Integrated course „Energy Economics“ - Markets for CO_2 Emission Allowances

Chair of Energy Systems
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Outline

- External costs
- Quantification of external costs
- Greenhouse gas problem
- European Cap-and-Trade system

Definitions

Emissions: Substances exhausted from a facility into the atmosphere, the hydrosphere etc. Likewise noise, tremor, odour, contamination, and radiation

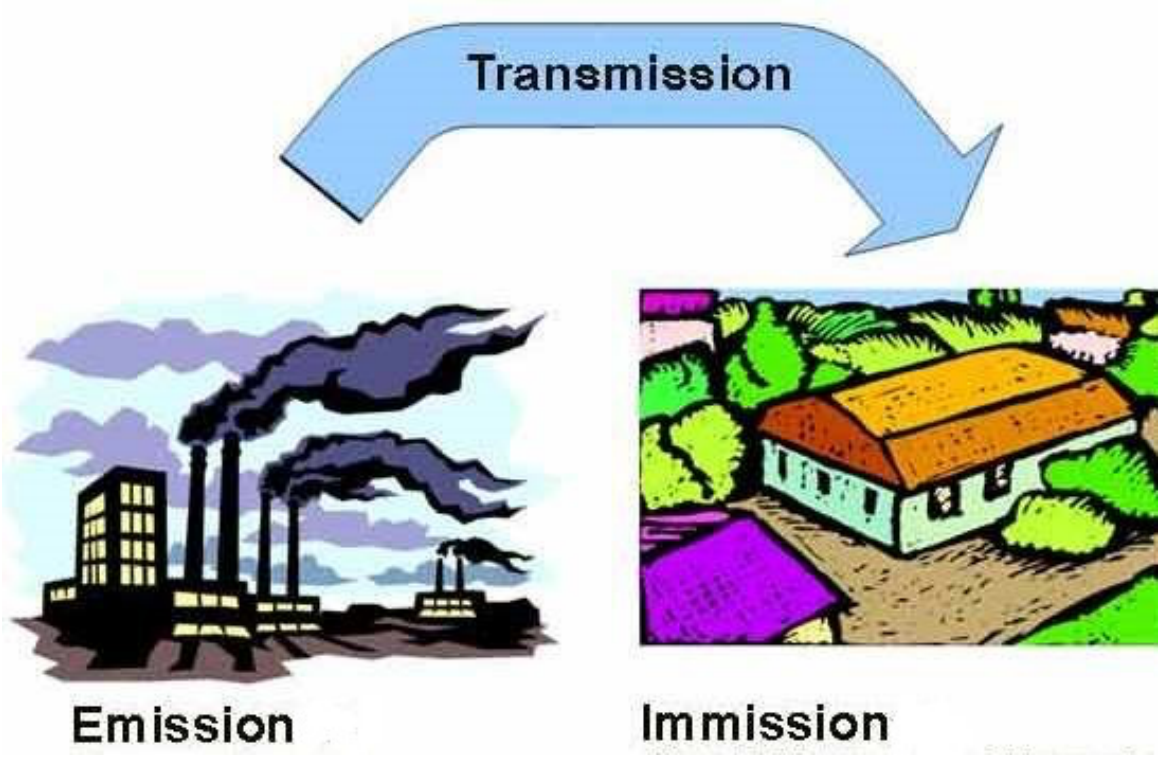
Immissions: distribution, transformation and metamorphosis of the emitted substances in the receiving ecosphere media

Damages: Impacts of immissions that are somehow negatively valued by humans

External effects: Impacts of economic activities on outsiders without compensation. In the case of damages, these impacts are “negative external effects”; if the impacts represent advantages, they are called “positive external effects”

External cost: Negative external effects expressed in money units

Definitions



Coase Theorem

If private parties can negotiate about allocation of resources at no cost, the market will solve the problem of externalities and allocate resources efficiently.

Pareto efficiency: outcome where no player can be made better off without hurting at least one other player.

Coase Theorem: Rancher vs Farmer

The problem is reciprocal: meat or crops.



Put up a fence:
- rancher pays
- farmer pays

Allow crops damage:
- rancher reimburses
- farmer absorbs

Rancher stops raising cattle.
Farmer stops growing crops.

Coase Theorem: Rancher vs Farmer

More crops get damaged as the herd count increases.

Number in Herd (Steers)	Annual Crop Loss (Tons)	Crop Loss per Additional Steer (Tons)
1	1	1
2	3	2
3	6	3
4	10	4

Annual cost of fencing: $9

Price of crop: $1 per ton

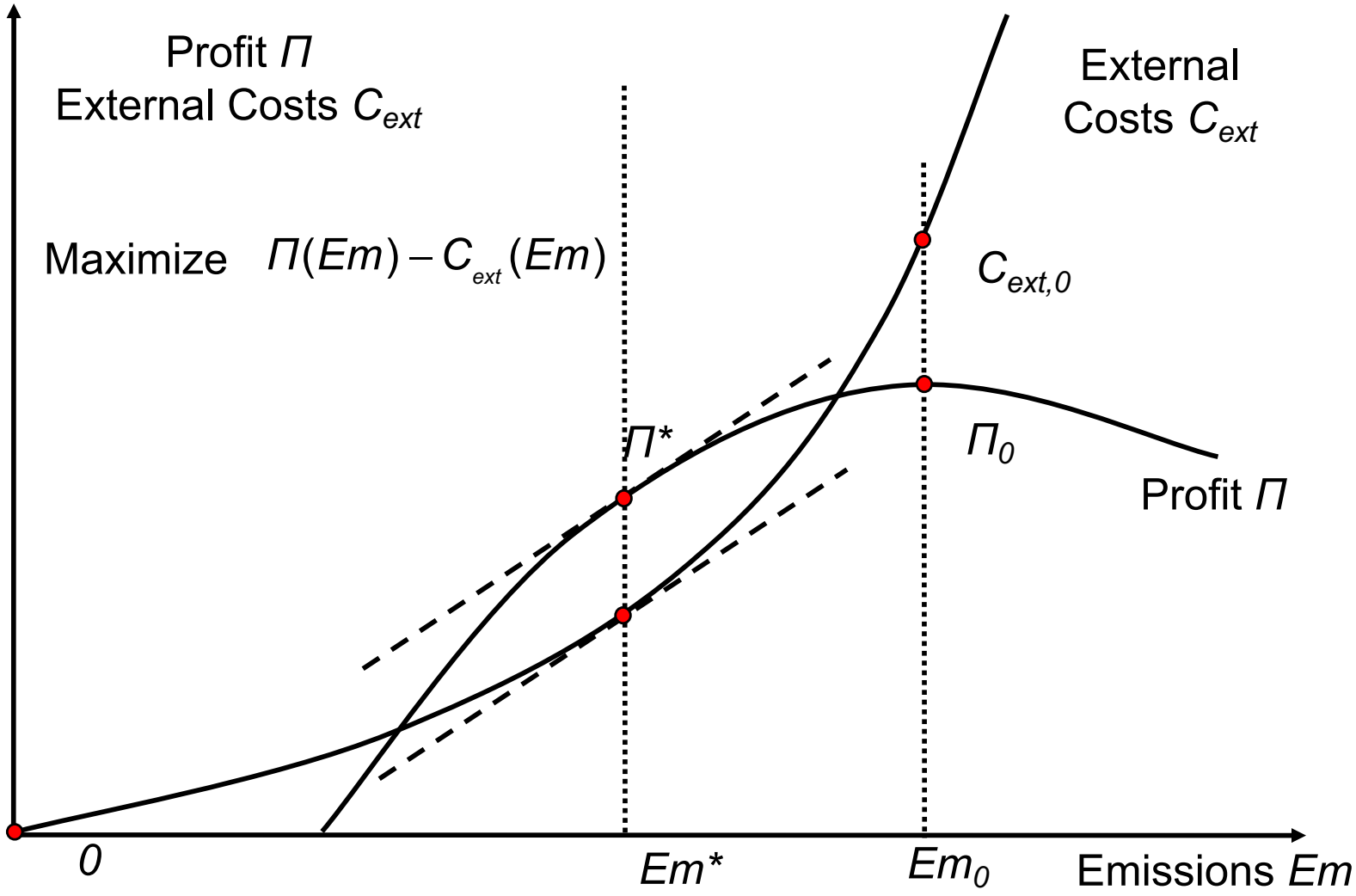
Value of crops: $12

Cost of cultivation: $10

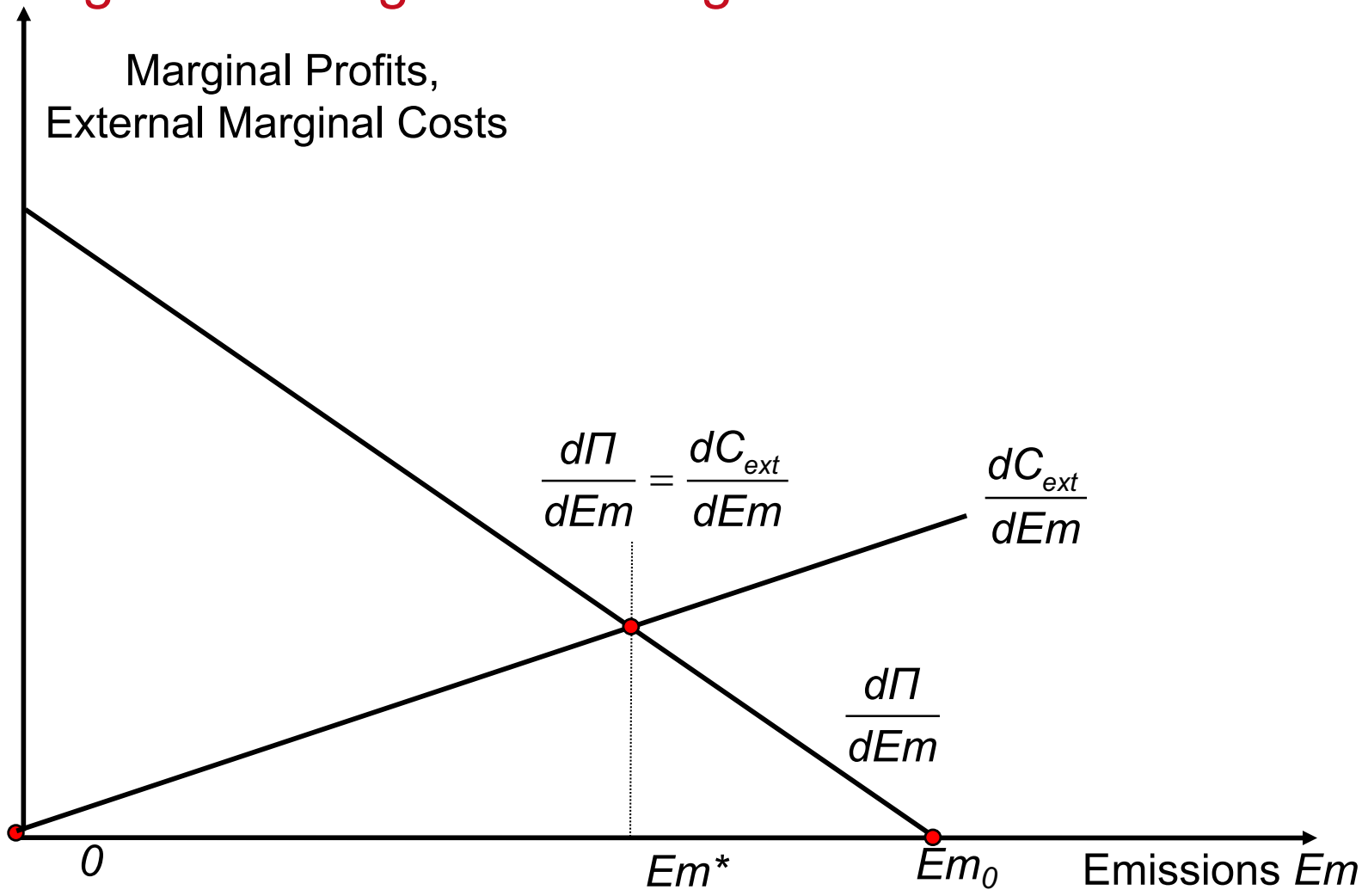
Value of damaged crops: $1

Source: Coase (1960)

Optimal Emmission Levels



Marginal Damages and Marginal Abatement Costs



Assumptions and Limitations

- Property rights are clearly allocated and enforceable.
  - Areas with no property rights – e.g. oceans.
  - Monitoring is not always possible.

- No transaction costs

- Small number of parties affected

- Equal bargaining power

- Cost for future generations

External Costs and Market Failure

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Individuals may suffer economic losses from emissions associated with energy activities that are not included in energy prices and thus are not compensated by the polluter

No Pareto-Optimum (some individuals can be better off without negatively affecting the situation of any other individual)

Coase-Theorem: Negotiations between polluters and affected parties could produce the Pareto-optimal condition, but negotiations may not be possible or successful due to

- many perpetrators and victims
- unclear cause-effect relationships
- high transaction costs

⇒ Market Failure

Strategies to Correct Market Failure

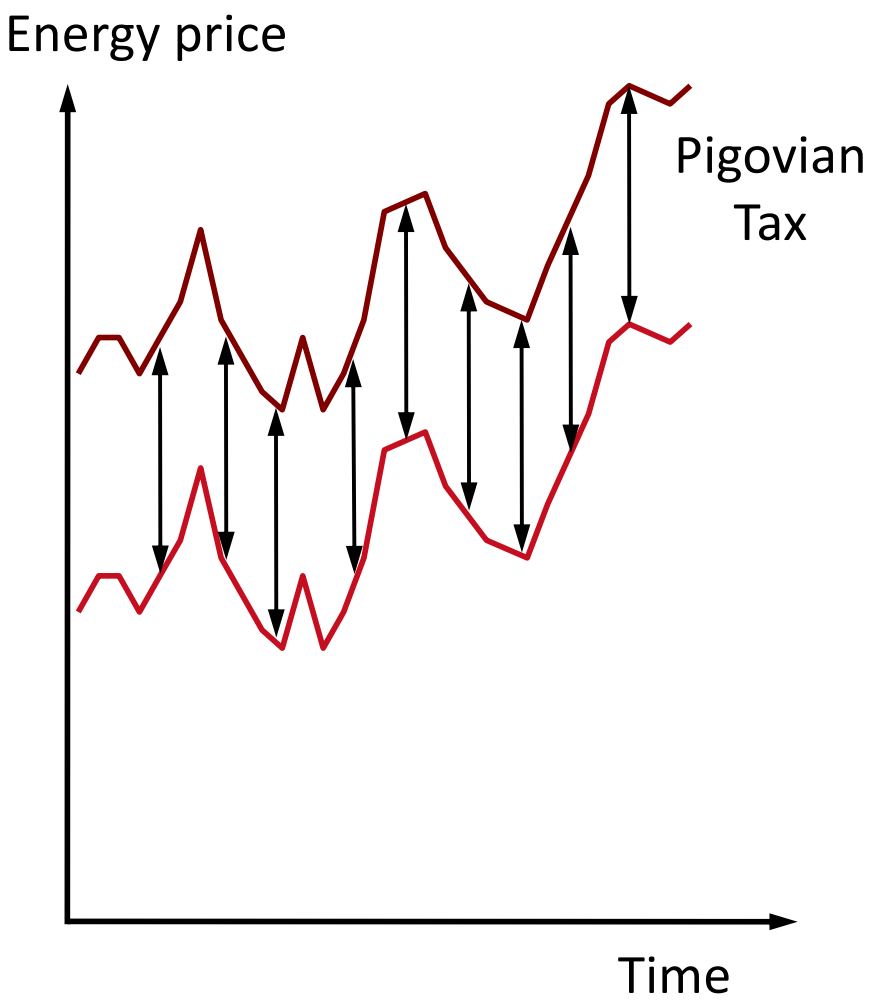
- Voluntary agreement with sanctions (KLEMMER et al. 1999): Polluters voluntarily agree to reduce emissions; the government threatens to apply other instruments if the agreement fails to be honored

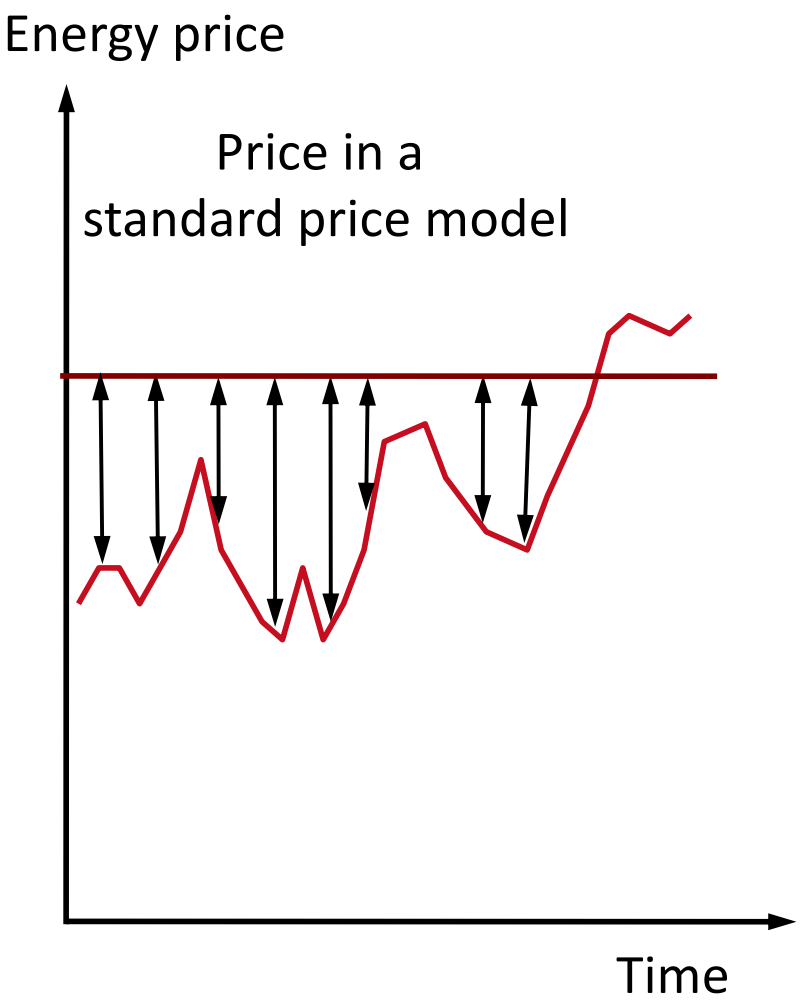
- Environmental Liability
  - with mandatory insurance; insurance premiums provide the internalization of external cost
  - Lawmakers and courts determine the admissible amount of external effects beyond which the injurer must come up with a compensation

Strategies to Correct Market Failure (Cont.)

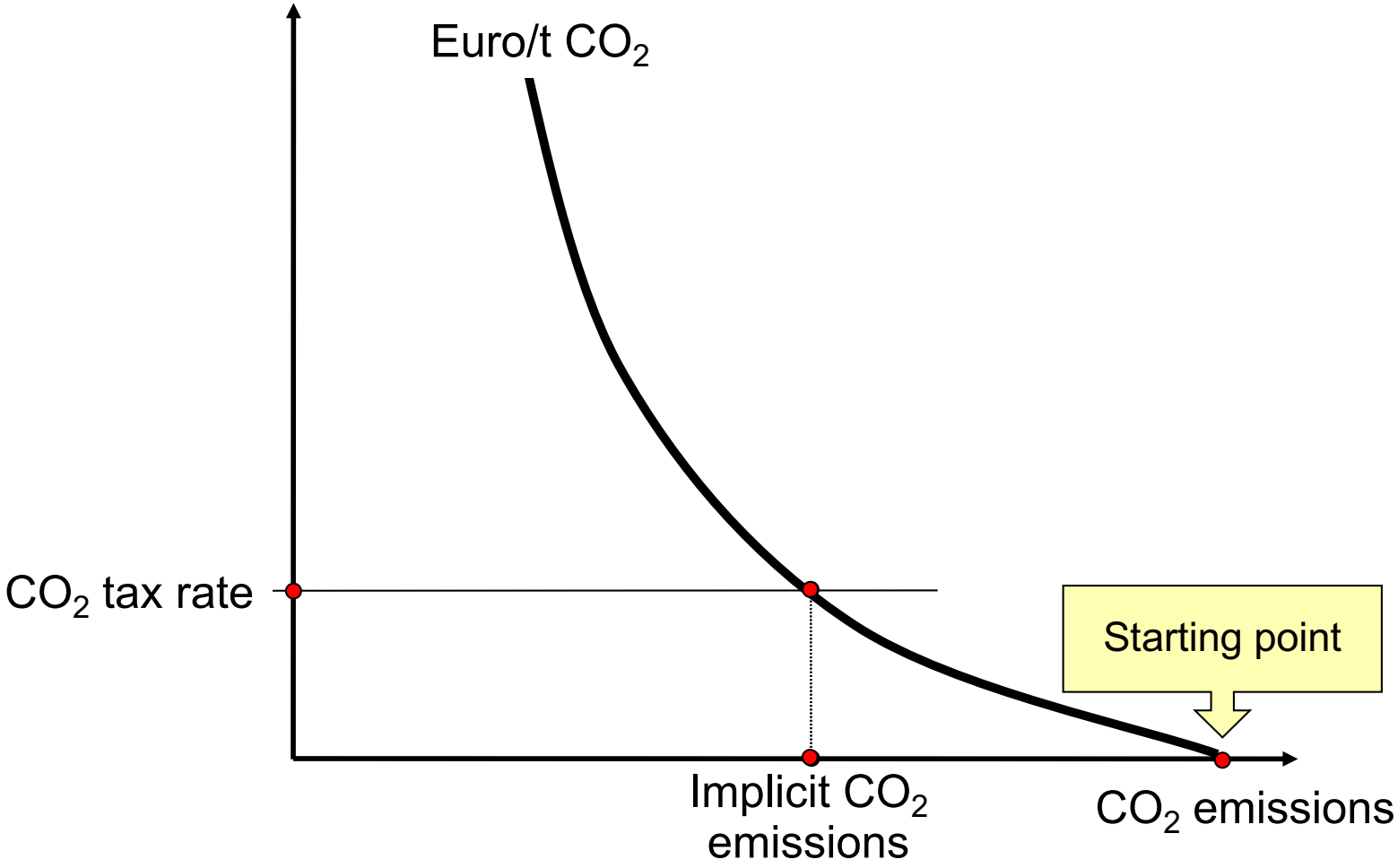
- Emission standards and norms (e.g. mandatory emission controls)
- Emission taxes (Pigou-Tax). By taxing emissions, the government puts a price on them
- Standard Price Approach (BAUMOL, OATES 1988)
  - Government auctions tradable allowances (fiscal instrument)
  - Free allocation of tradable allowances by government (Grandfathering, Benchmarking)

Emission Taxes versus Standard Price

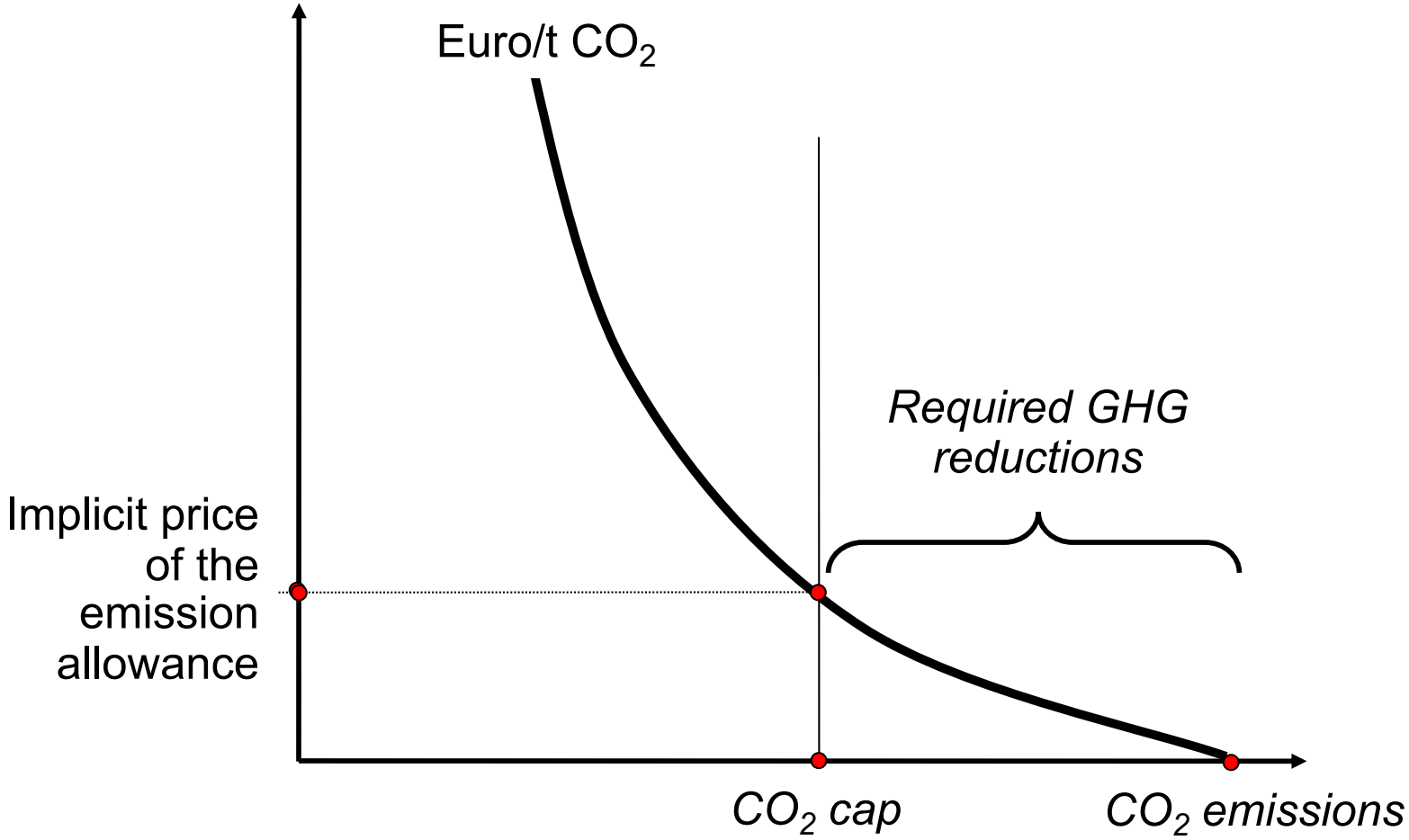




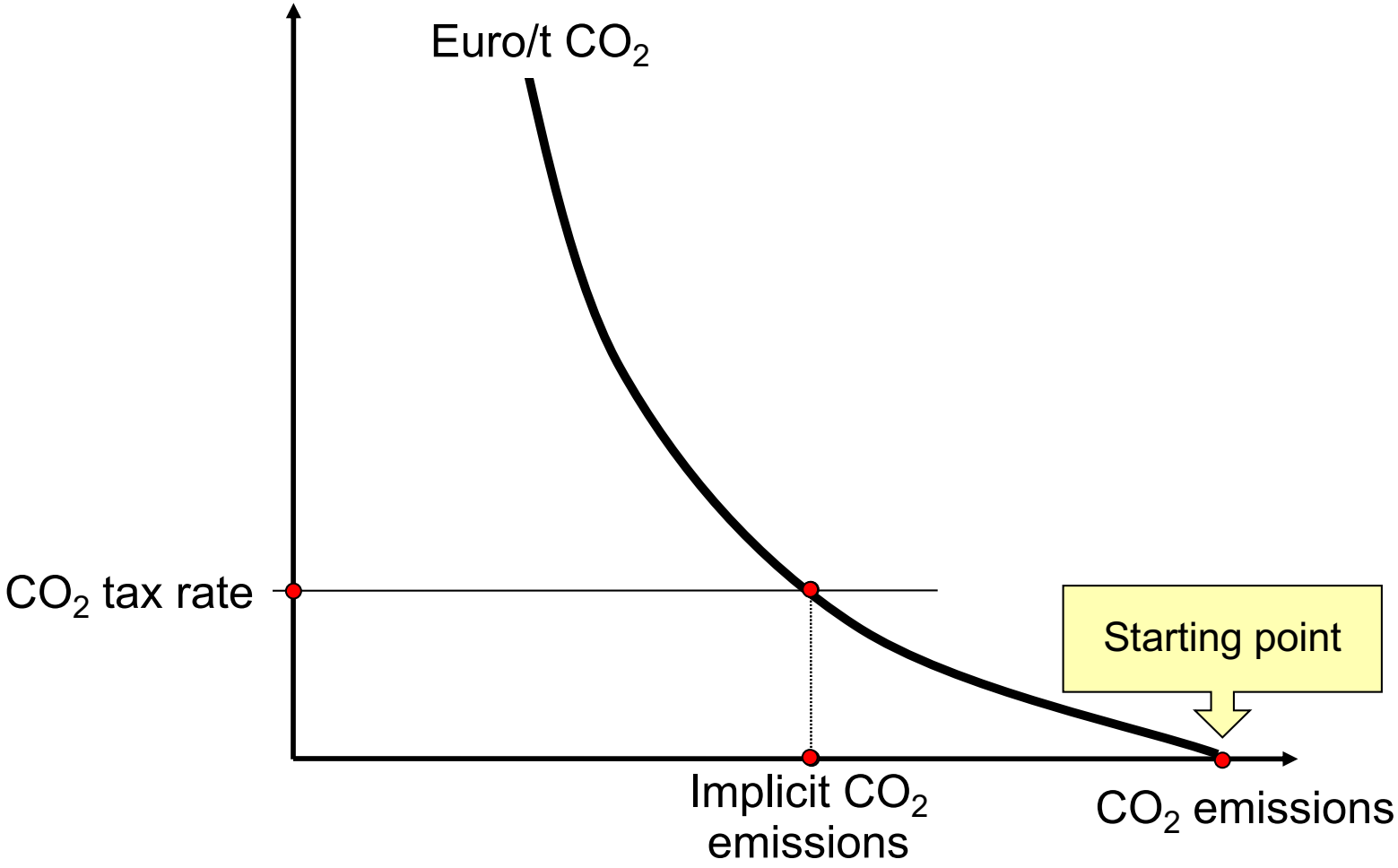
GHG Abatement Costs and a Pigou Tax



Uncertain GHG Abatement Costs Under Cap and Trade



Unknown GHG Abatement Costs and Pigou Tax



Pigou Tax

Optimal tax rate must be equal to the marginal cost of emissions.

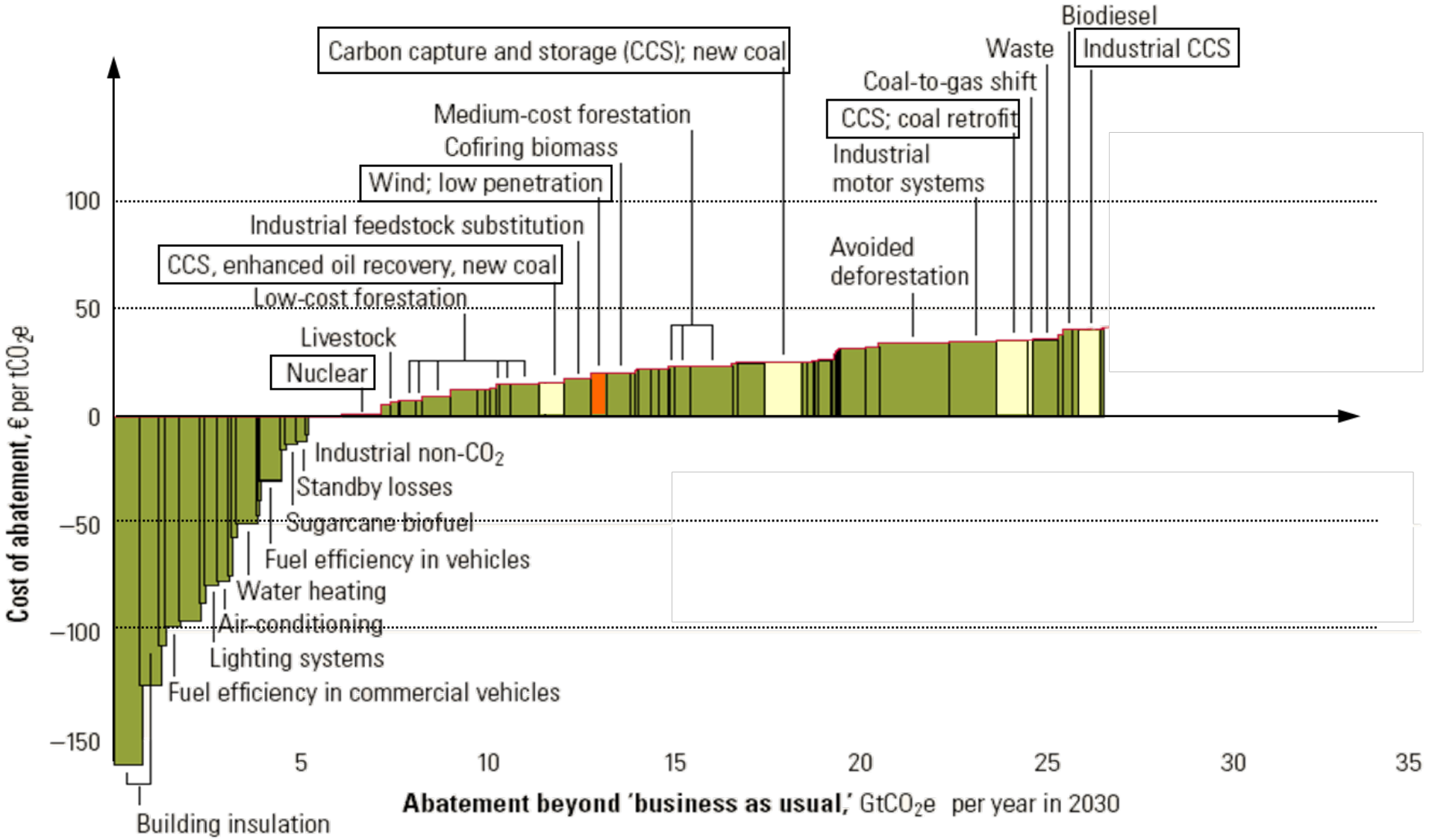
Without technology differences, all companies reduce their emissions to the same optimal level.

In case of technology differences, the company with lower abatement costs has a higher optimal emissions level.

→ Tax needs to be higher.

Costs of abating CO_2-Emissions

(Source: McKinsey & Company 2007)



Content of the Lecture

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External costs

Quantification of external costs

Greenhouse gas problem

European Cap-and-Trade system

Quantification of External Costs

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- Emissions
- Immissions: Atmospheric chemistry, Water Chemistry, …
- Damages depending on Dose Response Functions: initial level of other substances, duration, delay until the damage appears, presence of receptors
- Monetization of damages

Categories of Damages [VDI-directive No. 3780]

Economic damages in the narrow sense: destruction of physical assets that cause income losses, cleanup and repair costs

Losses to human life and health: number of concerned persons, number of years of life lost, duration and degree of medical treatment

Losses of environmental assets and environmental quality as far as not yet captured by category “economic damages”

Losses of quality of life: exposure to noise and vibration, but also fear of catastrophes, reduced autonomy and self-fulfilment;

Social institutions that are temporarily prevented from normal functioning (civil protection, health system, …): number of days times number of concerned persons

Monetization of Damages

- Cost of repair
- Human capital approach (cost of education and training, present value of future labor income forgone)

- Hedonic price approach (market transactions): individuals who expose themselves to a risk to life, noisy environment etc. for a financial return

- Contingent Valuation: Survey on individual willingness to pay for avoiding an environmental damage (strategic responses)

- Contingent Valuation (CUMMINGS *et al*. 1986): Evaluation of alternatives to the status quo in order to determine the individual indifference curve through the status quo. Because the alternatives are associated with financial effects, they can be determined from the slope of the interpolated indifference curve

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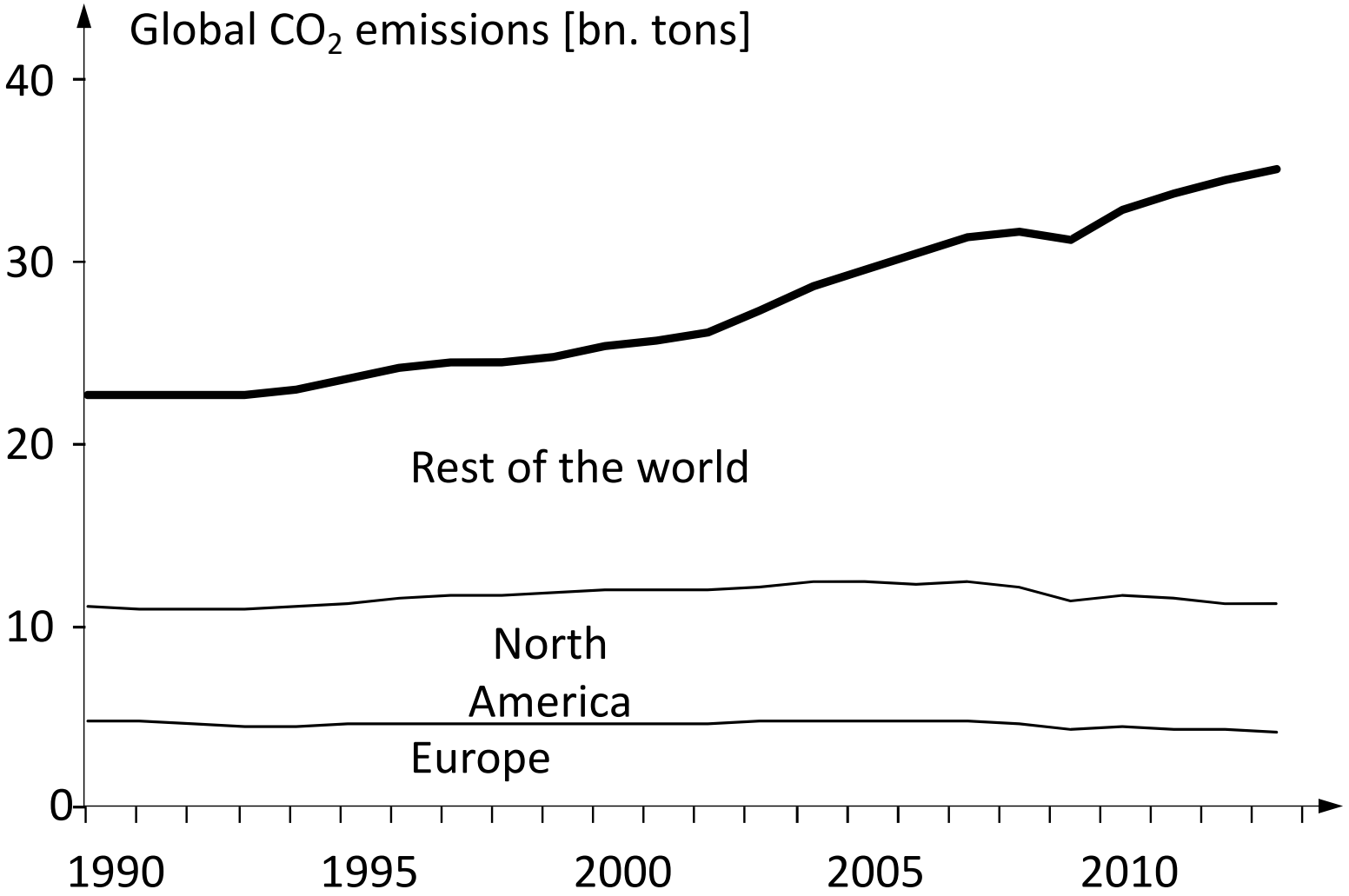
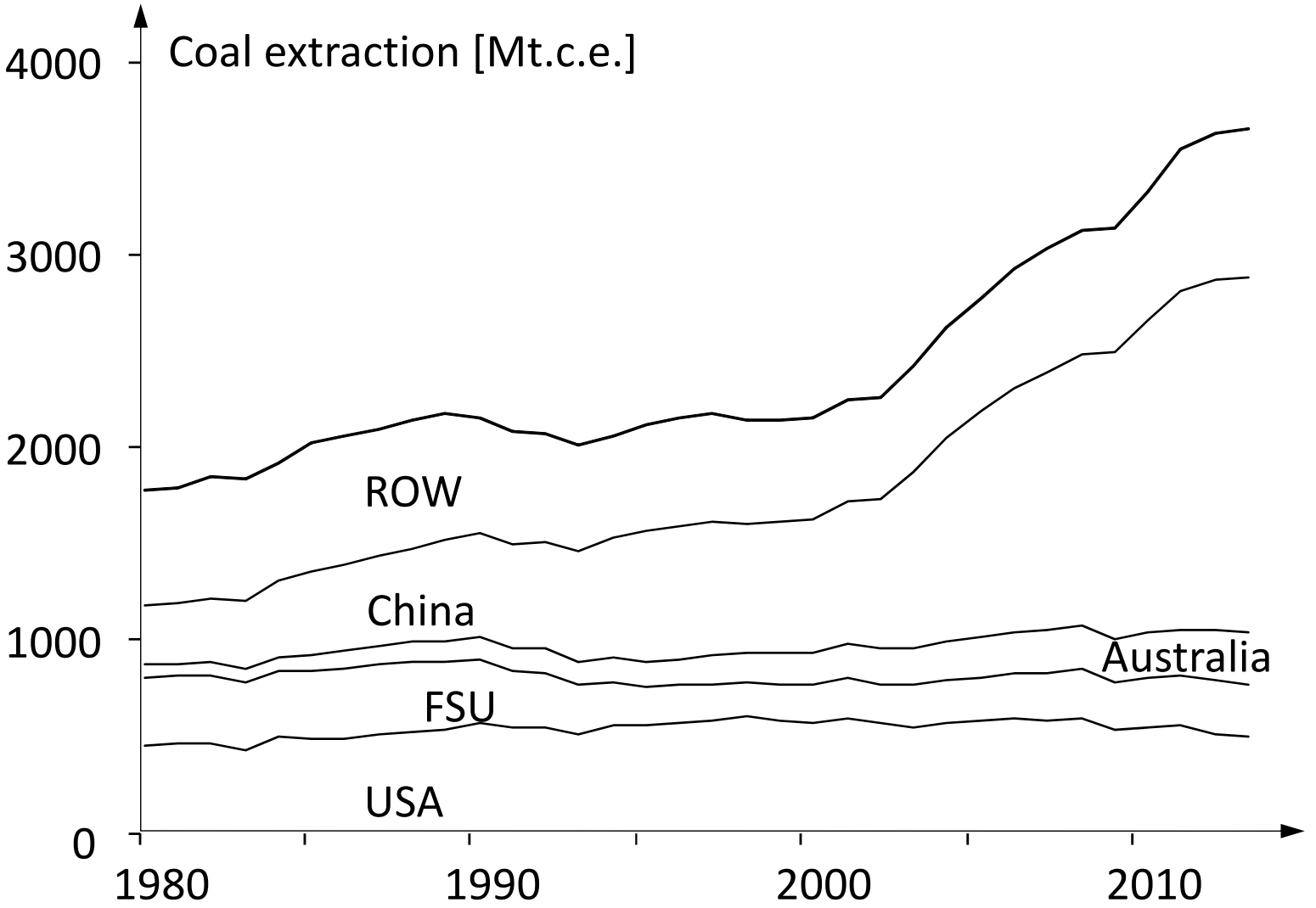
Global CO_2 Emissions [Source: BP 2010]



Global Coal Extraction [source: BP]



Characteristics of the Greehouse Problem

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Globalism: The location of emissions does not matter (Leakage problem)

Timeline: Damages affect future generations while the current generation has relatively minor impairments

Unavailability of reliable abatement technologies

Politics against Free riding: Solutions require an internationally coordinated and future-oriented approach: Who should provide what contributions? (International and intra-national distributive conflicts; Developing countries against grandfathering)

Measurement, Reporting and Verification