International Industrial Competitiveness, Carbon Leakage and Approaches to Carbon Pricing

www.climatestrategies.org

November 2012

Abstract

The report looks into regional as well as sectoral aspects of carbon leakage and competitiveness concerns induced by carbon pricing, and policies to address them. Carbon leakage is caused by the cost impact from CO_2 pricing on industrial production, induced changes in trade flows and investment decisions. The leakage potential across the most energy-intensive sectors is similar in the EU, Japan and also – according to first estimates – in China. In the short run, the effectiveness of different policies to address carbon leakage depends on the trade integration in each sector and the sectors' ability to absorb or pass on the extra costs without loosing market shares. A threat of lower export market shares could be eliviated both with export rebates of carbon costs or with free allowances, a relevant issue, e.g. for steel firms in the EU and Japan. From an industry point of view, carbon costs also matter for investment in the long-term. This concern is not taken into account by unilateral climate policies and needs further attention by policymakers as part of "green" technology development agendas. New carbon pricing schemes, in particular in China, will alter the business environment for investors in energy-intensive industries and would request new carbon leakage forecasts.

This report summarises the Climate Strategies project "*International industrial competitiveness, carbon leakage and approaches to carbon pricing – An analysis of the key sectors*" conducted from 2010 to 2012.

More information and underlying working papers are available on the CS website:
http://climatestrategies.org/research/our-reports/category/61.html

Introduction

Carbon leakage and international competitiveness issues are salient for governments and businesses because of the continuing and largely uncoordinated development of carbon pricing systems around the world. In addition, the economies are coping with an ongoing recession in most industrial countries. The discussion about the nature, extent and implications of the carbon leakage and international competitiveness effects of different national climate policy approaches has at least two dimensions: how effective are national schemes in this environment? How will energy-intensive industries handle the challenges of carbon costs, competition and investment given the short- and long-term market trends and fragmented climate policies?

In this report, the focus is on carbon leakage through industrial activities and refers to process emissions (direct emissions) as well as emissions from electricity use (indirect emissions), which are shifted to foreign locations as a reaction to unilateral carbon pricing. This shift can be based on the operational decisions of firms, e.g. to import more of a carbon-intensive input instead of producing it at home, or it can be based on the relocation of production sites as part of the overall investment decisions. The degree to which firms tend to change their operation and investment depends on their ability to pass through the carbon costs to their customers. However, there are also major factors beyond climate policy which determine such decisions, such as wages or other input costs, regulation or trends in demand and market developments.

From a climate policy point of view, any carbon leakage is an undesired effect as - while emissions are lowered at home - GHG are actually partly or fully emitted abroad instead.

This report highlights a number of findings on the effects from national carbon pricing in the EU, Spain, Japan and China on industrial sectors, in particular the Energy-Intensive Industries (EII). A sectoral perspective is added which shows how demand trends, cost structures, and regulation determine the EII ability to react to carbon pricing in different settings. In particular we look into steel, cement, aluminium, refining, chemicals and pulp and paper. Moreover, some of the remedies against industrial carbon leakage are investigated, with a focus on measures taken at the border, when goods from these sectors are imported or exported (BA – border adjustments).

Climate Policy in Times of Financial Crisis

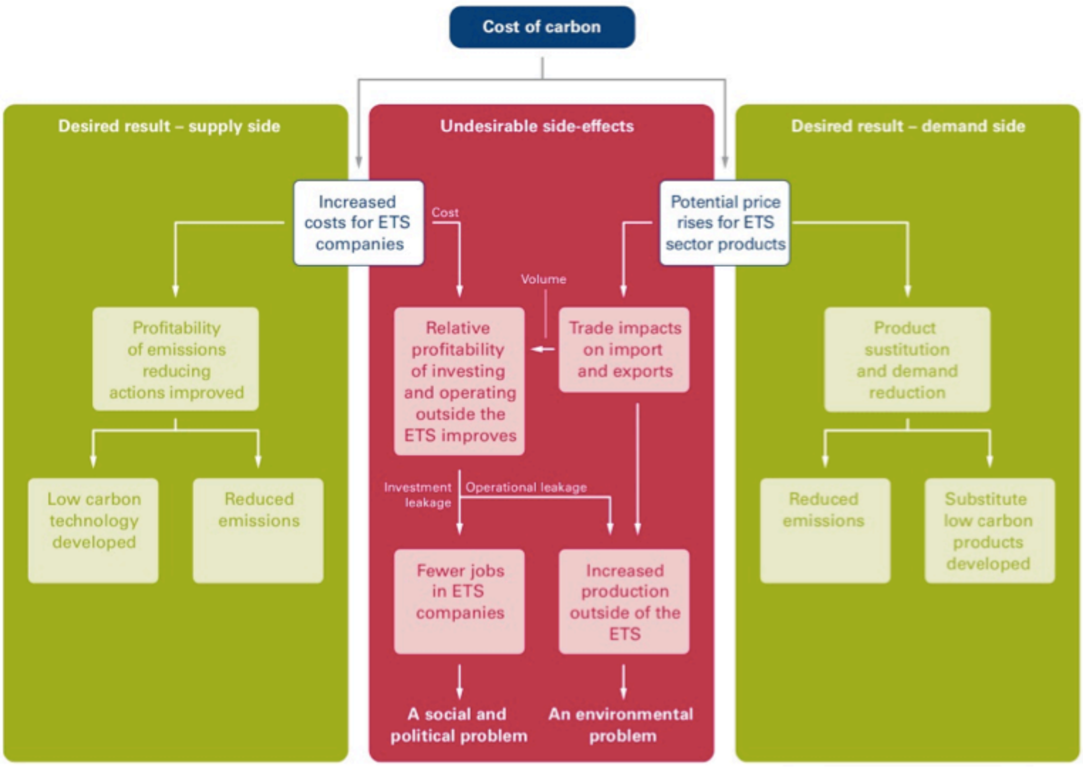
The research on competitiveness and leakage was undertaken on the backdrop of a major global financial and economic crisis. This crisis, and the related drop in output and GDP across the globe, added to the controversial international debate about how climate policies should progress in the mid- to long-term. The negotiations under the UNFCCC could not move towards higher climate protection as was required by the 2007 Bali Action Plan. The COP 17 in Durban achieved a timeline until 2015 for a new agreement to be negotiated and to become effective in 2020 the earliest. The European Commission (further: EU Commission), who had renewed in Durban its promise to deliver a unilateral reduction of 30% until 2020, has severe difficulties finding the support by all EU member states for such a step. The negative effects the crisis had on investment potential were highlighted in numerous reports on a more ambitious EU climate policy (e.g. EU Commission 2012) and are being regarded as detrimental to a low carbon development.

On the other hand, the slump in GDP caused, amongst other factors, falling allowance prices in Phase II (2008 - 2012) of the EU ETS. Price projections for Phase III are low as well, due to an oversupply of allowances and emission reduction credits. The debate on how to intervene into the EU ETS is still ongoing. One option to reduce the supply is to move to the 30% reduction target by 2020 instead of the 20% reduction target as stipulated in the 2008 climate and energy package.

The crisis affected the Energy-Intensive Industries (EII) severely. These sectors had to recover from demand slumping in all major markets during 2009, leading to cost cuts and restructuring, and delay of planned investment. Carbon costs were no longer at center of the attention. The EU carbon market is pro-cyclical and costs declined. Yet, with a view to new investments which have a horizon of up to 40 years, the EII demand political commitment for keeping their role in the mature economies' green development agenda (as set up e.g. in OECD 2011).

Despite the unfavourable economic situation and slow progress under the UNFCCC, there is an increasing number of national carbon pricing schemes in countries outside the EU, in particular in Australia (2012) and South Korea (2013). The US dropped national cap and trade plans, but this did not slow policies at state level: California introduced a cap and trade program, passed in 2011. Also, China plans to test emissions trading in seven provinces starting in 2015. Also, interest grew in the revenues from auctioning emission certificates as a means to reduce public debt, to improve budgetary performance, and to finance international cooperation on climate change policies by the UNFCCC Green Climate Fund.

Box 1 Cost of carbon – social and environmental effects



Source: Carbon Trust, 2010

European Union: The Future Climate Policy

The move to a 30% unilateral CO_2-reduction-target by the EU in 2020 remains on the policy agenda and is part of the international climate negotiations strategy of the EU Commission. The Commission released in 2010 calculations of the costs to increase the unilateral ambitions, assuming that the ETS and non-ETS sectors follow a predetermined share of the overall reduction burden (European Commission 2010). The future EU target will alter the potential for carbon leakage and this is of high political interest, despite the dampening effects the economic downturn has on emissions and CO_2 prices.

The carbon leakage effects from a 30% policy target as well as the potential remedies were subject to further investigation. Partial equilibrium analysis (e.g. by Monjon 2011) shows that European production levels in energy-intensive industries would drop once a tighter target leads to higher CO2 costs. Also, Monjon and Quirion (2011) have compared different ways to compensate industries for their carbon costs. In particular the adjustment of carbon costs at the border (border levelling) could deliver an effective result against carbon leakage in the cement and, partly, also in the steel sector. From a macroeconomic perspective – including labour market effects, redistribution of auctioning revenues or cross-sectoral effects - Pollit, Summerton and Thoung (2012) show that a move to the 30% unilateral reduction target would deliver a higher carbon price regardless of how the effort is shared between the ETS and the non-ETS sectors. It would cause an overall output decline in the steel and cement sectors, but not a significant increase in imports (and thus a related carbon leakage effect). According to their findings, the implementation of border adjustments as a remedy against carbon leakage from steel and cement imports has no major negative macroeconomic ramifications. However, it has an impact on the sectors' output, and imports demand declines in the range of 13 to 15% (which explains the effectiveness of such anti-leakage measures).

Border adjustments for imports also generate revenues which could be recycled to compensate carbon costs or to stipulate abatement investment. Their absolute size would amount to 5 to 6bn Euros if based on 2008 data according to Pollit et al. (2012) and a carbon price of 70 Euros. However, these numbers need to be corrected for the low carbon price prospects in Phase III of the EU ETS. In 2012 the CO_2 price was only around a tenth of the projections in the E3MG model applied by the authors. The revenues expectations thus would have to be adjusted in the same proportion if this price prevails during Phase III.

An analysis by Linares and Santamaria (2012) sheds some more light on how imports change under a CO_2 price. Their technology-based modelling approach examins for the Spanish cement, steel and refining industries how imports increase together with the carbon price if the demand for products from the sectors does not change (an assumption which only holds for times of business cycle peaks). Coastal clinker production would be fully substituted by imports to Spain at a CO_2 price of 18€/tonne. In the steel industry, the first reaction to an increasing CO_2 price would be increasing scrap use. For plants operating with the more carbon-intensive technology (BOF – blast oxygen furnaces), imports would increase dramatically at a CO_2 price of 12€. For steel from the low-carbon electric arc furnaces (EAF), imports would be more competitive at 20€/t CO_2 if demand remains unaffected by rising prices. Thus, as the Spanish steel production is largely using EAF (while other EU producers rely mainly on BOF), there is no immediate carbon leakage to be expected under the 30% policy target given the low CO_2 price of around 7 Euros in 2012. Refining industries face a different situation: due to large overcapacities in Asia, increasing production costs for diesel in Europe and a rising oil price, CO_2 cost have an impact on industries on the one hand, but are of little importance compared to the volatility of global markets and shifts in regional production on the other hand.

The macroeconomic analyses on the European policy situation help fill some gaps on the impacts of border levelling policies and on different burden sharing between ETS and non-ETS sectors under a 30% target. The analysis for the Spanish industries, moreover, indicates how different the producers in the EU member states are at a risk of leakage and could handle that risk. Their technological settings determine the intra-EU competitiveness impacts (steel) as well as the geographic exposure determines cheap transportation options (clinker) for imported substitutes.

JAPAN: A mandatory ETS – How Would EII be affected?

Japanese policymakers for some years have been discussing to turn the voluntary Japanese ETS into a mandatory scheme (Takamura and Kameyama 2009; Asuka et al., 2009). In 2011 and 2012 there were two design options under discussion for the treatment of the power producers: either they could be subject to a CO_2 tax while the manufacturers are covered by an ETS (design 1 "tax"), or they could be included under the ETS together with manufacturers (design 2 "ets").

These different options could have different cost impacts on the Japanese EII as the indirect carbon costs would differ. In order to generate first insights on such a mandatory ETS in Japan, the partial equilibrium model CASE II (Monjon and Quirion 2011) was extended and adjusted to represent the specific features in Japan (CASE-ASIA). In addition to the two policy design options, and differing from the EU ETS, the analysis refers to differentiated caps for each sector along their contribution to the Japanese overall emissions (Table 1). The power sector has to contribute the most (-18.7%), while refining has a specific target of -5.6% only, reflecting their high and the low shares in national emissions.

Table 1: Emission reduction ratio between 2005 and 2020, Japan

Sector	Reduction Ratio (2005-2020)
Cement	-7.5%
Hot rolled steel	-15.3%
Aliphatic intermediates	-5.6%
Electric power	-18.7%

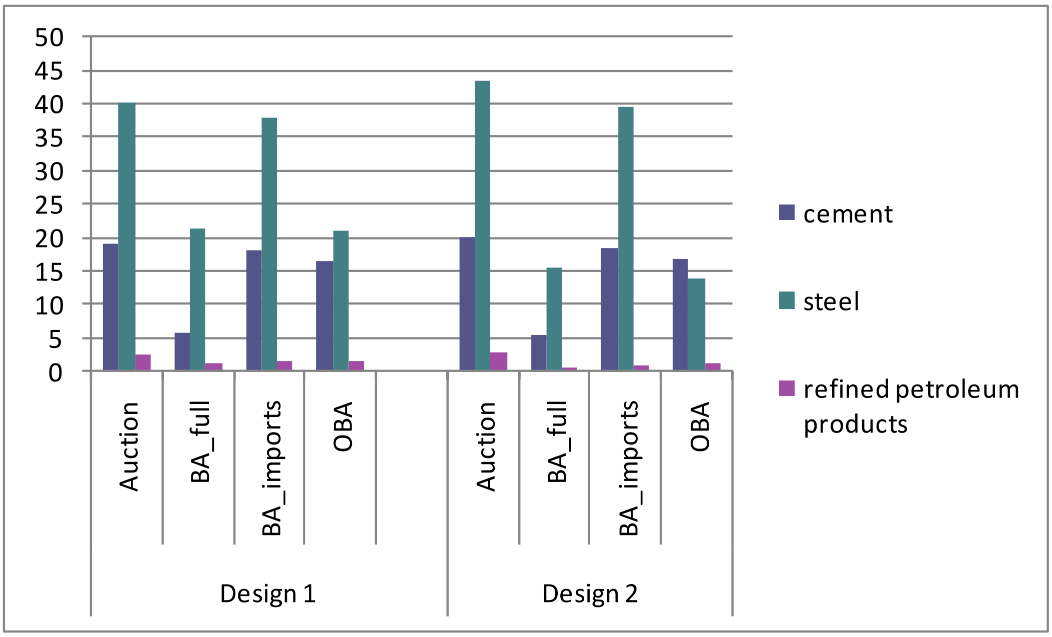
Source: evaluation by IGES based on Ministry of Environment (2010)

These reduction ratios were included in CASE-ASIA and the different caps were evaluated in the ETS under design 1 ("tax") and 2 ("ets"). By applying the above reduction ratio, the cap in 2020 would be 512.3 Mt CO_2e for the four sectors modelled, i.e. a decrease of 16.7% in emissions.

The two different design options for the power sector were analysed with respect to their impacts on carbon leakage and industrial production and in combination with different allocation rules for industries: (1) full auctioning for all sectors or full auctioning for manufacturing plus CO_2 tax for the power setor, or (2) auctioning as in (1) with full border adjustment for exports and imports, (3) auctioning as in (1) with border adjustment only for imports, or (4) auctioning as in (1) with output-based free allocation to the sectors. The power sector in all scenarios has either to pay the CO_2 tax (design 1) or it has to auction allowances under the ETS (design 2).

Figure 1 shows the different leakage ratios for the four sectors and for the different power sector treatments.

Figure 1 Leakage rates* for cement, steel and refining in Japan in 2020 (%); Design 1 represents a carbon tax on the power sector, design 2 includes the power sector in the ETS; Note: Under the Design 1, the CO_2-tax is USD66



*"Leakage rate" refers to the "leakage-to-reduction-ratio", i.e. the share of emissions reduction in a sector which is caused by a shift of emissions to other jurisdictions. Source: Monjon, 2011

The CO_2 price with an ETS for all sectors (design 2) is higher than with an ETS only for the three sectors (design 1), which is not surprising given the high share of the power sector in Table 1. Depending on the type of allocation, the CO_2 price in the other sectors varies between 14 and 30 USD/t CO_2e. Once the power sector is included in the ETS its demand for allowances pushes up the CO_2 price.

The higher CO_2 price for design 2 leads to more leakage across sectors in case of full auctioning, but this extra effect is small. Based on the logic of the CASE-ASIA model, a higher tax (or CO_2 price) for electricity leads to higher product prices for the EII. Higher prices reduce demand for EII products both at the national and at the international level. This dampens the leakage effect. With a constant demand, the leakage rates for the sectors would be much higher under design 2.

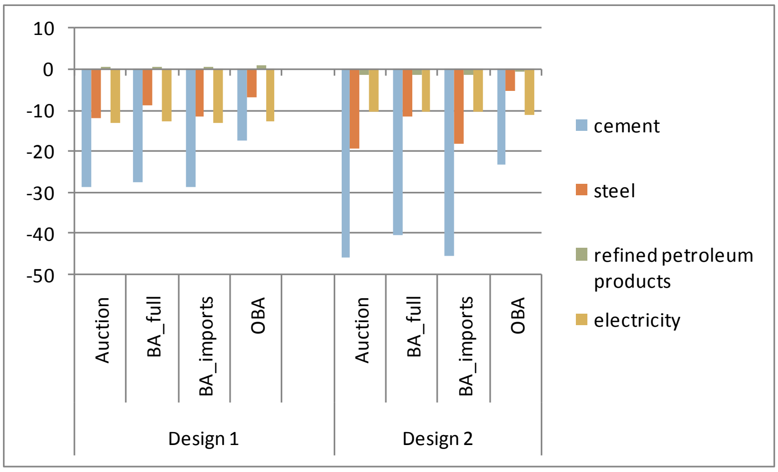
The impact on production is a very important indicator of how carbon leakage occurs in the sectors under investigation. As illustrated in Figure 2, the domestic production of cement in Japan would decline sharply under full auctioning of emission rights and in particular if the power sector is included in the ETS (design 2). Output decline is lower in the cement sector only in case of free allocation of emission rights (OBA in Figure 2). The steel industry would also decrease output by nearly 20% under full auctioning when power producers are included in the scheme, and around 10% if power producers are taxed. For all sectors, the decline in output would be reduced best by using output-based free allocation. The Japanese steel sector is most exposed to carbon leakage with a ratio of 40% (design 1) and 45% (design 2).

This is not surprising as the steel sector shows the highest cost impact from a CO_2 price in Japan. Steel production is modelled assuming average emissions from both production routes (BOF and EAF) and electricity costs have an important impact on steel prices. Monjon (2011) finds that for steel production leakage is most effectively addressed using output-based allocation. The cost adjustment for imports, i.e. a CO_2 price for imported steel, does not reduce the production loss very much. This indicates that carbon leakage from this sector would occur due to the loss of competitiveness in international markets, not so much in domestic markets. Consequently, only a full border adjustment (i.e. with export rebates) would help to mitigate the leakage from steel and this would yield similar rates as the free allocation. Yet, even with full export rebates and import tariffs, there is a significant production decrease in steel.

For cement the leakage rate would amount to around 20% under both designs and with auctioning of emission rights. Here, a full border adjustment is clearly more effective than free allocation. Due to the composition of trade flows in steel and cement in Japan, carbon leakage from exports is more important than from import competition. Thus, only a full levelling of carbon costs at the border will deliver a reduction of leakage. This also explains why output-based allocation works so well also for cement, as it makes exports cheaper. Results from CASE II for the EU ETS deliver a different recommendation: import cost adjustments outperform output-based free allocation in reducing leakage in the EU cement sector (Monjon and Quirion 2011), because imports are the major source of leakage. Thus, inclusion of importers in the EU ETS was identified as the most effective tool for the cement sector - in combination with full auctioning of emission rights (Droege et al., 2009, Carbon Trust, 2010).

For the refining sector results are not as significant as for cement and steel. There is little carbon leakage under auctioning (below 3%) with similar reduction effects if only the three sectors are included in the ETS (design 1) across all tools and only a slight differentiation if the ETS does include the power sector (design 2).

Figure 2, production level change (%) under a Japanese ETS with different designs for the power sector; note: Under the Design 1, the CO_2-tax is USD66



Source: Monjon, 2011

Implications - A Japanese Approach

The analysis of a mandatory ETS in Japan shows that carbon leakage from steel and cement production would undermine the effectiveness of the scheme. A full border adjustment would reduce the leakage rate. This is a different result than for cement production under the EU ETS, for which the inclusion of importers was identified as most effective. However, for steel the anti-leakage effect of border adjustments is similar to the performance of output based free allocation. As the free allocation would also keep production losses at a minimum, policymakers would probably rather opt for this anti-leakage tool, instead of the more contentious border adjustment option.

CHINA: CO_2 Cost Impacts on Industry - A First Rough Guide

When discussing unilateral carbon pricing by industrialised countries and leakage effects, China is the key country. The Chinese industries are still highly energy-intensive, but they are already targeted by national policies (Wang and Voituriez 2009). China has announced to introduce emissions trading in seven provinces starting in 2015 to further reduce its CO_2-emissions along the 12th five year plan (2011-2015). This five year plan includes a carbon-intensity reduction target of -17% and a further reduction of energy intensity by 16% until 2015.

CO_2 pricing in China can be expected to have a major market impact globally, due to the size of the domestic Chinese market for emission-intensive products such as steel and cement, and also because of China's rising share in global markets in a large number of emission-intensive products (e.g. chemicals, plastics, pulp and paper). The short term impact of a carbon price in China is difficult to estimate. The data available are only slowly improving. Moreover, for the state owned power sector market prices are not available to estimate the cost impacts from a carbon price.

Wang, Li and Zhang (2011) give a first estimate of the cost impacts from a CO_2 price in China. They use a concise data set (base year 2007) to evaluate the impact of a 100 Yuan (equivalent to 10 Euros) CO_2 price on the EII sectors in China. Wang et al. rely on data at an aggregate level, comparable to NACE categories, as sectoral and sub-sectoral energy and CO_2 emissions data are not available. This means that process emissions are not part of the evaluation. Instead sectoral CO_2 emissions are obtained based on adjusted sectoral total energy consumption data. China's Energy Statistical Yearbook provides information on energy consumption by fossil fuel types for 44 different sectors altogether, of which 20 were chosen for the CO_2 price impact analysis (Figure 3).

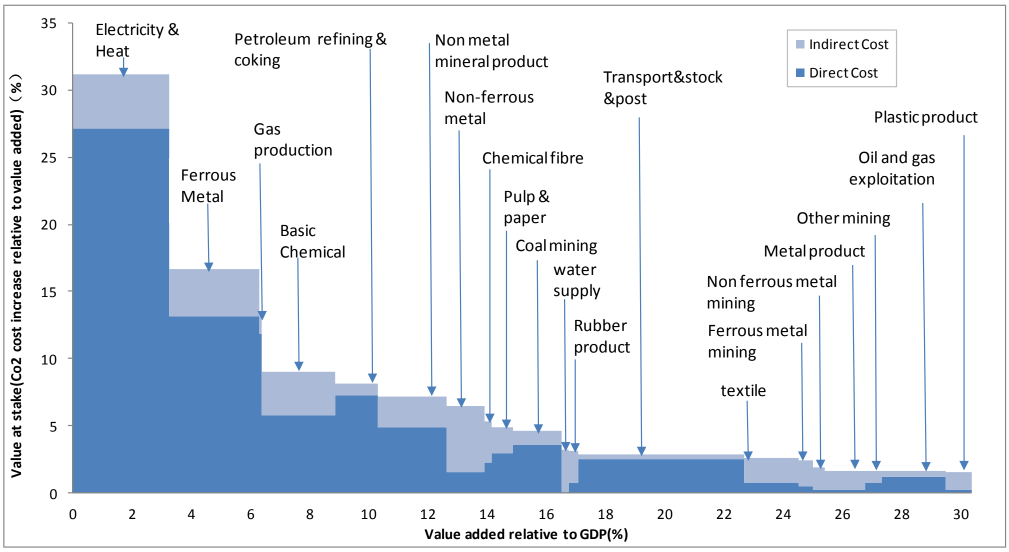
First, following the approach by Climate Strategies (Hourcade et al., 2007), the competitiveness impacts of a carbon price were calculated, using the rate of carbon cost to sectoral value-added (CtV) and the sectoral trade intensity as indicators (see figure 4). Second, the effects of such costs on the industry's domestic and export output levels were simulated.

For the analysis of the 20 sectors a carbon price of 100Yuan/t CO_2 was modelled as a CO_2 tax. Electricity and heat both are included. They pass on the CO_2 cost to the other sectors. The result for the cost impact rank five sectors as most affected, according to impact from all cost (indirect and direct). They include ferrous metals, basic chemicals, refining, non-metal mineral products (i.e. cement), non-ferrous metals (aluminium included).

If one would apply the EU ETS carbon leakage cost criteria (a cost impact of 5% or more of GVA and trade intensity 10% or higher, or either one 30% or more) to the Chinese industries, nine sectors, representing 13% of total Chinese GDP and 36.9% of total Chinese export (gross value), would be listed for cost compensation to reduce negative competitiveness effects and carbon leakage potential.

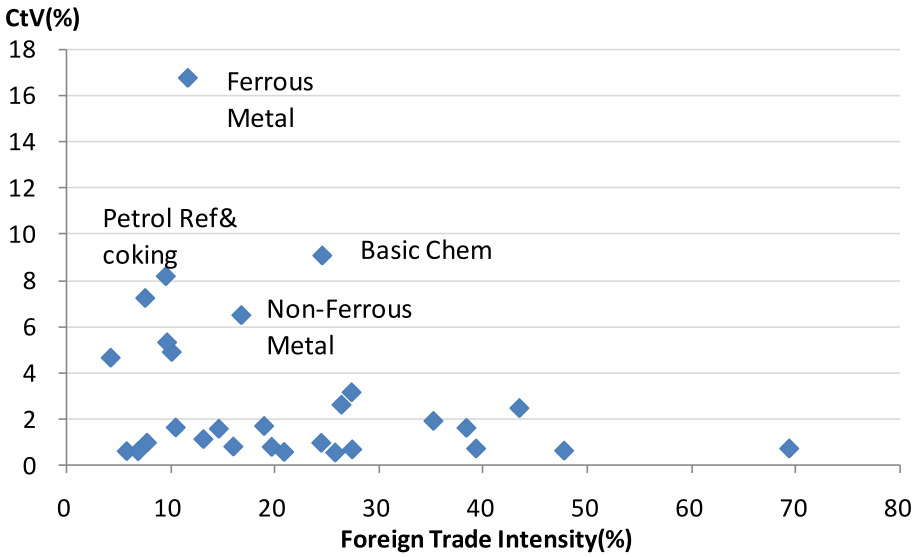
The impact of a 100Yuan/t CO_2 price on output in the different EII was calculated in a second step. Energy supply would be affected to a higher degree (coal mining: -11.4%, electricity power and heating generation: -6.6% and gas supply: -6.4%) than the EII output, which decreases by about 2-3%. Petroleum refining and the coke sector would disply an output reduction of 4.6%. The output in the light industries and labour-intensive sectors decreases by about 1%. This output reductions add up to a decrease of CO_2-emissions in the reference year 2007 of -11.15%. Moreover, exports from EII would decrease considerably, for instance exports of ferrous metals would decrease by one third of total exports

Figure 3, Impact of a CO_2 price of 100 Yuan/t CO_2 on value added. Note: the emissions cover energy combustion only; industrial process emissions are not included.



Source, Wang, Li and Zhang, 2011

Figure 4. Trade intensity and carbon cost impact, selected industries (100yuan/t CO_2)



CtV = carbon costs to sector value-added, Source: Wang et al., 2011

Implications – China

The analysis of a CO_2 price impact from 100 Yuan/t CO_2 on industry in China indicates that the sectors most affected by direct and indirect CO_2 cost include ferrous metals, basic chemicals, refining, and cement. These sectors – identified as being at risk of leakage in all quantitative investigations on competitiveness and carbon leakage effects – represent important parts of the Chinese economy including export flows. If China is interested in reducing energy-intensive exports, as could be observed in years with high growth rates and high domestic demand for steel or cement, a CO_2 price would serve this purpose and it would induce higher efficiency. In order to secure competitiveness for products which are at a higher position on the value chain, China might consider rebating carbon costs at the border (similar to VAT rebate).

If China embarks on CO_2 pricing this will change the competitiveness and leakage effects for its trade partners, too. Further analyses are needed to show the interaction of a Chinese CO_2 pricing policy on the trade flows with major trade partners (e.g.

Japan, US, Australia, EU), on carbon leakage, and also on the interactions with CO_2 price impacts on industries in these countries.

ENERGY INTENSIVE SECTORS: Perspectives on Future CO_2 Pricing

Energy-Intensive Industries (EII) are particularly exposed to emissions pricing, but will continue to play a very important role in low-carbon development across OECD and Non-OECD countries. National climate policies thus are a double-edged sword. On the one hand, steel, cement, aluminium, or basic chemicals represent the classic sectors of industrialisation and are large-scale emitters. On the other hand, the products from these sectors are integral part of a low-carbon restructuring of the economy, be it in new energy technologies, in new buildings and insulation projects, or as light materials.

The regional analyses on the carbon price impact show that for the EU, Japan, and China these sectors are most exposed to competitiveness and carbon leakage effects. Policy tools to prevent carbon leakage will alleviate the carbon cost impact. However, investigations into the sectoral perspective (Cook 2011a, 2011b, Droege 2012) show that industries are also wary about the general economic trends, while climate policy is not necessarily at the center of their attention. Of course, industries are not embracing emissions pricing in the light of fierce competition in international markets. More importantly, uncertainties about future demand, costs, and technological breakthroughs, and last but not least risks related to political frameworks determine firms' investment decisions and other strategic parameters. The following sections give an overview on steel, cement, aluminium, basic chemicals and pulp and paper as described in Droege (2012). In particular, the sectors' contribution to global CO_2 emissions, the global trends in demand and production, the role of carbon pricing and abatement options are highlighted.

Key Issues - Steel

The steel industry accounted for around 5% of global emissions in 2007. This rises to 10% if upstream extraction, transport of raw materials and downstream transportation of the final product are included. Production capacity is growing worldwide, particularly in emerging economies which use steel as a key input for infrastructure, but also in industrialised countries investing in new energy sources. Thus, this sector is of high importance in addressing the climate change challenge from two perspectives: as a source of emissions and as an input to low-carbon installations (e.g. windmills) (Wooders et al. 2009).

For the steel sector a set of factors determines the effects of a unilateral carbon pricing scheme on its performance. First, there are basically two technological options which cannot be altered in existing plants. The use of electric arc furnaces (EAF) is less emission intensive than the use of blast oxygen furnaces (BOF). In Spain, for example, the EAF route dominates production (see Linares and Santamaria, 2012) and thus the carbon cost impact is relatively low, reducing the risk of carbon leakage. Second, beyond the technological parameters, the steel industry has some diversfication in its product range, including speciality products. This makes the pass-through of carbon costs easier in some steel subsectors.

The demand side is determined by regional shifts in growth. Steel investments are undertaken in Asia, Middle East or Latin America. Around 70% of global steel production is concentrated in China, Russia, South Korea, Japan and the US . China is the largest source of expansion in production capacity and the Indian steel industry is expected to expand in forthcoming years. This rising capacity is going to have a significant impact on future emissions levels from the sector in different regions and on the intensity of competition. Even if new facilities were built to best available technology (BAT) levels, Wooders et al. (2009) expect that emissions from the steel sector in 2030 would still be around 60% higher than in 2005. Thus, climate policies in major steel producing countries are crucial to induce more efficiency. Abatement options in this sector include closing inefficient high polluting plants – a means to increase energy-efficiency in China -, improving energy and carbon efficiency at existing non-obsolete plants, ensuring best available technologies in newly built plants and increasing the use of scrap.

Key Issues – Cement

Cement production has high direct CO_2 emissions from processing clinker, adding up to 60% of the emissions per unit of cement (fuel combustion contributes 35%, electricity 5%). The direct emissions account for approximately 25% of industrial CO_2 emissions and 6% of total emissions globally (Cook, 2011a).

Cement production is very cyclical. Demand is closely linked to economic growth and activity within the construction industry - which depends upon public finances, infrastructure expenditure, residential and commercial building activity and interest rates. Following the economic crisis since 2009, cement production volumes have declined in most developed economies, in particular within Europe. World cement production in 2009 was estimated at around 3 billion tonnes, actually representing a 6.4% increase compared to 2008, driven by demand in China and other developing Asian countries. China reached a record 54% of global production in 2009, while in the US and Japan, cement production fell by 17% and 13% respectively (Cook, 2011a).

Following the economic downturn the cement industry went through a phase of overcapacities and market concentrations in Europe while the upward growth trend in Asia was not interrupted. Infrastructure and building investments in non-OECD countries will be the key determinant of global cement production for the next decades. Accordingly, the IEA forecasts a flat projected demand for OECD countries, while globally demand is forecasted to rise to around 3.1 billion tonnes per annum in 2015 and 4.1 bt in 2050.

The ability of the cement sector to pass through carbon costs is dependent on the development of trade costs and infrastructure. A landlocked cement plant has to rely on expensive road transport, but the transport cost keeps competitors out of the local market. Coastal plants operate in a more competitive environment; as shipping costs have decreased over the last decade, a unilateral CO_2 price imposes a competitive disadvantage. The specific situation of coastal plants explains why border adjustments to address leakage work well for this part of the cement industry (e.g. Monjon and Quirion 2011, Linares and Santamaria 2012).

The World Business Council for Sustainable Development (WBCSD) has noted that the emission intensity of cement production has fallen by around 14% between 1990 and 2009, both from substiting clinker and increasing energy efficiency. There are, however, limitations on the substitutability of clinker, These include their regional availability (e.g. slug ash), increasing prices, the properties of the materials and also intended application of cement.

Key Issues – Aluminium

The aluminium sector accounts for around 1% of global GHG emissions and is known for its high indirect CO_2 emissions from electricity use. These can be up to 75% of overall emissions. (Carbon Trust 2011). Regional differences in emissions levels per tonne of output are principally due to the carbon intensity of fuel sources.

The production of aluminium can take two different routes. The primary route is the production of alumina via smelting. The secondary route uses recycled aluminium scrap. Due to a lower operating temperature, the secondary route requires only 5% of the energy for primary smelting and thus leads to fewer CO_2 emissions. Recycling of aluminium is rising, in particular in China; however, it depends on business cycles, demand and availability.

Steep rises in primary energy prices between 2005 and 2008 had competitiveness effects for aluminium producers in the EU. EU producers had to carry the indirect costs from the EU ETS already since 2005 as power producers passed their opportunity costs through to their customers. This added to an overall unfavourable competitive situation. As an effect market shares have increased for producers with cheap electricity access, in particular from hydro-power (Brazil, Norway, Iceland), but also in locations with cheap gas (e.g. Doha, Qatar). Future energy costs are crucial for investment decisions. With rising oil prices and an increasing number of countries introducing carbon pricing policies (EU, Australia, South Korea or China), locations with low carbon energy such as hydroelectricity will be more favourable from both an environmental and economic standpoint. The past increase in primary production however, was driven by low cost access to electricity from fossil sources, e.g. in Russia and China, and the Middle East. China's global production share in 2009 was 35% with an dynamic upwards trend.

Around 77% of total aluminium production is traded globally. The global price of aluminium is determined on the London Metals Exchange and the Shanghai Future Exchange and has been very volatile in recent years. Producers are essentially price takers and so the profitability of operations is highly dependent on production costs and the global prices. This limits the cost pass-through ability of the sector.

Aluminium products are relatively homogenous. Both semi-finished products (e.g. bars, wires, pipes) and speciality products (e.g. powders, special alloys) can be made from recycled and virgin aluminium and will be indistinguishable in terms of their quality. Aluminium consumption is forecasted to quadruple between now and 2050, mainly in emerging economies. Demand may also increase in more developed countries between now and 2050 as aluminium is used in 'green growth' projects. New, close to market capacities will create more competition and will further challenge established producers to keep a competitive position given the upward energy price trend.

Reducing emissions in the aluminium production process can be achieved through innovative technologies in primary smelting and scrap use. Recycling rates are very high in the USA and Europe and growing in China, leading to competition for access to scrap material. Estimates on the global recycling rates are at approximately 60%, but in some countries like Brazil, Norway and Japan this is closer to 90%. The Carbon Trust (2011) estimates that if all countries increased their recycling rates to this level, the sector could cut its global emissions by around 5%. Of course also the type of electricity for aluminium production is the key component for a lower emission balance. China has the highest share of coal-based electricity, and Latin American producers use mainly hydropower and natural gas.

Key Issues - Basic Chemicals

The chemical industry has a high diversity of products in combination with a high integration of processing within and across the industry. In 2005, the chemicals sector contributed approximately 5% of global GHG emissions. At the same time, specific chemical products, such as insulation or light materials are part of the low-carbon future of many sectors.

Based on their chemical composition, there are five groups or subsectors, which differ considerably in their emissions: petrochemicals, basic inorganics, polymers, specialities and consumer chemicals. The first three subsectors constitute the group of basic chemicals. They had a share of around 57% of total chemicals sales in the EU in 2005. Investigations into the leakage exposure of basic chemicals (such as fertilizers, rubbers, organic and unorganic chemicals), refering to simulation of a carbon price impact, show a high cost impact combined with high trade intensity. An extreme case are carbon cost effects for fertilizers and nitrogen compounds, which have high indirect process emissions (European Commission 2009).

As with the other EII, the trend in overall global chemical sales shows a strong shift towards Asia. Sales have quatrupled in China between 1990 and 2009 at the expense of sales in the EU (-8%) and the US (-7%). Not surprisingly, the production location of the chemicals industry has been changing rather dramatically during the last decade. Historically, the high degree of technical specialism required in production has led to the concentration of the chemicals industry in high income countries. In recent years, both China and the Middle East have seen a rapid expansion in chemicals production capacity fuelled by domestic policies and demand. China has a government directive to become self-sufficient in chemicals production, and the Middle East has favourable regulatory conditions as well as an abundance of gas. Gas serves as a feedstock into the production of a number of chemicals. This relocation is mirrored in a change of trade patterns and the commodity markets, with the Middle East turning into the dominant inter-regional exporter in basic chemicals. Increasing production costs such as CO_2 costs are thus not easy to pass through along the value chain. The specialities and consumer chemicals with more complex production techniques (e.g. dyes and pigments, paints and inks) or a higher research and development input (e.g. for bio- and nanotechnology) are usually produced in small and medium enterprises. Competition is limited due to the product and service differentiation and CO_2 cost could be passed through much easier to final consumers.

Given the new global competition for supplying emerging markets, the investment in the historical sites is limited. Carbon cost differentials between these competing producer regions will gain further importance for investment decisions.

Climate policy measures have already had some impact on the industry's operations in combination with rising oil and gas prices, but also because the industry has a long-standing experience in dealing with its environmental impacts. The high reliance on fossil fuel hydrocarbons for example is tackled by a broader feedstock base, with alternatives such as bio-based renewable raw materials. This is to limit (carbon) cost exposure, but also to follow customer demand for higher environmental standards. In Europe, around 8% of feedstock sources are derived from biomass sources, and this will likely increase in forthcoming years.

Key Issues – Pulp and Paper

Pulp and paper are two sectors linked through the production chain: pulp is an input to the manufacture of paper and paperboard products. Both sectors have diverse and differentiated product structures and production routes. Based on 2005/2006 data, the pulp and paper industry globally contributed roughly 1% to global CO_2 emissions (estimates between 34 and 37Mt CO_2 in 2010, Droege 2012).

The production of pulp and subsequently of paper are dependent on the quality of the final output needs. Pulp can be produced via three main routes: mechanical pulping, chemical pulping and by using recovered paper. While chemical pulping results in higher quality fibres, it is more energy-intensive than mechanical pulping; recovered paper is by far the least energy intensive process. The quality spread is reflected in product prices and quality requirements also dermine input cost (Schumacher and Healy 2012b). However, the production process is fundamentally energy-intensive and so carbon pricing, alongside rising fossil fuel prices is of concern for the industry from a competitiveness standpoint.

The demand for pulp and paper products is strongly correlated to a country's income. Thus for emerging economies it is likely that demand for higher quality paper products will increase the coming years. Pulp and paper producers are concentrated in a small number of regions. Over half of the world's paper production originates from the US, Canada, China and Japan. In particular China continues to increase its production capacity. Pulp is similarly concentrated, in 2008 North America and Europe accounted for 72% of total worldwide pulp production.

Transport costs are also a significant cost component in the pulp and paper industry. In Europe, road transport is chosen for the majority of freight, and this is becoming increasingly costly. Similarly, with rising demand for commodities, shipping costs are increasing. The industry estimates external logistics to average at around 10% of turnover.

There are some options to substitute products and processes within the sector e.g. in terms of quality, wood type, and whether or not the material is from recycled sources. These factors will influence production costs and therefore product prices. The sector has already begun to respond to rising energy costs in a number of regions by shifting towards the use of biomass as a fuel source and reducing the energy consumed per tonne of output in recent years. Analyses across countries report a reduction in the purchased energy per unit of output of 20% and more between the years 1997-2007 (UBS Investment Research 2008). However, this differs across producer regions. The IEA (2007) estimates that Germany is operating close to levels representing best available technologies, identifying only a 2% improvement potential for energy use, whilst in the UK this was estimated to be at around 28%.

For developed countries, biomass already represents 49% of fuel used in the pulp and paper industry. This may be a practice adopted by more regions as a way of mitigating cost increases and carbon price exposure, but again will be constrained by the physical availability and prices of these alternatives to fossil fuels

In some regions the increase of recycling rates has some potential to reduce emissions. The average recycling rate worldwide is 45% but is higher in some regions such as the EU (70% in 2010). Although recycling rates are constrained by the physical availability of recycled materials, the IEA (2007) estimates an additional global recycling potential of 35%, with most of the opportunities located in North America and parts of Asia.

Breakthrough technologies for the drying component of the paper production process may be another source of abatement potential as it accounts for around 70% of total fuel consumed. New processes will be commercially viable in the next two decades, but most new technologies under development, face significant sunk costs and so may require supporting government policies to speed up the innovation process.

Implications for EII

The energy-intensive industries vary in their competitive situations, due to the ability to absorb or pass through additional costs. This is determined by their established technologies, innovation practices, favourable geographical locations, e.g. close to cheap fuel sources. The potential and actual carbon costs incurred to them in different countries increase the role for some of these determinants. Cheap energy must also be clean energy if the host country's climate policy charges emissions. This is illustrated by the aluminium industry example, but also by basic chemicals. Transportation costs for heavy but low-value-high-emission products, such as clinker and cement, could become cheaper than the carbon cost incurred, making imports competitive.

Moreover, the actual range for price differences is wide. While aluminium or chemicals are traded globally and companies are price takers, some cement firms dominate the separated regional markets, and thus prices can differ on a regional basis.

Given the broader green agendas envisioned by OECD and some non-OECD countries, producers of steel, aluminium and chemicals contribute also to low-carbon develoment. This contribution even creates new fields of competition, once sectors participate in developing innovative construction or other materials.

Producers have a better chance to pass carbon costs on to customers for those products with a low price elasticity of demand, which can be due to quality competition and few substitutes, such as high quality steel for automobiles, or specialised chemical products.

The long-term position of the EII across world regions is subject to increasing risks. While demand projections clearly indicate increasing dynamics in Asian or other regions for all EII, this does not wipe out investment risks which can relate to the political stability in a region (such as the Middle East) or future climate policies (e.g. in China) or the systematic market risks inherent to all long-term decisions (assumptions about demand, input costs, business cycles, raw material price volatility etc.). While it is an important issue to make climate policy as reliable as possible for the long run, e.g. by a clear commitment to an ETS or other measures beyond 2020, this will not reduce or even compensate for other investment risks. The very long-term horizon of EII investment is not and cannot be met with political frameworks of the same dimension. This is exemplified by the attempts made by the EU with its 2050 Roadmap, which inter alia suffers from a consistent implementation.

Summary of lessons learned

Modelling the cost impacts of a 30% reduction target in the EU on industries and the economy show that the EU could prevent carbon leakage from a higher unilateral emissions target at moderate cost. Analyses need to be amended to relate the EU policy decision to the increasing number of carbon pricing schemes abroad, which alter the trade and investment environment. In particular, the Chinese establishment of pilot ETS could determine the competiveness and leakage effects for industries in the EU, Japan and other trade partners with a carbon constraint.

A mandatory **Japanese** ETS would have an impact on the Japanese steel and cement production and would cause carbon leakage. This can be addressed through free allocation, which partly outperforms adjustment at the border with respect to negative impacts on domestic output. A cost compensation is especially crucial for leakage from export market losses.

A CO_2 price in **China** would impact the energy-intensive sectors in a similar way as in the EU or Japan - although at a higher scale due to the low energy-efficiency in China. Such a policy would serve the Chinese plans to decrease carbon intensities of its industries and to restrain exports in times of high economic growth.

For **energy-intensive sectors**, climate policy measures are not a central feature in times of economic stagnation. In the short term, a carbon price affects their strategic environment only to a limited extent as has become clear during the economic crisis of 2009. The sectors face a dynamic international environment, with shifts in demand, new competitors and increasing prices for raw materials.

As the climate policy horizons do not match the long-term stability concerns of investors, industries tend to demand that anti-leakage policies also compensate for the risks they are facing in international competition. The time horizon of the EII investments, however, cannot be met with consistent political frameworks of the same dimension.

References

Working Papers, Climate Strategies Project

Cook, Gregory (2011a) Investment, Carbon Pricing and Leakage – a cement sector perspective

Cook, Gregory (2011b) Use of Border Adjustment Measures – a cement sector perspective

Droege, Susanne (2012) Carbon pricing and its future role for energy-intensive industries. Key features of steel, cement, aluminium, basic chemicals, pulp&paper

Linares, Pedro, Santamaria, Alberto (2012) The effects of carbon prices and anti-leakage policies on slected industrial sectors in Spian – Cement, Steel and Oil Refining

Monjon, Stephanie (2011) Implementation of an emission trading scheme in Japan: Some food for thought

Pollit, Hector, Summerton, Phillip, Thoung, Chris (2011) Modelling the Impact of Policy Interventions on Carbon Leakage, Assessment with the E3MG Model

Quirion, Philippe, Schumacher, Katja, Healy, Sean (2012) Modelling the allowance allocation method for the EU ETS

Schumacher, Katja, Healy, Sean (2012a) Product level analysis and implications on competitiveness and carbon leakage for the aluminium sector

Schumacher, Katja, Healy, Sean (2012b) Product level analysis and implications on competitiveness and carbon leakage for the pulp and paper sector

Wang, Xin, Li, Ji Feng, Zhang, Ya Xiong (2011) Can China afford to commit to effective carbon pricing policies?

Literature

Asuka, J., K. Kanamoto and L. Xiang Chun, 2009. Emissions Trading and International Competitiveness: Case Study for Japanese Industries, available at http://www.cneas.tohoku.ac.jp/labs/china/asuka/

CEPI (2008), Issue Sheet – April 2008, available at: www.cepi.org

European Commission (2009), Commission Decision of 24 December 2009 determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, a list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage (C (2009) 10251)

Climate Strategies, 2012, Strengthening the EU ETS. Creating a stable platform for EU energy sector investment, Climate Strategies Report, www.climatestrategies.org

European Commission, 2010, Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage, Background information and analysis, Part II. Commission staff working document accompanying the communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions, COM(2010) 265 final

European Commission, 2012, Analysis of options beyond 20% GHG emission reductions: Member State results, Staff Working Paper, February 2012, SWD(2012) 5 final

Grubb, Michael and Cooper, Simone, 2011, Revenue dimension of the EU ETS Phase III, May 2011, Climate Strategies, available at www.climatestrategies.org

IEA (2007), Tracking Industrial Energy Efficiency and CO_2 emissions, OECD/IEA, Paris, Available at: http://www.iea.org/textbase/nppdf/free/2007/tracking_emissions.pdf

Monjon, Stephanie, 2011, Addressing leakage concerns. Is there a case for the EU to move beyond 20% GHG emissions reduction by 2020? Climate Strategies Working Paper, June 2011

Monjon, S. and P. Quirion, 2011, Addressing leakage in the EU ETS : Border adjustment or output-based allocation?, Ecological Economics, 70: 1957–1971.

OECD 2011, Towards Green Growth, available at: www.oecd-ilibrary.org/environment/towards-green-growth_9789264111318-en

Quirion, P., 2009, Historic versus output-based allocation of GHG tradable allowances: a survey, Climate Policy, 9: 575-592

Quirion, P., Schumacher, S., Healy, S., 2012: Modelling the Allowance Allocation Method of the EU ETS, CS Working Paper 2012, www.climatestrategies.org

Takamura, Y. and Y. Kameyama, 2009, Border Adjustments in Japanese Climate Policy, Climate Strategies Working Paper

UBS Investment Research (2008), Global pulp & paper economic outlook and financial performance, Global paper and forest products, available at: www.pwc.com

Wang, X., Voituriez, T., 2009, Can unilateral trade measures significantly reduce leakage and competitiveness pressures on EU-ETS-constrained industries? The case of China export taxes and VAT rebates, available at: www.climatestrategies.org

Authors and contact information

This policy brief was written by:

Susanne Droege
Stiftung Wissenschaft und Politik (SWP)

For more information, please contact:
Susanne Droege
Email: dge@swp-berlin.org

Andrzej Blachowicz
Email: andrzej.blachowicz@climatestrategies.org

Stiftung Wissenschaft und Politik (SWP)
German Institute for International and Security Affairs
Ludwigkirchplatz 3-4
10719 Berlin
Germany

Phone: +49-30-88007-0
Fax: +49-30-88007-100
www.swp-berlin.org

This policy brief refers to the working papers written during the Climate Strategies project on International Industry Competitiveness, Carbon Leakage and Approaches to Carbon Pricing as listed in the References. The author would like to thank Graham Sinden, Dora Fazekas and Andrzej Blachowicz for their helpful comments on an earlier draft.

All papers are available for download for free from:
http://climatestrategies.org/research/our-reports/category/61.html

Climate Strategies
www.climatestrategies.org

Climate Strategies is a charitable company limited by guarantee that provides world-class, independent policy and economic research input to European and international climate policy.

Climate Strategies works with a wide network of experts to bridge the gap between research and policy, and provides unrivalled analysis for international decision-makers in the fields of climate change and energy policy.

Climate Strategies is supported by range of national governments, businesses and foundations, it is entirely international in its design and remit.
All our research is published in the public domain.

Companies House Number 05796323.

Climate Strategies
21 Silver Street
Cambridge
CB3 9EL
United Kingdom

www.climatestrategies.org