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Energy research Centre of the Netherlands

Incentives for CO_2 capture and storage: how to get the economics right?

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Outline

Realising the economic potential of CCS

- Possibilities and limitations on the system level

Policy for CCS

- The European Union and its Member States
- The Kyoto Protocol (and CCS in developing countries)

Conclusions

Realising the economic potential of CCS

Realising the economic potential of CCS

"Economic potential": How much CCS will be realised given the interplay of different technologies in a market place

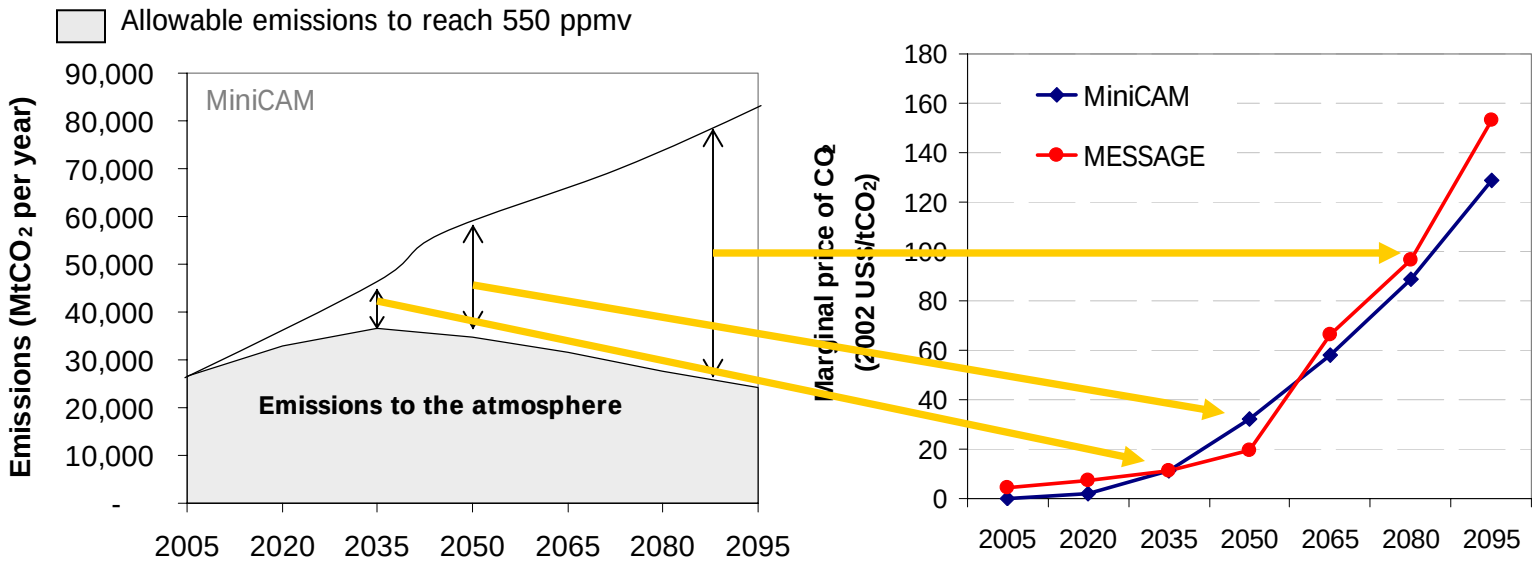
How to determine the economic potential?

- Determine desired GHG concentration level – e.g. 550 ppm
- Derive allowable global annual GHG emissions until e.g. 2100
- Determine baseline global GHG emissions until the same year
- Assume cost curves for technologies and global cost curve (GHG reductions ($GtCO_2$) vs. cost of reductions (US$/$tCO_2$)
- Optimise on cost (least-cost optimisation)
- So: technologies compete on the basis of costs for the emission reductions required

Realising the economic potential of CCS

How much of the technical potential for CCS would be used if CCS would compete for market share in the mitigation market?

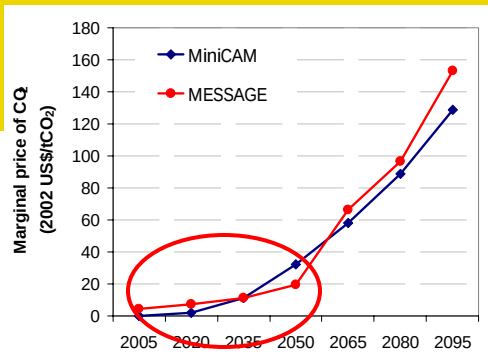
Optimisation on the lowest carbon price

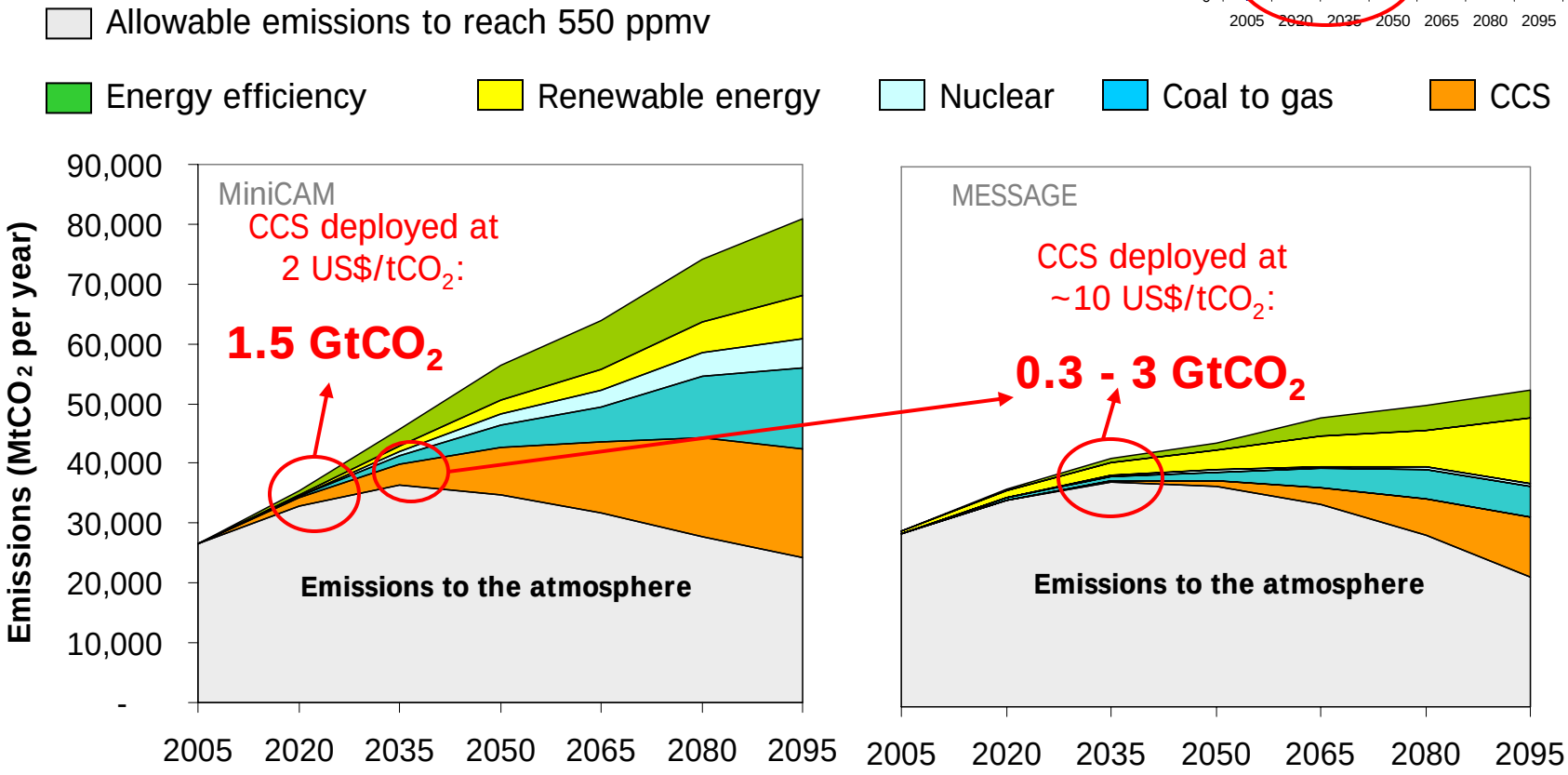


Renewables, energy efficiency, nuclear, etc. compete

Source: IPCC Special Report on CCS, 2005

Realising the economic potential





Cumulatively: 220 - 2200 $GtCO_2$ CCS used

Including CCS in the portfolio decreases overall mitigation costs with 30%

Source: IPCC Special Report on CCS, 2005

Realising the economic potential of CCS

Modelling studies foresee a grand role for CCS
CCS deployment 220 - 2200 $GtCO_2$ over 21st century
Geological storage capacity worldwide seems sufficient
Including CCS in the portfolio decreases overall mitigation costs with 30%
Numbers should be taken with a grain of salt!

- Cost assumptions appear optimistic
- Geological storage potential really big enough? And in the right places?
- CCS is rarely cost-effective by itself, so policy incentives required

Policy for CCS

Policy for CCS – a couple of general remarks

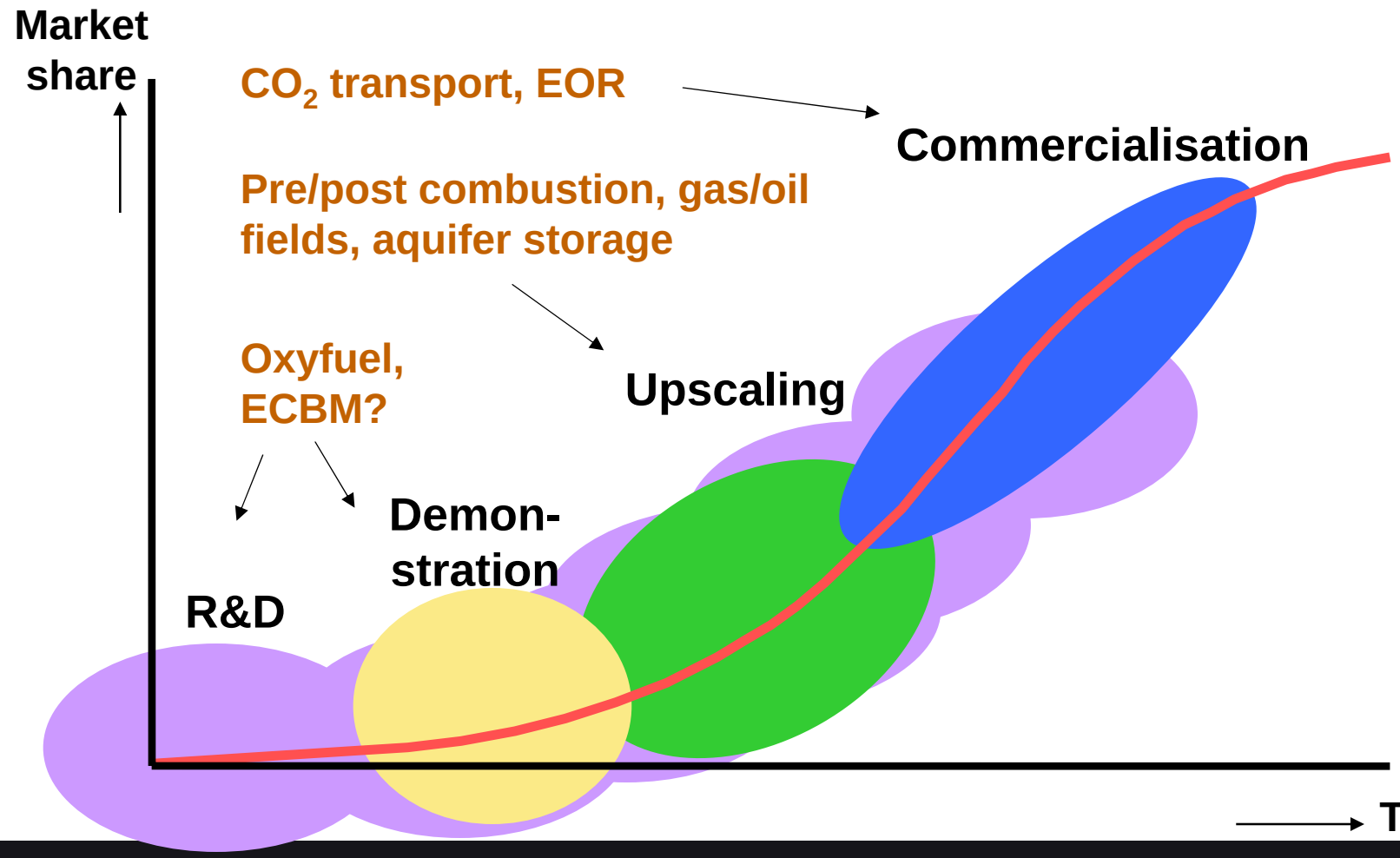
Considerations for government policymaking

"Appropriate" policy

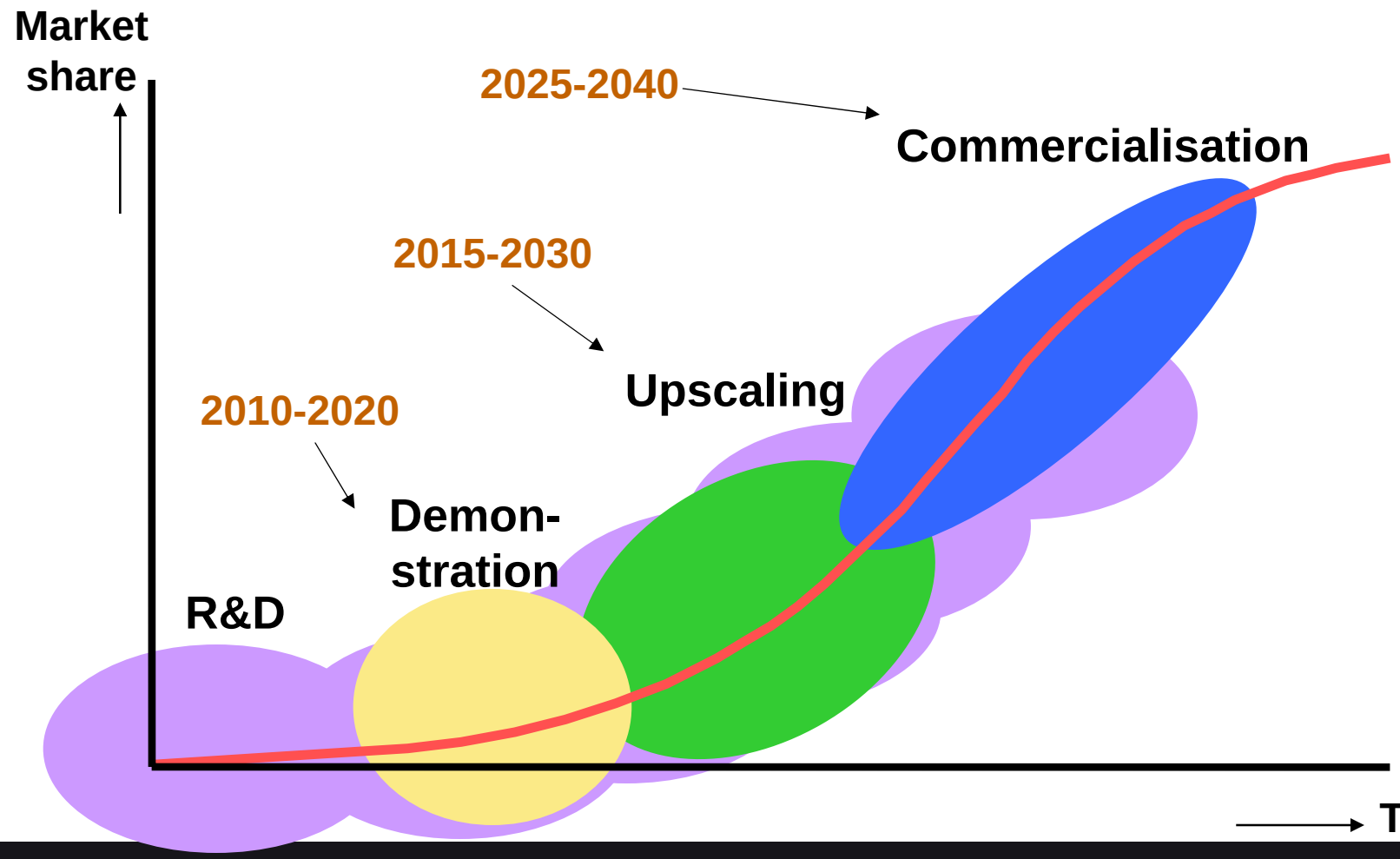
- Does the policy provide a solution to the problem?
- Is the policy instrument proportional to the problem?
- Is the policy affordable?
- Is the policy reversible, if necessary?
- Can undesired interaction with other policies be limited?

Often-mentioned categories: regulations & standards, taxes & charges, tradable permits, voluntary agreements, subsidies & incentives, research & development, information policies

Policy for CCS: Appropriate policy for innovation phase?



Policy for CCS: Timing?



Policy for CCS

Heterogeneity of CCS poses questions

- Appropriate: Generic climate policy vs. specific CCS policy
- Appropriate: Some components need R&D; others require market-based mechanisms
- Affordable: Resistance from environmental organisations against spending much on fossil-fuel based options while preferred options like energy efficiency and renewables are short of funding
- Affordable: information problems on costs

Timing of policies: when to do what?

First attempts being tried in EU and international fields

The European Union and its Member States

European Union: Emissions Trading Scheme

Each installation in the scheme has a right to emit a certain amount of CO_2 (allowance)

Coverage:

- 15,000 installations
- 45% of EU-15 emissions

Central body: European Commission (DG Environment)

National Allocation Plans essential Grandfathering, benchmarking, partially auctioning

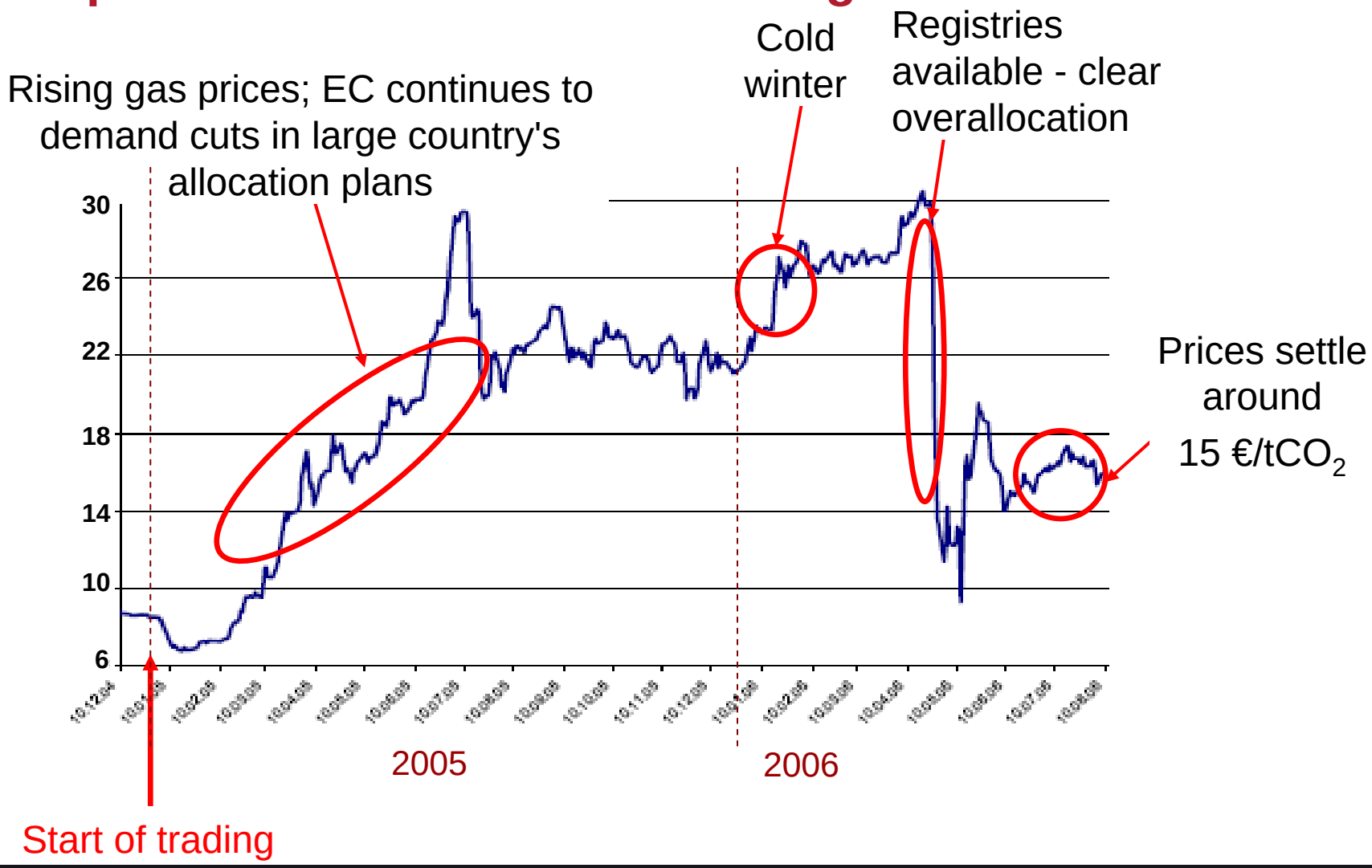
First period (trial): 2005 - 2007

Second period (for real): 2008 - 2012 (Kyoto commitment period)

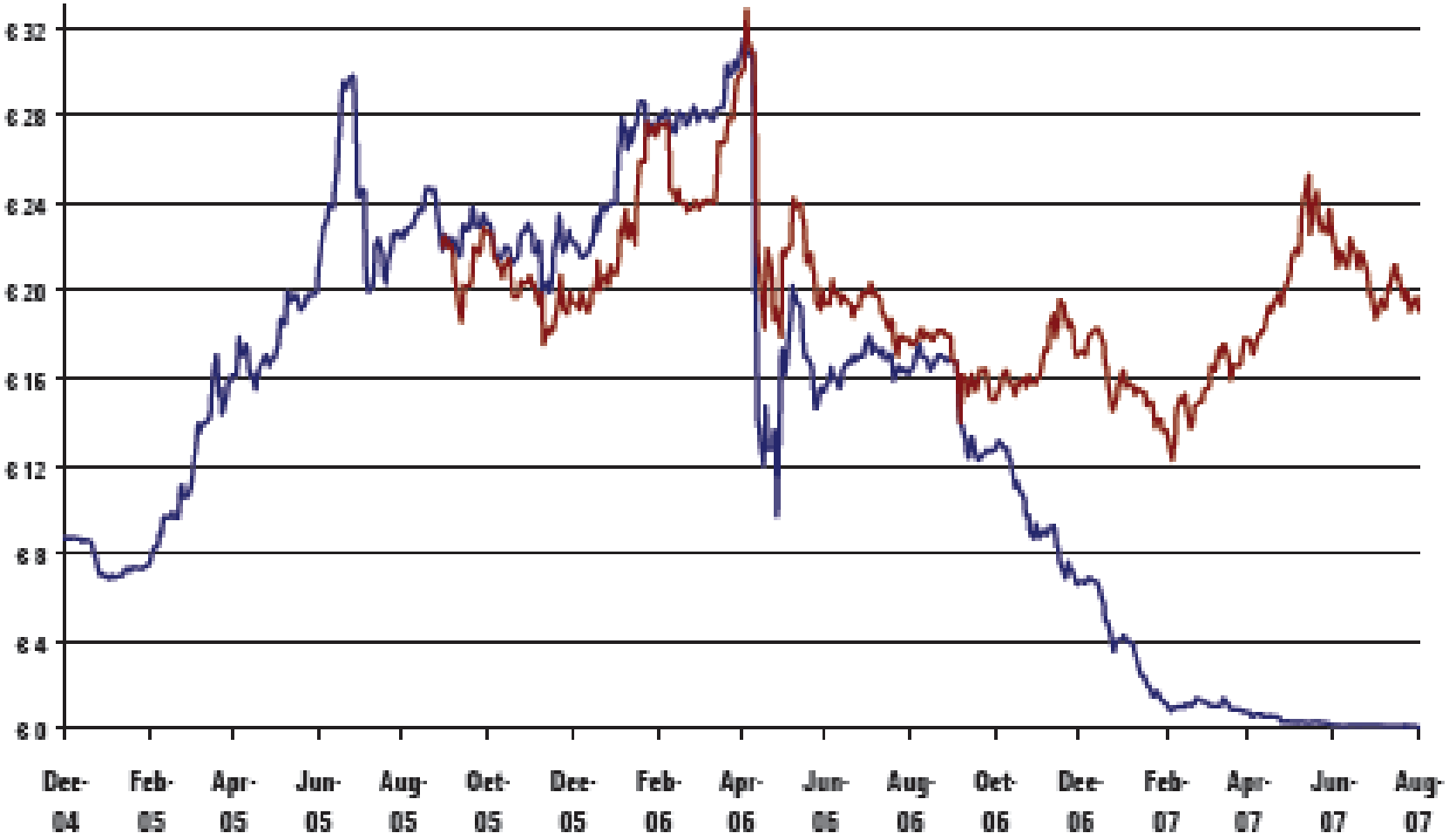
Penalties for non-compliance:

- 40 €/tCO_2 in trial period; 100 €/tCO_2 in 2008 - 2012
- plus compensation of allowances

European Union: Emissions Trading Scheme



European Union: Emissions Trading Scheme



EU ETS: suitable for CCS?

Cost-effective instrument, if strong incentive given

However, if EUA prices remain low:

- Preference for low-cost abatement options
- Innovation market failure
- ETS in its current form unlikely to lead to CCS deployment

→ Need for complementary policies

EU: Complementary policies to ETS

Public financial support (most likely Member States)

- Investment support
- Feed-in subsidies
- CO_2 price guarantee

Low-carbon portfolio standard with tradable certificates (most likely EU level)

CCS obligation (EU level)

EU: Complementary Member State policies?

Investment support

Feed-in subsidies

CO_2 guarantee

Characteristics:

- Demonstration/upscaling phase
- Environmentally effective
- Reduction of financial uncertainty for operator
- Possibly high costs
- Poor incentive for further innovation or cost reduction

EU: Complementary EU-level policies?

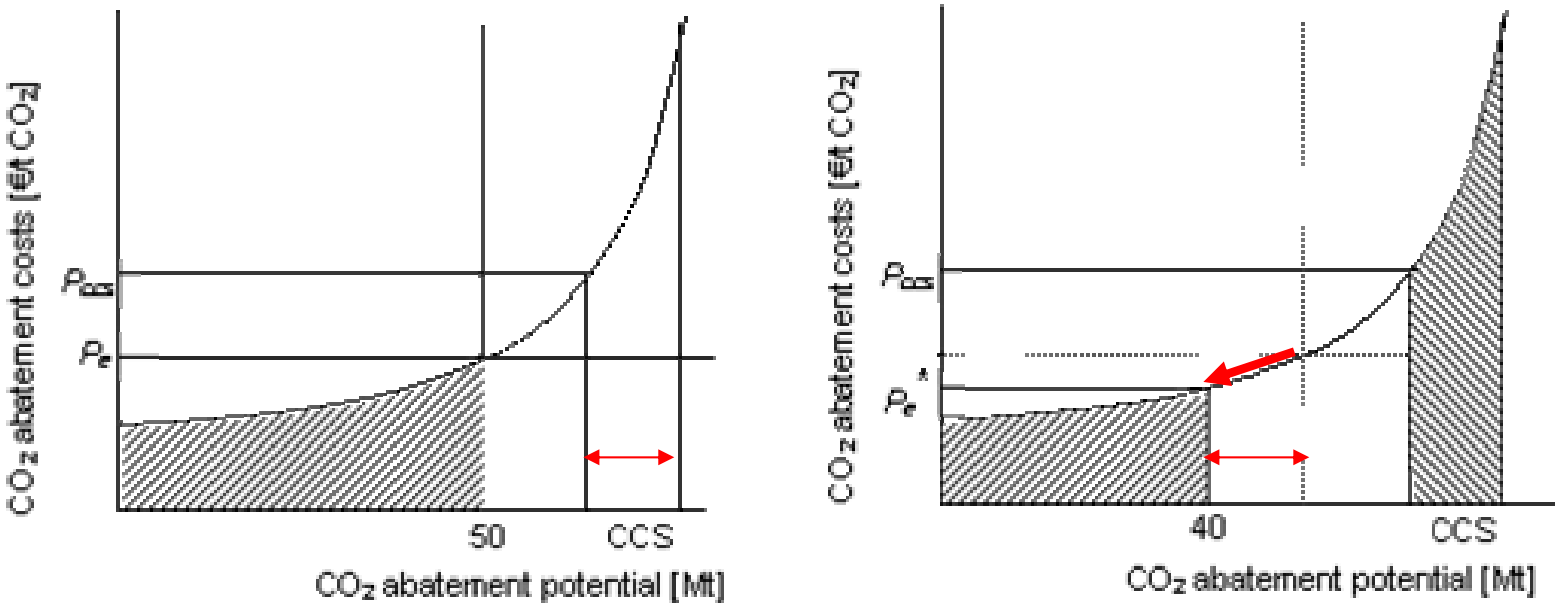
Low-carbon standard: Source minimum % of power from specified sources, tradable certificates

Obligation CCS for new fossil-fuel based power plants from 2020 onwards

Characteristics:

- Environmentally effective
- Risk for operator (technological, financial, and availability of storage)
- Incentive for further innovation and cost reduction
- Standard: complex and administratively challenging

EU: Interaction additional incentives ↔ ETS



Any additional instrument will reduce demand for EUAs and lower CO_2 market price *unless* cap is lowered accordingly

EU: Other interactions

Renewable energy:

Diversion of resources + attention (BIG issue for NGOs)

→ *% renewables contingent on CCS implemented?*

Innovation:

Cost reduction discouraged

→ *Portfolio standard, obligation*

Electricity market:

Technical reasons for placing CCS as baseload option,

however O&M cost lead to higher electricity price

Security of energy supply:

CCS only contributes if gas prices spur a shift to coal, and CO_2 prices are high enough for CCS

The Kyoto Protocol and CCS in developing countries

The Kyoto Protocol – brief history

1992: United Nations Framework Convention on Climate Change

- By now: 191 ratifications
- Objective: ".. stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."
- "Common but differentiated responsibilities"
- Emission registrations in place; secretariat formed

1997: Kyoto Protocol

- By now: 175 ratifications
- Annex B (industrialised countries): Emission reductions + emissions trading possibilities
- Non-Annex B (developing countries): No emission reductions, but voluntary participation in Clean Development Mechanism

The Kyoto Protocol

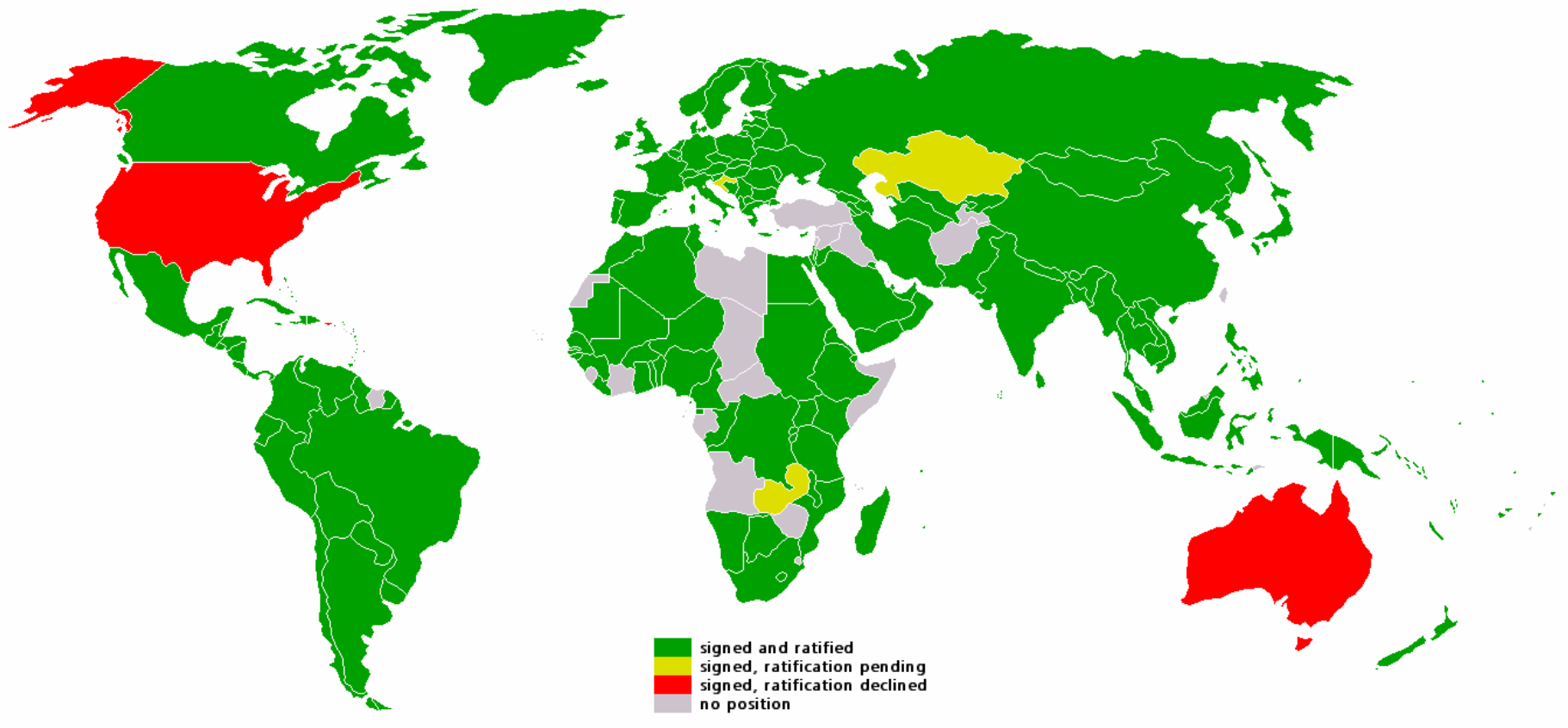
Kyoto targets (% change in 1990 GHG emissions by 2008-2012):

- Russia, Ukraine: 0%
- Japan: -6%
- United States: -7%
- European Union: -8%

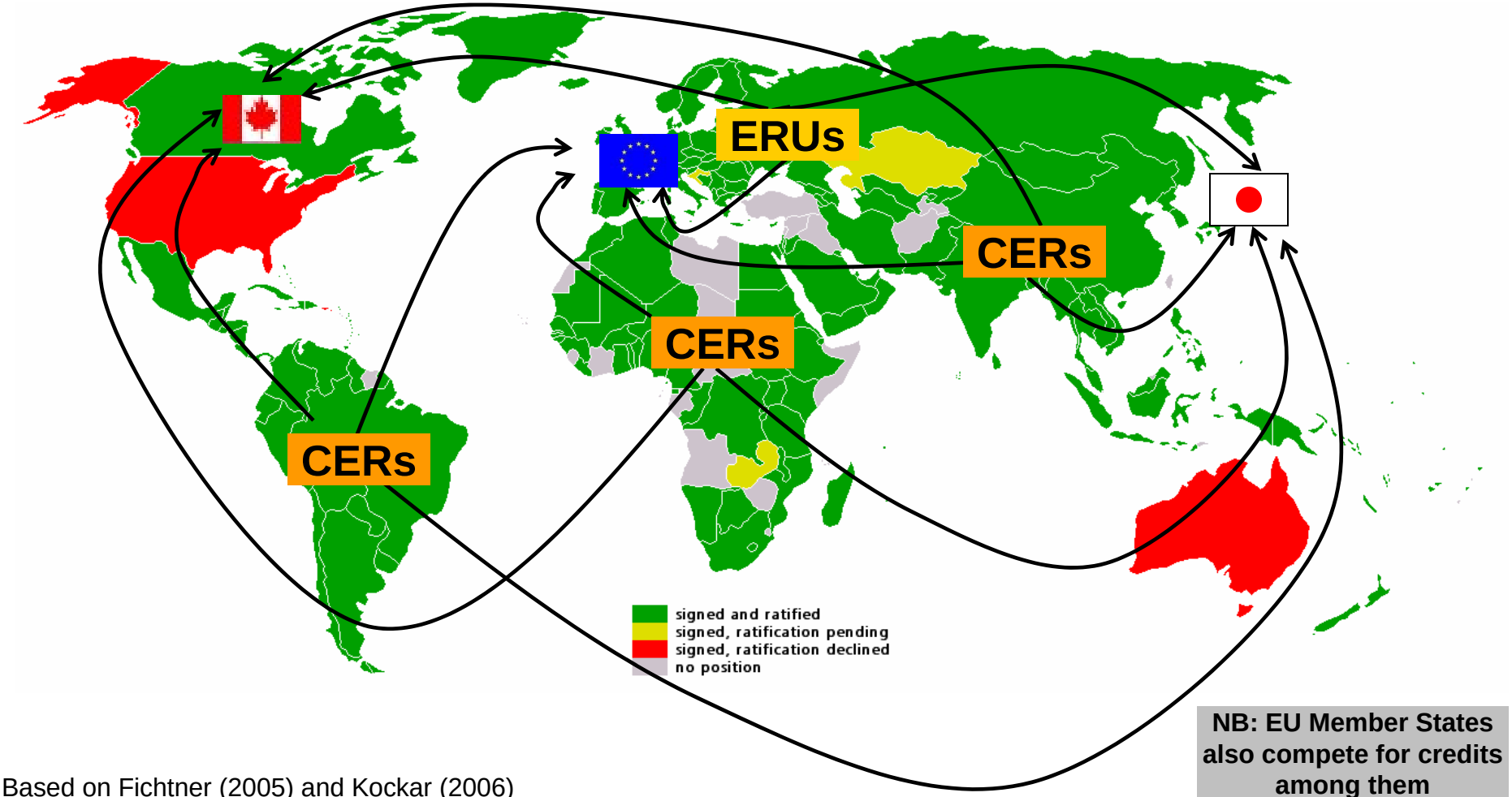
Kyoto mechanisms

- International Emissions Trading: Assigned Amount Units (AAUs)
  (Annex B ⇔ Annex B, allowance trading)
- Joint Implementation: Emission Reduction Units (ERUs)
  (Annex B ⇔ Annex B, project-based credits)
- Clean Development Mechanism: Certified Emission Reductions (CERs) (Annex B ⇔ non-Annex B, project-based credits)

The Kyoto Protocol ratifications



The Kyoto Protocol – Carbon trading "routes"



NB: EU Member States also compete for credits among them

Based on Fichtner (2005) and Kockar (2006)

The Clean Development Mechanism (CDM)

Project-based trading between buying (Kyoto-restrained) country and selling (not Kyoto-restrained) country

Two goals:

1. Contribute to sustainable development in host country
2. Lower Kyoto compliance costs for buying country

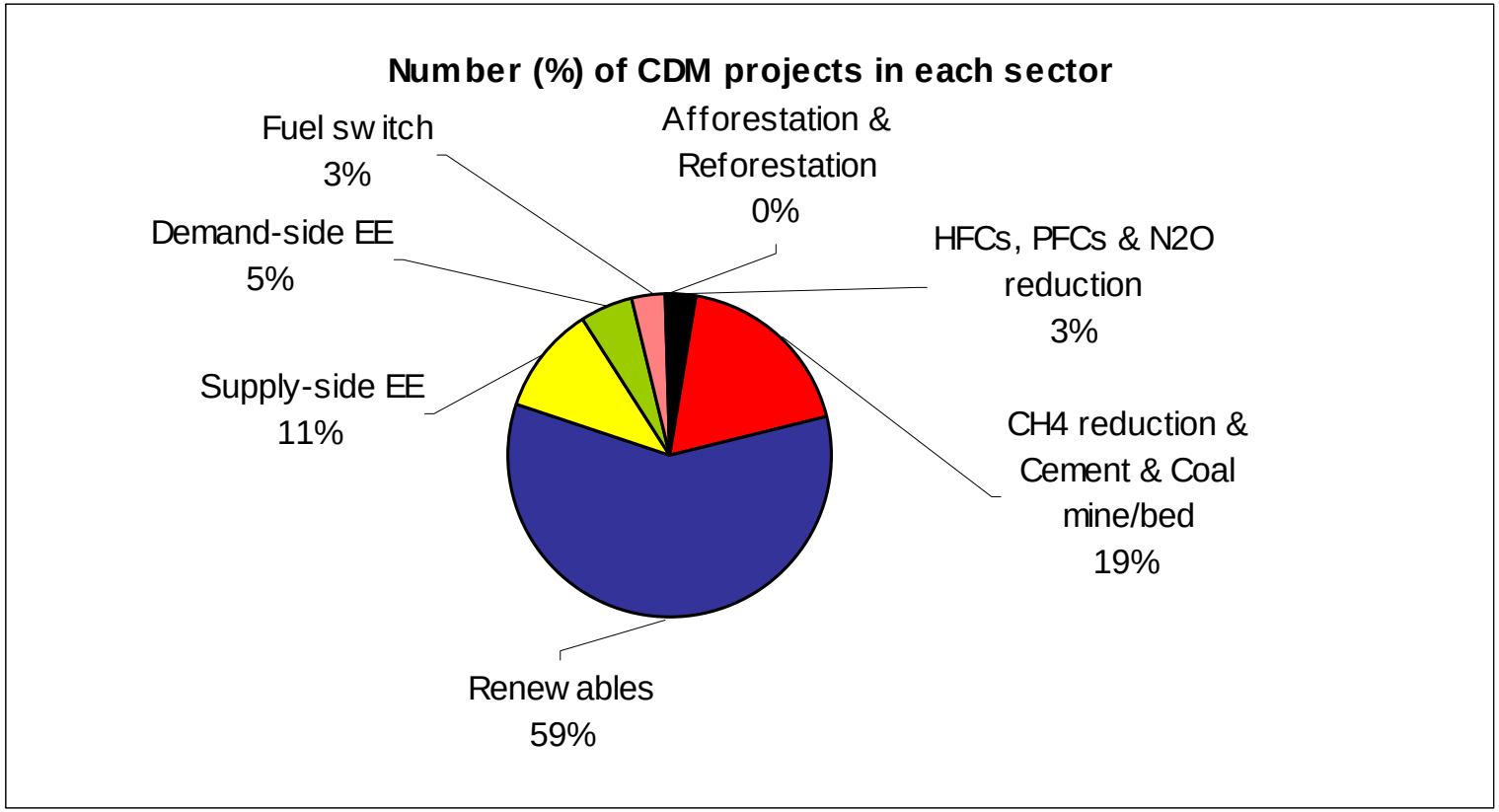
Main requirements:

- Reduce emissions relative to a baseline
- Demonstrate "additionality"
- Sustainable development; approval from host country
- Credible monitoring plan
- Third-Party upfront validation and eventual verification

The Clean Development Mechanism (CDM)

Currently: 738 projects registered

Emission reduction: 363 $MtCO_2$-eq/yr



CCS in the CDM?

Not (yet?) approved

Procedural problems:

- Long-term seepage of CO_2, and risks
- Accounting for potential impermanence of CO_2 reductions
- Regulations for site characterisation, selection, monitoring etc
- Long-term liability
- …

But, perhaps more importantly, political objections from Brazil, Least-Developed Countries, NGOs:

- Rules should be developed first, then we'll see whether they suffice
- CCS not sustainable enough for CDM; replaces better options
- Distrust of the oil industry
- Developing countries as guinea pigs
- Developing countries' institutions not strong enough

Consequences of CCS in the CDM: early opportunities

Capture-ready sources (gas processing, refineries, hydrogen, ammonia):
only compression costs

Cost-effective storage:

- Enhanced Oil Recovery: mature but additional at current oil prices?
- Enhanced Gas Recovery: demonstration phase
- Enhanced Coal Bed Methane: expensive, technical feasibility?

Groups of CO_2 point sources

2008-2012:

- Refineries
- Ammonia
- Hydrogen
- Gas processing

2012-2020: the above, and

- Power
- Cement

2020-2030: the above, and

- Iron and steel
- Biomass

Other considerations:

- Long lead times for transport infrastructure, storage site selection, characterisation, etc.
- Development of local capacity and regulation

Technical potential CCS in CDM: 2008-2012

($MtCO_2/yr$)	Brazil	China	India	Mexico	Saudi Arabia	South Africa	**Total**
Refineries	18	40	30	15	17	6	**125**
Ammonia	0,2	56	2,2	2,3	0	0,5	**61**
Hydrogen	0	0	0,4	0	0,5	0	**1**
Gas processing	Not available, possibly 100-200 Sleipners worldwide?						

Substantial potential in refineries, ammonia, and possibly gas processing

Source: IEA GHG CO_2 point sources database, 2006 version

Technical potential CCS in CDM: 2013-2020

($MtCO_2$/yr)	Brazil	China	India	Mexico	Saudi Arabia	South Africa	**Total**
Power[1]	56	4159	663	113	82	270	**5344**
Cement[1]	38	30	80	38	17	11	**213**

These are not “real” potentials, but more like an upper boundary!

Source: IEA GHG CO_2 point sources database, 2006 version

[1] Projected emissions in 2012, assuming growth rates between 50% (China) and 10% (Brazil) relative to 2006

What to expect of CCS in CDM?

Early capture opportunities could be realised right away

Barriers: long lead times, actual storage potential, but first and foremost: resistance to allowing CCS in the CDM

- Low market impact expected if allowed in Kyoto commitment period
- Technical potential rises after 2012: power sector
- Most cost-effective to apply CCS on new power plants, so need to start before 2012 if the growth in CO_2 from coal-fired power is to be reduced through CDM

Large uncertainties because of both data availability and confidentiality

Conclusions

Conclusions

Apart from technological considerations, the role of CCS in the energy system is determined by the political will to tackle climate change

In the EU, policy initiatives are underway

- ETS cost-effective incentive for CO_2 reduction, however market failures and low prices may hinder CCS deployment
- Additional incentives needed to advance large-scale CCS deployment
- EU-wide structural policies preferable, possibly complemented by MS policies in demonstration phase

Conclusions

Policies in Canada, US (state-specific) and Australia also considered, but are generally less structural than the initiatives in the EU

As part of the Kyoto Protocol, the inclusion of CCS in the CDM is uncertain

- Depends on convincing technological arguments as much as on “emotional” arguments from developing countries and NGOs

Thank you