REPORT

Sectoral agreements and competitive distortions

– a Swedish perspective

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Foreword

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1 Summary

The objectives of this study are to:

1. Give an overview of the current discussion concerning competition distortion in relation to climate policy,
2. Describe results from some studies estimating the actual competition situation for selected activities,
3. Describe what sector agreement models are suggested/ discussed by EU,
4. Describe what sectors are most interesting to target with a sector agreement from a Swedish point of view,
5. Analyse what parameters are important for reducing competition distortion for Swedish Industry.

Two studies, for the United Kingdom (Hourcade et al 2008) and Germany (Graichen et al 2008), have recently assessed the potential cost impact for different industrial sectors of CO_2-prices due to the EU ETS. *Maximum value at stake*[1] was used as metrics. The sectors with high potential impact, with a *maximum value at stake* larger than 10%, are in the United Kingdom Lime and cement, Basic iron and steel, Starches, Refined petroleum, Fertilizers and Nitrogen compounds and Aluminium. In Germany, the sectors with a *maximum value at stake* larger than 10% are: Cement and lime, Fertilizers and nitrogen compounds, Basic iron and steel, Aluminium, Paper and board, Other basic inorganic compounds and Coke, refined petroleum and nuclear fuels. Ex-ante studies of the impacts of competitiveness and carbon leakage due to the EU ETS fail to find actual impacts. However, that does not mean that there will be no impact in the future, which hold changes both in the EU ETS (method for allowance allocation, allowance prices etc) and possibly also other important circumstances (global demand for certain products and global product prices).

In this study, based on official Swedish statistics, the *maximum value a stake* has been calculated for 52 Swedish sectors**.** Seven sectors have a *maximum value a stake* of more than 4%: Coke and refined petroleum (21%), Pulp and paper (11%), Basic metals (10%), Non-metallic mineral (9%), Metal ore mines (6%), Air transport (5%) and Electricity, gas and heat (4%). If Air transport and Electricity, gas and heat are omitted, the five remaining sectors account for 22% of Sweden's carbon emissions. In the Swedish *Non-metallic mineral* sector (including Cement and lime) the *maximum value at stake* is considerably lower than for Cement and lime in the UK and Germany. This is most likely due differences in system boundaries. In the Swedish statistics, the Cement and lime industry is a minor part (in terms of value added) of the *Non-metallic mineral* sector, a sector that also includes Stone, sand and soil industry. The calculated *maximum value at stake* for *Non-metallic mineral* is therefore a poor proxy for the Cement and lime sector since other sub sectors may "dilute" the *maximum value at stake*. Differences in system boundaries may also explain the significant difference in *maximum value at stake* between the Swedish steel industry and UK and German steel industries. Other possible explanations may be a higher value added per unit, differences in how value added is calculated, different years applied for the analysis and lower CO_2-intensity for Swedish products.

[1] The *Maximum value at stake* for a company is the cost increase due to an introduced carbon price divided by the value added. The cost increase includes both direct costs and indirect costs such as cost increases due to increased electricity prices. See also section 3.1.3 for the full definition of maximum value at stake.

In late 2008, the EU proposed three types of sector approaches to be discussed under *the Ad-hoc Working Group on future commitments for Annex I Parties under the Kyoto Protocol* (AWG-KP):

i) *Sector CDM* – a CDM crediting mechanism with a previously established baseline
ii) *Sectoral no-lose mechanism* - Sectoral crediting against a previously established no-lose target
iii) *Sectoral emission trading* based on a sector emissions cap

Based on these three sectoral models, we have analysed what parameters are important for reducing competition distortion for Swedish industry. We have assumed that these sector agreements are implemented in a developing country (DC). We conclude that if sector agreements are to reduce distortions on competition, it is important that the sector agreements create a **real carbon price** in the DC, i.e. that emissions of carbon dioxide are associated with a cost for the emitter. All three sector agreement-models suggested by the EU can potentially create a carbon price. The driver for emission reductions are in all three cases the international demand for offsets.

As a potentially large buyer of off-sets, the EU demand for off-sets is likely to increase the carbon price in the DC sector. The choice of EU policy with respect to imports of off-set will therefore have great importance. Other buyers, such as other countries, emission trading systems or the voluntary credit market will of course also be important. Moreover, imports of off-sets may reduce the price on EU ETS allowances, thus further narrowing the carbon price gap between the two markets.

If an important objective of a sectoral agreement is to reduce competition distortion it should be implemented in sectors where the corresponding Swedish industry has significant carbon related costs and where there is significant trade intensity between Sweden and regions outside the EU. Our preliminary analysis indicates that Swedish sectors with potentially high *maximum value at stake* (direct carbon and indirect electricity cost) are Refineries; Pulp and Paper; Iron and Steel; Cement and Lime; and Metal ore mining. The sectors Aluminium and Fertilizers may be important, but have not been assessed explicitly in this study. In addition, electricity production can be important to include in a sectoral agreement since the electricity price may be a significant cost for certain sectors exposed to international competition.

Pass-through of costs – consumer incentives. If a sectoral agreement is to reduce competition distortion it is important that the sector participating in the sectoral agreement can pass through the additional carbon costs on the commodity so the carbon intensive products become more expensive for the consumer. A full pass through of the carbon cost could be compromised in countries with centrally regulated prices on carbon intensive commodities or other measures that shield the true price of carbon from the consumer.

Target setting – producer incentives. The rules for setting the targets in the DC sector are crucial from a producer incentive point of view. There are two main options here: 1) **absolute targets** and 2) **intensity targets**. Absolute targets create high incentives for carbon reductions as long as the targets are not re-negotiated. The disadvantage is that they might be difficult to negotiate due to difficulties in finding an appropriate emission level, risk for hot air and the inflexibility to future adjustments. Intensity targets are based on *output* times an *intensity factor* (called *benchmarking*). But benchmarking leads to reduced incentives: i) as a production subsidy it encourages overproduction and ii) dis-incentivises the substitution to carbon efficient products. A third, theoretical, option would be absolute targets that are updated according to historic emissions. This model would, however, seriously undermine the incentives for emission reductions.

In this study, we have argued that from a competition point of view, it's important to create a **carbon price** in the developing country. A different issue relates to how different sector agreement models influence the **compliance costs** of participating firms. We describe a situation where a DC industry sector is linked to the EU ETS, and where the EU industry pays for allowances (no free allocation). For a *Sector emission trading system* where the DC industry has to pay for allowances, the compliance costs could be compatible in the two regions. For *Sector CDM* and *Sector no-lose mechanism*, if the government implements a domestic carbon tax, the compliance costs may also be compatible in the two regions. However, if allowances are allocated freely to the DC industry and no tax is implemented, the DC industry would have no costs associated with the carbon emissions below the compliance level. There could here be a significant difference in compliance costs between the industries in the two regions. We have, however, not analysed if significant asymmetries in compliance costs can lead to competitive distortions between regions.

Contents

2 Introduction

2.1 Background

Within the UN Framework Convention on Climate Change the parties have agreed on cooperating in reducing greenhouse gas emissions in order to avoid the build-up of dangerous concentrations in the atmosphere. The parties have committed to participate with efforts following their ”Common But Differentiated Responsibilities and Respective Capabilities”.

Under the current climate policy regime, there are discussions whether the Kyoto protocol distorts the competition for industries. When the EU now proposes stricter emission reduction commitments (20% to the year 2020 or 30% if an international agreement is reached) there are fears that the competitive situation between the EU and the rest of the world will become further distorted. To reduce this risk, a possible solution is to introduce so called *Sectoral agreements* for developing countries (DC). This means that one or several developing countries take on commitments for one or several sectors, which potentially can reduce the competitive distortion between the DC and Sweden/EU. Such sectoral agreements may also allow developing countries to reduce emissions below a reference level (compliance level), which can render emission reduction credits (off-sets) that can be sold on the international market.

2.2 Objectives

The objectives of the study are to:

1. Give an overview of the current discussion concerning competition distortion in relation to climate policy (chapter 3).
2. Describe results from some studies estimating the actual competition situation for selected activities (chapter 3)

In addition, the study shall analyse some potential sector agreement models with the objective to provide guidance to the negotiations towards a Copenhagen agreement. The analysis shall address:

3. What models are suggested/ discussed by EU? (chapter 5)
4. What sectors are most interesting to target with a sectoral agreement from a Swedish point of view? (chapter 4)
5. What parameters are important for reducing competition distortion for Swedish industry? (chapter 6)

3 Competition and carbon leakage – a literature review

Greenhouse gas emissions need to be further reduced, which means that emission caps will have to be tightened. It is not likely that there will be a single global carbon price in the near future. Due to this and other reasons there is an increasing concern that countries with stringent climate policies will place domestic industries at disadvantage compared to competitors in countries with less ambitious climate policies. Concerns of the loss of industrial competitiveness and leakage of emissions is one of the major barriers to introduce more far reaching CO_2 mitigation obligations on industrial sectors in the EU (Hourcade et al. 2008).

The implementation of non-global climate policies, such as the Kyoto Protocol and domestic and regional emissions trading schemes that cap emissions for sectors that compete internationally creates a distortion in competition between companies (Reinaud 2008). When these distortions become significant, competitiveness concerns arise. Significant distortion of competition could be the case for some of the capped sectors or sub-sectors but not for all.

This chapter is based on a literature review of studies concerning the impact of climate policies on the competitiveness of sectors. It includes a description of parameters that determine the level of impact on competitiveness and which sectors that potentially are at risk and what the actual impact of some climate policies have been.

3.1 How will asymmetric carbon prices impact competitiveness?

3.1.1 Definition of competitiveness

Competitiveness is a loosely defined concept which is considered to be meaningless at the macroeconomic level and only applicable at a micro-economic level such as for instance sector level. According to Baron et al (2008) the OECD defines competitiveness by; "*the ability to produce high-quality, differentiated, products at lowest possible cost, to sustain market shares and profitability*". An additional definition of competitiveness given in Baron et al 2008 is that it is *a firms ability to sell (maintain or increase volumes) and its ability to earn (profits).*

3.1.2 Impact of asymmetric carbon prices on competitiveness

An asymmetric carbon price (such as EUA prices in the EU ETS) could lead to distortions in competitiveness for sectors covered compared to competing industries not covered. Production in sectors which export to, or import from regions which have not implemented a comparable climate policy may be at disadvantage depending on the following factors (Graichen et al 2008):

- the carbon intensity of the production process
- the carbon price (e.g. price for emission allowances)
- the significance of the additional carbon costs in relation to other production costs
- the extent to which these additional costs may be passed-through

The EU ETS has been blamed for increasing the production costs of European producers compared to their competitors and thereby:

- inducing carbon leakage, i.e. increasing emissions in countries/sectors not covered by the ETS
- destroying jobs in industries exposed to international competition and either directly (cement, iron & steel) covered or indirectly (aluminium) impacted by the ETS
- reducing profits in the above-mentioned industries.

The propositions given above can be true for some sectors but facts describing the actual situation for each sector will have to be used for verification. There is a common understanding that most sectors covered by the EU ETS have a theoretical possibility to make short term profits from the current structure of the scheme. Possibilities for profits occur in cases where the allowances are allocated for free and the industries are able pass through opportunity costs of CO_2 to product prices.

If the introduction of a carbon price results in a significant increase in costs for a sector in a region, the sector can be facing two different situations:

1. If there is no, or very small signs of international (or interregional) competition the costs of the carbon price can be passed-through to product prices (at least in an initial phase). In this way the profit margins for the sector/industries will remain.
2. If on the other hand, there is significant international competition, and thereby carbon costs are not passed through to product prices, the profit margins of the sector will be eroded.

As a consequence Neuhoff (2008) identifies four different types of company decisions that could be impacted by an asymmetric carbon price:

- new investments (risk for shift from location in carbon priced region to unpriced region)
- reinvestment (risk for non-pursued reinvestment)
- reduced production with potential closure
- closure of plant

3.1.3 How can the distortions of competitiveness be measured?

There are studies focused on describing how asymmetric CO_2-prices will impact specific (exposed) sectors, which try to find metrics in order to identify and measure the impact (Hourcade et al 2008, Reinaud 2008). Two parameters are important when determining the potential and actual distortions of competitiveness. The first parameter is the value at stake, which is used by Hourcade et al (2008) and Graichen et al (2008), defined by the equation given below

$$Value\ at\ stake = \frac{(Cost\ increase\ due\ to\ carbon\ price)}{Value\ added}$$

The value added is the explained by the figure below and is the incomes of the company minus operational costs and raw material input costs.

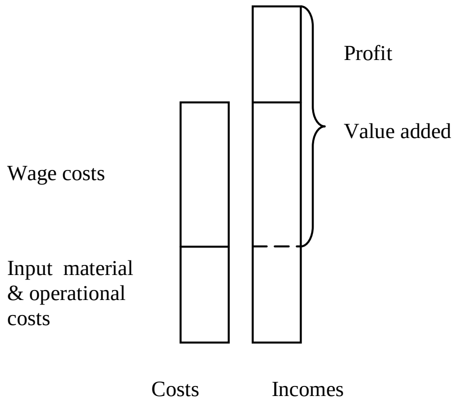


Figure 1 Value added of a firm.

A distinction is made between;

- maximum value at stake, MVAS, where the cost increase include both direct and indirect cost increases, i.e. both due to own cost increases and to increased costs of electricity due to pass-through of carbon costs in the electric power sector and
- net value at stake, NVAS, which only includes the direct cost increases due to the carbon price (not indirect costs due to changes in electricity prices)

The second parameter of importance is trade intensity. Hourcade et al (2008) claim that the biggest single constraint on the ability to pass on CO_2-related costs to customers is competition from regions outside the EU ETS. The non-EU trade intensity for a sector in a country is defined by the following equation (Hourcade et al 2008, Graichen et al 2008, European Parliament 2008):

$$Non-EU\ trade\ intensity = \frac{Value\ of\ exports\ to\ non\text{-}EU + value\ of\ imports\ from\ non\text{-}EU}{Annual\ turnover\ of\ sector + value\ of\ total\ imports_{From\ EU\ and\ non\ EU}}$$ [2]

The nominator represents the value of the non-EU trade, i.e. the export to non-EU countries and the imports from non-EU countries whereas the denominator represents the total market supply of the sector, including imports from other EU countries and from non-EU countries. The annual turnover includes the production of the sector considered (hence imports from other EU countries are not directly included here but are added by the second term in the denominator)

Actual impact of carbon prices can then be indicated by (based on Hourcade et al 2008):

- Changes in trade patterns due to CO_2-prices
- Increase in trade intensity due to changes in technology and industry structure
- Simulated mid-term equilibrium trade-flows resulting from asymmetric CO_2-prices, based on economic estimates of trade-elasticities and ranges of CO_2-price pass-through.
- Estimates of how investment and closure decisions (which are likely to be a major determinant for future trade flows) will respond to CO_2-price signals

In section 3.4.2, the results of two studies including an assessment of all sectors within a country (United Kingdom by Hourcade et al 2008 and Germany by Graichen et al 2008) are presented. The

[2] The annual turnover of a company or sector is the annual amount of money earned by business through sales of goods and services.

aim of the two studies was to identify which sectors that face high CO_2-cost impacts due to direct and indirect emissions.

3.2 Carbon leakage

3.2.1 Definition of carbon leakage

According to Reinaud (2008) carbon leakage is the movement of production away from areas where carbon constraints exist to areas where they do not. Going through literature we find distinctions between different types of carbon leakage. Based on the distinctions made by Makipaa et al (2008) and Reinaud (2008) we divide the carbon leakage into two types, where the first one, competitiveness-driven, can be divided into three sub-categories:

- **Industry specific leakage**: This means that industry is moving activities from capped areas to areas without or with less stringent carbon policies, which leaves space for increases in the original area.
    - In the short term the industry specific leakage means that carbon –constrained products lose market shares internationally to the benefit of unconstrained competitors
    - In a longer term the industry specific leakage means that investments in new production are relocated to countries with less stringent climate policies due to the differences in returns on capital.
    - Low-carbon technologies developed under stringent climate policy can be applied also in other regions and reduce the emissions in these regions (hence this type would constitute a negative carbon leakage).
- **Fossil fuel channel of leakage**: Stringent climate policies reduce the relative world-price of fossil fuels which in turn increases their use in the rest of the world.

The carbon leakage can be defined by a ratio (and thereby be expressed as a percentage):

$$Carbon\,leakage = \frac{emission\ increase\,in\,sector\,outside\,emission\,capped\ region}{emission\,reductions\ in\,sector\,in\,capped\ region}$$

Both the increase of emissions and the emissions reductions should be the result of the climate policy.

3.2.2 How can carbon leakage be monitored and measured?

In the short term an indicator of carbon leakage is the change in international trade flows of products impacted by carbon constraints. Example of such products could be either carbon intensive or electricity intensive, which either are impacted directly by the carbon constraints or indirectly by higher electricity prices. Impact on the trade flows of indirectly impacted products might need more time to be fully developed.

Reinaud (2008) suggests that sectoral carbon leakage can be monitored by the pass-through of climate policy induced cost. The reasons for a sector not being able to pass through 100% of carbon costs can be many (see section 3.1). Neuhoff (2008) argues that leakage concerns only occur where industry faces the full carbon price, e.g. from a carbon tax or auctioning of allowances.

3.3 Distortion of competition due to climate policy – the discussion today

Fears for negative effects of future climate regimes include the fear for carbon leakage and job leakage. However, losses of competitiveness and carbon leakage due to uneven climate policies are risks restricted to a group of industry sectors and sub-sectors and not all trade-exposed emission intensive sectors. As described in section 3.5 there are different possibilities on how to solve problems of reduced competitiveness for industry facing regional carbon costs and carbon leakage. One solution discussed is sectoral approaches. A more thorough description and analysis of different proposed sectoral approaches is given in chapter 5 and 6. Some have even suggested that sectoral approaches could replace the Kyoto system for Annex I countries after 2012. However, according to Höhne & Ellerman (2008) the chair of the AWG-KP[3] summarized the section in Bonn by saying that sectoral approaches "*should not replace nationwide targets but should instead complement them*". Neuhoff (2008) state that sectoral approaches should not be seen as a means to reduce carbon leakage but rather as an instrument for facilitating public and private initiatives to contribute to best practice sharing and accelerate international cooperation towards a global deal.

In the following section we present an overview of the discussions on distortions in competition based on literature review. Today a number of reports have been written on the competitive impact of the unilateral carbon price for the European industry realized by the EU ETS. The fears for distortion in competition between industry in countries with binding targets for emission reductions (developed countries or Annex I countries) compared to industry in countries without binding targets (non-Annex I countries), realized by international agreements are principally the same as the fears displayed by and for the European industry.

3.3.1 Discussions in the international community

The Intergovernmental Panel on Climate Change
Already in its 2nd assessment report the IPCC writes about leakage concerns. In the 3rd assessment report it is written that increasing prices can lead to changes in trade and relocation of industry to non-Annex I countries corresponding to a leakage of 5-20%. The IPCC also states that exemptions for certain sectors (energy intensive industry) probably reduce the size of leakage but raise aggregated costs for the system. In addition the IPCC points out that the transfer of new, low-carbon technologies and know-how may lead to lower leakage and in the long run even offset the leakage. In the 4th (latest) assessment report, the IPCC writes that a crucial assumption for estimating the amount of carbon leakage is the substitutability between imports and domestic production[4], being smaller if not perfect substitutability is assumed as is the case in many studies. In addition it is proven by studies that the development of new technologies in carbon constrained regions and technology diffusion from such regions increases global emission reductions.

The EU (on the international arena)
In the EU input to the AWG-KP[3] submitted in November 2008, sectoral agreements are discussed both as a means to improve the current flexible mechanisms and to increase participation in the mechanisms. The EU also talks about cost-effectiveness and environmental integrity, which to some part can include the reduction of carbon leakage and hence distortion of competitiveness.

[3] Ad-hoc Working Group on further commitments for Annex I Parties under the Kyoto Protocol
[4] If the assumption is that the substitutability is not 100%, the leakage will be significantly lower.

However, the EU also states that initial research results suggest that the risk of carbon leakage is concentrated in a few industrial sectors.

The general scientific discussion on distortion of competition

A number of studies have been performed, both so called ex-ante studies (i.e. theoretical studies not based on observations) and ex-post studies (i.e. based on observations), in order to determine the impact on competitiveness of an asymmetric carbon price. Specific results from such studies are presented in section 3.4, but some general conclusions are given here. The results from the studies of the impact of the EU ETS show that not all sectors are at risk for distorted competition. Certain specifics like trade intensity and possibility to pass through costs on product prices as well as the design of the carbon constraint (e.g. in the case of cap and trade, the allocation method) are of importance. The studies also show that sectors are not homogeneous and need to be analyzed on a sub-sector level in order to identify what industries are at risk. Most ex ante studies pointed at risks of distortion in competition for the industry included in the EU ETS, whereas the ex-post studies failed to find evidence that the EU ETS actually has had any significant impact on trade flows for the included sectors. More details of the results of the sector specific studies are given in section 3.4. The ex-post studies also claim that the studied period for the effects of the EU ETS on the European industry is too short and has included a number of specific circumstances, mainly significant increases in demand and prices (crude oil and metals), which makes it difficult to single out any impact of the EUA price. The short time period also makes it difficult to see any changes in the trend for placing of new investments. The impact might be different in the future since;

- there are plans on changing the method of allocation; from free allocation to more, or full auctioning. The free allocation and for some sectors the over-allocation has had the potential to minimize the increased costs, or even enabled industries to make profits by passing through opportunity costs to product prices
- the EUA price might increase due to stricter emission caps
- long-term effects of the asymmetric carbon price will be possible to evaluate and hence placing of new investments can be evaluated

Although many studies have focused on the EU ETS, which is the largest scheme with a regional carbon price to date, also other regional carbon prices have been studied. Neuhoff (2008) say that econometric analyses made of environmental taxes introduced on European industry during the last two decades show no negative impact on industrial activity. Also countries with high energy tax levels are economically successful. However, according to many economists competitiveness is not applicable on a country level but rather on a sectoral or microeconomic scale. Hence, countries are not competing with one another. Neuhoff also writes that most of the carbon tax schemes provided for some kind of exemption for very carbon intensive products and hence, most of the industry sectors included in the EU ETS. This means that further analysis is needed for these sectors.

Said all this it is also important to remember that the introduction of a carbon price has the aim to accomplish a transition to low-carbon solutions, hence promoting low-carbon solutions at the expense of carbon intensive solutions.

3.4 Assessments of competition distortion and carbon leakage

In this section some results of studies on the impact of asymmetric carbon prices on industry are presented. Most studies have focused on the EU ETS and the sectors impacted by it.

3.4.1 Ex-ante studies of impact of asymmetric carbon prices on competitiveness and carbon leakage

According to Reinaud (2008) there are studies where carbon leakage has been modelled based on the introduction of taxes in some sectors. These results show that: at a tax level of $21/ton CO_2 applied in Japan and the EU-15, there will be a leakage rate of 55% in the steel sector. Other studies model the impact of an emissions trading scheme at €20/tonCO_2 applied to the EU-27, which results in leakage rates ranging between 0.5%-25% for the iron and steel sector and between 40-70% for the cement sector, depending on (among other parameters) how allowances are allocated. However, Reinaud argues that it might not be appropriate to model the impact of an ETS with a carbon tax, if for instance free allocation is applied. If allowances are allocated for free, they will be valued at their opportunity cost, and hence overestimate the negative impacts on companies' profit margins. Specifically, Reinaud (2008) claims that the existing literature has demonstrated higher cost pass-through capacity in the refinery and cement sectors than in the aluminium sector – the iron and steel and the paper and pulp sectors fall in between.

In the following section results from sector specific ex-post (observation based) studies of the impact of the EU ETS are presented.

3.4.2 Ex-post studies of impact of asymmetric carbon price on competitiveness and carbon leakage – the impact of the EU ETS

Several studies (Graichen et al 2008, Hourcade et al 2008, Reinaud et al 2008, Baron et al 2007, etc.) show that only a few industrial sectors of the economy, accounting for 1-2% of total GDP (gross domestic product) are at risk facing significant cost increases due to higher carbon prices. They base this conclusion on the potential cost increase facing the sector as a result of an assumed carbon price level (€/ton CO_2)

As described in section 3.1 specifics of sectors are of great importance when analysing the vulnerability and risk for impact of an asymmetric carbon price (trade intensity, possibility for cost pass-through, mitigation costs etc) and hence this is just a first assessment of potential impact. In Figure 2 and Figure 3 the results of the assessments of the potential cost impact of CO_2-prices on sectors in the UK (Hourcade et al 2008) and Germany (Graichen et al 2008) respectively are shown. The metrics used are NVAS and MVAS as described in section 3.1. One conclusion from these two assessments is that the overall impact on the national economy is limited. In the UK, the sectors with a potential cost increase of at least 2% together correspond to roughly 1% of GDP and the corresponding figure for the German case is 2%. In Table 1 we compare which sectors that have the highest potential cost increase (combined direct and indirect VAS) in the assessment for the UK industry and German industry. Important assumptions in the studies are the direct price of CO_2 emissions, i.e. the assumed price for EUAs and the indirect price increase of electricity. Hourcade et al assumed that the direct CO_2 price is 20€/tonne and the indirect increase of electricity price is 10 €/MWh whereas Graichen et al assumed the same direct CO_2 price but due to differences in electricity production between the two countries the indirect impact on electricity prices in the German case was 19.34 €/MWh.

Table 1 Sectors with high potential impact – potential value at stake (direct and indirect cost increases compared to gross value added) based on Hourcade et al (2008) and Graichen et al (2008). Ranked, with sectors with highest potential impact first.

Sectors with potential value added at stake> 10% (sectors given within parenthesis are lower than 10%

UK	Germany
1. Lime	1. Cement
2. Cement	2. Lime
3. Basic Iron & steel	3. Fertilizers and nitrogen compounds
4. Starches	4. Basic Iron & steel
5. Refined petroleum	5. Aluminium
6. Fertilizers and nitrogen compounds	6. Paper & board
7. Aluminium	7. Other basic inorganic compounds
8. (Other basic inorganic compounds)	8. Coke & refined petroleum & nuclear fuels
9. (Pulp and paper)	9. (Starches)
	10. (Flat glass)
	11. (Pulp)

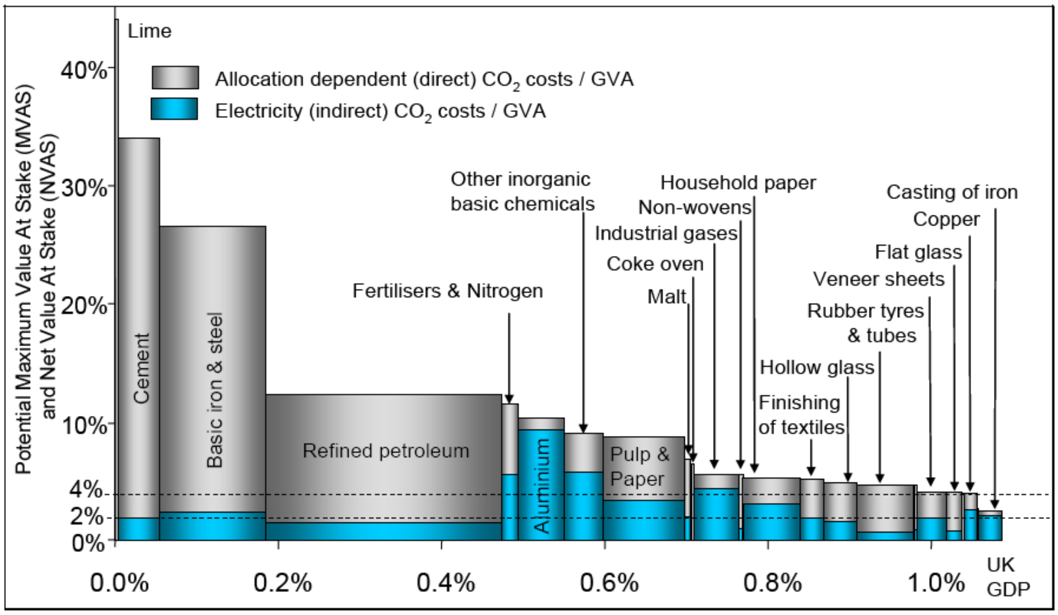


Figure 2. Value at stake related to GVA for selected UK industry sectors. The data used is mainly valid for 2004. Assumed EUA price is 20 €/tonne and the indirect electricity price increase is 10 €/MWh. Source: Hourcade et al (2008).

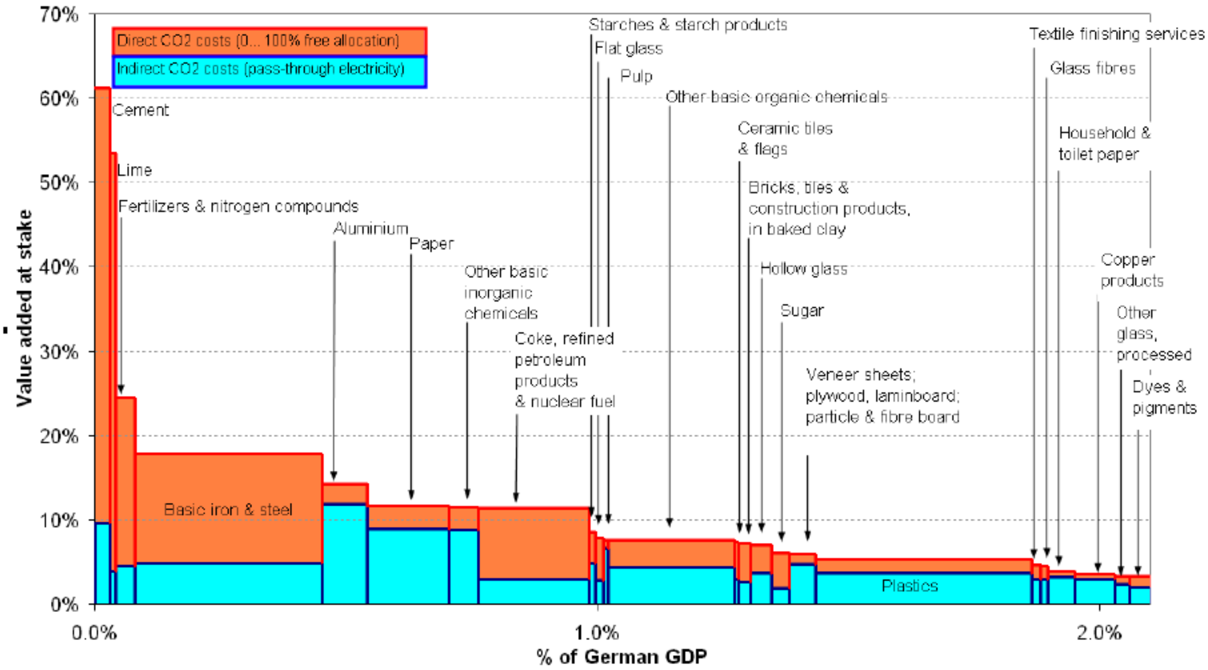


Figure 3 Value at stake related to GVA for selected German industry sectors. The figure is based on data for 2005. Assumed EUA price is 20 €/tonne and the indirect electricity price increase is 19.34 €/MWh. Source: Graichen et al 2008.

Table 1 shows some differences in the results for the two national studies. One reason for these differences is that the indirect emissions from the use of electricity differ in the two cases. In the study of the UK sectors electricity production is assumed to be based on gas fired installations with approximate emissions of 350-410 kg CO_2/MWh, whereas the study on the German sectors assumes coal based production with average emission of 967 kg CO_2/MWh. This difference results in a value added of €10/MWh in the UK case and almost €20/MWh in the German case. There are also some minor differences in the specification of the sectors that contribute to the differences but the difference in the indirect cost for electricity is of most importance.

It is also of importance to recognise that to analyse sectors at this level might be too general. In some sectors there are distinctions between specific processes which are of greater importance than the final product. This is recognised by many researchers and in-depth studies of each sector have been made in order to find out actual impacts and possibilities to adjust for them.

Graichen et al 2008 also makes an assessment of previous studies where the cost impacts of the EU ETS on different sectors have been evaluated. The reviewed studies include:

- direct costs for internal abatement measures
- costs for buying allowances (net revenues from selling allowances) and
- indirect costs from increase in electricity prices, assuming a 100% pass-through in the electricity sector.

The studies used figures for EUA prices instead of actual abatement costs (based on the assumption that cost-minimising companies are expected to realize all abatement measures with costs below the price for EUAs). This results in a systematic overestimate of compliance cost.

Table 2 shows the summary of the overview made by Graichen (see the reference list for the complete references of the studies referred to in the table). According to Graichen et al 2008, the IEA distinguishes between two scenarios, one with 2% and one with 10% purchasing of allowances at an allowance price of €10/EUA. The other studies assume 100% purchasing and allowance prices of 15€/EUA (Umweltbundesamt, 2007), €20/EUA (McKinsey/Ecofys 2006) as well as €15/EUA and €30/EUA (Smale et al 2006).

Compared to other sectors, the German cement sector seems to be particularly at risk for increased production costs due to the carbon price. However, according to Graichen et al the German cement sector has very low trade intensity with countries outside the EU. The low trade intensity could mean that the possibilities to pass through carbon costs to product prices are high. For some sectors, especially steel and aluminium production, it is necessary to differentiate by process. If this is done the production of steel by EAF (Electric Arc Furnace), brick roof tiles and various paper products are the least affected. There are also striking differences in the estimates for refineries. Smale et al (2006) only predict an increase of 0.3-0.6% (relative to marginal costs), while McKinsey/Ecofys estimates a price increase of 20% even compared to average costs. Emissions saving potentials were not considered when calculating the figures, which can play a role when determining the competitiveness and cost burden.

Table 2 Overview of impacts of emissions trading on production costs. Source: Graichen et al 2008.

Product	Marginal Cost Increase (%)	Average Cost Increase (%)	Auctioning (%)	EUA price (€/tonne)	Reference
Steel	8.0		100	15	Smale et al. (2006)
	17.0		100	30	Smale et al. (2006)
-Electric Arc Furnace		0.8	2	10	IEA (2005)
		0.9	10	10	IEA (2005)
		2.9	100	20	McKinsey (2006)
Basic Oxygen Furnace (BOF)		0.7	2	10	IEA (2005)
		1.3	10	10	IEA (2005)
		17.3	100	20	McKinsey (2006)
Cement		1.9	2	10	IEA (2005)
		3.4	10	10	IEA (2005)
	84.4	28.0	100	15	Umweltbundesamt (2007)
	70.0		100	15	Smale et al. (2006)
	144.0		100	30	Smale et al. (2006)
-dry process		36.5	100	20	McKinsey (2006)
Newsprint		1.1	2	10	IEA (2005)
		1.6	10	10	IEA (2005)
	2.6		100	15	Smale et al. (2006)
	6.0		100	30	Smale et al. (2006)
Aluminium		3.7	2	10	IEA (2005)
		3.7	10	10	IEA (2005)
	4.0		100	15	Smale et al. (2006)
	13.0		100	30	Smale et al. (2006)
- Primary aluminium		11.4	100	20	McKinsey (2006)
- Secondary aluminium		0.5	100	20	McKinsey (2006)
Paper	29.1	8.9	100	15	Umweltbundesamt (2007)
- Chemical pulp for market		1.0	100	20	McKinsey (2006)
- Paper from chem. pulp		2.1	100	20	McKinsey (2006)
- Chemical pulp and Paper		2.4	100	20	McKinsey (2006)
- Mechnical pulp and Paper		5.5	100	20	McKinsey (2006)
-Thermo-mechanical pulp and Paper		7.5	100	20	McKinsey (2006)
-Recovered fibre pulp and Paper		3.4	100	20	McKinsey (2006)
Container glas		5.9	100	15	Umweltbundesamt (2007)
Flat glas		4.8	100	15	Umweltbundesamt (2007)
Bricks		3.9	100	15	Umweltbundesamt (2007)
Roof tiles		2.9	100	15	Umweltbundesamt (2007)
Refinery	0.3		100	15	Smale et al. (2006)
	0.6		100	30	Smale et al. (2006)
		20.5	100	20	McKinsey (2006)

Sector specific results

As already mentioned most studies show that the risk of carbon leakage is concentrated within a few industrial sectors and in order to fully assess the risk for carbon leakage these sectors should be analysed in-depth. In the study by Graichen et al 2008 both an economy wide assessment of sectors at risk (presented in the previous section) and sector specific analysis of the identified exposed sectors is presented. Exposed sectors are defined as sectors with the value at stake higher than 10% and trade intensity with countries outside the EU being higher than 10%. In total there are 5 sectors within this group in the German economy, i.e.:

- fertilizers and nitrogen compounds
- basic iron and steel production
- aluminium production
- pulp and paper production and
- other basic inorganic chemical industry

The sector specific analysis focuses on the following parameters:

- processes and products (energy and carbon intensity)
- energy use (sources for energy use, i.e. coal, natural gas other)
- trade flows (imports and exports to non-EU countries compared to intra-EU flows)

Some of the results from the sector specific analysis of Graichen et al and others are presented below.

Mineral oil refining
Both the German (Graichen et al 2008) and British (Hourcade et al 2008) assessment of sectors with high value at stake, place the oil refining sector among the top ten. However, according to Baron et al 2007 the EU ETS has so far had a minimal effect on the competitiveness of the refining sector. This is mainly explained by the fact that the sector has benefited from high profit margins during the last years. According to Baron et al 2007 the margins for European refineries have been increasing during since 2003. Although there is a distinction between refineries of different types, i.e. with different processes[5], the main part of the sector has felt the increase of profit margins. In the current conditions a full auctioning of allowances at €20/ton CO_2 would represent a cash cost equivalent to 1% of the cost of the crude oil processed, whereas margins are at a level close to 5% (Baron et al 2008). Hence for the mineral oil refining sector, the profit margins are sufficiently large to continue production and upgrading of existing facilities even in the worst case scenario where carbon cost can not be passed through to product prices Neuhoff (2008).

According to an interview study among parties in the refining sector the carbon price has been recognized as a signal promoting energy efficiency. They also state that there still are abatement options in the sector. The focus of the industry has mainly been on avoiding compliance cost rather than optimizing its profits under the scheme.

The fact that there has been little impact on the sector during these first few years is a poor indicator of what might happen in the future, partly due to the specific situation that has prevailed with;

- a increasing global imbalance due to the shift towards diesel in Europe (once this has reached a new balance profitability patterns for European refineries might change)
- the dramatic increase in crude oil prices, which has diminished most other cost increases
- the free and high allocation of allowances

Iron & Steel production
The steel sector is also one of the identified sectors with high value at stake and high world trade intensity. The world trade patterns in the sector have changed dramatically during the past 20 years. World-trade was 26% in 1990 and 40% in 2007. China is now the largest exporter; steel production in China has grown by 232% between 2000 and 2006.

When considering the value at stake and hence competitiveness impacts differentiation between different technologies should be made, mainly between the BOF route (blast oxygen furnace, ore based steel production) and the EAF (electric arc furnace, scrap based production). The BOF sector has higher direct emissions and is the main sub-sector at risk.

[5] For hydroskimming refineries the margins have decreased, whereas for the cracking refineries margins have increased.

The sector itself has in an early stage of the discussion of the introduction of the EU ETS warned for severe impact on the sector. The ex-ante studies showed diversified results depending on assumptions; tax versus allowances, price elasticity, product differentiation across regions, transport costs and other trade barriers. In addition, the leakage rate is sensitive to the level of pass-through of the carbon cost and hence allocation method.

The ex-post study made by Baron et al 2008 can not identify an effect of the EU ETS on the competitiveness of the European steel industry. One explanation to this might be that the sector was generally over-allocated during the first trading period and hence compensated for any increased cost.

At the same time world demand and average prices have increased dramatically during the past few years. An increase in the utilization rate of European installations was noted during the studied period (2005-2006) which is an indicator that profitability also has increased.

The future impact might still be notable if allowances are to be auctioned and the emission cap is tighter.

Cement

Since cement mills tend to be located close to the demand, leakage in cement is likely to focus on clinker (the carbon intensive input material for cement). For clinker the relative costs of CO_2 are high. According to Baron et al 2008 the EU ETS has increased the cost of production in the cement sector, with an allowance price of €25/ton CO_2, the additional cost amounts to €22/ton CO_2. This is equivalent to all other variable costs combined (excluding labour). In addition increased electricity prices the EU ETS would also increase the production costs of cement.

If fixed costs of production are large relative to annual fixed costs of an installation, which is the cased for clinker production, then firms can gradually reduce production volumes where they face increasing import volumes. Hence in this way we could see decreasing utilization of European installations if they were to lose in profitability.

According to Hourcade et al 2008 the EU cement producers seem to face low international pressure. With high market shares on domestic markets, they are expected to have high ability to pass on opportunity costs of carbon and profit from free allocation. However, the situation differs from country to country. Baron et al 2008 describes a number of different studies made in order to estimate the carbon leakage for the cement sector (i.e. Ponssard & Walker 2008, Szabo et al (2003, 2006), Demailly & Quirion (2006) and Hourcade et al 2008). The results differ but Baron et al 2008 draw the general conclusion that two assumptions drive the magnitude of leakage rates in ex-ante studies:

- barriers to international trade other than transportation costs and
- the method of allocation of allowances

There are a number of barriers for cement trade as listed by Reinaud et al:

- transportation costs, transportation cost for 1 tonne cement 100 km by road is approximately 10€, whereas the average cost for cement (excluding transportation cost) is 65€/tonne. Transportation costs by sea are lower but then storage capacity in harbours has to be taken into consideration. Large countries with few ports are less sensitive to imports
- Import restrictions
- Balance between capacity and consumption in the rest of the world
- The cost of instability (higher for imports)'

- Product differentiation
- Service differentiation
- No export capacities
- Relocation barriers

There are three main channels open for cement producers to reduce their exposure to CO_2-pricing:

1. replacing clinker production with clinker imports
2. reducing clinker content of cement
3. energy efficiency improvements

There are different types of cement with different amount of clinker and hence CO_2 intensity. However, the utilisation is partly determined by national standards. A shift in standards and hence cement qualities could significantly reduce the CO_2 emissions from the sector (for further description of the product differentiation see Reinaud et al 2008).

EU27 net imports of cement and clinker grew slightly in 2005 and 2006 but the increase was modest in comparison to the increase that occurred during 1997-2002. The econometric analysis of the changes in European cement trade by Baron et al 2008 did not reveal any impact from the EUA price.

The impact in the future might be different since for instance allocation method might change towards auctioning. According to Reinaud (2008) free allocation proportional to recent production volume of clinker would be necessary to address the problem of leakage. This will however, dampen the product price increase of clinker throughout the cement value chain. Free allocation proportional to recent production volumes weakens much of the desired incentive for substitution towards lower carbon materials for construction. Likewise subsidies to carbon intensive products or production also reduce product prices and thus the economic incentive to shift towards alternative with less carbon intensity.

A study made by the Boston Consulting Group, BCG (2008) on behalf of the cement industry concludes that the clinker production in the EU will be seriously affected by carbon leakage in the future if the proposed changes of the emissions trading directive for the third phase (2013-2020) are carried through. The proposed changes are that the national allocation plans will be replaced by common rules, where total amount of allowances will be reduced by 21% compared to the 2005 level, no free allocation to the energy sector, 80% free allocation and 20% auctioning for the other sectors from 2013 with an linear increase to full auctioning by 2020. BCG (2008) state that as much as 81% of the EU clinker production would be at risk for leakage (move out to countries outside the EU) at an allowance price level of €25/ton by 2020 assuming full auctioning of the allowances. BCG (2008) also states that if the clinker production moves to countries outside the EU, there is a risk that the cement production also moves. The study also recognises that there is a proposed exception in the Directive meaning that industries where a significant risk for carbon leakage can be demonstrated will receive 100% free allocation also after 2013. BCGs calculations for a case with 100% free allocation but a reduction of allowances of 21% compared to 2005 level will also result in a significant impact of the EU clinker production. The study presents detailed country level analysis of the risk of carbon leakage for the clinker production in the EU based on no free allocation and different levels of EUA prices. According to the study an EUA price of €26/tonne would result in 100% carbon leakage from the Swedish sector. The study made by BCG (2008) is made on behalf of the cement industry which probably means that the input data for the cement industry is very accurate however; sources and assumptions are hard to follow due to the way references are presented.

Aluminium

Aluminium smelting plants are usually located near (or even onsite) abundant and low-cost electricity generating plants. Production of aluminium from alumina requires significant amount of energy, specifically electricity. Recycling of aluminium has increased, and the production of secondary aluminium (scrap based) requires only 5% of the energy needed for the production from bauxite ore. Unlike the recycling of iron & steel there is much less (or no) difference in quality between primary (ore based) aluminium and recycled. The world trade of aluminium is high. Due to its high specific value, transportation costs are small in comparison to other costs. The imports from non-EU countries of aluminium correspond to 56% of the intra-EU imports whereas exports to non-EU countries correspond to 42% compared to intra-EU exports. Trade intensity for the sector is approximately 25% (non-EU countries).

The aluminium sector has not been included in the EU ETS but is still identified by both Graichen et al and Hourcade et al as a sector with high value at stake. The reason is the high electricity intensity of the sector and hence the indirect impact of the increased electricity prices. Mainly the primary aluminium industry is at risk for distorted competition. However, also the primary aluminium sector can be divided into two main technologies, where the more energy efficient rout is the dominant one in Europe. According to Reinaud et al 2008 the operational (i.e. variable) cost in primary aluminium smelter could increase by 9-30% depending on the electricity intensity of the smelter due to an allowance price of €20/ton CO_2.

According to Baron et al 2008, electricity prices has risen faster within the EU than outside, as a results of producers passing through opportunity costs. However, most primary aluminium producers operate under long-term electricity contracts which mean that few have been exposed to the rising electricity prices. However, Baron et al 2008 states that 6.5% of the European smelters have closed down during 2005-2006 due to their inability to secure power contracts, indicating that high electricity prices is a problem. On the other hand it is not possible to show that even without the EU ETS the European electricity prices had not been to high. In addition, imports to Europe have increased during the first trading period. This could partly be explained by the closure of installations but also to the increasing demand. Econometric analysis could not reveal any changes in trade patterns during 1999-2006. Baron et al 2008 identify the following reasons for why it is difficult to identify the impacts of the EU ETS on the primary aluminium sector during the first trading period:

- the long-term electricity contracts
- a high demand of aluminium and correspondingly high world prices
- high levels of imports following an increasing consumption and no additional production capacity coming on-line
- direct greenhouse gas emissions of aluminium smelters were not included in the EU ETS during this period.

The future impact might look different due to a number of reasons:

- plans to include also direct emissions from aluminium smelters in the EU ETS
- expiry of long-term electricity contracts, by 2010 65% of the European smelters will have to renew their contracts and by 2016 none of the European smelters will benefit from old contracts decided on before the EU embarked the electricity market reform.

Paper and paperboard

In the study by Hourcade et al of the UK sectors with high value at stake and thus at risk for distortions in competitiveness due to the EU ETS, the pulp and paper industry was not among the top ten. Hourcade et al recognizes that the results of the analysis of the UK pulp and paper sector might not be representative to the corresponding sectors in other EU countries since the size of the sector, the raw material use and the energy mix differs significantly. For instance, installations using a high amount of on-site CHP generation based on waste or biomass are relatively less exposed to the indirect effects of increased electricity prices (since this production does not need allowances; waste is not included in the EU ETS and/or biomass based fuel has an emission factor of 0).

In the corresponding study for the German economy Graichen et al placed the paper and paperboard sector among the ones with at value at stake higher than 10% whereas the pulp sector was not among the top ten sectors. The German paper industry uses recovered paper as raw material corresponding to 66%, which is higher than the average European value. The main part of the fuel mix in German pulp and paper industry relies on fossil fuels (natural gas) and electricity. Biofuels only contribute with 17% of energy demand. The trade intensity of the German paper and paperboard is almost 20%.

Hourcade et al further identifies significant differentiation within the sector depending on process. Some production processes are self-sufficient with respect to energy supply whereas others require significant external supply of energy, especially electricity. The table below summarizes the differences in carbon intensity between pulp and paper production technologies.

Table 3 Carbon intensity in pulp and paper production. Source: Hourcade et al 2008, based on McKinsey and Ecofys 2006.

1) Industry	2) Indirect CO_2 emissions	3) Direct CO_2 emissions	4) Total CO_2 emissions
5)	6) Ton CO_2 per ton pulp/paper		
7) Chemical pulp & paper	8) 0.07	9) 0.04	10) 0.12
11) Chemical pulp & paper	12) 0.62	13) 0.00	14) 0.62
15) Mechanical pulp & paper	16) 1.03	17) 0.00	18) 1.03
19) Thermo-mechanical pulp & paper	20) 0.12	21) 0.02	22) 0.14
23) Recovered fiber pulp & paper	24) 0.27	25) 0.34	26) 0.61

Baron et al 2008 did not include the pulp and paper industry in their analysis.

3.4.3 Is carbon leakage a significant problem?

According to Reinaud (2008) none of the simulations focusing on sectoral leakage indicate a leakage rate near 100%; meaning that it is highly unlikely that carbon leakage would diminish the effort to reduce emissions in an industry (sector) to zero. Hence, the general notion that a cap in a country or region will result in even more emissions globally is contradicted by all quantitative studies.

However, there are only imprecise and highly uncertain ranges of leakage estimates for some sectors (steel, aluminium and cement) and not for all sectors pointed out as being at risk (e.g. refining sector, paper and pulp chemicals etc.). Higher leakage rates would be expected in the steel and primary aluminium sector than in the cement or electricity sectors – since the latter are much less traded. According to Neuhoff (2008) the refining sector is less exposed to leakage since the profitability is so high. Based on the analysis given in the previous section mainly based on Baron et al 2008, Graichen et al, Reinaud and Hourcade et al, ex-post studies of the impact of the EU ETS on the most exposed sectors so far show no sign of impact. However, in the future the impact might be more significant at least in some sectors. The sectors at risk should be assessed individually to see whether long-term carbon price differences would result in relocation of industrial activity and thus carbon leakage. If so, there are different options for addressing this potential leakage (see next section).

3.5 What measures can reduce distortion of competitiveness and carbon leakage?

There is a discussion of different options on how to solve the distortion of competition due to the carbon cap for the European industry. However, measures to address leakage will have to be handled with care as they could be seen as protectionistic and thus undermine international efforts to pursue climate policy.

Common fears for the post 2012 regime of the EU ETS are carbon leakage and job leakage. According to Neuhoff (2008) there are different options for dealing with these fears (which basically address fears of distorted competitiveness):

1. Conditional free allocation
2. State aid for support of investment and re-investment
3. Export taxes (border adjustments, can function similarly to value added tax)
4. Government-led sectoral agreements.

However all of the suggested policies have their drawbacks and challenges and should therefore be applied with restriction. The following drawbacks are listed:

- Conditional free allocation and state aid:
    - Little substitution to low carbon products/services
    - Distortion of investments
    - Bureaucratic constraints for innovation
    - Risk of lock-in
- Border adjustments:
    - Has to be aligned with international climate engagement
    - Might be very difficult to negotiate and implement since they are viewed upon as trade barriers
- Government-led sectoral agreement
    - Requires strong policies of developing countries
    - Risk of low common denominator

In the light of these arguments and given the negative side effects associated with all of the measures, Neuhoff does not favour any of the measures in particular but advices to keep all options on the table and to explore in international discussions how to minimise their negative side effects.

Reinaud 2008 writes that if governments want to minimise carbon leakage and help the industry to achieve greenhouse gas emissions reductions they would need an objective quantitative basis to determine what measures should be applied for what sectors. The actions of governments should not be based on speculation but rather on simulated effects and monitored indicators.

The prevention of carbon leakage should not occur without consideration of costs (to other sectors and the economy more generally).

Subsidies can address leakage – but at a high cost. They limit incentives for emissions reductions and innovation in the sector where they are applied. Therefore the cost of delivering emissions reductions has to be bourn by other sectors of the economy. It reduces the incentive for industry to develop low cost options for emissions reductions that can be replicated in developed countries.

4 Exposure to carbon related cost impacts in Swedish sectors

In this chapter, based on official Swedish statistics, we have estimated the carbon related cost impacts for 52 Swedish sectors, using the measure *Maximum value at stake, MVAS,* as suggested by Hourcade et al, 2008.

Maximum Value At Stake = (*Cost increase due to EU-allowances* + *Indirect cost increase due higher electricity price*)/ *Value added*

The calculations are based on the following assumptions and conditions:

- The datasets used are from Statistics Sweden (SCB, 2009) and represents the year 2004. The reason for choosing the year 2004 is that this year is the last year before the EU ETS started.
- Due to the grouping of sectors in the statistics, we haven't been able to separate Aluminium production from Iron and Steel - they are both represented in the sector *Basic metal production*. We have not been able to separate Cement and Lime from *Non-metallic mineral*, a sector which also includes Stone, Soil and Sand production. Nor have we been able to separate Fertilizers from Chemical industry.
- Costs for allowances are applied to the sectors participating in the EU ETS. In addition, Air transports have been included since they will participate in phase III.
- In the calculated maximum value at stake we assume that industry has to pay for all allowances. If instead, industry were to receive allowances freely, the costs for CO_2-allowances will be zero, and the value at stake will only be due to increased costs for electricity.
- Only CO_2 related allowance costs have been included.
- Small installations are also assumed to pay for allowances. This is a simplification, since in reality installations under a critical size are not included in the EU ETS. We have, however, not been able to separate small installations in the data set.
- We assume a carbon price of €20/ton CO_2, which is the same price as used in the German and Brittish studies. This is probably an underestimate of future allowance price.
- Costs for the Swedish carbon tax and green electricity certificates are not included in the analysis. This means that the analysis only show the carbon related impacts from the EU ETS.
- For the electricity price impact, we assume that the electricity price is determined by coal based production. This probably overestimates the electricity price impact since at times the electricity price in Sweden will be determined by gas based production. We further assume that an emission factor of 92 g CO_2/MJ coal and a production efficiency (fuel to electricity) of 45%. This results in an electricity price impact of €14.7/MWh.
- The exchange rate is assumed to be 1 € = 10 SEK.

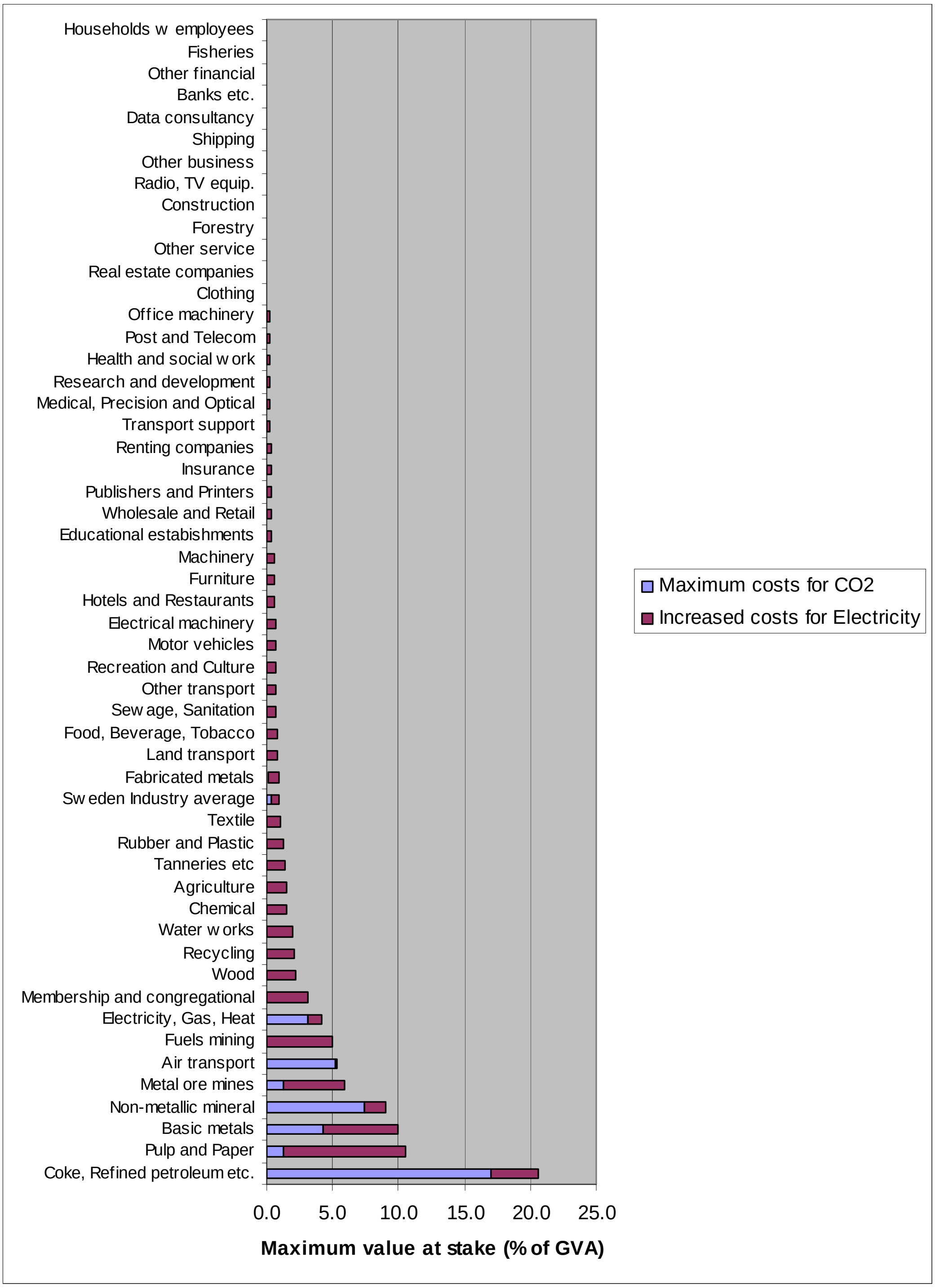


Figure 4 Maximum value at stake as share of gross value added for Swedish industrial sectors. Based on methodology by Hourcade et al 2008 and Swedish statistics for 2004. It is likely that within the presented sectors, there are sub-sectors with a higher MVAS than the sector average. Steel and Aluminium are included in *Basic metals*, Cement and Lime in *Non-metallic minerals* and Fertilisers in *Chemical industry*. Only CO_2 related allowance costs have been included and we assume that industry has to pay for all allowances. The costs for Swedish carbon tax and green electricity certificates are not included. We further assume an allowance price of €20/ ton CO_2, an exchange rate of 10 SEK per EUR and an electricity price impact of €14.7/MWh

The results are presented in figure 4 and we can conclude that:

- Seven sectors have a *Maximum Value at Stake, MVAS* of more than 4%: Coke and Refined petroleum (21%), Pulp and Paper (11%), *Basic metals* including Iron and Steel and Aluminium (10%), *Non-metallic mineral* including Cement and Lime (9%), Metal ore mines (6%), Air transport (5%) and Electricity, Gas and Heat (4%). The sector Fuels mining has a calculated *MVAS* of 5%, but is a marginal economic activity in Sweden with a contribution to gross value added of less than 0.02%.
- It is probable that within the presented sectors, there are sub-sectors with a higher *MVAS* than the sector average. For instance, the Cement sector is grouped with Stone, Sand and Soil production in *Non-metallic minerals*; Blast furnace steel production and Aluminium are grouped with other sub-sectors in *Basic metal production*; Fertilizers are grouped with other *Chemical industries*.
- The seven sectors with the highest MVAS correspond to 41% of Sweden's CO_2-emissions (26 Mt CO_2) in 2004.
- It can be argued that Air transport and Energy, Gas and Heat are not subject to international competition. If these sectors are omitted, the five remaining sectors with an MVAS above 4% (Coke and refined petroleum, Pulp and Paper, Basic metals; Non-metallic mineral and Metal ore mines) correspond to 22% of Sweden's CO_2-emissions (14 Mt CO_2).
- In the sectors Coke and Refined petroleum; Non-metallic mineral; Air transport and Electricity, Gas and Heat, the cost impact is mainly due to allowances.
- In the sectors Pulp and Paper; Basic metals; and Metal ore mines, the cost impact is mainly due to increased costs for electricity.

Comparison with studies in the UK and Germany

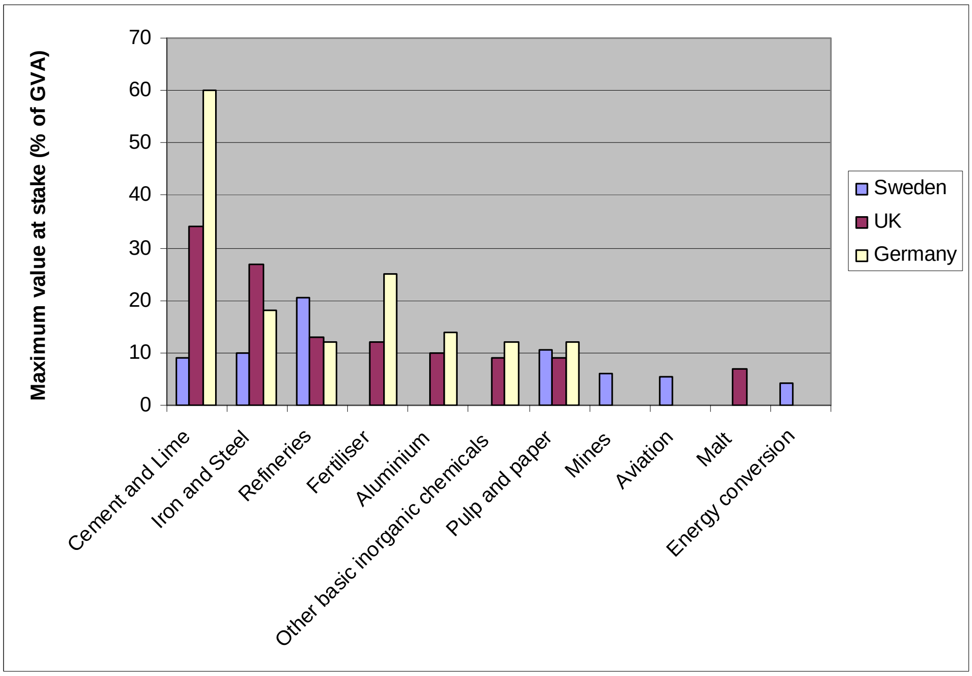


Figure 5. A tentative comparison of the *Maximum value at stake* for the most impacted sectors in Sweden, UK and Germany. Swedish values are from this study, UK values from Hourcade et al 2008 and German values from Graichen et al 2008. The comparison is only indicative since sector system boundaries differ considerably between Sweden and UK/Germany. For instance, in the Swedish values, *Cement and Lime* are represented by the *Non-metallic mineral* sector, which also includes *Soil, Sand and Stone* industry; *Iron and Steel* is represented by the sector *Basic metals* which also includes *Aluminium*.

The Swedish results are compared to the corresponding studies for the UK (Hourcade et al 2008) and Germany (Graichen et al 2008).

Main observations include:

- In the Swedish *Non-metallic mineral* sector, including Cement and Lime, the *Maximum value added at stake* is considerably lower than for Cement and Lime in the UK and Germany. This is most likely due differences in system boundaries. In the Swedish statistics, the Cement and lime industry is a minor part (in terms of value added) of the *Non-metallic mineral* sector, a sector that also includes Stone, Sand and Soil industry. Therefore the *MVAS* for *Non-metallic mineral* is probably a poor proxy of the *MVAS* for Cement and Lime as other sub sectors would "dilute" the *MVAS* (Lyberg, 2009).
- Differences in system boundaries may also explain the significant difference in *MVAS* between the Swedish Steel industry and UK and German Steel industries. Other possible explanations may be a higher value added per unit, differences in how value added is calculated, different years for the statistics and/or lower CO_2-intensity for Swedish products.
- Mines, Aviation and Energy conversion show a significant cost impact in Sweden. These sectors are not included in the UK and German studies.

- Fertilizers, Aluminium and Other inorganic chemicals show a high cost impact in UK and Germany. These sectors have not been analysed separately in Sweden since they are grouped with other sectors in the statistical data.

5 Sector agreements on the policy agenda – an overview

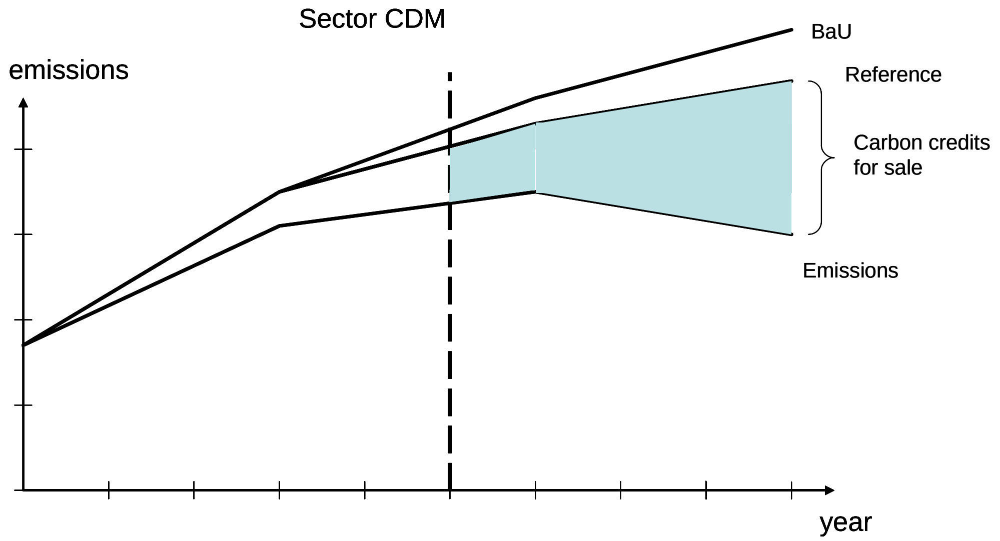
In this chapter we briefly describe what sector models are most interesting from an EU policy point of view. The text is based on the EU communication to *the Ad-hoc Working Group on future commitments for Annex I Parties under the Kyoto Protocol* (AWG-KP), 4 November 2008 (FR-11-04-AWG-KP). The figures are based on Lema (2008), but modified.

The EU proposes three types of sectoral approaches to be discussed under the AWG-KP:

1. Sectoral crediting mechanisms – based on baseline and credit approach. These can be divided into two types:
    a. Sector CDM – a CDM crediting mechanism with a previously established baseline
    b. Sectoral no-lose mechanism - Sectoral crediting against a previously established no-lose target
2. Sectoral emission trading based on a sectoral emissions cap

5.1 Sector CDM

For a *Sector CDM* model, aggregate emission reductions in a specific sector within a country are credited against a sectoral reference level for emissions on the basis of a baseline. Normally for *CDM Projects*, *business as usual* projections are used as the reference level from which credits are calculated. This means that all reductions below *business as usual* render CER credits.



For *Sector CDM* however, EU has suggested that the *reference level* should reflect national circumstances and be set sufficiently below *business-as usual* projections. This reference level should change and become more ambitious over time.

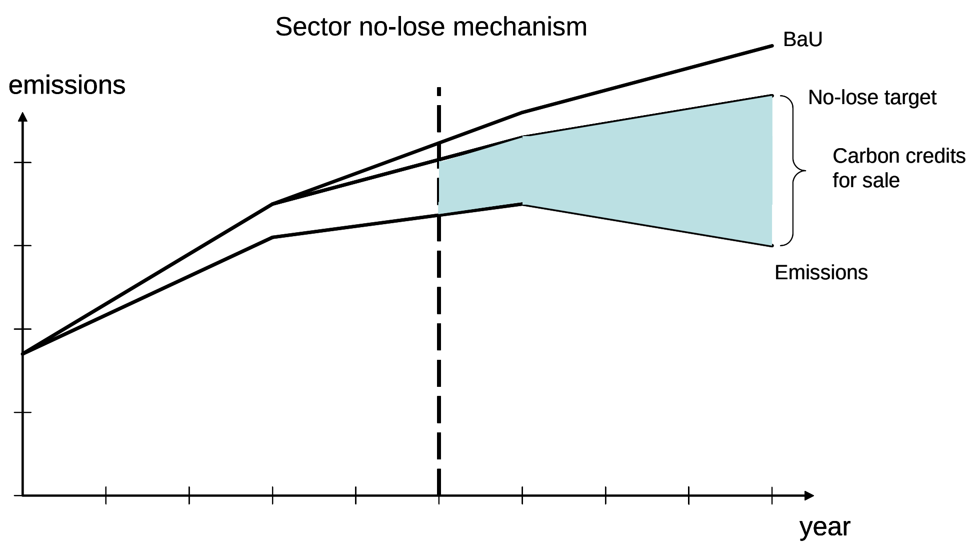
It's unclear who owns the credits that are produced (i.e. who is the so called *host*); it can be either a public entity (for instance the government) or a private entity (for instance the industrial firms).

According to the EU, one of the advantages of the sectoral CDM is that it could address the issue of potential carbon leakage. Other advantages mentioned are that it would:

- significantly scale up the finance for mitigation action
- significantly strengthen developing countries engagement in systematic mitigation action
- address the problems of additionality where based on an ambitious sectoral reference level
- reduce administrative costs to participants

5.2 Sectoral no-lose mechanism

The *Sectoral no-lose mechanism* is also a sectoral crediting mechanism and very similar to *Sector CDM* in its approach. Aggregate emission reductions in a specific sector within a country are credited against an agreed *no-lose-target*. The *no-lose target* level should reflect national circumstances and be set sufficiently below *business-as usual* projections. The EU suggests that the government or another public entity owns the credits that are produced.



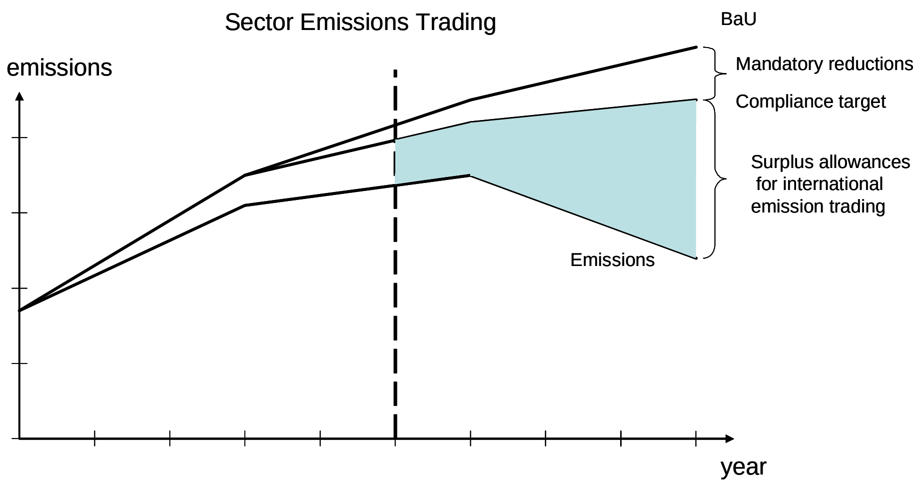
Sectoral crediting mechanisms (sector CDM and sector no-lose mechanism) may provide a cost-effective means for Annex I parties to achieve their emission reduction targets. At the same time, these mechanisms may provide incentives for enhanced mitigation action by developing countries and for recognising actions on a sectoral basis by developing countries in the carbon market.

5.3 Sectoral Emission Trading

The EU states that it "considers it worthwhile to explore proposals on introducing emission trading based on sectoral targets and linking emissions trading schemes established on a voluntary basis in developing countries to international emissions trading".

In sectoral emissions trading, a compliance level is negotiated. The compliance level defines the mandatory reductions to be achieved by industry and available volumes of emission allowances. The EU proposal states that parties may allocate emission allowances to private entities In general, the allowances can be issued to industry freely or through auction.

Linking of these sectoral emissions trading schemes to the global carbon market would provide financial support from the carbon markets towards reaching the sectoral emissions targets. This would significantly scale up the carbon market while providing a cost-effective means for Annex I parties to achieve their emission reduction targets.



An advantage of participating in trading over participation in sectoral crediting mechanisms is that tradable units can be allocated ex-ante on the basis of a target applied to a sector. The EU suggests that sectoral emissions trading initially should focus on sectors with high emissions, high mitigation potential, large point sources and sufficient data availability.

6 How can sector agreements reduce competitiveness distortion?

If a sector agreement is to be successful in reducing competition distortion between Sweden/EU and a developing country (called DC), how should a sector agreement be designed? What parameters are important when addressing competitive distortion? In this chapter we list and discuss the following parameters:

1. Creating a price on carbon
2. Interaction with the EU ETS - linking
3. Targeting sectors

4. Indirect effects – electricity
5. Pass-through of costs – consumer incentives
6. Target setting – producer incentives
7. Compliance costs for participating industries

6.1 Creating a price on carbon

If a sector agreement is to be successful in reducing competition distortion, a fundamental requirement is that it creates a real price on carbon emissions and therefore makes carbon intensive products more expensive in the DC. This creates incentives for improving carbon efficiency and for developing more carbon efficient technologies. If a carbon policy fails at creating a price on carbon, there will be no incentives for reducing carbon emissions further than without the policy.

So, how could a carbon price be defined and created under a sectoral agreement? In economic theory, there is a relation between emission reductions and the marginal cost for these reductions. The *marginal abatement cost curve* in figure 6 illustrates how emission reduction costs in a DC industrial sector depend on the level of reductions.

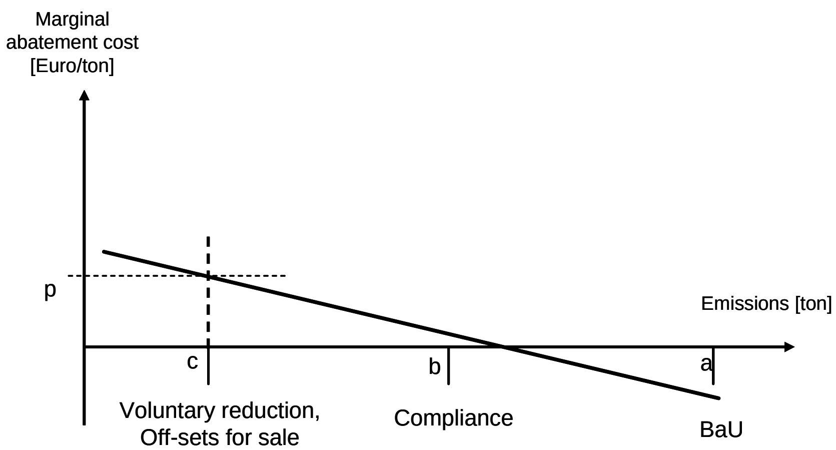


Figure 6. A schematic marginal abatement cost curve for a DC industry sector

The costs for emission reductions are low at first, but as emissions decrease (moving left in the figure) each additional reduction will be more and more expensive. If a climate policy is introduced that leads to a price on carbon (for instance a carbon tax or a price on emission allowances), emission reductions will be motivated up to the level where the cost for reductions equals the carbon price. This is however a simplification. Experience shows that in the absence of carbon policies there exists a volume of reduction measures at negative cost. However, we can still expect that a price on carbon will motivate emission reductions and that the higher the carbon price, the higher emission reductions are motivated.

Assume that we implement a sectoral agreement, for example a *Sector emission trading model.* In the absence of a climate policy, emissions would reach the BaU-level (a in the figure). According to the sector agreement, a compliance level is negotiated below the BaU-level (b in the figure). To reach this level requires an effort from the DC. These reductions will probably include reductions at negative cost and possibly reductions at low cost. After reaching the compliance level (b) the DC can choose to reduce emissions further (for instance to the level c). By doing so, the additional reduction below the compliance level would render tradable offsets. The incentives for doing this come from the international demand for these offsets.

A potential buyer of these offsets is the EU ETS, but also other emission trading systems and other buyers of carbon offsets. If the buyers are prepared to pay, say, €10 per ton for these offsets this will create an incentive in the sector for reducing emissions down to the level where abatement costs are equal to €10/ton. The volume of reductions when moving from (b) to (c) can then be sold at €10/ton. The net profit will be the difference between the abatement costs and the income from offset sales. Operators in the DC with reduction options that cost below €10/ton can perform these reductions and sell the surplus of allowances at €10/ton. If an operator decides to continue emitting carbon at the same level as before, this is associated with an opportunity cost of €10/ton. In conclusion, the demand for offsets from this sector creates a shadow price on carbon, in this example €10/ton.

Our example of defining a carbon price for a *Sector emission trading system* is valid for the other sector agreement-models. In a *Sector-CDM* and *Sector no lose mechanism* there is a compliance/reference level below BaU that requires an effort that does not render offsets. If the sector over-performs i.e. reduces emissions below the compliance/reference level, this renders off-sets for sale.

In summary, all three regimes can potentially lead to a carbon price being created. The driver for emission reductions are in all three cases the international demand for offsets. It is therefore crucial that there is an international demand for the off-sets. Without buyers there will be no reason to perform beyond compliance. In this perspective, it will be crucial what policies the EU and other large buyers will apply for imports of sectoral offsets.

6.2 Interaction with the EU ETS - Linking

Competition distortion can be reduced by EU off-set imports in two ways:

1. The EU demand for off-sets will increase the carbon price in the DC sector, thus reducing the competition distortion between the DC and the EU,
2. Imports of off-sets may reduce the price on EU ETS allowances, thus further narrowing the carbon price gap between the two markets.

Creating a price in the DC sector. As a potentially large buyer of off-sets the EU will be an important driver for creating a price on carbon in the DC sector. The choice of EU policy with respect to imports of off-set will therefore have great importance. Other buyers, such as other countries, emission trading systems or the voluntary credit market will also be important. A carbon price can be created in the DC without involving the EU, but in practice, as a potentially large off-sets buyer, the participation of the EU will have significant importance.

Off-sets imports may reduce the carbon price in the EU ETS. If off-sets are imported at a price lower than the EU allowance price, this would reduce the allowance price in the EU ETS.

The mechanism for this is described in figure 7 and in the text below.

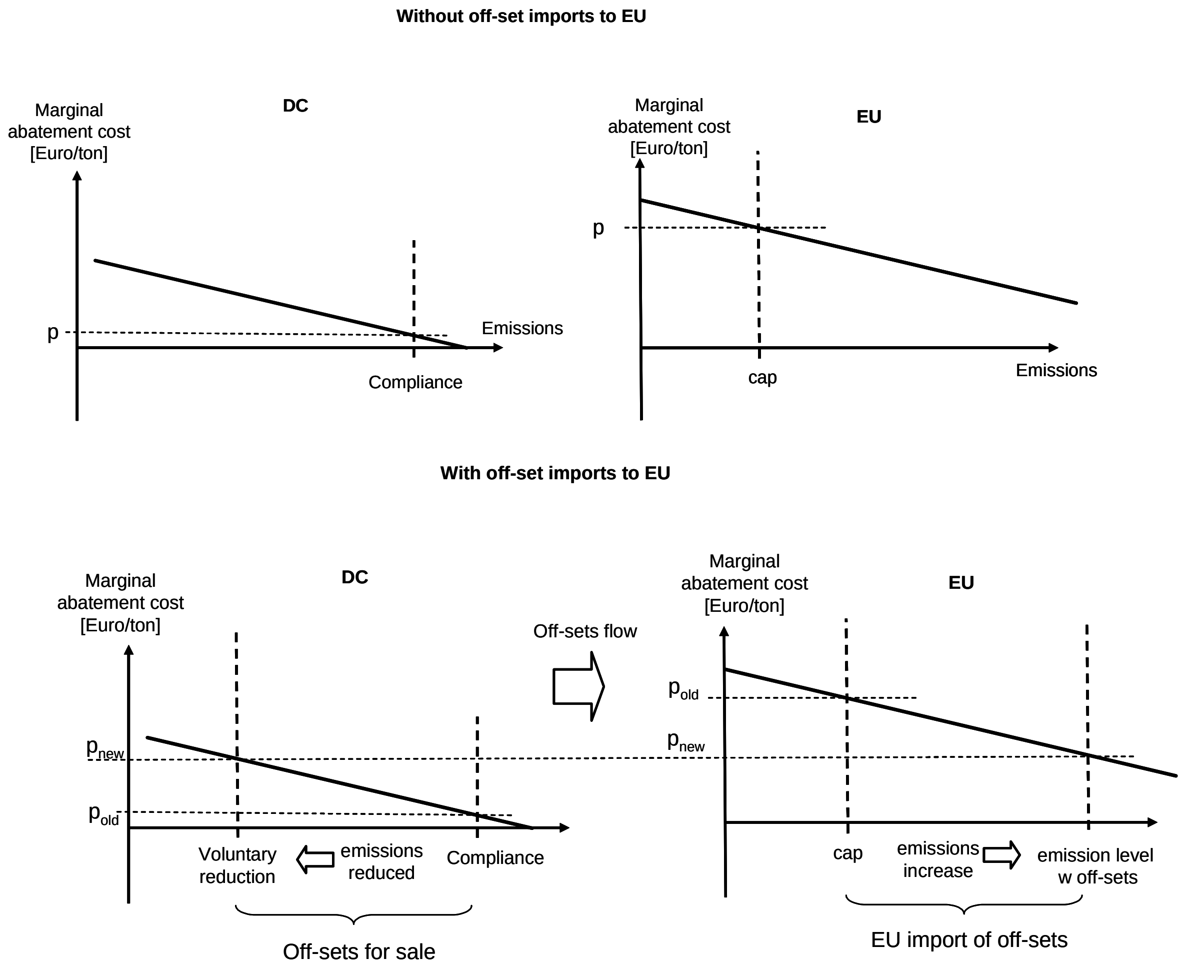


Figure 7. The process of producing off-sets in a DC and selling to the EU and how carbon price is influenced in the two systems.

The figure illustrates how emission reductions in the DC are sold as offsets to the EU and how this influences the carbon price in the two systems. We have assumed that the two systems are of the same size (in terms of emissions) and that the marginal abatement costs are higher in the EU. We have further assumed that the EU cap is not reduced (a simplification, which is commented below). The top part of the figure shows the situation before reductions have been performed. In the DC, the compliance level prescribes what reductions are needed. The MAC-curve describes the cost of the last ton reduced. This cost defines the shadow price in the DC, *p*. We have assumed that in the developing country the compliance level can be reached at a relatively low cost. In the EU ETS, the cap prescribes the emission level and what reductions are needed. The MAC-curve tells us what is the cost of the last ton CO_2 reduced and this defines the allowance price in the EU, *p*. We assume that the allowance price is considerably higher in the EU than in the DC.

The bottom part of the figure shows the situation if EU buys off-sets from the DC. In reality, it is possible that the EU cap will be reduced if offsets, additional to the previous situation, are allowed. However, in order to illustrate the mechanism of linking, we have here assumed that the EU cap is unchanged. The EU demand for offsets results in emissions being reduced in the DC (moving left in the figure). These off-sets are sold to the EU, where emissions increase correspondingly (moving right in the figure). As long as emission reductions are cheaper in the DC than in the EU it will be profitable for the DC to reduce emissions further. In principle, the DC will reduce emissions until the marginal abatement costs are equal in the two systems. In reality, there will be a price difference between the two markets due to transaction costs, risk cost and other barriers.

From the figure, we can see that imports of off-sets or linking can have significant consequences on the carbon price in the two systems. In the DC, producing off-sets for trade will increase the carbon price in the DC. In the EU, assuming a hypothetical case where the cap is unchanged, imports of offsets will reduce the carbon price, and thus further narrowing the carbon price gap between the two markets.

Balancing imports of sector off-sets with a stricter target in the EU
However, if the EU allows for imports of off-sets from sector agreements, it is possible that there will be a reduction of the EU emission target – a reduced cap. With a reduced cap, offset imports may still reduce the EU allowance price. The net impact on allowance price from a reduced cap and off-set imports as compared to a reference case (no cap reduction and no offsets imports) requires a detailed analysis. In any event, it can be concluded that with a reduced cap in the EU, it would become even more favourable (for both parties) to export offsets from the DC to the EU.

Fully integrating a DC sector to the EU ETS
In addition to importing off-sets to the EU ETS, a further extension would be to consider a full integration between a *Sector emission trading system* and the EU ETS.

The economic consequences of linking two emission trading systems depend on the marginal abatement cost-functions and the relative size of the two regions. If we assume that abatement costs are in general cheaper in the DC than in the EU and that the EU cap is <u>not</u> reduced, experience from studies of linking emission trading systems show that with linking:

- the carbon price in the EU decreases, the carbon price in the DC increases
- emission reductions will shift from the EU to the DC
- the EU pays the DC for emission reductions
- overall costs are reduced
- compliance costs (costs for reductions plus allowances) are reduced both in the EU and in the DC.

Even if this example is valid for linking a *Sector emission trading system* to the EU ETS, similar consequences can be expected from linking other *Sector agreements* with EU ETS. In this regard, the main difference between the different Sector agreement-models is that with *Sector CDM* and *Sector no-lose targets* off-sets are only traded one way, from the DC to the EU ETS. However, even in these Sector agreement-models, if we assume that emission reductions are considerably cheaper in the DC, we can expect that the consequences of linking will show similar economic dynamics.

Should the EU industry pay for reductions in developing countries?
The principle of emission trading is that industries with high abatement costs buy reductions from

industries with low abatement costs. This reduces costs for both parties and is an overall cost effective way to reach a global emission target. However, as the EU ETS developed, the system was criticised because carbon efficient industries were meant to pay competitors with low carbon efficiency to reduce emissions and become more CO_2-efficient.

With the introduction of sector agreements we can expect similar reactions from EU industry towards developing countries. EU industry will argue that it is unfair that they pay their competitors in DCs to become more CO_2-efficient. At the end, emission trading does not force anyone to pay for reductions; it gives each industry the flexibility of two alternatives – reduce emissions or buy reductions from someone else.

6.3 Targeting sectors

If an important objective of a *sector agreement* is to reduce competition distortion it should be implemented in sectors where the corresponding Swedish industry have significant carbon related costs and where there is a significant trade intensity between Sweden and regions outside the EU.

A preliminary analysis (in this study) indicates that Swedish sectors with potentially high *maximum value at stake* (direct carbon and indirect electricity) include Coke and Refined petroleum, Pulp and Paper, Basic metals including Iron and Steel and Aluminium, Non-metallic mineral including Cement and Lime and Metal ore mines. However, the Swedish data that is used is at an aggregated level and values for the sectors with potentially high carbon related costs are probably diluted by other sub-sectors. Air transport has a calculated MVAS of 5%, but we haven't analysed to what extent aviation is exposed to international competition. The sectors Aluminium and Fertilizers have not been assessed explicitly. The sector *Electricity, Gas and Heat* has a calculated MVAS of 4% but is not significantly exposed to trade with countries outside the EU. However, in a developing country, electricity production can be important to include since the electricity price may be a significant cost for industries exposed to international competition like Aluminium, Pulp and Paper, Steel and Mining.

A corresponding analysis of British sectors (Hourcade et al 2008)) shows that sectors with high value at stake include (in decreasing order of importance) cement and lime, iron and steel, refined petroleum, fertilizers, inorganic chemicals and paper. A corresponding analysis in Germany (Graichen et al 2008) indicates the same sectors, but with a slightly different order.

In general there are also other additional circumstances and structures of sectors which facilitate sectoral approaches. In Höhne et al (2008) three specific sectors are pointed out as suitable candidates, the power and heating sector, the cement sector and the iron & steel sector. They are all quite concentrated sectors, i.e. few operators produce significant part of the total production, they contribute significantly to overall global emissions (electricity 26 percent of global greenhouse gas emissions, iron and steel 3 percent of global greenhouse gas emissions and the cement sector 5 percent of global CO_2 emissions). At the same time trade intensity is very different for the three sectors as well as the concern for distortion of competition if not covered. World trade in the cement sector is low; nonetheless there is a concern for competitive distortions. In the iron and steel sector world trade is significant whereas in the heating and power sector the trade is strongly limited by transfer capacity and no concerns of competitive distortions in the sector are raised. However, the indirect impact of increased electricity prices on other sectors are a concern for competitive distortions and those would be reduced if the electricity sector would be subject to sectoral agreements.

6.4 Considering indirect effects – electricity

Experience from the EU has shown us that not only carbon intensive industries are impacted by the carbon price of the EU ETS. Electricity production in the EU is included in the EU ETS and since the electricity producers can pass on their costs for carbon on consumers, there has been a significant increase in the price of electricity due to the carbon price. This has clearly had an impact on electricity intensive industries, such as aluminium and pulp and paper.

If these industries in the EU will compete with corresponding industries in a developing country, it's important that sector agreements address the indirect effect of a carbon policy on electricity intensive industries in the DC. This can be done by including the electricity producing sector of the DC in a sector agreement. If doing so it is important that the electricity sector in the DC passes through the carbon cost to the electricity price so that the electricity users pay the full carbon cost on their electricity use. However, in reality in many markets the electricity price is regulated and the electricity producers can not pass through the full carbon cost to consumers. Moreover, large industrial electricity users often negotiate long term contracts with lower electricity prices.

An additional advantage of targeting the electricity producers in a sector agreement is that this sector often has significant volumes of low cost carbon reductions.

6.5 Pass-through of costs – consumer incentives

If a sector agreement is to reduce competition distortion it is important that the sector participating in the sector agreement can pass through the additional carbon costs on the commodity so the carbon intensive products become more expensive for the **consumer**. If the carbon costs can not be passed through from producers to consumers, this would shield the consumer from the true price of carbon. This reduces the consumer incentives to choose more carbon efficient products.

In the section above this has been argued for the electricity sector, but is valid for other carbon intensive sectors such as iron and steel, cement and refineries. A full pass through of the carbon cost would be compromised in countries with centrally regulated prices on carbon intensive commodities.

For commodities traded on the international market, for instance steel, it is important that the major producing countries are subject to a real carbon price the carbon price is passed through in all countries. If some significant countries would not pass-through the carbon cost this may create a significant distortion in competitiveness. This may lead to decreased passed-through in the other countries, closures or relocation.

6.6 Target setting - producer incentives

If an objective of a sectoral agreement is to create a carbon price, equally important is that targets are set in way that does not reduce the **producer incentives** for carbon reduction and undermine the full carbon price.

From an incentive point of view, the process of setting targets (determining compliance levels) for DC industry is similar to the allocation of emission allowances in an emission trading system. In order to understand how the setting of compliance levels in a sector agreement influence incentives, important experience can be drawn from the EU ETS and how allowances have been allocated to industry.

From an incentive point of view, the setting of a compliance level in a sector agreement can be done in three different ways:

1) Absolute targets with no ex-post adjustment
The **absolute target** model means that an absolute emission target is negotiated before the agreement enters into force. This target can be based on either emissions (historic or projected) or intensity targets multiplied by production (historic or projected). It is crucial that this target is not adjusted ex-post, since that would introduce perverse incentives. The target should be defined both on the national sector level and on installation level and not renegotiated. The positive feature with an **absolute target** model is that it does not introduce perverse incentives to increase emissions or production.

The disadvantages are:

- Difficulty in estimating the emission levels. If the targets are too strict, the carbon price will be too high; if levels are too slack, the carbon price will be to low and there will be risk of hot air,
- There is no flexibility to update the targets, once the system starts,
- The uncertainty in setting appropriate levels and not allowing updating flexibility may lead to difficulties in negotiating an **absolute target** model.

The updating dilemma
If ex-post adjustments are not allowed, after several years, the predetermined target (both at installation level and sector/national level) will become increasingly irrelevant. After 5, 10, 20 years the sector may have significantly increased or decreased production and emissions and it will become increasingly difficult to justify the pre-determined compliance level. It would here be tempting to revise the targets. However, allowing for adjusting the targets would introduce perverse incentives for industry to act in a way that increases revenues from credit sales. A compromise would be to base targets on *intensity targets* and *output*.

2) Intensity targets with ex-post adjustment of output
The **intensity target** model means that target is defined as an *intensity factor* (i.e. ton CO_2/ton pig iron produced) multiplied by *output* (i.e. ton pig iron). This method is also referred to as *benchmarking*. The *output* value is continuously updated according to the actual outcome. The *intensity factor* should (from an incentive point of view) be negotiated before the agreement enters into force. The intensity factor may be changed over time following a pre-determined schedule. The positive features of **intensity target** model are:

- it provides flexibility as it allows for ex-post adjustments of output
- it rewards carbon efficiency, since companies with low specific emissions will reach the targets easier and may be able to sell more credits than companies that are less carbon efficient.

The disadvantages with the **intensity target** model are:

- as a production subsidy it encourages overproduction, and
- disincentivises the substitution to carbon efficient products.

3) Emission targets with ex-post adjustment
A third theoretically possible method is **emission targets with ex-post adjustment.** This means that the compliance level is based on emissions and updated as emission levels change. However, this method introduces a strong perverse incentive for the operator to maintain or increase emissions in order to gain revenues in the future. This model severely undermines the full carbon price and should be avoided.

Pass-through of costs from a producer perspective
If the DC does not pass-through carbon costs to the consumer, this creates two problems:

- For competitive reasons, the EU industry will in response have difficulty in passing through their carbon costs to the consumer. This would shield the consumer from the true carbon cost and reduce the consumer incentives to choose carbon efficient alternatives.
- Secondly, if the EU industry has to pay for their allowances and **cannot** pass through the carbon costs to the consumer this may lead to unsupportable cost increases which may lead to closures or carbon leakage. There will therefore be strong pressure on the EU to compensate industry by issuing free allowances to the industry. This would in turn decrease the producer incentives to reduce carbon emissions.

The best solution is therefore that both regions (DC and EU) can pass through the full carbon costs on the consumer.

6.7 Compliance costs for industry

In this section, we discuss how different sector models influence the **compliance costs** of participating countries. For a *Sector emission trading system*, the compliance costs for participating companies have two components: 1) the carbon reduction costs and 2) the costs for allowances. For a *Sector CDM* and *Sector no-lose mechansim* model, it is more complicated. As in *Sector emission trading system*, there are costs for carbon reductions, but no costs for allowances. Instead of allowances, the national government may choose to implement a domestic carbon tax for industry. This tax would then correspond to the cost for allowances in a *Sector emission trading system.* But there are alternative national policies that could be implemented with a relative modest cost for industry. For instance technical standards, tax refund schemes or penalties.

Experience from emission trading systems show that the cost of allowances or taxes for a sector can be 10-20 times higher than the cost for emission reductions. For carbon intensive industries, the cost for allowances may be significant reaching more than 30% of the value added. For a developing country firm participating in a Sector agreement, it will therefore be highly important if there is a cost for allowances or a corresponding tax. For carbon intensive industries this may influence the funding available for investments.

If a sector agreement in a developing country is linked to a carbon market in another region, there may also be a risk of differences in compliance costs between regions. Assume a situation where a DC industry sector is linked to the EU ETS, and where the EU industry pays for allowances (no free allocation). For a *Sector emission trading system* where the DC industry has to pay for allowances, the compliance costs could be compatible in the two regions. For the *Sector CDM* and the *Sector no-lose mechanism*, if the DC government implements a domestic carbon tax, the compliance costs may also be compatible in the two regions. However, if allowances are allocated freely to the DC industry and no tax is implemented, the DC industry would have no costs associated with the carbon emissions below the compliance level. There would here be a significant difference in compliance costs between the industries in the two regions. We have, however, not analysed if significant asymmetries in compliance costs can lead to competitive distortions between regions.

6.8 Should industry be compensated for increased costs?

The rationale for allocating allowances freely to industry can for instance be to compensate firms for increased costs it faces in the sector agreement. However, if the operator can pass through the costs to the consumer there is little justification for compensation. On the other hand, if industry can not pass through the carbon costs to the consumer (which would be unfortunate for other reasons), there may be a need for compensation. Free allocation could be one way to do this. Other options could be tax reductions or other forms of state aid.

The question of free allocation is likely to become a contentious issue. Since the value of allowances is considerable, there is considerable wealth to be gained (or lost) through allocation of allowances, which opens for substantial rent seeking efforts from the DC industry.

Does free allocation influence incentives for carbon reductions?
The option of compensating industry by free allocation should be carefully considered. Firstly, if the DC government decides to issue allowances freely to industry this would constitute a significant transfer of wealth from the state to the firms. Secondly, as discussed in section 6.7, free allocation may have a significant impact on a company's compliance costs, which may distort competition between regions. A third issue is that free allocation may, if implemented in an unappropriate way, may introduce perverse incentives with respect to carbon reductions.

6.9 How are targets set within the EU?

As the EU climate and energy package that was passed in the council and parliament in December 2008, there is a recent example of target setting between countries. According to the EU Energy and Climate package, the EU has decided to reduce emissions of greenhouse gases by 20% to the year 2020 as compared to the year 1990. In 2005 a 6% reduction has been achieved, leaving 14% emission reduction to be achieved from 2005 to 2020. This effort will be divided between the EU ETS and the non-ETS sectors in the following way:

- a 21% reduction in EU ETS sector emissions compared to 2005 by 2020;
- a reduction of around 10% compared to 2005 for the sectors that are not covered by the EU ETS.

ETS-sectors
These sectors currently include *Iron and steel*, *Mineral* including *Cement and Lime*, *Pulp and paper* and *Energy including refineries*. The aviation sector will be included in 2012.

A major change compared to earlier phases is that in phase III (2013-2020) there will not be any national allocation plans, but a common EU-wide cap. The Commission proposed that auctioning of allowances should become the basic principle of allocation. The Commission estimates that more than 50% of the allowances will be auctioned.

In a "transitional" phase, free allowances will be issued to industrial installations and in some cases also to electricity production plants. The rules for free allocation will be adopted in 2010 and aim at harmonising allocations for all firms across the EU with the same or similar activities. The proposal states that the allocations should be based on benchmarks, e.g. a number of allowances per quantity of historical output.

Non-ETS sectors
Non-ETS sector are made up of small scale emitters in a wide range of sectors such as transports (cars, trucks), buildings, services, small industrial installations, agriculture and waste. These sectors currently represent some 60% of total greenhouse gases emissions in the EU.

Within the Member States there will be an effort sharing of the 10% reduction. According to the climate and energy package, all member states have individual targets expressed as a percentage, which average out at -10%. GDP/capita has been used as the main criterion when setting the national targets. In figures, this means that less wealthy member states will be allowed to increase their emissions in non-ETS sectors by up to 20% above 2005 levels. These targets do, however, still represent a cap on their emissions and will still require a reduction effort. By contrast, in the wealthier Member States, where GDP/capita exceeds the EU average, an emissions reduction above the EU average is required, up to a maximum figure of -20% below 2005 where GDP/capita is highest. In contrast to the ETS, the there are no provisions for trading reductions between Member States. However, the CDM-mechanism can be used for complying, up to a certain level.

7 Key messages

Key messages from this study include:

Climate policy raises concerns of industrial competitiveness. Greenhouse gas emissions need to be further reduced, which means that emission caps will have to be tightened. It is not likely that there will be a single global price for carbon in the near future. Due to this there is an increasing concern that countries with stringent climate policies will place domestic industries at disadvantage compared to competitors in countries with less ambitious climate policies. Concerns of the loss of industrial competitiveness and leakage of emissions are one of the major barriers to introduce more far reaching CO_2 mitigation obligations on industrial sectors in the EU.

Metrics for assessing competitive distortion. Two metrics have been identified and used in order to measure how asymmetric CO_2-prices will distort competitiveness and impact specific (exposed) sectors (Hourcade et al 2008, Graichen et al 2008, European Parliament 2008). The first parameter is the *Maximum value at stake* and the second parameter of importance is *Trade intensity*, described in chapter 3.

Recent studies in the United Kingdom and Germany have assessed the impact on competitiveness of the EU ETS. Two studies, for the United Kingdom (Hourcade et al 2008) and Germany (Graichen et al 2008), have recently assessed the potential cost impact for different industrial sectors of CO_2-prices due to the EU ETS. Maximum value at stake was used as metrics. The sectors with high potential impact, with a maximum value at stake larger than 10%, are in the United Kingdom Lime and Cement, Basic Iron and Steel, Starches, Refined petroleum, Fertilizers and Nitrogen compounds and Aluminium. In Germany, the sectors with a maximum value at stake larger than 10% are Cement and Lime, Fertilizers and Nitrogen compounds, Basic iron and Steel, Aluminium. Paper and board, other basic inorganic compounds and Coke & Refined petroleum &

nuclear fuels. However, the studies also conclude that sectors need to be analysed in detailed and separated into sub-sectors in order to find solutions to prevent distortions of competitiveness and carbon leakage.

Ex-ante studies of the impacts of competitiveness and carbon leakage due to the EU ETS fail to find actual impacts. However, that does not mean that there will be no impact in the future, which hold changes both in the EU ETS (method for allowance allocation, allowance prices etc) and possibly also other important circumstances (global demand for certain products and global product prices).

Impacted sectors in Sweden. Based on official Swedish statistics, the maximum value a stake (MVAS) has been calculated for 52 Swedish sectors**.** Seven sectors have a MVAS of more than 4%: Coke and Refined petroleum (21%), Pulp and Paper (11%), Basic Metals (10%), Non-metallic mineral (9%), Metal ore mines (6%), Air transport (5%) and Electricity, Gas and Heat (4%). If Air transport and Electricity, Gas and Heat are omitted, the five remaining sectors account for 22% of Sweden's carbon emissions.

Comparison of Sweden with Germany and United Kingdom
In Sweden, the *Non-metallic mineral* sector, including Cement and lime the *Maximum value at stake* is considerably lower than for Cement and lime in the UK and Germany. This is most likely due differences in system boundaries. In the Swedish statistics, the Cement and Lime industry is a minor part (in terms of value added) of the *Non-metallic mineral* sector, a sector that also includes Stone, sand and soil industry. Therefore the *MVAS* for *Non-metallic mineral* is probably a poor proxy of the *MVAS* for Cement and lime as other sub sectors would "dilute" the *MVAS*. Differences in system boundaries may also explain the significant difference in *MVAS* between the Swedish steel industry and UK and German steel industries. Other possible explanations may be a higher value added per unit, differences in how value added is calculated, different years for the statistics and lower CO_2-intensity for Swedish products.

Three sectoral agreements on the EU policy agenda. The EU proposes three types of sectoral approaches to be discussed under *the Ad-hoc Working Group on future commitments for Annex I Parties under the Kyoto Protocol* (AWG-KP):
i) *Sector CDM* – a CDM crediting mechanism with a previously established baseline
ii) *Sectoral no-lose mechanism* - Sectoral crediting against a previously established no-lose target
iii) *Sectoral emission trading* based on a sectoral emissions cap

Creating a price on carbon. If sector agreements are to reduce distortions on competition, it is important that the sector agreements create a real carbon price in the DC, i.e. that emissions of carbon dioxide are associated with a cost for the emitter. All three sector agreement-models suggested by the EU can potentially create a carbon price. The driver for emission reductions are in all three cases the international demand for offsets.

The EU demand for off-sets will increase the carbon price in the DC sector, thus reducing the competition distortion between the DC and the EU. As a potentially large buyer of off-sets the EU will be an important driver for creating a price on carbon in the DC sector. The choice of EU policy with respect to imports of off-set will therefore have great importance. Other buyers, such as other countries, emission trading systems or the voluntary credit market will of course also be important. A carbon price can be created in the DC without involving the EU, but in practice, as a potentially large off-sets buyer, the participation of the EU will have significant importance. In addition, imports of off-sets may reduce the price on EU ETS allowances, thus further narrowing the carbon price gap between the two markets.

Targeting sectors. If an important objective of a *sectoral agreement* is to reduce competition distortion it should be implemented in sectors where the corresponding Swedish industry has significant carbon related costs and where there is significant trade intensity between Sweden and regions outside the EU. Our preliminary analysis based on Swedish aggregated statistics, indicates that Swedish sectors with potentially high *maximum value at stake* (direct carbon and indirect electricity cost) are Refineries; Pulp and Paper; Iron and Steel; Cement and Lime; and Metal ore mining. The sectors Aluminium and Fertilizers may be important, but have not been assessed explicitly in this study.

Indirect effects – electricity. Experience from the EU has shown us that not only carbon intensive industries are impacted by the carbon price of the EU ETS. Electricity production in the EU is included in the EU ETS and since the electricity producers can pass on their costs for carbon on consumers, there has been a significant increase in the price of electricity. In DCs where electricity intensive industries compete with Swedish electricity intensive industries, for instance pulp and paper or aluminium, including the electricity sector in a sectoral agreement could potentially reduce the competition distortion for these industries. If so, it is important that the electricity producers in the DC can pass on the carbon costs on the consumers.

Pass-through of costs – consumer incentives. If a *sectoral agreement* is to reduce competition distortion it is important that the sector participating in the *sectoral agreement* can pass through the additional carbon costs on the commodity so the carbon intensive products become more expensive for the consumer. A full pass through of the carbon cost could be compromised in countries with centrally regulated prices on carbon intensive commodities or other measures that shield the true price of carbon from the consumer.

Target setting – producer incentives. The rules for setting the targets in the DC sector are crucial from an incentive point of view. There are two main options here: 1) **absolute targets** and 2) **intensity targets**. Absolute targets create high incentives for carbon reductions as long as the targets are not re-negotiated. The disadvantage is that they might be difficult to negotiate due to difficulty in finding an appropriate emission level, risk for hot air and the inflexibility to future adjustments. Intensity targets are based on *production* times an *intensity factor* (called *benchmarking*). But benchmarking leads to reduced incentives: i) as a production subsidy it encourages overproduction and ii) dis-incentivises the substitution to carbon efficient products. A third, theoretical, option would be absolute targets that are updated according to historic emissions. This model would, however, seriously undermine the incentives for emission reductions.

In this study, we have argued that from a competition point of view, it's important to create a carbon price in the developing country. A different issue relates to how different sector agreement models influence the compliance costs of participating firms. We describe a situation where a DC industry sector is linked to the EU ETS, and where the EU industry pays for allowances (no free allocation). For a *Sector emission trading system* where the DC industry has to pay for allowances, the compliance costs could be compatible in the two regions. For *Sector CDM* and *Sector no-lose mechanism*, if the government implements a domestic carbon tax, the compliance costs may also be compatible in the two regions. However, if allowances are allocated freely to the DC industry and no tax is implemented, the DC industry would have no costs associated with the carbon emissions below the compliance level. There could here be a significant difference in compliance costs between the industries in the two regions. We have, however, not analysed if significant asymmetries in compliance costs can lead to significant competitive distortions between regions.

Should industry be compensated for increased costs?

The rationale for allocating allowances freely to industry can for instance be to compensate firms for increased costs it faces in the Sector agreement. However, if the operator can pass through the costs to the consumer there is little justification for compensation. On the other hand, if industry can not pass through the carbon costs to the consumer (which would be unfortunate for other reasons), there may be a need for compensation. Free allocation could be one way to do this. Other options could be tax reductions or other forms of state aid. If industry is compensated by free allocation, it is important that it is done in a way that does not reduce the incentives for carbon reductions.

8 Further work

Issues that we recommend for further study include:

1. Analyse if differences in compliance costs for firms participating in market based carbon policy regimes may lead to competition distortion.
2. In this report maximum value added at stake has been calculated for 52 Swedish sectors based on aggregated data available from Statistics Sweden. We recommend that *Maximum value added at stake* and possibly *Trade intensity* is calculated for the sectors participating in the EU ETS based on **sub sector** data in order to resolve MVAS for key sectors such as Cement and Lime, Steel, Aluminium, Metal ore mines and Fertilisers.
3. Calculate corresponding *Maximum value at stake* on the EU level for the sectors participating in the EU ETS and compare with the official EU threshold values that will be used for determining if a sector should be subject to free allocation or not in phase III of the EU ETS.
4. In sectors identified to be at risk: investigate the climate for new investments; is there an impact on future investments? Do companies rather invest in new production capacity in countries outside the EU ETS? Why? The impact on future investments of the EU electricity market and prices. What is most important, the removal of subventions of electricity prices or the increase due to carbon prices?
5. Effort sharing between EU and DC. How can an appropriate target level be determined, without creating hot air (too low carbon price) on one hand; and on the other hand not compensating DCs enough?
6. Developing country perspectives: Can developing countries bear the same carbon price as the EU? What reasons and costs are there for NOT having the same carbon price globally?

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