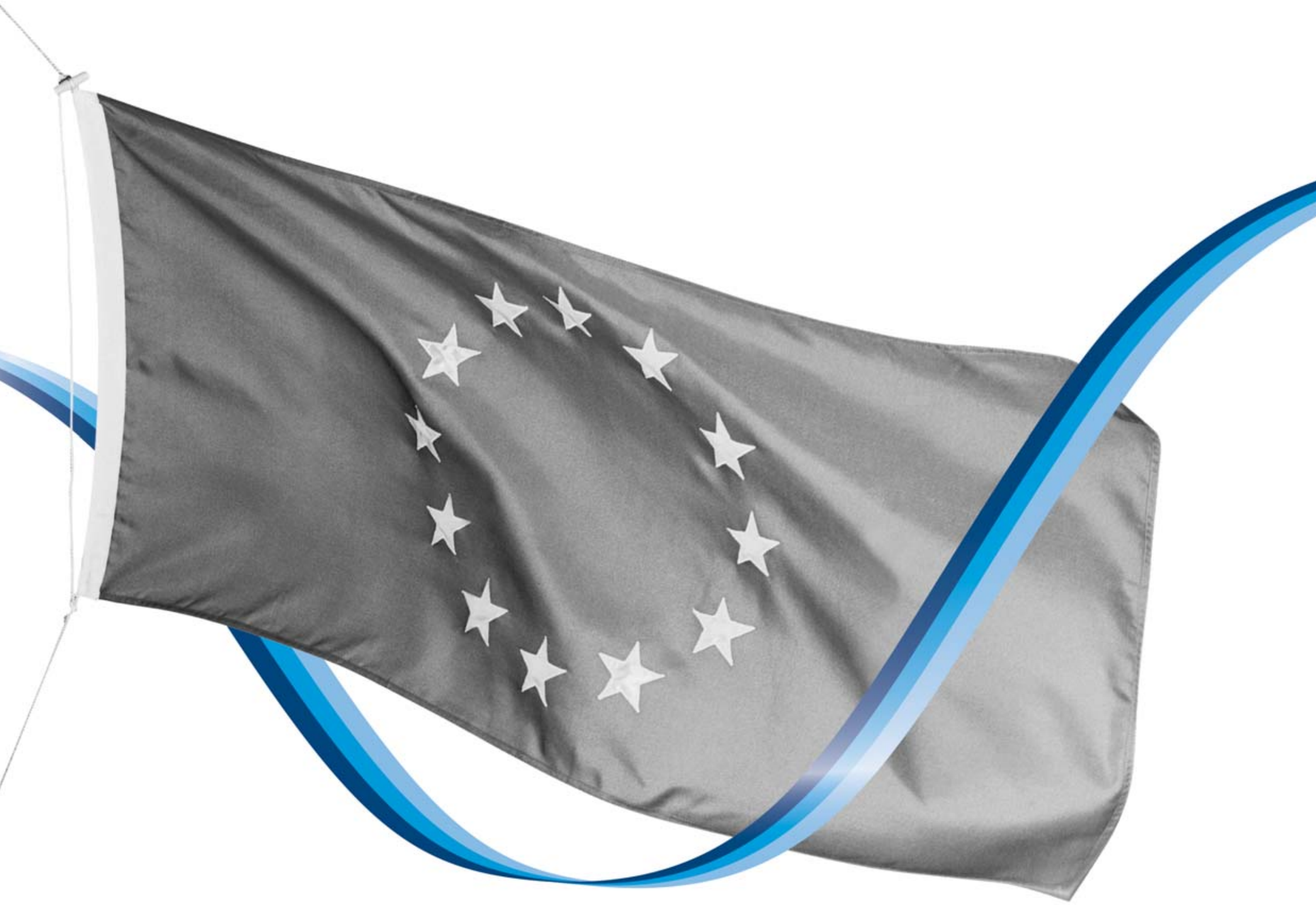
EU ETS impacts on profitability and trade

A sector by sector analysis



This Carbon Trust report is based on research by Climate Strategies,* an international network organisation that develops and delivers rigorous, independent academic analysis to meet the needs of international climate change policymaking. The Carbon Trust is a founding supporter of Climate Strategies. This report presents Carbon Trust insights based upon our synthesis of their underlying academic work.

* Climate Strategies (2007): J.C. Hourcade, K. Neuhoff, D. Demailly and M. Sato, Differentiation and dynamics of EU ETS industrial competitiveness impacts, www.climate-strategies.org.

Contents

Preface

The potential impact of carbon pricing – and in particular the EU ETS – on industrial competitiveness continues to worry business in the UK and the EU. The interventions by the European Commission to strengthen Phase II of the scheme, from 2008–2012, has underlined the seriousness of the endeavour and raised expectations for carbon prices.

Our previous studies have concluded that in these circumstances, and over the five-year period of Phase II, most participating sectors are likely to profit from the scheme, or at the very least are unlikely to suffer any significant negative impacts.

However no sooner has the dust begun to settle on Phase II allocations, than attention has turned to Phase III, running from 2013 potentially out to 2020. The EU's adoption of an ambitious commitment to a 20% CO_2 reduction by 2020 even in the absence of wider international participation – and a growing belief that Phase III will see significant cutbacks in allowances to manufacturing industry – continue to stoke concerns about potential competitiveness impacts. In addition, as governments seek deeper cuts in emissions, they are paying more attention to specific, high emitting activities rather than to sector averages.

To extend and deepen our earlier work on the topic, this report looks at cost, trade characteristics and competitiveness issues at a much more detailed activity level right across UK manufacturing. It also brings new research to bear upon the debate between business and academics about likely price and trade responses to higher carbon prices with particular attention to the high-profile sectors of cement and steel. It reaches the surprising conclusion that the 'trade and competitiveness' impacts on manufacturing may, ironically, turn out to be more of an environmental than a financial worry.

As with our previous report on the EU ETS, this report is based on research convened by the European research network Climate Strategies, of which the Carbon Trust is a founding supporter. The Climate Strategies programme included a CBI-hosted review of initial research, a release of a draft report for open consultation, and stakeholder consultation meetings hosted by the UK Emissions Trading Group (July 2007) and the French IDDRI (September 2007).

This report however presents the Carbon Trust's own conclusions based upon our view of the underlying research.

Tom Delay, Chief Executive
Michael Grubb, Chief Economist

Previous publications available from the Carbon Trust
2007 EU ETS Phase II allocation: implications and lessons.
2006 Allocation and competitiveness in the EU emissions trading system options for Phase II and beyond.
2004 The European emission trading scheme: implications for industrial competitiveness.

Key findings

The EU ETS and other carbon control measures out to 2020 will have negligible impact on the international competitiveness of more than 90% of UK manufacturing activities. Overall, the EU ETS can extend with deeper emission cutbacks in Phase III (post 2012), without damaging UK or European competitiveness, but issues around a few key activities do merit policy attention.

These key activities account for under 1% of total UK GDP yet constitute over 50% of manufacturing CO_2 emissions. Moreover companies that receive substantial free allocation but pass carbon costs on to their consumers will generally maintain or increase their profits. However the resulting loss of market share for the most exposed sectors, such as cement and steel, leaks emissions abroad and this makes competitiveness an environmental as much as an economic issue. Total leakage by 2020 is unlikely to exceed 1% of EU emissions, but it could be much higher from some sectors.

The chart below shows key data for the 23 activities whose costs would be most affected by paying for all the CO_2 they emit. Our report combines this data with analysis of the effect on prices and international trade in order to identify the small group of activities for which competitiveness is an issue for the environment, as well as for business, and to identify potential responses. The table on the right summarises the activities found to be most likely to be exposed to such competitive effects, and what action could be taken.

Out of 159 UK manufacturing activities studied, only a few are potentially exposed:

Significantly: Cement/clinker; steel from blast oxygen furnaces; aluminium	EU cement and steel producers could lose up to 8% market share to overseas production in central price cases with highest trade sensitivities. Sufficient free allocation to maintain their profits can buy time to negotiate a multilateral response to trade exposure.
Plausibly: Fertilisers & nitrogen compounds; 'other' inorganic basic chemicals; pulp, paper and paperboard	Should be in the EU ETS with a compensating rate of free allocation, combined with other measures to help them tackle their exposure to carbon and electricity costs.
Possibly, at higher CO_2 prices: Some refineries; manufacture of glass; household paper; tyres; copper; potentially one or two other basic chemical processes	At higher carbon prices, some products from some refineries and a few other big activities could face trade impacts. Should be in the EU ETS; modest free allocation in Phase III, particularly for new sectors, would protect profits and give time to invest in lower carbon solutions, but should not extend beyond that.
Significantly, but very small activities: Notably lime production	Loss of market share to overseas production would involve tiny absolute carbon leakage. A political decision as to whether to ignore, offer protection, or exempt.

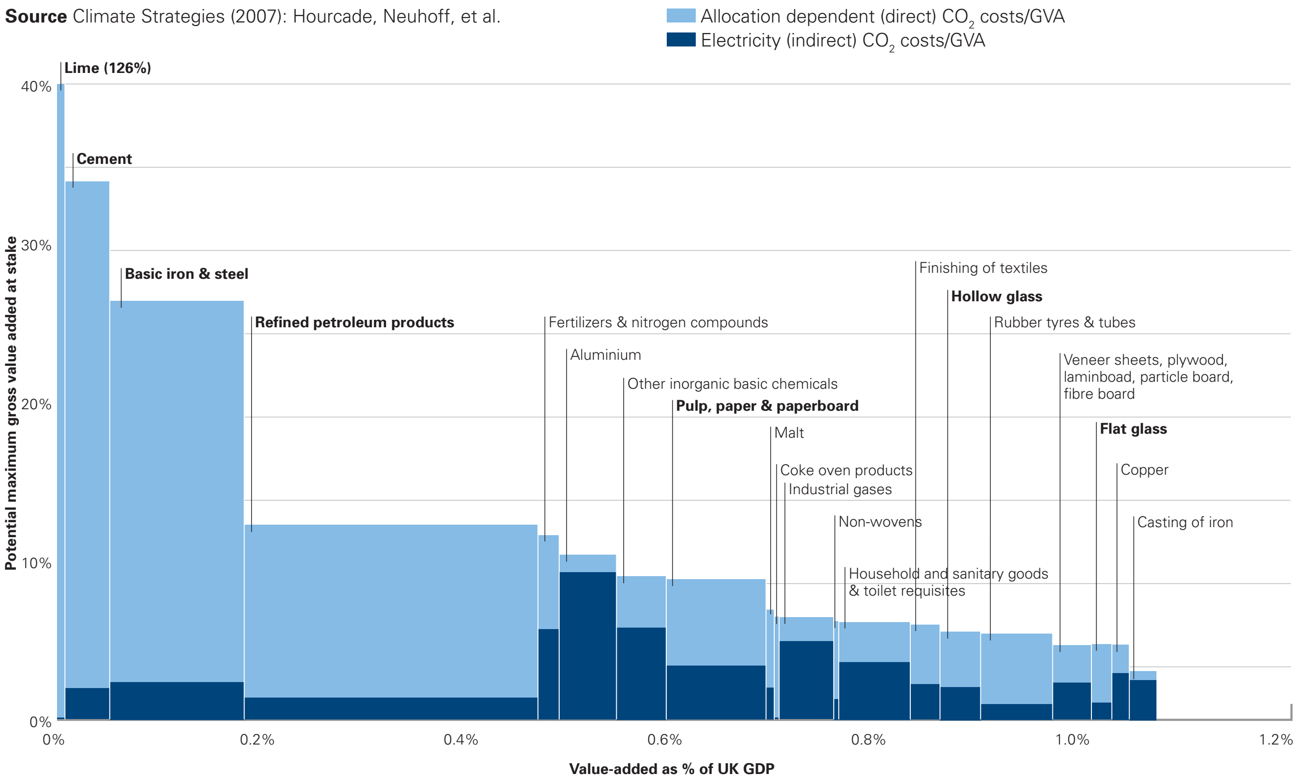
Chart 1

Manufacturing activities most cost-sensitive to CO_2 pricing

The vertical axis shows the cost increase brought about by paying the full cost of CO_2 at €20/t CO_2 as a percentage of the activity's current value added. The horizontal axis indicates the scale of the activity's contribution to the UK's GDP. The area of each column is proportional to total CO_2 emissions. The **dark blue** bars show the cost of carbon that will be paid through higher electricity prices (equivalent to €10/MWh at €20/t CO_2).

The **light blue** bars show the cost due to the carbon emitted through direct fossil fuel consumption and manufacturing processes. Activities labelled in **bold** are in sectors that already participate in Phase II of the EU ETS. Some combustion facilities in other sectors may also be participating, and more sectors will be added in Phase III. Definitions of value-added and numbers for each activity are in the Annex of this report.

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.



Executive summary

Context

As the dust settles on the design of the second phase of the EU ETS (2008–2012), attention is turning to the implications of its likely development after 2012. The EU Council's adoption of a 20% CO_2 reduction target implies stronger cutbacks across a wider range of European business. This raises concerns about the possible impacts on the competitiveness of UK and European industry from more sustained and/or higher carbon prices, from likely cutbacks in the levels of free allocations, and from the expansion of and/or additions to instruments that impose a cost of carbon, like the UK's Carbon Reduction Commitment. Previous research has underlined the need to quantify potential impacts before jumping to conclusions, and to consider impacts on both costs and product prices, in the face of international trade. This study spans most of UK manufacturing industry and further deepens our previous work by ensuring coverage of all relevant CO_2 emissions (including process and on-site emissions), a wider range of carbon prices, and by conducting detailed exploration of cement and steel sector impacts and responses.

Identifying carbon-intensive sectors

The 2-digit Standard Industrial Classification (SIC) divides manufacturing into 15 sectors. Our screening analyses of potential carbon cost impacts covers 159 manufacturing activities in 11 of these 15 sectors, which comprise over 90% of manufacturing emissions and about two-thirds of manufacturing value-added. No activities in the remaining four sectors are likely to be exposed. For the twenty most carbon-intensive activities each €10/tCO_2 they pay would increase their input costs by more than 2% of their gross value-added (GVA). Carbon prices out to 2020 are likely to be in the range €20–€40/tCO_2, corresponding to a cost increase exceeding 4–8% of GVA if they paid for all their emissions. Sectors that receive free emission allowances or do not participate in the EU ETS would still be affected because the EU ETS will increase electricity prices. Under likely UK electricity sector conditions, half of the 'top twenty' – plus three other activities – face such indirect electricity cost increases exceeding 1% of GVA for each €10/tCO_2 increase in the carbon price.

These 23 most carbon exposed activities, as mapped out in Chart 1, account for more than half of manufacturing sector CO_2 emissions, and one-seventh of the UK's total CO_2. Economically they comprise around 1% of the value-added of the UK economy and about 0.5% of employment. This reflects the fact that most of the emissions in manufacturing are in primary production, while most value-added is in the downstream processing and applications.

Most other activities are well below these threshold levels of carbon exposure. Carbon costs for such activities would be very small compared to differences in labour, energy and other input costs, between EU and non-EU countries and over time. The €:$ exchange rate, for example, appreciated by more than 50% between 2001 and 2006, with a much bigger impact on costs for most sectors than would be created by a carbon price of €20/tCO_2.

Thus the cost impacts of the EU ETS or other carbon price instruments are highly concentrated. Cost impacts between different companies in the UK market may be significant for a much wider group, but the possibility of significant impacts on international trade outside the EU need only be seriously examined for a limited number of specific industrial activities that comprise around 1% of the UK economy together – not on the economy overall.

The most cost-impacted sectors

Production of lime and cement, and of basic iron and steel, stand out as far more carbon-cost-sensitive than other activities; paying €20/tCO_2 would increase their production costs by more than 25% of GVA.* These sectors comprise about 0.2% of the UK economy and 0.1% of employment. At present, free allocation of emission allowances offsets almost all of these costs, but this does not necessarily prevent trade effects as explained below.

The next most carbon cost-sensitive activity, refining, is bigger economically but the EU ETS is unlikely to have much impact on the trade of oil products. Amongst other factors, a cost of €20/tCO_2 on refinery emissions is well under €1 per barrel of oil equivalent, making it small compared to daily fluctuations in crude oil prices (and differences in tax). In addition there are several strategic benefits that link European refineries to their product markets. However, competition between EU refineries may make different emissions allowance allocations between EU countries, and even individual refineries, politically sensitive. Harmonising free allocations could be complex and create perverse incentives. Avoiding free allocation altogether by requiring refineries to buy allowances from the market or via auctions, would avoid these problems and the benefits of this requirement may outweigh any plausible international trade impacts.

Aluminium has been noted as exceptionally exposed to carbon prices in our previous studies. In addition, fertilisers (with other nitrogen compounds including ammonia), inorganic basic chemicals, and pulp and paper all face cost impacts close to 5% of GVA per €10/tCO_2 that they pay. To offset such carbon costs, these latter sectors would have to raise average product prices by about 1% for each €10/tCO_2 paid, which may become significant for highly tradable products – particularly at higher carbon prices or if other costs (such as extension to non-CO_2 gases) are added. Moreover, many of these activities are large users of electricity. At €20/tCO_2, UK electricity prices would rise by c. €10/MWh if generators pass through the 'opportunity' cost – comparable to the range of existing electricity price differences across the EU. Aluminium smelting stands out for its electricity-related exposure, as noted in our previous reports, but electricity price increases would also increase sector input costs by 3–6% of GVA for fertilisers, inorganic basic chemicals, and pulp and paper, though the extent to which manufacturers would in practice see such cost increases may vary for reasons laid out later in this report.

* Throughout this report, references to cement include production of clinker (which is the most energy-intensive component of cement) and references to blast furnace steel include on-site production of coke (which contributes about 5% of steel emissions). The steel data in Chart 1 comprise all UK steel output including a c. 20% contribution from lower carbon electric arc processes; blast furnace steel itself has maximum value at stake similar to cement.

What is at risk?

The activities at risk account for well under 1% of UK GVA in total and 0.5% of UK employment. For these activities the net effect of carbon cost exposure depends upon the extent to which a sector (i) has free allocation, (ii) can pass costs through to product prices, and (iii) can reduce its emissions. The impacts of the EU ETS are complex and not necessarily negative, even for sectors facing significant cutbacks and costs – as illustrated by electricity generation, which tends to profit in aggregate because the pass-through of carbon costs to electricity prices increases revenues far more than it increases costs. Our previous reports have set out the principles and presented aggregate sector data. The most fundamental and general insight is that sectors with substantial free allocation have incentives to profit in the short term by passing through carbon costs, but the more they add these costs to their product prices, the more they risk losing market share to foreign competition. Profit and competitiveness are not synonymous: in terms of EU ETS impacts, they are often opposites, as higher prices generate profits from free allocation but attract imports.

Increased imports and/or loss of exports may represent a leakage of emissions from within to outside the EU. This does not necessarily mean emissions will increase, e.g. importing electricity-intensive products may reduce global emissions if they come from largely carbon-free electricity systems such as in Norway or Iceland. However, focusing on leakage helps to align economic and environmental goals and keeps the focus on issues around the EU ETS, rather than on other trends and influences on trade and competitiveness.

The extent to which carbon cost differences across countries result in leakage depends upon the impediments to greater trade. For example, the cost of producing industrial gases is sensitive to carbon prices, but transport cost and safety considerations impede any leakage. A given company may produce specialised products not matched by foreign competition, or have local networks that favour local production. However, trade is generally growing, suggesting a weakening of barriers to trade, and most activities in our 'top 20 + 3' have trade intensities in the range 10–30%. This suggests a significant scope for changing trade patterns, though existing trade may not imply a high sensitivity to cost differences if it is driven by other factors, such as differences in the availability or composition of raw materials.

A number of the less cost-exposed activities in Chart 1 are unlikely to face significant trade impacts, due to such trade barriers. However, we could not rule out slight trade impacts particularly at higher carbon prices for manufacturing of glass, household paper products, tyres, and copper. These activities, and a couple of specific chemical products that fall just below our threshold, may merit further study and monitoring of trends to establish whether there is a plausible case for concern over time, and if so, whether free allocation would be an appropriate response. Also some other smaller (less than £50m GVA) activities, including lime, coke production and possibly some specialist food or chemical products, could be affected. Our conclusion that refining will not generally be affected also merits further testing and monitoring, given the complexities of different refineries and product streams. International trade in the rest of UK manufacturing out to 2020 is unlikely to be materially affected even if it participates in the EU ETS or equivalent carbon controls with no free allocation.

To explore the nature and scale of potential impacts for the most exposed activities, this report considers more fully at the European level the two major activities for which carbon costs are most unequivocally significant: cement and steel products.

Detailed analysis of cement

As a relatively homogenous product, cement produced in different regions could in principle be relatively easily substituted, but continuing big price differences between countries reflect transport cost and other barriers to trade. Imports have risen, but mainly to southern Europe, reflecting an imbalance between limited domestic production capacity and surging domestic demand. However the industrial structure is globalising, with import sourcing switching from north Africa to China; and there has also been a trend to growing imports of clinker, the intermediate energy-intensive component of cement.

Our earlier studies showed that if manufacturers priced to maximise short-run profits, coastal markets would suffer leakage whilst European producers overall could profit substantially. Chart 2a summarises the impact of the EU ETS on cement trade and profits in the EU overall, for various scenarios of allocation, pricing behaviour and carbon price levels. If producers do not raise prices at all, there is no impact on trade but profit margins decline as the proportion of free allocation falls and turn negative with no free allocation, across all carbon price scenarios. However if producers pass on the full marginal/opportunity costs, profit margins rise sharply if they have extensive free allocation – increasingly so at higher carbon prices – or remain roughly constant with zero free allocation.

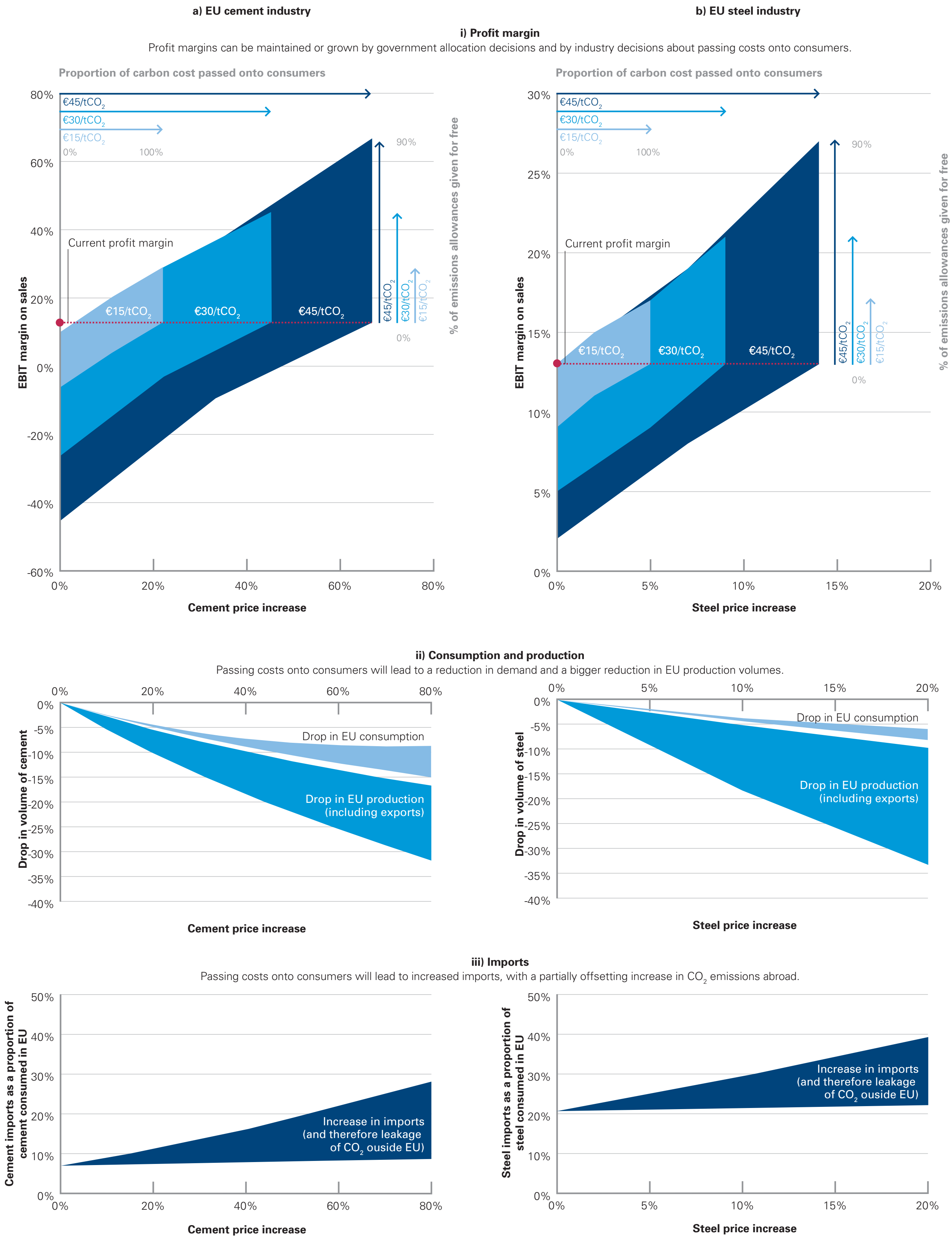


Chart 2

Impact on profits and demand for the EU cement and steel industries of different carbon prices, allocation and cost pass-through decisions

Source Carbon Trust analysis based on data from Climate Strategies (2007): Hourcade, Neuhoff, et al.

As indicated in the second panel of Chart 2, EU production declines as producers raise cement prices. This is partly because higher prices reduce demand, but the drop in production is bigger because of rising imports. These imports drive the emissions leakage and are shown separately in the third panel. Trade responses, as measured from historical patterns, are quite uncertain and this is reflected in the broad range shown. With full pass-through of marginal/opportunity costs, imports rise from the current 8% to 13–27% depending on the carbon price and trade sensitivities assumed.

The pattern with half pass-through is more varied, with up to a few percentage points increase in imports and impacts on profit margins ranging from loss to significant gain depending upon allocation methods. For a central case, with 50% pass-through of carbon costs at €30/tCO_2, domestic cement consumption declines by about 5% and imports displace another 0.5–5.5% across the range of trade sensitivities considered. The sector overall may profit if the proportion of business as usual emissions that are allocated for free significantly exceeds the pass-through rate.

The actual degree of emissions 'leakage' combines many uncertainties in demand, trade and abatement responses. However if the technical options for abatement are limited, it is quite possible that at higher carbon prices and increased rates of cost pass-through, cement imports could outweigh domestic reductions as a source of emission 'reductions' – hardly the desired aim of the EU ETS.

Detailed analysis of steel

For steel, production of 'flat' products (e.g. panels) from iron ore in blast oxygen furnaces dominate emissions and potential cost exposure, and forms the main process in UK steel production. The exposure of 'long' steel products (e.g. for construction), predominantly from electric arc furnaces using scrap, is much less.

The specialised nature of most flat steel products (e.g. 40% goes to automotive) provides some short-term protection and the EU has until recently produced as much steel as it consumed despite international price differences of 20–40%. The steel market has historically been largely regional rather than global, but non-EU trade intensity is growing and in 2006 the EU became a net importer, largely from China. Steel trade is much more sensitive to price differences than cement is, and consolidation is increasing this sensitivity further. In addition, steel is slightly more exposed to electricity prices than cement is.

However the relative impact of a given carbon cost on product prices is much less than for cement, as is the impact on profit margins (Chart 2b). Compared to the base case, profit margins decline but remain positive even if the industry passes on no costs.

The combination of low price impacts and higher trade sensitivities together make the estimated impacts of cost pass-through on steel trade comparable to those on cement trade for a given carbon price and pass-through.

Thus for a case with 50% pass-through of carbon costs at €30/tCO_2, domestic steel consumption declines by about 2% but EU production declines by 2.5–9% across the range of trade sensitivities considered; again however this would yield net profits if the sector receives significantly above 50% free allocation. The abatement cost curves in the model suggest higher scope for steel abatement than for cement, and this significantly exceeds leakage except for the combination of the most extreme assumptions around all three variables of price (€45/tCO_2), cost pass-through (100%), and trade sensitivity. Such combinations can generate several times the central estimates of trade impact – though even in this case, profit margins rise if such conditions are combined with a high degree of free allocation.

Like any numerical modelling, the assumptions underpinning these results are subject to challenge. Probably the most fundamental argument is about whether the estimates of trade sensitivity based on past data – which underpin the model results – reasonably represent the future. Our highest impact results use the highest estimates of trade sensitivities that have been made on the basis of past responses to price differences. Industry argues that globalisation, and associated industrial consolidation, may further increase trade sensitivity to price differences, to beyond even the higher levels suggested by the results in Chart 2. There is no robust analytic answer to this conjecture, but increased imports of both cement and steel in the past couple of years, though modest in cement outside southern Europe, could be taken as indicating such a change, with EU ETS costs playing some role.

However, we did not find compelling evidence of 'tipping points' in carbon prices beyond which there would be a dramatic decline in market share. Even if these may exist, free allocation could enable companies to avoid such consequences by reducing levels of cost pass-through required to maintain a given profit margin.

Nor is there compelling evidence of 'tipping points' in relation to new investment. In the energy-intensive, trade exposed sectors, new investment in the EU is confined mostly to upgrading existing sites. In many sectors, foregoing this in favour of overseas investments-for-import would carry several risks, including those around how long carbon price differences would remain. However, relocation of steel investment is already under consideration and carbon costs could exacerbate this. This provides an additional reason to consider response options.

Options for reducing leakage

Leakage through closure of existing facilities in favour of imports is deterred in many national allocation plans by provisions to withdraw allowances from facilities that close. Whether free allocation in general addresses leakage depends upon the business response. If companies prioritise protecting market share and thus do not pass through much carbon cost – behaviour corresponding to the left hand side of the panels in Chart 2 – impacts on product prices and therefore on leakage will be minimal.

However if businesses seek to maximise short-run profits, free allocation is much less effective in preventing leakage: an incentive remains for these sectors to reduce domestic production, sell the allowances and import substitutes or carbon-intensive intermediate products. The irony of our analysis is that whilst business has worried about competitiveness impacts of the EU ETS and environmental constituencies have argued these concerns to be hugely overstated, the relevant impacts suggest the opposite to be more rational. With a high degree of free allocation, many sectors including cement and steel may profit from the EU ETS, and yet lose market share that represents significant emissions leakage to other parts of the world, reducing the environmental gain.

The provision of free allowances for ‘new entrants’ may similarly protect the near-term profitability of new investments in Europe, but as set out in our previous report this may undermine the long-term environmental effectiveness of the EU ETS.

Thus, a case remains to consider other options for protecting against carbon leakage. As outlined in our previous report, these might include rebates of carbon-associated costs upon export, various forms of border adjustments for imports, or international sector-based agreements. However, a rush to general protective measures could be extremely risky to international trade, and such risks would need careful consideration.

The maximum impact of carbon prices on the cost of other major activities is less than a third of that for cement or blast furnace steel. With the possible exception of aluminium and other non-ferrous metals (that are presently outside the EU ETS), trade and profit impacts will be correspondingly less. For the next most exposed group of activities identified (fertilisers, inorganic basic chemicals, and pulp and some paper products) free allocations could address the cost impacts of their direct emissions, but not their relatively more significant electricity consumption. Border-related solutions may be even more difficult in relation to electricity-associated cost impacts. Recycling of revenues from EU ETS auctions to electricity-intensive activities is one option that could be considered. However the strategic need is for electricity-intensive industries to access directly low cost, low carbon electricity sources, which would genuinely reduce their exposure. Varied government decisions, both around the EU ETS and more widely in electricity market regulation, could facilitate this.

Recommendations

The EU ETS can and should continue with deeper emission cutbacks post 2012. This need not damage UK or European competitiveness overall. Our previous publications summarised the benefits of increasing levels of auctioning and these conclusions remain unchanged. However the extent and pace at which free allocations are reduced should differ between sectors according to their degree of cost and trade exposure.

For a very small number of carbon-intensive, internationally exposed activities headed by steel and cement production, governments should establish a transitional ‘compensating rate of free allocation’ on an activity-specific basis, based upon the likely degree of cost pass-through given international trade conditions. The scale of free allocation to electricity-intensive activities in the EU ETS (notably pulp and paper) should also take account of their electricity consumption, whilst manufacturing of fertilisers and basic chemicals might benefit from being brought into the EU ETS on a similar basis. Together with aluminium smelting these constitute four trade-exposed electricity-intensive activities for which additional measures, linked to redistribution of auction revenues or equivalent ‘downstream’ allocation of electricity-related allowances, could be considered (subject to state aid and associated legal considerations). However, focused measures to facilitate direct, long-term investment in low carbon electricity generation may offer the best long-term solution.

A watching brief is justified for about half a dozen other activities, possibly with some free allocation for those in the EU ETS. Concern about international competitiveness does not in itself justify free allocation for other sectors in the EU ETS – or for free allocation within other instruments that tackle less energy-intensive activities, such as the UK’s Carbon Reduction Commitment.

Moving to a low carbon economy will require all sectors to face carbon costs. The existing approach of almost 100% free allocation to manufacturing industries shields them from this. Continued free allocation offers a medium-term palliative that can protect profits in relevant activities but is less effective at tackling leakage from either existing facilities or new investments.

The modest degree of leakage predicted means that the EU ETS can be extended in its current structure. However to provide a more robust longer term solution and to influence expectations for new investments, the EU should signal its intent in international negotiations to pursue multilateral solutions to problems of leakage.

1. Measuring cost and trade exposure

Competitiveness is a broad concept, but in the debate about the EU ETS it has come to mean one main thing: the fear that imposing a cost of carbon in Europe will result in loss of profits and market share for UK and European business. The key issues are how much might costs rise; and what might happen if companies raise prices to reflect these carbon costs, given foreign competition that may not face the same costs? This report sets out to deepen our understanding of these dimensions, and how they may interact in UK and European manufacturing industry.

No company likes to see its costs rise. At the same time, companies like to operate in markets that can support higher prices for their products. The fact that the EU ETS may do both, but to different degrees, lies at the heart of the debate around the competitiveness implications of the EU ETS, and defines the main challenges in estimating its impact.

Our first report[1] clarified the importance of these two dimensions and modelled the impact on five sectors – electricity, cement, steel, paper and aluminium. It showed that, according to economic theory, sectors could price products so as to maximise near-term profits and potentially gain from the introduction of the scheme. That model assumed carbon prices in the range €5–25/tCO_2 and concluded that firms were extremely unlikely to be exposed to significantly decreased profits over the first two phases of the EU ETS, whilst free allowances are allocated in line with need for participating manufacturing sectors.

Our subsequent report[2] took a wide view of cost exposure across the main manufacturing sectors of the UK economy, and introduced a graphical way of representing the cost impact of the EU ETS on different sectors in the international context. This report develops and applies this to individual manufacturing activities, and builds upon our earlier work in three additional respects.

First, the underlying data were explored in much greater depth. Manufacturing can be divided into 15 major sectors and further subdivided into more than 160 individual activities. The data available *inter alia* from the EU ETS verified 2005 emission records, that were not available at the time of our previous reports, facilitated coverage of all possible sources of emissions relevant to the EU ETS, including process and on-site emissions that fall outside the scope of government energy statistics. Chart 3 shows the distribution of total CO_2 emissions, including process and on-site emissions, across the fifteen main manufacturing sectors in the UK as defined at the aggregated 2-digit level of Standard Industrial Classifications (SIC). Four out of these stand out – iron and steel (21 MtCO_2); refining (20 MtCO_2); chemicals (17.8 MtCO_2); and 'construction materials' including cement (13.7 MtCO_2). Together these four broad sectors account for just over half the total CO_2 emissions from UK manufacturing.

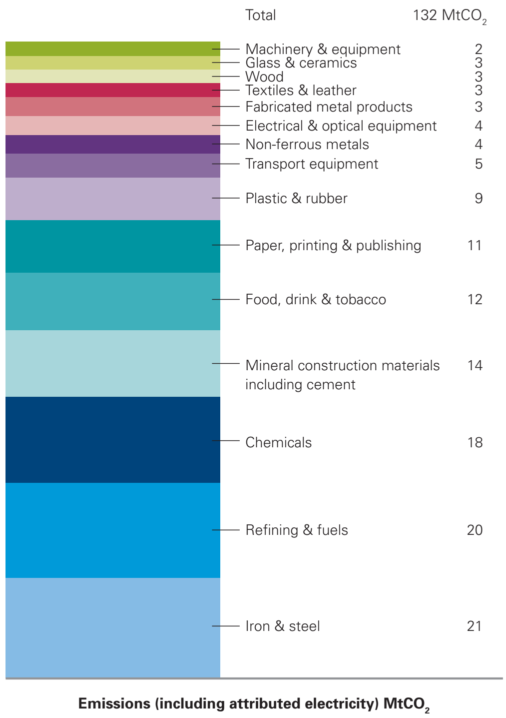


Chart 3

UK manufacturing CO_2 emissions (including electricity attributed)

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

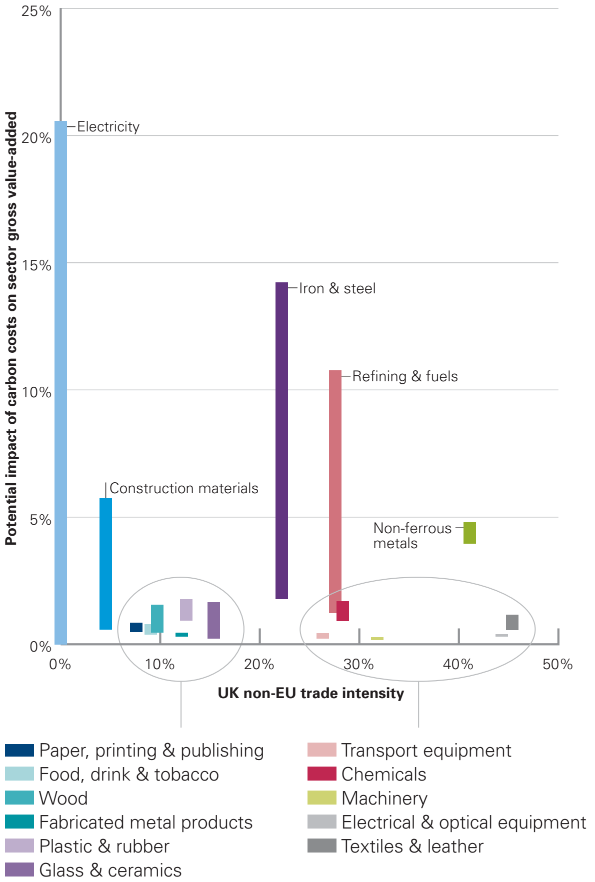
Later sections of this report go into further detail, breaking 11 of the sectors into their 159 individual activities and analysing each individually.

Second, we investigate a wider range of carbon prices, over longer periods. Forward trading prices for EU ETS Phase II are currently just over €20/tCO_2, out to 2012. The prices for Phase III will depend upon design and allocation decisions yet to be taken. However, the decision of the EU Council of Ministers to adopt a 20% CO_2 reduction target for 2020 implies higher prices. Moreover, the IPCC has reported that prices in the range US$20–50/t$CO_2$ are likely to be needed over such a timeframe to be consistent with climate change goals. On this basis, prices in the range €20–40/tCO_2 are likely out to 2020. We present our main data for a price of €20/tCO_2 in a form that can easily and visually be scaled up to higher prices.

Third, we explore the nature of profit and trade impacts on cement production and on steel production in much greater detail.

[1] The Carbon Trust, *The European Emissions Trading Scheme: Implications for Industrial Competitiveness* (2004)

[2] The Carbon Trust, *Allocation and competitiveness in the EU Emissions Trading System: Options for Phase II and beyond* (2006)



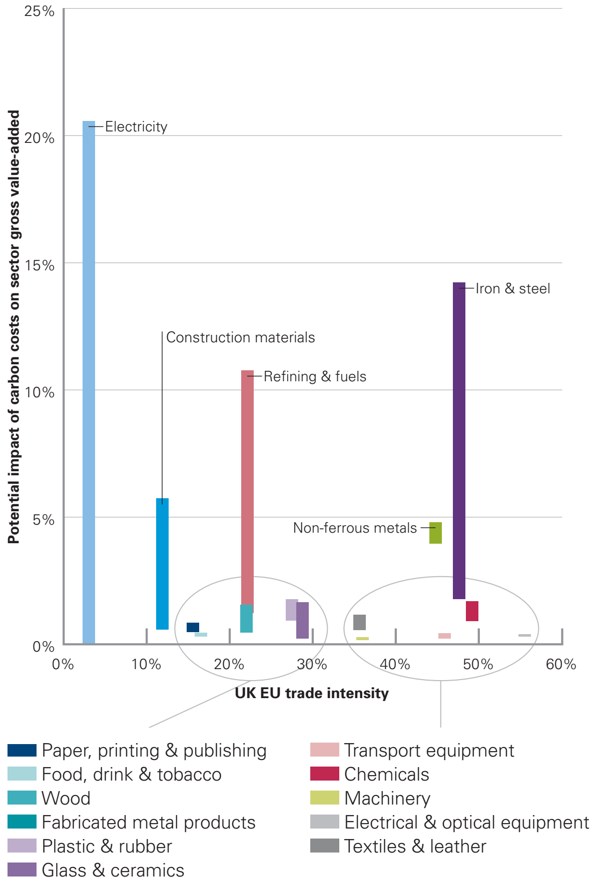


Chart 4

Value-added at stake for main manufacturing sectors, vs UK trade intensity outside the EU, at €20/tCO_2

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note The vertical axis shows potential impact of carbon costs on sector input costs as a proportion of sector value-added, prior to any mitigation or other response. The upper end of each bar shows impact with no free allocation of allowance (maximum value-added at stake, MVAS), the lower end corresponds to free allocations covering all direct emissions, leaving residual impact of increased electricity costs (net or minimum value-added at stake, NVAS). Data are shown for an allowance price of €20/tCO_2, a corresponding €10/MWh electricity price increase, and negligible impact on other input costs (see Annex).

The horizontal axis shows UK non-EU trade intensity, defined as (value of exports to non-EU + value of imports from non-EU) / (annual turnover + value of imports from EU + value of imports from non-EU).

For consistency given incomplete availability of more recent data, trade data are mostly for 2004. More recent trends in cement and steel trade are considered in the following sections of this report.

Chart 5

Value-added at stake for main manufacturing sectors, vs UK trade intensity within the EU, €20/tCO_2

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note For explanation see Chart 4 and Annex. The horizontal axis shows UK – EU trade intensity, defined as (value of exports to EU + value of imports from EU) / (annual turnover + value of imports from EU + value of imports from non-EU).

Cost impacts

Chart 4 shows the potential cost impact on these fifteen sectors and on electricity production of a carbon price of €20/tCO_2 using the methodology developed in our previous report[2]. The vertical axis presents the potential gross value-added (GVA) at stake, defined as the net impact of CO_2 costs on input costs relative to sector GVA. GVA is a far more relevant indicator than gross turnover, and far less volatile than direct measures of profit.[3] See Annex for definitions and discussion. However, our first report[1] and the detailed studies of cement and steel presented in this report do present direct estimates of profit impacts.

The lower end of each bar in Chart 4 shows the minimum exposure of sectors irrespective of whether they participate in the EU ETS. This minimum exposure is due to the electricity price increase induced by the EU ETS.[4] For EU ETS participant sectors, the lower end of the bar shows the impact if a sector receives free allowances equal to its 'business-as-usual' emissions and if it takes no abatement action.

The upper end of each bar shows the potential exposure if a sector receives no free allowances and must pay for all its emissions. Depending on how policymakers decide to charge for emissions allowances, this payment might be made by buying allowances at auction, by buying allowances off other sectors at a market price or by paying an equivalent carbon tax. An additional significance of the upper end is that it indicates the potential impact of the carbon price on the 'marginal' or 'opportunity' cost of changing production volumes, for sectors participating within the EU ETS irrespective of whether or not they are given free allowances.[5] For sectors within the EU ETS, as long as production of more or less output is not accompanied by any change in allocation of carbon allowances, that production decision faces the full cost of extra allowances, or the opportunity cost of not selling allowances. If firms were to increase the price of their products by the added cost of buying allowances to produce more volume, and if they were given emissions credits free, then such behaviour would lead to large profit gains from the EU ETS. However, these higher product prices could cause firms to lose market share to foreign imports over time.[6]

Therefore, in Chart 4, the bars of cost exposure are plotted horizontally against the sector's recent UK trade intensity of imports from and exports to outside of the EU. This gives an indication of the degree of international trade faced by the sector *vis-à-vis* regions which are not part of the EU ETS and therefore the potential for loss of market share if the firms in that sector raise their prices to cover the cost of carbon allowances.

[3] The Climate Strategies report (Charts 34–35) presents analysis of GVA trends in Germany for most of the sectors covered over the past 10 years, finding that with few exceptions the indicator is relatively stable. For most manufacturing sectors, value-added is 25–40% of gross turnover. See Annex.

[4] The chart shows results for an electricity pass-through resulting in wholesale electricity cost increase of €10/MWh. For a carbon price of €20/tCO_2 this is equivalent to full pass-through of opportunity costs (the marginal cost of generating more or less power) from gas plants, or a 60–70% pass-through from coal plants. This broadly corresponds to UK power sector operation in recent years. Full pass-through of opportunity costs from coal plants, e.g. in systems with very little gas generation, would increase electricity prices by c. €15/MWh. Either case implies substantial profits to the power sector. In regulated markets the costs would be much lower, if regulators allowed generators to pass through only average costs. Scaling the electricity price for such different conditions would move the lower point of the bars in direct proportion.

[5] See Annex to our first report[1].

[6] See previous reports[1, 2]. Sectors outside of the EU ETS would face the input cost impact at the bottom of each bar (electricity price exposure) and an equivalent incentive to change the price of their products. There would be no divergence between average and marginal costs, and no resulting scope for profiting from such divergence.

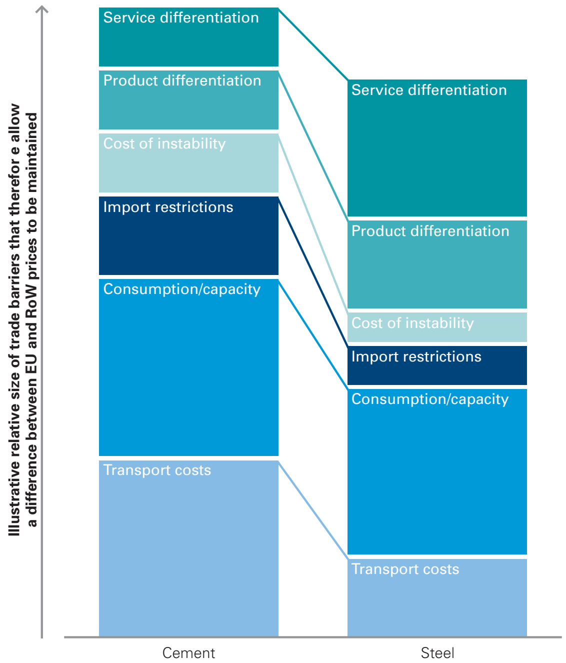


Chart 6

Impediments to trade (illustrative)

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Trade impacts
Trade is complex. Domestic production often continues despite considerable international cost differences. Understanding this is relevant to any consideration of competitiveness impacts. Chart 6 sets out six factors that impede the unlimited flow of goods based upon just small price differences, and illustrates in qualitative terms their relative importance for cement and steel as based on sector interviews:

1. Transport costs can range from negligible to decisive. The cost of importing electricity to the UK from outside Europe is prohibitive, for example, whilst the cost of importing aluminium is trivial compared to its value. With high weight per unit value, cement is costly to transport especially by road; steel much less so. Transport costs also include the costs of handling and storage facilities at ports and other trade terminals.

2. The balance between capacity and consumption in different regions can be crucial for activities in which production facilities are capital intensive and slow to build, like cement, steel, and many energy-intensive sectors. In the near term, an activity cannot be threatened by imports from regions which have no spare capacity, or may be driven to import if local demand exceeds local supply. Over time, such imbalances drive investment cycles, with high prices raising the incentive for new investment. The question is then whether carbon cost differentials are likely to change long-run investment location decisions.

3. Import restrictions may be implicit or explicit and take various forms. In some cases, local firms may take up available storage or other handling capacities themselves, or relevant processing capacity may be unavailable. Product standards may also have the effect of restricting imports.

4. Instability can also deter trade, which often requires some degree of local investment. Fluctuation in exchange rates are the most obvious – the €:$ rate, supposedly one of the more stable, climbed 50% over 2001–2006. Potential for retaliation may also deter foreign entry, if a foreign producer may fear a price war, either on the EU market or in its own local market, as big EU firms are trans-national. Other sources of instability could include fluctuations in international transportation costs (as in recent tanker costs), breakdowns of vessels or handling facilities, and – for the case of carbon costs – uncertainty about carbon prices and the pace at which other, exporting regions might adopt either equivalent policies, or tariffs on energy intensive exports (as Egypt has done on cement and steel exports). In addition, exporters may not be able to react so quickly to changing product requirements in local markets.

5. Product differentiation may often favour domestic production which is adapted to specific local requirements (including domestic or European health, safety and environment standards). Even in the relatively homogenous product of cement, issues of colour, consistency, strength and workability may differentiate sources. The same is true to a much greater extent in a wide variety of specialised steel products.

6. Service differentiation is a final important factor, covering for example timely delivery, price stability, and certainty in availability. More intangible dimensions springing from local culture, language and relationships may in practice be even more important in helping to favour domestic production.

Obviously, none of these on their own are decisive, or will protect a domestic industry against a big, sustained international cost difference: trade, indeed, is about trying to reap the benefits of differences in production costs as much as possible. But they do explain why trade is not an 'all-or-nothing' response to minor cost changes. Rather, increased costs in Europe would tend to depress exports and increase imports over time.[7] Economists seek to measure these responses through observations of how trade has responded to price differences in the past – defining 'trade elasticities'. We apply trade elasticities, and discuss debates around them, in sections 2 and 3 of this report.

The implication is that the more a sector raises its prices in response to carbon costs, the more rapidly it will increase its exposure to international trade. In particular, if product prices in an EU ETS sector are raised to reflect the 'opportunity/marginal costs', towards the top of each bar in Chart 4, this will tend to increase revenues for participants by far more than the average cost increase, which, with a high degree of free allocation, is towards the bottom of each bar. Initially this would generate large profits, but such pricing might lead to a rapid loss of export markets and attract imports.

Behind this pricing decision lies the biggest controversy around competitiveness analysis of the EU ETS. Economic theory tends to assume that firms maximise profits. Applying well-developed theories of profit-maximising behaviour, our first study[1] predicted that all participating sectors would pass through a majority of opportunity costs, and thereby profit substantially in the initial phases of the scheme, with modest loss of market share. As discussed in that report, such behaviour was strongly contested by industry, and some branches of economic theory have also focused on the preferences of managers, as distinct from shareholders, to adopt pricing typically based on average costs, so as to grow or at least maintain market shares over the longer term – even if any incremental production is at a loss. Ultimately no 'rule' can capture all the factors that may drive managerial decisions about these trade-offs, and hence what share of carbon costs they may add to product prices. In this study, we simply illustrate the implications of different cost pass-through decisions, rather than predict what might be 'optimal' from different perspectives.

Chart 5, in which the horizontal axis shows the UK trade intensity within the EU, illuminates other trade issues. In almost all cases, the trade intensity with other countries in the EU is higher than with countries outside the EU, even for the UK. This reflects the lowered trade barriers within the EU. Since all EU countries face the same carbon price, there is not the same scope for carbon cost differences and if companies do adopt pure 'profit maximising' pricing, in theory different allocations would not generate price differentials or affect trade flows.

However, different allocations would affect relative costs and hence either relative profitability, or product prices if companies price to recover average, rather than opportunity/marginal costs.[8] In this context the bars in Chart 5 assume a different significance, since the height of each bar indicates the sensitivity of value-added to differences in allocations between different Member States.

The final, crucial issue is the extent to which aggregating different processes and products into whole sectors may mask important differences at a more disaggregated level. Individual case studies can of course generate specific insights, but they lose the 'big picture'. In this report, we break down 11 of the major sectors illustrated in Charts 3, 4 and 5 into 159 activities as defined by Standard Industrial Classification at the 4-digit level and present the cost exposure and trade characteristics for each. The activities studied together account for two thirds of the value-added of UK manufacturing industry and 90% of associated emissions.

Four of the 15 sectors in Charts 3, 4 and 5 are not studied. These are fabricated metal products, machinery & equipment, electrical & optical, and transport equipment. They are characterised mainly by mechanical and electrical engineering and information technology, which involve little process CO_2 emissions and which are not energy intensive activities compared to primary production and thermal processes. The data in Charts 4 and 5 confirm the very low impact of carbon costs for these sectors, and the available evidence supports the reasonable assumption that this holds true for all the individual activities within each of these sectors.[9]

[7] However, the Climate Strategies report notes that climate policy itself could affect trade barriers – probably increasing them for example by increasing transport costs or by increasing consumer interest in lower carbon products.

[8] Also, different power sector structures could result in different electricity price impacts, as outlined in Section 6, generating some difference in minimum value at stake for firms in different EU countries.

[9] At the request of the automotive industry, Climate Strategies also carried out a 4-digit analysis of the 11 activities defined under the aggregated transport equipment sector. For carbon costs of €20/tCO_2, no individual activity exceeded 1% MVAS, or had NVAS above 0.5%, of gross value-added. Another Carbon Trust study included modeling of vehicle manufacturing and concluded that profit-maximising behaviour would lead to a small rise in EBITDA if the sector joined the EU ETS, under the central scenario assumptions. (The Carbon Trust (2005), *UK Climate Change Programme: potential evolution for business and the public sector*, Chart 17)

2. Mineral construction materials including cement

The manufacture of cement and concrete, lime, and stone products for construction contains the most carbon cost sensitive activities of all the sectors. Globally, cement production accounts for about 5% of CO_2.

Although it is a relatively homogenous product, cement transport costs have ensured it has remained a relatively localised business. However, its carbon intensity raises the question of whether carbon costs could change that.

The overall sector comprises twelve activities as defined at the SIC 4-digit level, and Chart 7 illustrates their individual sensitivities to carbon costs, mapped against trade intensity in 2004 (more recent trends are discussed below). This illustrates the importance of such detailed analysis, as two activities stand out: the manufacture of cement, and of lime. These two activities account for almost 90% of sector emissions and about 13% of its value-added (the latter nearly all attributable to cement).

The bulk of value-added for the sector is in much less carbon-intensive downstream activities, with more than half in the manufacture of ready-mixed concrete and concrete products. Lime is a very special case, with uniquely high process emissions (about 30 times bigger than its fossil fuel emissions) but it is small in absolute terms and is not therefore discussed further here.

From the standpoint of total emissions and economic significance, the main exposed activity is cement production. This has a minimum value at stake of 2% and a maximum value at stake at 35%, indicating that cost impacts are very sensitive to allocation, and also the opportunity/marginal costs of operating with fixed allocation. At the same time, cement is heavy and bulky and therefore costly to transport. Compared to the average cement cost in the EU of around €65/t, it costs around €10 to move a tonne over 100km by road, and costs around €15–20/t to ship across the Mediterranean Sea including loading and unloading. Consequently cement is traditionally a localised business. UK non-EU trade intensity is low despite big international price differences, with UK prices at least 50% higher than, for example, prices in much of the developing world (Chart 8). Historically, prices in EU countries have not reflected prices outside the EU, and even the link between the prices in various EU countries is weak.

The price and the profitability of cement production in a given country has traditionally depended on national factors (such as the number of companies and the balance between supply and demand). EU cement firms have faced low international pressure and made good profit margins.

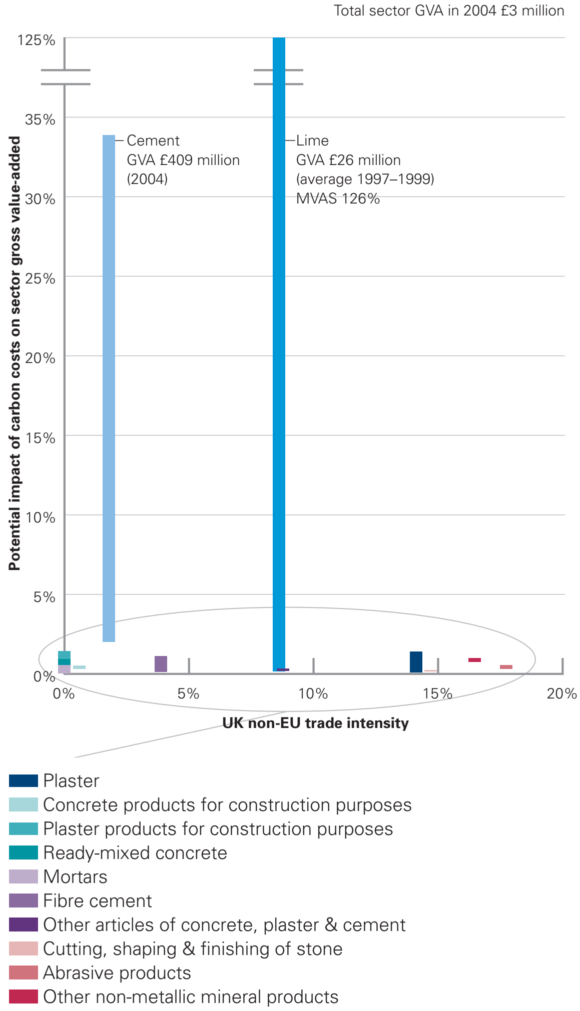


Chart 7

Value at stake for construction materials vs UK trade intensity outside EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes.

Is this changing? In aggregate, the EU now imports around 8% of its cement from outside the EU. Total imports to individual EU countries have increased at 4%/year, and this has been driven mainly by rising imports from outside the EU. Such trends are consistent with our previous studies, which suggest that sustained cost differences of £10–15/t (€20–30/t) would be sufficient to overcome international transport costs, though some inland markets would remain protected. However imports have been dominated by Spain and Italy, as domestic production has failed to keep pace with their construction boom, driving up prices and attracting imports. (Chart 9)

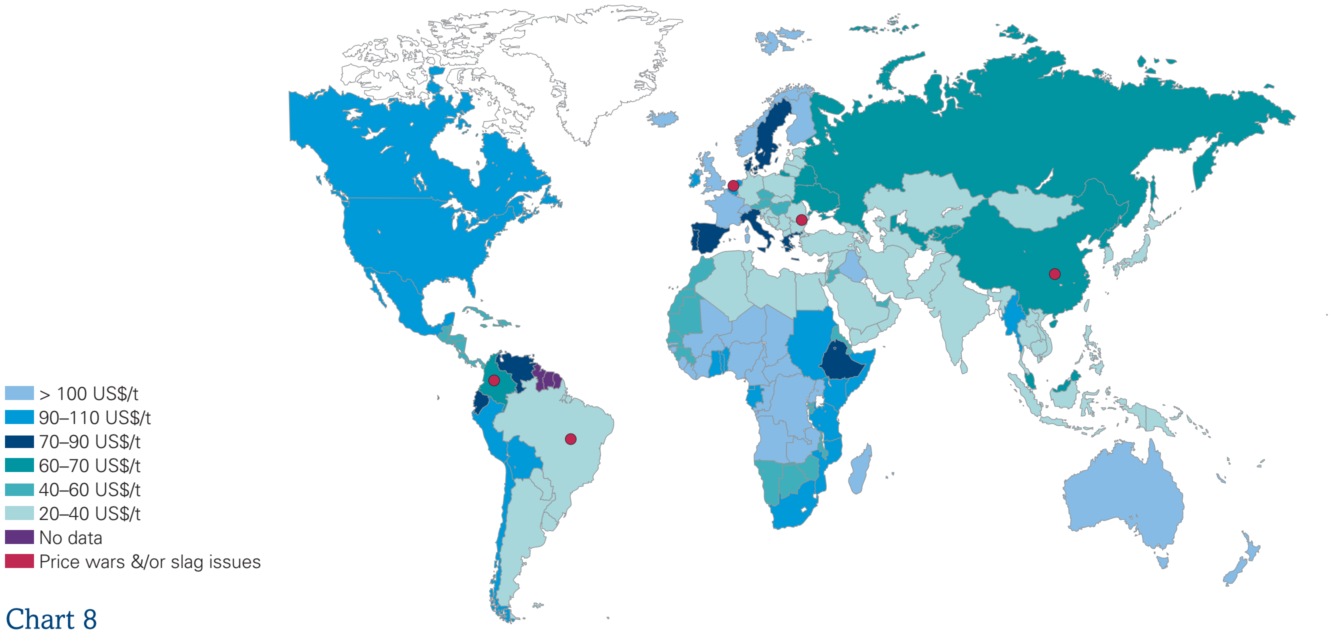


Chart 8

World cement prices in US$/t (2006)

Source Climate Strategies (2007): Hourcade, Neuhoff, et al. Underlying data from Exane BNP Paribas.

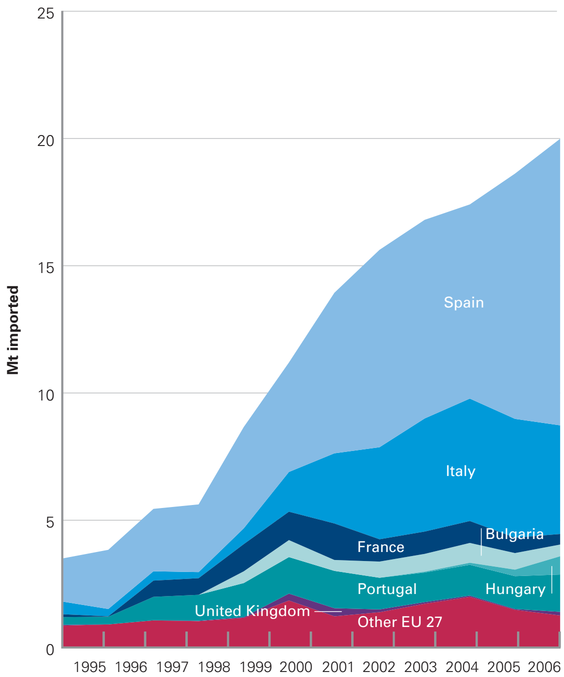


Chart 9

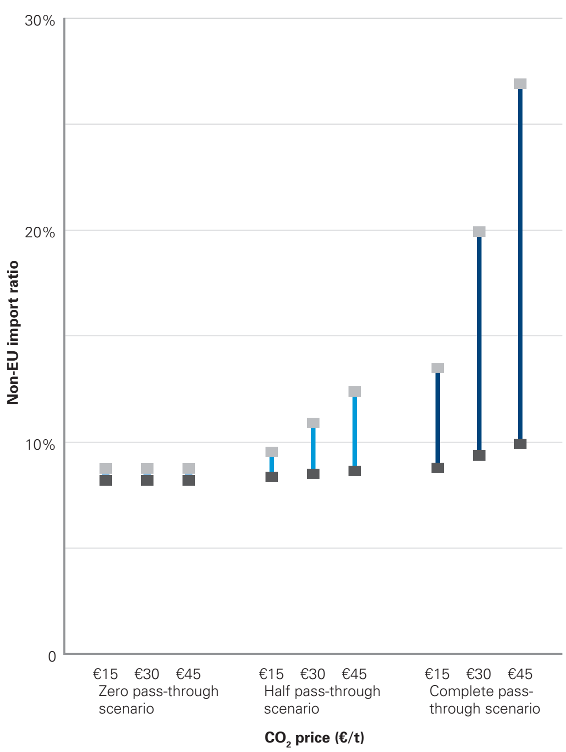
Trends in cement imports to the EU by country (1995–2006)

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

In 2006, cement imports to the EU from China surged to 8Mt (again, mostly to Spain and Italy). However this was not a break from the aggregate imports trend, but rather represented Chinese cement replacing Turkish and Egyptian imports – in part after Egypt imposed an export tariff of around €8 per ton of cement to force domestic producers to supply their home market, at lower domestic prices. The trade has also increasingly shifted away from cement towards clinker, the carbon-intensive intermediate product in cement manufacturing, supplied to grinding stations within Europe; both trends predate the EU ETS.

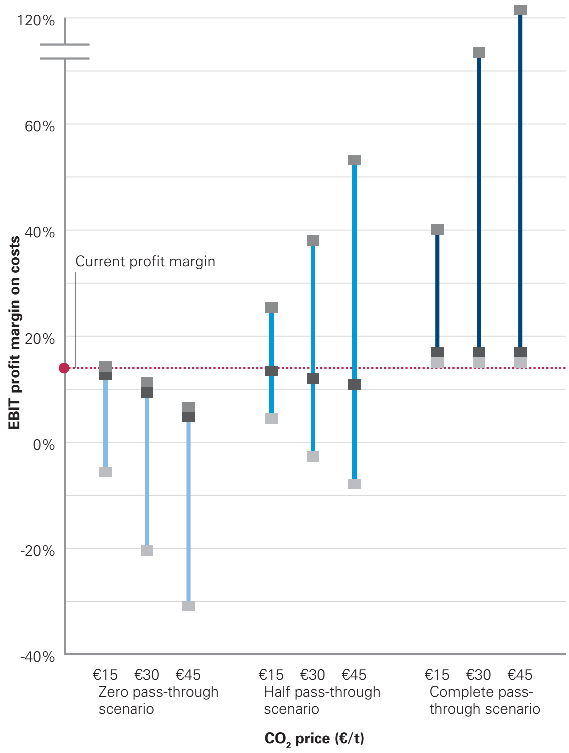
In terms of carbon cost impacts, the % impact on value-added is roughly twice the corresponding % impact on product prices required to recover margins. A carbon price of €30/tCO_2 with no free allocation would raise cement costs by around €25/t (see Chart 2). Clearly, passing on these costs, could in principle be sufficient to cause imports at scale, subject to the various other kinds of barriers to trade summarised in section 1. If EU producers have substantial free allocation, they might make substantial profits from such pricing, reducing domestic production, importing cement or clinker, and selling surplus allowances.

There is strong historical evidence that cement producers have tended to pass-through cost changes (for example from exchange rate fluctuations) and limited, but disputed, evidence that some UK producers did pass on a modest portion of EU ETS opportunity costs into cement prices during 2005–2006.



a) Impact on imports to EU

Emission allowances given free or auctioned
Allowances varied in proportion to actual output



b) Impact on profit margins

Full auction of emission allowances
90% of required allowances given for free
Allowances varied in proportion to actual output

Chart 10

Estimated EU ETS impacts on EU cement sector (a) imports and (b) profit margins by 2015 for various allocation, price and pass-through assumptions

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note The charts show modelled impacts on (a) import ratio, i.e. imports as a % of total domestic consumption, and (b) profit margins (earnings before interest and tax over costs) for three carbon prices (€15, €30 and €45/tCO_2), under three different assumptions about pricing (no pass-through, half pass-through, and full opportunity cost pass-through.) The vertical range shows the impact of different allocation approaches, ranging from full auctioning to a free allocation equal to 90% of recent emissions. A third allocation case reflects an initial allocation equivalent to full free allocation but then scaled in proportion to subsequent output. This removes any difference between average costs and the opportunity cost of changing production and is equivalent to industries adopting a maximum price pass-through equivalent to recovering the average cost impact of the EU ETS. This variable allocation has consistently the least impact on profits, production, or emissions, because it largely shields the sector from carbon price impacts except as mediated through electricity price rises.

To illustrate the implications, Chart 10 shows the results of a modelling study of the impacts of EU ETS prices in the range 15–45€/tCO_2 on aggregate EU cement sector import intensity (Chart 7a) and profit margins (Chart 7b), for a range of allocation and cost pass-through decisions described in the note on the left of this page.

The model incorporates abatement opportunities available over the next ten years and associated costs. These suggest that producers would reduce emissions by less than 10% at the CO_2 prices considered, so they are still (very small) net purchasers even if allowances equivalent to 90% of their 'business-as-usual' emissions are given for free. Both the abatement and the estimate of trade responses relate to responses in the short to medium term, out to the middle of Phase III of the EU ETS which is likely to be 2015. It does not model issues around possible relocation of investment in new cement production plants.

The results show just how sensitive the impact of the EU ETS on profit and imports is to industry pricing decisions. If producers leave cement prices completely unchanged (zero pass-through scenario) there is no impact on trade and profit margins decline. With free allocation, the decline in profit margin is due primarily to the carbon impact on electricity prices. Profits turn to losses if firms are required to buy many allowances, reaching more than -30% at the highest prices under 100% purchase if producers do not increase their prices at all.

In sharp contrast, full pass-through of carbon costs generates big profits for cement production if it has free fixed allocation, with profit margins rising to 40%, 70% and 120% for the different carbon price levels. However the rising product price attracts imports which, at the highest prices and trade sensitivities, rise from the 8% to 27% averaged across the EU. It is cheaper to transport by sea than by land therefore UK imports in such a scenario could well be even higher. And if no allowances are given for free, this same loss of market is accompanied by no increase in profit margins and therefore an overall reduction in the gross profit of UK cement production.

The half pass-through scenarios result in modest impacts all round: imports may rise, but not by more than a few percentage points for the EU overall, whilst profit margins may either rise or fall depending upon the allocation scenario.

In all cases, if the allocation of allowances are varied in proportion to actual output, the impact on price, trade and profit will be much lower.

Like most modelling exercises, specific assumptions and results can be challenged. However, the main insights are likely to be robust. For almost any credible carbon prices, the net cost impacts with close to 100% free allocation are clearly trivial compared to existing international price differentials, exchange rate fluctuations, or indeed transport costs. The net impacts are only material as a result of specific cutbacks in allocation or price pass-through decisions that raise costs or prices by far more than the minimum value at stake exposure. The exceptionally high maximum value at stake, however, does make the sector potentially sensitive to allocation and prices decisions, by government and industry respectively.

One insight from this is that it is relatively easy for government allocation decisions to protect profit margins in the cement industry. Governments could aim to establish a ‘compensating rate of free allocation’ (CRFA) that would leave net profitability unchanged. However, this does require a judgement about likely pricing decisions: to underline this again, the economics literature suggests that one would expect an ‘optimal’ pass-through of carbon costs to prices of well above 50%, generating substantial profits with some loss of market share, whereas the industry has strongly contested this conclusion and argues that its scope for factoring in carbon costs to product prices is much less.

On the assumption that price increases would be limited to avoid a major loss of domestic markets, so that production volumes are not greatly affected, the compensating rate of free allocation is inversely related to the likely pass-through of costs to prices: 30% pass-through would imply that the sector needs to receive about two thirds of its allowances for free to compensate, whereas pass-through of 70% would imply that being given about one-third of allowances for free would suffice. Moreover, despite the greater loss of market share at higher prices, the increased value of the free allowances more than compensates; the modelling actually suggests the CRFA would decline slightly at higher carbon prices, for a fixed pass-through assumption.

As an indicative middle assumption, a 50% pass-through with a carbon price of €30/tCO_2 would raise cement prices by around €12/t, about 20% of the current EU average price, with imports rising sharply from the current 8%, but only displacing a few percent of domestic production. In this case, about 50% free allocation would compensate producers and maintain profits at the baseline level. The modelling underpinning this is at EU level; whether these conditions would be appropriate for UK producers, potentially more exposed to sea trade, would require additional analysis.

The impact of the EU ETS on the incremental costs of producing more or less cement, at the prices predicted during Phase II and likely during Phase III, will create a strong incentive for the industry to produce less and to import cement or clinker, so as to cash in any surplus allowances. The incentive to do so will be all the stronger for the EU-based multinational companies that increasingly dominate the cement industry.

From this perspective, the ‘competitiveness’ problem is not so much a problem for industry as for the environment. An appropriate compensation rate of free allocation – well below the present 100% – can protect net profits. But replacing domestic production with imports will not reduce emissions. Indeed it may well increase them, partly because production may come from less efficient facilities (as with much current Chinese production), but also because of the emissions (and other environmental impacts) associated with bulk cement transport. In (admittedly extreme) scenarios in which EU imports have increased from 8% to over 20%, import substitution would be greater than actual mitigation, which is projected to be under 10% based on currently available technologies. EU cement sector emissions could decline by 20%, and the industry could still profit; but the majority of the emission ‘savings’ would be exported rather than avoided.

Some of the policy implications and options arising are outlined at the end of the next section (on steel) and in our concluding discussion.

3. Iron and steel production

Steel, manufactured from iron ore in blast oxygen furnaces, is almost a symbol of industrial development and of energy consumption. Steel production also has high emissions from the chemical conversion processes involved. Like cement, iron and steel account for around 5% of global CO_2 emissions.

Steel has been heavily traded within Europe but until very recently the EU overall remained self-sufficient in steel production. There are widespread fears that carbon costs, along with the globalisation of the industry, could change this.

Chart 11 shows the activities within the UK iron and steel sector. Basic iron and steel production – 80% from three plants operated by one company – stands out as the carbon-intensive part of the sector. Moreover, it accounts for about half the value-added of the sector, and in 2004 UK trade intensity outside of the EU was close to 20% (and nearly 50% within the EU).

There are two quite different routes to steel production. The UK industry is dominated (80%) by blast oxygen steel (BOS) furnace production from iron ore. The alternate route, electric arc furnace (EAF) production from scrap metal, consumes much less energy but its output is constrained by the availability of scrap. The two routes are used to produce different products, EAF producing 'long' products particularly for construction, whilst 70% of BOS production across Europe is of more specialised 'flat' products, of which 40% is for the automotive industry.

Viewed globally, steel has been a regionalised business. Chart 12 shows that EU countries collectively traded 120Mt with other EU countries, exported about 40Mt to other regions and imported 25Mt from them. Similar patterns are evident in the Americas and in Asia.

However, this pattern is challenged by cost differences and recent trends. The average cost of steel production in the EU has been 10–20% higher than the 'rest of world' average, and is up to 40% more expensive than countries with easy access to abundant iron ore and cheap energy, like Brazil, Ukraine and Russia. Unlike cement, the high value-to-weight ratio of many flat products in particular mean that transport costs do not provide significant protection. Other factors do impede trade, including the specialisation of many flat products, and quality demands and hence the potential importance of close business relationships, for example with automotive manufacturers. One way this barrier has been addressed is by trading 'semi-finished' products. Economic estimates of trade sensitivity (elasticities) based upon past data show the steel trade to be far more sensitive to price changes than the cement trade (but there are wider uncertainties in the estimates).

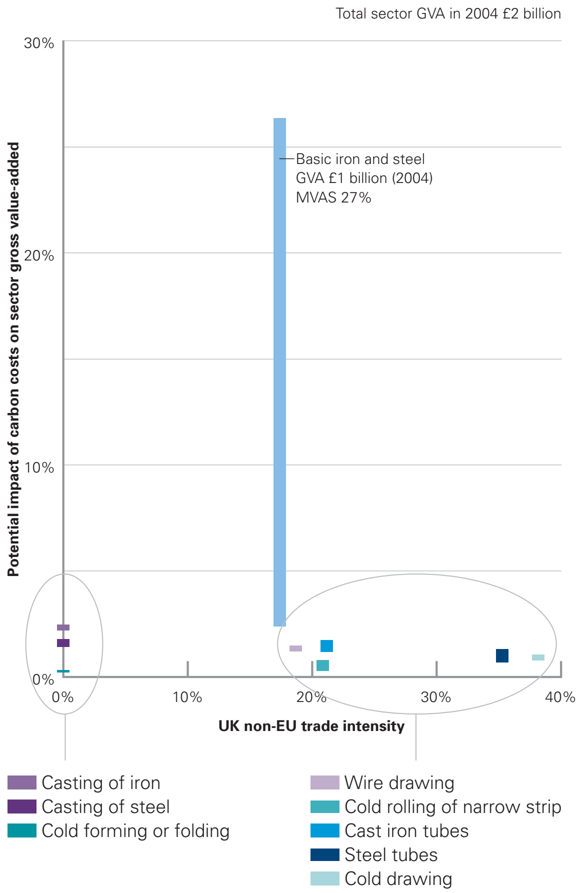


Chart 11

Value at stake for iron and steel vs UK trade intensity outside EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation.

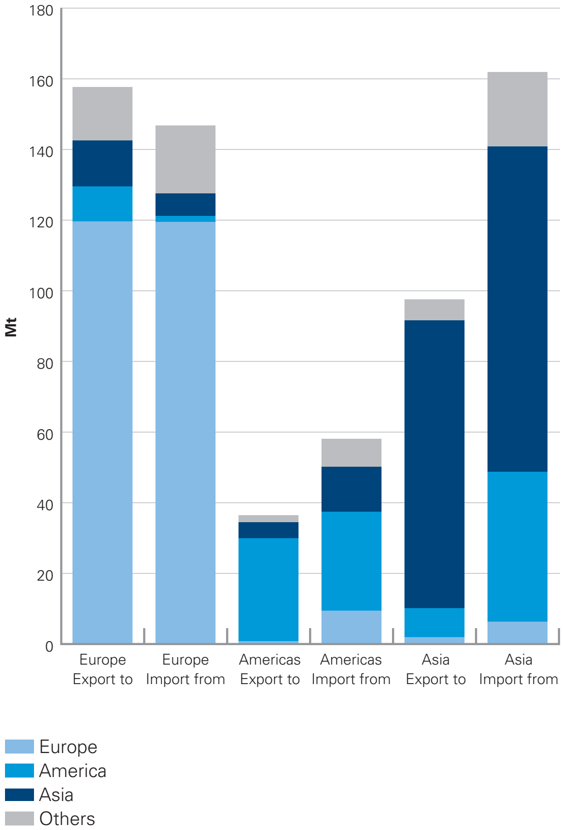


Chart 12

Steel trade across regions, 2004

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

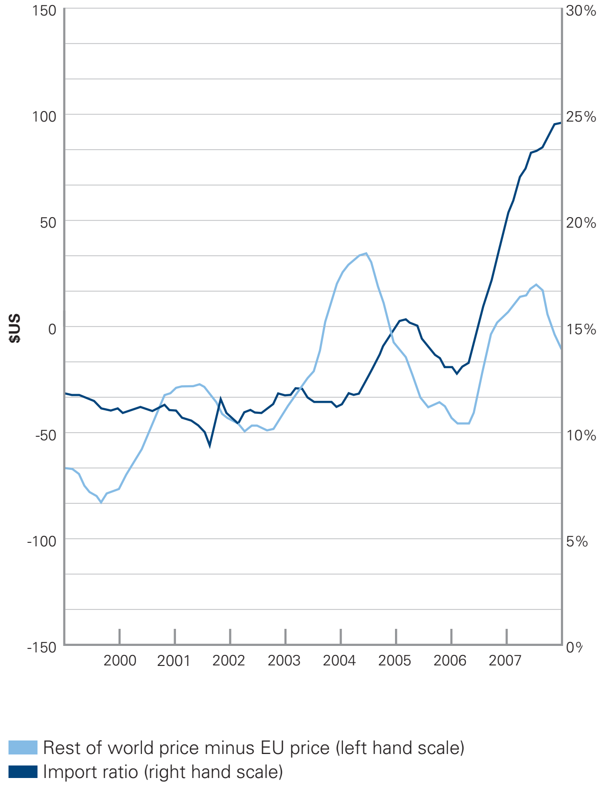


Chart 13

Evolution of EU steel import ratio and price difference from rest of world

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note The chart shows smoothed monthly data for the % steel imports into the EU, and difference between EU and rest of world steel prices.

Moreover, the steel industry has been volatile and change is rapid and high-profile. Mittal's takeover of Arcelor dominated the front pages of financial papers for months, and has spurred further international consolidation of the industry. Against this background, Chart 13 shows also that steel imports to the EU surged during 2006. This rapid change turned the EU from being roughly net self-sufficient, at 15% imports and exports, to importing 25% of its flat steel products in 2006.

Against this background, the modelling techniques and scenarios as set out in the previous section on cement were also applied to steel. Again, the modelling was at an aggregate EU level, and trade sensitivities were based on the range of historical estimates, with the 'high pass-through' scenarios accompanied by the highest estimates of trade elasticities found in the literature.

The data again are appropriate to short to medium term responses, out to about 2015 and include the potential to abate emissions. The latter suggest that the steel sector could abate by more than 10% making it a (small) net seller of allowances under the scenarios in which producers get 90% of business as usual emissions for free.

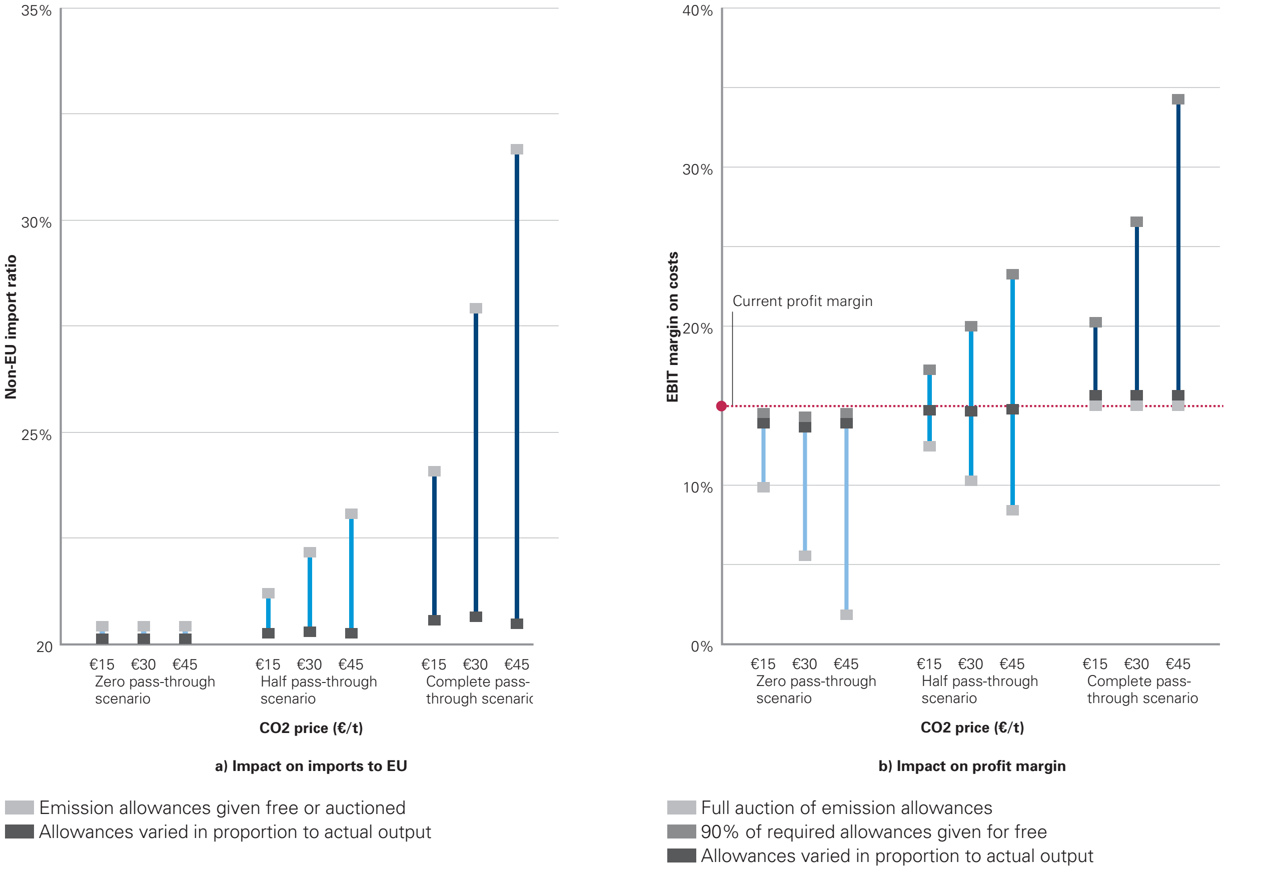


Chart 14

Estimated EU ETS impacts on EU blast furnace (BOS) steel sector (a) imports and (b) profit margins by 2015 for various allocation, price and pass-through assumptions

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See notes for Chart 10 for explanation.

Full pass-through of opportunity/marginal costs into prices with 90% free fixed allocation generates profits, though at a lesser scale than cement. The average margin on EU steel production increases from 15% to 20–35% across the range of CO_2 prices. This is countered by an increase in imports, that rise from a base of 20% (gross) to 24–32% under the different carbon prices. In the medium and high CO_2 price cases, observed reductions in EU steel sector emissions could exceed 20% but again, some of this might in practice be due to displacement by foreign production.

The results displayed in Chart 14 indicate an impact on steel imports that, relative to a base level of 20%, is broadly comparable to that on cement, but profit margins are much less affected, by pricing and allocation decisions. This is because carbon costs change steel prices much less than for cement, but trade is much more sensitive to a given price difference, and the two effects roughly net out.

Avoiding any change in product prices or trade at all (zero pass-through) has negligible impact on profit margin for the free allocation scenarios – indeed the value of net allowance sales from abatement, roughly offsets the impact of electricity costs. With no free allocation, the profit margin declines from 15% by roughly 5 percentage points for each €15/tCO_2 added to be CO_2 price, to reach close to zero in the highest carbon price (€45/tCO_2) scenario.

The gross profits of the industry are affected by the volume of production, but the impact on margins generally swamps this. In a central case, with 50% pass-through of €30/tCO_2, EU steel production declines by 6% but this is trivial compared to a one-third increase in margins (from 15% to 20%). However the political challenge is that the cutback in production could be very unequally spread between companies and indeed countries, for both cement and steel production.

As with cement, if only half the costs are passed through to prices, impacts are much more moderate: imports rise only by a few percent, and profit margins rise or fall according to the degree and nature of free allocation. Again, the scenarios where allowances are varied with variation in proportion to actual output have negligible impact on either trade or prices.

Although specific numerical assumptions and results can be challenged, the main insights are likely to be robust within reasonable ranges. There is however even greater scope for debate about the trade assumptions than there was for cement, particularly at higher carbon price and pass-through levels. In the middle scenario of carbon costs and pass-through (€30/tCO_2 and 50% pass-through of marginal/opportunity costs) steel prices rise by 5%, which remains very small compared to historical fluctuations and existing cost differentials. But in the most extreme case, it increases by 15%.

Unlike cement, in which there is a significant natural degree of trade protection arising from intrinsic transport costs (that also varies according to location, providing a natural gradation of response), the barriers to greater international trade in steel are more to do with human constructs, for example those arising from product and service specialisation of different companies. In addition, natural factors may endow some foreign producers with a cost advantage, in terms of access to iron ore.

Historically, the barriers to unfettered trade (outlined in section 1 of this report) have been sufficient to support EU producers despite their higher costs: the analysis here fully captures past evidence about the sensitivity of trade to such price differentials. However, the general trends towards globalisation – and the specific wave of international consolidation in the steel business – could substantially reduce such barriers, in part by facilitating internal company trade in semi-finished products to make the best trade-off between raw BOS production costs (e.g. in Brazil and Russia), and the benefits of product and service specialisation close to final markets. The core criticism from the steel sector of analysis such as that presented here, in other words, is that analysis based upon historical evidence of trade sensitivities reflects a world that no longer exists. By definition, it is almost impossible to analyse in any objective fashion quite how much the future world will differ from the past; but it does imply a need to play close attention to trends.

The sharp rise in steel imports in 2006 probably reflects some combination of: the structural factors outlined, temporary changes in the supply-demand balance (driven by sharp rise in Italian and Spanish demand) and the impact of carbon costs in 2005–2006. Disentangling these different causes is probably impossible, but in an increasingly globalised steel industry, carbon cost differentials could play a bigger role. Again, the global companies themselves would profit by such a shift (which is why they would make it); but the value-added, and the emissions associated with basic production, would migrate from the EU.

These analyses in this section are based on the characteristics of existing production plants, but raise questions about the possible impact of the EU ETS on the location of investment in major new plants. Since such plants are capital intensive and have very long lifetimes, this is also a question about long-term expectations.

Many factors bear upon major new investment decisions. In terms of CO_2 influences, these include the scope for innovation to lower emissions, expectations about how current cost differentials might change (including for example whether and how quickly other regions might develop CO_2 controls) and whether the EU ETS might develop any policy response to competitiveness concerns (such as the Border Tax Adjustments currently proposed by the French government).

The investment response may differ greatly between sectors. In cement, plants have rarely if ever been built ‘for export’: the fundamental drivers of international cost differences are modest compared to transport costs, making any such investment inherently risky. As noted, trade has been driven far more by imbalances between domestic demand and capacity. New steel investment, however, is under considerable pressure to locate abroad because fundamental drivers of cost differences between countries far outweigh transport costs: factoring in carbon cost differentials may make this look even more attractive.

In a bid to prevent the EU ETS encouraging such investment migration – between EU countries as well as outside – most EU countries have offered free allowances to ‘new entrants’. Economically, this amounts to a subsidy to new investment to offset future carbon costs. They have also discouraged closure of old plant by withdrawing allowances if they cease operation. Our previous study[2] noted how this can reduce the effectiveness of the scheme for power generation. This can be considerably alleviated if new entrant allocations are benchmarked to a standard CO_2 emissions rate per unit output. This would still however face the risk that new investment in the EU will be preserved but the plants will run at low output, with the companies importing products and recouping their investments by selling allowances – hardly a productive use of capital. If other regions are slow to catch up, the EU may still have to show willingness to consider other measures in the longer term, as appropriate to specific sectoral conditions.

A rate of free allocation designed to compensate profit impacts offers a medium-term palliative: producers consistently argue that they would moderate pass-through of opportunity costs so as to minimise impacts on domestic production rather than to maximise near-term profits. Longer term measures to tackle leakage from carbon-intensive activities, as outlined in our previous study[2], include intensity based output (that varies with output), global sector agreements, and border taxes or adjustments of various kinds. A key conclusion from this study is that such measures need be considered only for a few specific activities, starting with cement and steel – and even for these, trade impacts are modest enough to allow time for in-depth analysis of the options and their negotiation at a multi-lateral level.

4. Energy production: refining and coke

The energy production sector (excluding power generation) is dominated by refining, emissions from which account for over 3% of CO_2 from the UK and the EU overall. Refining also accounts for almost all the sector's value-added.[10] These data suggest refining to be the third most carbon-cost-sensitive of the major activities considered in this report, and the most economically significant of any of the major emitters of carbon.

Coke production is significant mainly as an input to BOS steel production and these emissions are attributed to steel; Chart 15 shows only the residual GVA. Given the extent of UK facilities for importing coal – which could be turned relatively easily to coke imports – coke imports for steel production could be an additional source of leakage attributable to the steel sector, analogous to importing clinker for cement production.[11] No energy input data were found for processing of nuclear fuel, hence it is not shown on the chart.

For refineries, despite the relatively high carbon intensity per unit GVA, carbon costs should be set in a context of high international oil prices. These drive a turnover that is, quite uniquely, more than ten times the GVA, which makes impacts on prices a small fraction of the % GVA impacts. For example an emissions cost of 20€/tCO_2, paid in full, would add €0.58/barrel, less than a hundredth of the traded crude price. The impact on prices at the pump, after taxes, would be even smaller – probably less than 0.5%. The dramatic swings of EU ETS prices in 2006 would be lost in the noise of daily fluctuations in the price of crude, and are small too compared to the differentials in tax rates between different EU member countries.

This does not mean that refining is a hugely profitable activity – in fact refining margins have been volatile and sometimes very low. However an earlier Carbon Trust study, with a relatively simple model of the petroleum market in the UK estimated that the change in sector profits (EBITDA) at a 30€/tCO_2 carbon price would by 2020 be less than 1%; turning from slightly positive (if the free allocation of emission allowances are reduced at 1% p.a.), to fractionally negative for deeper cutbacks.[12]

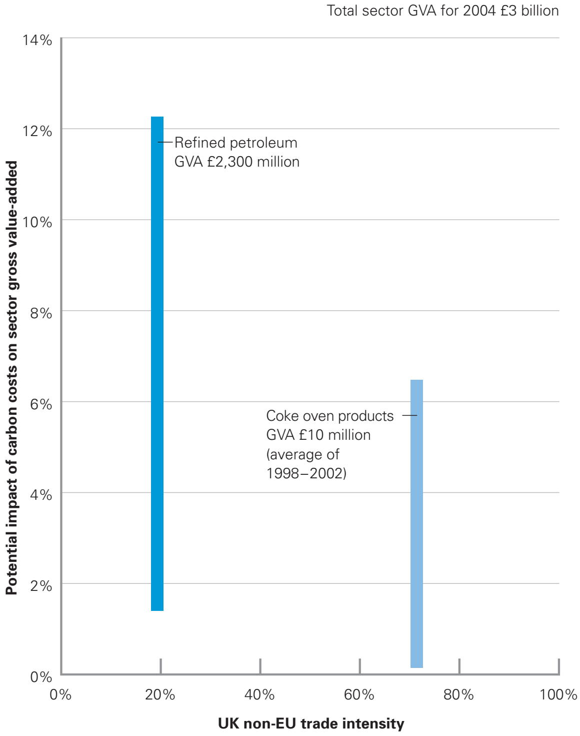


Chart 15

Value at stake for energy transformation (refining and coke) vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes, and footnote 10.

[10] Breakdown of value-added between the sub-sectors was not available in official statistics, the Climate Strategies report makes indirect estimates but the uncertainties would not affect the main conclusions about refining presented here. The balance of GVA is due to nuclear fuel processing for which energy data were not found.

[11] Separate data on the economic (e.g. value-added) significance of coke for steel production was not available (nor indeed, for clinker in cement). Note that the very small scale (value-added) of the residual coke activity in Chart 15 may make it prone to data errors.

[12] Carbon Trust (2005), *UK Climate Change Programme: potential evolution for business and the public sector*, Chart 27.

The high turnover, volatility and geopolitical nature of the oil business also means that other considerations easily dominate over carbon costs. Oil refineries have traditionally been located close to demand for four reasons:

1. Transport costs are higher for refined products than for crude oil: refined products require dedicated tankers/pipelines and storage capacity for each product to ensure product quality, which increases transport and logistics costs and also reduces flexibility.

2. Investors have been reluctant to invest in capital-intensive facilities in many of the oil exporting countries due to fear of expropriation or political instability, or related supply disruption that would disrupt the dedicated crude oil supply.

3. Coastal refineries near markets can optimise their production by mixing various types of crude oil in response to seasonal changes in product demand and market changes, a benefit that is difficult to achieve where refineries are located close to oil production and dedicated to a particular crude oil steam.

4. Refineries close to market can respond to market changes immediately, whereas refineries with long shipping times lack flexibility and will have a greater proportion of 'stress' sales.

The close match between refinery capacity and consumption observed in many regions – and the continuation of refineries through years of low economic margins – is a response to these four factors. As a result, transport and distribution infrastructure is now tailored to the location of refineries. Large-scale changes towards importing refined products into the EU could require significant investment and restructuring of the infrastructure.

Against this background, the scale of trade indicated in Chart 15 reflects mainly complementary product markets, not cost differences. Crude oil results in a 'natural' mix of gasoline and diesel: US consumption of gasoline exceeds this ratio, and the reverse is true in Europe, so EU refineries export gasoline to the US, and import diesel, and some other products from spare refinery capacity in other regions. Environmental specifications, especially EU low sulphur standards, require additional treatment of this diesel, and limit the import volumes.

Relocation of new refining capacity is not a plausible risk. There is no expectation of new greenfield investment or large scale expansion of refining capacity in the EU-25, both because of challenging environmental regulations and because climate policy, higher prices, and security of supply concerns are likely to prevent further consumption growth (EU consumption has been stable over recent years). Scaling back existing refining capacity, which has largely completed a major round of investments, in favour of imports, in response to quite small cost differences is unlikely.

Different refineries would be in different positions. Some may have direct pipeline connections to some of their product markets, potentially precluding direct product competition. In addition, there is a big difference between hydroskimming refineries, which rely on separating out the different components within crude oil, and more complex refineries with crackers that can split molecules to generate a different mix of products. Most refineries in Europe have been, or are being, upgraded to complex refineries and the impact of carbon costs on the economics of this investment are trivial compared to the benefits – there is no evidence that investment plans have been altered due to the EU ETS.

In short, despite its relatively high carbon cost relative to value-added, the refining sector in the EU overall is unlikely to see significant leakage or loss of competitiveness due to the EU ETS, (see Climate Strategies report, Annex 2 for additional discussion).

The risk, rather, is that different emissions allocations between Member States could distort the financial position of different refineries within the EU: at €20/tCO_2, a 10% difference in allocation would generate a 1% difference between the value-added of different refineries. If margins are tight (for example if EU demand declines), this could represent a non-trivial impact on the relative position of different centres within companies and of different refineries within the EU which could in particular be politically problematic. Obviously, tackling climate change should and will create winners and losers – but preferably, not ones caused simply by different allocation decisions, with no relevance to carbon intensity. The obvious solution to this would be to harmonise refinery sector free allocations at an EU level. This could be done most simply by giving them no free allocation, requiring them to buy all their allowances from the market or at auctions, to avoid any ensuing debates about baselines or benchmarking.

5. Chemicals

Compared to the previous sectors, chemicals is a hugely diverse sector comprising 27 activities at the SIC 4-digit level. As illustrated in Chart 16, these vary widely in both their carbon cost-exposure, and trade intensity.

Two activities stand out for their high maximum potential carbon-cost sensitivity, comparable to that of refining: manufacturing of fertilisers and nitrogen compounds (dominated by the production of ammonia) and manufacturing of inorganic basic chemicals (IBCs). Though economically these account for only 3.5% of value-added in a sector that is dominated by the value of pharmaceuticals, cleaning agents and paints, and organic chemical products, they are highly electricity-intensive. They are economically significant activities, with IBC having value-added comparable to cement production. Unlike cement however, for these two sub-sectors, GVA is a relatively low proportion of total turnover, at 17% and 26% respectively, implying that the impact of carbon costs on product prices would be moderated accordingly.

These two most carbon cost-sensitive activities have UK trade intensities outside of the EU at about 13% and 20% respectively. Without deeper analysis, it is hard to reach firm conclusions about possible competitiveness impacts and leakage. One constraining factor might be if the cost or safety considerations create significant barriers to transporting some of the basic chemicals, including chlorine. The next most carbon-cost-sensitive activity – manufacturing of industrial gases – might also be protected by the costs and risks of transporting such products, which could account for the low existing trade intensity in this case (which is even lower for intra-EU trade).

However such barriers would be less significant in the context of relocating a wider production line (e.g. PVC). Overall the exposure of such activities is nothing like as big as for steel, and the carbon cost impacts are much less than for cement – but the barriers to leakage, at least from existing facilities, may vary and for some products be much lower than for cement.

For fertilised nitrogen compounds and for IBCs, the trade intensity of UK with EU partners is about twice that outside the EU. However, their potential sensitivity to allocation differentials between EU member states is less clearcut than for refining, since the difference between maximum value at stake and minimum value at stake – which drives the sensitivity to allocation differences – is much less. However this in turn points to the other feature that distinguishes many of the chemical sector production activities from cement, BOS steel or refining – namely their electricity intensity.

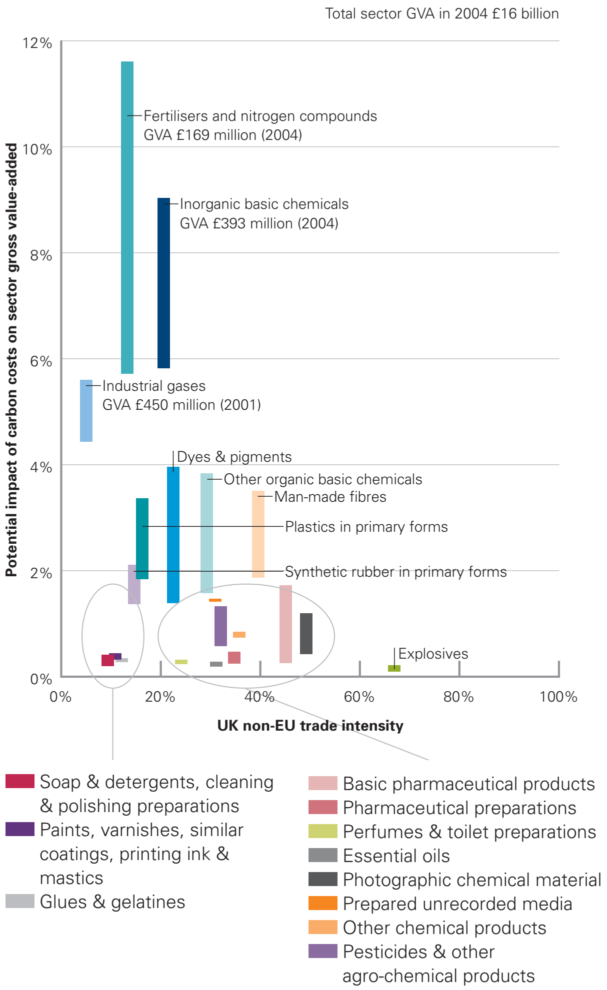


Chart 16

Value at stake for chemicals sector vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes.

The chemicals sector is notable for several activities that fall just below our threshold level. Organic basic chemicals are the most striking, as they account for £1.7bn of value-added and have very high international trade intensities (50%, and 29% for EU and non-EU trade respectively); this may also deserve some scrutiny. Plastics manufacturing forms another £1bn+ industry, even more heavily traded within the EU though much less externally (55% and 16% respectively).

Finally, the SIC classification does not accurately represent the different processes of the chemicals sector, and impacts at the individual firm level are also difficult to assess. For example, there is minimal understanding of firms' production portfolio of products, and the heat exchange between different production processes including CHP. More in-depth studies of specific products and process could thus be particularly valuable in this sector.

6. Non-ferrous metals and electricity exposure

Non-ferrous metals, and particularly aluminium production are exceptional for the electricity-intensive nature of production, high value per unit weight and high international trade intensity.

Chart 17 underlines the electricity-cost-sensitivity of aluminium production – though even this may understate it for the smelting process itself.[13] There are three smelting plants in the UK with a combined value-added similar to UK cement production. Copper production is moderately carbon cost-sensitive. Both metals have UK non-EU trade intensities above 20%, and internal EU trade intensities of 50–60%.

Our earlier studies[2] emphasised the special characteristics of aluminium, and the need to consider it at the level of individual smelters which often own their own power plants, or have special long-term contracts. The former offer a special case of 'opportunity costs' – the companies could still in principle choose to close down the smelter and sell the power (or allowances) to the grid.

Such activities face a more fundamental question of where they can best be located, which sources of power they can best utilise, and whether they should get involved in lower carbon power investments to protect their main asset base. In practice, the cheapest electricity in the world tends to be either zero-carbon (e.g. high-head hydropower) or very high carbon (e.g. strip-mined brown coal) in locations far from major population centres (e.g. Iceland or Australia). Greater production from the former induced by carbon prices in Europe would reduce global CO_2 emissions and from a global perspective be a sensible response to economic signals in a carbon-constrained world; a move to the latter would increase global CO_2 emissions. Neither could be prevented through ETS allocation decisions, since the emissions are indirect through electricity consumption.

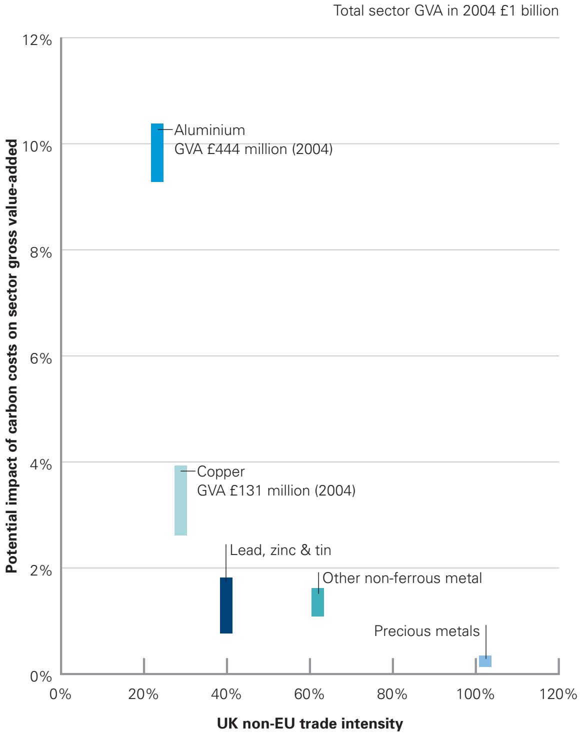


Chart 17

Value at stake for non-ferrous metals sector vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes.

[13] Smelting-specific studies suggest even higher sensitivity than indicated in the chart, probably because the aluminium production activity amalgamates primary and secondary processes and may include some additional, less electricity-intensive parts of the overall production process.

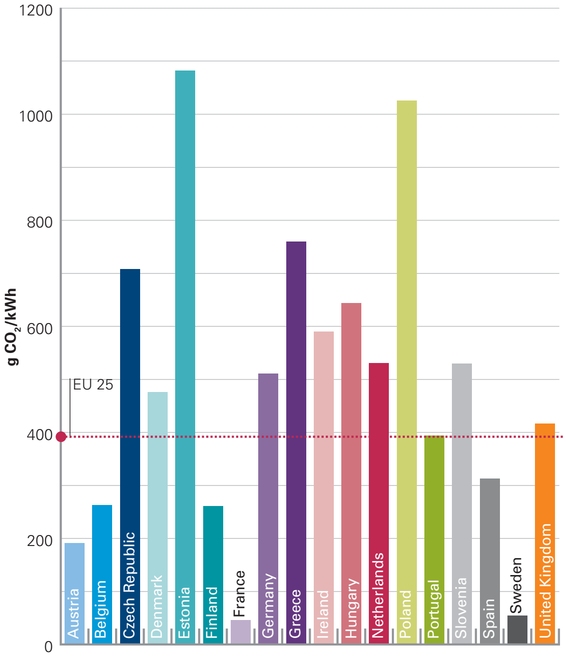


Chart 18

Carbon intensity of electricity production in EU countries

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

	Model A	Model B
Belgium	2–14	
France	1–5	
Germany	13–19	17
Netherlands	9–11	15
United Kingdom		13–14

Table 1

Two model estimates of electricity price increases (in €/MWh) due to CO_2 costs at €20/tCO_2

Source Sijmet et al 2006. *CO_2 price dynamics*, ECN, The Netherlands.

Possible power price impacts need to be set in the context of existing differences between EU countries. Power prices already differ by €10–20/MWh across Europe, with UK industrial electricity prices mid-range. In addition, the carbon intensity of different power production systems varies widely, as illustrated in Chart 18, with the UK close to the EU average.

These factors – and different ownership and regulatory structures – affect the extent to which EU ETS prices would be fed through to power prices. Table 1 shows estimates from two different models of the power price increases that might be expected in different EU countries.

With ongoing liberalisation of European electricity, carbon costs are likely to be passed through to electricity consumers in most countries with increasing consistency. This will help to level impacts between EU countries, but won't reduce the impacts on internationally exposed industries like aluminium. More rapid progress to decarbonise power generation in the EU could help, but may not lower the opportunity cost impact for decades. However, many low carbon options – including both nuclear power and wind energy – share the basic financial characteristic of most electricity-intensive production activities, of being very capital intensive, with low running costs. Electricity-intensive production activities could thus try to protect themselves by investing directly in low carbon generation, as with Finnish pulp and paper sector investment in nuclear power.

Government policy options could include considering whether revenue raised from EU ETS auctions could be redistributed to electricity intensive users, though this may raise many complexities and require exemptions from State Aid rules. 'Downstream' allocation of electricity-related users might raise similar complications. A more detailed treatment was beyond the scope of this study.

7. Wood and paper products

The broad sector associated with 'wood products' is one of the two largest manufacturing contributors to the UK's overall GVA. The combination of pulp production with paper and paperboard stands out as the biggest emitter, and the most exposed in terms of value at stake and non-EU trade intensity.

The manufacturing of household and sanitary paper-based goods is another large industrial consumer of both direct energy and electricity, though much less heavily traded, suggesting trade barriers probably due to the bulky nature of the product. Most of the other activities are downstream, with 60% of the sector GVA in printing and publishing, which requires low energy inputs.

The likely long-run implications of the EU ETS for the sector overall are difficult to assess. It is characterised by multiple production technologies (mechanical and chemical pulping); different product types (pulp, newsprint, fine papers, packaging, and sanitary and household); multiple raw materials (wood and recycled fibre); and energy as a side product in some of the production technologies (chemical pulping producing waste liquor, and heat recovery with mechanical pulping). Chemical pulping can produce surplus energy, whereas others (mechanical pulping, fine paper when not integrated with chemical pulping) require significant external supplies, especially of electricity. Recycled fibre based paper production is a much less energy intensive process than wood based paper production. The role of combined heat and power is often important, making financial impacts potentially sensitive to EU ETS allocations to CHP plants.

In general, paper production is more energy and electricity intensive per unit of output than the pulp production, but trade with both EU and non-EU countries is focused on pulp: the 2004 non-EU trade intensity of pulp was 66% compared to 15% for paper and paperboard. These general observations suggest that a deeper analysis of UK pulp production would be valuable.

In addition, the UK pulp & paper industry is small in relation to other Member States, especially Germany and Scandinavian countries. Pulp production in the UK is dominated by the chemical process, whereas other countries use the more electricity intensive mechanical pulping. Given the high intra-EU trade intensity of both pulp (36%) and paper and paperboard (56%), a closer coordination of analysis and policy responses with other countries, particularly in Scandinavia, would make sense. Harmonising allocation itself could be helpful, though of course this would not address the differences arising from electricity pass-through discussed in the previous section. Moreover the diversity of pulp and paper processes for broadly the same product could, if substantial free allocation were retained, lead into a morass of debate about appropriate benchmarking methods for comparing performance and allocation across different facilities.

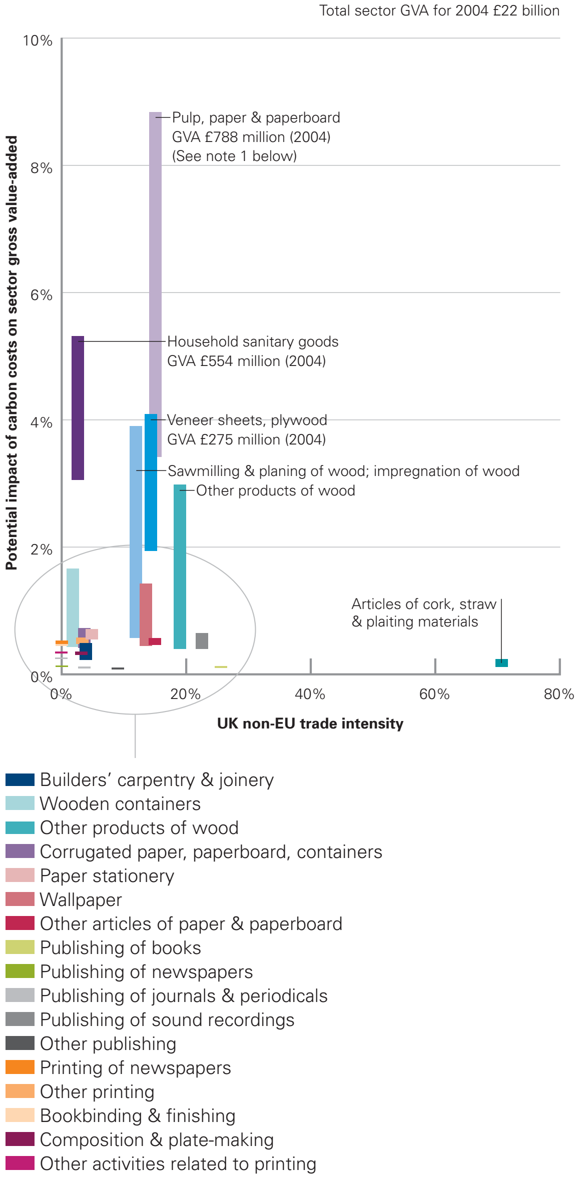


Chart 19

Value at stake for the wood, paper and printing sector vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note 1 The bar aggregates two sectors – manufacturing of pulp and manufacturing of paper and paperboard. The split into two sub-sectors is not available for energy inputs, GVA and turnover data. In terms of production volume in 2006, paper and paperboard accounts for over 95% of the aggregate. As such, trade data for paper and paperboard is used to estimate trade-intensity for this sector. See Chart 4 for explanation of axis.

8. Food, drink and tobacco

Food, drink and tobacco together comprise the biggest single manufacturing sector of the UK economy in terms of gross value-added. Out of its 34 activities, only one – the manufacture of malt – is carbon-intensive enough, in terms of production process, to reach the top 20 most carbon-intensive activities in Chart 1.[14]

Food is not a core sector of the EU ETS and relatively few facilities exceed the EU ETS's 20MW threshold, so relatively few activities would even register carbon costs at all. With the exception of malt, the electricity intensity of almost all activities is also low. Moreover, although value-added is widely distributed among the various activities, the energy intensive ones are generally very small compared, for example, to bread, meat, and chocolate, which each create over £2bn GVA.

Malt itself is significantly traded (23%), and unusual in that external trade is far bigger than trade with EU partners. This probably reflects the importance of raw material location. Transporting the refined product (malt) is likely to be far cheaper than moving the raw material (barley). This may eclipse any trade implications of carbon costs for production based upon EU raw material. Such factors also highlight that in some respects, trade issues in the food sector can be strongly influenced by the Common Agriculture Policy.

Our earlier study[15] presented a case study of brewing, which is about 20 times the scale of malt production. Assuming profit-maximising responses, the analysis suggested a gain of about 2% in profits (EBITDA) by 2020 if brewing entered the EU ETS, on the allocation and price scenarios indicated in that study.

The other factor which may be of particular relevance, not in relation to direct EU ETS costs per se but in relation to the wider agenda of carbon control, is the overall lifecycle emissions of food, drink & tobacco products. The sector's main feedstock sector, agriculture, is relatively carbon-intensive (through the impact of nitrogen fertilisers, as noted in section 5, and methane from ruminants and soils). Thus in the food sector, the overall carbon footprint of products may be much more significant than just the manufacturing process emissions. Should the cost of those emissions ever be internalised by the supply chain, they are unlikely to be significant in relation to the final product purchase price. A much greater exposure exists, however, in relation to changes in consumer purchasing behaviour away from carbon-intensive products in favour of low-carbon alternatives. The Carbon Trust is piloting work on product carbon footprinting and carbon labelling to develop understanding of this opportunity[16].

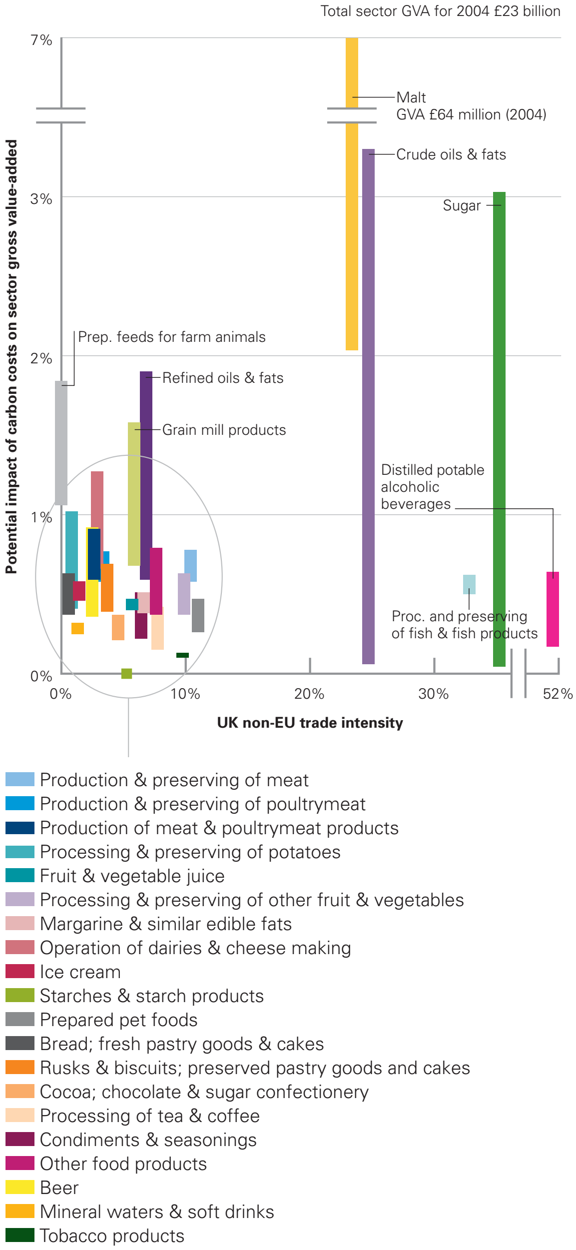


Chart 20

Value at stake for the food, drinks and tobacco sector vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes.

[14] GVA and turnover data were not available for a few activities and hence these activities do not appear in Chart 20.

[15] Carbon Trust (2005) *The UK Climate Change Programme: Potential evolution in business and the public sector.*

[16] Carbon Trust (2007) *Carbon Footprints in the supply chain: the next step for business.*

9. Other sectors studied

Data for three other sectors were studied. In these sectors no activity was identified that had a maximum value at stake above 6%. Eight, however, do enter the top 20 shown in Chart 1 with a maximum value at stake above 4%.[17] The sectors are plastics and rubber; glass and ceramics; and textiles and leather. The full results are displayed in Charts 21–23.

Plastics and rubber

The plastics and rubber sector is sizeable economically and the manufacture of rubber tyres and tubes stands out as the most economically significant activity that is exposed, with GVA exceeding £500m. There are no obvious constraints to trade of such products, borne out by current non-EU trade intensity of almost 20%, and about twice this for trade with other EU countries. There might thus be some potential for leakage in rubber manufacturing at higher carbon prices, if it were brought into the EU ETS. Tyre retreading is much smaller, and protected by the cost of exporting and re-importing tyres.

Glass and ceramics

The next biggest activities economically are the two main types of glass products (hollow and flat glass), which are in the EU ETS. Together these account for almost £500m GVA, and have relatively similar carbon and trade characteristics, with a maximum value at stake of 4–5%, external trade intensity of about 10% and trade with other EU countries close to 30%. The relatively low external trade intensity does suggest significant transport costs, as might be expected given the relatively fragile nature of the product. Both also have a high ratio of GVA to turnover (in range 45–50%), implying that the impact on product prices could be around half of the corresponding value at stake figure (e.g. 2–3% increase in glass prices for full pass-through of opportunity costs at €20/tCO_2).

These somewhat cement-like characteristics imply potential for the main glass manufacturing activities to make profits from the impact of the EU ETS on product prices, but also slight potential for leakage at higher carbon prices and pass-through rates.

Textiles and leather

The textiles and leather sector contains a range of activities just as complex as contained in the chemical sector. Manufacturing of non-wovens registers in terms of minimum value at stake and is extensively traded, but accounts for just £45m of GVA; the two activities indicated as most exposed to indirect electricity impacts are the relatively tiny activities of throwing, preparation & texture of silk, synthetic/artificial filament yarn and other textile weaving, for which data may be suspect. By far the most economically significant activity, textiles finishing (at £230m GVA), appears in the source data as trading only domestically. Therefore, no major activities appear subject to significant carbon price impacts.

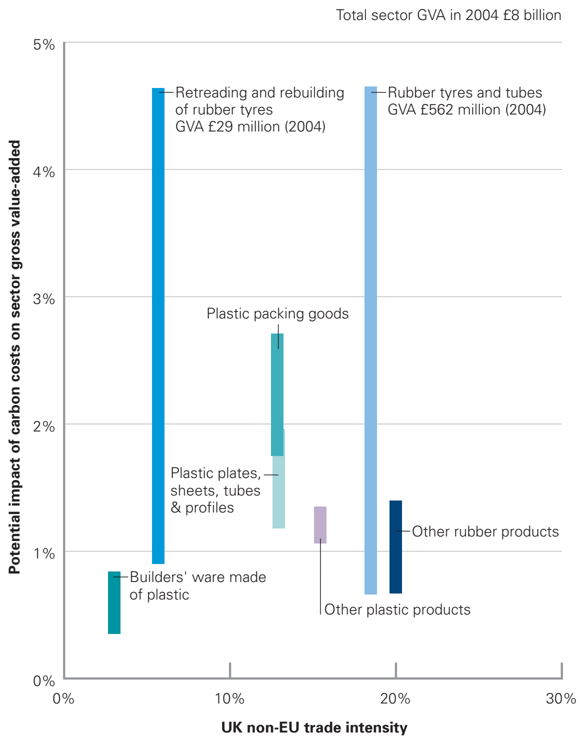


Chart 21

Value at stake for the plastic and rubber sector vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes.

[17] Two of the textile categories (throwing, preparation & texture of silk, synthetic/artificial filament yarn; and other textile weaving), have GVA of only £4m/year and £6m/year respectively; the data may be suspect, as they are easily distorted.

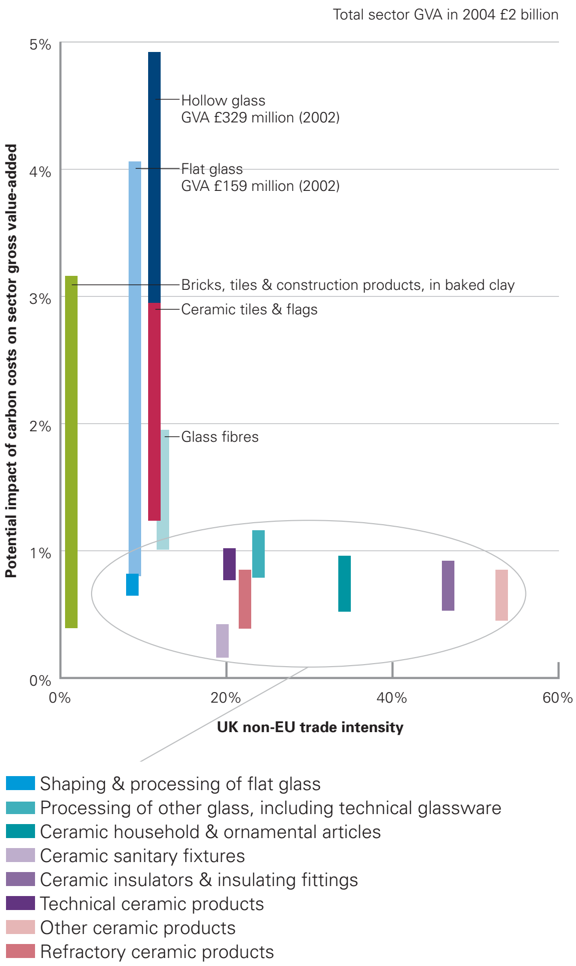


Chart 22

Value at stake for the glass and ceramics sector vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes.

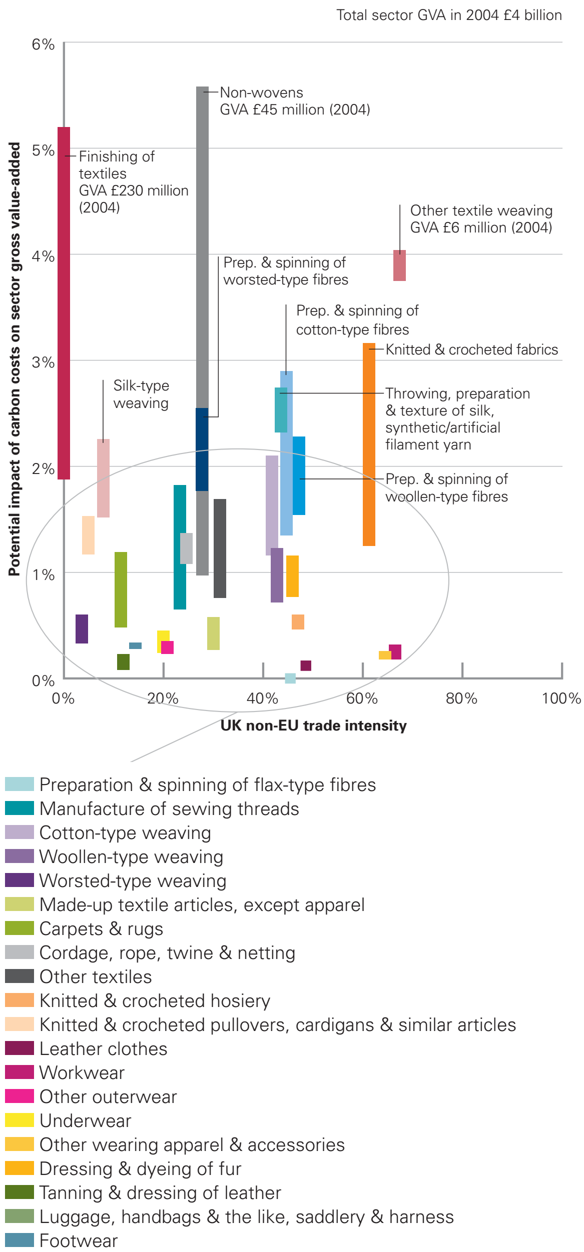


Chart 23

Value at stake for the textiles and leather sector vs UK trade intensity outside the EU

Source Climate Strategies (2007): Hourcade, Neuhoff, et al.

Note See Chart 4 for explanation of axes.

Conclusions

This report has surveyed implications of carbon pricing in the UK and Europe for international competitiveness and for emissions leakage at a detailed activity level. The analysis has shown that a relatively small number of specific activities, mostly related to primary raw materials production and thermal processing, dominate potential cost exposures.

These are the activities for which carbon costs can be significant compared to the trade barriers that permit cost differences between countries and regions.

The detailed analysis covered 11 sectors that comprise the majority of UK manufacturing emissions and value-added in UK manufacturing. Within the 11 sectors, 159 activities were analysed.

Out of 159 activities we identified a 'top 20' for which full imposition of carbon costs at €20/tCO_2 (with no free allocation) would increase input costs by more than 4% of associated gross value-added; and an additional three for which the electricity exposure on its own would exceed 2%. These are plausible thresholds below which the difference of carbon costs between the UK and non-EU trade partners can reasonably be considered as immaterial compared to, for example, the impact of exchange rate fluctuations, differences in raw material, labour and tax conditions, and the logistical benefits of locating in the same continent as customers. Activities above these thresholds account for about 1% of UK GDP and 0.5% of employment. The EU ETS is not a macroeconomic risk, but it could be an issue for particular activities.

Carbon costs (or other impacts) below these thresholds may well be material in terms of the relative competitive position and profitability of different companies within the UK market, but the focus of this study has been upon trade outside the UK.

At the opposite end of the spectrum, we have conducted detailed analysis of the two activities that stand out for their very high sensitivity to carbon costs. For cement production, full carbon costs could be very substantial, easily sufficient to overcome the initial barrier of international transport costs. The net impact on costs, with a high degree of free allocation, is however small in relation to the transport cost barrier. With a high degree of free allocation, UK cement producers would have substantial scope to profit, in part by passing through prices to a degree that increased imports, and selling the resulting surplus allowances. The extent of free allocation which could eliminate such profiting depends upon the extent to which industry passes through carbon costs to prices; the underlying analysis presents evidence covering a considerable range of possibilities, but there is unquestionably scope for the sector to profit substantially from the current approach of 100% free allocation. Faced with the prospect of continuing carbon price differences, the industry could also decide to relocate new investment outside Europe, though such investment focused on exporting would inevitably entail considerable risks given transport costs.

In several respects the analysis for steel identifies similar fundamentals, with much greater trade sensitivity offset by much lower relative impact on product prices than for cement. There are however two key differences. One is that the steel industry is a substantial exporter; and exports would be most exposed if producers passed carbon costs through to export prices. The other difference is that the steel industry is globalising in the face of systematic production cost differentials without the protection of high transport costs. Relocation of new investment is therefore entirely plausible anyway; an expectation of sustained carbon cost differentials would add an additional driver for this.

Such trade-related impacts would occur because they make economic sense for the companies concerned. In many cases, companies – and in particular multinationals that switch production to outside Europe – would profit. However, the net effect of this 'leakage' would be that emissions from these sectors would not reduce by nearly as much as appears within Europe. From this perspective, the wrong people have been worrying about the competitiveness impacts of the EU ETS – the potential for leakage of emissions in a few key sectors may be more an environmental, rather than an economic, concern.

This does however need to be kept in perspective. Under a central case of €30/tCO_2 and 50% cost pass-through, our analysis estimates that leakage from cement and steel sectors in Europe would amount to under 8% each of their emissions even at the highest trade sensitivities found in the literature. Together their verified emissions in 2005 accounted for 8% of total European CO_2 emissions. Our analysis has explained why these stand out as the most likely to face leakage. Moreover, industry arguments that domestic producers would pass through very little carbon cost implies pricing strategies to minimise loss to overseas production – avoiding leakage – rather than to maximise short-run profits. The EU ETS out to 2020 is thus likely to result in the 'export' of no more than 1% of total EU CO_2 emissions. Policies explicitly to avoid leakage would be desirable, but there is plenty of time to pursue negotiated solutions first at a multilateral level.

The ultimate challenge is not to resist the trade effects of carbon pricing, but to decarbonise manufacturing industry. Leakage and potential impacts on competitiveness can be offset by innovation and investment in low carbon solutions – and trade, combined with carbon controls, will be crucial in spreading these solutions globally. Those countries, and companies, that are the first to rise to this challenge will end up the winners in the carbon-constrained world of the 21st Century.

Annex: diagrams and data in context

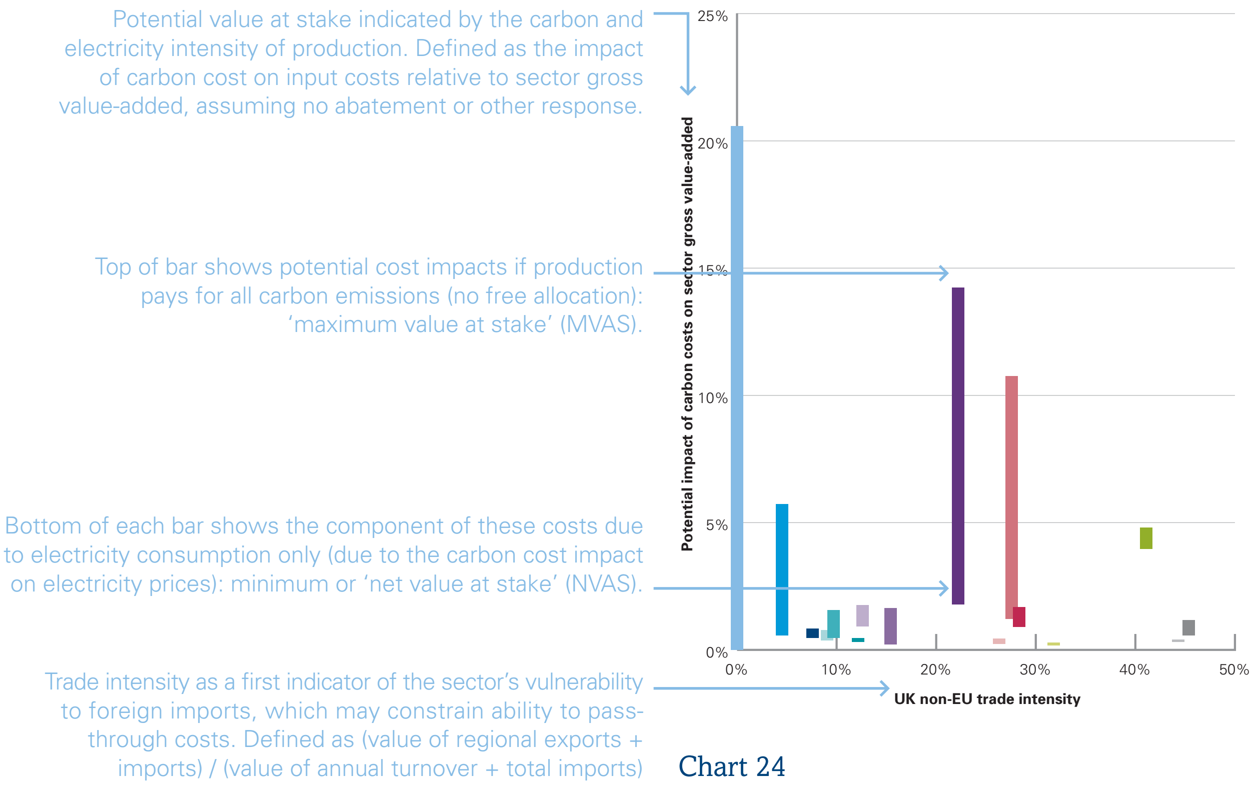


Chart 24

Guide to the format of main cost and trade indicator charts

Understanding the graphs

This report has adopted a standardised form of chart to present basic data on cost impacts of carbon prices, and international trade. The same format is used for Charts 4 and 5 (for sector-level data), 7 (mineral construction industry), 11 (iron & steel), and 15–23 (other sectors). To aid understanding, the key general features are summarised in Chart 24 and the main indicators are discussed briefly here.

The main measure of cost impact for each activity, on the vertical axis, is the potential increase in input costs of a €20/tCO_2 carbon price relative to gross value-added (GVA), which we term 'potential value at stake'. The vertical range for each activity is defined by two points:

- the lower point reflects the cost increase from higher electricity prices only, arising from EU ETS cost pass-through in electricity generation, for which we use a rate consistent with typical UK conditions (€5/MWh for each €10/tCO_2). This cost is faced by sectors whether or not they participate in the EU ETS;
- the upper point reflects the cost increase if an activity has to pay for all its CO_2 emissions, including the electricity-related costs and (if it is the EU ETS) without any free emission allowances.

We term the latter the maximum value at stake (MVAS), and the former net (or minimum) value at stake (NVAS). Each assumes no abatement or other actions to reduce the costs and in that sense is a worst-case.

The data in the graphs throughout this report use a carbon price of €20/tCO_2, but the numbers would scale directly in proportion for different carbon prices.

The horizontal axis in the Charts show the simplest indicator of international trade – the main constraint on companies passing through carbon costs – in terms of recent trade intensities. This is defined as combined imports and exports relative to overall domestic turnover + imports. The main Charts show trade intensity data between the UK and regions outside the EU, that may not face a carbon cost on comparable production activities. Trade tends to be more volatile over time than energy consumption. Data limitations at the detailed sub-sector level mean that 2004 data had to be used for most Charts, with more recent trends for cement and steel discussed in those sections of the report.

Given the numerous factors that create cost differences between operations in different countries, a low present trade intensity suggests barriers to trade that could make it easier for domestic companies to pass through carbon costs. However, note that the converse is not necessarily true. A high trade intensity may reflect a high sensitivity to international cost differences, but it could also be driven by other factors, such as differential availability of raw materials or other constraints on domestic production. A high trade intensity suggests a need to look closely at the factors that drive trade, and does not automatically imply high exposure.

Scope, choice and interpretation of cost impact indicator

The value at stake indicator does not translate directly to potential impact on profits. A firm's profit margin may be substantially lower than its value-added (see definition in glossary on page 35), so the scale of carbon costs relative to current profits may be much bigger. However, this does not offer a viable index for comparing impacts on different activities. Reported profits are volatile over time and influenced by the depreciation strategy of a firm, and tax rates, which might vary across sectors, countries and time. Carbon costs would also reduce the tax burden, further complicating comparisons. In contrast, GVA is comparatively stable, giving a more robust indicator, and encompasses the main cost components over which a firm has direct control. Finally, it has the advantage that it is available at 4-digit SIC code level.

In addition, as stressed in our analysis, the actual impact on profits is complex because it depends upon how the EU ETS affects both costs and revenues. Since free allocations are fixed in advance, an individual operating decision for a facility within the EU ETS will face a full cost of carbon – to buy allowances or forego selling the allowances associated with its emissions. This corresponds roughly to the MVAS. A key issue discussed in the report is whether (or how much of) this 'opportunity cost' may be passed on to prices, increasing the competitive market price for the product. Combined with the governmental decision on free allocation, this determines the scope for profit or loss from the scheme.

To illustrate the potential relationship between carbon costs and sector profits, our detailed studies of cement and steel production do focus on profits as measured by earnings before interest and tax (EBIT), as mapped out for cement and steel in Chart 2. These results illustrate directly the potential impact of cost pass-through and allocation decisions on the average profit margins of the EU cement and steel sectors in aggregate, for a range of carbon prices (sections 2 and 3).

The analysis focuses upon carbon costs, including process emissions, but does not consider the possible impacts of policies to tackle other greenhouse gases – for example, expansion of the EU ETS to include methane or nitrous oxide. For most manufacturing activities, other gases are non-existent or trivial compared to CO_2. For a few industrial processes, however, they may dominate, and these would need to be studied on a case-by-case basis.

The potential for some manufacturing activities to pass through costs to product prices implies that electricity may not be the only source of 'indirect' cost increases. However, for the vast majority of manufacturing activities the electricity cost impacts are likely to dominate all others combined – particularly if cost pass-through in other activities is low in the way that many companies argue is likely. The data in Table 2 below indicates the increase in primary product prices required for these sectors to maintain profitability.

UK manufacturing data in context

As a report mainly for UK business, the analysis in this report focuses mainly upon data for the UK manufacturing sector. Standard Industrial Classification (SIC) categories are used; for detailed definitions see http://www.statistics.gov.uk/methods_quality/sic/explain_sectiondf_dg_dh.asp. The screening cost analysis involved data collection across all of UK manufacturing at a SIC 2-digit aggregate sector level, with 4-digit level analysis for all those sectors with any potentially carbon-intensive components. The four engineering-based sectors that were not presented at sub-sector level account for over one-third of UK manufacturing GVA, but only 5% of emissions (with most of this due to their electricity consumption), and each of these has average MVAS of less than 0.5% at €20/tCO_2.

Data were derived from a range of government sources complemented with industry data, the latter particularly concerning on-site and process emissions which are important for a number of the most exposed sectors but which tend to be poorly represented in government energy statistics. Data sources are described in the underlying Climate Strategies report, which provides further details and comparative analysis with a SIC 4-digit analysis of German manufacturing industry. It also shows that the sectoral composition of UK manufacturing industry is comparable to the EU average.

Trade is very much a European issue and the EU ETS creates a single carbon price across the EU, together with the surrounding European Economic Area countries that have now decided to join the scheme (Norway, Switzerland, Iceland). The detailed modelling of trade impacts on cement and steel production is thus conducted at an EU aggregate level, and presents all data in terms of EU aggregate impacts.

As a relatively service-based economy, UK manufacturing accounts for just under 20% of total UK GDP. The 'top 20 + 3' sub-sector activities – as ranked on the basis of full carbon cost impacts (MVAS), and (second) electricity cost exposure (NVAS) – together account for about 6% of manufacturing sector value-added, i.e. just over 1% of total UK GDP. However, they account for 56% of manufacturing sector CO_2 emissions, and 13% of total UK CO_2 emissions.

Turnover and product price impacts

Table 2 sets out some basic data for our top '20 + 3' sub-sector activities. One useful additional indicator here is overall turnover. Sectors differ considerably in terms of their turnover relative to GVA. For example, cement and glass have low input costs relative to the value they add through their capital investment and labour inputs; this makes GVA quite a high proportion of total turnover, typically approaching 50%. In contract, high oil prices mean that the value-added by refineries is a small fraction of total turnover. These factors tend to affect profit margins in similar ways, if measured relative to turnover.

			Maximum value at stake at €20/tCO_2	Minimum value at stake at €20/tCO_2	Trade intensity (EU / non-EU)	Gross value-added (GVA) at basic prices		Employment	GVA / turnover	Implied average product price rise to offset €20/tCO_2	
	SIC sector code	**Manufacturing activity**	**0% free allocation**	**100% free allocation**	**%**	**£m in 2004**	**% UK GDP**	**% UK**	**%**	**0% free allocation**	**100% free allocation**
1	2652	Lime	125.6%	0.2%	13.8 / 8.6%	26	0.00%	n/a	47.3%	59.37%	0.00%
2	2651	Cement	33.9%	2.0%	12.2 / 1.8%	409	0.05%	0.02%	42.9%	14.54%	0.86%
3	2710	Basic iron & steel and ferro-alloys	26.4%	2.4%	47.1 / 17.4%	1064	0.13%	0.08%	16.2%	4.28%	0.39%
4	2320	Refined petroleum products	12.3%	1.4%	19.3 / 19.3%	2300	0.29%	0.04%	8.7%	1.07%	0.12%
5	2415	Fertilizers & nitrogen compounds inc. ammonia	11.6%	5.7%	23.5 / 13.2%	169	0.02%	0.01%	16.8%	1.96%	0.96%
6	2742	Aluminium	10.4%	9.3%	47.5 / 23.2%	444	0.06%	0.04%	19.9%	2.07%	1.85%
7	2413	Other inorganic basic chemicals	9.0%	5.8%	40.7 / 20.6%	393	0.05%	0.02%	26.1%	2.36%	1.52%
8	2111 & 2112	Pulp, paper & paperboard	8.8%	3.4%	56.2 / 15.1%	788	0.10%	0.06%	22.4%	1.98%	0.76%
9	1597	Malt	6.9%	2.0%	5.3 / 23.4%	64	0.01%	0.00%	19.4%	1.35%	0.39%
10	2310	Coke oven products	6.5%	0.1%	23.8 / 71.4%	10	0.00%		46.4%	3.01%	0.07%
11	2411	Industrial gases	5.6%	4.4%	8.1 / 5.0%	450	0.06%	0.02%	48.6%	2.72%	2.16%
12	1753	Non-wovens	5.6%	1.0%	43.8 / 27.8%	45	0.01%	0.00%	18.1%	1.01%	0.18%
13	2122	Household & sanitary goods	5.3%	3.1%	18.1 / 2.6%	554	0.07%	0.04%	17.4%	0.92%	0.53%
14	1730	Finishing of textiles	5.2%	1.9%	0.0 / 0.0%	230	0.03%	0.03%	39.4%	2.05%	0.74%
15	2613	Hollow glass	4.9%	1.5%	32.1 / 11.3%	329	0.04%	0.06%	46.9%	2.31%	0.71%
16	2511	Rubber tyres & tubes	4.6%	0.7%	37.9 / 18.5%	562	0.07%	0.03%	31.6%	1.47%	0.21%
17	2512	Retreading & rebuilding of rubber tyres	4.6%	0.9%	12.5 / 5.7%	29	0.00%	0.00%	34.5%	1.60%	0.31%
18	2020	Veneer sheets, plywood, laminboard, etc.	4.1%	1.9%	35.3 / 14.3%	275	0.03%	0.02%	27.6%	1.13%	0.54%
19	2611	Flat glass	4.1%	0.8%	24.9 / 9.0%	159	0.02%	0.01%	49.85	2.02%	0.40%
20	1725	Other textile weaving	4.0%	3.8%	105 / 67.4%	6	0.00%	0.00%	11.8%	0.47%	0.44%
21	2744	Copper	3.9%	2.6%	57.4 / 28.9%	131	0.02%	0.01%	16.75	0.66%	0.44%
22	1715	Throwing, preparation & texture of silk & filament yarn	2.7%	2.3%	67.9 / 43.6%	4	0.00%	n/a	28.6%	0.78%	0.66%
23	2751	Casting of iron	2.5%	2.2%	0.00 / 0.00%	234	0.03%	0.02%	41.35	1.02%	0.91%
		Total				**£8 675**	**1.08%**	**0.52%**			

Table 2

Key data for 'top 20 + 3' SIC 4-digit activities

Combining these data gives a basic insight into the rise in average product prices that would be required to offset a given increase in input costs, relative to value-added. This is shown in the final columns, which give respectively the percentage average product price rise required to offset (a) the full carbon costs (no free allocation) or (b) the carbon costs from electricity alone. The potential % impacts on lime, cement and steel prices stand out. Amongst the significantly internationally traded goods (non-EU trade intensity above 10%), the price rise required to offset paying €20/tCO_2 in full is 4.3% for steel, in the range 2–2.5% for aluminium, inorganic basic chemicals and glass, and below 2% (or 1% for each €10/tCO_2) for others.

If sectors receive a high degree of free allocation and only seek to recover electricity-related costs (the final column), the product price rise required exceeds 1% (or 0.5% for each €20/tCO_2) only for aluminium, 'other' inorganic basic chemicals, and industrial gases.

New sectors in the EU ETS

In its first two phases, the EU ETS concentrated upon the biggest emitting industrial sectors. In Phase III, its scope is expected to expand significantly. In addition to incorporating aviation, several additional manufacturing activities are likely to be added. The main criteria are significance, monitorability, and typical size of installation which determines the relative administrative costs of participation.

The leading candidates include several activities in our top '20 + 3'. Extension from ferrous to non-ferrous metal production, including both aluminium and copper, is likely, together with some major secondary metals processing, encompassing casting of iron. Ammonia production, a dominant emitter in the fertiliser + nitrogen compounds category, is likely to be included.

Several production processes from the mineral construction industry sector are expected to be incorporated: gypsum processing, a major component in manufacture of plaster products which has GVA comparable to cement and key fibrous products (rock wool and stone wool). These activities feature in the component analysis of mineral construction materials (section 2), with MVAS of between 1 and 2%. One of the major arguments for including these has been to improve comparability with competing construction products, notably glass wool which already falls under glass production in the EU ETS.

The chemicals sector is the most complex. Coverage of refining-related activities is likely to be extended to include a major part of petrochemicals processing at facilities above a certain threshold that produce basic organic chemicals. These register with MVAS just below 4% in our analysis. A few other very specific energy-intensive chemical processes may be added. In addition, there is serious attention to expanding the scope of the EU ETS to include nitrous oxide emissions from a few specific chemical activities; these would not be covered by the analysis in this report.

As emphasised throughout our analysis, the implications of being included in the EU ETS for a given sector depend very much on its characteristics, and on allocation decisions. With a high degree of free allocation, being included is likely to be economically advantageous, particularly for those sectors less exposed to international trade. The biggest benefit overall, however, may be that such expansion broadens the scope of industries engaged in a consistent, efficient and level playing-field of carbon control, which can best incentivise them in the move towards a low carbon economy.

Glossary

Clinker	Solid nodules of material from cement kilns, subsequently ground and mixed to produce cement.
Leakage	Displacement of emissions from inside to outside the EU ETS region.
Marginal/opportunity costs	The incremental costs (savings) of producing more (less) output (including the cost of associated emission allowances).
Pass-through	The addition of input costs to product prices.
Process emissions	Emissions arising as part of chemical process other than fossil fuel combustion.
Trade intensity	Trade volume (exports to + imports from a given region) divided by total turnover (production + all imports).
(Gross) value -added (GVA)	Value of output minus the costs of intermediate goods (not including labour) purchased as inputs. GVA is generally used for whole sector or economic value-chains.
Value at stake	Increase in input costs arising from EU ETS relative to GVA, assuming no abatement or other response.

Acronyms

BOS	Blast Oxygen Steel (produced in blast furnace from iron ore)
CRFA	Compensating rate of free allocation (% free allocation required to neutralise profit impacts of EU ETS)
EBIT (DA)	Earnings before interest and tax (and depreciation and amortisation)
MVAS/NVAS	Maximum/net (or minimum) value at stake
SIC	Standard Industrial Classification of manufacturing activities

This Carbon Trust report draws upon the findings of the Climate Strategies project on analysing competitiveness issues, under its EU ETS workstream. The full technical report is available from www.climate-strategies.org. Charts may be reproduced from this report on the condition that they are cited either with the full reference accompanying the chart, or in the abbreviated form as 'Source: Carbon Trust and Climate Strategies'. All other content is strictly subject to the copyright provisions on the back cover.

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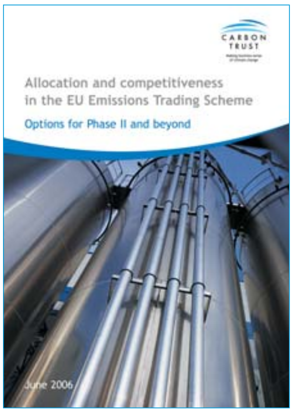

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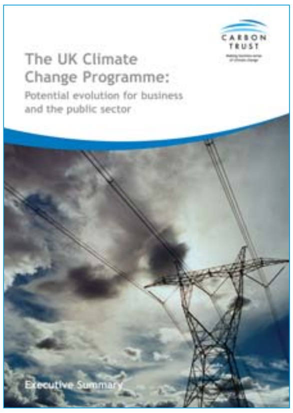

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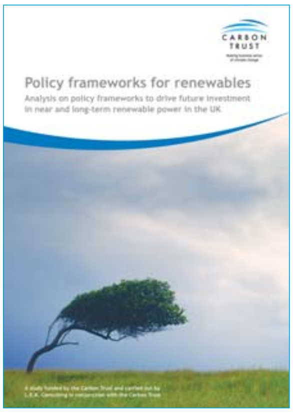

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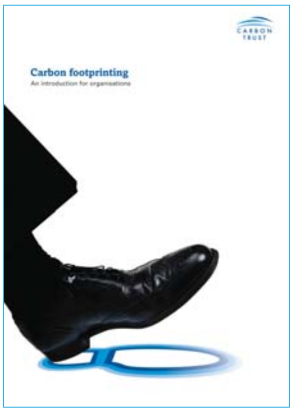

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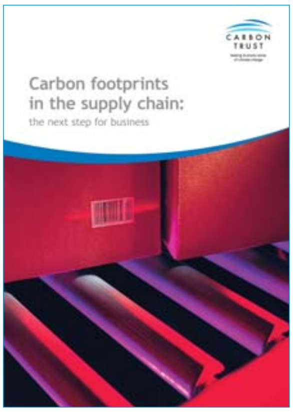

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