L_t}$ is *exogenous* estimate taken from population models
- Capital $\boldsymbol{K_t}$ is calculated as part of the model (-> *endogenous*) (next building block)
- Parameter $\boldsymbol{\gamma}$ is estimated $\boldsymbol{\gamma = .3}$
- Technological Progress $\boldsymbol{A_t}$ is *exogenous* 'estimate'
- Damage $\boldsymbol{D_t}$ is approximated as a quadratic function of temperature :

$$D_t = a_0 + a_1 T_t + a_2 T_t^2$$

- Costs of emission reduction is estimated as a function $\boldsymbol{\Lambda_t (\mu_t)}$ of the emission-control rate $\boldsymbol{\mu_t}$

Dynamic Integrated model of Climate and the Economy (DICE) (Nordhaus, 1997)

- Emission

- Emissions from production in period t (flow):

$$E_t = \sigma_t (1 - \mu_t) A_t K_t^{\gamma} L_t^{1-\gamma}$$

  - σ_t: ratio of uncontrolled industrial emissions to output (metric tons of carbon per output, 'carbon-intensity of output')
  - μ_t: emissions-control rate (fraction mitigated at cost $\Lambda_t(\mu_t)$)

Dynamic Integrated model of Climate and the Economy (DICE) (Nordhaus, 1997)

- Temperature
  - Temperature: In period ***t*** temperature increase w.r.t. preindustrial is

$$T_{t+1} = T_t + \sigma \left(F_t - \lambda T_t \right)$$

  - Temperature increases proportional to the difference between
    - Radiative forcing F_t in period ***t***
    - The equilibrium forcing λT_t that would correspond to T_t
    - σ characterizes delay in temperature increase (small σ slow change)
- Welfare function
  - Welfare function:

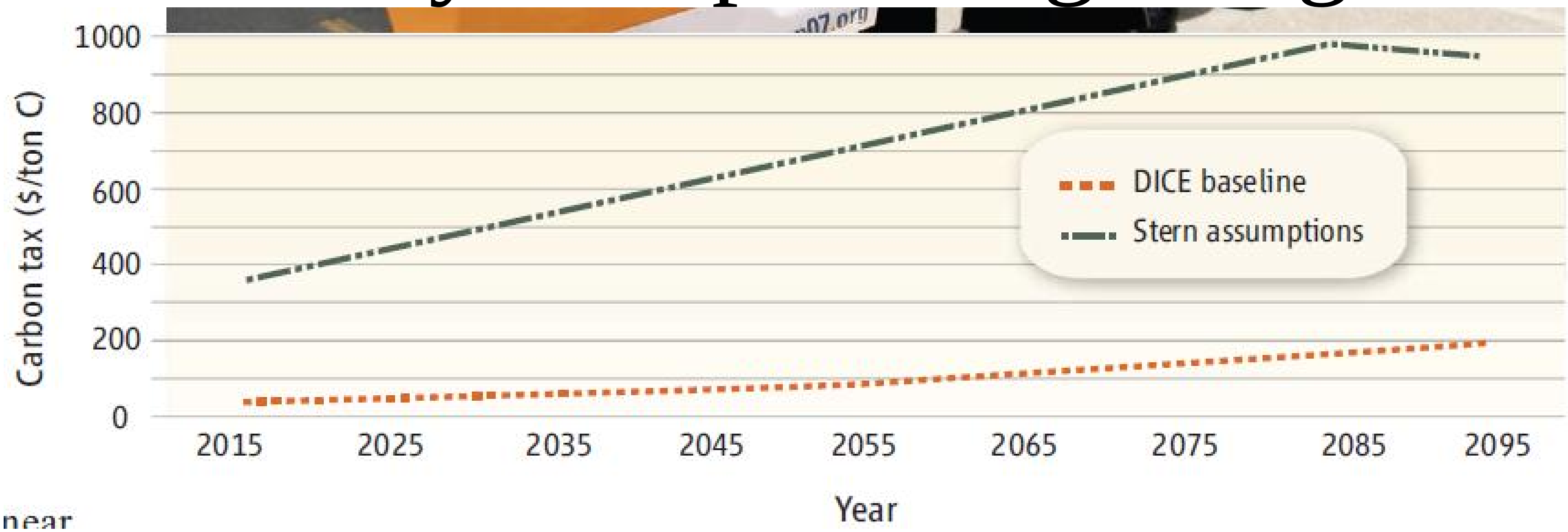
$$W = \sum_t \frac{1}{(1+\rho)^t} u(C_t, L_t)$$

with

Setting stringency: The Policy Ramp vs. The Big Bang

- Climate "policy ramp"
  - Efficient GHG control policy: "modest rates of emissions reductions in the near term, followed by sharp reductions in the medium and long term." (Nordhaus, 2007)
    - If implemented via a tax: ~$30/ton of CO_2 initially, rising gradually to $200/ton towards 2100
- The "Big Bang"
  - Immediate and aggressive GHG control
  - Stern Review (2006)

Policy Ramp vs. Big Bang



Comparing the optimal carbon tax under alternative discounting assumptions. The Dynamic Integrated model of Climate and the Economy (DICE model) (*5*) integrates the economic costs and benefits of greenhouse-gas (GHG) reductions with a simple dynamic representation of the scientific and economic links of output, emissions, concentrations, and climate change. The DICE model is designed to choose levels of investment in tangible capital and in GHG reductions that maximize economic welfare. It calculates the optimal carbon tax as the price of carbon emissions that will balance the incremental costs of abating carbon emissions with the incremental benefits of lower future damages from climate change. Using the DICE model to optimize climate policy leads to an optimal carbon tax in 2005 of around $30 per ton carbon (shown here as “DICE baseline”). If we substitute the Stern Review’s assumptions about time discounting and the consumption elasticity into the DICE model, the calculated optimal carbon tax is much higher and rises much more rapidly (shown as "Stern assumptions").

Nordhaus (2007)

The Big Bang & the Stern Review

- 2006: UK government releases a report: *The Economics of Climate Change: The Stern Review*, lead by Sir Nicholas Stern
- SR estimates of costs of global warming are substantially higher than earlier estimates
  - Used similar data and methodology (IAM)
  - Review summary:
    - Unabated, climate change could result in an annual **5-20%** decline in global output by 2100.
      - Comparison: US great depression – 1929-1930 real GDP fell by 9%
    - Costs to mitigate are around **1%** of GDP
    - Policies for strong GHG reductions should be implemented immediately.

- Why did the SR come to such a starkly different conclusion than the ramp?
  - Discounting (lower discount rate)
  - Damages (higher damages)

The Ramp

- The climate-policy ramp (gradualist approach)
  - Based on output of "integrated assessment models" (IAM)
    - DICE: Dynamic Integrated Model of Climate and the Economy (Nordhaus and colleagues)
    - Mathematical model of economic growth accounting for the effects of global warming.
      - Dynamic economics: choices over consumption, working (labor), production, investment
      - Geophysical dynamics: emissions→greenhouse gas stock →climate change
    - Estimated reduction in gross world product:
      - 4.5^o F → 2%. -- 9.0^o F → 5%

DICE model assumptions

- Optimal policy

In this run, emissions are set to maximize the value of net economic consumption. More precisely, this run finds a trajectory for emissions reductions that balances current abatement costs against future damages from global warming.

- *Spirit of the* ***Stern*** *Review:* Low discount rate.
- ***Gore*** *emissions reductions:*
Achieve global emissions reductions of 90 percent by 2050.

DICE model estimates

- Assumes discount rate of 4% :

  – Scenarios considered:
    - “optimal (tax) policy”: +$3T <Policy ramp-like policy>
    - Kyoto-like without US: $0T <BAU / baseline>
    - “Stern”: -$15T <“Big Bang”-like policy>
    - “Gore”: -$21T

DICE model estimates PVEBN

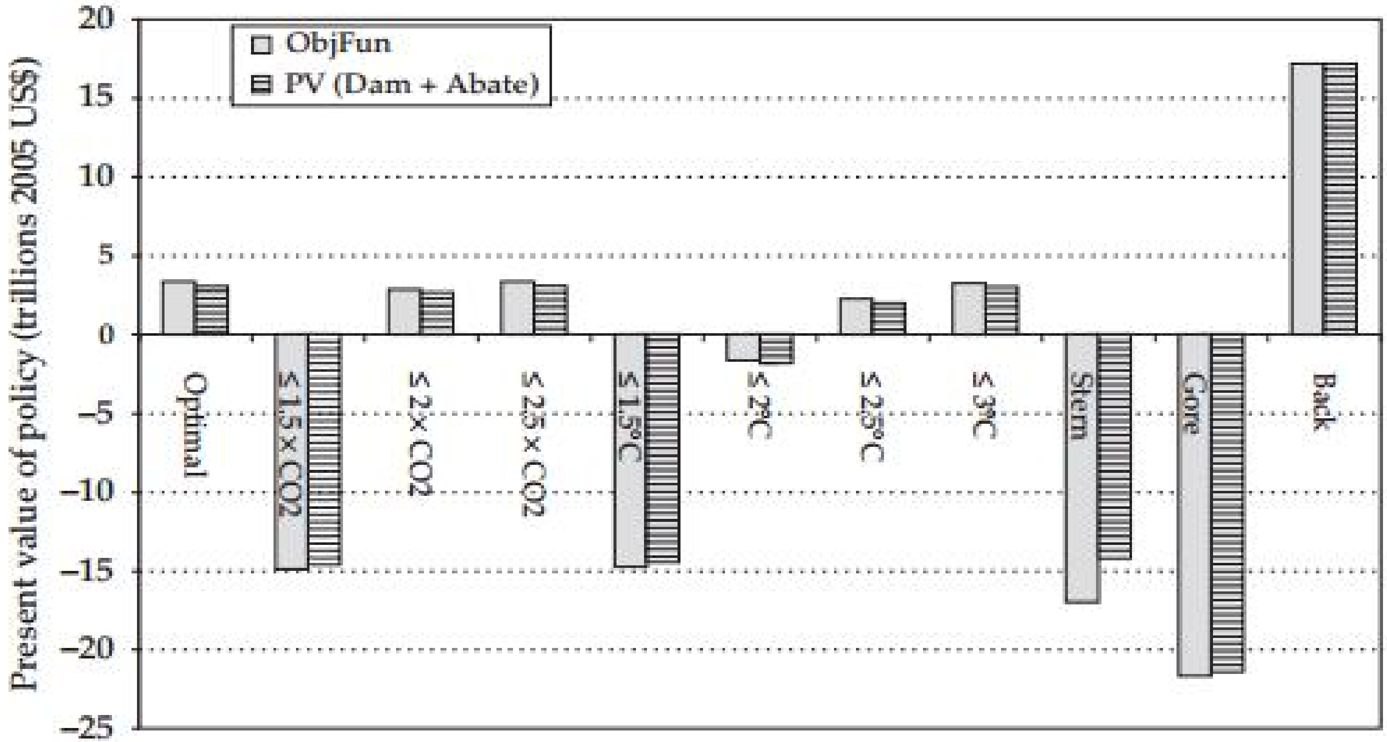


Figure 5-1. Present value of alternative policies. The difference in the present value of a policy relative to the baseline under two mea-

DICE model estimates B/C

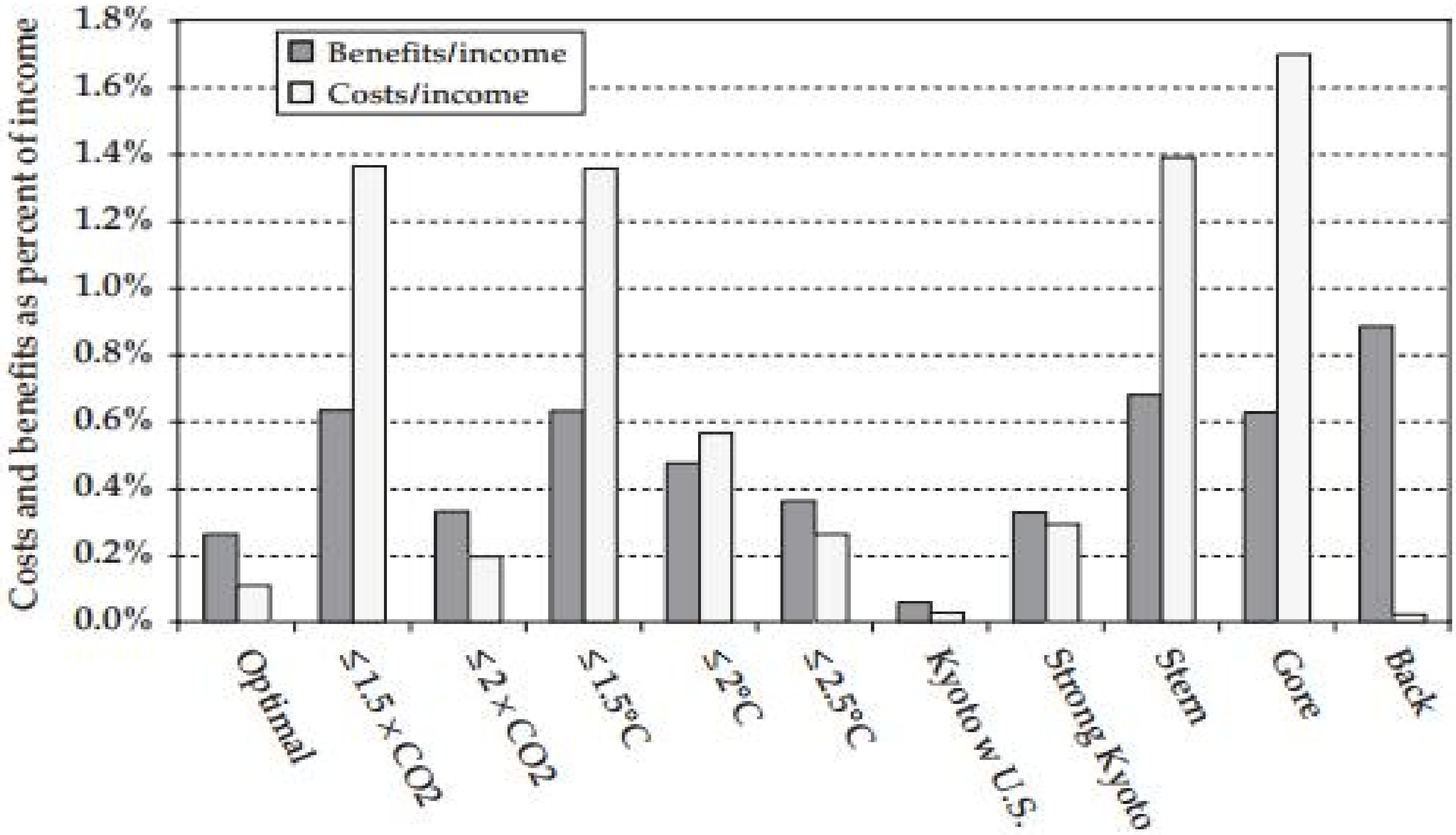


Figure 5-3. Costs and benefits as percentage of income. Abatement

Discounting

- Weitzman (2007): “(t)he biggest uncertainty of all in the economics of climate change is the uncertainty about which [rate] to use for discounting.”

- Discounting motivations:
  - 1) social “rate of time preference” (reflects how individuals make choices on payoffs over time)
  - 2) “marginal productivity of investment” (opportunity cost of investment or time value of money)

Discounting – Ramsey equation

- Ramsey optimal growth model: central framework for thinking about dynamic investment decisions.
- $r = \rho + \eta g$ *--equation holds in the welfare optimum--*
  - *r:* real return on capital
  - *ρ:* social rate of time preference, rate at which utility from consumption is discounted
  - *g:* growth rate of consumption
  - *η:* %-decrease in marginal utility from a %-change in consumption "elasticity of marginal utility of consumption"
    - How quickly MU falls as consumption rises.
    - Also indicates: aversion to consumption inequality among generations.
      - Lower *η* (Stern)→ MU changes relatively little over consumption→ pays less attention to whether future is richer/poorer → cares less about intergen. inequality
      - Higher *η* (Nordhaus) → MU changes more rapidly→ more attention to income (consumption) changes → cares more about intergen. inequality.

Some conclusions

- Weitzman (2007): ‘On the political side … my most-charitable interpretation of (the Stern Review’s) urgent tone is that the report is …
  - an essay in persuasion…
  - that is more about gut instincts regarding the horrors of uncertain rare disasters whose probabilities we do not know…
  - than it is about (conventional) economic analysis.
- SR might be right (“act now”) for the wrong reasons (due to bad model parameters instead of a careful analysis of uncertainty).’

Kyoto Protocol to the UNFCC

- Written 1997, in force 2005
- Rich countries: cut to 5.2% below 1990 levels by 2012


The Japan Times

Conference adopts Kyoto Protocol

Greenhouse gas emissions to be cut by average of 5.2%

KYOTO COP3

Kyoto convention's success open to debate

Gist of Kyoto Protocol

Strengths

- Market based approach—cost effectiveness
- Flexibility (international trading, clean dev. mech.)
- Focus on rich countries puts burden on responsible parties, with greater ability to pay
- Established emissions inventorying & reporting
- First step

Weaknesses

- 4 of 5 largest emitters not constrained
  - US has not ratified
  - Russia's allocation won't bind until 2012
  - China and India not bound
- Emissions leakage
- Poor incentives for compliance (withdrawal provision)

Aldy and Stavins (2007)

International Cooperation

Problem:

- Causes of climate change are global ➔ international cooperation needed
- Near-term, concentrated costs, long-term future benefits
- Although agreeing on research and coordination of efforts, hard to agree on whether and how much to restrict greenhouse gases

International Cooperation

Some reasons:

- Free-riding incentives
- Conflicting interests (e.g. oil-exporting countries might oppose reductions)
  - Differing Responsibility: five countries (USA, China, Russia, Saudi-Arabia, Canada) produce more than half of world's carbon
  - five countries (USA, China, Russia, Japan, India) consume account for more than 50% of carbon consumption
  - Industrialized countries have contributed the majority of historical emissions
  - Per-capita emissions in developing countries much smaller

International Policy Considerations

- **Different options**
  - Formal treaties (binding under international law) or less rigorous, nonbinding agreements
  - From modest commitments to share information to agreements on restrictions of emissions and penalties

- **Underlying difficulty:**
  - Design the agreement such that every party benefits and has no incentive to drop out

International Cooperation : Game theory perspective

- The players of the game
  - → Who is involved?

  We: For simplicity 2 players

- The rules of the game
  - → Who decides when?

  We: Both decide simultaneously
  - → What are the decision alternatives?

  We: Binary decision to abate or not to abate
  - → What is the information available for decision making?

  We: Players know the payoff matrix, but not what action opponent chooses

- The payoffs
  - → For any combination of actions there is a given payoff

Game theory perspective

Game Theory: Decision Tables

- Players A with actions
  - a1=pollute
  - a2=abate
- Players B with actions
  - b1=pollute
  - b2=abate

Payoff Table for Player A:

Decision table for A	Payoffs given B's action		
Alternative actions		b_1	b_2
	a_1	2	4
	a_2	1	3

Remark: All that matter for out solution strategy for the game turns out to be that $1<2<3<4$ (ordinal information). You can replace 1,2,3,4 by arbitrary numbers satisfying this relation.

Game theory perspective

Game Theory: Decision Tables -> Payoff Matrix

- Decision Tables for the 2 players A and B with two actions/decision alternatives
- Symmetric Game = Symmetric Payoffs
- The 2 Table are generally merged into one :

Decision table for A	Payoffs given B's action		
Altenrative actions		b_1	b_2
	a_1	2	4
	a_2	1	3

Decision table for B	Payoffs given A's action		
Alternative actions		a_1	a_2
	b_1	2	4
	b_2	1	3

Decision tables are merged into payoff matrix

Game theory perspective

Game-theory: pay-off matrix

Action alternatives for B

Action alternatives for A		pollute: b_1	abate: b_2
pollute	a_1	2, 2	4, 1
abate	a_2	1, 4	3, 3

Payoffs for A , B

First number: pay-off to A , second number: pay-off to B

Question: Who should choose which strategy?

Game theory perspective

- To predict the outcome of the game we need assumptions how players/countries handle strategic interdependence
- Countries maximize their own net benefit from their actions taking into account the other countries' likely action
- No collaboration between countries takes place.

Game theory perspective

Standard solution for a non-cooperative game:

- A set of choices is called a Nash equilibrium if each player
  - is choosing the best possible action
  - Given the other players action
- Then: Neither country would benefit by deviating unilaterally
- Or: A Nash equilibrium is a strategy combination, where all strategies of al players are the mutually best responses.

Game theory perspective

		B's strategy	
		Pollute	Abate
A's strategy	Pollute	2, 2	4, 1
	Abate	1, 4	3, 3

- First number: pay-off to A, second number: pay-off to B
- Who should choose which startegy?
- Prisoner's dilemma
- Typical problem with International Environment Agreement.

Game theory perspective

- Can we transform the non-cooperative game such that {abate, abate} becomes a NE?
- We can include penalties for defection ➔ Can change payoff matrix to make {abate, abate} Nash equilibrium.
- BUT, No supranational body can enforce agreement
- Hence International Environmental Agreement (IEA) must be self-enforcing

Self-enforcing IEA

- A self-enforcing IEA is an equilibrium outcome to a negotiated environmental problem that has the following properties:
  - There are N countries in total, of which K choose to cooperate
  - Each cooperative country selects abatement level that maximizes aggregate pay-off for cooperation countries.
  - Each defecting country maximize individual pay-off
  - No signatory country can gain by unilaterally withdrawing from agreement (internal stability)
  - No non-signatory country can gain by unilaterally entering to the agreement (external stability)

Games with multiplayers

- Barrett (1994)
- Let there be N identical countries, of which K choose to abate.
- $NB_P = a+bK$ (Net benefit from polluting)
- $NB_A = c+dK$ (Net benefit from abating)

Prisoner's dilemma

- a = 0, b = 5, c = -7, d = 5

Table 9.1 The Prisoner's Dilemma example with 10 countries

	Number of abating nations other than *i*									
	0	1	2	3	4	5	6	7	8	9
Nation *i* pollutes	0	5	10	15	20	25	30	35	40	45
Nation *i* abates	–2	3	8	13	18	23	28	33	38	43

2 stable equilibriums

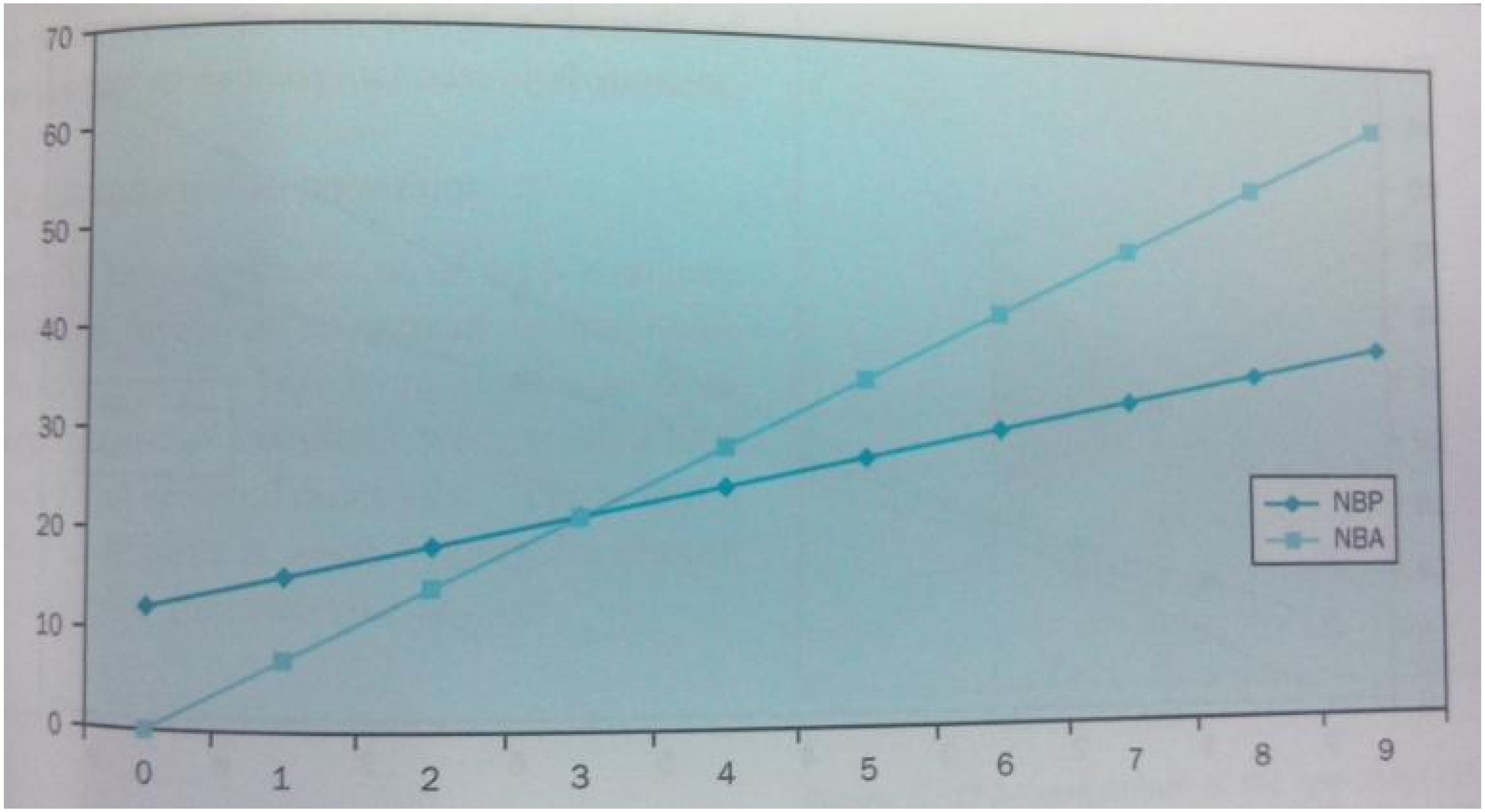
- a = 12, b = 3, c = -7, d = 7

Table 9.2 The Prisoner's Dilemma example with alternative parameter values

	Number of abating nations other than *i*									
	0	1	2	3	4	5	6	7	8	9
Nation *i* pollutes	12	15	18	21	24	27	30	33	36	39
Nation *i* abates	0	7	14	21	28	35	42	49	56	63

2 stable equilibriums

- a = 12, b = 3, c = -7, d = 7



Self-enforcing equilibrium

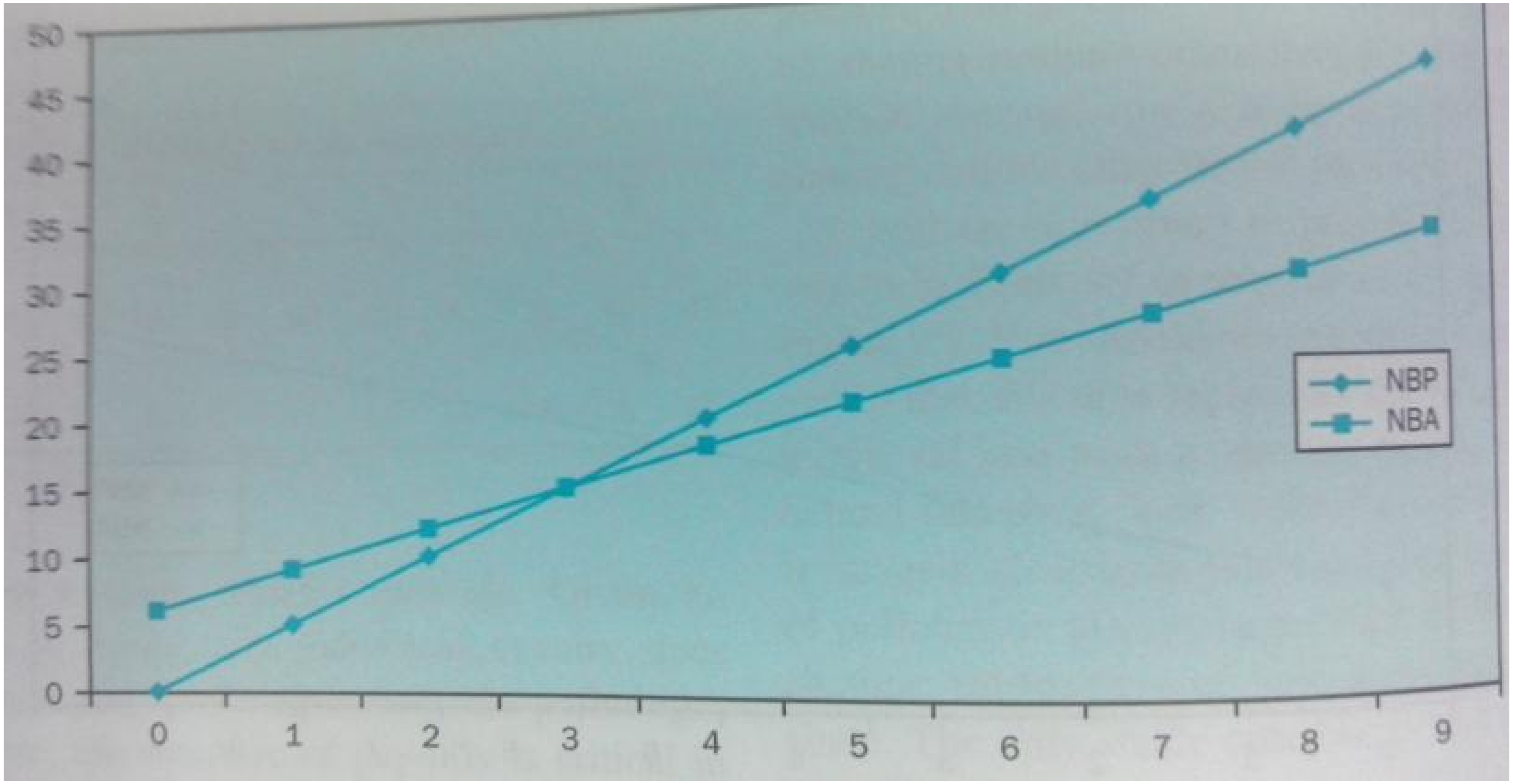
- a = 0, b = 5, c = 3, d = 3

Table 9.3 The Prisoner's Dilemma example with third set of parameter values ($a = 0$, $b = 5$, $c = 3$ and $d = 3$)

	Number of abating nations other than *i*									
	0	1	2	3	4	5	6	7	8	9
Nation *i* pollutes	0	5	10	15	20	25	30	35	40	45
Nation *i* abates	6	9	12	15	18	21	24	27	30	33

Self-enforcing equilibrium

- a = 0, b = 5, c = 3, d = 3



The Kyoto Protocol - background

1992: UN Framework Convention on Climate Change http://unfccc.int/

- recognized there is a problem: CO_2 emissions are warming the planet

- stabilize CO_2 at "at a level that would prevent *dangerous* anthropogenic (human induced) interference with the climate system.“

  goals:
  1) ensure that ecosystems can adapt to climate change
  2) make sure that food production not threatened
  3) allow sustainable economic development

- requires precise and regularly updated inventories of greenhouse gas emissions from industrialized countries

-"Parties to the Convention“ agree to develop national programs to slow climate change; meet at “Conference of Parties” (COP’s); where binding international treaties (i.e. Kyoto) can be made. (Currently at COP 19)

- establishes a "framework" document -- something to be amended or augmented over time

The Kyoto Protocol - background

1992: UN Framework Convention on Climate Change http://unfccc.int/

- places the heaviest burden for fighting climate change on industrialized nations
  - Annex 1: industrialized economies and economies in transition
  - Annex 2: the richest Annex 1 countries
  - (aka the Organization for Economic Cooperation and Development (OECD))
- general target: collectively reduce emissions to 1990 levels by 2000
  - (but no mechanisms, enforcement proposed)
- support developing countries' climate change activities.
- developing countries' emissions will grow before they shrink
- developing countries will have largest climate change impacts; work to mitigate

The Kyoto Protocol

Dec 1-11, 1997: representatives from 160 countries agreed to enter into binding limits on emissions of greenhouse gases

TARGETS:

Total: reduce developed nation emissions to 5% below 1990 levels during "commitment period" 2008-2012
(most countries need -18% reduction in BAU by 2008)

37 industrialized nations and the EU subject to binding emissions targets

Greenhouse gases: CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6

PENALTY:

Non-compliant countries will have to reduce emissions by 1.3 units for every unit of emissions "overshoot" in subsequent commitment period.

Ex: if your emissions target is 7Gtons per year by 2012, and you end up at 10Gtons/yr, in the next commitment period (2013-2020) you will have to reduce by 4Gtons/yr (in addition to any new targets)

Three primary mechanisms

1. Emissions trading
   - trade carbon units between Annex 1 countries (flow is from countries with carbon credits to countries with carbon overshoots)
   - example: Europe's Emissions Trading System (ETS)

2. Joint Implementation
   - Annex 1 countries can invest in a emissions-reduction project in another Annex 1 country and receive emissions reduction units (ERU)

3. Clean Development Mechanism
   - Annex 1 countries receive ERUs for emissions reductions in developing countries
   - must certify reductions.

PROS:

- Countries can 'buy their way out' by buying carbon credits from other countries
- Developing countries have incentive to reduce emissions by selling carbon credits

Kyoto comes into force when 55% of the global CO2 emissions are covered by Kyoto-ratifying countries

Kyoto took effect on Feb 16, 2005 after ratification by Russia

Brown = signed and ratified (dark brown = Annex 1 & 2)
Blue = signed and unratified

EU Greenhouse Gas Emission Trading System (EU ETS)

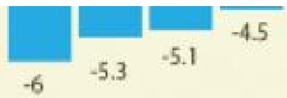
1. Create allowances equivalent to the EU Kyoto assignments for each country
2. Distribute them to the nations, and then the nations distribute them to the large emitters
3. Each year, large emitters must return allowances equivalent to their emissions that year

Phase 1 (2005-2007): allowances given out freely; involves 40% EU CO_2
EU emissions grow by 1.9% in two years

Phase 2 (2008-2012): CDM and JI included; 60% allowances auctioned

Phase 3 (2012-): aviation included; most allowances must be auctioned; - new cap means -21% of 2005 emissions by 2020

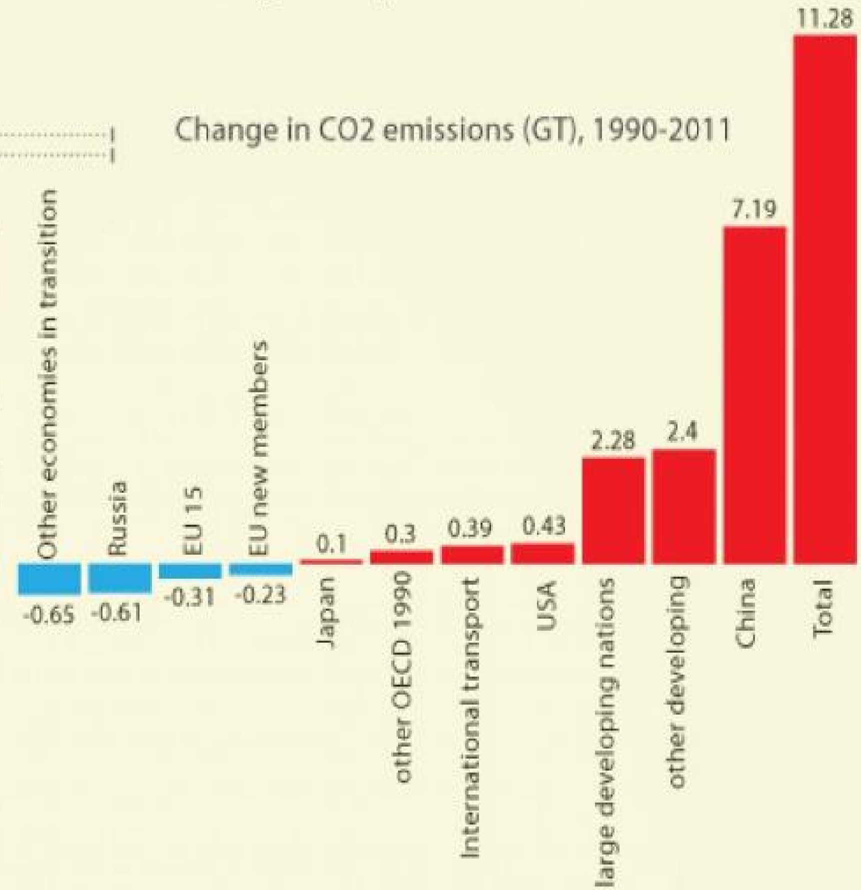
"Cheaper, not cleaner"
--The Economist

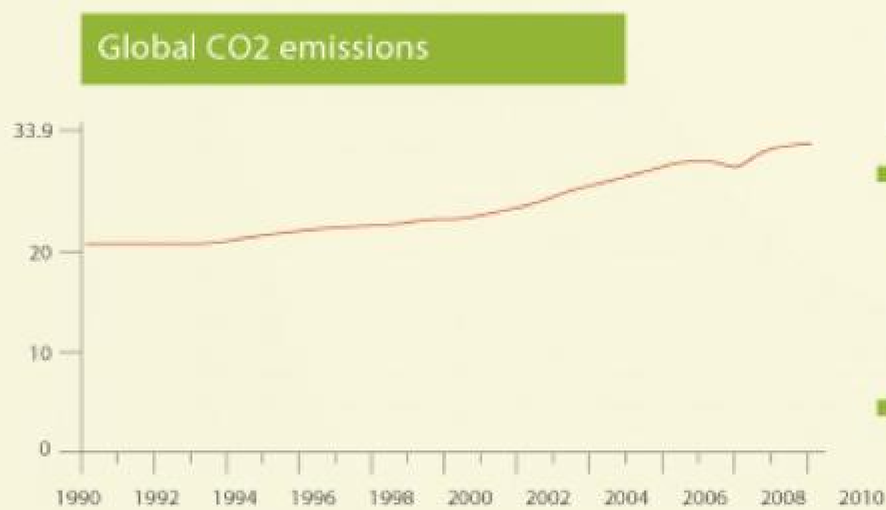


fallen significantly.

CHANGE IN CO2 EMISSIONS BY REGION

- Unfortunately, outside of the Kyoto targets, emissions from developing economies have increased considerably since 1990, with China accounting for over 60% of the global increase.





SO HAS THE KYOTO PROTOCOL WORKED?

- Looking at the chart to the left, clearly not. Overall, global emissions have showed no sign of slowing down and the skew created by the global economy makes individual nation targets misleading, in that sense the Kyoto Protocol has been a failure.
- However, as the only international binding treaty of its kind, it has been a very important first step in global climate diplomacy. The key is whether or not further and more robust steps will follow.