Centre for Energy and Environmental Markets

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Designing Policy Instruments to Combat Climate Change

Lessons learnt from the EU ETS

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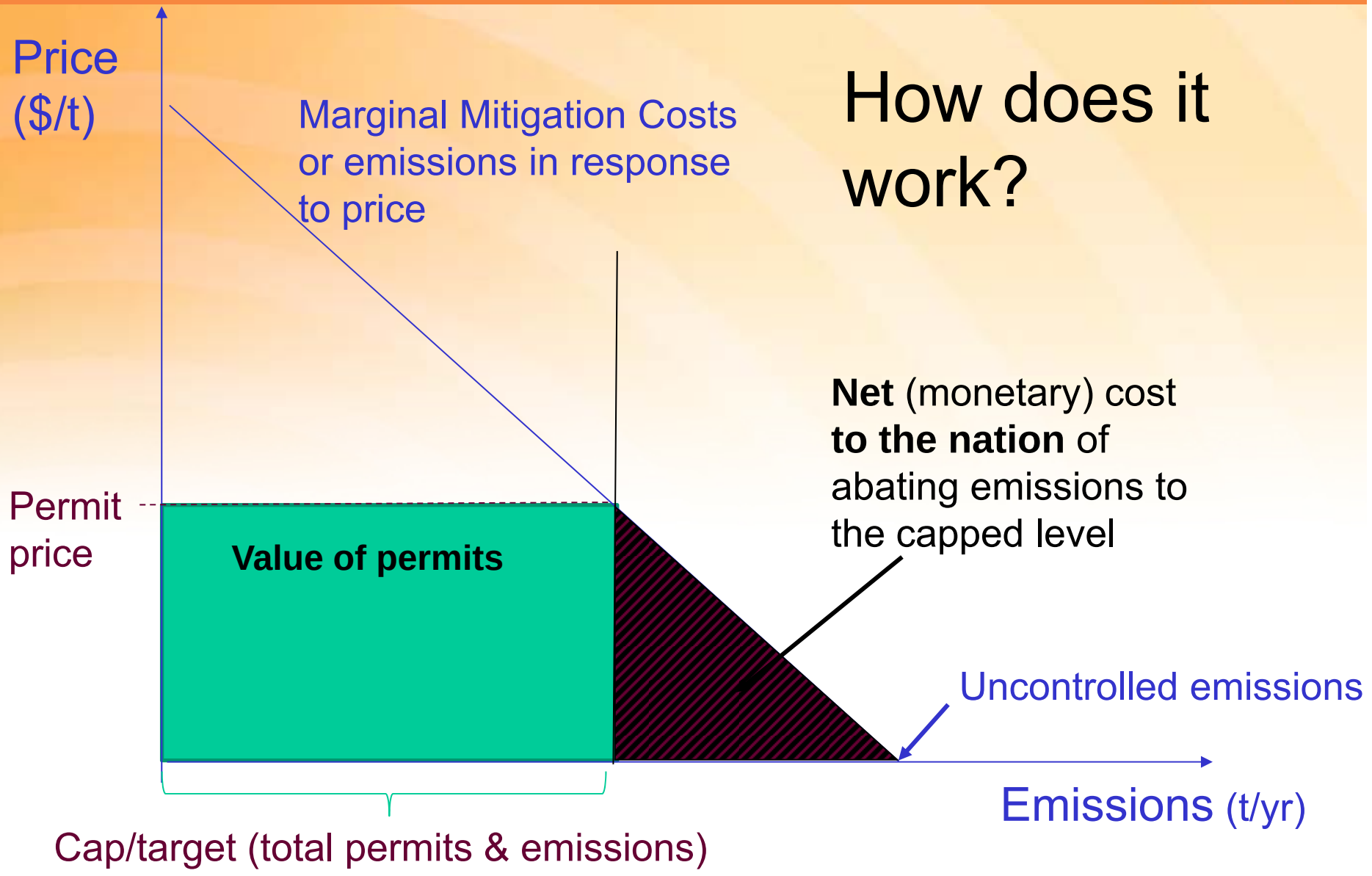
Motivation

- To combat climate change, effective, efficient, and equitable policies are necessary to achieve high reductions (80-95%) in the long run
- Economic textbooks argue that a well-designed Emissions Trading Schemes (ETS) can be an efficient and effective policy instrument
- Emissions trading schemes are designer markets and policy makers have to choose the design...
- Important lesson to be learnt from 5 years of operation of the biggest ETS: design affects performance

Methods that help to design and evaluate policy

Approaches	Ex-ante (Design)	Ex-post (Evaluation)
Theory	X	(x)
Modelling	X	(x)
Experiments	X	(x)
Econometrics		X
Interviews	X	X
Case studies	X	X

How does it work?



Key Design features of EU ETS (I)

- **Target**
  - Phase I and II: Cap level left to the Member States (National Allocation Plans), approval by the European Commission
  - Phase III: Harmonised cap determined at European level
  - Full banking within a phase and one year borrowing, no banking and borrowing between Phase 1 and Phase 2
- **30 participating countries (EU-27 and Liechtenstein, Norway and Iceland)**
  - Covers around 50% of Carbon Dioxide emissions (CO_2) of EU
  - Around 40% of total greenhouse gas (GHG) emissions of EU
- **Downstream scheme for CO_2 from stationary sources**
  - Installation-based
  - Power generation & selected industries
  - Phase I cap: 2,082 Mt CO_2 p.a. covered (all GHG in Switzerland are 53 Mt CO_2)
  - Phase II cap: 2,083 Mt CO_2 p.a. extended scope ~ 85 Mt CO_2-e
  - Phase III: 1,930 Mt CO_2-e p.a. further activities and gases (N_2O and PFC) ~ 100 Mt CO2e (2,039 Mt CO_2-e) and ~200 Mt aviation (in 2013)

Key Design features of EU ETS (II)

- **Allocation based on National Allocation Plans (NAP)**
  - Allocation left to the Member States, approval by the European Commission
  - Ceilings for auctioning (≤ 5% phase 1, ≤ 10% phase 2, 100% electricity sector phase 3). Actual auction share: Phase 1: 0.13%, Phase 2: 3%, Phase 3: ~ 50%
  - Total amount of allowances to be allocated and amount per installation
  - Policies & Measures for the non-ETS sectors (informative)
- **Sanctions**
  - Penalty of 40 €/t CO_2 (until 2007), 100 €/t CO_2 (from 2008) and make-good provision, no price cap or floor
- **Price Containment Measures:** only indirectly through banking and borrowing
- **Offset Mechanisms**
  - Limited use of Kyoto credits (Clean Development Mechanism (CDM) and Joint Implementation (JI))
- **Technical Aspects**
  - Yearly monitoring (mainly calculation based) and reporting of verified emissions
  - Phase 1 2005-2007, Phase 2 2008-2012 (= Kyoto Phase), Phase 3 2013-2020

Evaluation criteria

- **Environmental Effectiveness**: the extent to which the environmental objective is achieved.
  - Macro Perspective: Does the ETS achieve emission reductions globally?
  - Micro Perspective: Does the ETS achieve the given (ineffective) target?
- **Efficiency**: the extent to which the required objective is met at least cost.
  - Macro Perspective: Does the policy achieve emissions reductions at lower costs compared to other instruments?
  - Micro Perspective: Does the ETS achieve the given target at least cost?
    - Is the ETS designed efficiently?
    - Does it lead to innovation in the long run? (dynamic efficiency)
- **Equity aspects**: the extent to which any group is disadvantaged or favoured.
  - Burden sharing between generations
  - Burden sharing within generations

Relevant design elements

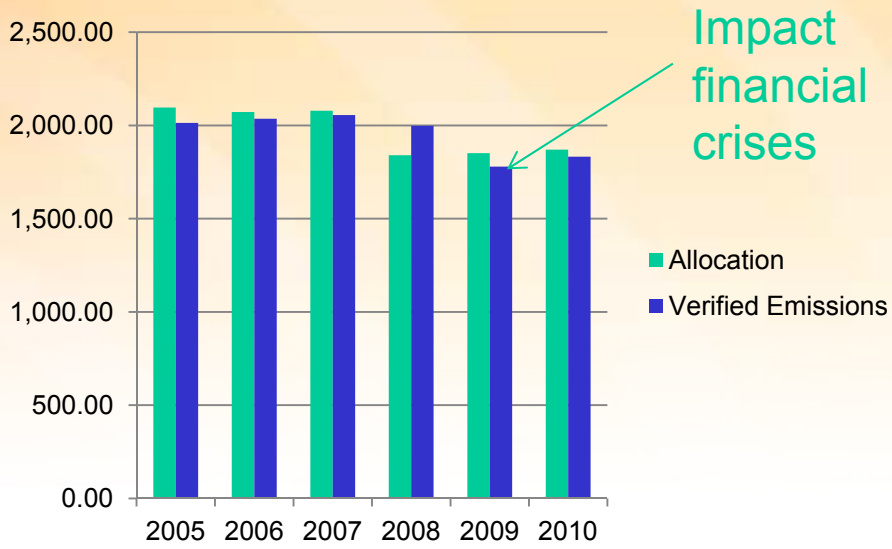
- **Environmental Effectiveness**
  - Target
  - Leakage
  - Offsets — Macro Perspective
  - Sanctions
  - Monitoring/Reporting/Verification — Micro Perspective
- **Efficiency**
  - Coverage — Macro Perspective
  - Target
  - Market (firm decisions) — Micro Perspective
- **Equity aspects**
  - Burden sharing between generations: Targets over time
  - Burden sharing within generations:
    - Country level (developed vs. developing countries): Targets and allocation method
    - Sectoral level (households vs. industry): Targets and allocation method

What are the targets?

Macro
- **Target**
- Leakage
- Offsets

Micro
- Sanctions
- M/R/V

EU25 in $MtCO_2e$ (CITL)



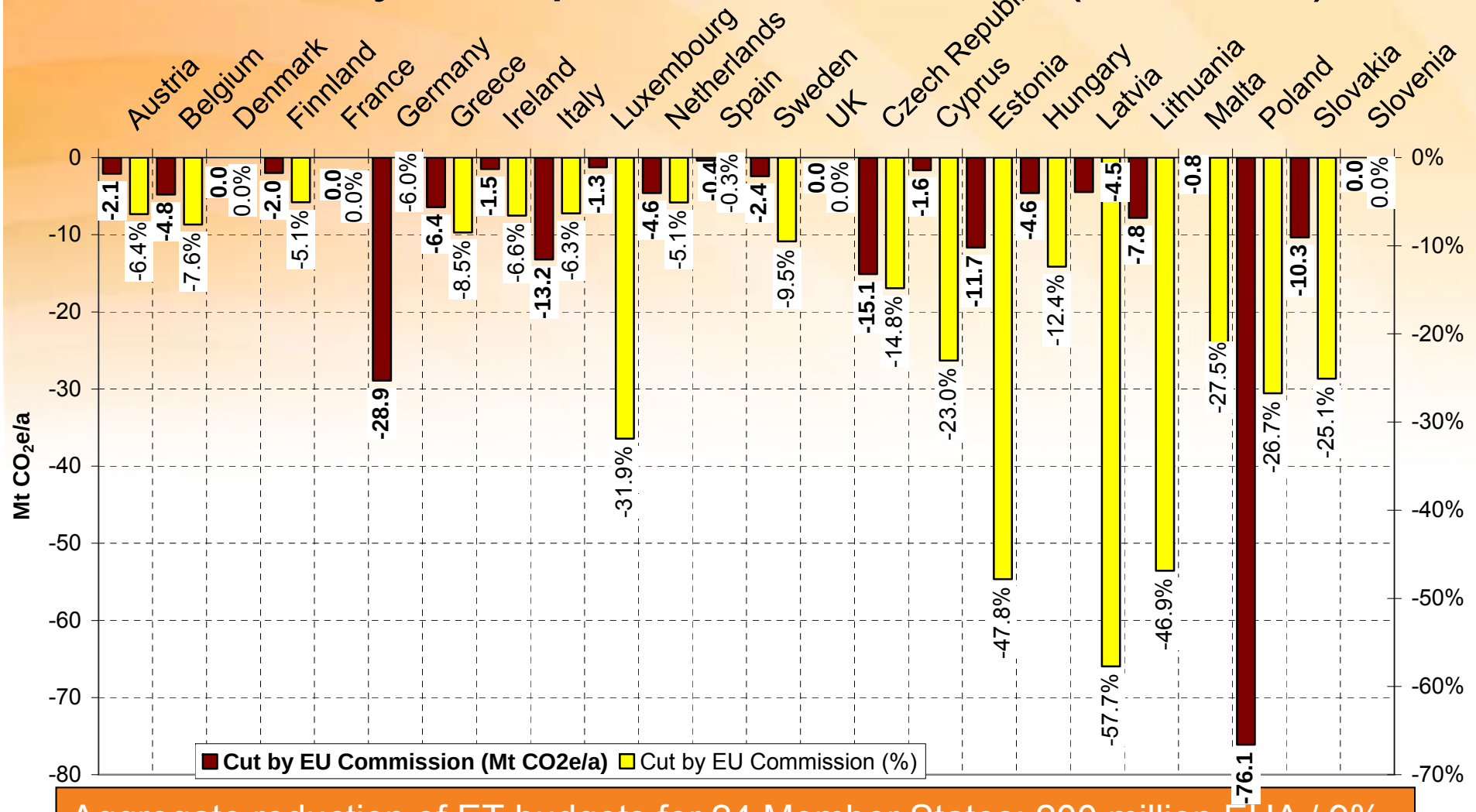
Phase I: EUAs allocation exceeded verified emissions by 141 Mio. tCO_2

Phase II: - Substantially improved by EC decisions (see next slide)
- 5.9% below 2005 verified emissions, 2008-2010 48 Mio tCO_2 below verified

Phase III Proposal: -21% compared to 2005 for ETS sector (11.3% below phase II allocation)

- The targets of the EU ETS are becoming more stringent over time, Commission has a crucial role in target setting

Decision by European Commission (Phase II)



Aggregate reduction of ET-budgets for 24 Member States: 200 million EUA / 9%

Source: NAPs and Commission decisions

Was the EU ETS achieving emissions reductions?

- To assess emissions reductions a counterfactual has to be calculated
- Different studies with different approaches
  - Ellerman et al (2010) use a simple approach based on GDP intensity and emissions 1990-2007:
    - Phase 1: -210 Mt CO_2 (EU-25)
  - Anderson and Di Maria (2011) include temperature changes ect.

    Net Abatement in Mt CO_2 for EU-25 (Verified emissions – BAU emissions): 2005=84; 2006=62; 2007=28; Total=174 (2.8%)
    Stringency of target: 27.9 Mt CO_2 (0.45%) (Allocation – BAU emissions)

- The EU ETS in Phase 1 did not lead to substantial emissions reductions
- In Phase 2 more substantial reductions are likely

Target setting: Lessons learnt

- High quality data is needed (same monitoring methods and externally verified) otherwise historical inflation of base year emissions has to be assumed
- Target setting based on projections is likely to be inflated
- Small reductions compared to inflated base year emissions are likely to lead to an excess allocation
- Crucial role of the European Commission to limit excess allocation

Cap fixes maximum abatement and no other policies for the same sectors can achieve further reductions!

Is leakage a problem?

Macro
- Target
- **Leakage**
- Offsets

Micro
- Sanctions
- M/R/V

- Definition (IPCC 2007): An emissions increase abroad caused by unilateral climate policy measures at home.
- But it is not only unilateral climate policy: it can be caused by differences in carbon prices.
- Different channels for leakage: Production channel, fossil fuel channel, (technology channel)
- Sectors at risk are those with high carbon costs (direct and indirect through electricity) and high exposure to international trade – this lowers the possibility to pass-through carbon costs e.g. Cement, Steel, and Paper
- Problem addressed through free allocation

- Early ex-post studies (Ellerman et al 2010) show that there **was no statistical evidence of a change in net imports** due to the introduction of a carbon price for cement, steel and refineries in the early years
- Caution: First phase poor indicator on what will happen in the future, as result can be due to generous allocation, no pricing in of opportunity costs

What are the effects of offsets?

Macro
- Target
- Leakage
- **Offsets**

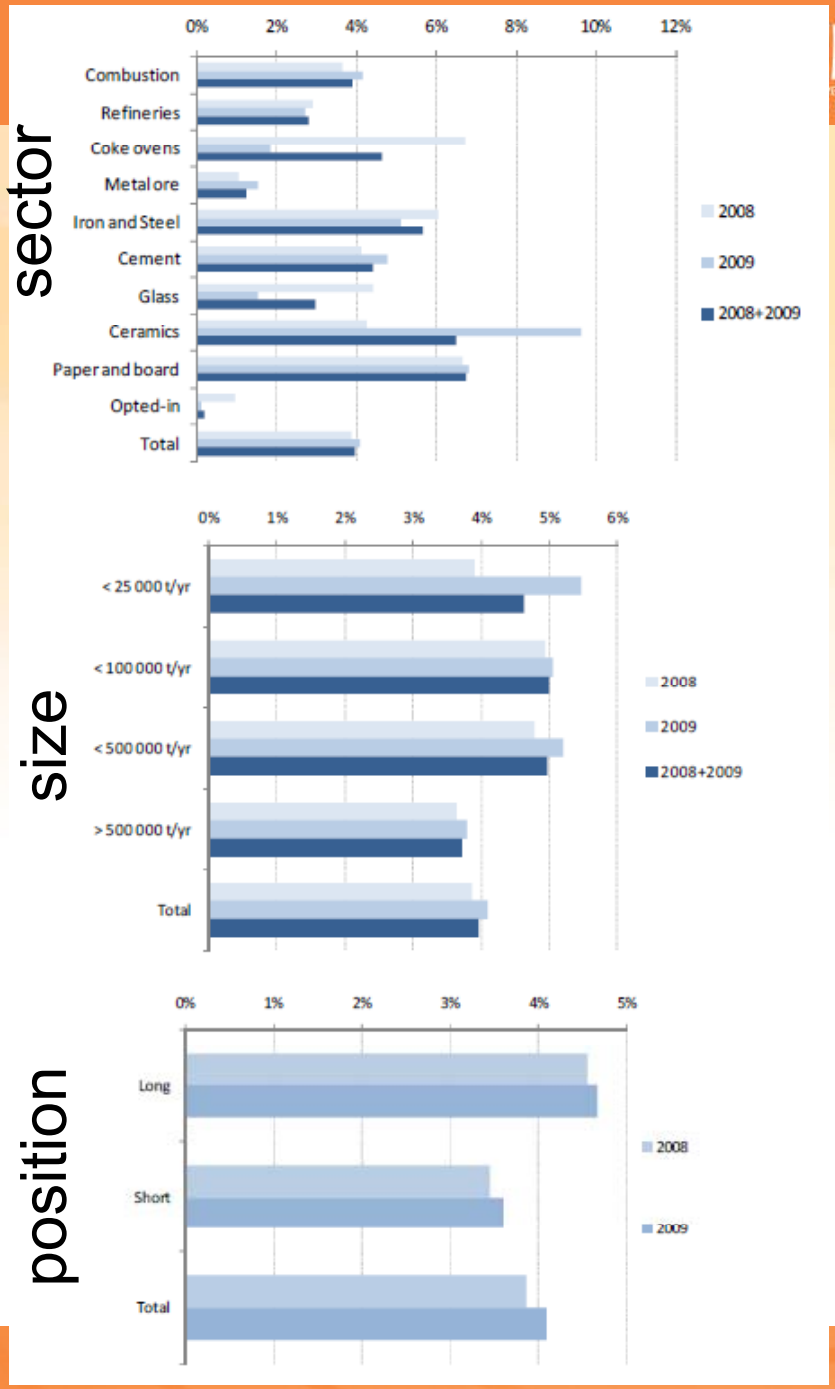
Micro
- Sanctions
- M/R/V

- Defintion: Offsets are emission reductions compared to a baseline that occur through projects outside the cap and trade system
- Can be used by ETS participants as a substitute for ETS allowances (abatement outside ETS)
- Offsets are, for example, the Certified Emissions Reductions (CER) of the Clean Development Mechanism (Kyoto Protocol Art. 12)
- Aim of offsets:
  - Enhance global efficiency (increases the range of abatement options)
  - Help developing countries to develop in a less carbon intensive way (technology transfer)
  - Lead to more stringent targets of developed countries in the long run
- Offets lead to cheaper emissions reductions within the system BUT not to direct additional reductions
- Risk that emissions reductions are ‚false' if projects are non-additional
- EU ETS: Use of offsets is limited at installation level (on average around 13% of allocation in Phase II; around 280 $MtCO_2$-e/a)

- What was the role of offsets?
- Studies question the additionality of around 40% of projects (Schneider 2007)

Role of Offsets

- Kyoto Mechanisms did not play major role in Phase 1 (mainly swaps between EUAs into CERs) and around 4% in Phase 2
- 2008-2009: 40% of offsets issued before May 2010 have been surrendered in the EU ETS
- The use of offsets is concentrated and not yet very intense or frequent
- 65% of CER surrendered in the EU ETS came from 10 large HFCs or N_2O projects



Source: Trotignon, R. 2011

Sanctions

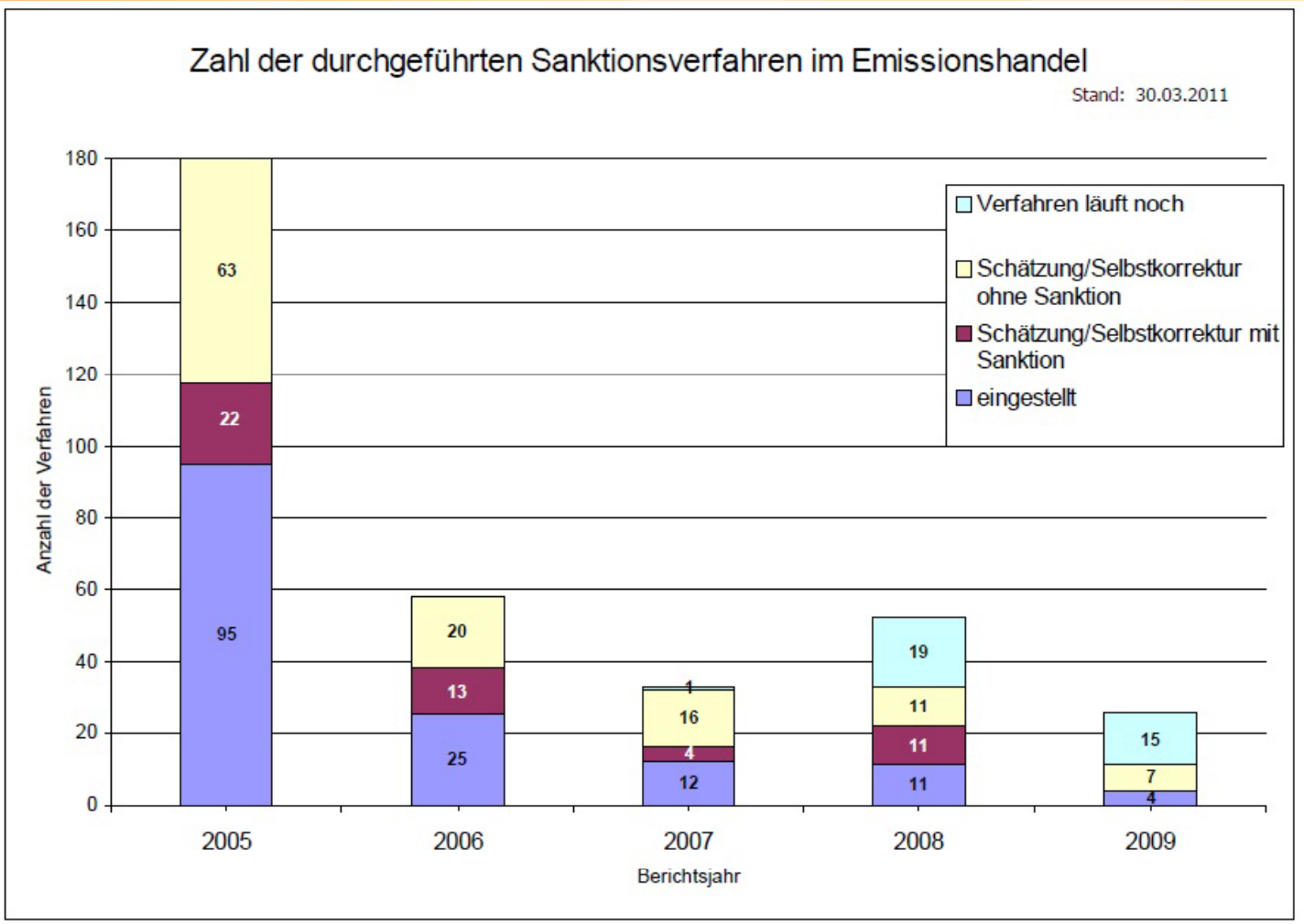
Macro
- Target
- Leakage
- Offsets

Micro
- **Sanctions**
- M/R/V

- Experiments show that there is a trade-off between effectiveness and efficiency (Restiani and Betz 2010)
- Higher sanction levels induce higher prices, investment and compliance
- EU ETS penalty is deterrent: combination of fixed penalty (100€ /EUA missing) and make good provision
- Level of compliance high

- Sanctions are high, compliance is high, and therefore target is achieved
- Deterrent sanctions may lead to overinvestment in the future, when targets become more stringent.
- Use of sanctions reduces over time due to firm getting familar with M/R/V rules

Development of Sanctions (Germany)



Source: German Emissions Trading Authority

Monitoring, Reporting, and Verification

Macro
- Target
- Leakage
- Offsets

Micro
- Sanctions
- **M/R/V**

- Theory and Experiments show that there is an incentive for strategic reporting: inflate emissions (allocation) or deflate emissions (surrendering)
- Monitoring, reporting, and verification is based on EU guidelines and national regulations
- For Phase III a MRV regulation is to be introduced in order to harmonise the process
- Calculation methods dominate and only few companies use continuous monitoring
- Consistency over time is important

- Monitoring, reporting, and verification is crucial but costly (fixed costs)
- Conflict of interest for verifiers, since they are paid by participants
- Reports are important information for market since they determine demand

Is the EU ETS efficient?

Macro
- **Coverage**
- **Target**

Micro
- Market

Coverage: What are the costs and benefits of covering companies in an ETS compared to an alternative policy?
- Efficient coverage depends on stringency of the cap, transaction costs (fixed/variable and depending on policy) and distribution of mitigation costs (Betz/Sanderson/Ancev/2010)
- Simulations show that, given the lax targets of the Phase 1 and 2 of EU ETS, the costs temporarily outweigh the benefits of covering small companies, as transaction costs are largely fixed costs

Target: Was the target set efficiently between covered and non-covered sectors?
- Phase I and II: Most countries did not take marginal abatement costs of covered and non-covered sectors into account in setting the target, as the analysis of National Allocation Plans showed (Betz/Rogge/Schleich 2006)
- Phase III: European Commission did take marginal abatement costs and other policies into account

Coverage: Emissions – Installation relation

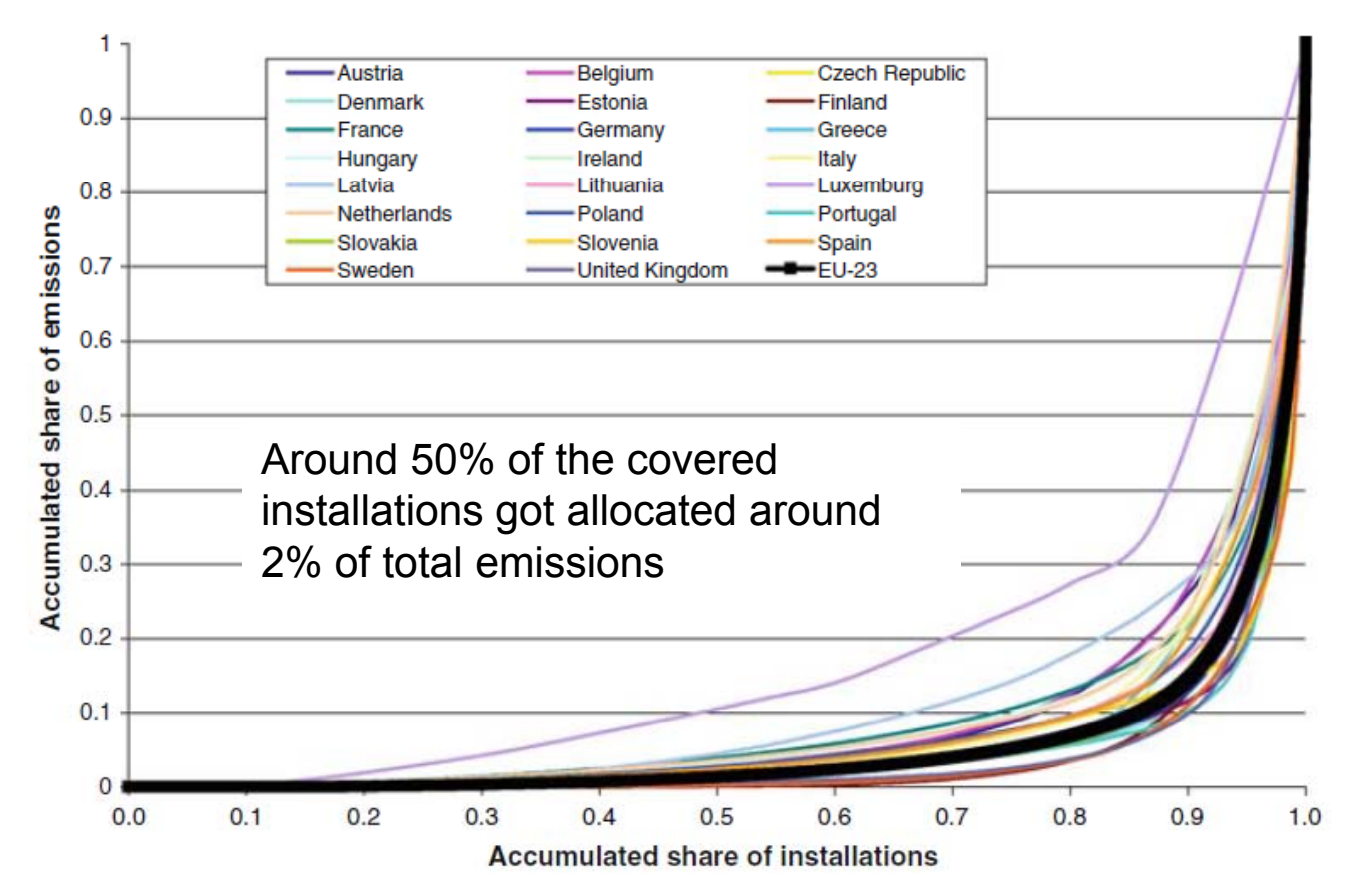
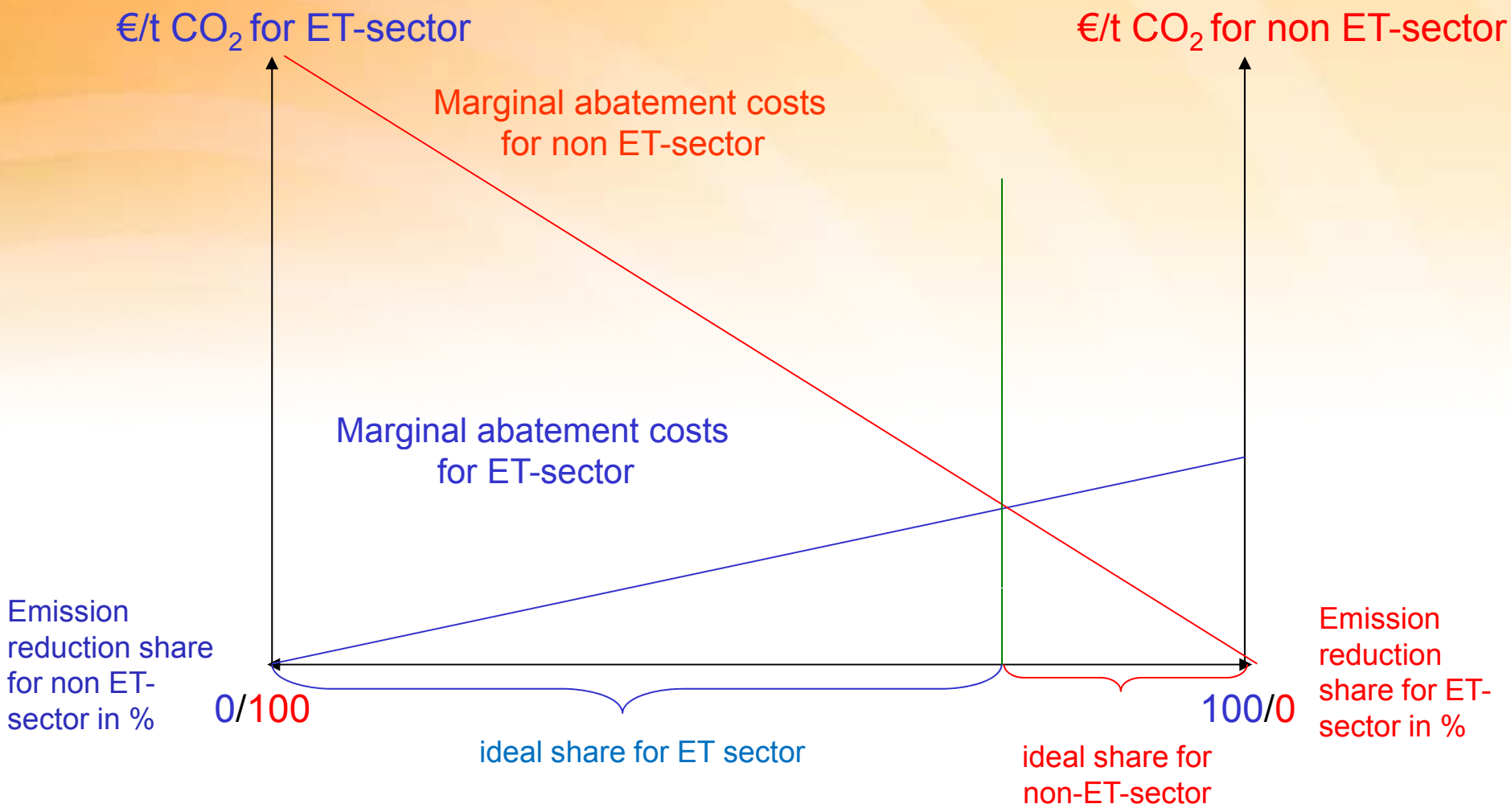


Fig. 1 Share of verified emissions 2005 compared to share of number of installations (Lorenz Curve).
Source: Community Independent Transaction Log (CITL) data

Target setting of ET and Non-ET sector

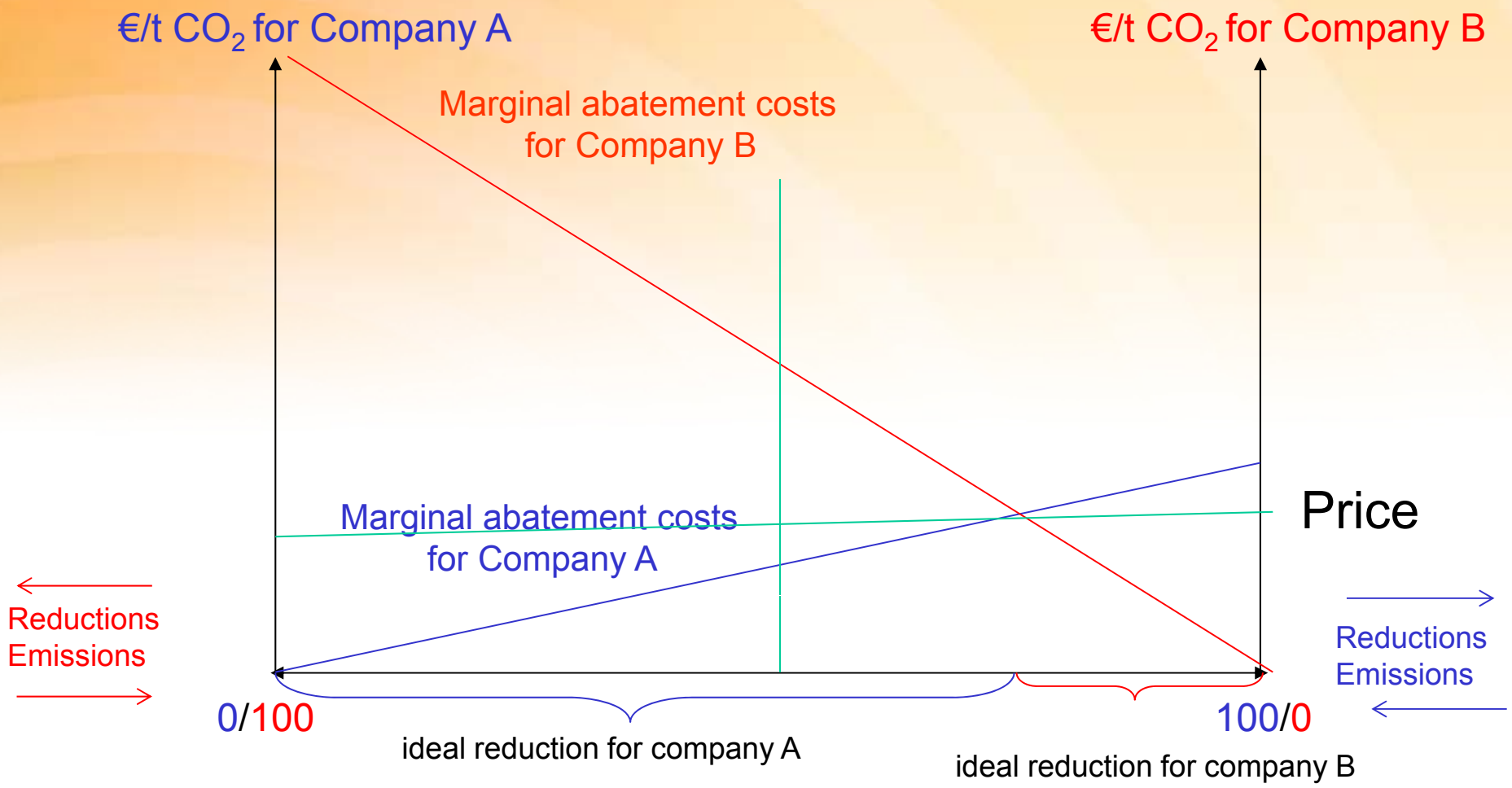


Market efficiency

- Market input related factors
  - Information on abatement options and costs (incl. offsets)
  - Transparency e.g. emissions, reserves
  - Market structure e.g. competitiveness
  - Transaction costs
  - Uncertainty
  - Rational participants (profit maximising, risk neutral)
  - Market oversight
- Output
  - EUA price and volume development
  - Market transactions
  - Production volume
  - Import/Export volume
  - Technology and fuel use
  - Investment and investment plans

- Theory: Under ideal conditions of market input related factors, allocation method only has financial effects, no operational effects (Coase)
- EU ETS (Betz, R.; Rogge, K.; Schleich, J. 2006) :
  - Phase 1: 99.7 % free allocation based on 27 different methods
  - Phase 2: Only around 3% of auctioning, rest free allocation

Theory: Efficiency of ETS based on trading



EU ETS market efficiency

Necessary market conditions	EU ETS
▪ Information on abatement options and costs (incl. offsets)	▪ 60% of companies do not know their abatement costs[1]
▪ Transparency e.g. emissions	▪ Emissions are revealed annualy
▪ Market structure	▪ 46% of emitters did not trade, mainly due to excess allocation. Under-allocated installations avoid trading on the market by internally transfering allowances without payment (61% of companies). Market power?
▪ Transaction costs	▪ Transaction costs are high, especially for small emitters, as they tend to be fixed costs
▪ Uncertainty	▪ UNFCCC process uncertainty affects trust in long-term future of EU ETS
▪ Rational participants	▪ Theory and Experiments: free allocation and uncertainty aversion reduces market efficiency[2]
▪ Market oversight	▪ Oversight is missing, as scandals of VAT carrousel and phishing show

1) KfW/ZEW 2011 2) Theory: Baldurson and von der Fehr 2004; Experiments: Goree et al. 2010; Betz and Gunnthorsdottir 2009

Allocation affects efficiency

- Free allocation to existing installations leads to strategic behaviour and provides rents to incumbents
  - historic vs. benchmarking affects efficiency
    - Updating of baseperiod: incentive of more emissions as strategic motivation for additional allocation in the future -> less abatement
    - Updating with benchmark: Strategic incentive only for higher production output
  - Fuel-specific vs. fuel-neutral benchmarking distorts reduction decisions
- Free allocation to new entrants coupled with withdrawal of allocation from ceasing installations gives an incentive to keep inefficient plants in operation.
- Allocation to new entrants based on benchmarks on capacity installed gives perverse incentive to build oversized boilers (Denmark has reduced allocation BAT/benchmark)

Auctioning will improve efficiency

Auction design matters (Betz, Seifert, Cramton, Kerr 2010)

Distortions of Allocation Methods

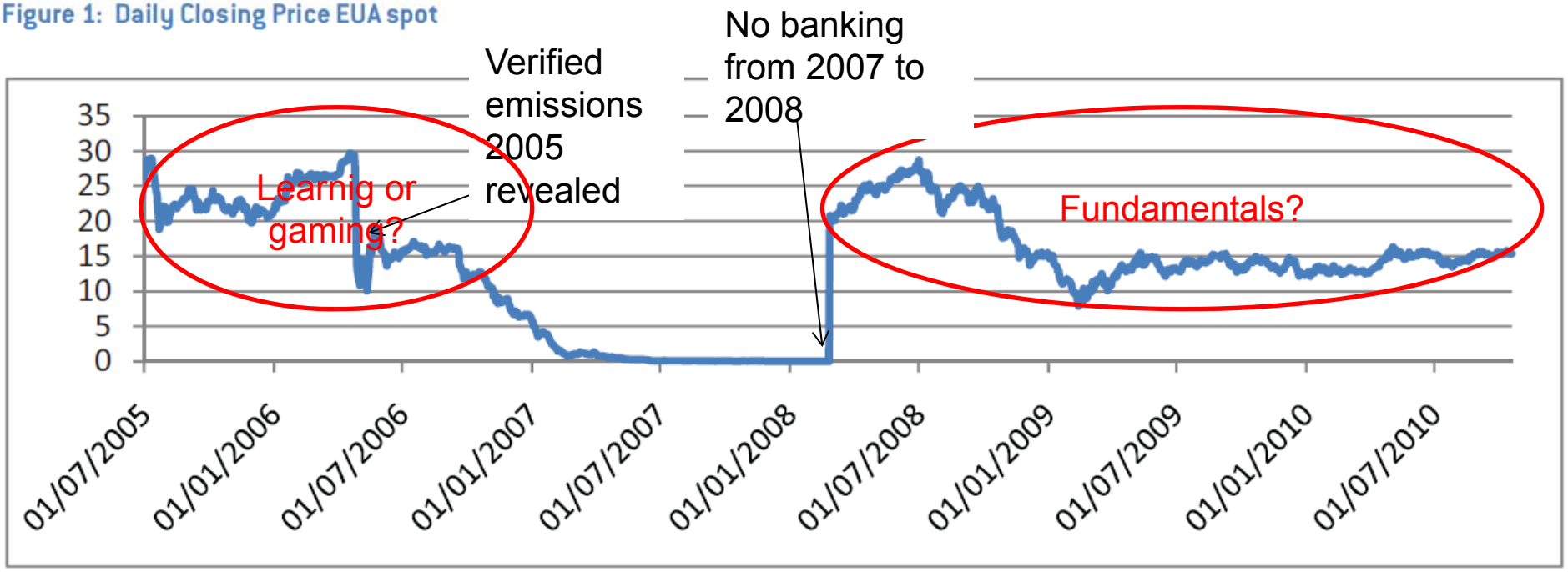
Allowance allocation method	*Impacts*	More expenditure on extending plant life relative to new build		Increase plant operation		Less energy efficiency investment
	Distortions	Discourage plant closure	Distortion biased towards higher emitting plants	Shields output (and consumption) from average carbon cost	Distortion biased towards higher emitting plants	Reduce incentives for energy efficiency investments
Auction						
Bench-marking	**capacity only**	X				
	capacity by fuel/ plant type*	X	X			
Updating from previous periods'	**output only**	Y		X		
	output by fuel/ plant type*	X	X	X	X	
	emissions	X	X	X	X	X

Note: X indicates a direct distortion arising from the allocation rule. Y indicates indirect distortions if allocation is not purely proportional to output/emissions.
* Differentiating by plant type adds additional distortions compared to purely fuel-based.

Source: Neuhoff et al. Climate Policy 2006

Price and Volume Development

Figure 1: Daily Closing Price EUA spot



- In theory: Prices should reflect scarcity of permits
- Efficiency should lead for a given target to a low permit price c.p.
- Price volatility may reflect uncertainty
- Phase II: Influence of fundamentals (fuel prices, temperature, availability of hydro power, stock market) but also influence of policy decisions

Source for price graph: Abrell et al. 2011

Dynamic efficiency/Innovation incentives

- Theory: Expected carbon price will give companies (emitters and technology companies) an incentive to invest in low emitting technologies (R&D as well as adaptation of technologies)
- EU ETS evaluation based on case studies (Rogge, Schneider, Hoffmann 2011), interviews (Rogge, Hoffmann 2010) shows:
  - EU ETS does not yet lead to significantly higher rate of investment and adaptation of low emitting technologies
    - Some influence on CCS investment
    - Technology specific policies and fuel price expectations more important
  - EU ETS has had an impact on organisational processes
    - Management is aware of carbon costs
    - Carbon costs are included in investment models
- Analysis on patent data (Dechezleprêtre and Calel 2011) indicates that there may have been positive effects in innovation, especially in France and Germany in 2005

Major barriers to innovation:

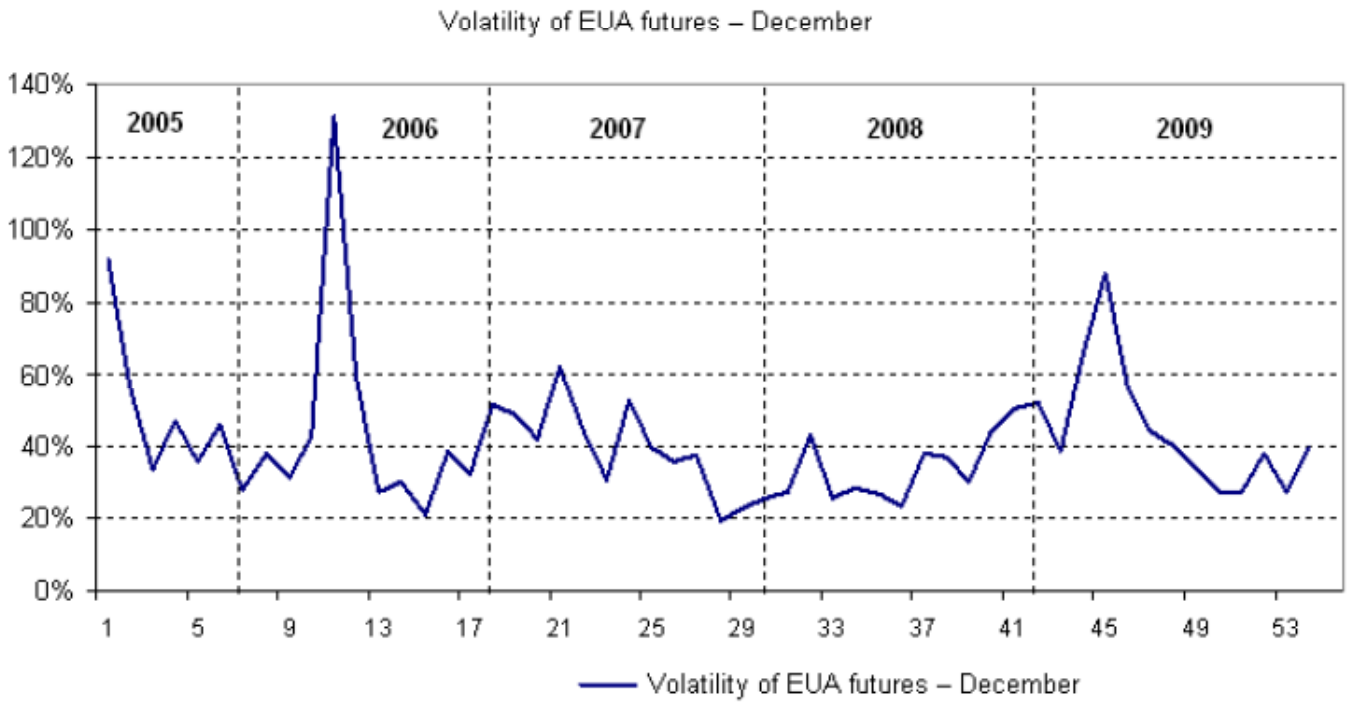
Allocation: excess permits and distortions due to free allocation methods

Long term expectations: uncertainty of future of ETS and cap, price volatility

Therefore investments are postponed due to option value for waiting for more information

EUA futures price volatility

Graph no. 1 – Price volatility observed for CO_2 allowances between 2005 and 2009



Source: *CDC Climat Recherche*

Source: Prada Report 2010

Is the EU ETS fair? (I)

Burden sharing **between generations: Targets**

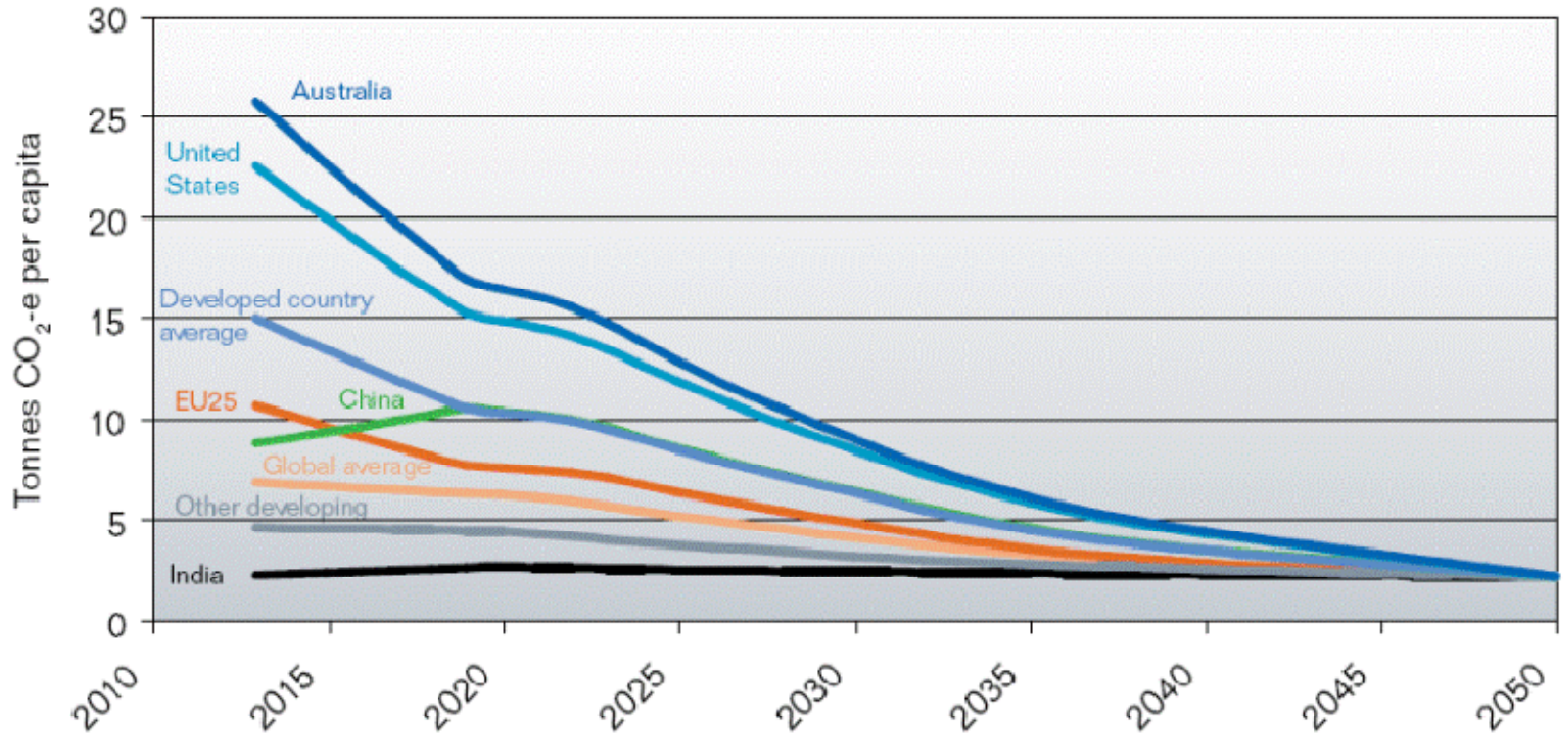
- Difficult to judge, depends on emissions path over time (see next slide)
- With regard to science, international targets need to be made more stringent
  (8-18 Gt CO_2-e is the gap of current pledges to 2°C target)

Burden sharing **within generations:**

- Burden sharing **between nations: Targets and revenue recycling**
  - Kyoto and EU ETS do grandfather emission permits to countries
  - Phase I and II EU ETS: No financial transfer to developing countries
  - Phase III:
    - Voluntary declaration to use part of auction revenue for mitigation and adaptation in developing countries (e.g. Measures to Avoid Deforestation) Now mainly left to Member States.
    - Member States have to make some transfer to Eastern European Countries out of solidarity

Garnaut: Global agreement scenario

Figure 9.5 Per capita emissions entitlements for the 450 scenario, 2012–2050

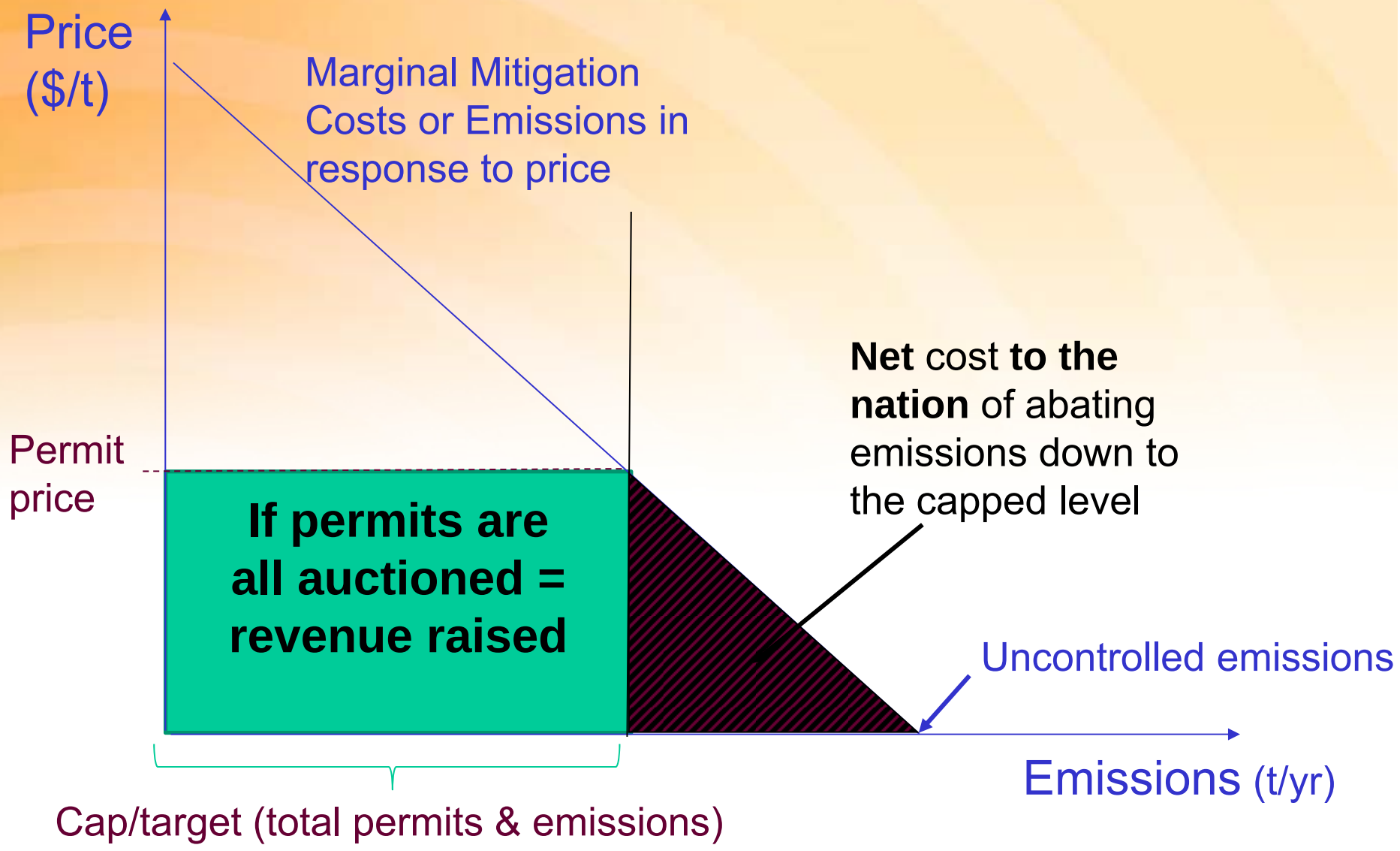


Note: The graph starts in 2012. Australia's 2012 starting value assumes Kyoto compliance, as do those for the EU25. Other countries start at their emissions level given by the reference case (the no-mitigation scenario) in 2012.

Source: Garnaut 2008

Is the EU ETS fair? (II)

- Burden sharing **within generation: Allocation method**
  - Recall: Under ideal conditions, companies receiving free allocation will take the opportunity costs of allowances into account when making production and investment decisions and thus the final allocation of allowances is independent of the primary allocation and method.
  - Companies pass through the carbon opportunity costs to their customers and thus receive rents. The pass-through is necessary to achieve an efficient allocation of reductions (substitution effects etc.)
  - Who wins?
    - "Windfall profits" for those companies who receive free allocation and can pass-through the costs: Phase I electricity sector: €13 bn/a (Keppler and Cruciani 2010)
    - High income households profit more from increase in share values of those companies with windfall profits
  - Who loses?
    - Low income households will suffer higher impact compared to high income households (regressive impact)
  - What are the solutions to have less regressive effects in the long run?
    - Auctioning and using the revenue to compensate low income households


Price ($/t)
Marginal Mitigation Costs or Emissions in response to price
Permit price
If permits are all auctioned = revenue raised
Net cost to the nation of abating emissions down to the capped level
Uncontrolled emissions
Emissions (t/yr)
Cap/target (total permits & emissions)

Excess allocation by sector

(% of ???)

Figure 5: Excess allocation by sector

Source: Abrell et al. 2011

Auction revenue recyling options

Options

- **Compensation to consumers** (but not in a way that negates carbon-saving behaviour caused by carbon price)
- **Compensation to companies** (e.g. workers made unemployed (but not in a way that negates the carbon price signal to lose that job))
- **Support low-carbon technology** and **energy efficiency** to overcome well-known market failures for innovation and for information (but what are the best support mechanisms?)
- **Reduce existing taxes** like income tax, which cause deadweight losses throughout economy

EU ETS 50% of revenue *should* be spent

- Demonstration projects for mitigation and adaptation;
- Renewable energies and energy efficiency technologies;
- REDD, technology transfer and adaptation in developing countries;
- EU forestry sequestration;
- Carbon capture and storage;
- Public transportation;
- R&D in energy efficiency and clean technologies;
- Energy efficiency measures or financial support in lower & middle income households;
- Administrative expenses.

Estimation of regressive impact of EU ETS Phase 3 in Germany

Table 8.1: Initial Burden of the EU ETS

	Annual mean values (2003€)			EU ETS burden relative to household income		
Net equiv. income decile	Average Income	Direct electricity expenditure	Indirect electricity expenditure	direct	indirect	total
1st	9,134	519	493	0.059	0.054	0.113
2nd	13,858	539	748	0.039	0.054	0.093
3rd	16,993	579	918	0.035	0.054	0.089
4th	20,540	601	1,109	0.029	0.054	0.083
5th	22,939	614	1,239	0.027	0.054	0.081
6th	25,412	633	1,372	0.025	0.054	0.079
7th	28,607	612	1,545	0.022	0.054	0.076
8th	31,742	645	1,714	0.021	0.054	0.075
9th	38,314	662	2,069	0.017	0.054	0.071
10th	59,681	769	3,222	0.014	0.054	0.068
Mean	26,627	618	1,443*	0.029	0.054	0.083

Square root of number of persons in household used as equivalence weight.
Households weighted by sampling weights as given in the SOEP.
*Indirect electricity expenditure estimated to be 7/3 of direct electricity expenditure.

Source: Johanna Cludius 2011, Diplomarbeit (unpublished work)

General conclusions

- A flexible process to improve the design over time seems crucial to achieve an effective, efficient and fair ETS... Lobbying is compromising early design
- Design matters... the instrument may not work in practice as claimed in the textbook
- Effectiveness: Commission played a crucial role in target setting
- Efficiency:
  - Static: Risk if rules get too complicated and complex some companies will not participate in trading
  - Dynamic incentives: Too early to judge but we may need complementary policies to enhance R&D and diffusion e.g. Sweden introduced a carbon tax that can be avoided when undertaking an energy efficiency audit.
- Equity matters: if allocation unfair, may give emission trading bad name → harms future use of market mechanisms (instrument hopping)
- What did we want in the outset: a price or a quanitity instrument? ETS was setting a price but not reflecting the quantity restrictions of Phase 1

Specific design recommendations

- Target
  - Data and M/R/V rules have to be inplace in order to dermine target
  - Brave politicians or specific institutional set-ups are necessary to set ambigous targets, as no other policy can go beyond the target. Some positive feed-back mechanism of the price.
- Coverage
  - Upstream coverage for small emitters may be more efficient. Opt-out in Phase III
- Allocation
  - There has not been any free allocation formula that did not lead to distortions
  - Auctioning is becoming the dominant form, and auction revenue will have important role to play in terms of fairness
- Sanctions
  - Non-complinance is related to M/R/V quality, which improved over time
- Offsets
  - Additionality is crucial and offsetting is no long-term solution. International offset may play a role in achieving a common price over different, not directly linked systems
- Market
  - More transparency and disclosure of information necessary: e.g. Moving from calculation to measurement
  - Oversight is necessary to have long term trust in the market

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