ECN

Energy research Centre of the Netherlands

Klimaatmitigatie en hoe je daar afspraken over maakt

Heleen de Coninck

Radboud Universiteit, Nijmegen,18 mei 2011

Dit college

Het Energieonderzoek Centrum Nederland

Emissies, baseline projecties en mitigatiescenario's

Mitigatie, kosten en technologie

Mitigatie in Europa

[pauze]

Beleidsopties

Wat voor internationaal verdrag?

Framing van klimaatverandering in de internationale context

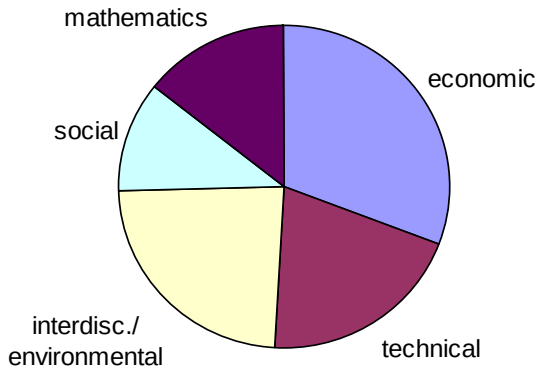
De huidige situatie

Energy research Centre of the Netherlands

Petten

Amsterdam

ECN Policy Studies



ECN Policy Studies provides

knowledge and strategies that matter for a sustainable energy future

Key in Dutch energy and climate policy, also active in EU and global energy and climate policymaking

65 researchers with backgrounds in engineering, economics, social science and environmental sciences

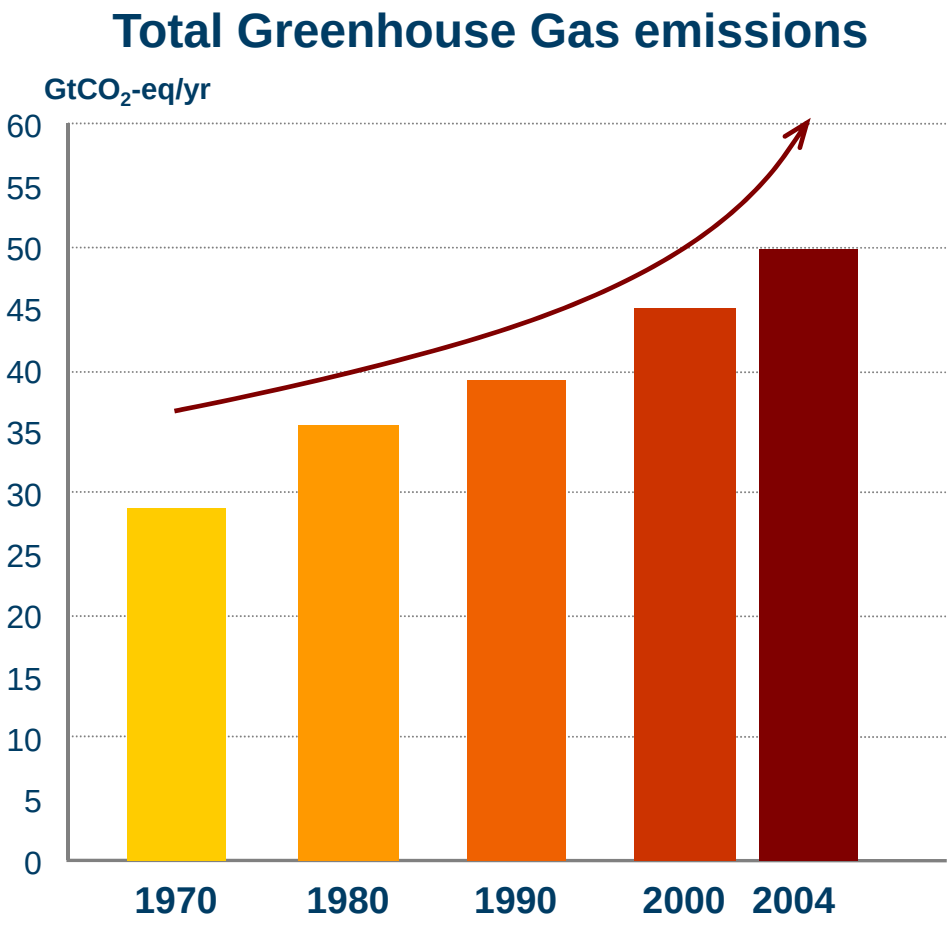
Addressing energy and climate policy challenges using quantitative analysis and qualitative thinking

De hamvraag

What international agreement can deliver the required climate change mitigation?

Emissies, baseline projecties en mitigatiescenario’s

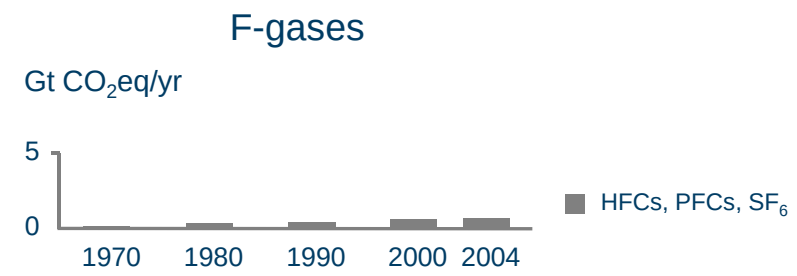
The challenge

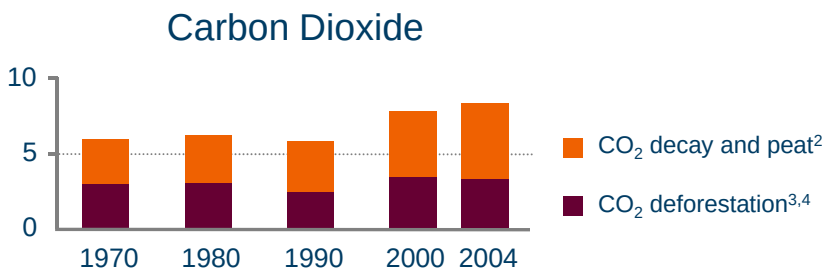


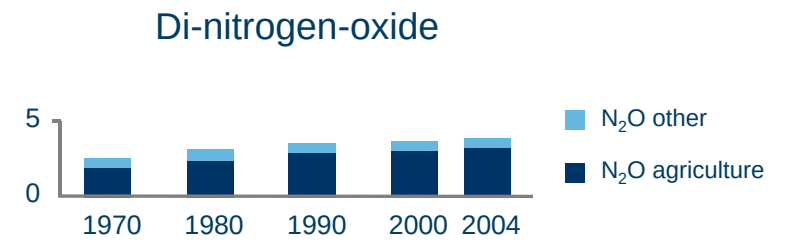
Between 1970 and 2004 global greenhouse gas emissions have increased by 70%

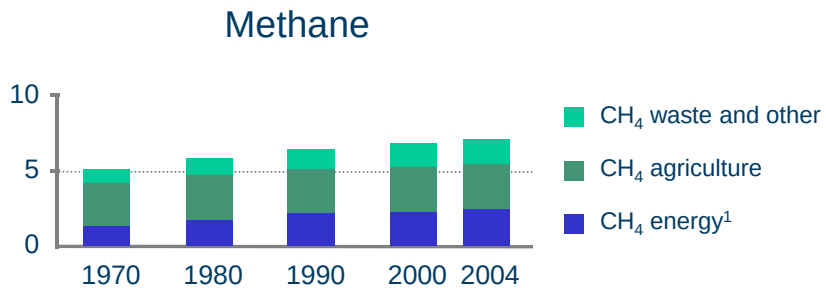
IPCC, AR4, 2007

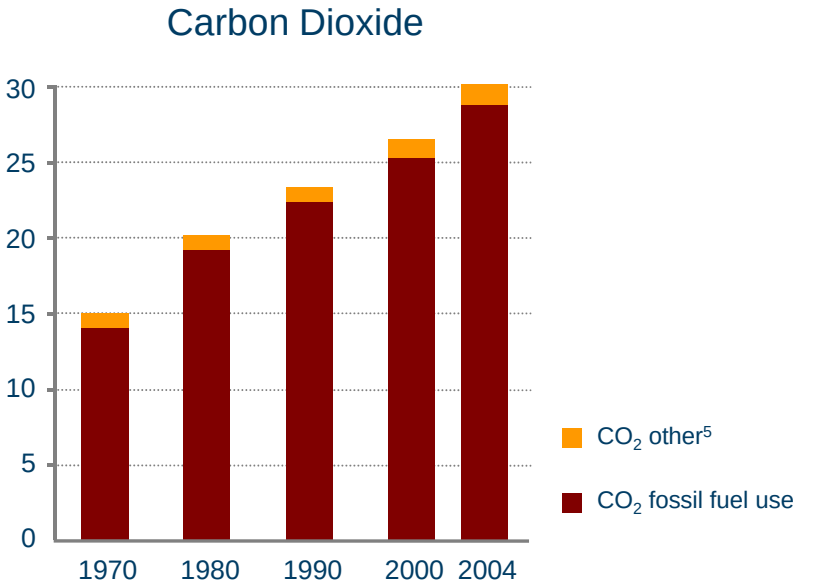
Carbon dioxide is the largest contributor





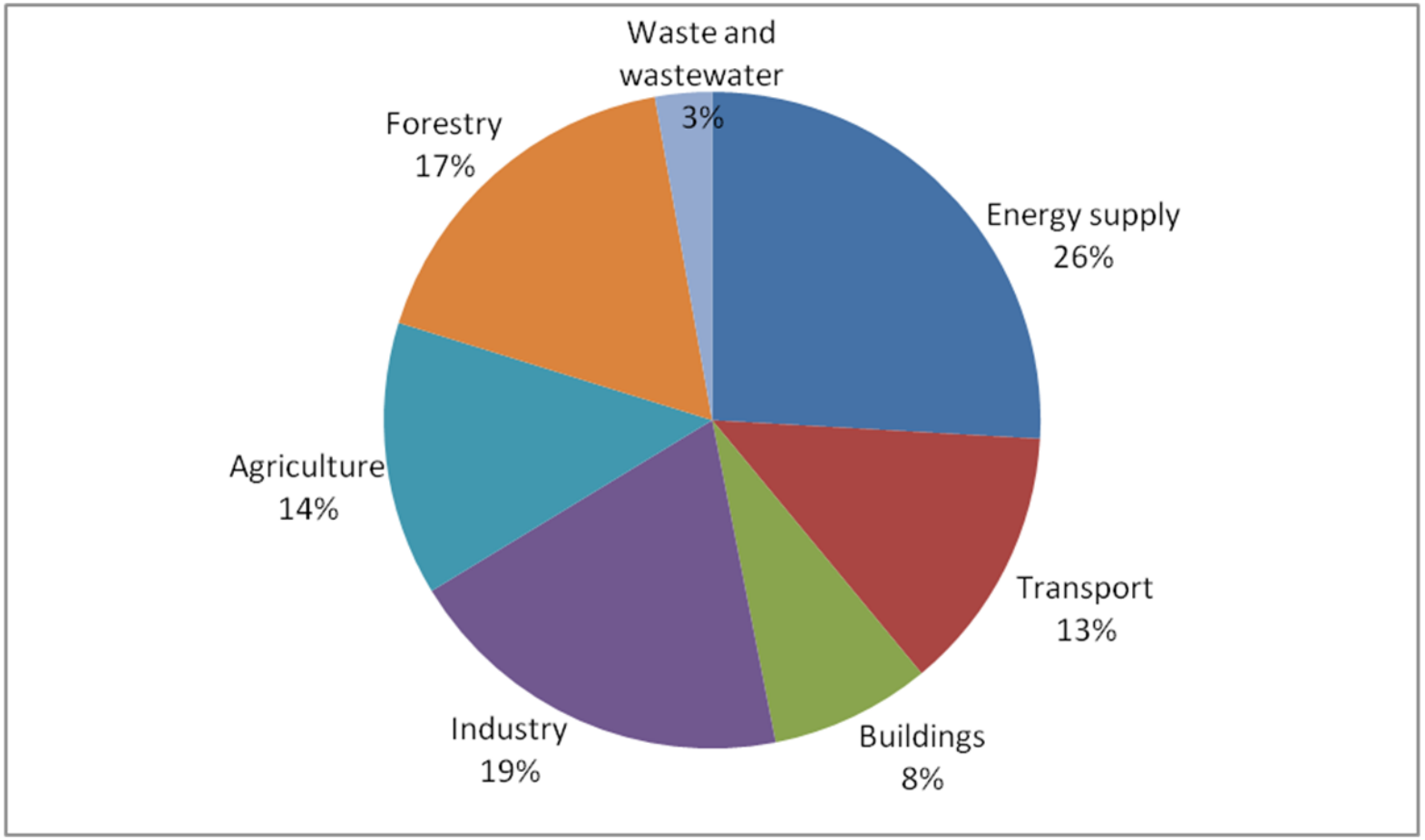






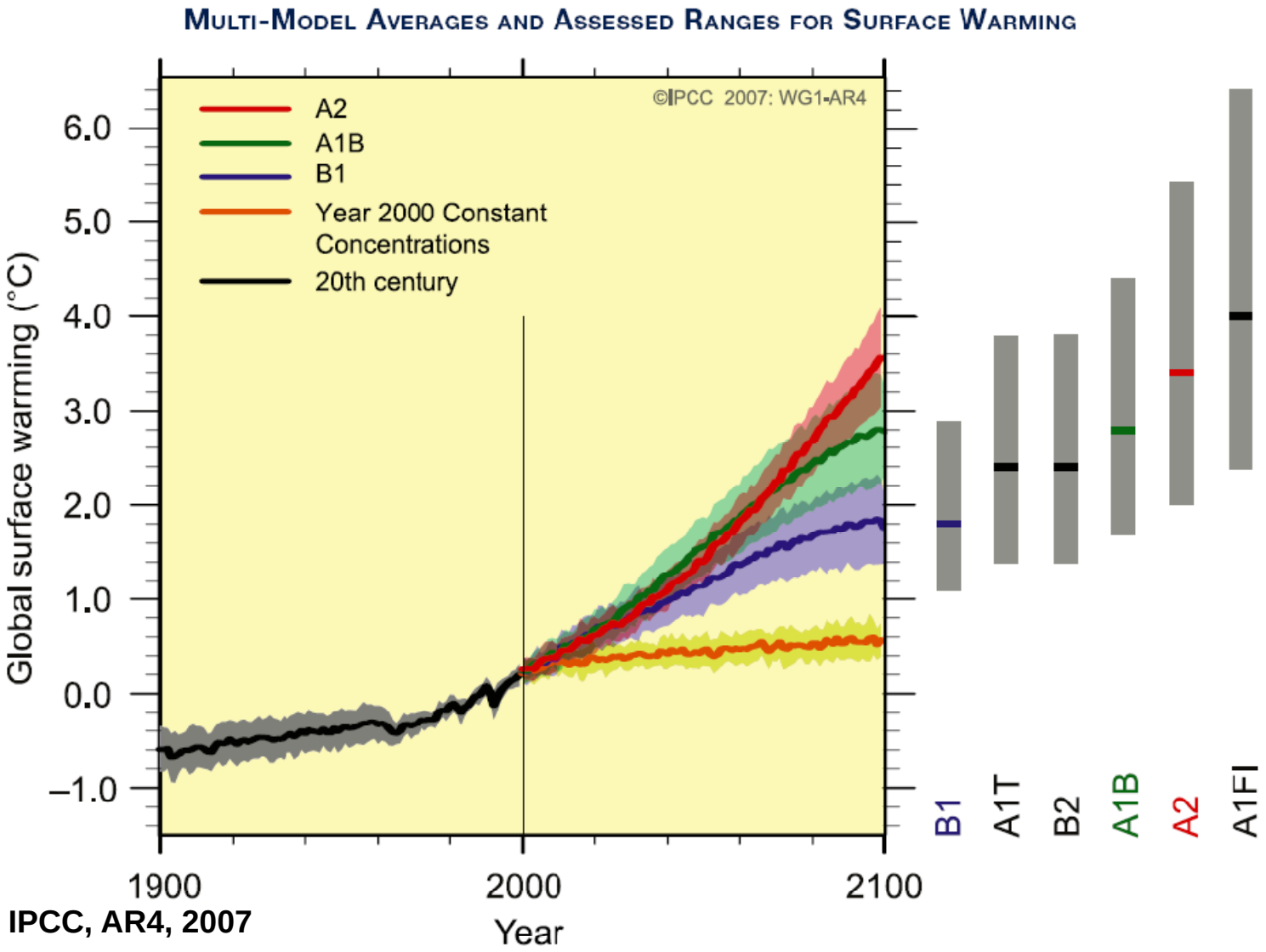
IPCC, AR4, 2007

Different sectors play a role…



IPCC, AR4, 2007

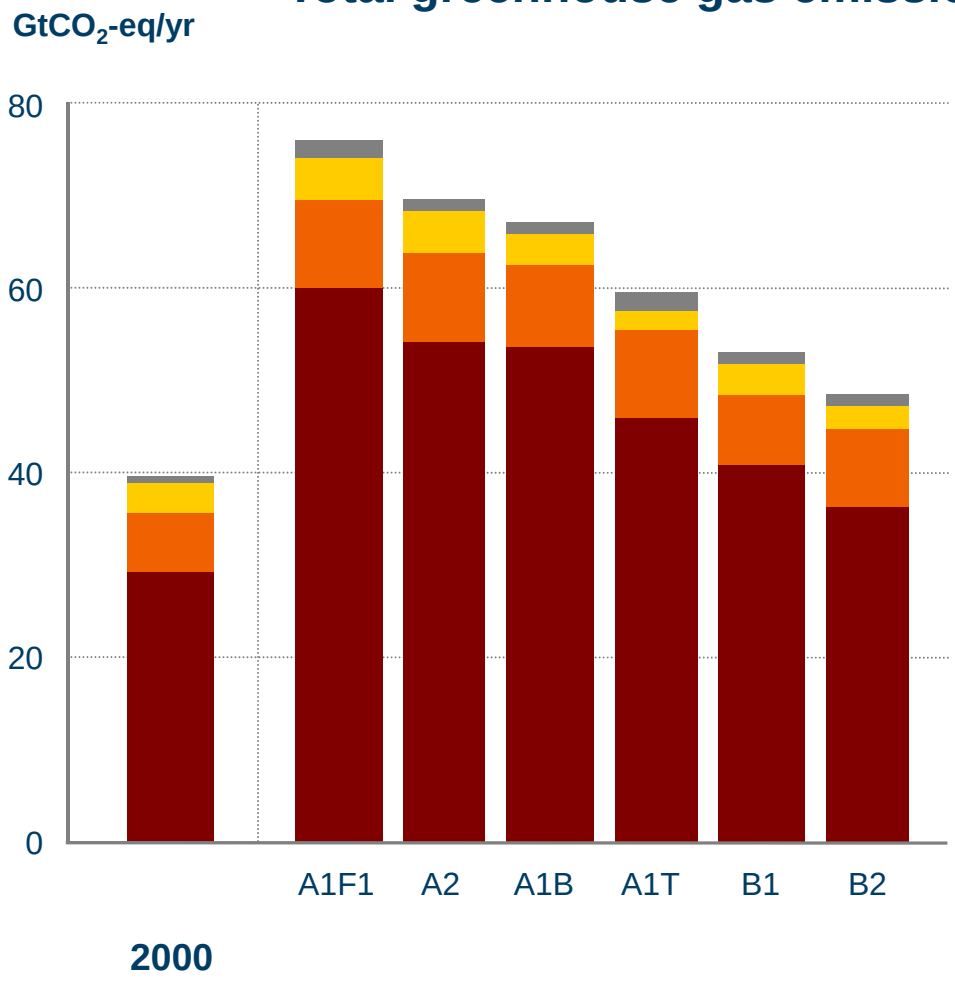
Projections of future changes in climate



IPCC, AR4, 2007

Global greenhouse gas emissions will continue to grow

Total greenhouse gas emissions

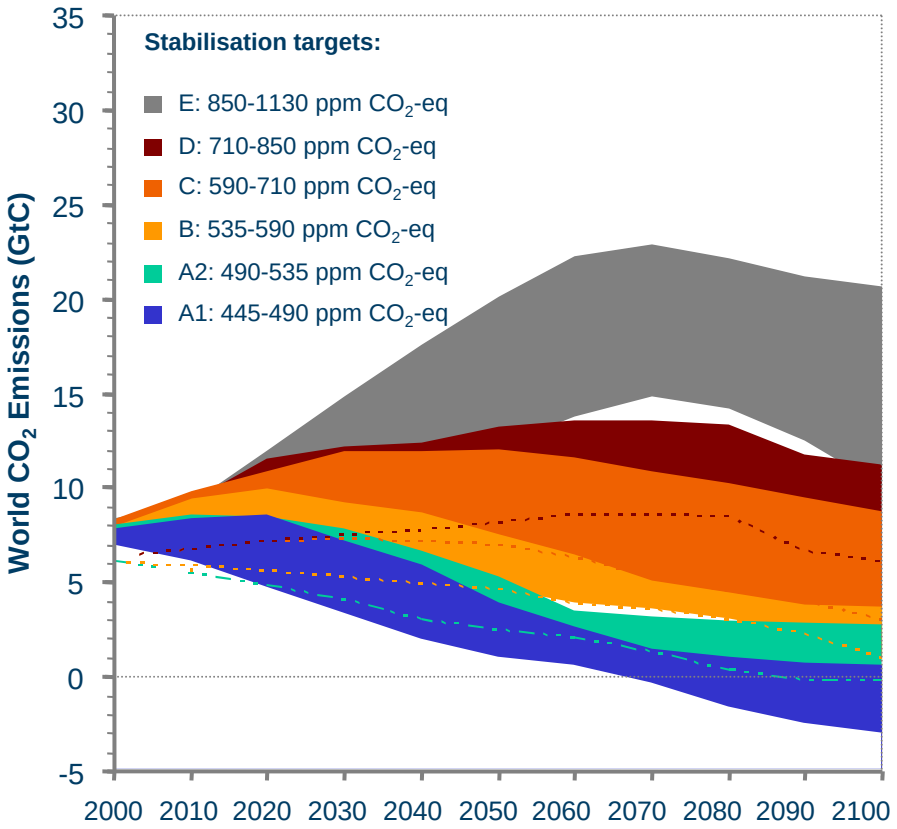


By 2030 there will be a 25-90% increase in greenhouse gas emissions compared with 2000 unless additional policy measures are put in place

IPCC, AR4, 2007

The lower the stabilisation level, the earlier global CO_2 emissions have to peak

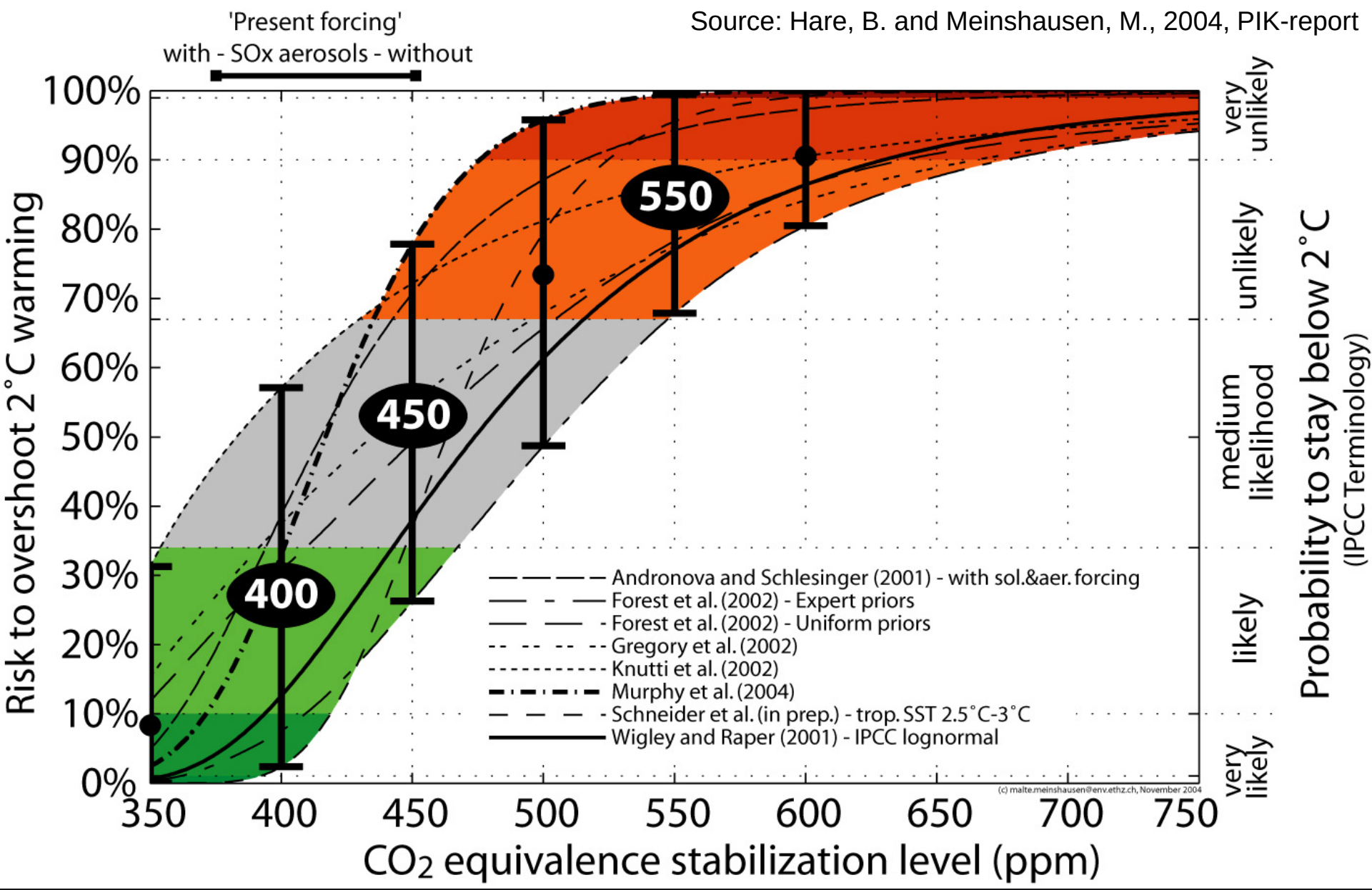
- The lower the target stabilisation level limit, the earlier global emissions have to peak.
- Limiting increase to 3.2 – 4°C requires emissions to peak within the next 55 years.
- Limiting increase to 2.8 – 3.2°C requires global emissions to peak within 25 years.
- Limiting global mean temperature increases to 2 – 2.4°C above pre-industrial levels requires global emissions to peak within 15 years and then fall to about 50 to 85% of current levels by 2050.



Multigas and CO_2 only studies combined

IPCC, AR4, 2007

Source: Hare, B. and Meinshausen, M., 2004, PIK-report

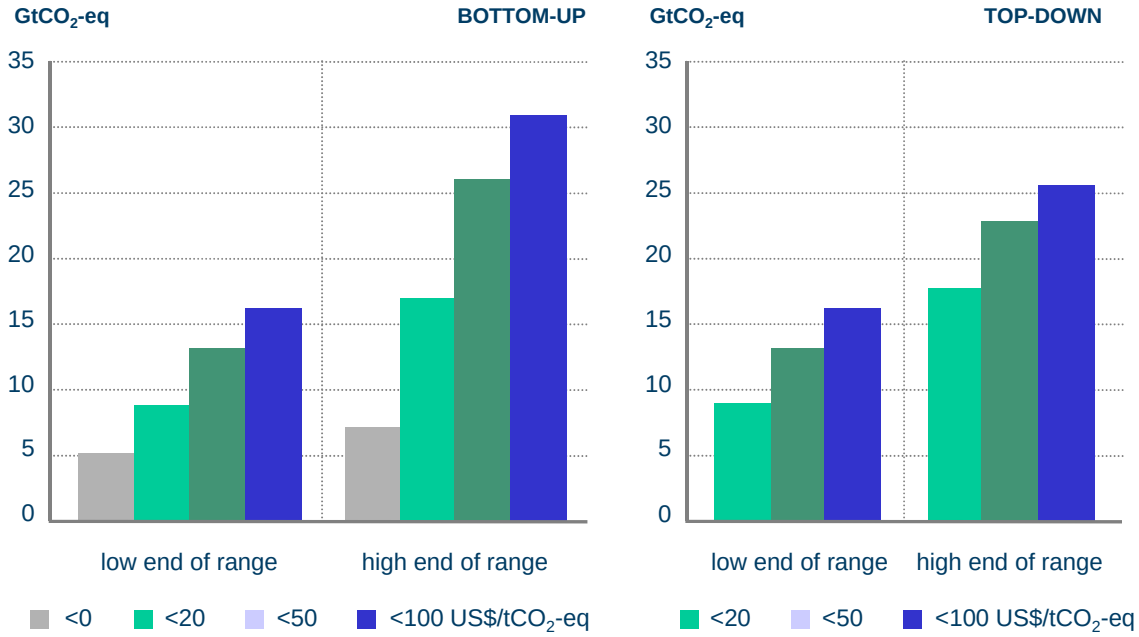


Mitigatie, kosten en technologie

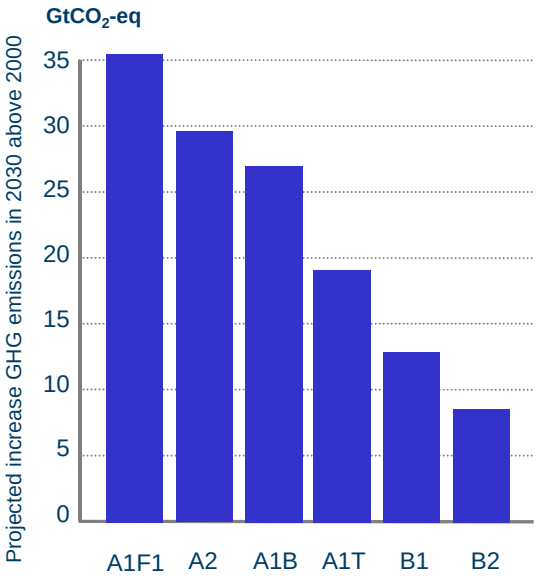
Emissions of greenhouse gases can be avoided

Substantial capability to prevent emissions of greenhouse gases in 2030.

Economic mitigation potential until 2030 could offset the projected growth of global emissions, or reduce emissions below current levels



Global economic potential in 2030



Greenhouse gas emissions

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

IPCC, AR4, 2007

Mitigation measures do not have an unrealistically high price

What does US$50/t$CO_2$-eq mean?

Crude oil

~US$25/barrel

Gasoline

~12ct/litre
(50ct/gallon)

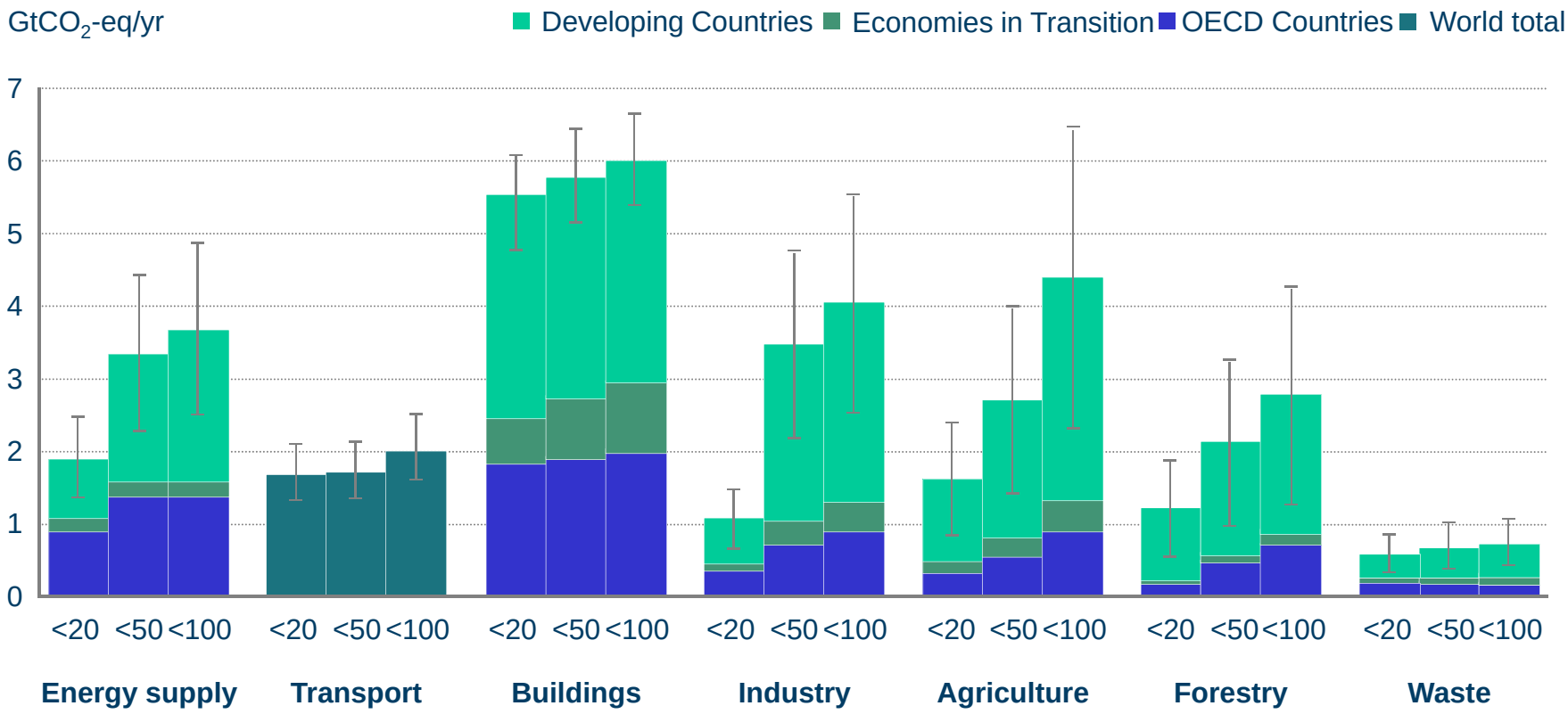
Electricity

from coal fired plant:
~5ct/kWh

from gas fired plant:
~1.5ct/kWh

IPCC, AR4, 2007

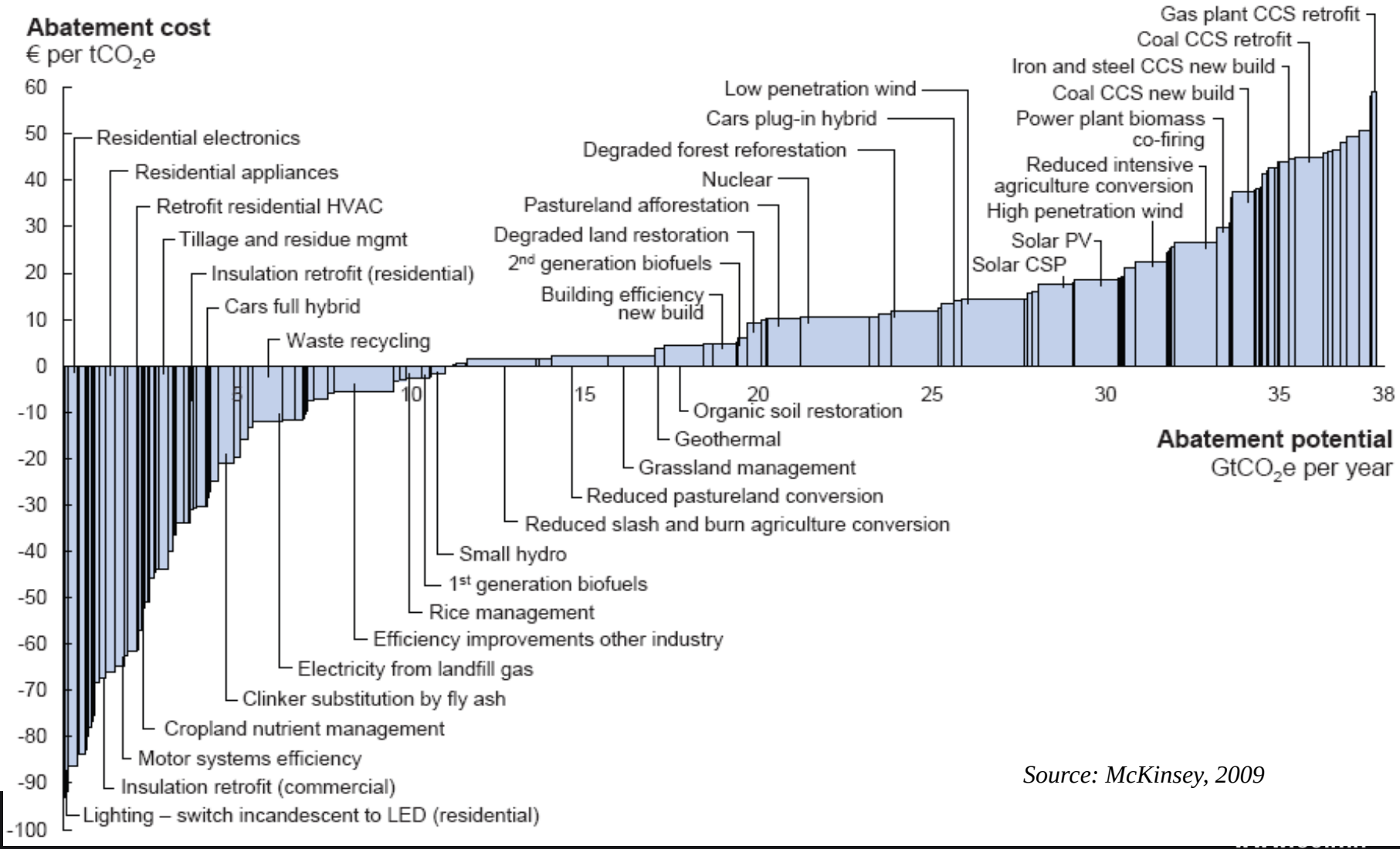
All sectors and regions have the potential to contribute



Emission reductions based on the end-use of energy

IPCC, AR4, 2007

The (McKinsey) abatement cost curve



Source: McKinsey, 2009

How can emissions be reduced? Energy supply

Key mitigation technologies and practices currently commercially available

Renewable (hydropower, solar, wind, geothermal and bioenergy)

Combined heat and power

Early applications of CO_2 capture and storage (CCS)

Efficiency

Fuel switching

Nuclear power

Key mitigation technologies and practices projected to be commercialised before 2030

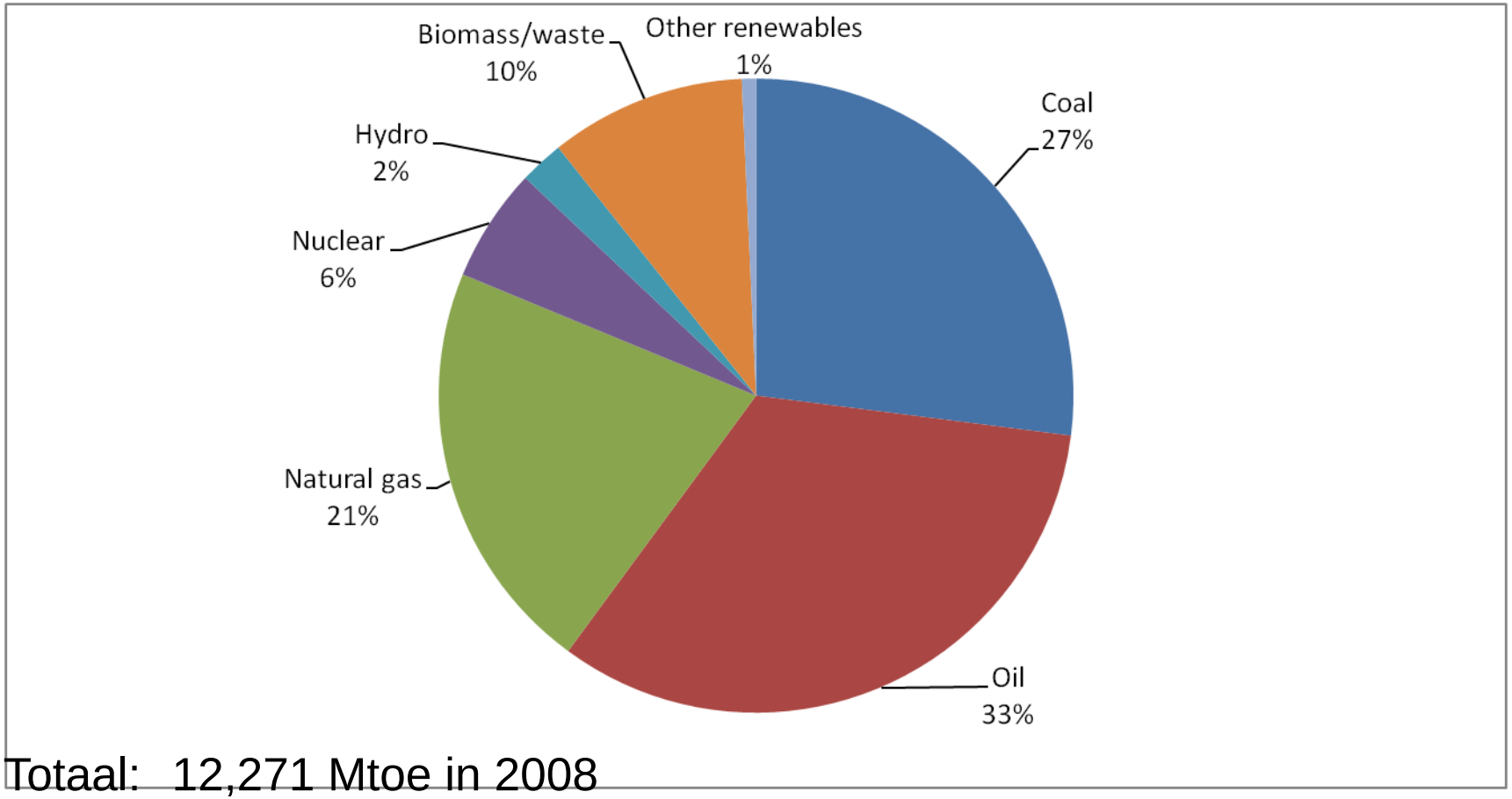
CCS for gas

Biomass and coal-fired electricity generating facilities

Advanced renewables (tidal and wave
energy, concentrating solar, solar PV)

IPCC, AR4, 2007

World primary energy consumption in 2008



Totaal: 12,271 Mtoe in 2008

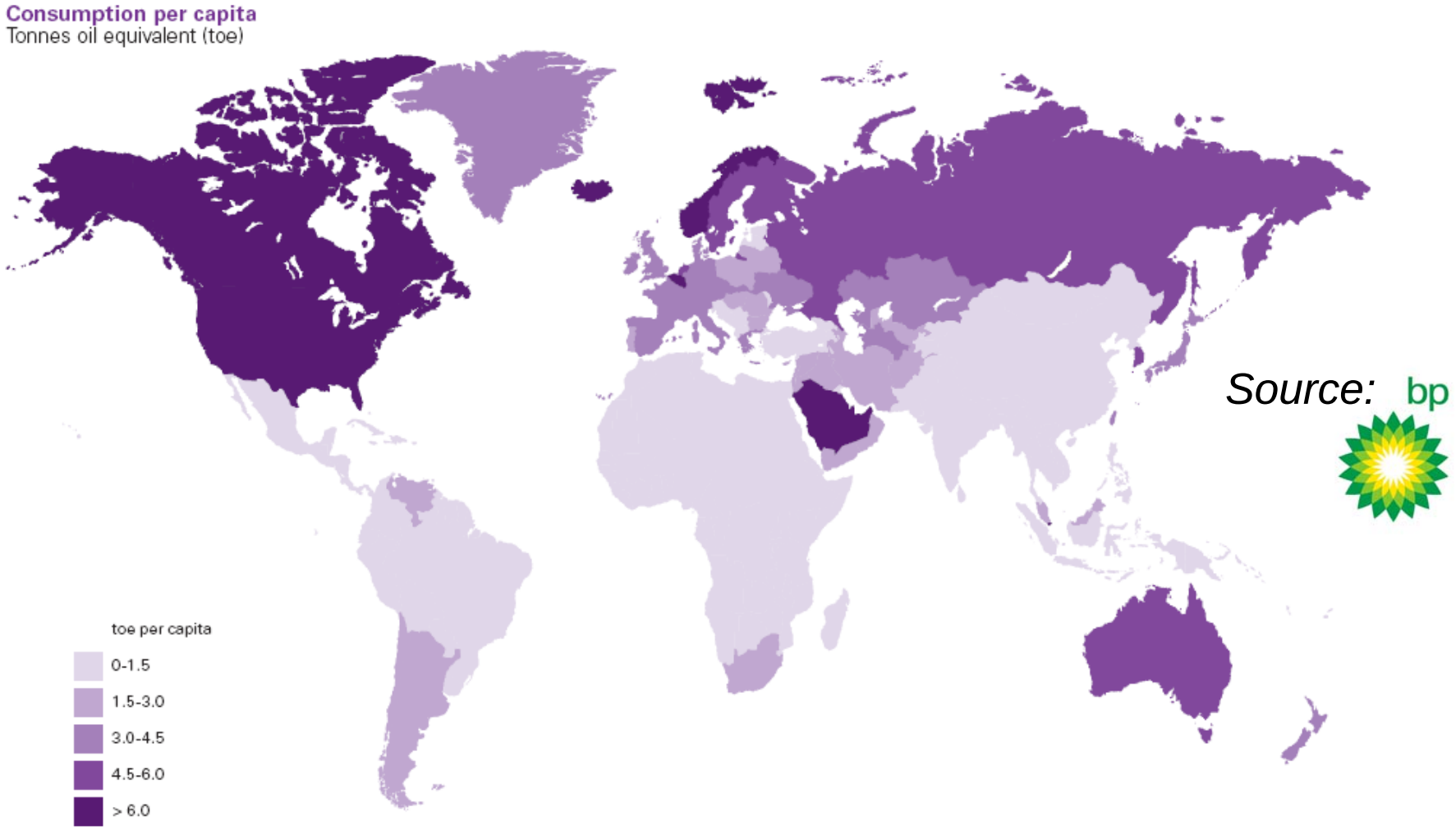
(in 1980: 7,229 Mtoe)

Bron: IEA World Energy Outlook 2010

Uses of primary fuels

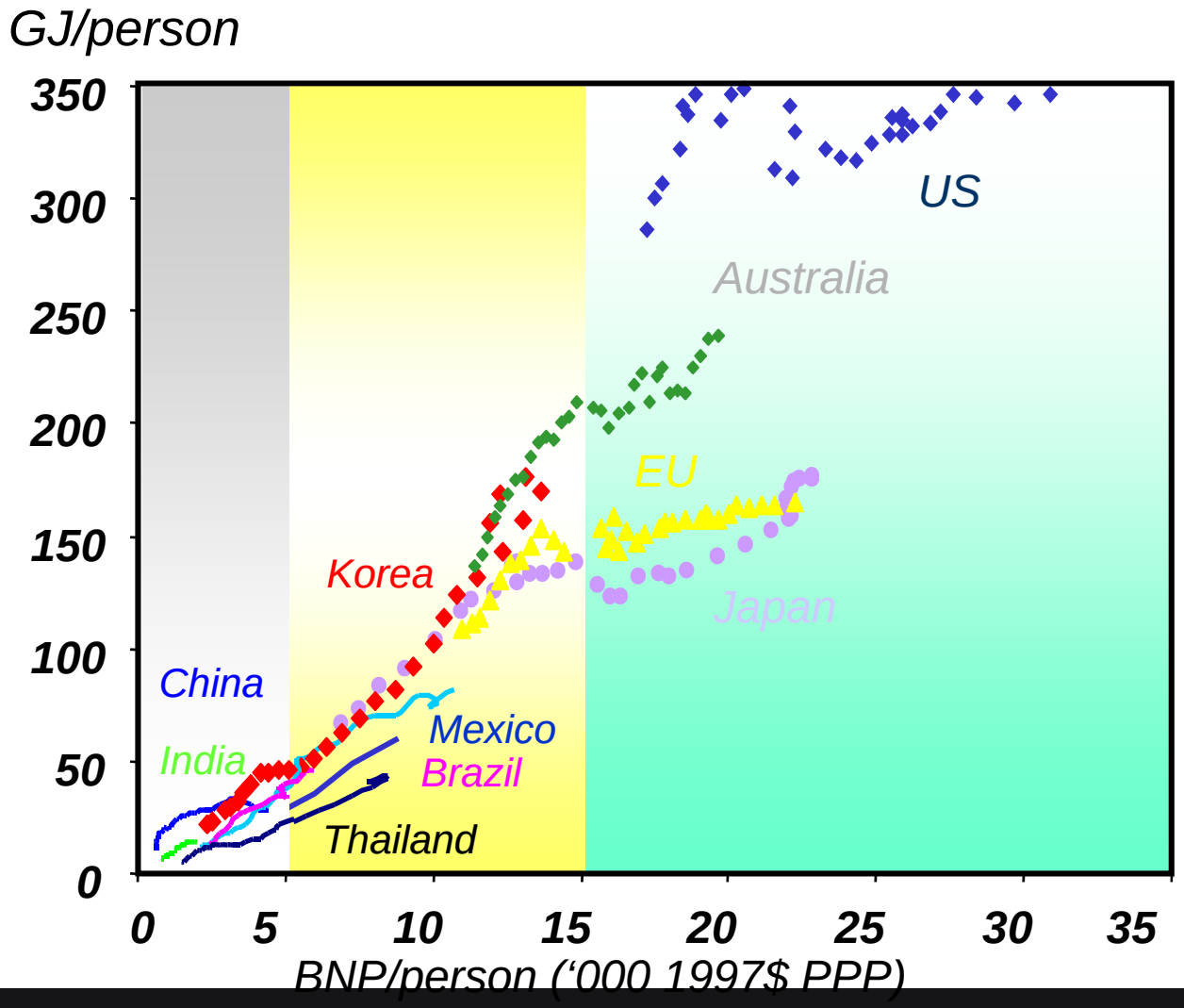
Oil	Transport fuels, chemical industry, heating (buildings), electricity
Coal	Electricity, heating (industry and buildings)
Natural gas	Heating, electricity, chemical industry
Nuclear	Electricity
Hydropower	Electricity
Biomass	Heating, electricity
Solar PV, wind	Electricity

Primary energy consumption per capita



Source: bp

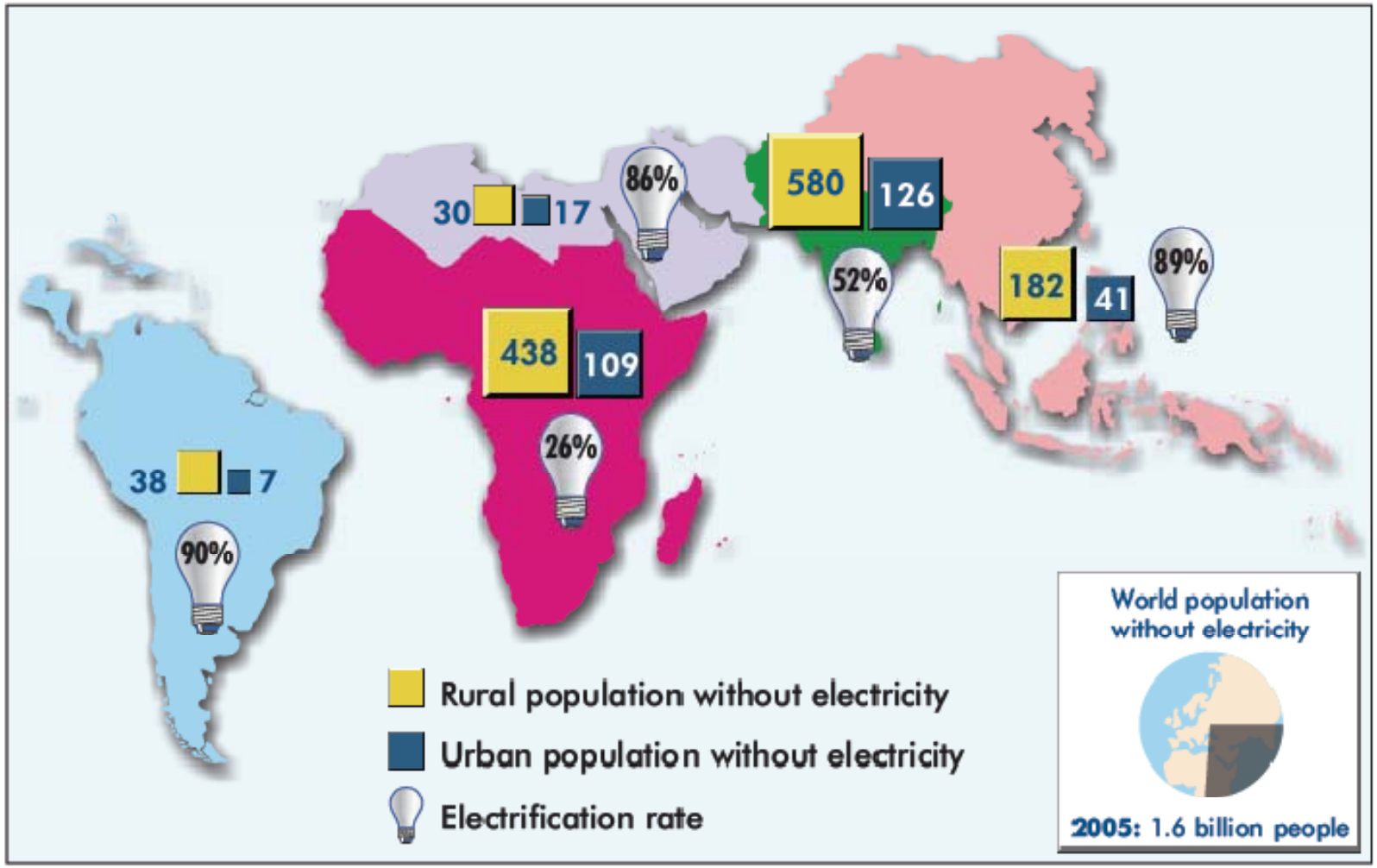
Growth of energy use with growing income



- ***+$25k/person**: little extra energy*
- ***+$15k/person**: services dominate growth*
- ***+$10k/person**: industrialisation almost complete*
- ***+$5k/person**: industrialisation and mobility begin*

Source: IMF, BP, IIASA

Energy access challenges



How can emissions be reduced? Transport

Key mitigation technologies and practices currently commercially available

More fuel efficient vehicles

Hybrid vehicles

Biofuels

Modal shifts from road transport to rail and public transport systems

Cycling, walking

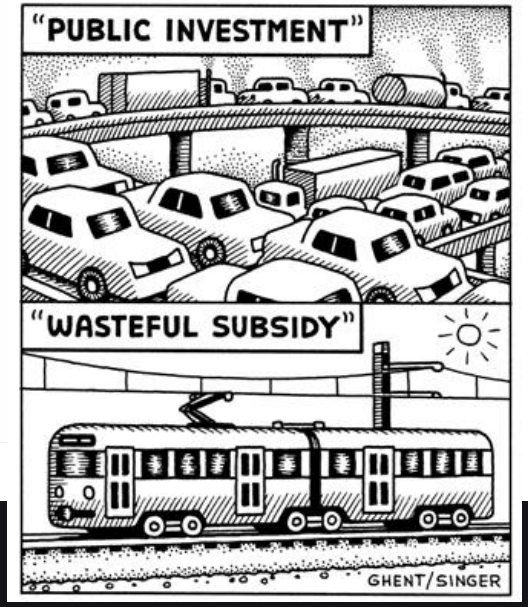
Land-use planning

Key mitigation technologies and practices projected to be commercialised before 2030

Second generation biofuels

Higher efficiency aircraft

Advanced electric and hybrid vehicles with more powerful and reliable batteries



IPCC, AR4, 2007

How can emissions be reduced? Industry

Key mitigation technologies and practices currently commercially available

- More efficient electrical equipment
- Heat and power recovery
- Material recycling
- Control of non-CO_2 gas emissions

Key mitigation technologies and practices projected to be commercialised before 2030

Advanced energy efficiency

CCS for cement, ammonia, and iron manufacture

Inert electrodes for aluminum manufacture

IPCC, AR4, 2007

How can emissions be reduced? Buildings

Key mitigation technologies and practices currently commercially available

Efficient lighting

Efficient appliances and air-conditioners

Improved insulation

Solar heating and cooling

Alternatives for fluorinated gases in insulation and appliances

Key mitigation technologies and practices projected to be commercialised before 2030

Integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control

Solar PV integrated in buildings

IPCC, AR4, 2007

How can emissions be reduced? Agriculture

Key mitigation technologies and practices currently commercially available

Improved land management

Restoration of cultivated peat soils and degraded land

Improved rice cultivation technology.

Improved livestock and manure management

Improved N-fertiliser application (+ bioenergy crops)

Key mitigation technologies and practices projected to be commercialised before 2030

Improvement of crop yields

IPCC, AR4, 2007

How can emissions be reduced? Forestry

Key mitigation technologies and practices currently commercially available

Afforestation, reforestation

Forest management

Reduced deforestation

Harvested wood product management
(+ bioenergy crops)

Key mitigation technologies and practices projected to be commercialised before 2030

Tree species improvement

Improved remote sensing technologies for mapping, land use change and carbon sequestration potential

IPCC, AR4, 2007

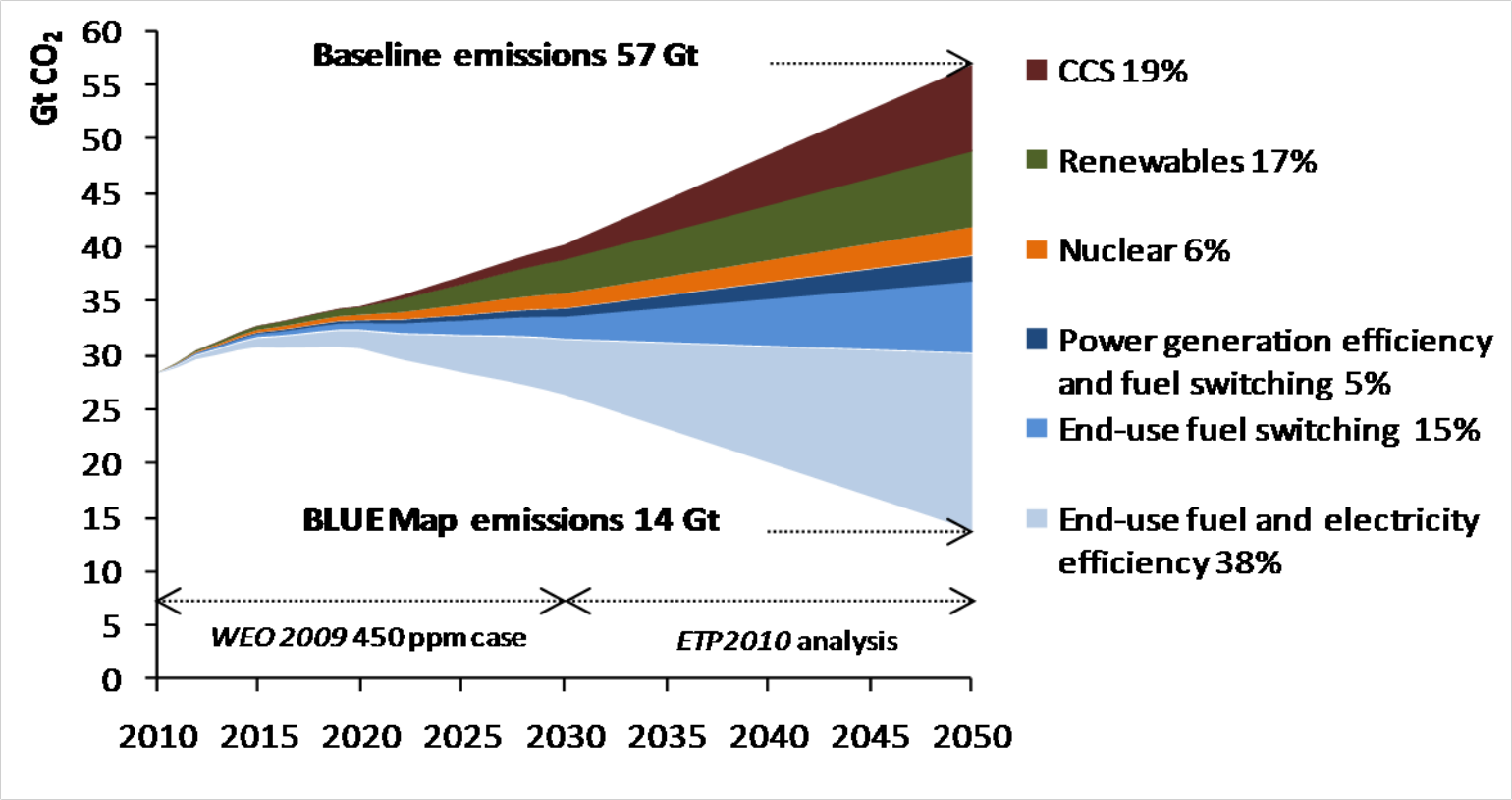
How can emissions be reduced? Changes in lifestyle & behaviour

Key mitigation technologies and practices currently commercially available

- Consumers change their behaviour through their choice of lifestyle options
- Staff incentives encourage a change in practices in the workplace
- Car owners employ a more fuel- efficient way of driving; ‘eco-driving’, by accelerating and braking less strongly.
- Reduce car use by shifting to other modes of transport.

IPCC, AR4, 2007

Mitigation technologies



IEA, 2010

Mitigation technologies

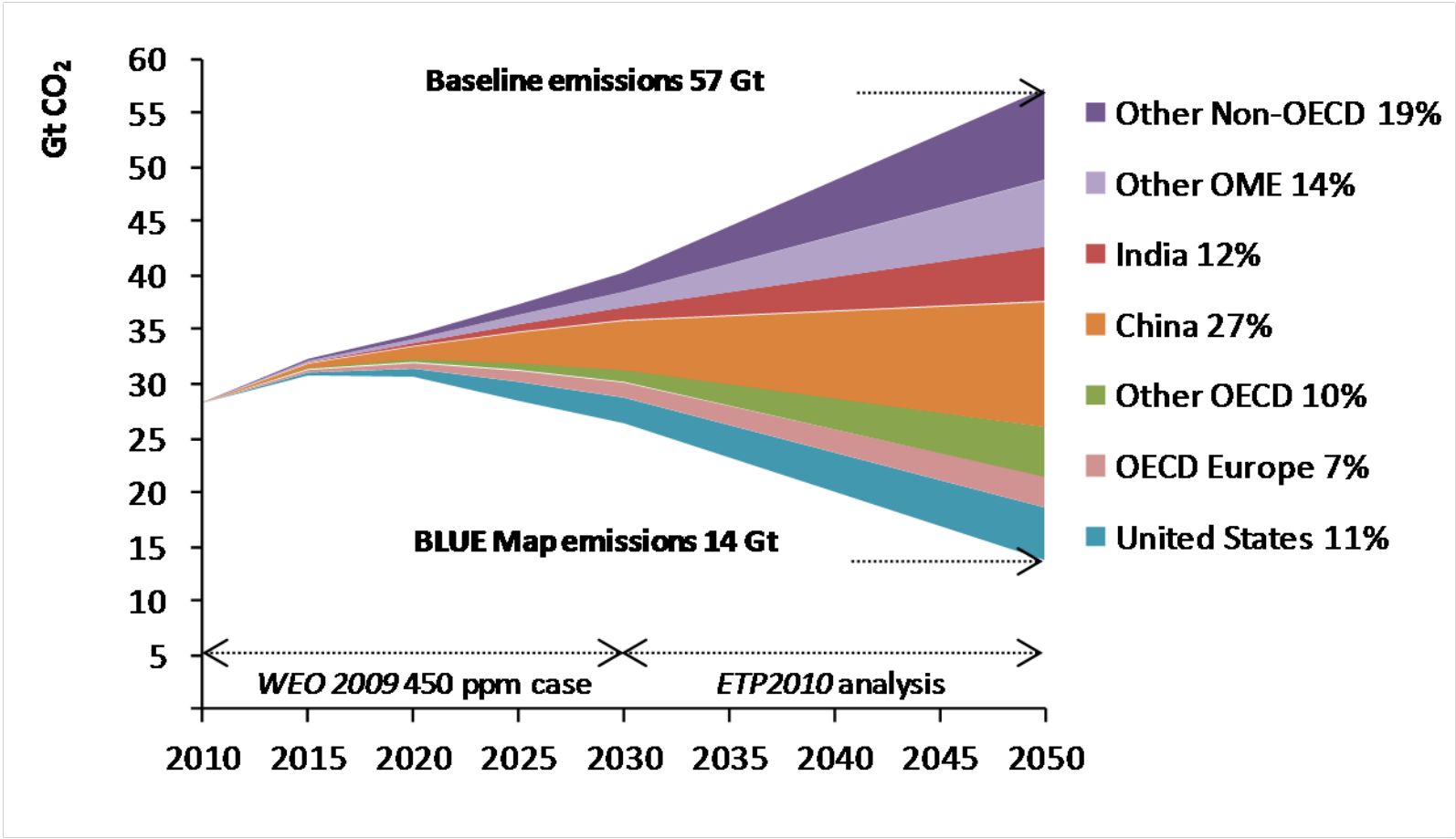
A mix of mitigation options needed to stabilize concentrations

Uncertain if strategies will be successful

- Inertia are large and limit opportunities to reduce risks
- Mitigation will lead to additional cost
- Some technologies lead to resistance
- International coordination needed
- Few actors are willing to invest in innovative technologies

IEA, 2010

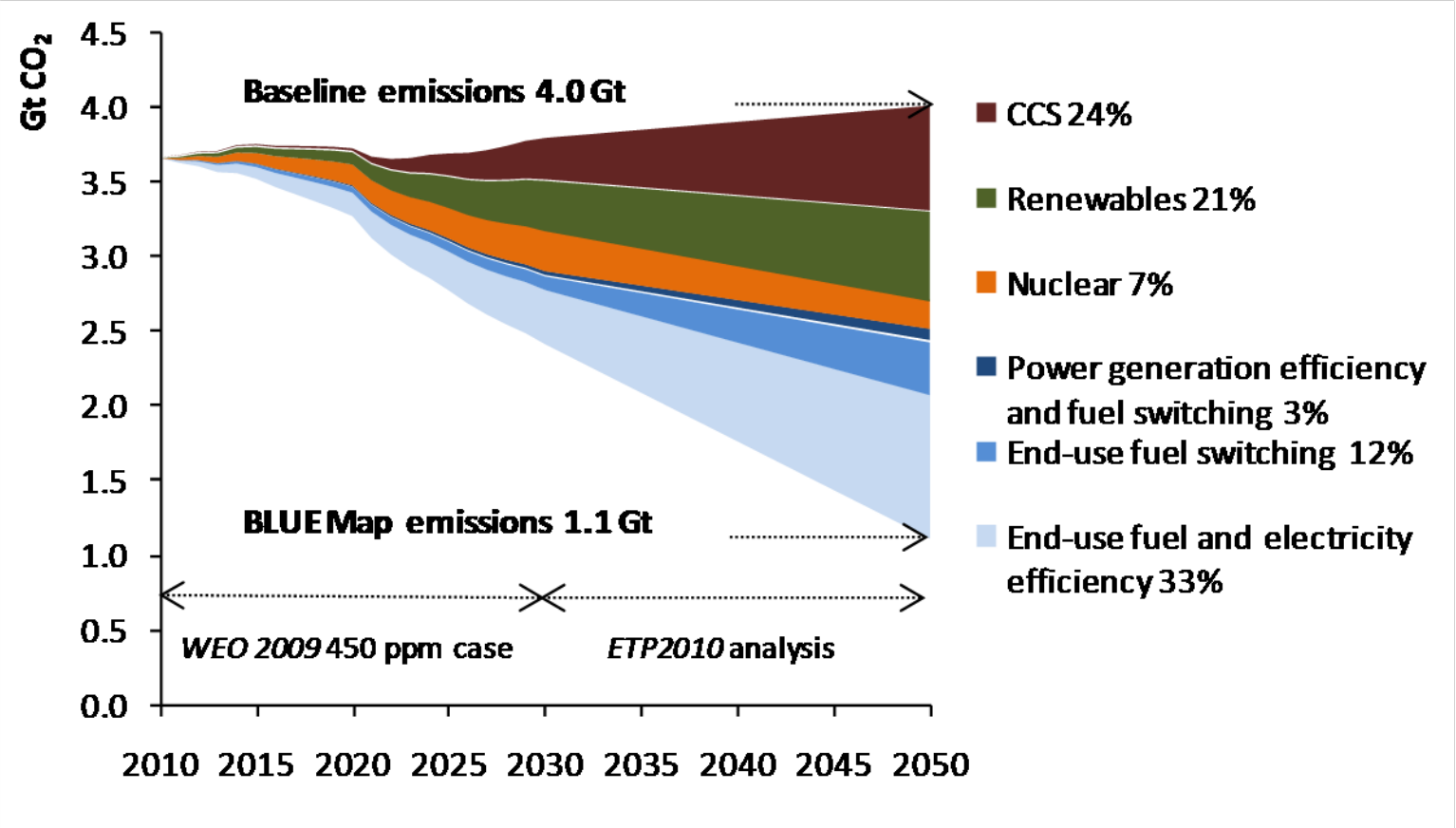
Energy-related mitigation by region



IEA, 2010

Hoe zit dat in Europa?

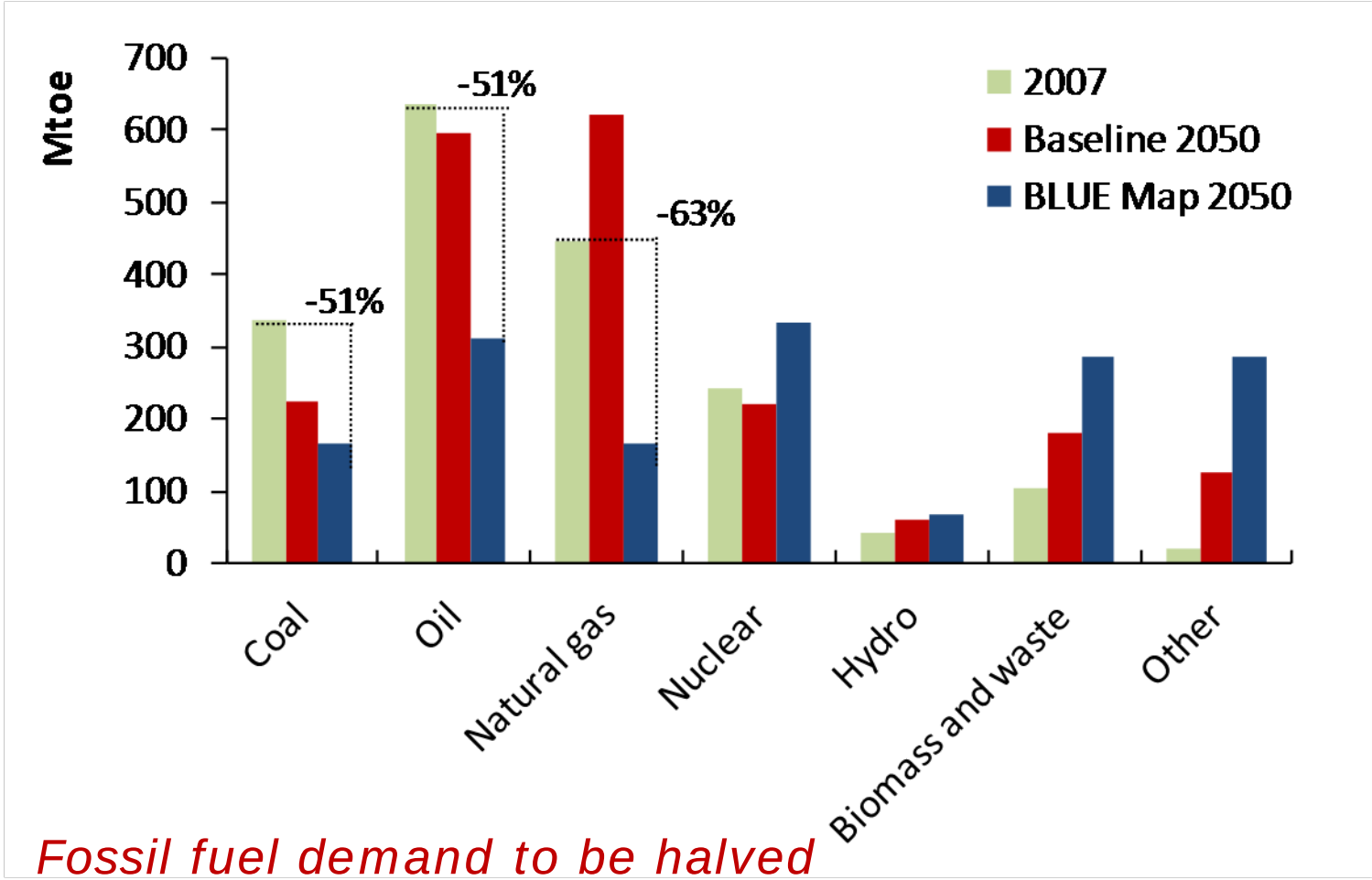
Contributions to emissions reductions in Europe



IEA: End-use sector measures contribute nearly two-thirds of the emissions reductions

IEA, 2010

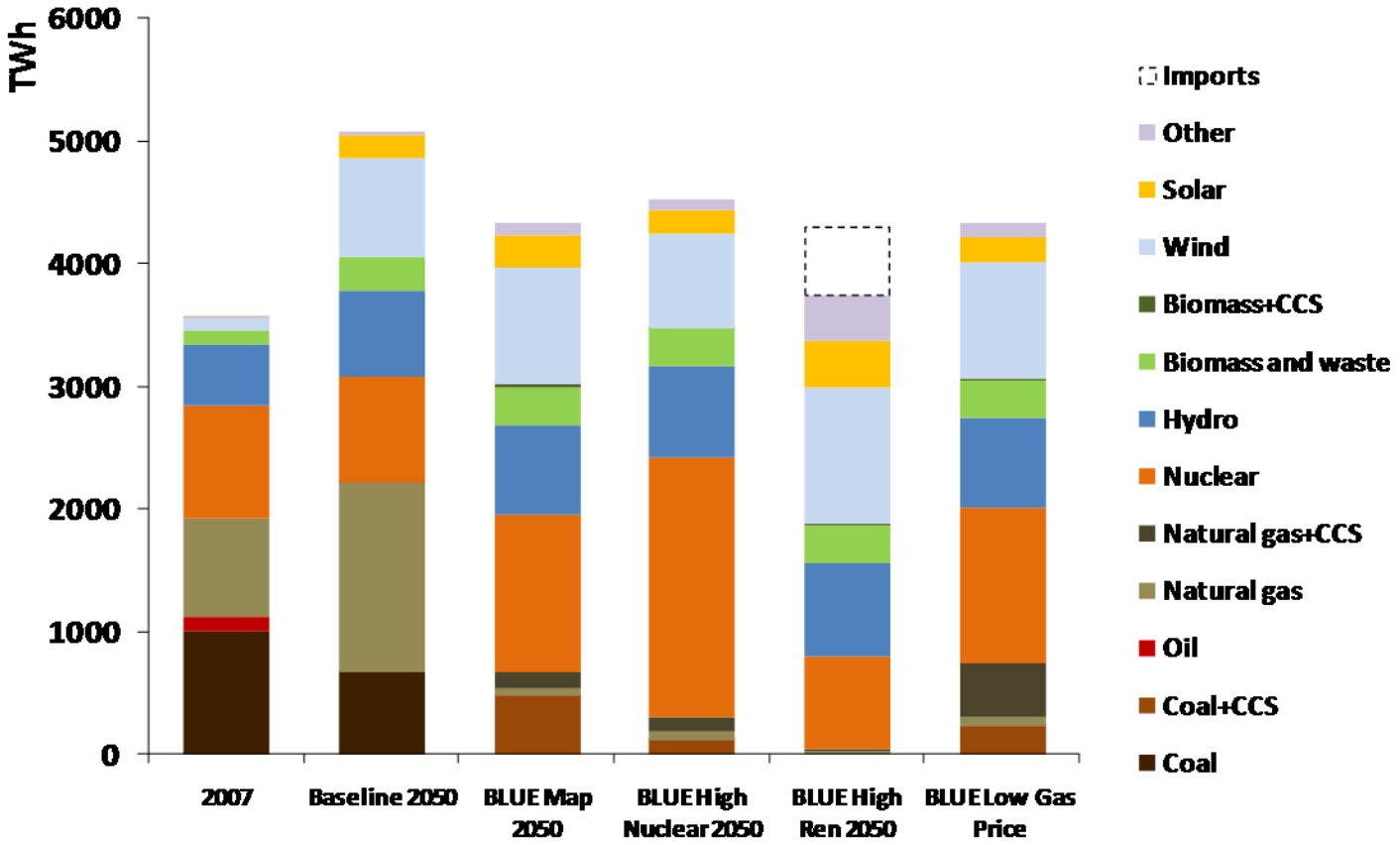
Primary energy demand by fuel and by scenario in Europe



Fossil fuel demand to be halved

IEA, 2010

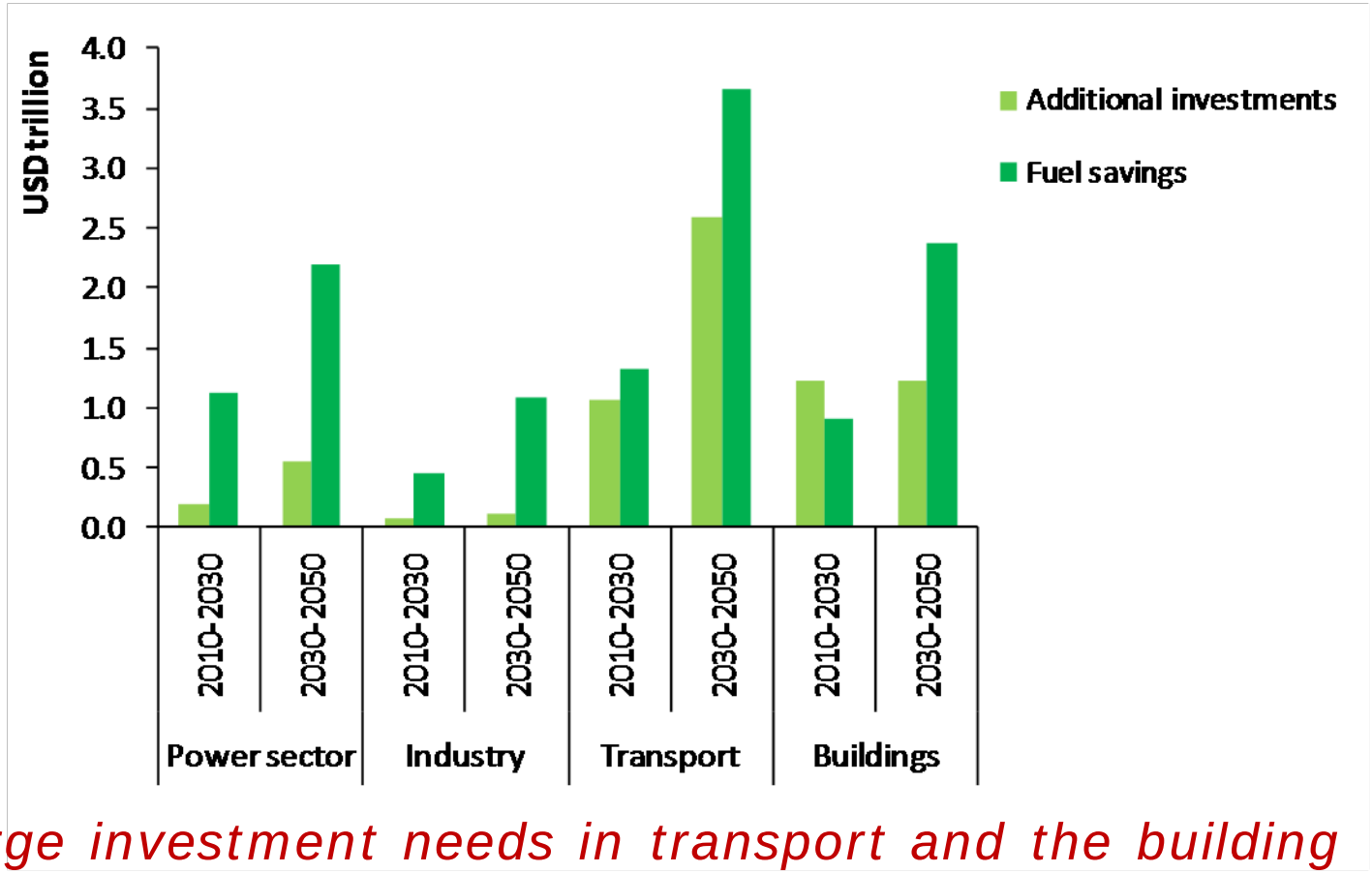
Decarbonisation of power generation



Mix of nuclear, renewables and fossil fuels with CCS will be needed to decarbonise the electricity sector.

IEA, 2010

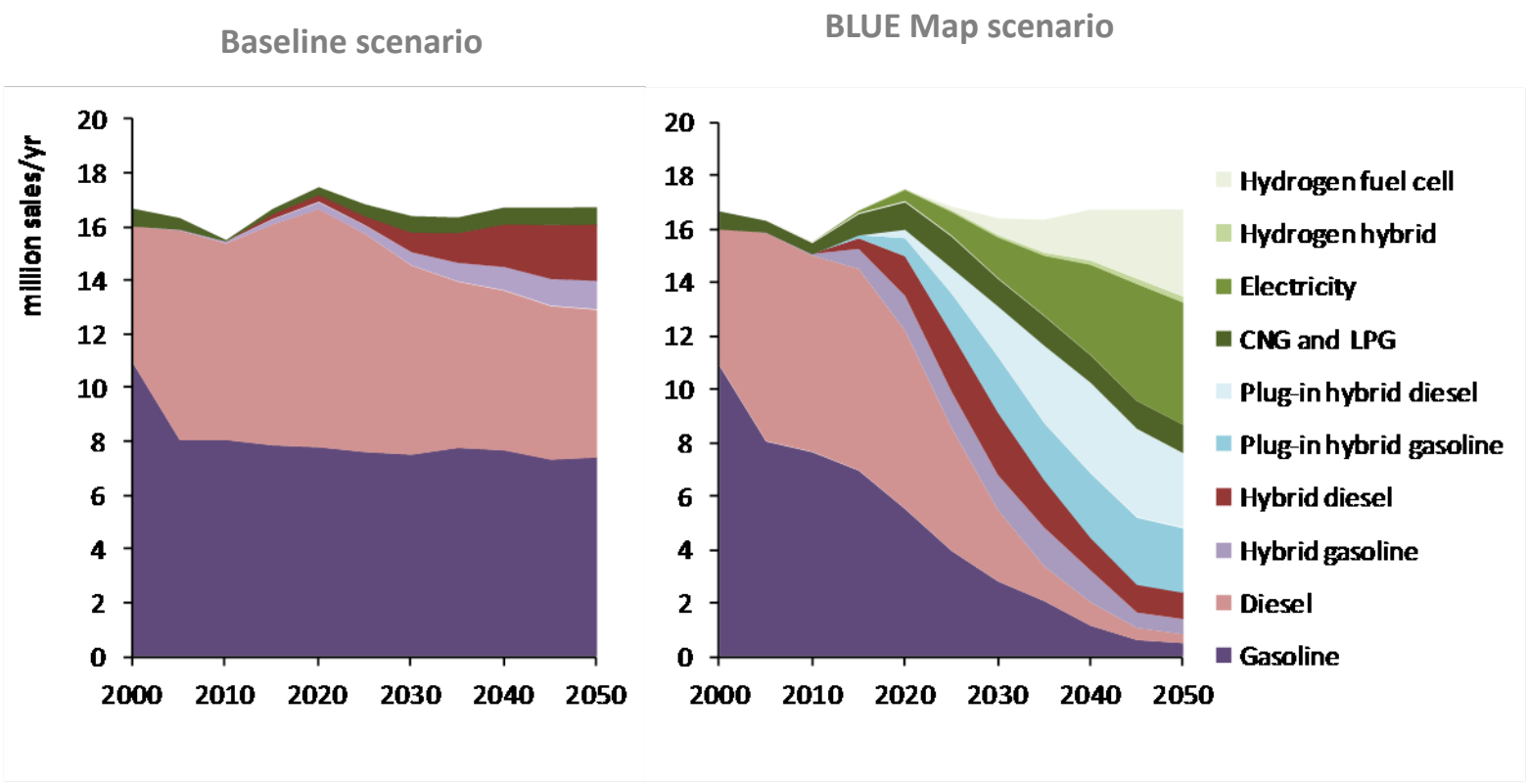
Additional investment needs and fuel cost savings for OECD Europe



Large investment needs in transport and the building sectors may be compensated by fuel savings.

IEA, 2010

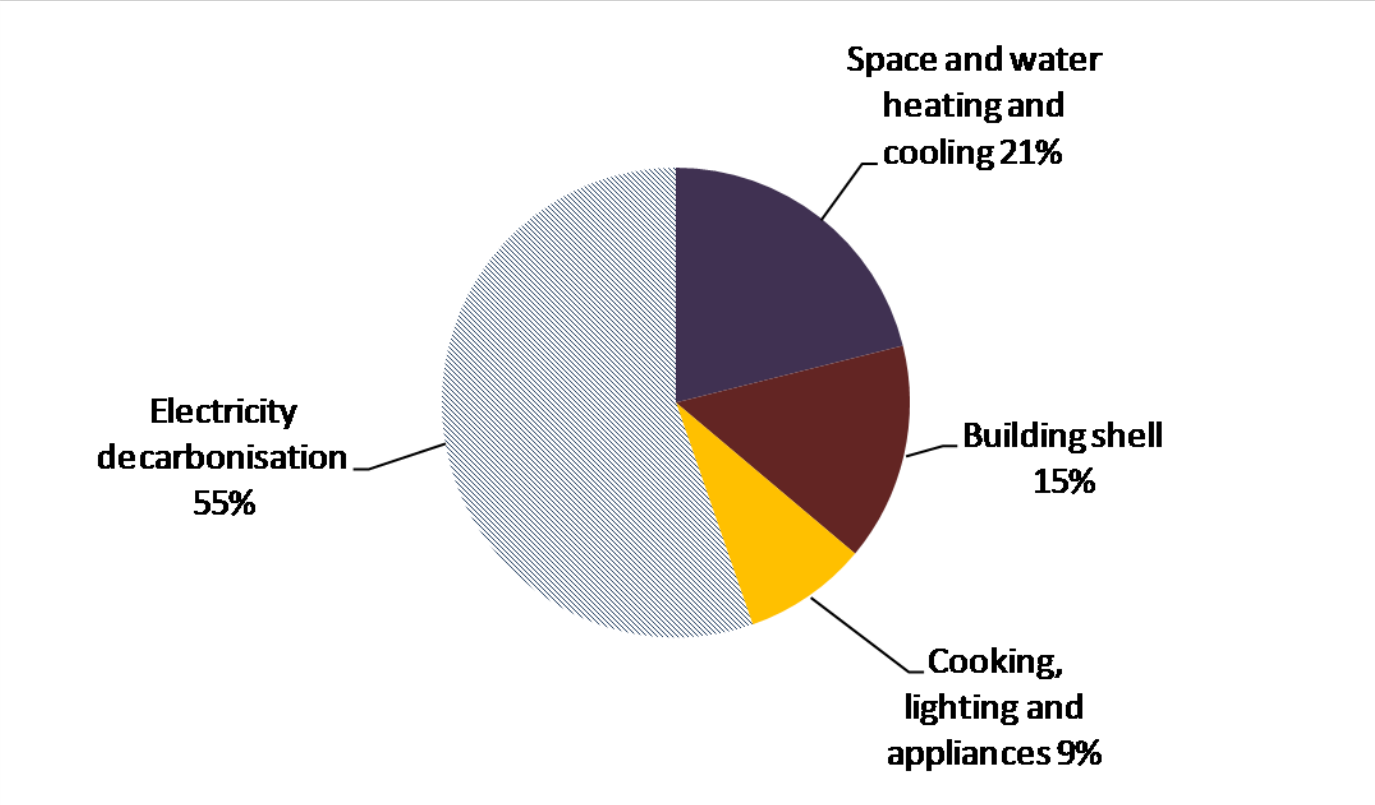
Passenger light-duty vehicles sales by technology in OECD Europe in the Baseline and BLUE Map scenarios



A wide range of new LDV technologies contribute to emissions reductions under the BLUE scenario.

IEA, 2010

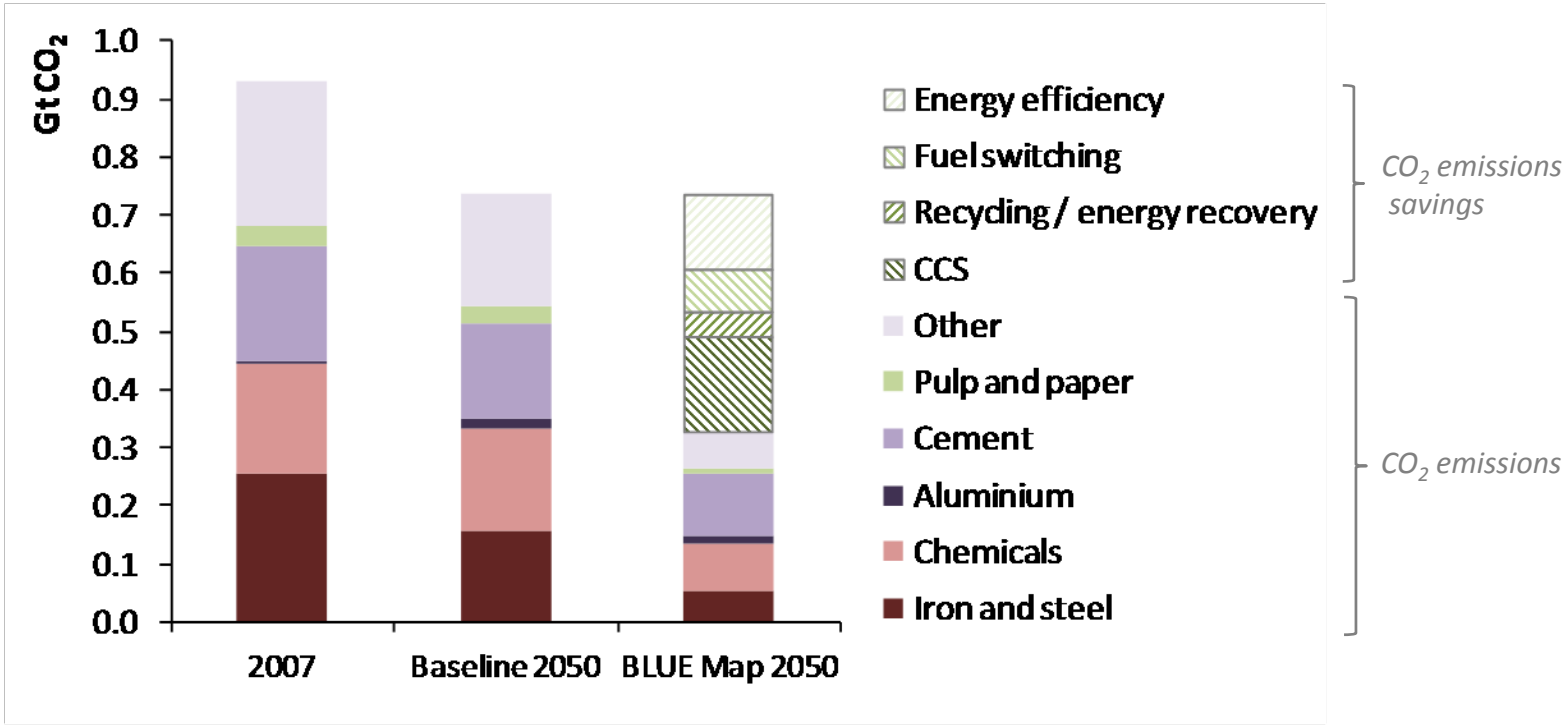
CO_2 emissions in the buildings sector in Europe



Decarbonisation of the electricity sector contributes over half of emissions reduction in the buildings sector.

IEA, 2010

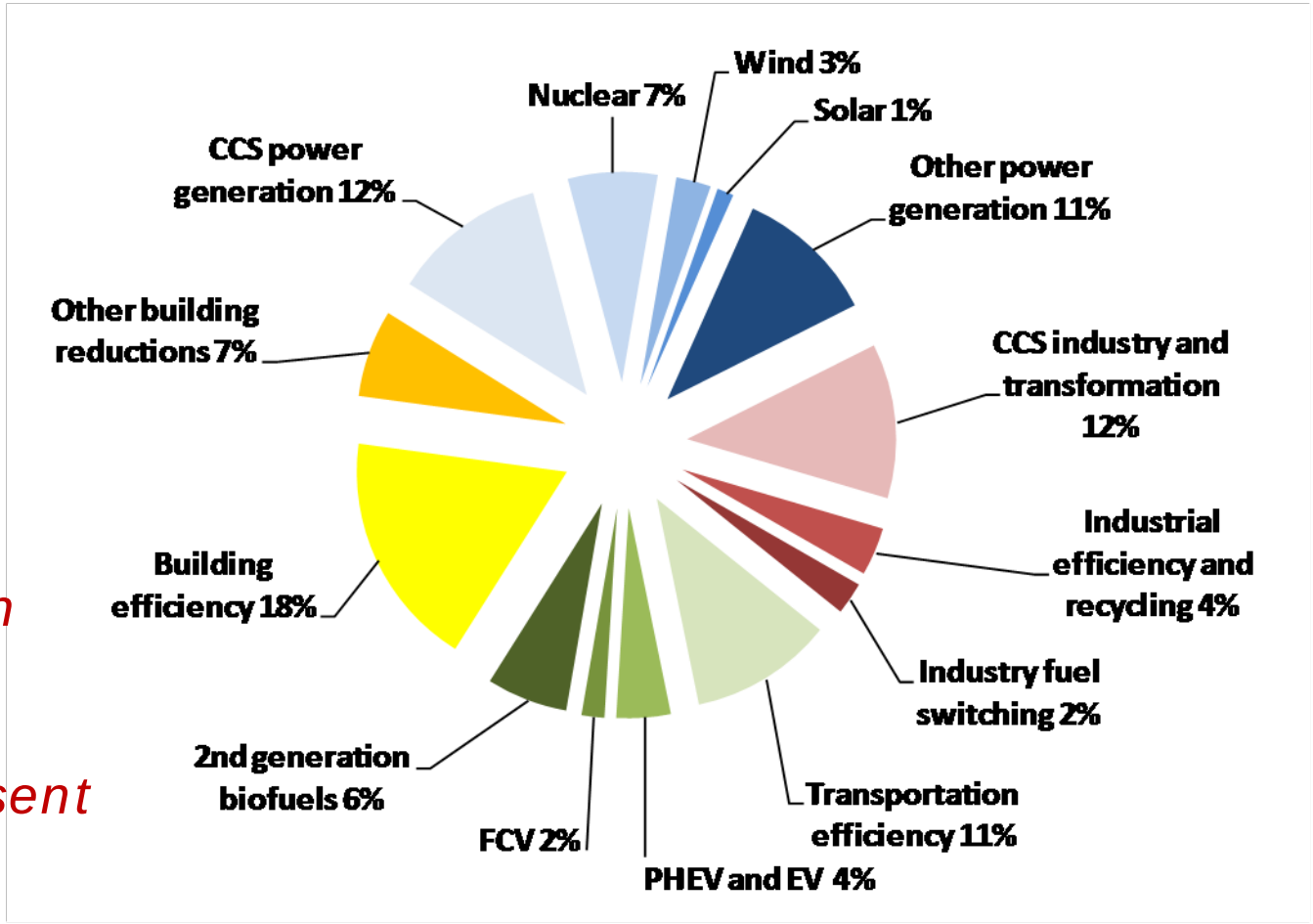
Direct energy and process CO_2 emissions in industry by sector in Europe



Energy efficiency and CCS are the two most important abatement options in industry.

IEA, 2010

Contributions to emissions reductions in Europe

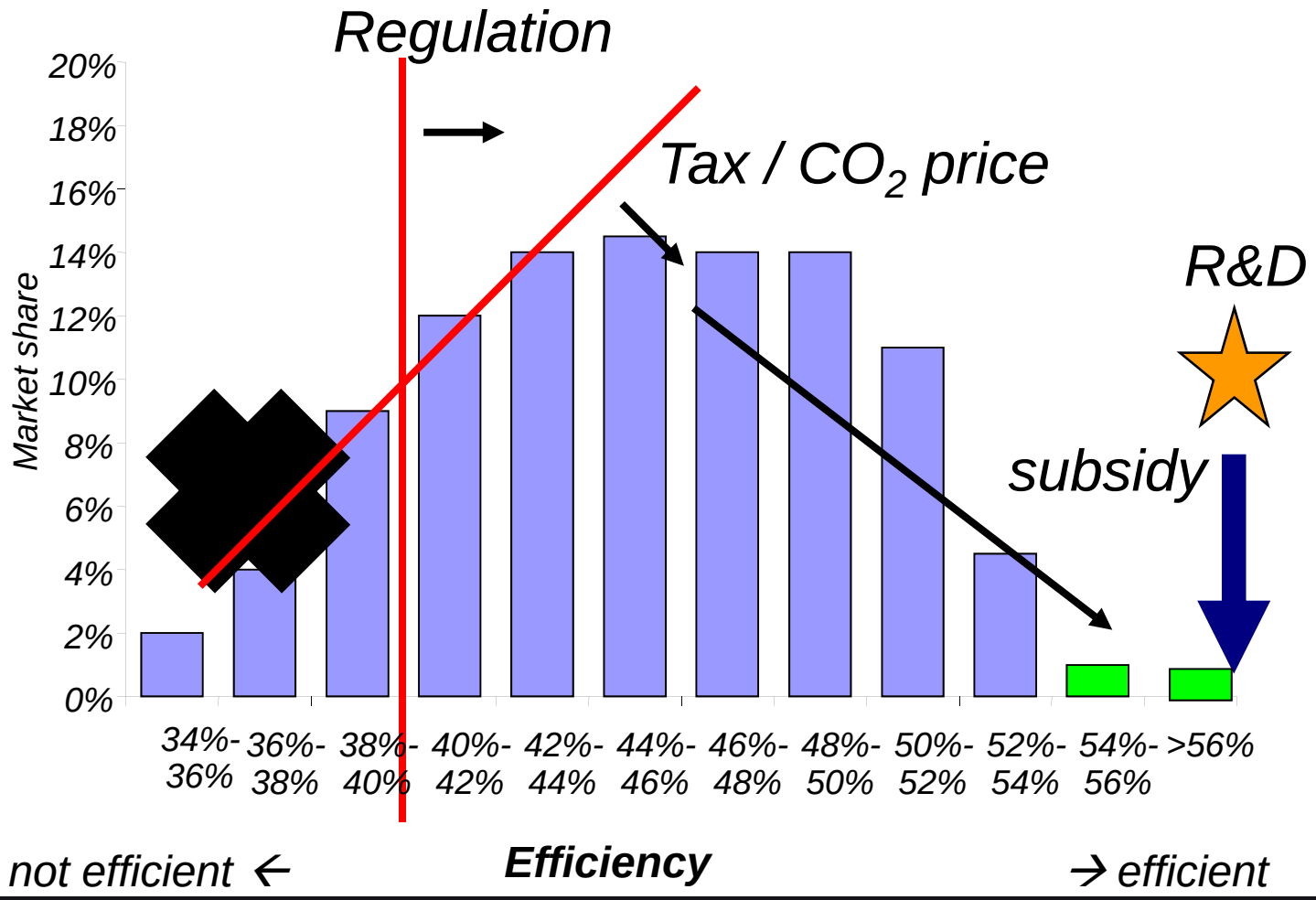


Reductions in the buildings and power sector represent the largest savings

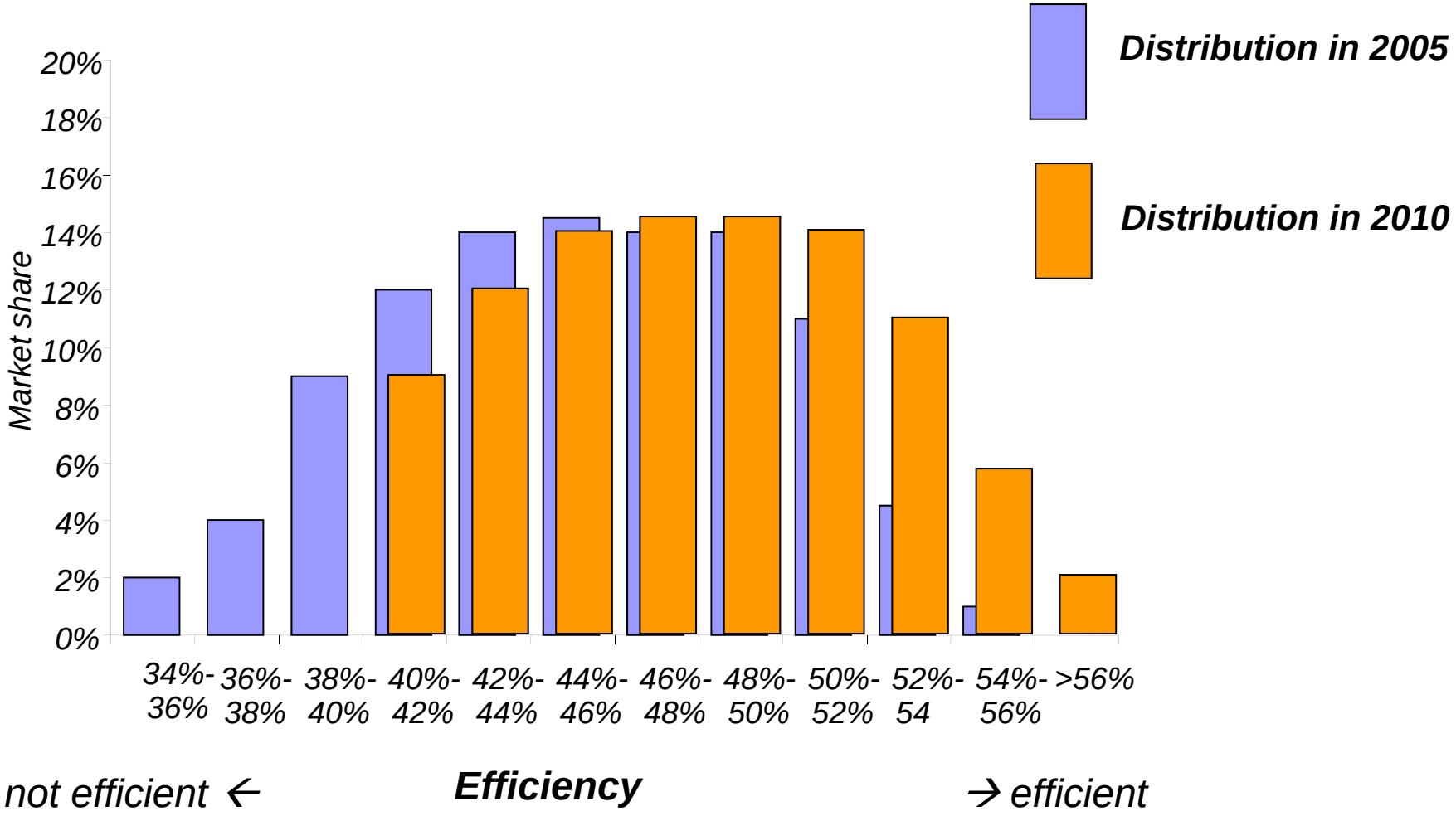
IEA, 2010

Policy choices

Combination of policy instruments to lift rate of energy efficiency improvements



Result: faster efficiency improvements



Technological progress?

from

50 kWh / year

to

500 kWh / year

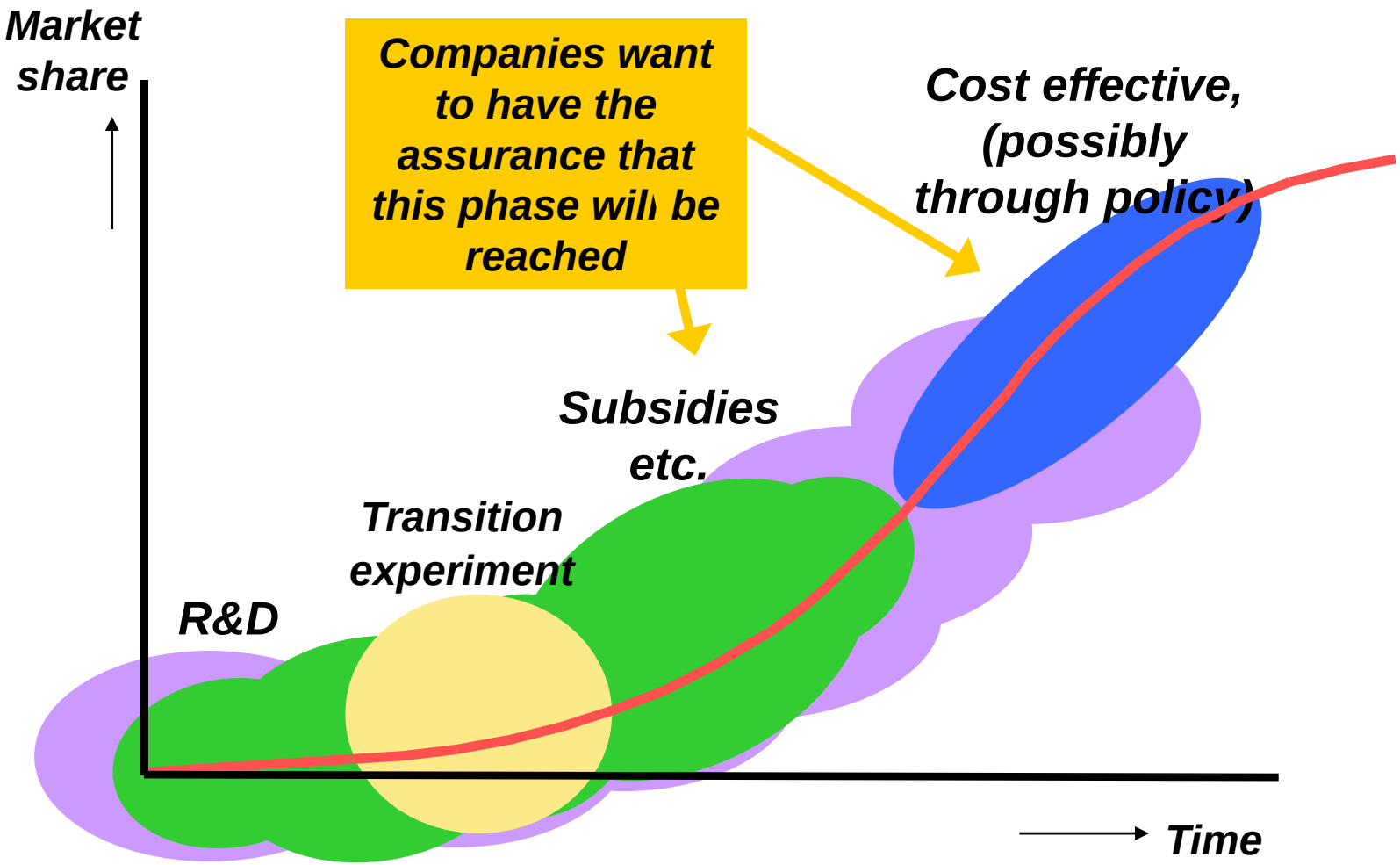
and

6 liters / 100 km

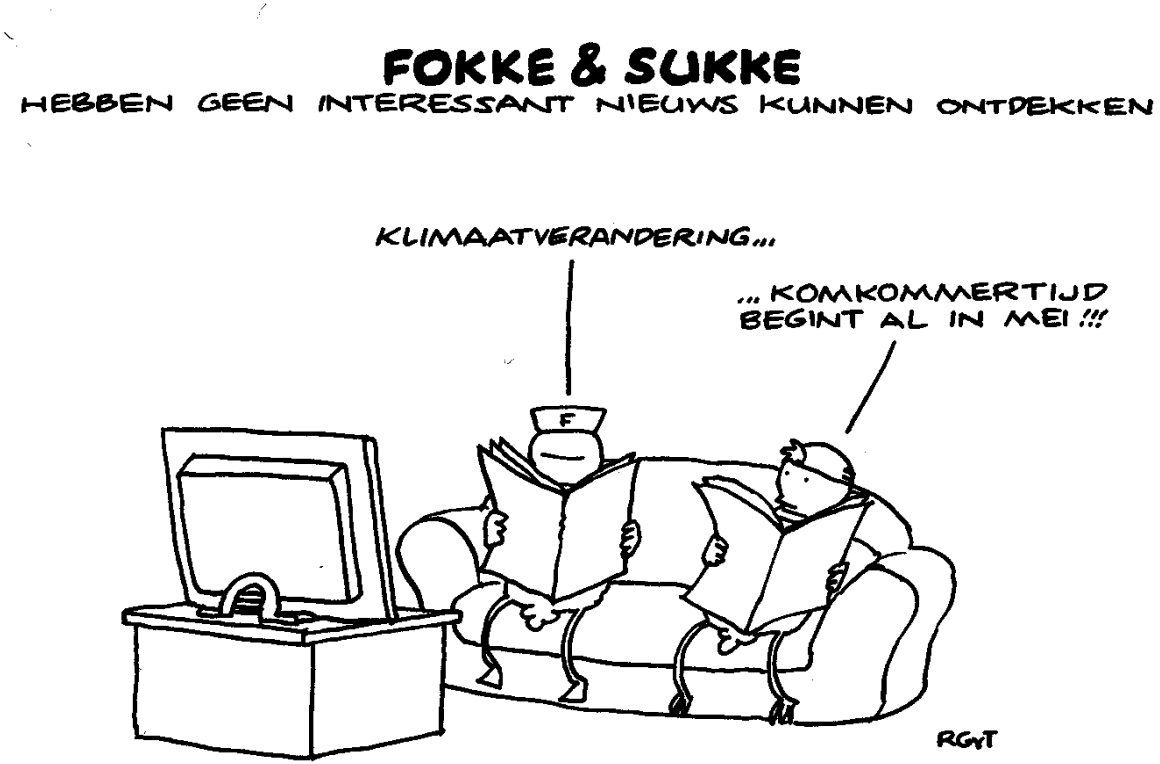
to

20 liters / 100 km

The transition process



Wat voor internationaal verdrag?



International institutions: the basics

Build a coalition to address a collective action or cooperation problem

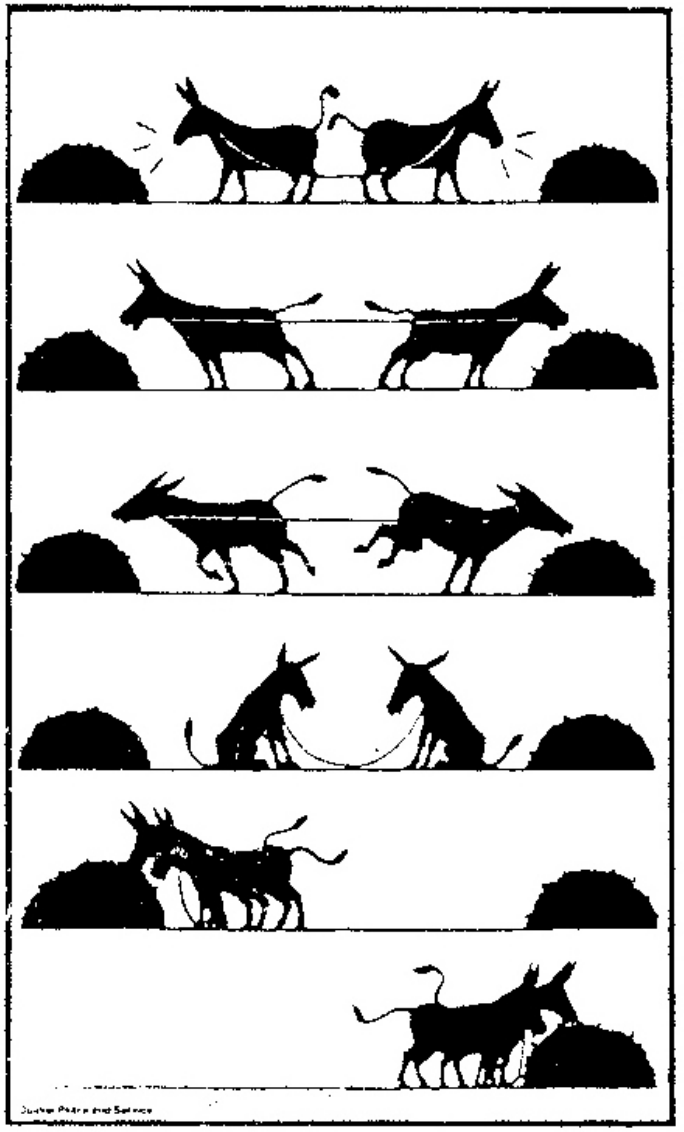
In the UN, actors are exclusively states

International agreements: Characterised by non-enforceability

- Only exceptions: UN Security Council and WTO
- International environmental agreements: soft power and self-enforcing

Preventing climate change: global public good problem

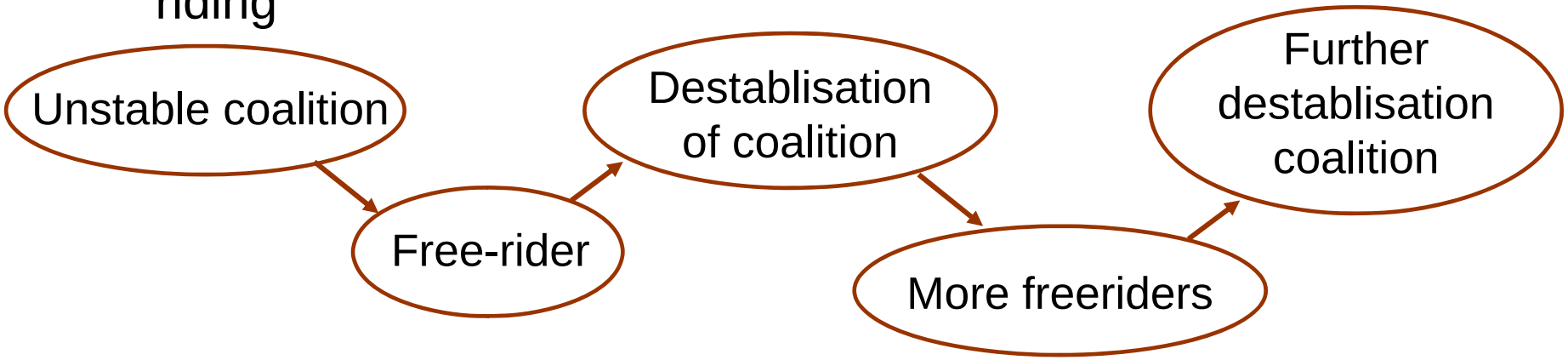
- Non-excludable benefits
- incentives for free-riding



Consensus is necessary…

Coalitions to provide global public goods are unstable because:

- Often there is asymmetry in country's interests, so complicated deals have to be struck – careful balance
- Non-excludable benefits encourage free-riding
- No supra-national authority to punish or even discourage free-riding



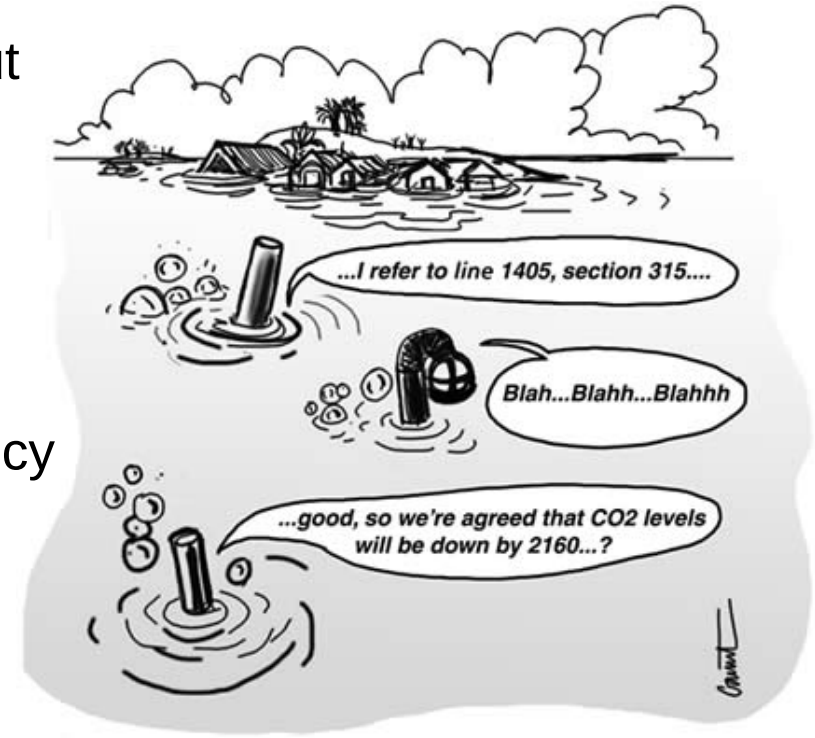
→ **Non-participation and defection threat to agreement**

… but slow

Agreeing on Kyoto took only two years, but entry into force took ten since 1995

Negotiation process lengthy:

- Getting every single country on the same level of knowledge
- Agreeing on the problem and urgency
- Time needed to examine the consequences
- Political approval processes
- Agreeing on the solution
- Changing governments and political preferences



Introducing the process: it's about reciprocity

Victim: the country bothered by the problem

Perpetrator: the country causing the problem

Sometimes they are one and the same:

- Symmetric externality
- Issue-specific reciprocity

If there is a discrepancy

- Asymmetric externality
- "Positive exchange": victim pays the perpetrator to address the problem
- "Negative exchange": victim coerces the perpetrator into addressing the problem

Mitchell and Keilbach (2001)

Characterisation of negotiations

Developing countries: want everyone to mitigate and pay for adaptation

EU: 20 t
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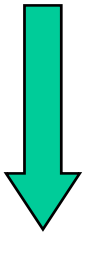
capita
s so low, no
justification for action.
Annex I first!



US: only want to participate if China and India do

Deadlock

Framing of climate change mitigation

Traditional country-based framing

We are dealing with a problem

- With a global scope
- Of which the root causes lay in welfare and associated energy use
- Which has an obvious metric (greenhouse gas emissions)
- Economists: problem occurs because greenhouse gas emissions are the unpriced externality
- Therefore, we should price the externality
- Global price on CO_2 through tax (impossible) or international emissions trading (implying CO_2 cap)

➢ Kyoto Protocol reflects this thinking

What is a fair way to distribute mitigation responsibilities?

Based on a negotiated outcome?

Based on cumulative historical contribution to climate change?

Based on future contribution to the climate problem?

Based on carbon intensity?

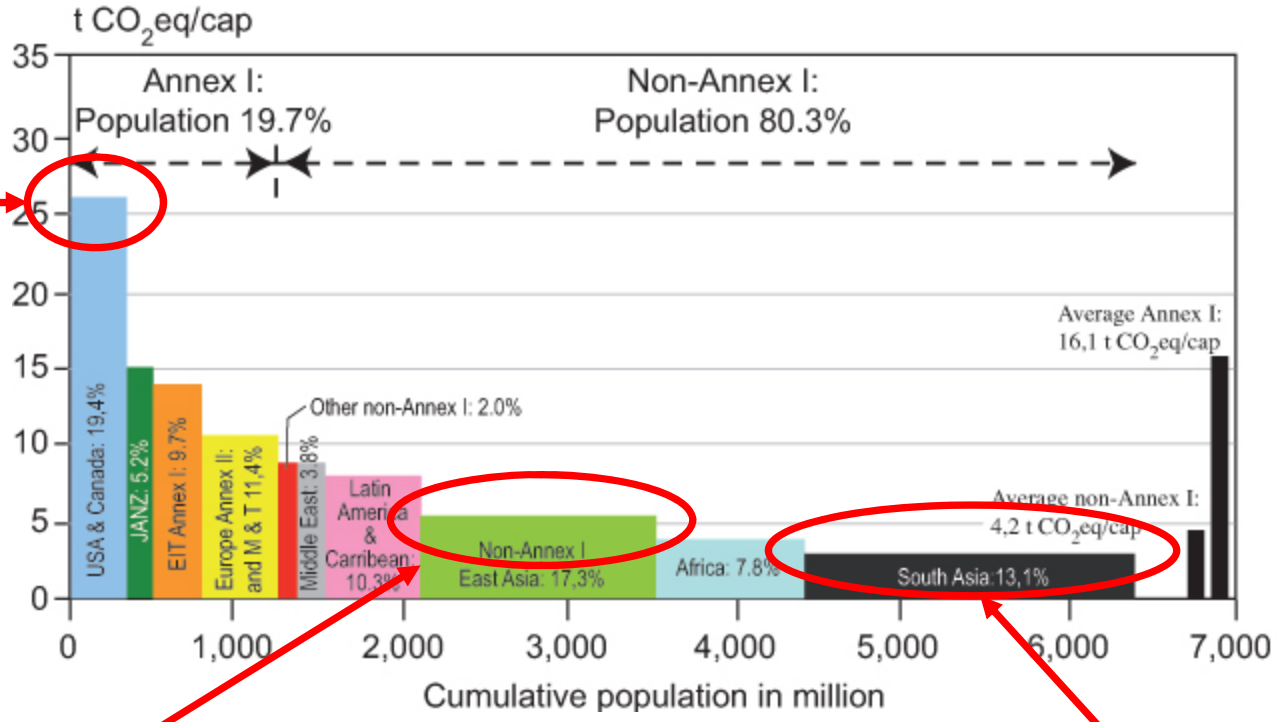
Based on the reduction potentials (geography, climate)?

Based on national average greenhouse gas emissions?

Based on the emissions of the individuals in a country?

Traditional country-based framing: Kyoto

Moral obligation to reduce, but high costs



Increasing emissions but much lower than Annex I

Very low per capita emissions but growing middle class

What has happened to Kyoto?

Conclusion: Kyoto has led to some emission reductions, but insufficient to address the problem

Traditional individual-based framing

Every person has a right to emit as much as he wants/can, up to a certain level which is regarded unsustainable

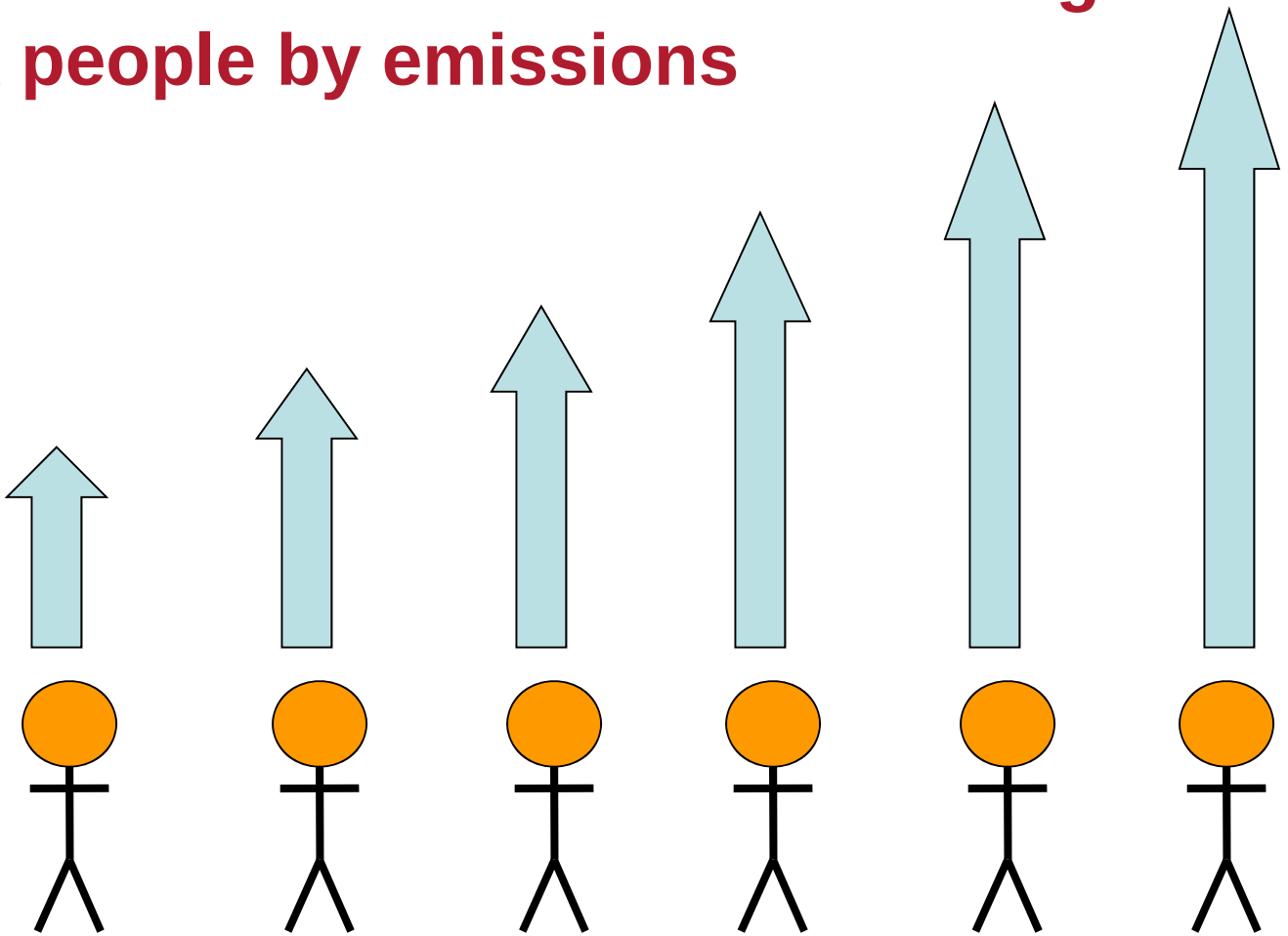
Focus on the individual

Treat every individual the same

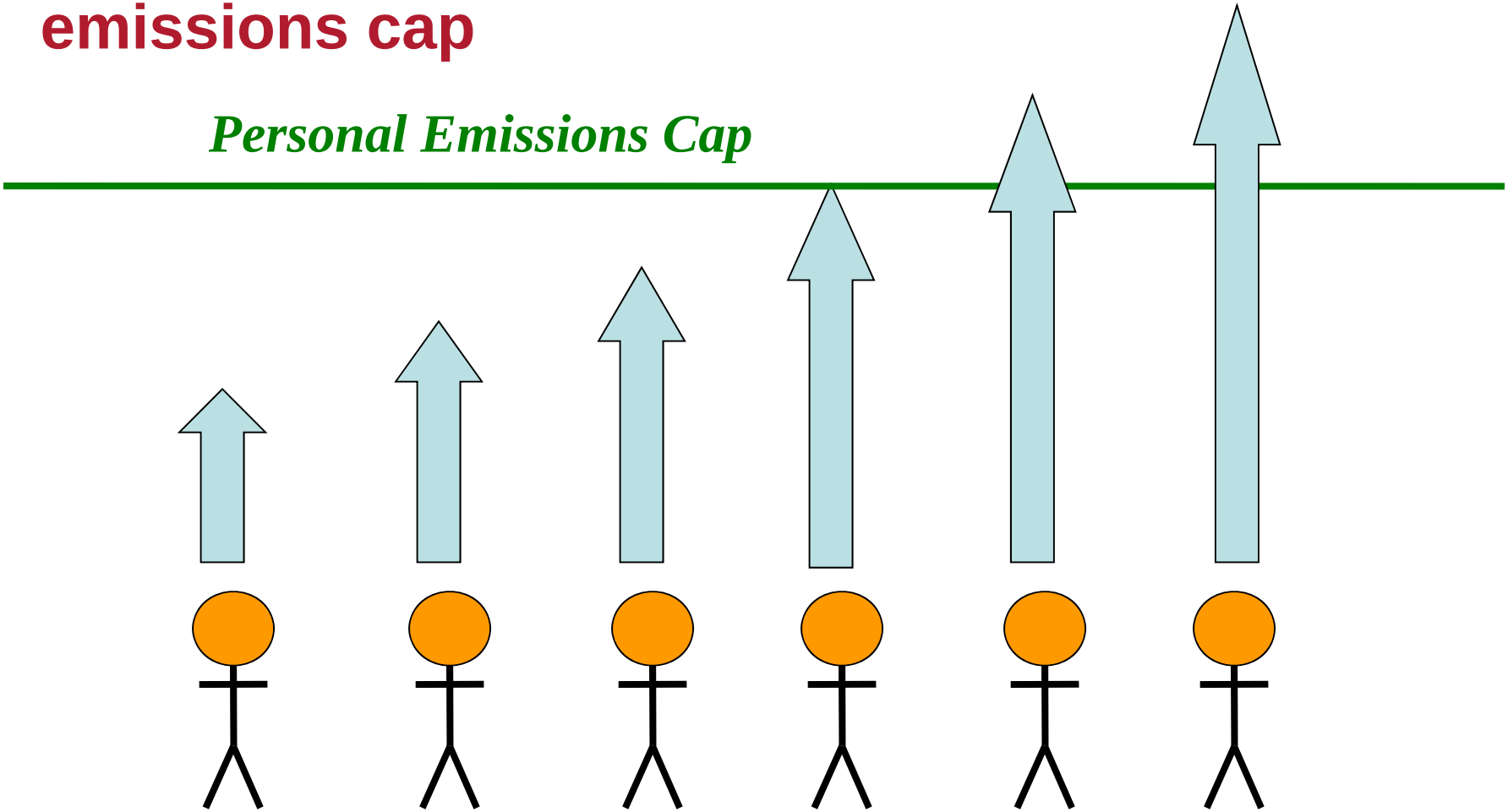
Calculate the appropriate allowance for the emission of an individual

Add up the individual allowances for each citizen in a country to find the nation's cap

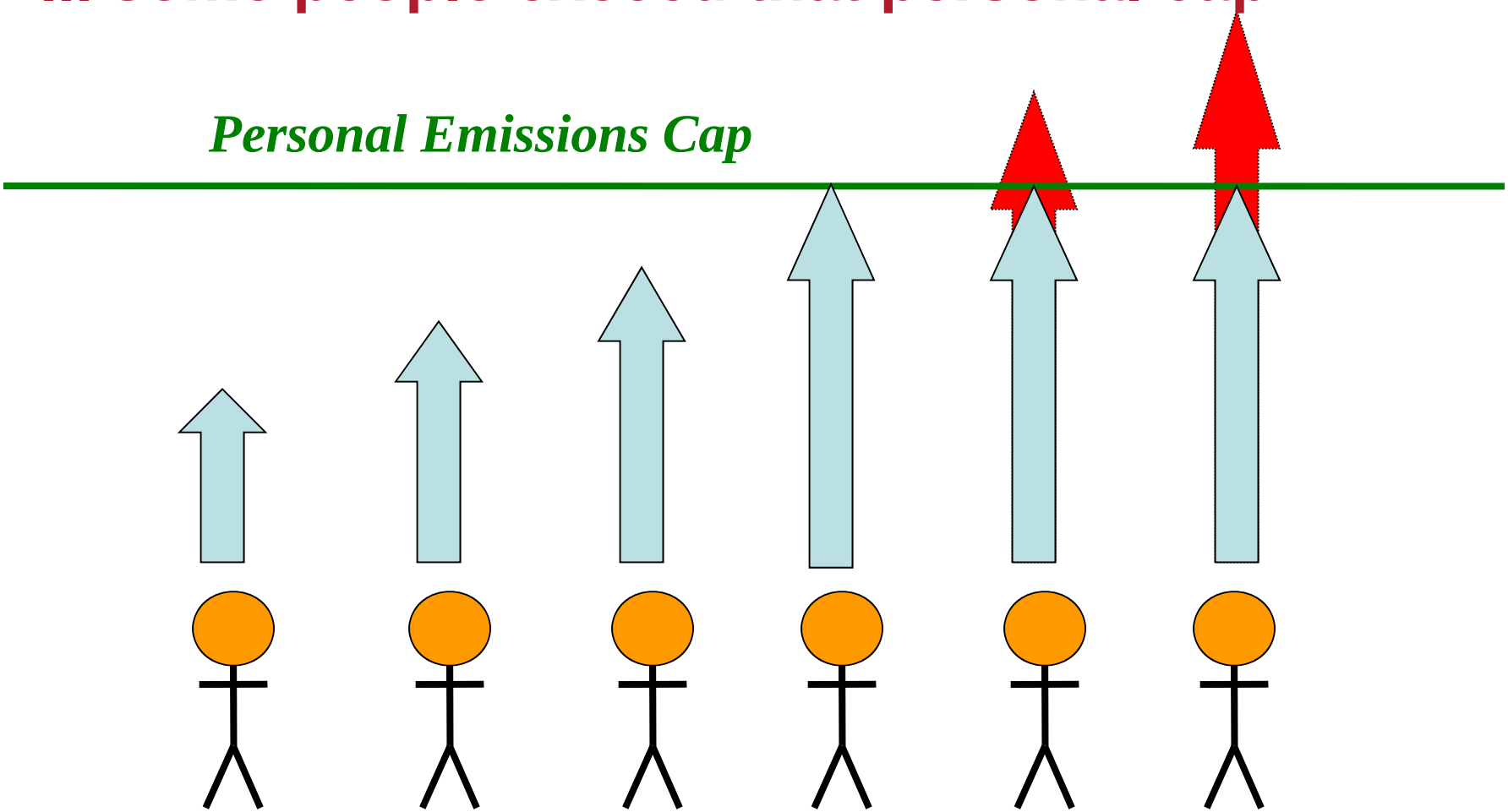
Traditional individual-based framing: rank people by emissions



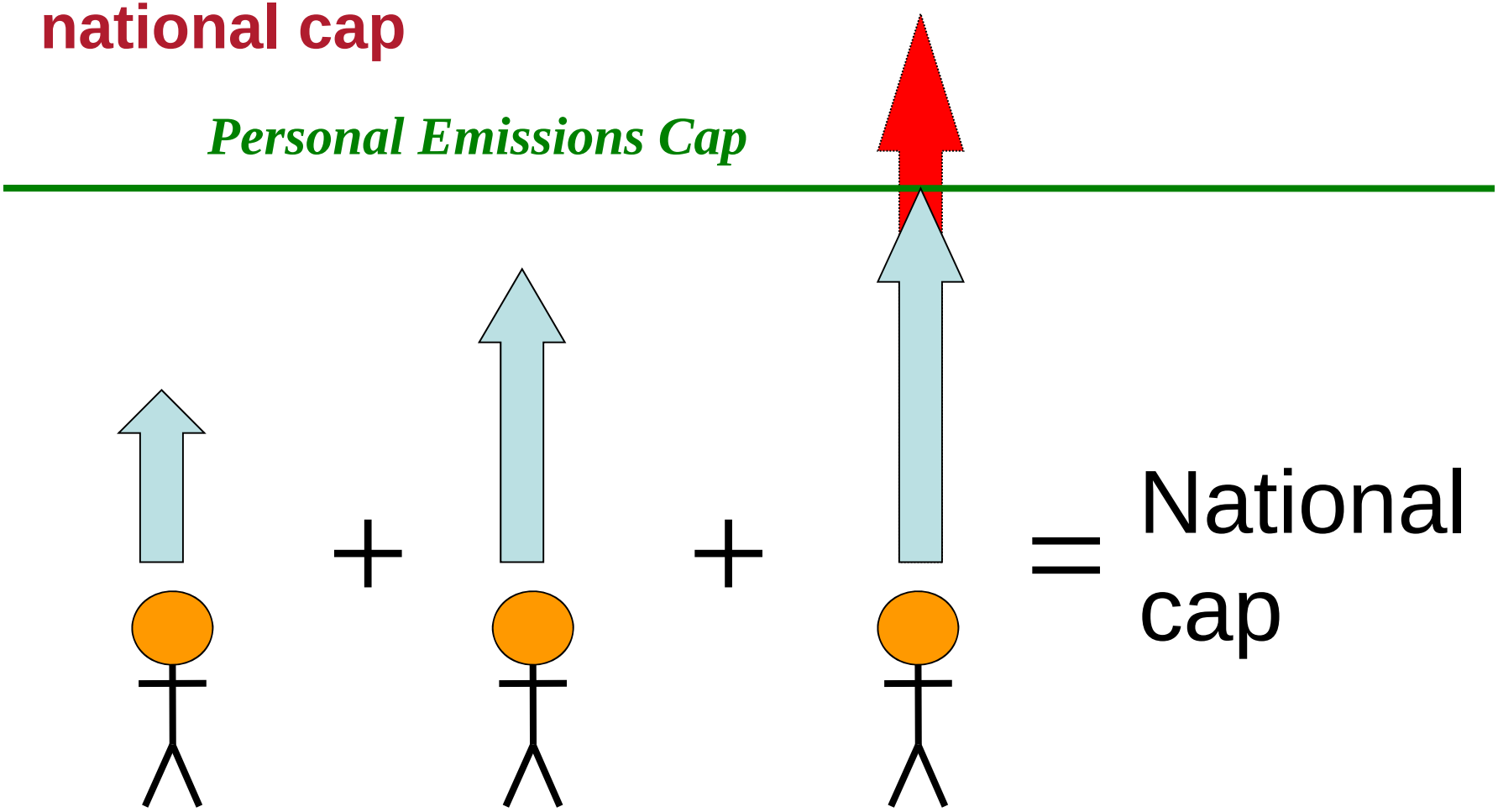
... determine globally applicable personal emissions cap



... some people exceed that personal cap

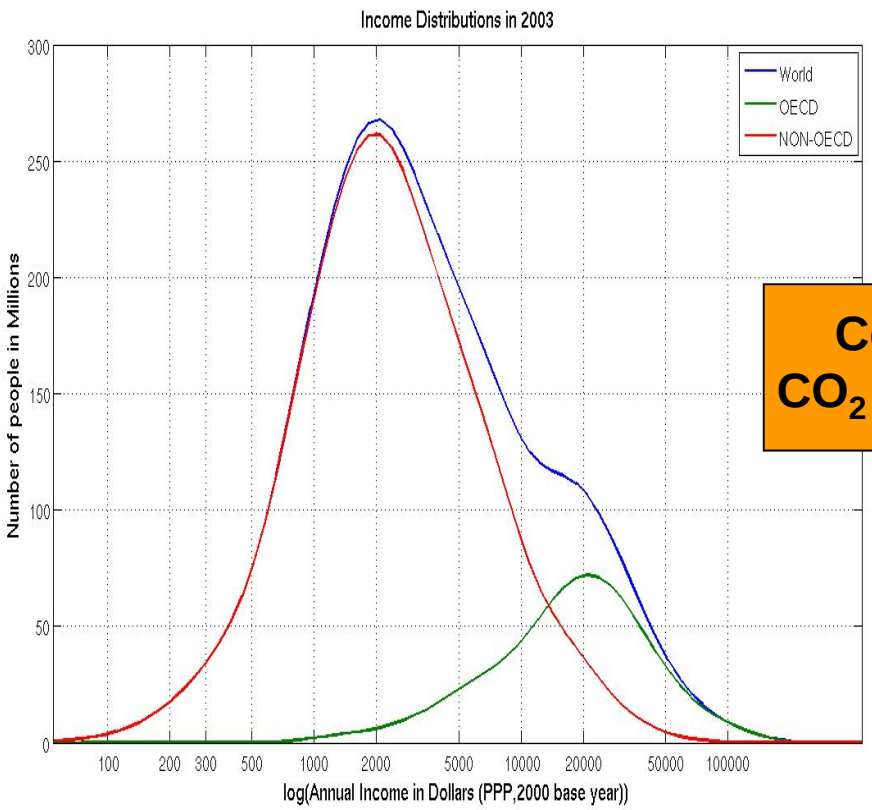


... the people in a nation determine national cap

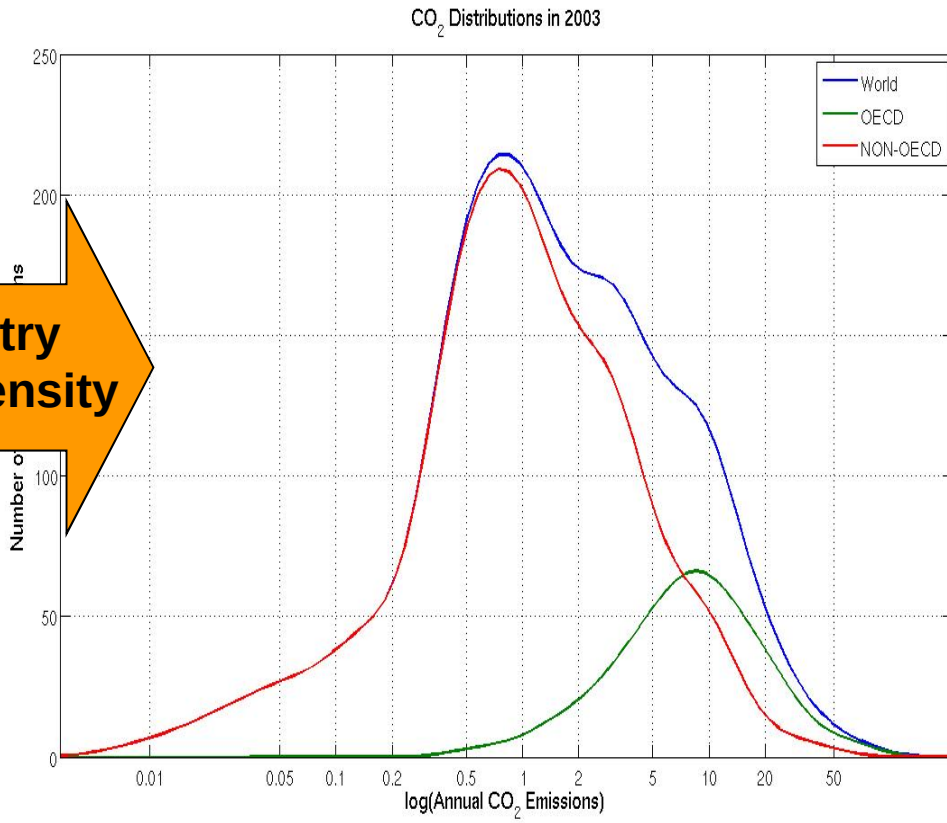


Those exceeding personal cap need to reduce

Traditional individual-based framing

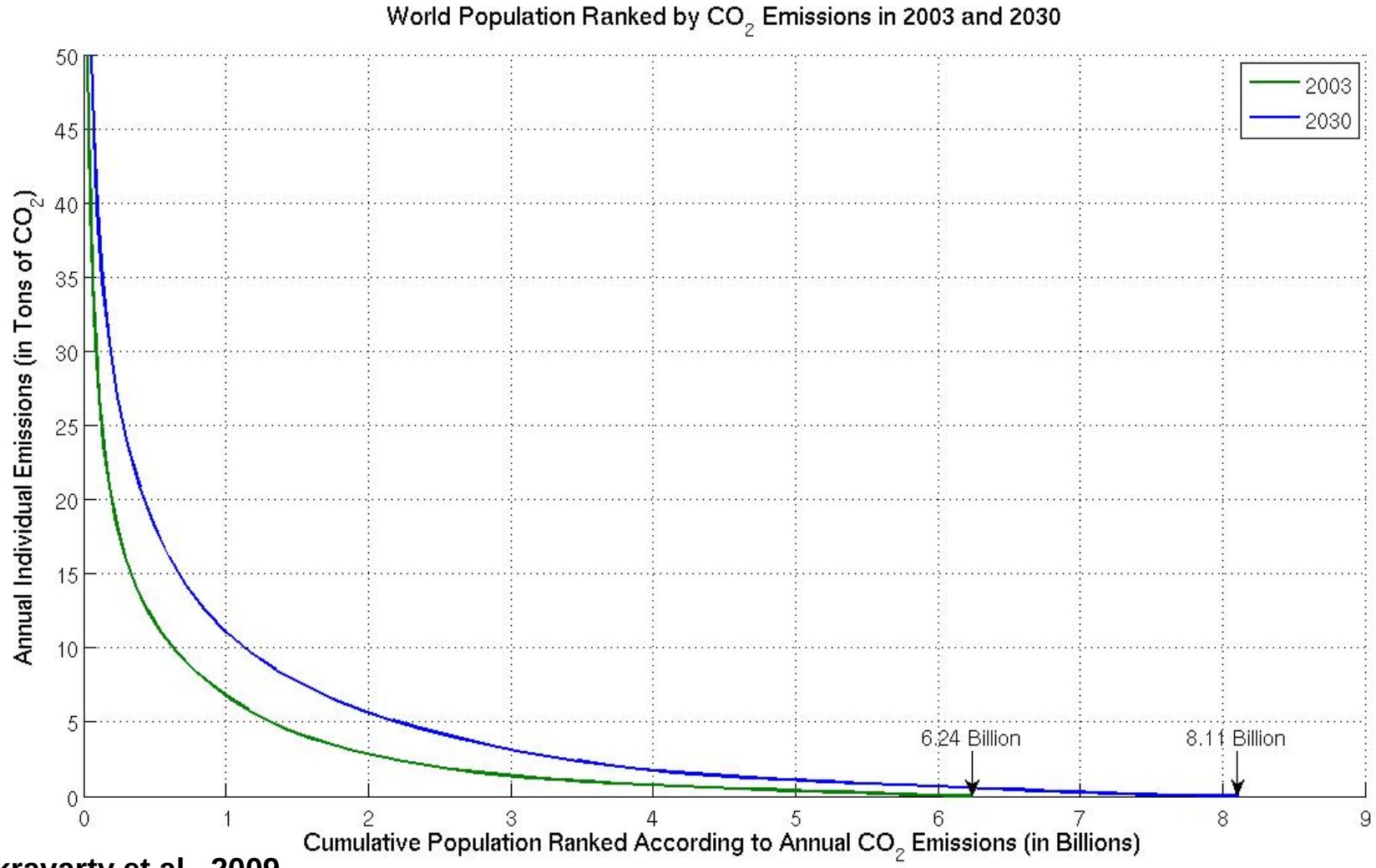


Country CO_2 intensity



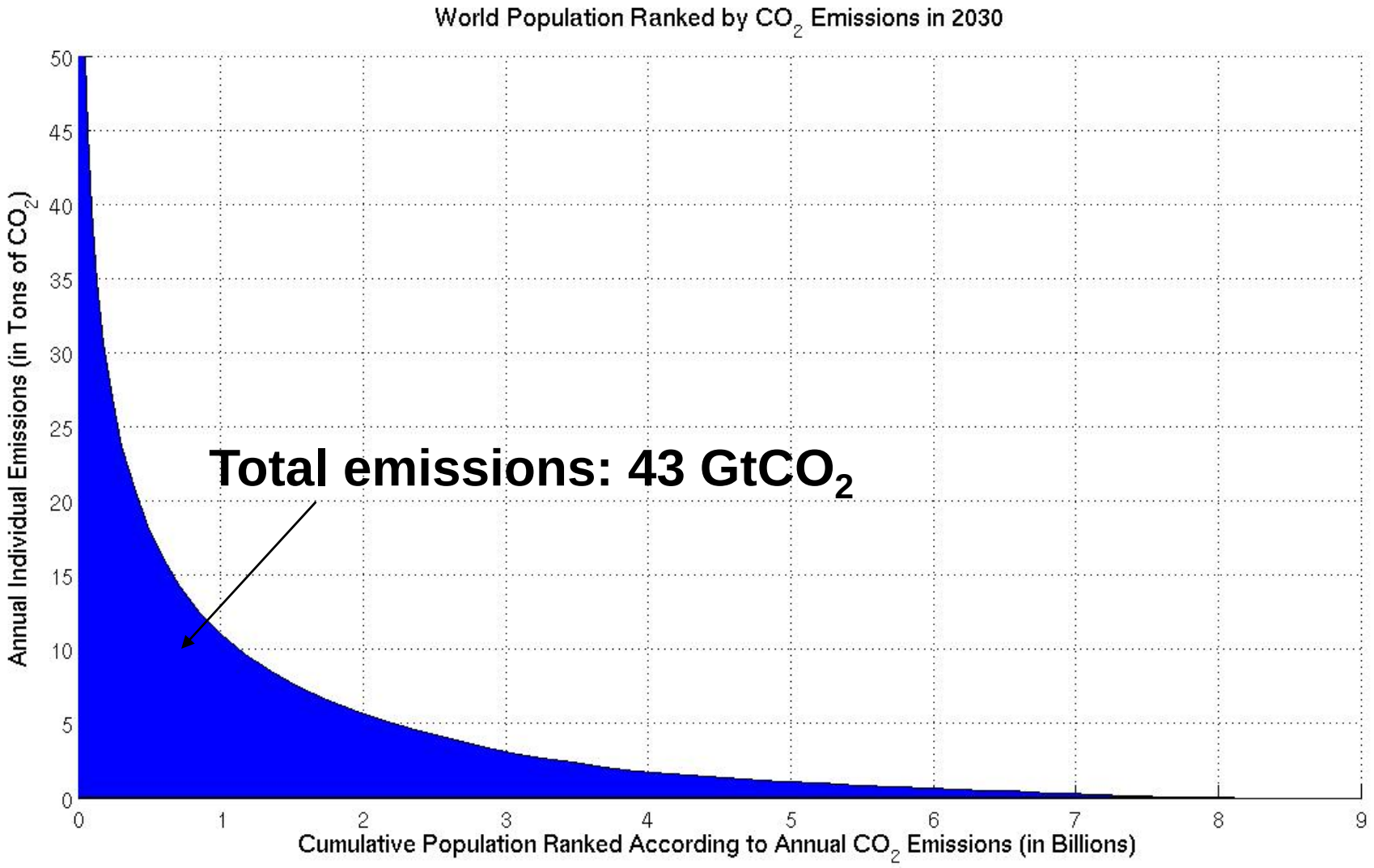
Chakravarty et al., 2009

Traditional individual-based framing

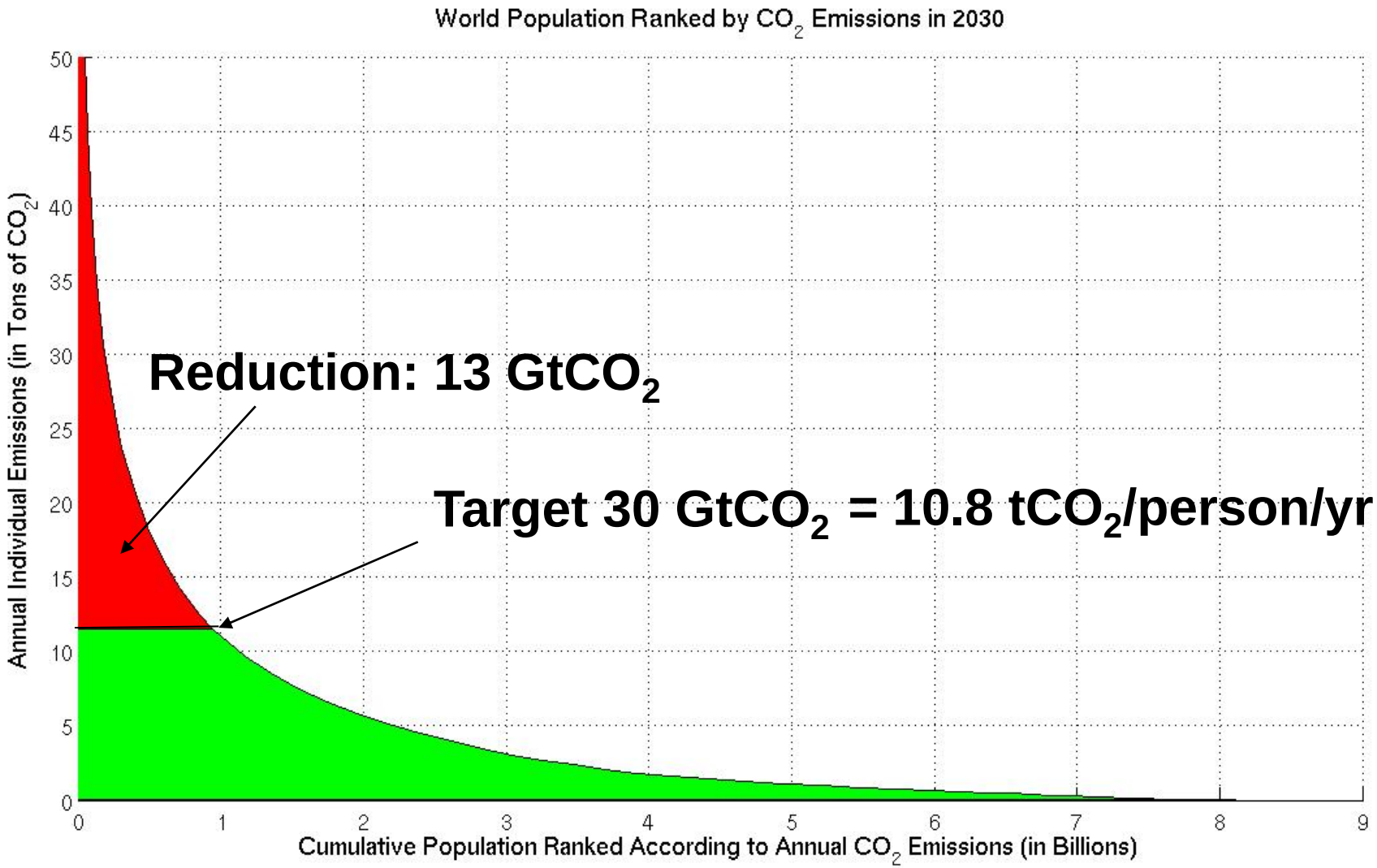


Chakravarty et al., 2009

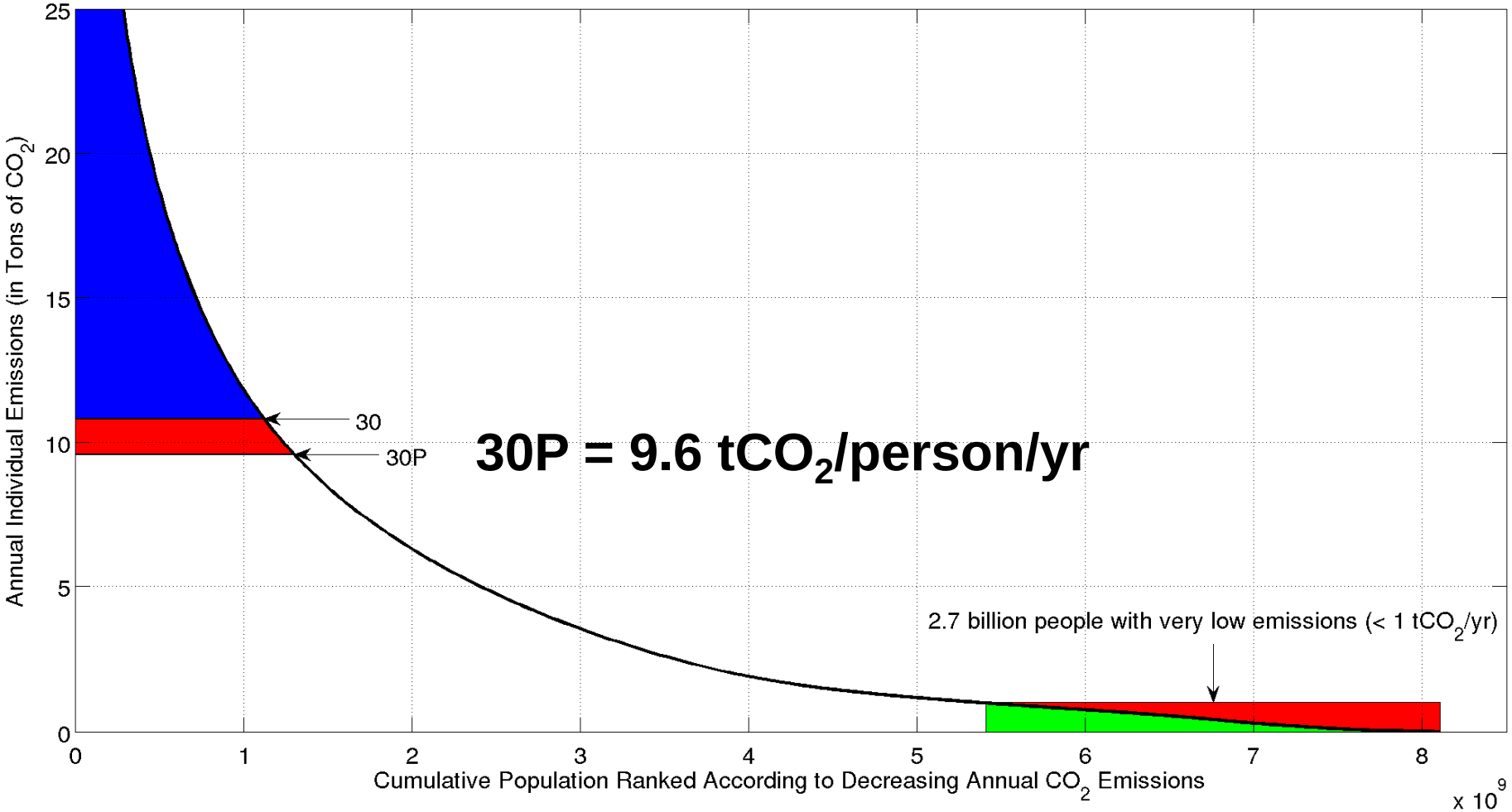
Choose a global target: 30 $GtCO_2$ in 2030



Choose a global target: 30 $GtCO_2$ in 2030



“Headroom” for the poor



“Liberal-institutionalist” framing

Emissions: Industrialised countries; impacts: poor countries

Costs of reducing emissions high, while benefits to others

Countries act as self-interested rational actors

Emission reduction agreement is not in the interest of those that should most urgently reduce emissions

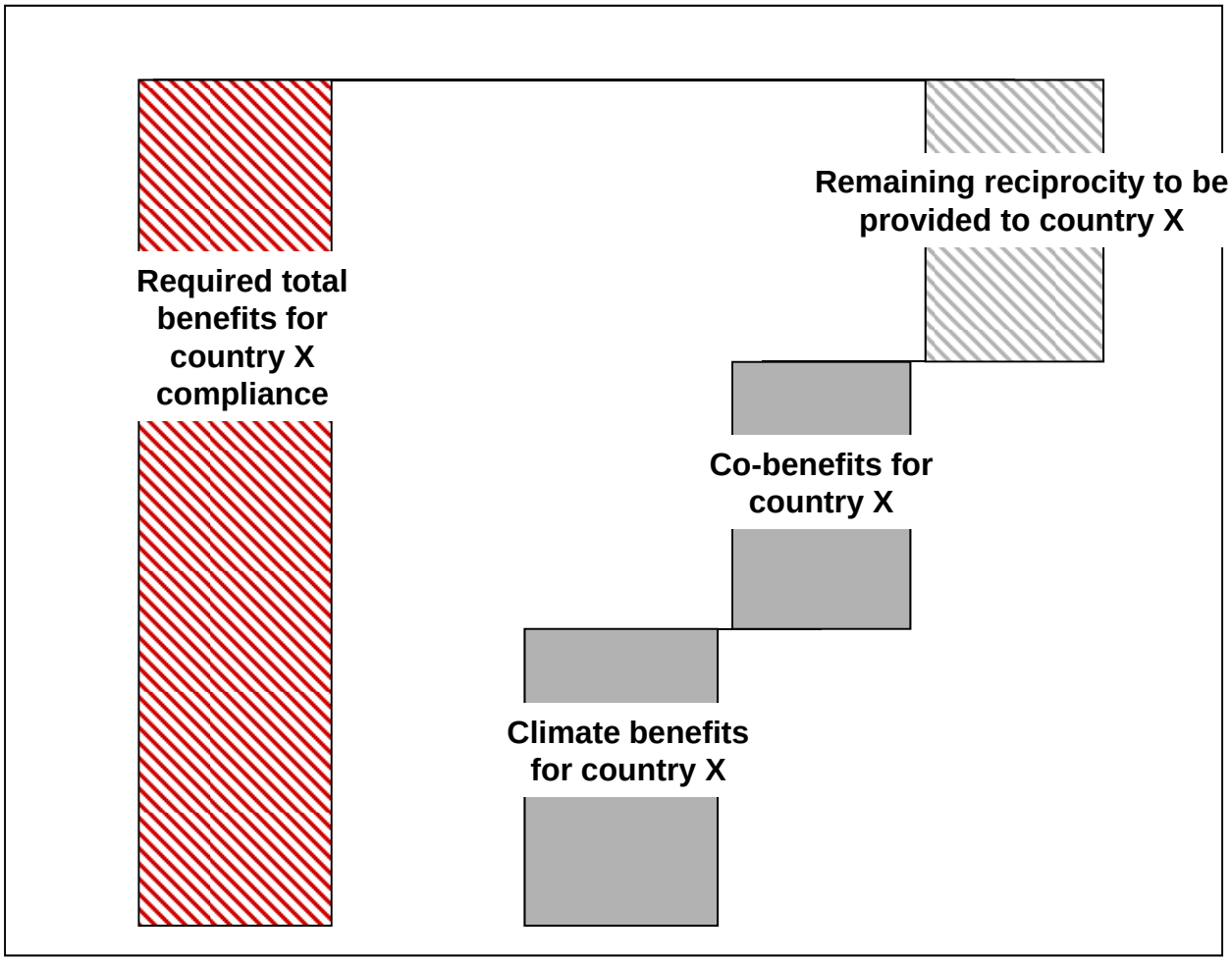
Little means of enforcement of international agreement

Self-reinforcing agreements: “attractive to sign and want to carry out the terms of agreement”

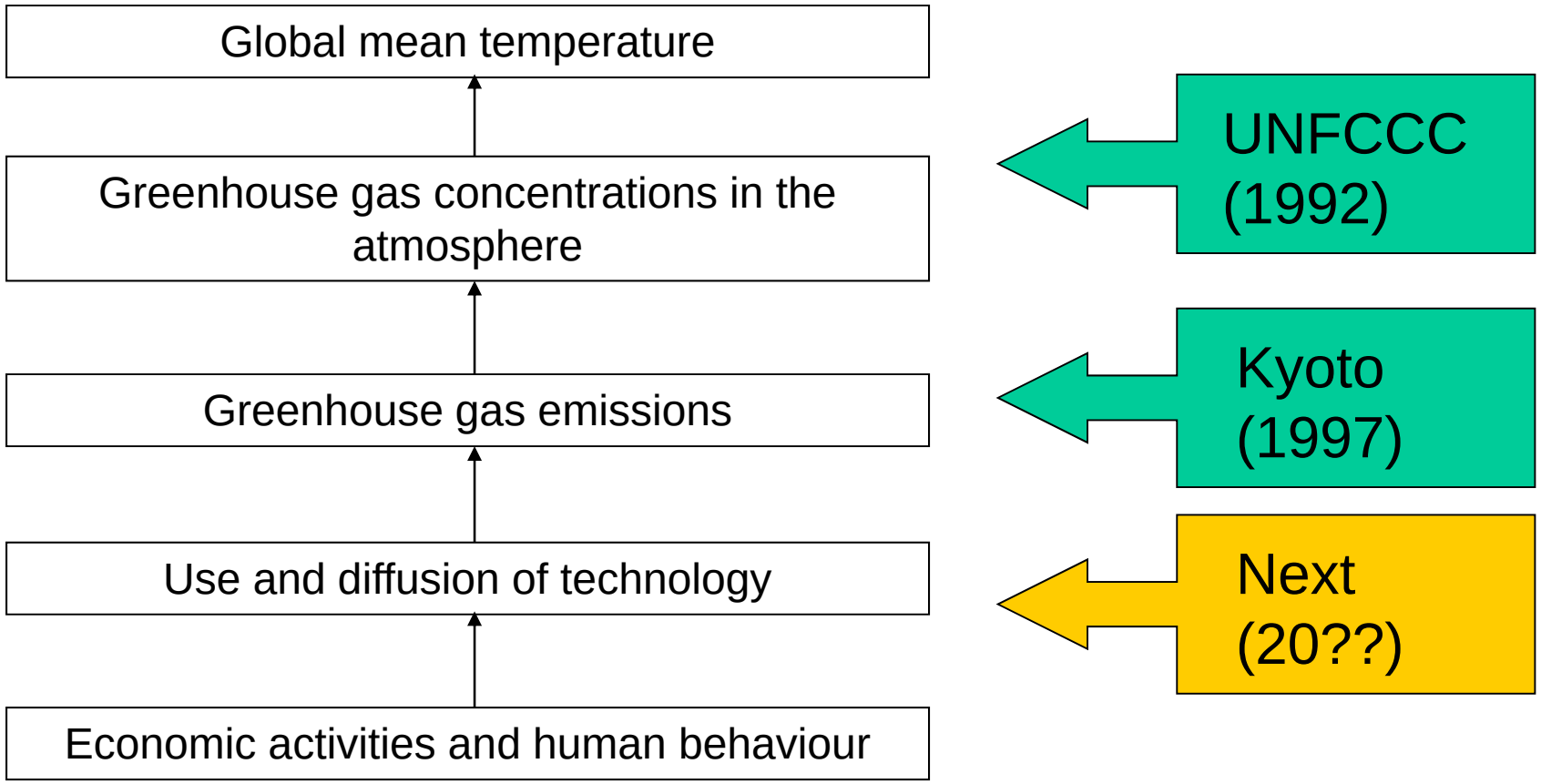
Reciprocity “perceived equivalence of costs and benefits between parties”

Can we design an international agreement that is in everyone’s interest?

Three means of reciprocity



Climate change causal chain and policy points of intervention



Technology and reciprocity

Innovation and economic benefits

First-mover advantages and export potential

Reducing market inefficiencies

Opportunities, not constraints

Forms of agreement on technology

Type 1: Knowledge sharing and coordination	• Carbon Sequestration Leadership Forum (CSLF)
Type 2: Research, Development & Demonstration	• ITER fusion reactor
Type 3: Technology transfer	• Multilateral Fund under the Montreal Protocol
Type 4: Standards, mandates, incentives	• International Convention for the Prevention of Pollution from ships (MARPOL)

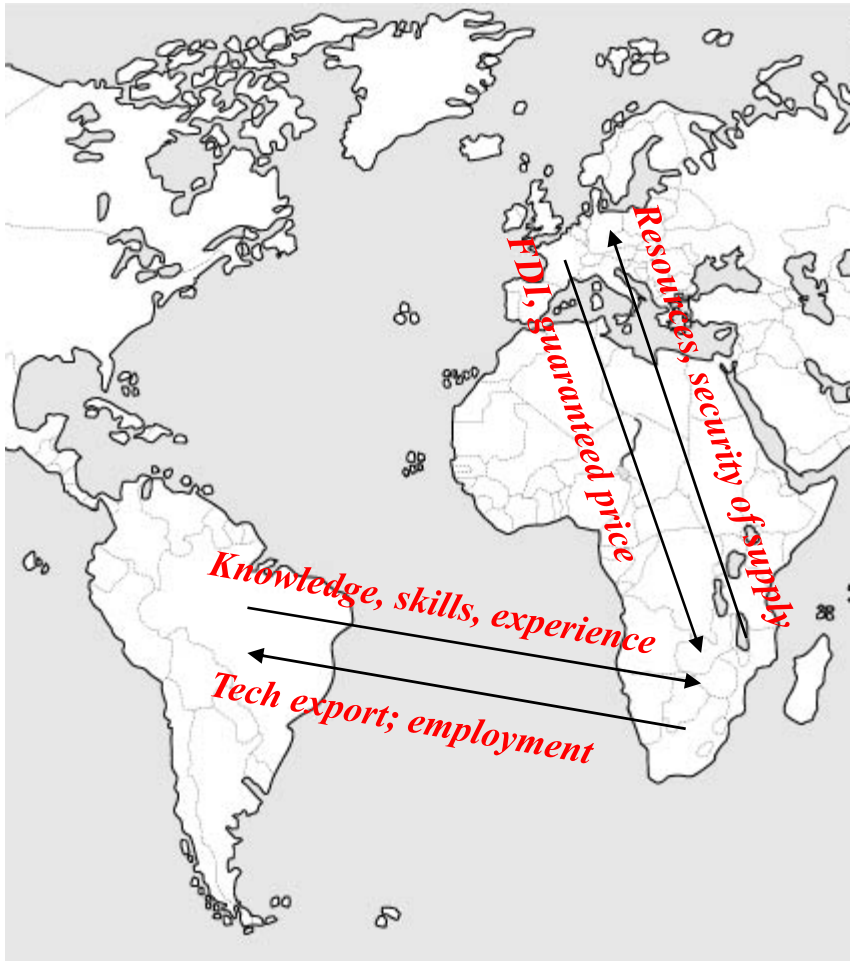
Example of technology-oriented agreement: bioethanol

Participants: Brazil, Mozambique, EU

EU: secure and sustainable biofuel supply

Brazil: export of technological know-how

Mozambique: land, FDI, employment



Current situation

Copenhagen Accord/Cancun Agreements

Collective agreement to meet 2C

"Pledge and review"

- Developed countries emission reductions
- Emerging economies/developing countries "mitigation actions"

Fund for adaptation, mitigation, technology (bilateral and through Green Climate Fund):

- Fast-start finance: 3x10 billion
- Long-term: 100 billion/yr

Technology Mechanism: Technology Executive Committee and Climate Technology Centre and Network

Measurable, Reportable, Verifiable

- Developed countries: in accordance with Kyoto
- Developing countries: domestic MRV

How does Cancun compare to Kyoto?

Issue	Kyoto	Cancun
Overall target	UNFCCC	2C
Developed country mitigation	“Legally binding emission reductions”	“Pledge and review”
Developing country mitigation	Clean Development Mechanism	Voluntary actions, assistance on policy
Adaptation	Fund (slowly starting)	Fund (renewed attention)
Technology	-	Technology Mechanism
Finance	Through markets (CDM)	30 billion 2010-2012 100 billion 2020
MRV	For developed countries only, and in CDM	Developed and developing countries

What kind of international agreement works for climate change mitigation? My best guess…

An international agreement that:

- Monitors and registers developed country's actions (emissions *and* finance)
- Actively brokers technology and sectoral agreements between countries and industries
- Stimulates innovation systems in developing countries
- Provides finance for actions in developing countries

Industrialised countries: domestic policy, emission trading schemes (with potential international trading and CDM)

Emerging economies: low-emission growth

Developing countries: voluntary low-emission development planning

Wat denken jullie?

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