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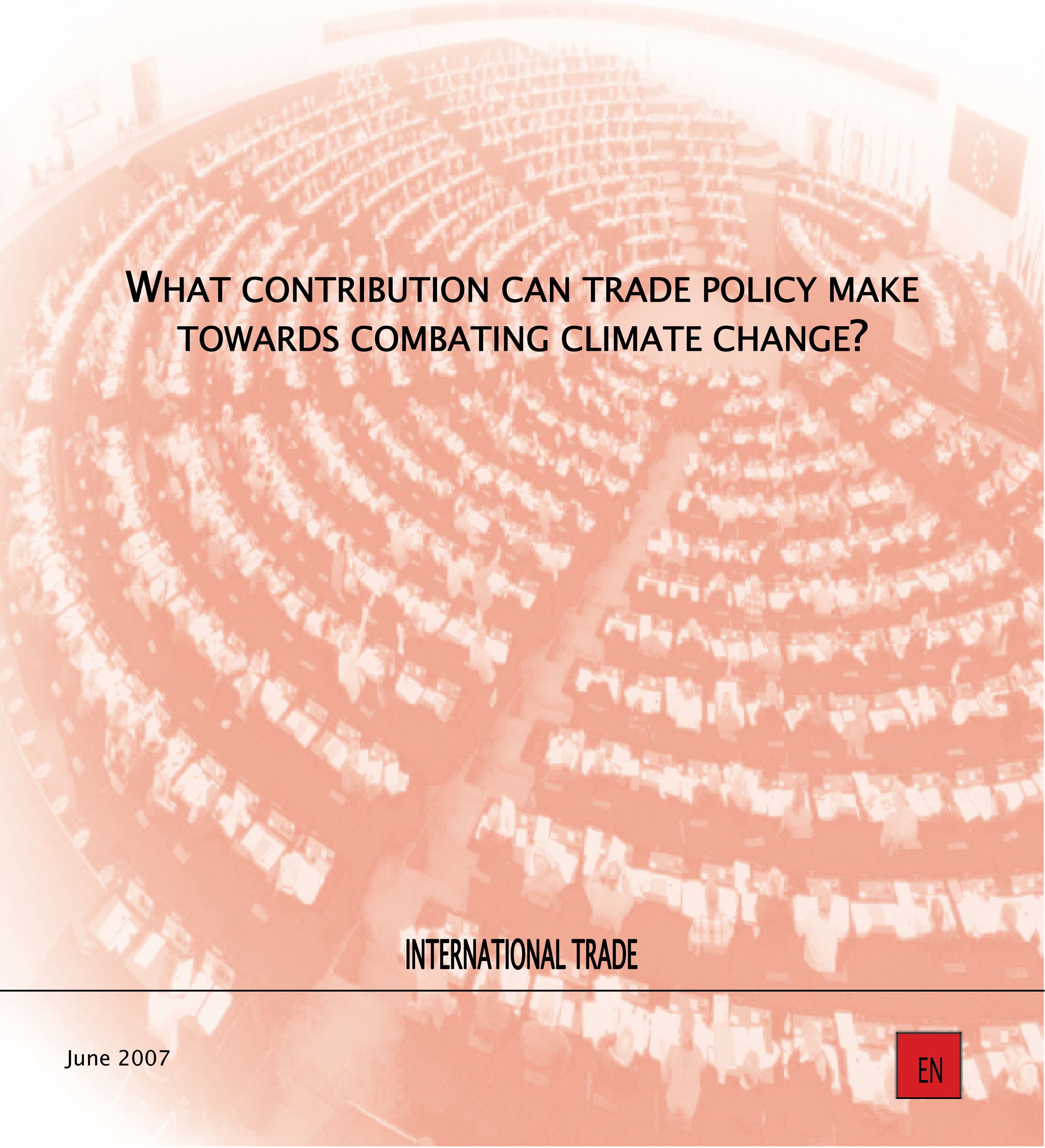

WHAT CONTRIBUTION CAN TRADE POLICY MAKE TOWARDS COMBATING CLIMATE CHANGE?

INTERNATIONAL TRADE

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SUMMARY

This report covers three different but related issues in international trade and climate change. First, by comparing the climate impacts of specific EU-produced goods with their imported counterparts, the report quantifies some of the ways in which international trade contributes to increased global greenhouse gas emissions. Secondly, the report examines ways in which market-based policy instruments could be employed within the context of trade policy. Lastly, the report examines the legal opportunities and obstacles to employing trade-related measures as a means of combating climate change, including the possibilities for altering the WTO rules. The climate impacts of trade are substantial and key mechanisms exist that could help deal with these impacts, although full realisation of these opportunities requires the establishment of clear institutional and legal frameworks.

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1 Executive Summary

Trade policy presents an area of opportunity for the EU to address the problem of global climate change. One approach is implementing measures to increase trade in environmental technologies and green services, as EU Trade Commissioner Peter Mandelson has identified in his call for a WTO-level initiative that would allow a 0% tariff deal for such goods and services. Of even greater potential significance are trade policies that help ensure countries' own climate-change initiatives do not put them at a competitive disadvantage in the international marketplace.

International trade is significant in size and continues to grow. Between 1990 and 2005, world trade volumes increased by 5.8% annually, while total economic output grew by 2.5% per year. Growth in trade was highest for manufactured products (6.4%), followed by agricultural products (3.8%) and fuels and mineral products (3.5%). Alongside this increase in trade volume, CO_2 emissions—especially from the transport sector—have also increased. Emissions from the European transport sector increased by 20% between 1990 and 2001. Also, international trade in climate-specific instruments is already underway, spurred on by the linking mechanisms that join the EU European Trading System (EU ETS) to the flexible JI/CDM project-based mechanisms of the Kyoto Protocol.

This report covers three different but related issues in international trade and climate change. First, by comparing the climate impacts of specific EU-produced goods with their imported counterparts, the report quantifies some of the ways in which international trade contributes to increased global greenhouse gas emissions. Secondly, the report examines ways in which market-based policy instruments could be employed within the context of trade policy. Lastly, the report examines the legal opportunities and obstacles to employing trade-related measures as a means of combating climate change, including the possibilities for altering the WTO rules. The climate impacts of trade are substantial and key mechanisms exist that could help deal with these impacts, although full realisation of these opportunities requires the establishment of clear institutional and legal frameworks.

Key Findings

- **Trade, transport and CO_2 emissions.** CO_2 emissions related to trade are steadily increasing. A shift in emissions from developed to developing and emerging countries is also occurring, due to the relocation of resource-extraction and production activities through international trade. This "CO_2 leakage" is in many cases accompanied by increasing levels of overall emissions due to less efficient overseas production processes.
- **Efficiency vs. total quantity in emissions.** Sea-based shipping emissions are 40 times lower than air freight emissions per ton-kilometre of freight. However, due to the fact that sea-based shipping currently accounts for 90% of world freight transport, it contributes twice the overall level of CO_2 emissions compared to freight transport by air.
- **Carbon emissions from traded versus EU-produced goods.** For most empirical case studies in this report, producing and delivering goods within Europe is less CO_2 intensive than importing from overseas, with this difference driven mainly by transport emissions. In some cases, however, higher production-related emissions in Europe outweighed the lower transport emissions.
- **Impact of overseas relocation on unit costs of production.** The impacts of the EU ETS on unit production costs are most significant in energy-intensive sectors due to the pass-through of ETS-permit costs from electricity producers to electricity users. However, the contribution of EU ETS prices is still small when compared to other cost factors, such as labour.
- **Consumer vs. producer countries.** The total cost of production for the four sectors examined in this study (i.e. steel, aluminium, newsprint, cement) would increase between

1.3% and 3.7% in Europe, assuming an EU ETS price of CO_2 of 10 € per tonne. These costs increases would not be faced by non-Annex B (developing) countries (which lack Kyoto-mandated carbon caps). Thus the cost advantages of these countries are also in the range of 1.3% to 3.7% due to the EU ETS system.

- **EU European Trading System (EU ETS) and Kyoto Protocol.** The EU ETS dominates the global carbon market, representing 74% of volume and 87% of value as of September 2006. The EU ETS is the key driver of international demand for project-based emission reduction projects through the CDM/JI flexible mechanisms of the Kyoto Protocol.
- **Market based instruments (MBIs).** Recent experience in using market-based instruments in environmental policy has demonstrated their ability to improve environmental performance in a cost-efficient way. Climate-related MBIs could also be effectively implemented in the context of trade policy, provided the appropriate institutional and legal frameworks are put in place.

The following table summarises key opportunities for trade-related measures that could be adopted to combat climate change. Further detail is provided in the main report.

Summary Table. Potential opportunities for trade-related measures to combat climate change

Measure	Potential use	Key issues
Lower tariffs for climate-friendly goods and services	Lower tariffs reduce costs, thereby increasing trade in these goods	• Could be pursued bilaterally or multilaterally (WTO rules present no obstacles) • Defining "climate friendly" difficult and contentious
Government subsidies related to energy efficiencies	Subsidies reduce costs, stimulating investment and demand	• Permissible under WTO, but cannot be contingent on export performance or require use of domestic products. Also cannot target a specific industry.
Climate labelling schemes (voluntary and mandatory)	Labelling informs consumers of climate impacts of goods and services	• WTO's Technical Barriers to Trade agreement bars standards that create an "unnecessary obstacle to trade", and favours international standards over national ones. • It is unclear whether standards can be set on production and process methods (PPMs) that do not affect the end characteristics of final products
Government procurement policies	In purchasing, governments could consider climate attributes of goods and services	• WTO Agreement on Public Procurement allows consideration of non-economic factors and establishment of standards (preferably international ones) • Still uncertain to what extent governments can prefer products (e.g. biofuels) certified as "sustainable"
International trade in greenhouse-gas credits via Kyoto's flexible mechanisms	Trade in GHG credits allows carbon reductions at least cost	• Has been quite successful but key challenges remain related to cost effectiveness, additionality of emissions reduction and effect on EU-based emissions reductions.
Responses to competitive distortions due to Kyoto Protocol		
Countervailing duties	Duties against imports from non-parties could offset costs of EU carbon measures	• WTO does not currently allow countervailing duties for "implicit subsidies" such as lack of carbon charging
Carbon taxes (or tradable permits) with border tax adjustments	Border tax adjustments could offset costs of EU carbon measures	• GATT allows BTAs to adjust for direct taxes, but it is unclear and untested whether adjustment can be made for indirect taxes on an input (e.g. energy) consumed during production

2 Introduction

Climate change remains at the top of the EU's political agenda. At the EU summit in March 2007, leaders of the EU's 27 Member States recommitted themselves to addressing the challenge of climate change by committing to unilateral cuts of 20% in CO_2 emissions relative to 1990 levels. The EU leaders pledged to increase cuts to 30% if other developed and emerging nations also join an international climate agreement.

The rapid growth in international trade represents a key challenge (and key opportunity) for climate policy. Transport of traded materials is energy intensive and there is concern that production could move to countries not bound by greenhouse-gas restrictions. However, international trade also presents new opportunities for addressing climate change. For example, EU Trade Commissioner Peter Mandelson, during his speech in Oslo, Norway on 9 February 2007, called for a WTO-level initiative which would see "alongside a wider deal on manufactured goods as part of the Doha Round – an agreement to a 0% tariff deal for these key green goods [environmental technologies] and free trade in green services". He described trade policy as a key tool for both deepening stability of the relationship between producer and consumer countries, as well as improving energy efficiency.

The European commitment to unilateral action to address climate change poses economic challenges for the EU's businesses and citizens. For example, the abatement costs associated with efforts to reduce CO_2 emissions increase the price of EU-produced goods and services. For some sectors, such as electricity generation, which face very little international competition, the majority of these costs can be passed on to their customers through higher electricity prices. However, for EU firms exporting their products abroad or facing competition from countries not bound by Kyoto targets, carbon costs pose a competitive disadvantage. Should production be relocated out of the EU due to rising production costs associated with CO_2 abatement, "carbon leakage" could occur, meaning that carbon emissions could increase overall.

There is a need to quantify the economic and environmental impacts of traded goods versus goods produced within the EU. Similarly, there is an opportunity to learn from successes in the EU's environmental policies and explore how they might be applied to international trade issues. Lastly, there could be important ways in which the WTO and trade policy could promote environmentally friendly goods and services globally (e.g. through lower tariffs on environmental technologies, as well as through incentives for foreign investment in climate-friendly projects and development of product standards and certification). Trade policies could potentially offset economic disadvantages arising from adherence to the Kyoto Protocol, by eliminating the associated free-rider problem, thereby creating incentives for non-parties to join the climate treaty.

Given these complex and interrelated challenges, policy makers need good information and analysis on international trade and climate change issues. This report provides factual information regarding the extent of these interactions, analysis as to the underlying mechanisms at work, and a clear description of feasible policy options to ensure that trade's contribution to climate change is minimised where possible.

This report covers three different but related issues in international trade and climate change. Section 3 compares the climate impacts of specific EU-produced goods with their imported counterparts, quantifying some of the ways in which international trade contributes to increased global greenhouse gas emissions. Section 4 examines ways in which market-based policy instruments could be employed within the context of trade policy. Section 5 examines the legal opportunities and obstacles to employing trade-related measures as a means of combating climate change, including the possibilities for altering the WTO rules.

3 International trade and CO_2 emissions

This section covers several variables involved in determining how international trade policies may impact global CO_2 emissions. Issues covered include: the geographical shift in CO_2 emissions from developed to developing nations, an investigation of proportional and total CO_2 emissions between different modes of transportation, and the balance of CO_2 intensity for internationally-traded goods, regarding emissions from both production and transportation.

3.1 Trade, transport and CO_2 emissions

Summary of key issues and results

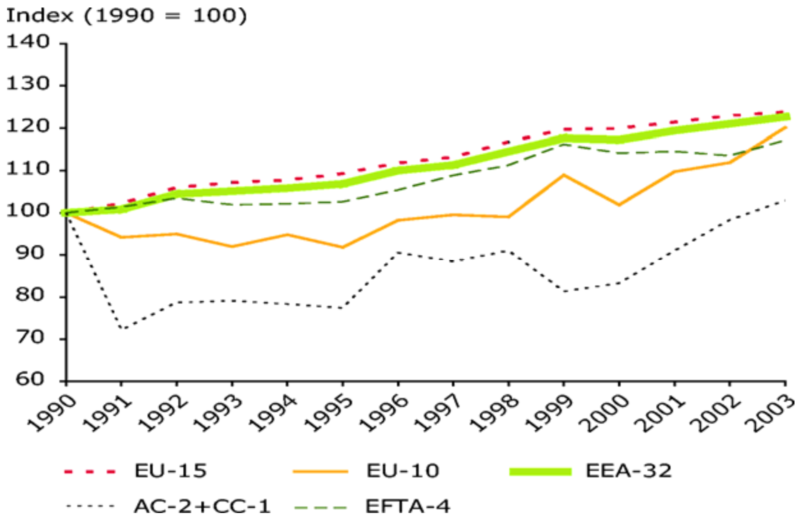
- **Increase in CO_2 emissions.** CO_2 emissions related to transport and international trade are consistently increasing, in Europe as well as in all other world regions.
- **Shift in production and CO_2 emissions.** Many industrialised countries are shifting their resource base to other world regions, in particular to developing and emerging countries. The process of reducing domestic material extraction and processing, and at the same time increasing international trade, leads to a shift of CO_2 emissions towards the global South ("CO_2 leakage").
- **Losses in CO_2 efficiency.** This shift is in many cases accompanied by increasing absolute levels of emissions, as technologies and energy systems in developing and emerging countries are often less CO_2 efficient as in industrialised countries.
- **Accounting of CO_2 emissions in producing countries.** The shift of emission sources is in most cases not reflected in the Kyoto emission inventories of industrialised countries, as emissions are accounted in the country wherein they occur and are not allocated to the final consumers in other countries.

3.1.1 CO_2 emissions of different transport modes

Rapid increase in world trade outpaces economic growth. Increased international trade and deeper integration of different world regions in global markets are two central characteristics of current globalisation processes. Since 1950, trade has increased by a factor of five for agricultural products, by a factor of eight for fuels and by a factor of more than 500 for manufactured products. Between 1990 and 2005, growth in world trade volumes averaged 5.8% annually, while production grew by 2.5% per year. Growth in trade over this period was highest for manufactured products (6.4%), followed by agricultural products (3.8%) and fuels and mineral products (3.5%) (WTO, 2006).

Transport-related CO_2 emissions also on the rise. Along with this manifold increase in international trade, CO_2 emissions from transport are also increasing. For example, in Europe, the GHG emissions from transport increased by 20% between 1990 and 2001 in the EEA-31 countries (see Figure 1). In the EU-15 countries, GHG emissions from transport increased by 21%, contributing 86 % to total EEA-31 transport emissions (EEA, 2003). Not only in Europe, but also in other world regions, CO_2 emissions related to transport are on the rise.

Figure 1. Total EEA-32 greenhouse gas emissions from transport.



AC-2+CC-1 represents Bulgaria, Romania and Turkey
Source: EEA, 2006 (www.eea.europa.eu)

Mode of transport a critical factor in analysing and addressing CO_2 emissions. Different modes of transport have considerably different intensities of CO_2 emissions per tonne kilometre (tkm) of transported freight. This is a key issue when evaluating the climate impacts of trade. Table 1 shows the European average emission factors that are applied in the analyses undertaken in this report.

Table 1. CO_2 emissions for different modes of transport

Mode of transport	CO_2 emissions (in g/tkm)
Lorry (12 t)	110
Lorry (24 t)	92
Lorry (36 t)	84
Maritime shipping	14
Train	23
Plane	607

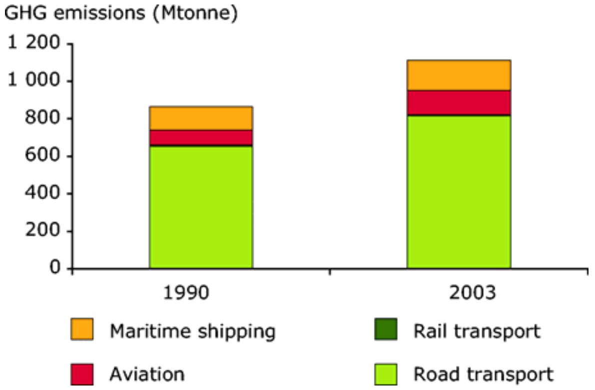
Sources: EUROSTAT (2003), Ecoinvent (2007), UBA (2006)

Note that the CO_2 emission factor for air transport (607 g per tkm) assumes the use of modern high-capacity freight planes. Older planes can have emission factors of up to 2,500 g CO_2 per tkm, depending on the energy efficiency of the engines.

Maritime shipping is by far the most CO_2-efficient mode of transport, with only 14 grams of CO_2 emissions per ton kilometre. Shipping is followed by train transport (23 g), then road transport, with lorries showing significantly higher factors (between 84 and 110g, depending on the size of the lorry). Air transport has by far the highest CO_2 emissions per ton kilometre (a minimum of 600 g), illustrating the high relative climate impact of air transport.

Aggregate GHG emissions vary by transport mode. Europe's total greenhouse emissions by transport mode are shown in Figure 2. Road transport contributes by far the most (73%) to total transport-related GHG emissions. Maritime shipping ranks second (14%), followed by air transport (12%). Rail transport plays only a marginal role.

Figure 2. GHG emissions from transport increases in Europe (1990-2003).



Source: EEA, 2006 (www.eea.europa.eu)

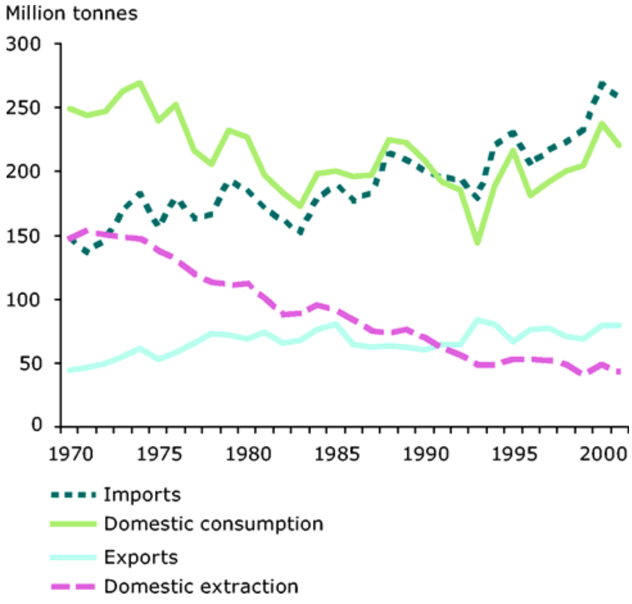
Both the efficiency and volume of transport modes are important. Concerning CO_2 emissions related to global trade, a recent study by British Petrol and the Institute for Physics and Atmosphere in Wessling, Germany, revealed that maritime shipping is increasingly contributing to climate change. Shipping is responsible for transporting around 90% of world trade and has doubled its volumes in the past 25 years. Annual emissions from shipping today range between estimated 600 and 800 million tonnes of CO_2, or up to 5% of the global total, which is around double of total emissions from air transport (Vidal, 2007). The total climate impact of transport is thus not only a matter of efficiency (grams of CO_2 emitted per ton of freight transported), but also a matter of the total quantity (scale) of international trade activities.

3.1.2 CO_2 leakages due to geographical shifts in production

Increased consumption depletes domestic supplies, industrialised nations import materials to fulfil demand. Over the past 20 years, the resource base for many industrialised nations has increasingly shifted to other world regions. To a growing extent domestic raw material extraction has decreased, as resource imports from other world regions have expanded. The industrialised nations are thus becoming increasingly dependent on foreign providers, particularly in the areas of fossil fuels and metal resources. For example, Europe's import dependency with regard to non-renewable raw materials is 83% for iron ores, 80% for bauxite and 74% for copper (European Commission, 2006).

By increasing imports, Europe outsources CO_2 emissions. Thus, Europe has significantly reduced the domestic extraction and processing of metal ores, substituting increasingly by imports of semi-manufactured metal products from other world regions (see example in Figure 4). This implies that the CO_2 emissions related to the very energy and emission intensive processes of metal extraction and purification are also relocated from Europe to other world regions. This phenomenon is termed **"CO_2 leakage",** i.e. the apparent decrease of CO_2 emissions by reducing domestic production but increasing international trade.

Figure 3. Extraction, imports, exports and consumption of metal ores in the EU-15



Source: EEA, 2006 (www.eea.europa.eu)

A recent study investigated the increasing international trade between the US and China between 1997 and 2003 from the perspective of CO_2 leakages (Shui and Harriss, 2006). The authors revealed that US CO_2 emissions would have increased between 3% and 6% if the goods imported from China had been produced in the US. In addition, about 7% to 14% of China's current total CO_2 emissions were a result of producing exports for US consumers. The overall impact on climate change was negative, as global CO_2 emissions related to production increased by an estimated 720 million metric tons, due to the fact that Chinese production technologies are more energy and emission intensive than the ones applied in the US.

Allocating CO_2 emissions to producers masks effects of consumer behaviour. The current scheme of carbon accounting in the Kyoto Protocol follows an approach of "producer responsibility". This means that CO_2 emissions are accounted in the country where the actual CO_2 emissions occur. Therefore, the Kyoto emission inventories of some countries could reveal a positive (downward) trend, while the consumption patterns of the population remain unchanged and the absolute amounts of CO_2 are actually increasing.

Allocating CO_2 emissions to consumers has advantages but poses difficulties. Many researchers and NGO representatives therefore argue that the current accounting system should be changed to an approach of "consumer responsibility", where the final consumer is responsible for all CO_2 emissions related to the consumption of products, independent from the location of its production. This would, however, require allocating all CO_2 emission related to different process steps along the international production chains to the final consumers in the different countries.[1] Models to calculate these data regarding CO_2 emissions embodied in internationally traded products are currently being developed (see, for example, Lenzen et al., 2004), but internationally standardised data are so far not available.

[1] In the scientific literature on environmental indicators, there is an ongoing debate whether environmental consequences of production and consumption activities should be allocated to the consumer (consumer responsibility), to the producer (producer responsibility) or whether the responsibility should be shared by different actors (for example, Lenzen et al., 2006; Rodrigues et al., 2006).

3.2 *Impact of overseas relocation on the unit costs of production*

Final unit costs of production are based on many factors, and the effect of the EU Emissions Trading System on unit costs varies substantially, based on the energy consumption involved in manufacturing each product. This section evaluates the effects of implementing the EU Emissions Trading System on unit costs of production, focusing particularly on case studies of four tradable goods: steel, aluminium, newsprint, and cement.

Summary of key issues and results

- The impacts of the EU Emission Trading System (ETS) on production unit costs are most significant in energy-intensive sectors, because the power generating sector passes the cost increase onto the energy customers by means of higher energy prices.

- The unit production costs vary significantly among different scenarios, but the share of total costs due to the EU ETS is still marginal compared to other cost factors, such as labour.

- Most studies confirm that the effects of the EU ETS on unit production costs depend on the assignment mechanism of emission allowances. In general "grandfathering" (i.e. granting exceptions to existing installations) leads to higher production cost increases and CO2 leakage than an "output-based" allocation.

- In the four sectors analysed in this study (steel, aluminium, newsprint, cement), total production costs would increase between 1.3% and 3.7% assuming an EU ETS price for CO2 of 10 € per ton. These costs increases would not be faced by non-Annex B (developing) countries (which lack Kyoto-mandated carbon caps). Thus the cost advantages of these countries are also in the range of 1.3% to 3.7% due to the EU ETS system.

3.2.1 Background to the analysis

The unit costs of production of manufactured products depend on a large number of factors, including labour costs, capital costs, overhead costs, costs for raw materials and intermediate production inputs, taxes, and environmental costs (such as CO_2 permits).

These costs differ considerably from country to country, particularly when comparing Annex-B countries of the Kyoto Protocol with non-Annex B countries. The particular impacts of the ETS on the unit costs within the European Union also differ due to different allocation schemes for CO_2 allowances on the national level. It is also important to note that factors other than environmental costs, in particular labour costs, provide in most cases the main incentive for enterprises to relocate industrial production (ZEW, 2006). Nevertheless, the impact of the additional costs caused by the emission trading system on global competitiveness of the European industry is an important topic in the current discussion on environmental policy in Europe.

In order to provide a quantitative estimate of the impact on the unit costs of production if production were relocated from the EU to a non-Annex B country, a literature survey of existing cost assessments and cost scenarios was undertaken.

As the total difference in production costs between Annex B countries and non-Annex B countries is the sum of a large range of diverse cost factors, not only due to environmental costs, we assume that these additional environmental costs do not occur in non-Annex B countries.

The literature review and the assessment of the impacts on unit costs focus on four key manufactured products that are particularly vulnerable to the implementation of climate change policies: steel, aluminium, newsprint, and cement. Those industries are known to be very energy intensive and to contribute a major share of the CO_2 emissions in Europe. For these four products, quantitative estimates of the ETS-induced environmental costs in Europe were collected and evaluated vis-à-vis the cost structure in non-annex B countries.

In our assessment we review the effects of emission allowance prices of 10€/tCO_2, 15€/tCO_2, and 30€/tCO_2 on the unit production costs of several industries. The literature distinguishes among different national mechanisms of emission allowance assignment, different emission allowance price levels, and different emission allowance trading systems.

3.2.2 Analyses by sector

Our assessment is primarily based on two studies from the literature (see Annex 1 for details): the study of Reinaud (2005) and the research paper of Smale et al. (2006). In this report, the assessment focuses on the impact of the EU ETS on the unit costs of four selected sectors: steel, aluminium, pulp and paper (newsprint) and cement. It should be mentioned that other costs scenarios have calculated lower cost effects than presented in this report due to the ETS.[2]

In the tables, the different cost scenarios are illustrated. For each sector, the electricity price increase for the three allowance price scenarios is shown separately. The share of the cost increase due to the ETS-induced increases in electricity prices is presented as the 'total price increase due to indirect effects'. These results are based on the assumption that the full opportunity costs of the CO_2 allowances of the power generation sector are passed on to the other manufacturing industries. In contrast to the marginal cost increase (see below), the estimates for total cost increases all originate from only one study (Reinaud, 2005) and thus can be directly compared. Consequently, total cost increases show a proportional trend for the three different cost scenarios (10€, 15€, 30€).

In practice, however, only a part of the CO_2 opportunity costs of the energy sector is passed on to other sectors, reducing the indirect effects of the ETS on the total unit production costs. This assumption influences the 'marginal product cost increase', which captures the impact of opportunity costs of carbon allowances on the marginal production costs.

The tables for the four products in the next chapter illustrate that the marginal cost increases do not follow a proportional trend. This can be explained by differences in the methodologies applied in the two studies to calculate the 'marginal product cost increase'. In the 15€ and 30€ scenario, the increase refers to the marginal cost increase on production (see Smale et al., 2006), which is defined as direct CO_2 costs (purchasing costs of CO_2 emission allowances.) and the increase in the electricity price level. The 'marginal product cost increase' of the 10€ scenario, however, refers to the results of Reinaud (2005), who additionally included in the direct CO_2 costs the internal CO_2 emission abatement costs, for example investments in less carbon intensive technologies and the purchase of additional emission allowances from the market. For this reason, the cost increases for the 10€ scenario is always proportionally higher than the cost increases for the 15€ and 30€ scenarios.

[2] For example, see Reinaud (2005), who also presented two output-based scenarios, with much lower cost differences, calculating with total costs instead of marginal costs and using an output-based allowance allocation has less impact on the costs than grandfathering.

Steel

Two steel-production methods dominate global steel production: the basic oxygen furnace (BOF) process and the electric arc furnace (EAF) process (Reinaud, 2005), of which the BOF process is the more capital-intensive method. Both methods are very energy intensive. In order to enable a comparison of the results of the studies of Reinaud (2005) and Smale et al. (2006), we selected the BOF data for the general steel production costs (Table 2).

Table 2. Estimates for cost increases [%] in the steel industry due to the EU ETS

	Allowance price scenarios [%]		
Cost scenarios	10€/tCO_2	15€/tCO_2	30€/tCO_2
Electricity price increase	11%	16%	32%
Total cost increase due to indirect effects	0.5%	0.7%	1.5%
Marginal product cost increase	7.7%	8%	17%

Source: Reinaud, 2005; Smale et al., 2006

Since steel production is very energy intensive, an increase in energy prices due to the EU ETS results in higher unit production costs of steel, mirrored by the total cost increases due to indirect effects which range between 0.5% and 1.5%.

If we assume that the industry passes the indirect costs of ETS on to the short-run marginal product, the total marginal costs increase for steel would be 7.7% for an allowance price level of 10€/tCO_2 (Reinaud, 2005), 8% for an allowance price level of 15€/tCO_2 (Smale et al., 2006), and 17% for an allowance price level of 30€/tCO_2 (Smale et al. 2006). Those price increases measure the impact of opportunity costs of carbon allowances on the marginal cost of steel production (Smale et al. 2006).

As noted above, these cost increases with different price scenarios do not follow a linear trend, as Reinaud (2005) include more costs types into the direct abatement costs than Smale et al. (2006).

Aluminium

The aluminium sector is not directly covered by the EU ETS, but as a result of increased power prices, the production costs increase. In comparison with the other products, the effect of the electricity price increase is greatest for aluminium, as electricity makes up 35% of the total production costs of aluminium. The various estimates for cost increases in the aluminium industry due to the EU ETS are summarised in Table 3.

Table 3. Estimates for cost increases in the aluminium industry due to the EU ETS

	Allowance price scenarios [%]		
Cost scenarios	10€/tCO_2	15€/tCO_2	30€/tCO_2
Electricity price increase	11%	16%	32%
Total cost increase due to indirect effects	3.7%	5.6%	11.2%
Marginal product cost increase	3.75%	4%	13%

Source: Reinaud, 2005; Smale et al., 2006

The energy price increase causes a total cost increase between 3.7% and 11.2%, depending on the respective allowance price level. The marginal product price increase varies between 3.75% and 13%. There is hardly any difference between the 'total cost increase due to indirect effects' and the 'marginal production costs increase', as whatever level of opportunity costs is passed on to the aluminium sector, the electricity price is the decisive cost driver.

Newsprint

The paper industry is a capital-intensive industry in a competitive international market (CEPI, 2002). Electricity costs amount to about 12% of the variable production costs in the pulp and paper industry (Reinaud, 2005). Although the raw material costs are rising with the increase of wood prices, the energy costs remain a key factor.

If full opportunity costs are assumed, the energy price increase causes a total cost increase of 1.1% to 3.3%, depending on the respective allowance price level. The marginal product price increase (including the direct emission costs) varies between 2.6% and 6%. It is noteworthy that Reinaud (2005) got a higher value for the marginal cost increase for an allowance price of 10€/tCO_2 than Smale et al. (2006) for an allowance price of 15€/tCO_2 (Table 4). This is due to the different assumptions on direct costs, as explained above.

Table 4. Estimates for cost increases [%] in the pulp and paper industry due to the EU ETS

	Allowance price scenarios [%]		
Cost scenarios	10€/tCO_2	15€/tCO_2	30€/tCO_2
Electricity price increase	11%	16%	32%
Total cost increase due to indirect effects	1.1%	1.6%	3.3%
Marginal product cost increase	3.9%	2.6%	6%

Source: Reinaud, 2005; Smale et al., 2006

Cement

On the one hand, cement production is a highly energy-intensive process and amounts to around 2% of the global primary energy consumption (World Energy Council, 1995). Not surprisingly, the electricity consumption (including combustibles) accounts for over a quarter of the total costs of the cement production (Reinaud, 2005). Hence, it is the major key cost factor. On the other hand, the cement production itself causes large amounts of CO_2 emissions. The diverse estimates for cost increases in the cement industry due to the EU ETS are summarised in Table 5.

Table 5. Estimates for cost increases in the cement industry due to the EU ETS

	Allowance price scenarios [%]		
Cost scenarios	10€/tCO_2	15€/tCO_2	30€/tCO_2
Electricity price increase	11%	16%	32%
Total cost increase due to indirect effects	1.5%	2.2%	4.5%
Marginal product cost increase	18.6%	70%	144%

Source: Reinaud, 2005; Smale et al., 2006

The electricity price change due to ETS feeds into indirect costs, which lead to a total unit cost increase between 1.5% and 4.5%. Because of the high CO_2 emissions in the cement production process, direct cost increases are much higher than indirect cost increases. The marginal product cost increase ranges between 18.6% and 144% and is extremely responsive to allowance price increases. The cement industry itself emits very large amounts of CO_2, which is the reason why the EU ETS has such a visible impact on the marginal production costs.

Again, there is a difference between the values estimated by Reinaud (2005) and the values estimated by Smale et al. (2006).

The cost increase at the output-based 2% and 10% scenarios is much lower, due to two effects: 1) an output-based allowance allocation has less impact on the costs than grandfathering, and 2) the direct cost estimation of Renaud (2005) includes internal abatement strategies and possible allowance revenues that are not included in the direct cost increase of Smale et al. (2006).

3.3 Case studies: CO_2 emissions from production and transport

Measuring CO_2 emissions from production and transport is an important part of analysing the effect of international trade on global climate change. Detailing the activity-specific emissions related to international trade allows for a deeper evaluation of trade and its relation to climate change. For instance, calculating CO_2 emissions specific to various transport modes reveals widely disparate levels of CO_2 emissions in transporting a given product. Also, production costs for the same goods vary between each country, and these differences must be taken into account when evaluating the contribution of trade to CO_2 emissions.

Summary of key issues and results

- In most empirical case studies, producing and delivering goods within Europe is less CO2 intensive than importing from overseas, especially due to the emissions related to the large transport distances.
- Most product-specific studies show higher emission factors of production in other world regions compared to Europe – this is particularly significant in the case of the Chinese steel sector and indicates that if Europe continues to outsource material and energy intensive stages of production, absolute levels of CO2 are likely to increase on the global level.
- When goods are produced overseas and transported to Europe, shipping emissions per ton of freight are almost 40 times lower than the emissions generated when transported by air. This gives a clear indication that incentives should be implemented to increase the costs of transports by plane (e.g. through a kerosene tax).
- However, overall CO2 emissions of international trade are not only a question of relative emission intensities, but also of absolute levels of transport. Maritime shipping is much more energy and emission efficient than air transport, but the sheer growth of the maritime fleet in the past decades resulted in the fact that today maritime shipping contributes twice the amount of CO2 emissions compared to transport by planes.
- When goods are transported within Europe, rail transport should be favoured over transport by lorry, as CO2 emissions are more than three times higher in the case of lorry transport.

Relevant factors regarding trade and CO_2 include proportional versus volume-based emissions from various transport modes, and the energy consumption involved in producing each respective product. In order to establish a better understanding of these issues, this section quantifies CO_2 emissions for specific goods covering a broad spectrum of international trade scenarios.

3.3.1 Background to analysis

CO_2 emissions from production outside the EU and from transport to the EU markets vs. produced within the EU are estimated for four industrial and two agricultural products. With regard to industrial products, four products have been selected:

- Aluminium (Australia vs. France)
- Steel (China vs. Germany)
- Cement (China vs. Germany)
- Fertilisers (USA vs. Italy)

With regard to agricultural products, the two products selected are

- Apples (New Zealand vs. Germany)
- Lamb (New Zealand vs. UK)

To calculate emissions generated during the production process, the emission factor for the particular process or sector is determined by dividing the total annual emissions of the industrial sector by the total annual production volume. The majority of the factors used in the present study has been taken from different national emission inventories submitted to the IPCC under the Kyoto Protocol.

For the calculation of the emissions generated during the transport of the product to the retailer the emission factor for the particular transport mode has to be multiplied by the transport distance. For a detailed description of the calculation methodology see Annex 2.

3.3.2 Summary of results

Table 6 and Table 7 illustrate the summarised results of the different case studies for CO_2 emissions generated during production at different sites overseas and within Europe and transported to a retailer or construction site in Europe. The results are ordered by product (Table 6: industrial products, Table 7: agricultural products) and by transport-mode combination. In most cases, products imported from outside the EU have higher CO_2 emissions than their counterparts that are both produced and consumed within the EU. To take a case from this study, cement produced in China and shipped to Germany has twice the CO_2 emissions than cement produced and consumed in Germany. The higher emissions for imported products stem from transport-related emissions, especially in cases where products are transported by air. In a few cases, the greater production efficiency in certain non-EU countries means that for some products the CO_2 impact is lower if produced abroad. In the case studies examined in this study, lamb produced in New Zealand and shipped to the UK by sea has lower CO_2 emissions than that produced and consumed in the UK. This is also true for fertiliser produced in the United States and shipped to Italy.

Table 6: Summarised results of the analyses of different transport scenarios for production sites of industrial products overseas and within Europe.

		Aluminium				Cement				Steel					Fertiliser			
[kgCO_2/t]		AUS Lorry	AUS Rail	FRA Lorry	FRA Rail	CHN Lorry	CHN Rail	GER Lorry	GER Rail	CHN Lorry	CHN Rail	CHN Ship	GER Lorry	GER Rail	USA Lorry	USA Rail	ITA Lorry	ITA Rail
Production		1610	1610	1540	1540	640	640	530	530	3190	3190	3190	1050	1050	900	900	1150	1150
Transp.	Lorry	65		67		13		28		15			2		20		16	
	Rail		18		18		3		8		4			0,46		6		4
	Ship	322	322			360	360			351	351	354			104	104		
Total		1997	1950	1607	1558	1012	1003	558	538	3557	3546	3544	1052	1050	1024	1010	1166	1154

Table 7: Summarised results of the analyses of different transport scenarios for production sites of agricultural products overseas and within Europe.

		Lamb				Apples					
[kgCO_2/t]		NZ-Ship	NZ-Plane	UK-Lorry	UK-Rail	NZ-Ship-Lorry	NZ-Ship-Rail	NZ-Plane-Lorry	NZ-Plane-Rail	GER-Lorry	GER-Rail
Production		498	498	1607	1607	60	60	60	60	251	251
Transport	Lorry			7		48		19		7	
	Rail				2		13		5		2
	Ship	291	3			292	292				
	Plane		11413					11257	11257		
Total		788	11913	1614	1609	399	365	11336	11323	258	253

3.3.3 Detailed Results: Industrial products

Aluminium (Australia vs. France)

As an example of an Australian company producing aluminium, we chose “Comalco Rio Tinto Aluminium“ (smelter and refinery near Gladstone, Queensland), which operates the biggest aluminium smelter in Australia. The endpoint of transport is the aluminium processing enterprise “TRIMET“ in Germany (Düsseldorf, North Rhine-Westphalia). Our example for aluminium production in Europe is the French company Setforge in L’Horme (St. Etienne, Loire), which is Europe's biggest aluminium producer. The endpoint for transport is again “TRIMET“ in Düsseldorf, Germany. We compared the following transport-mode combinations:

- AUS-Lorry: lorry-ship-lorry: Gladstone-Brisbane-Rotterdam-Düsseldorf
- AUS-Rail: rail-ship-rail: Gladstone-Brisbane-Rotterdam-Düsseldorf
- FRA-Lorry: lorry: L'Horme-Düsseldorf
- FRA-Rail: rail: L'Horme-Düsseldorf

The factors used for the calculation of production emissions are given in Table 8. We show the emission factors for the two case study countries plus one additional country (USA), for which an emission factor was available. The emission factor the the US is slightly higher than the one for Australia, France shows the lowest emission factor.

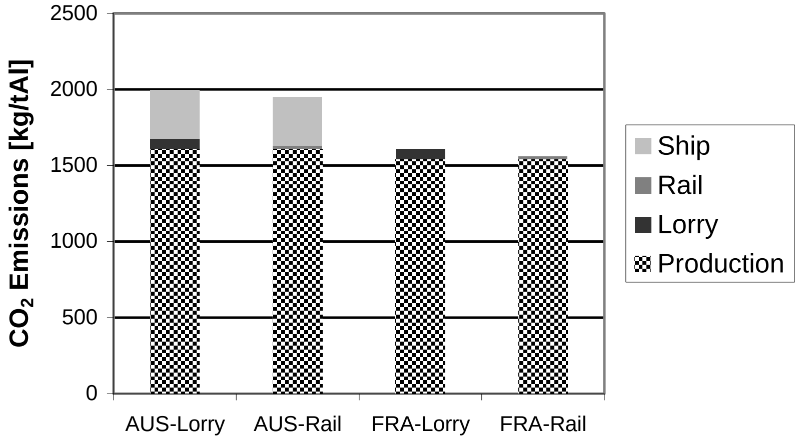
Table 8. Aluminium production: CO_2 emission factors [tCO_2/tAl] for aluminium production (2004). Two case study countries plus comparing country (USA).

Case study countries		Additional country (for comparison)
Australia	**France**	**USA**
1.61	1.54	1.68

Sources: Australian Government, 2006; EEA, 2006a,b; US EPA, 2007

Different transport scenarios were analysed for aluminium produced in Gladstone, Australia and L’Horme, France, and subsequently transported to a processing company in Düsseldorf, Germany. The comparison of CO_2 emissions of one tonne of aluminium generated during production and transport in Europe and overseas shows that the difference between the two most climate-efficient transport scenarios (AUS: rail-ship-rail, FRA: rail) is around 400 kg of CO_2 per tonne. In other words, producing aluminium in France and transporting it to Germany emits about 20% less CO_2 (Figure 4).

Figure 4. Aluminium production and transport: Comparison of different scenarios of CO_2 emissions [kgCO_2/tAl], generated during production and transport of one tonne of aluminium in Australia and France.



Generally, comparison of total CO_2 emissions between aluminium production and transport shows that the aluminium production process is highly energy consuming. The share in total emissions of the production process is approximately 83-99%.

Due to the difference in the emission factors for rail and lorry transport (23:84), transporting aluminium across short distances (e.g. from Gladstone to Brisbane) by train emits less than a third of the amount of CO_2 emitted by lorry transport. From a climate perspective, transport by train therefore is clearly more climate efficient than transport by lorry.

Cement (China vs. Germany)

As an example of a Chinese company producing cement, we chose “Tianjin Cement Co., Ltd.” (Tianjin, near Beijing). In Germany we chose “LaFarge Zement“ in Oberusel (near Frankfurt, Hesse). The endpoint of both transport chains is assumed to be a retailer or construction site in Germany (Hannover, Lower Saxony). Again we compared different transport-mode combinations including ship, lorry, and rail transport. The factors used for the calculation of production emissions are given in Table 9. We again show the values for the two case study countries (China and Germany) as well as for three other countries, for which emission factors were available. China shows the highest emissions per ton of cement, followed by Australia, the EU and the USA.

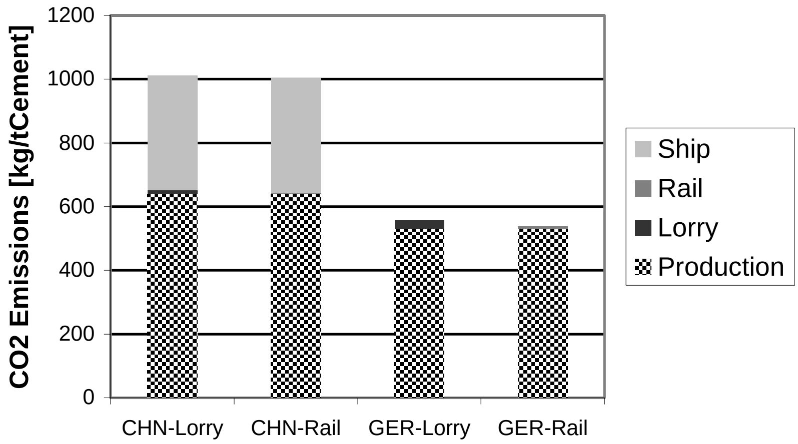
Table 9. Cement production: CO_2 emission factors [tCO_2/tCement] for cement production (2000). Two case study countries plus comparing countries (EU-15; USA; Australia).

Case study countries		Additional countries (for comparison)		
China	**Germany**	**EU-15**	**USA**	**Australia**
0.64	0.53	0.53	0.49	0.55

Sources: Tsinghua University, 2005; EEA, 2006a,b; US EPA, 2007; Australian Government, 2006.

Different transport scenarios were analysed for cement produced in Tianjin, China and Oberusel, Germany and transported to a retailer or construction site in Hannover, Germany. The differences in CO_2 emissions generated during production and transport of one tonne of cement were compared. The difference between the two 'best case' scenarios (CHN: ship-rail, GER: rail) is around 500 kg/t, which means that producing cement in Germany and transporting it within Germany emits approximately 50% less CO_2 than if cement is imported from China (Figure 5).

Figure 5. Cement production and transport: comparison of different scenarios for CO_2 emissions [$kgCO_2$/tCement], generated during production and transport of one tonne of cement in Germany and China.



In comparison with the aluminium production, with respect to the contribution of cement production overseas versus transport to the total carbon dioxide emission, an increase in the share attributed to transport can be seen. However, the production process still contributes 50% more to total emissions than transport. Cement production in Germany emits less CO_2 compared to China - 530 kg/t (Germany) versus 640 kg/t in China – which corresponds approximately to 99% of the total emissions.

Steel (China vs. Germany)

For steel production in China we chose "Jiangyin Haida Ornamental Materials Co., Ltd." (Jianying, near Shanghai), one of the major steel producers in China. For Germany, we selected the "ThyssenKrupp AG" located in Hamburg. The endpoint of transport for retail or construction in both cases is Hamburg. Again we compare different transport-mode combinations including ship, lorry, and rail transport. The factors used for the calculation of production emissions are given in Table 10. We illustrate the factors for Germany and China plus for Australia as a comparing country. The table illustrates that steel production in China is around 4 times more CO_2 intensive than in Germany.

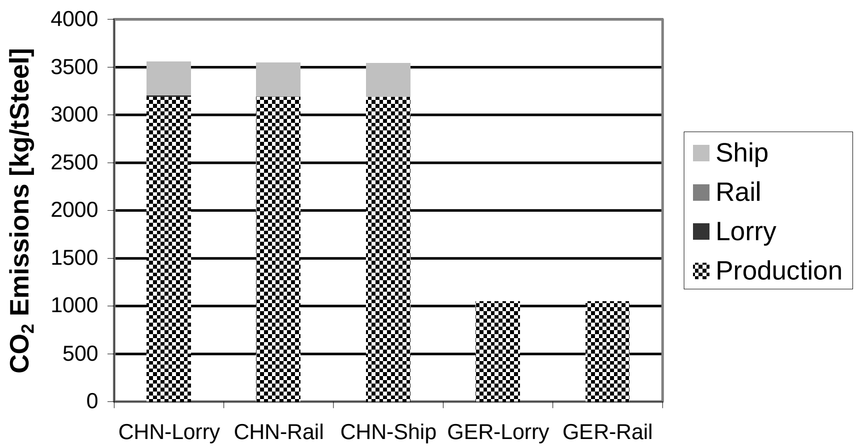
Table 10. Steel production: CO_2 emission factors [tCO_2/tSteel] for steel production (1995). Two case study countries plus comparing country (Australia).

Case study countries		Additional countries (for comparison)
China	**Germany**	**Australia**
3.19	1.05	1.61

Sources: Price et al., 2001; EEA, 2006a,b; Australian Government, 2006.

Different transport scenarios were analysed for steel produced in Jiangying, China and Hamburg, Germany, and transported to a retailer in Hamburg, Germany. Differences in CO_2 emissions generated during production and transport of one tonne of steel within Europe and overseas were compared. The difference between the two 'best case' scenarios (CHN: ship-ship-rail, GER: rail) is around 2500 kg/t, which signifies that producing steel in China and transporting it to Germany results in CO_2emissions 3.5 times higher than when it is produced in Germany (Figure 6).

Figure 6. Steel production and transport: comparison of different scenarios of CO_2 emissions [$kgCO_2$/tSteel], generated during production and transport of one tonne of steel in Germany and China.



Similar to aluminium, the production process accounts for the bulk of cement production's total carbon dioxide emissions. Overseas, the production process accounts for 90% of the total emissions, whereas production in Germany results in almost 100% of total emissions. The production of one tonne of steel in Germany generates only a third of the CO_2 emissions of one tonne of Chinese steel: 1050 kg/t (Germany) versus 3190 kg/t.

Fertiliser (USA vs. Italy)

As an example of an American fertiliser company we chose the New York Organic Fertilizer Company (NYOFC). For Italy, we chose Yara, located in Ravenna (Emilia-Romagna). The endpoint of the transport chain is assumed to be the region of Florence (Tuscany). Again we compared different transport-mode combinations including ship, lorry, and rail transport. The factors used for the calculation of production emissions are given in Table 11. We illustrate the factors for the US and Italy as the case study countries plus the comparing value for the

EU-15. According to the table, fertiliser production is most CO_2 intensive in the average EU-15, whereas Italy performs better than European average and the US performs best.

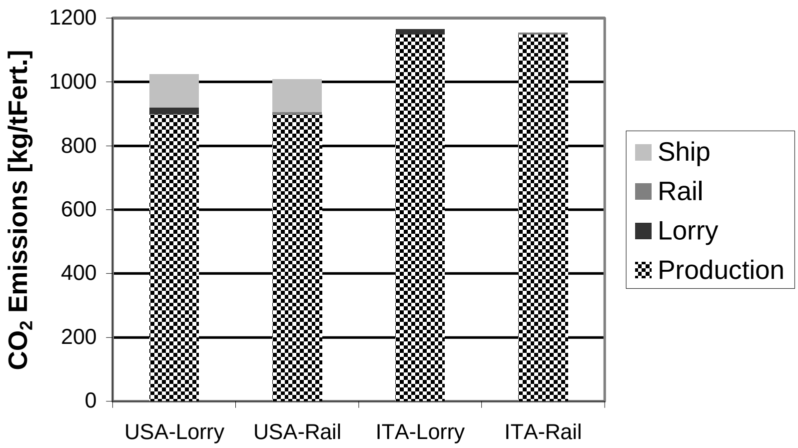
Table 11. Fertiliser production: CO_2 emission factors [tCO_2/tFert.] for fertiliser production (2004). Two case study countries plus comparing value (EU-15).

Case study countries		Additional countries (for comparison)
USA	**Italy**	**EU-15**
0.9	1.15	1.4

Sources: US EPA, 2007; EEA, 2006a,b.

Different transport scenarios were analysed for fertiliser produced in New York, USA and Ravenna, Italy, and transported to a retailer in Florence. Differences in CO_2 emissions were compared for one tonne of fertiliser during production and transport. In contrast to the cases discussed above, production in the USA is so efficient that the total emission of carbon dioxide is lower than when produced in Italy. The difference between the two 'best case' scenarios (USA: ship- rail, ITA: rail) is around 150 kg/t, meaning that production in the USA and subsequent import to Europe emits around 13 % less carbon dioxide (Figure 7).

Figure 7: Fertiliser production and transport: comparison of different scenarios of CO_2 emissions [kg CO_2/tFert.], generated during production and transport of one tonne of fertiliser in Italy and the USA.



Analysing the contribution of fertiliser production versus transport to total carbon dioxide emissions shows that the fertiliser production process amounts for approximately 90% of the total amount of emitted CO_2 when produced in the USA and transported to Italy, and for almost 100% when produced within Italy. Fertiliser production in the USA is less emission intensive (900 kg/t) than in Italy (1150 kg/t**)**.

3.3.4 Detailed Results: Agricultural products

Lamb (New Zealand vs. Great Britain)

As example for a company in New Zealand producing lamb we chose a farm in the area around Nelson (South Island). The endpoint of transport is a lamb resale enterprise in London. Our example for lamb being produced in Europe is a farm in Kent (S-E England). The endpoint of transport is the same lamb resale enterprise in London. In addition to the different transport-mode combinations compared so far (including ship, lorry, and rail transport), this time we also incorporate aerial transport, as it seems plausible that for hygienic and freshness reasons agricultural products, rather than industrial goods, are transported by plane[3]:

- NZ-Ship: ship: Nelson-London
- NZ-Plane: ship-plane: Nelson-Wellington-London
- GB-Lorry: lorry: Kent-London
- GB-Rail: rail: Kent-London

The factors used for the calculation of production emissions are given in Table 12 and were extracted from the publication by Saunders et al., (2006). It has to be noted that only direct (energy use) and indirect (production inputs, such as fertilisers) CO_2 emissions were considered in the factors, but no CO_2 emissions related to capital (machinery, buildings,etc.). In the case of the agricultural products, no factors were available for comparing countries and only those of the two case study countries are presented. The factors show a significant difference: UK production is almost 6 times more CO_2 intensive, in particular due to higher input of fertilisers (nitrogen) and higher CO_2 intensity of fuels and electricity.
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Table 12. Lamb production: CO_2 emission factors [tCO_2/tLamb] for lamb production (2006).

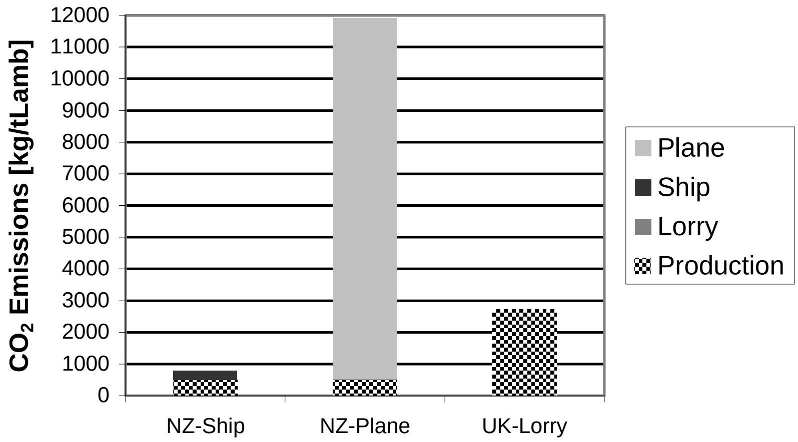
NZ	UK
0.50	2.72

Source: Saunders et al., 2006.

Different transport scenarios were analysed for one tonne of lamb produced in Nelson, New Zealand and Kent, Great Britain and transported to a processing company in London, Great Britain. Comparison of CO_2 emissions generated during production and transport shows that the difference between the two most climate-efficient transport scenarios (NZ: ship, UK: rail) is almost 2000 kg of CO_2 per tonne of lamb. In other words, due to the extremely efficient production (e.g. because of outside grazing during the whole year) producing lamb in NZ and transporting it to Great Britain generates around 70% less CO_2 than when produced and transported within the UK (Figure 8). Figure 8 also illustrates the enormous difference between transporting goods by air and by sea over long distances.

3 It should be noted that the authors were not able to find data on the share of the selected agricultural products being transported by plane versus ship.

Figure 8. Lamb production and transport: comparison of different scenarios of CO_2 emissions [kgCO_2/tLamb], generated during production and transport of one tonne of lamb in New Zealand and Great Britain.



Comparing the contribution of lamb production and transport to the total CO_2 emissions shows that due to the efficiency of the lamb production process in New Zealand the share of production in the total CO_2 emissions is quite low in comparison with the industrial products – 63 % when transported by ship, and 4 % when transported by plane. When produced in Kent, the share in total emissions attributed to transport is rather marginal, due to the very small transport distance within England (80 km).

The comparison of carbon dioxide emissions related to lamb production in New Zealand and in Great Britain shows a difference of approximately 2200 kg/t. Hence, producing one tonne of lamb in Great Britain generates more than five times the CO_2 production emissions than in New Zealand (2700 kg/t vs. 500 kg/t).

On a long-distance level, it can clearly be seen that despite the bigger distance, shipping generates far less carbon dioxide than transporting by plane. Hence, from a climate perspective, transport by ship is clearly more climate efficient than transport by plane. However, the need for freshness of the transported product might favour aerial transport.

Apples (New Zealand vs. Germany)

As an example of a company in New Zealand growing apples we chose an orchard in the area around Nelson (South Island), as it is one of the main apple orchard regions in New Zealand. The endpoint of transport is a resale enterprise in Strasbourg, France. Our example for apples grown in Germany is an orchard close to Freiburg (Baden-Württemberg). The endpoint of transport is the same resale enterprise in Strasbourg. Again we compare different transport-mode combinations including ship, lorry, rail, and aerial transport.

For the calculation of production emissions the factors are given in Table 13.

Table 13. Apple production: CO_2 emission factors [tCO_2/tApples] for apple production (2006).

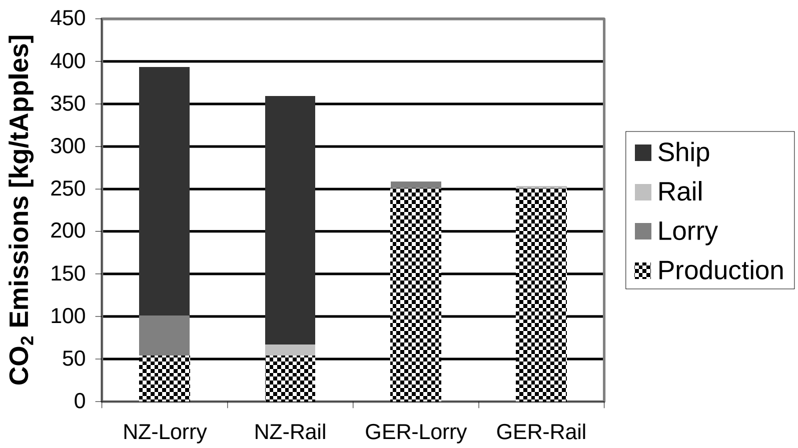
NZ	GER
0.054	0.25

Sources: Saunders et al., 2006; Umweltbundesamt, 2007.

The comparison of carbon dioxide emissions related to apple production in New Zealand and in Germany shows a difference of approximately 200 kg/t. Hence, producing one tonne of apples in Germany generates almost five times the production emissions than in New Zealand.

Different transport scenarios were analysed for apples grown in Nelson, New Zealand and Freiburg, Germany and transported to a resale enterprise in Strasbourg, France. Comparison of CO_2 emissions generated during production and transport of one tonne of apples in Europe and overseas shows that the difference between the two most climate-efficient transport scenarios (NZ: ship-rail, GER: rail) is around 100 kg of CO_2. In other words, despite the extremely efficient production (e.g. advantageous climate, orchard size, etc.) growing apples in NZ and transporting them to France emits around 44% more CO_2 than producing them in Freiburg, Germany (Figure 9).

Figure 9. Apple production and transport: comparison of different scenarios of CO_2 emissions [kgCO_2/tApples], generated during production and transport of one tonne of apples in New Zealand and Germany.



Comparison of the contribution of apple production and transport to the total CO_2 emissions shows – even more clearly than in the lamb case – that due to the efficiency of the apple production process in New Zealand, its share in the total CO_2 emissions is very low in comparison with the industrial products – 16 % when transported by ship, and 1 % when transported by plane. This relationship is strengthened by the larger transport distances within Europe (570 km from Rotterdam to Strasbourg, and 220 km from Frankfurt respectively). Again, in the case of growing apples in Europe (Freiburg, Germany), the production process accounts for almost 100% of the total emissions.

4 Environmental policy assessments

This section assesses the key lessons applicable to trade policy that can be garnered from the EU's experience with market-based environmental policies. In addition, we assess how well the EU ETS is interacting with the flexible mechanisms set up under the Kyoto Protocol. We also provide a primarily qualitative evaluation of the EU's experience with market-based tools and the flexible mechanisms under the Kyoto Protocol, augmented with existing quantitative information found in the literature.

4.1 Summary of key findings

- Use of market-based instruments (MBIs) is growing worldwide. For specific applications, MBIs have proven their ability to improve environmental performance in a cost-effective way. A key strength of MBIs is their ability to offer dynamic economic incentives to reduce environmental impacts. MBIs are not suitable solutions to all environmental problems, requiring the more traditional regulatory approach of command-and-control policies.

- Market-based instruments are applicable to trade policy. In theory, MBIs could also be implemented in the specific context of trade policy. Instruments such as tariffs, tariff reduction, tradable permit systems, subsidies, government procurement and product labelling could all be employed with the explicit aim of both reducing the climate impacts of trade and ensuring fair competition in international markets.

- Kyoto's flexible mechanisms are a test bed for market-based approaches to addressing climate change. The three Kyoto mechanisms—International Emissions Trading, Clean Development Mechanism and Joint Implementation—together constitute the first-ever legal and institutional framework for global trade in greenhouse gas emissions. The challenges related to their implementation, efficiency, and effectiveness provide important lessons for international market-based mechanisms generally.

- Implementation is constrained (and enabled) by institutional and legal frameworks. MBIs are highly dependent on institutional capabilities to design, monitor and enforce their effective implementation. Multilateral and bilateral agreements constrain (and enable) the implementation of these policy tools in a trade context. Future climate agreements and future trade agreements need to be integrated into a coherent framework that enables the effective implementation of MBIs across borders.

- The key constraints on policy implementation in a trade context are legal in nature. Current international trade law forms the key constraint on what trade policies governments can implement to combat climate change. These legal issues are addressed in Section 5.

4.2 Assessment of market-based instruments for environmental policy

Market-based instruments (MBI) have become an increasingly important component of the environmental policy within the EU. While most use of these instruments occurs at the Member State level, such policies have become increasingly important at the EU level as well (EEA, 2005, p. 7). This trend reflects a global phenomenon, as implementation of MBI has expanded in countries around the world (UNEP, 2004, p. 17 and US EPA, 2004, p. 1). Market-based instruments are one part of a broader set of policy tools used in environmental policy. Other approaches fall into the category of command and control (CAC) instruments that directly regulate behaviour through fixed requirements.[4] Though an important part of the portfolio of policy options, these regulatory approaches are outside the scope of this report.

Many environmental problems stem from the fact that the true social costs of certain activities are not borne by those engaging in those activities. These external costs—externalities—are instead pushed more broadly onto society, including those who are not involved in any way in the activity causing the environmental problem. Market-based environmental policies seek to correct this problem by ensuring that more of these costs are "internalised", meaning that creators of these costs also pay for them. In this sense, MBIs are very much in line with the principle of *polluter pays*, a principle central to EU environmental policy. There are several types of MBIs in use today: tradable permits, environmental taxes, environmental charges, environmental subsidies/incentives, and liability and compensation schemes. Table 14 briefly describes these instrument types and summarises key lessons about their effectiveness.

Table 14. Types of market-based instruments

Instrument	Brief description	Use, effectiveness and key lessons
Taxes	Taxes levied on an environmentally harmful activity raise the economic cost of that activity and thus reduce the level of the activity overall.	Taxes and charges are the most widely used market-based instruments in environmental policy. They do not specify fixed environmental performance targets and are often conceived as a means of ensuring that the "true cost" of environmentally damaging activities are paid. Carbon and fuel taxes are an example of climate-related taxes.
Charges	Charges are similar to taxes in that they raise the cost of environmentally harmful activity. Typically, the term "charge" refers to a payment in exchange for a specific environmental service (e.g. sewerage or water purification).	See *taxes* above.
Tradable permits	Typically a cap and trade system wherein governments establish the maximum allowable level of pollution, allocating pollution permits to those taking part in the system. Those able to reduce their pollution at lower cost can sell their permit to those unable to do so. The EU ETS is such a system.	Cap and trade systems have proven themselves as a means of achieving environmental gains at relatively low cost. The key challenge has been in how governments set the cap and allocate the subsequent permit rights (e.g. free allocation or charging for the permits). Free allocation creates large windfall profits for those covered by the system, while auctioning impedes adoption of such system due to political opposition against paying for something that has been historically free.

[4] Examples of command and control policies include emissions standards, technological standards, product requirements and bans on specific practices or substances (EEA, 2005, p. 14).

Instrument	Brief description	Use, effectiveness and key lessons
Subsidies and incentives	Subsidies can increase the level of environmentally beneficial activities (e.g. renewable energy generation) by lowering the cost of these activities. Removal of environmentally harmful subsidies reduces incentives to damage the environment.	A key success for subsidies is in the area of renewable energy policy, wherein the provision of guaranteed prices for renewable energy (so-called *feed-in tariffs*) has resulted in dramatic investment growth. The guaranteed prices (which are sometimes set at a declining schedule over time) reduce the investment uncertainty associated with renewable energy projects.
Government procurement	Public expenditures can be directed by non-price guidelines to take into account environmental aspects of goods and services.	In 2002, European Court of Justice rulings determined that environmental and social criteria could be taken into consideration in public procurement decisions. EU Directives 204/17/EC and 2004/18/EC specify green public procurement rules (EEA, 2005, p. 112).
Liability and compensation	Holding polluters legally and financially liable for harm to the environment creates incentives for all actors that could potentially harm the environment to take precautionary measures that reduce this risk.	This tool has received relatively less use than other MBI, and is dependent on legal proceedings that can be expensive and protracted.
Information tools	Though not typically categorised as MBIs, information tools such as product labelling reveals hidden environmental information that allow consumers to make more informed economic decisions. Information tools are thus an instrument that overcomes a market failure (i.e. imperfect information) and create incentives to make different economic choices.	Both voluntary and mandatory labelling systems have shown their effectiveness in guiding consumer behaviour. Climate-related use of information tools includes energy-use information on appliances and carbon emissions information on automobiles.

A key strength of MBIs is their ability to offer dynamic economic incentives to reduce environmental impacts. A key drawback of MBIs is that for many instruments, no set level of environmental performance can be established, as the level of environmental performance is a function of individual actors responding to economic incentives. In contrast, many command and control tools are able to guarantee achievement of set performance levels. Emissions trading combines both aspects (dynamic incentives and achievement of fixed environmental performance targets. Such trading systems could be established at the national, supranational and global level but require a corresponding legal and institutional framework in order to function.

Since 2005, the European Union has operated the world‘s largest tradable permit scheme for greenhouse gases: the EU Emissions Trading System (EU ETS). The EU ETS represents a major milestone in climate policy, and will play a key role in shaping what future emissions trading schemes will look like elsewhere. The scheme has met with significant challenges, however, stemming from an over-allocation of permits, as well as concerns about international competitiveness and windfall profits earned from the free allocation of permits. More information on the EU ETS is covered in Section 4.2.

Taken together, MBIs have proven their ability to improve environmental performance in a cost-effective way. They are clearly not suitable to all purposes and highly dependent on institutional capabilities to design, monitor and enforce their effective implementation. However, their growing adoption in Europe and elsewhere has shown that they will become an increasingly important part of environmental policymaking at the domestic, EU and (eventually) international level.

4.3 Application of market-based instruments to trade policy

Market-based environmental instruments are also of growing interest in the context of international trade. This interest come from two opposing sides: 1) from those wishing to implement these tools as a means to address environmental problems, and 2) from those concerned that such implementation could harm international trade or already comes into conflict with established international trade law.

Having assessed these policy tools for their original objectives, we describe the ways in which they could be adapted for possible trade policy applications. In assessing their applicability to trade, we pay attention to those political, economic, and institutional dimensions that could help or impede their effective implementation. Legal aspects are addressed in detail in Section 4.

Climate-related MBIs that are currently receiving attention in the trade context include:

- Carbon taxes (or tradable permits) with border tax adjustments
- Lower tariffs for climate-friendly goods and services
- Government subsidies related to energy efficiency
- Climate labelling schemes (voluntary and mandatory)
- Government procurement policies
- International trade in greenhouse-gas credits via Kyoto's Flexible Mechanisms.

The economic rationale for market-based instruments stems from their ability to correct for market failures like externalities and imperfect information. This rationale also applies at international levels. However, there is also concern about using these policy instruments in the context of trade policy. The key concern is that they could be used as a disguised means of favouring domestic economic interests, thereby coming into conflict with the international effort to liberalise trade through trade agreements such as the WTO.

It is important to note that these instruments could be used to target domestically emitted GHG, foreign emitted GHG, or both. In the first case, locally emitted GHG of imported and domestic products can be controlled through domestic regulations. An example of this type of policy would be CO_2 emissions limits on new cars sold within the EU. In this case, the trade implications are an implicit function of a domestic policy. In contrast, policies targeting foreign-emitted GHG emissions are explicitly trade related, reaching across international boundaries to address the climate impacts stemming from imported goods' material make-up, production, and transport.

Table 15 shows the key ways that each instrument could be implemented in a trade policy context to combat climate change. Many of these policies are already in use in a domestic context (e.g. subsidies to renewable energy and biofuels), while others are still only under consideration as potential trade policies (e.g. border tax adjustments).

Table 15. Climate MBIs applicable to trade policy

Market-based instrument	Possible use to combat climate change in a trade policy context
Lower tariffs for climate-friendly goods and services	Lower (or zero) tariff levels on climate-friendly goods and services could be agreed (either bilaterally or multilaterally). This would have the effect of lowering prices, thereby increasing trade in these goods and services.
Carbon taxes (or tradable permits) with border tax adjustments	Countries that impose costs on domestic carbon emissions could implement border tax adjustments (BTA) to counteract negative competitive effects on their industries. BTA can take the form of taxes imposed on the embodied carbon emissions in imported goods or as credits to exporting firms equivalent to the carbon taxes in producing their exported products.
Government subsidies related to climate effects	Trade policy could be used to control what types of subsidies are allowable, basing subsidy policy on the climate impact of specific activities. Policies could include the explicit banning of subsidies to activities harmful to the climate and the explicit allowance of subsidies to climate-friendly activities.
Climate labelling schemes (voluntary and mandatory)	Internationally recognised labelling schemes would overcome information problems associated with traded goods. Without such labelling, GHG-emission attributes are not apparent to end consumers and governments.
Government procurement policies	The climate impact of goods and services could be taken into account in public purchasing. Government purchasing in OECD countries is significant at 10 –25% of total economic activity (UNEP and IISD, 2005, p. 88).
International trade in greenhouse-gas credits via Kyoto's flexible mechanisms	International markets in greenhouse gases have already been established as a means to achieve Kyoto targets and could be both altered and expanded in future international accords.

Though MBIs show potential for trade-specific implementation, obstacles to their use remain. Table 16 summarises key political, economic and institutional obstacles to using MBIs in a trade context to combat climate change. This list of obstacles is not exhaustive, focusing instead on the most salient sticking points. As can be seen from the case studies investigated in the previous section, knowing the actual climate implications of traded versus domestically produced goods is information intensive and dependent on simplifying assumptions. These information needs about the climate impacts of production, transport and use affect the administrative feasibility of many of these policy options and may even require formal codification in the legal language of bilateral and multilateral agreements. Please note that legal obstacles are explicitly excluded from this table, as the legal implications of trade-policy approaches are the subject of Section 5.

Table 16. Key policy, economic and institutional obstacles to using climate MBIs in a trade context

Market-based instrument	Key policy, economic and institutional obstacles
Lower tariffs for climate-friendly goods and services	• Developing countries see this as advantageous to developed countries, as the latter are typically the source of these new technologies and services. • Defining "environmental goods" has proven problematic in past efforts. For example, in the case of biofuels, "sustainability" and "life-cycle climate impact" will be contentious to define given the ambiguous environmental effects of some biofuel types and production methods.
Carbon taxes (or tradable permits) with border tax adjustments	• BTAs on embodied CO_2 are controversial, with some stakeholders concerned about negative political ramifications • Administering BTAs requires product-specific information on embodied CO_2, which is more difficult to obtain for some products and countries than others
Government subsidies related to energy efficiency	• Eliminating environmentally harmful subsidies is difficult due to entrenched interests opposing reform • Subsidies require public expenditure and can distort economic decision-making in negative ways • In the case of biofuels, the ambiguous environmental effects of some biofuels complicate stances toward the subsidies granted by domestic and foreign governments
Climate labelling schemes (voluntary and mandatory)	• Getting international agreement on criteria for labelling is difficult and will be opposed by those harmed by the scheme • A decision will need to be taken regarding what aspects the label includes (e.g. manufacture, transport, use).
Government procurement policies	• Budget constraints put a practical upper limit on how far governments are willing to bind themselves to climate-friendly purchases • Requires availability of climate-specific information, which is unavailable or difficult to obtain for many products
International trade in greenhouse-gas credits via Kyoto's Flexible Mechanisms	• Key challenges remain related to cost effectiveness, additionality of emissions reduction and effect on EU-based emissions reductions.

4.4 Assessment of the interactions of Kyoto's flexible mechanisms

4.4.1 Kyoto Protocol

In order to achieve the overall emission reductions required by the 1997 Kyoto Protocol, each Annex I country has been assigned a set amount of allowable emissions for the period from 2008 to 2012. In addition to encouraging parties to develop domestic policies to substantially reduce emissions of six greenhouse gases, the Kyoto Protocol has also established three ‘flexibility mechanisms’ that allow acquisition and trading of emission credits in order to provide low cost and diverse options for meeting the reduction goals.

The flexible mechanisms of the Kyoto Protocol have created a new international market in greenhouse gases that has resulted in over € 5.4 billion in emissions credits trading hands in 2006 (Capoor; Ambrosi, 2007, p. 3). The mechanisms have allowed reductions to be made at lower cost with the most efficient firms (and countries) gaining from their ability to sell their greenhouse gas credits on the international market.

As shown in Table 17 below, the three flexibility mechanisms are International Emissions Trading (IET), Joint Implementation (JI), and Clean Development Mechanism (CDM). The IET mechanism allows trade of AAUs between two Annex I countries. Both the JI and CDM are project-based mechanisms that generate emission credits based on the GHG reductions resulting from the project. The JI projects are located in Annex I countries (primarily those countries with economies in transition), while the CDM promotes projects in developing countries that lack Kyoto targets.

Table 17. Kyoto Protocol Flexibility Mechanisms

Flexible Mechanism	**Description**
International Emissions Trading (IET)	IET allows trade of Assigned Amount Units (AAU) between two Annex I countries.
Joint Implementation (JI)	JI projects are emission-reduction projects in Annex I countries, especially Russia, the Ukraine, Central and Eastern Europe. Resulting ERU credits are viable in 2008 (in both EU ETS and Kyoto) from projects beginning in 2000 or later. Public sector buyers dominate the market. Russia and the Ukraine host a majority of JI projects (UNEP Risoe Center, 2007).
Clean Development Mechanism (CDM)	CDM projects are emission-reduction projects in non-Annex I countries with a focus on sustainable development. Resulting CER credits are divided between the host country and private investing firm. Resulting CER credits are viable in the EU ETS beginning in 2005 (and in Kyoto beginning in 2008) from projects beginning in 2000 or later. Private investment buyers dominate the market. In 2006, 61% of the CDM market was in China (Capoor; Ambrosi, 2007, p. 4) .

4.4.2 European Union Emissions Trading System (EU ETS)

As the cornerstone of the EU’s emission reduction strategy, the European Union Emissions Trading System (EU ETS) cap and trade instrument was launched ahead of the first commitment period of the Kyoto Protocol in January 2005. The first ETS trading period is from 2005 to 2007. The second phase coincides with the first phase of Kyoto, from 2008 to 2012, and 5-year trading periods beginning in 2013 will follow thereafter.

Currently, the EU ETS dominates the global carbon market. Between January and September 2006, the ETS held the vast majority in volume at 74 percent and in value at 87 percent. Despite a sharp drop in the market after the 2005 emissions were released in May

2006, the volume of carbon traded on the ETS market nearly doubled from 324 million tonnes of CO_2 equivalent (tCO_2e) in 2005 to 764 tCO_2e by the end of September 2006 (Capoor; Ambrosi, 2006, p. 1).

The EU ETS includes more than 12,000 energy-intensive industrial sources across Europe that generate approximately 46% of the EU's emissions (equivalent to 2 billion tonnes of annual CO_2 emissions) (Bernheim, 2007). These industrial sources cover the iron and steel processing and production, pulp and paper, minerals, and energy production sectors. Unlike the flexibility mechanisms of the Kyoto Protocol that cover all six greenhouse gases (GHGs), the EU ETS only covers CO_2.

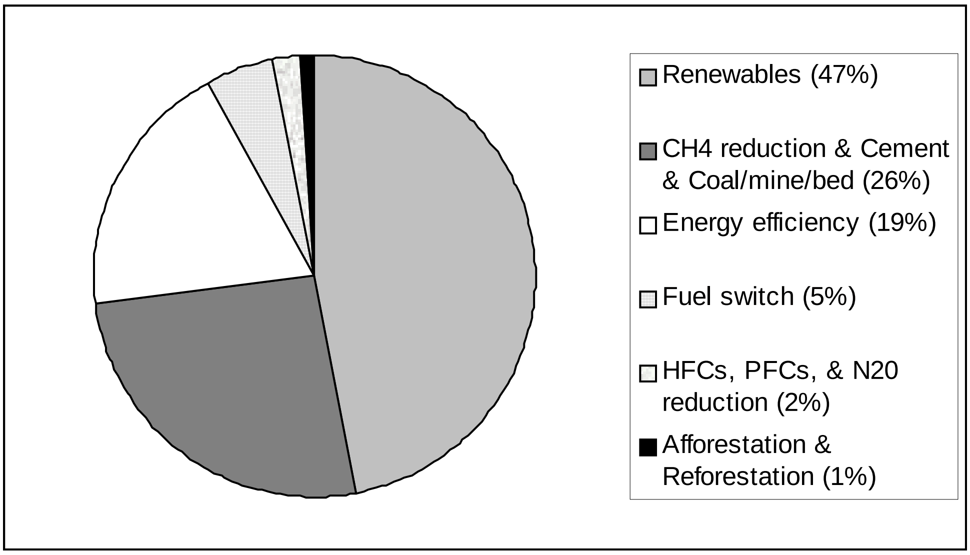
The EU ETS significantly reduces compliance costs for Member States. The Commission estimates that without the ETS costs to achieve Kyoto emission reduction targets could reach €6.8 billion annually. However, through the ETS, reduction targets can be achieved at an annual cost of €2.9 to €3.7 billion, which is less than 0.1 % of GDP in the EU (MEMO/06/452, 2006, p. 7).

4.4.3 Joint Implementation (JI)

Joint Implementation (JI) includes emission-reduction projects located in Annex I countries (i.e. primarily those with 'economies in transition'). Emission reduction units (ERU) generated from these projects are equivalent to one AAU or one tonne of CO_2. Resulting ERU credits from projects as far back as 2000 will be counted beginning in 2008.

As of May 2007, 162 JI projects are confirmed. As shown in Figure 10 below, 47 percent of projects to date have focused primarily on renewable energy and 26 percent of projects have focused on methane (CH4) reduction. Renewable energy projects are dominated by hydro and wind, with 27 percent hydro-based projects and 24 percent wind-based projects (UNEP Risoe Center, 2007).

Figure 10. Number of JI projects according to project type



Source: Adapted from UNEP Risoe Center (UNEP Risoe Center, 2007).

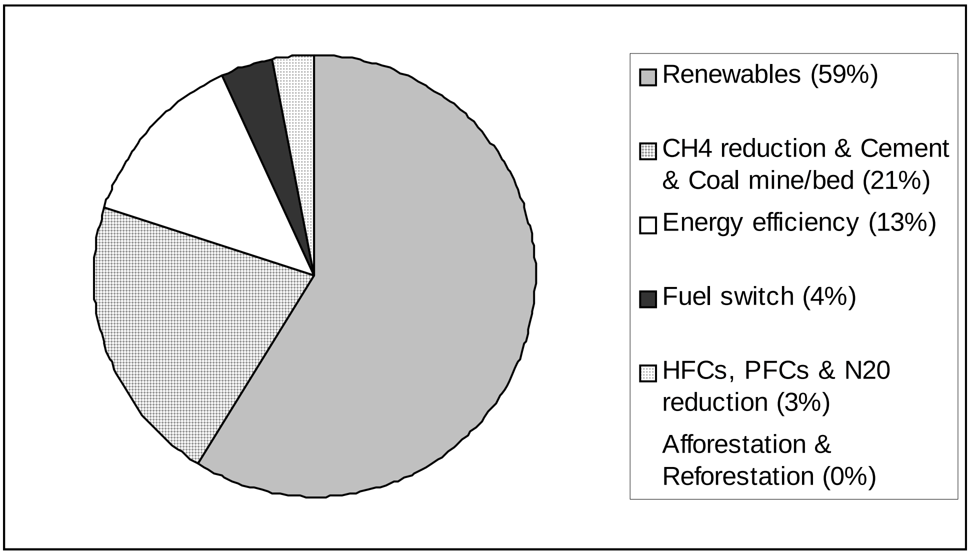
JI projects represented approximately five percent (by volume) of project-based transactions as of September 2006, while CDM projects represented more than 91 percent (Capoor; Ambrosi, 2006, p. 1). This difference is attributed to both a less established and lengthy review process for JI projects and increased demand for CDM projects through the EU ETS, which have been tradable since 2005.

4.4.4 Clean Development Mechanism (CDM)

Clean Development Mechanism (CDM) projects are located in developing countries that do not have Kyoto targets. Certified Emission Reduction units (CER) generated from these projects are equivalent to one AAU or one tonne of CO_2. Resulting CER credits from projects from 2000 have been counted in ETS since 2005.

As of 2006, there are 365 confirmed CDM projects and 750 projects are under development (UNDP, 2006, p. 11). As shown in Figure 11 below, CDM projects are primarily focused on renewable energy (biomass energy and hydro), with methane reduction as the next highest project type category. However, 53 percent of the CERs that have been issued have been for HFC-related projects.

Figure 11. Number of CDM projects according to project type.



Source: Adapted from UNEP Risoe Center (UNEP Risoe Center, 2007).

The UNDP states that 1 billion CERs could be generated by the end of 2012, which would cover 15 to 25 percent of the total market for emission units under the Kyoto Protocol (UNDP, 2006, p. 12). While amounts vary, costs to reduce greenhouse gases can be as low as USD 0.50 (i.e. 50 cents) per tonne in developing countries. This is far lower than the cost in OECD countries, which can be as high as USD 100 if compliance is through domestic actions. Industries can trade resulting credits at significantly higher values of USD 5–9 per metric tonne of CO_2 equivalent (Cosbey, 2005).

It is important to note that CDM projects are not evenly distributed geographically. Approximately 96% of the projects are located in Asia and Latin America, while a very small proportion of projects are in Africa and the Middle East. China, India, Brazil, South Korea and Mexico dominate CERs with volume and revenue flows expected at approximately 82 percent of the market through 2012 (UNDP, 2006, p. 12).

4.4.5 Linking Directive

The Linking Directive was adopted in 2004 by the European Commission in order to allow Member States to use credits in the EU ETS from both JI and CDM projects to offset carbon emissions in their home country.

The Directive itself does not set CER and ERU credit limits, rather each Member State through the Commission-approved National Allocation Plan (NAP) sets its own limits. If more

CDM or JI projects are conducted in a trading period than allowable, the Linking Directive allows companies to save them for the next ETS trading period, although currently there are no NAPs that allow for banking credits.

Despite the risks involved, the Linking Directive has significantly increased demand for project-based emission reduction projects by providing a viable market. However, the ETS could potentially boost the supply side of the ETS market, putting downward pressure on permit prices. This is especially true for CDM projects, which have generated tradable credits since 2005. However, projects have started to slow down because there is uncertainty beyond 2012 as to whether CERs and ERUs will have value (Capoor; Ambrosi, 2006, p. 1).

Table 18. Linkages among Kyoto's Flexible Mechanisms

Linkage	Description
EU ETS – JI Projects	The Linking Directive has not created additional incentive for JI projects beyond the Kyoto Protocol because credits are not eligible until 2008, however, demand for ERU credits will affect the size of the JI market in the future. Through September 2006, JI projects are valued at USD 93.9 million at a volume of 11.9 million tonnes CO_2 (Capoor; Ambrosi, 2006, p. 1). The potential addition of aviation and surface transport could add increased demand for ERU credits.
EU ETS – CDM Projects	The Linking Directive and has created an incentive for CDM projects because credits have been eligible since 2005. Through 2006, CDM projects are valued at USD 2.3 billion at a volume of 214.3 million tonnes CO_2 (Capoor; Ambrosi, 2006, p. 1). While this is only a fraction of the market, success of CDM projects is closely aligned with demand from Member States, especially beyond 2012. The potential addition of aviation and surface transport could add increased demand for CER credits.

4.4.6 Key Successes

The key successes of linking the EU ETS with the Kyoto Protocol's JI and CDM mechanisms are that by linking credits from all three, the carbon market has become more liquid through increased options for greenhouse gas reductions. The JI and CDM emission-reduction projects have the potential to be a 'win-win' for both the host country that is benefiting from cleaner technology and the Member State that is reducing the same amount of CO_2 equivalent for a fraction of the cost. The hope is that by linking these different mechanisms and providing a wider range of options for reducing emissions, the carbon market will become more efficient in distributing resources and allowing cleaner technologies to thrive.

The CDM mechanism has matured beyond the JI mechanism because CER credits resulting from CDM projects have been transferable to the EU ETS since 2005. Unlike the JI process, the CDM process is well established and has succeeded in attracting buyers and sellers in projects in developing countries. Host countries, especially China and India, were initially concerned that they would not benefit from the process, but now play a major role in the market. China recently announced that it will set up a fund with loans from the World Bank and Europe to support CDM projects. Developed countries are also eager to see success in the market. In February 2007, the European Commission approved Germany's request to increase its limit on CER/ERU credits from 12 to 20 percent.

4.4.7 Key Challenges

There are multiple challenges to implementing the Linking Directive due to project approval timing, market risk, additionality, economic efficiency, credibility, and effectiveness. In addition, it is difficult to ensure that projects actually promote sustainable development so that they benefit both the host country and the environment in the long term. There is also a continued need to be vigilant about the Member State's caps on CER/ERU credits so that European companies implement a significant portion of their emission reductions at home, despite the higher costs.

- **Project Approval.** The project approval process for both JI and CDM is very slow. Projects can take years to be approved. Such long approval timelines complicate planning and decision-making in the private sector and therefore present challenges to linking project-based mechanisms with the ETS.

- **Market Risk.** CERs and ERUs are often purchased at a fixed price ahead of completion of a project, which may be different than the market price at the time of delivery (World Bank, 2005, p. 3). Also, there is no agreement on the price of carbon beyond 2012, so it is difficult for private investors to justify funding projects.

- **Economic efficiency.** There are considerable challenges associated with creating an economically efficient market. One example of a failure in the market is with HFC-23 reduction projects. In a February 2007 assessment of the CDM mechanism in *Nature*, the author found that it would cost less than €100 million to capture and destroy HFC-23 in developing countries, while the associated credits are valued at €4.6 billion. The UNFCCC is working to close loopholes to ensure that companies do not have the opportunity to make windfall profits.

- **Additionality.** Additionality represents the need to show that a project is reducing emissions beyond what would have occurred in a 'business as usual' (BAU) or baseline scenario. The complexity inherent in proving that a project is bringing additional benefit presents a key challenge to JI and CDM projects, thereby presenting additional risk in undertaking an emission-reduction project for a European company.

  - **Credibility.** Double counting credits is a key concern in CDM and JI projects. For example, double counting can result from more than one entity counting credits for the effects of a project or from the counting the emission reductions in an intermediate and final product. The European Commission has addressed double counting in its decision 13 November 2006 (2006/780/EC) that establishes Commission oversight in the 2008 to 2012 trading period to ensure sound accounting procedures for CER/ERU credits.

- **Effectiveness.** A key challenge for Member States is to achieve the goals outline in their individual NAPs within the trading period. The ETS and Linking Directive are still relatively new, and trading has not even begun for JI projects. Thus, it is difficult to measure the effectiveness of linking these mechanisms, however there are concerns that projects may be approved that do not meet both the goals of sustainable development and emission reductions. The 'Gold Standard' was created by environmental NGOs to provide an independent review of CDM and JI projects to ensure high quality projects that meet both goals simultaneously.

4.4.8 Proposed Policy Changes

Proposed policy changes to the EU ETS has implication for the JI and CDM project markets. The EU ETS currently focuses on CO_2 emissions from energy-intensive installations in iron and steel processing and production, pulp and paper, minerals, and energy production. There is a proposal for legislation to add the aviation industry to the ETS, which has broad implications for the transportation sector. In the proposal, there is a provision for aircraft operators to use JI and CDM project credits to offset their emissions, which would increase the demand for CER and ERU credits (CEC, 2006, p. 6).

In November 2006, the European Commission launched a review of the EU ETS, with a final report expected in the fall of 2007. Environmental NGOs are promoting the 'Gold Standard' to ensure that JI and CDM projects achieve the goals of sustainability and emission reductions in host countries. The overall criticism resulting from the first trading period between 2005 and 2007 (ahead of the Kyoto Protocol) was that emission caps were set too high, and in some cases an artificial market allowed companies to generate windfall profits, especially from CDM projects related to HFC reductions in developing countries.

National Allocation Plans (NAP) that set individual caps for Member States are currently being submitted for the 2008 to 2012 trading period as part of the EU ETS. The Commission has thus far held its commitment to lowering caps and of the first ten plans decided on by the Commission, all except the UK were not approved as proposed, rather the allowed caps were all significantly lowered. The future of CDM and JI projects depends largely on the demand for CER and ERU credits, but there is a delicate balance between boosting the market for low-cost projects in developing countries and actually investing in emission reductions in Europe.

5 Trade policy assessments

This section explains various strategies within trade policy that can be incorporated to curb CO_2 emissions and discusses the legal framework that enables and constrains use of these options. The section describes the potential for introducing special rules in the WTO, how trade policy could respond to competition distortions due to the Kyoto Protocol, and also examines how the WTO Committee on Trade and the Environment could contributes to combating climate change.

5.1 Potential for introducing special rules in the WTO

This section examines the potential for introducing special rules into the WTO to address climate change. None of the WTO agreements currently make direct reference to climate change, although many of their provisions have implications for climate change policy.[5] The section therefore examines how current WTO rules impact climate change policy in order to determine which WTO rules might need to be changed. Lastly, the section considers possible means for making such changes or introducing new rules into the WTO.

5.1.1 Trade-related measures to combat climate change

There are several trade-related measures to combat climate change that could be developed. The main purpose of these measures is to shape the international market to

[5] It is possible to infer the impact of WTO provisions on climate change through the normal rules for treaty interpretation and previous WTO rulings on those provisions. It must be emphasised that only WTO dispute settlement panels and the Appellate Body can make definitive interpretations of WTO rules.

create incentives for trade that is beneficial to the climate, as well as disincentives for trade that is harmful.

Table 19 lists the key trade-related measures that could be used to combat climate change and summarises some of the key issues explored in this section.

Table 19. Trade-related measures to combat climate change

Trade-related measures	Key Issues
Conditioning market access for goods and services upon exporters accepting international standards on climate change	• Non-discrimination among WTO Members is current rule • Potential application of GATT General Exceptions concerning the environment – evolving jurisprudence
Limiting market access on goods that are not compatible with climate change policy objectives	• Non-discrimination as between "like products" is current rule • Trade distinctions between products on basis of how produced is very controversial
Facilitating market access for goods that are compatible with climate policy objectives	• Difficulty finding multilateral agreement on this • Generalised system of tariff preferences is possible for developing countries
Product standards and labelling	• Application of the TBT Agreement to PPMs based standards is unclear • Preference for international standards, although national standards may be permitted
Subsidies for production of climate-friendly goods and services	• Permissible so long as no export subsidies or does not cause injury • Subsidies for adaptation for new environmental requirements no longer permitted
Incentives to encourage foreign investment in climate friendly projects	• Permissible so long as any distinctions relate only to a project's status (e.g. under Kyoto Protocol) and not as a barrier to entry
Climate friendly public procurement programmes	• Built in flexibility is considerable • General exceptions concerning the environment

Conditioning market access for goods and services upon exporters accepting international standards on climate change

In recent years, increasing attention has been given to the idea of placing limits on the goods from countries that have not accepted international standards on climate change. There are two primary means for imposing such limits: import bans and increased tariffs.

WTO rules on tariffs are very clear and are found in the GATT 1947. The "most favoured nation" rule in GATT Article I prohibits discriminating among countries in respect of tariffs and other trade-related policies. GATT Article XI prohibits the imposition of quantitative restrictions on imports or exports. Therefore, any special import bans or tariffs that are based on whether a country has signed up to international climate change standards would be in violation of those provisions.

However, if a violation of any GATT provision is found, it is still possible for a WTO Member to justify its violation through the General Exceptions provisions in GATT Article XX. Article XX(b) allows for exceptions necessary to protect animal, plant or human life or health and Article XX(g) allows for exceptions related to the conservation of natural resources. Both exceptions could apply to climate change policy.

There is some WTO jurisprudence on Article XX. A number of tests and indicators have been developed to ensure that the trade restrictions are bona fide, and not for abusive economic protectionism. For example, an important factor taken into consideration is whether the country concerned has consulted with its trading partners before implementing a trade measure.[6] One way to help ensure that such measures would be seen as bona fide would be whether an internationally agreed statement existed. For example, were the successor to the current version of the Kyoto Protocol to call for such a trade restriction, then this could be considered in establishing whether climate-based trade restrictions were bona fide.

That said, the WTO jurisprudence has frowned on explicit efforts to influence the environmental policies of other countries. For example, in the first two environment related trade disputes in the WTO, the Venezuela Gasoline case[7] and US-Shrimp I case,[8] the Appellate Body ruled that Article XX cannot be used to allow trade restrictions, if their purpose is to coerce other WTO Members.

A possible change in the WTO rules might be an explicit exception that would allow for limiting market access from countries that do not accept international climate change standards. Such an amendment would be unprecedented.

Limiting market access on goods that are not compatible with climate change policy objectives

Rather than limiting market access of certain countries, it may be possible to limit market access to goods and services not compatible with climate change policy objectives. As above, this could involve import bans or special tariffs. However, there is a major WTO challenge in product-based restrictions, namely, the fundamental difficulty in distinguishing between two physically and functionally "like" products that differ in the way they are produced.

Many goods have an impact on the climate on the basis of how they are produced, especially regarding how much and what type of energy is used in their production. Placing trade restrictions on the basis of the energy consumption raises a problem not completely resolved in the WTO. According to GATT Article III, trade discrimination between "like products" is prohibited. There has been long-standing uncertainty as to whether two products that have the same end use, but involve different modes of production with different impacts on the climate, are "like products".

There has been some case law on this, which indicates that factors such as the risks associated with physical characteristics and consumer preferences should be taken into

[6] See United States—Import Prohibition of Certain Shrimp and Shrimp Products, 12 October 1998, Report of the Appellate Body WT/DS58/AB/R ('US-Shrimp I').
[7] United States – Standards for Reformulated and Conventional Gasoline, Report of the Appellate Body adopted 20 May 1996, WT/DS2/AB/R 1996
[8] Supra 6.

account.[9] Such criteria could help to support a case for making distinctions on the basis of how climate-friendly a good is. However, the criteria created by case-law have not been endorsed in any WTO political process, and since there is no rule of precedent in the WTO dispute settlement process, they cannot be considered permanent. It should also be noted that even if GATT Article III is found to be violated, it may be possible for the trade restriction to be saved by Article XX, as described above.

A possible change in WTO rules would clearly stipulate that the two products are not alike if the processing and production methods differ in specified ways.

Facilitating market access for goods that are compatible with climate policy objectives

Another trade-related approach to combating climate change is to facilitate market access for goods that are compatible with climate policy objectives. The instrument for doing so is to have lower tariffs for such goods. Here, the WTO rules do not present any obstacles. It is certainly possible for WTO Members to negotiate lower tariffs on such goods, or to apply lower amounts than what they have "bound", so long as no country is discriminated against in the process. There are, perhaps, difficulties in their application. For example, the WTO negotiations on facilitating market access for "environmental goods and services" have not succeeded in reaching agreement on how to define "environmental goods and services". This is partly for political reasons and partly because it can be very challenging from a technical perspective.

In addition, it is also possible for developed countries to apply lower tariffs to developing countries. Lower tariffs for developing countries for products deemed to be compatible with climate policy objectives can fall under the Generalised System of Tariff Preferences (GSP) that are in Part IV of the GATT 1947. Although this has been the subject of WTO litigation,[10] it appears to be possible for GSPs to be applied on the basis of whether a developing country subscribes to specified international norms, e.g. standards relating to climate change.

Product standards and labelling

Governments may seek to endorse product standards or labelling procedures for products that have an impact on the climate, e.g. for energy efficiency. Regardless of whether these standards and procedures are mandatory or voluntary, the WTO Agreement on Technical Barriers to Trade (TBT) contains relevant rules.

The TBT Agreement allows countries to have mandatory or voluntary standards for environmental purposes, unless they create an "unnecessary obstacle to international trade". The TBT Agreement favours those that are based on international standards. WTO Members must use international standards as a basis for their national ones, unless the international standards are 'ineffective or inappropriate". A national standard based on an international standards is presumed not to create an unnecessary obstacle to international trade. Members choosing not to follow international standards may have a more difficult time defending themselves against WTO challenge. Therefore, so long as climate-change standards are set internationally, the WTO rules should not be an obstacle.

There is some controversy about whether the TBT Agreements permits standards and labels based on production and processing methods (PPMs) that do not affect the physical

[9] European Communities – Measures Affecting Asbestos and Asbestos-Containing Products, Report of the Appellate Body adopted 5 April 2001, WT/DS135/AB/R ('EC-Asbestos').
[10] EC – Tariff Preferences, WT/DS246/AB/R, Appellate Body report of 7 April 2004.

characteristics of the end-product. (Appleton, 1999; Abdel, 1999). However, there has not been a WTO case on this issue.

Possible changes to the WTO could clarify whether standards and labels based on unincorporated PPMs are permissible. They could also set clearer guidance for those countries seeking to unilaterally establish standards and labels.

Subsidies for the production of climate-friendly goods and services

Countries may seek to provide subsidies for the production of climate-friendly goods and services. Such subsidies might run afoul of the WTO Agreement on Subsidies in only a few instances. One is where the subsidy is contingent on export performance. Another is where the subsidy requires the use of domestic goods over foreign ones. A further instance is where a subsidy has the effect of being available only to certain enterprises and causing injury to a domestic industry of another Member or prejudging the interests of another Member. The determination of both the specificity of the subsidy and the injury caused by it is complex and done through a case-by-case analysis – although some guidance and presumptions are provided in the Agreement.

At one time, the Subsidies Agreement provided that assistance to existing facilities to promote adaptation to new environmental requirements may be non-actionable, provided that it:
• is a one-time non-recurring measure;
• is limited to 20% of the cost of adaptation;
• does not cover the cost of replacing and operating the assisted investment;
• is directly linked to and proportionate to a firm's planned reduction of nuisance and pollution, and does not cover any manufacturing cost savings that may be achieved; and
• is available to all firms, which can adopt the new equipment and/or production processes.

However, this provision was time-bound, and is no longer operational, as a consensus did not emerge among WTO Members to renew it. It has been asserted that were this provision to be reinstated, it might be useful to promote renewable energy, which often requires high levels of up-front investment (Sell et al., 2005).

Therefore, a possible rule change would explicitly allow subsidies for climate change policy purposes.

It should be noted that subsidies for agricultural products, including biofuels, are covered by the Agreement on Agriculture. Possible revisions of the Green Box might protect subsidies for biofuel crops, although it may also be appropriate to specify conditions for ensuring that these subsidies are for sustainably grown crops.

Incentives to encourage foreign investment in projects that achieve climate policy objectives

Investment in projects that achieve climate policy objectives is sorely needed if changes in infrastructure and production processes are to take place at the desired scale. There are several WTO rules that place conditions on foreign investment, including in the Agreement on Trade-Related Investment Measures and the General Agreement on Trade in Services. However, so long as the investment incentives do not explicitly exclude investors on the basis of whether they are party to an international agreement or attach certain prohibited conditions (e.g. local content rules), then these WTO rules do not prevent schemes like the Clean Development Mechanism.

Public procurement programmes to achieve climate policy objectives

Governments may seek to achieve climate policy objectives through their public procurement policies. For example, they may want to develop programmes whereby they only purchase products that are made using a specific type or amount of energy. The WTO Agreement on Public Procurement (AGP) contains a set of complex disciplines on the standards that can be used for conditions and technical specifications in procurement contracts. Although there is no case law yet on the AGP, the language of the text suggests that governments could gear their procurement policies towards climate policy objectives. Firstly, it appears that non-economic factors are not prohibited from being included as conditions in the technical specifications. Secondly, references to standards are permitted (there is a preference for international standards, but national ones can also be used). Thirdly, performance-based specifications can be used, e.g. vehicles with low emissions.

One of the areas of uncertainty, however, is the extent to which governments can prefer products that have been certified as sustainable, such as biofuels, in their procurement programmes. The language of the treaty is not completely clear, although it is likely that if governments wish to specify that certified products meet the technical specifications, they must also allow for equivalent products that meet those standards, but are not specifically certified. It is also worth noting that in December 2006, WTO Members agreed a provisional revision of the AGP which explicitly allows tender specifications for the purposes of environmental protection.

Possible rule changes to the AGP might clarify whether tenders can specify products that have been specifically certified as sustainable.

5.1.2 Possible ways to incorporate new rules into the WTO

Should governments conclude that current WTO rules are insufficiently flexible to accommodate effective climate policy, there are several ways in which changes to WTO rules can be made. These are:

- Amend the WTO agreements
- Adopt an interpretative understanding
- Adopt a waiver
- Negotiate a new agreement, which would be part of the WTO set of agreements

Table 20 lists the possibilities for incorporating changes to WTO rules and summarises some of the key issues explored in this section.

Table 20. Possibilities for incorporating changes to WTO rules

Possible changes to WTO rules	Key Issues
Amendment	• Need at least two thirds members to accept • Most amendments only binding on those that accept them
Interpretative understanding	• Requires at least a three-quarter majority • Cannot involve a fundamental change to the WTO
Waiver	• Time limited • Disputes can still arise
Adoption of a new WTO Agreement	• Very long and complex process

Amendment the WTO agreements

The Agreement on the Establish the WTO sets out the procedures for amending any of the WTO Agreements. Amendments for specified provisions (e.g. Articles I and II of the GATT 1994) must be accepted by all WTO Members. Other amendments that alter the balance of rights and responsibilities in the WTO will enter into force for those members accepting the amendment, which cannot be less than two-thirds of the membership. All other amendments can be accepted by a two-thirds majority and will apply to the entire membership.

Achieving the necessary support for amending the WTO agreements will likely be very difficult indeed, especially of those provisions requiring unanimity. It may be possible to meet the two-thirds threshold, but that too is difficult and will still leave one third of the Membership that will not need to comply. There has been some experience with trying to amend the WTO. In 2005, the WTO General Council approved a protocol to amend the Agreement on Trade Related Aspects of Intellectual Property Rights to make it easier for developing countries to obtain generic versions of prescription medicines.[11] This amendment will enter into force upon acceptance by two-thirds of the WTO membership. At present, only 7 of the 150 Members have accepted the amendment – although Members originally gave themselves a deadline of December 2007 to do so.

Adopt an interpretative understanding

In cases where the WTO measure would be adequate, so long as it was interpreted in a specific manner, it would be possible for WTO members to adopt an interpretative understanding as guidance. Such an understanding would be authoritative and would likely be considered by adjudicative bodies that were interpreting those WTO provisions. Such an understanding would need to be adopted by the WTO General Council or the Ministerial Conference, which requires at least a three-quarter majority of members. Under the terms of Article IX of the Agreement Establishing the WTO, such an understanding is expressly not an amendment, and therefore cannot be used to create fundamental changes to WTO provisions, for example substantive changes to the rules on discrimination or subsidies.

Agreeing a waiver

In cases where WTO members want to allow a specific climate policy instrument that is in contravention of WTO rules, they may seek to adopt a waiver. A waiver can be granted for a

[11] WT/L/641, 8 December 2005.

two-year period, which is renewable, and has been used to allow deviations from the TRIPS Agreement for essential medicines and the Kimberley Process for conflict diamonds.

In addition to a waiver being time limited, a further deficiency is that Members can still access the dispute settlement body if they determine that a WTO benefit has been nullified or impaired. Both of these factors will work against the long-term policy certainty so necessary for climate change. On the other hand, a waiver only requires a two-thirds majority to be adopted.

Adoption of a new Agreement

Should WTO members come to the conclusion that a new WTO Agreement is needed to properly incorporate climate policy objectives, such an instrument could, in principle, be negotiated. However, it should be expected that such a project would be very complex indeed and would require the deployment of considerable human resources over a long period of time. Experience under the current Doha Development Agenda, where negotiations are currently suspended after many deadlines have passed is not encouraging.

5.2 Responding to competition distortions due to the Kyoto Protocol

The Kyoto Protocol contains provisions whose full application could distort competition, especially vis-à-vis non-parties. This section will discuss two possible trade measures to offset competitive losses:

- Application of countervailing duties against imports from non-parties
- Application of a border tax adjustment for carbon taxes vis-à-vis imports from non-parties

An additional measure might be an import ban discussed above in section 5.1. Table 21 summarises the possible responses to competitive distortions and lists some of the key issues involved.

Table 21. Possible responses to competitive distortions stemming from the Kyoto Protocol

Possible responses	**Key Issues**
Countervailing duties	• WTO definition of subsidy does not apply to implicit subsidies • Causation (injury and compensation) is difficult to prove
Border tax adjustment (BTA)	• Contested interpretation of GATT Article III vis-à-vis process based taxes • Applicability of GATT General Exceptions concerning the environment is unclear • Limited flexibility under GATS for BTAs in relation to cross-border services

Countervailing duties

Countries not applying the Kyoto Protocol are implicitly subsidising their exporters by not imposing the rules entailing economic costs that Kyoto parties are imposing. In other words, non-party producers do not pay the full costs of production that parties do.

The WTO Agreement on Subsidies and Countervailing Measures allows for the imposition of countervailing duties, which are the responses to certain kinds of subsidies that cause domestic injury in the importing country. But that Agreement envisages a different kind of subsidy than the implicit subsidisation of not joining the Kyoto Protocol (Pauwelyn, 2007). According to Article I, a subsidy is a direct financial contribution from the government or some other income or price support to a specific industry. This definition would preclude the scenario described above, which involves a government refusing to act, rather than providing direct support. The only case where the Subsidies Agreement would allow a countervailing duty arising out of a government refraining from acting is when a government refuses to collect what is due to it. The reference for that determination is the exporting country; therefore if a country does not have, for example, a carbon tax to begin with, it cannot be said to be subsidising its industry by not collecting such a tax.

Finally, even if a subsidy was found to exist, under the terms of the Subsidy Agreement, in order to be able to impose a countervailing duty, an importing country must be able to demonstrate causation (i.e. that the subsidy caused domestic injury and that the countervailing duty is appropriate to compensate this injury). This could prove rather difficult in this context, given that the climate-change policy is so broad, its economic impacts will likely be rather diffuse and difficult to isolate.

Border tax adjustments

Some Kyoto Parties, such as Japan and Switzerland, are creating fiscal instruments – i.e. carbon taxes – as incentives to mitigate carbon emissions. Depending on the severity of the charges, countries imposing carbon taxes may wish to offset some of the international competitiveness losses through border tax adjustments (BTAs). BTAs are taxes imposed on imports or tax-relief granted to exports, used to level the playing field between taxed domestic industries and untaxed foreign competitors. They are commonly used for goods that are subject to indirect taxes such as sales taxes, value added taxes, and so on.

BTAs for these sorts of taxes are permitted under the GATT, but the extent to which they can apply to energy inputs is unclear. This raises the issues referred to in section 5.1, as to whether the WTO permits distinctions based on the method by which a good is produced, and not just based on attributes of the final product (Chaytor and Cameron, 1995).

There is some WTO jurisprudence to consider, although none of it is conclusive. In the Superfund case of 1987,[12] the panel stated that the United States could legally tax imported goods based on chemicals used during production (i.e. that a process-based BTA was legal, as long as it was non-discriminatory). But the panel did not determine whether countries could tax imports based on inputs unincorporated into the final product, leaving the implications for carbon taxes unclear (Biermann and Brohm, 2003). More recent cases under the GATT/WTO suggest that there is some flexibility in the international trade rules to allow such adjustments in this context. For example, in United States – Taxes on Automobiles,[13] the GATT Panel found that tax differentiation on the basis of gasoline consumption, as well as differences in application of a luxury tax, were not inconsistent with GATT Article III, even

[12] L/6175 - 34S/136, 17 June 1987.
[13] United States – Taxes on Automobiles, Report of the Panel, 29 September 1994 (not adopted) DS31/R

though they applied differently to cars that were otherwise similar. Although that case is not a direct parallel to a BTA for a tax on process, since it involved physically discernible difference in the final product characteristics, it is nonetheless instructive that the Panel considered the environmental purposes of the tax as relevant.

In the end, while the GATT allows BTAs to adjust for direct taxes in the case of both imports and exports, it is unclear and has never been tested whether such adjustment is permissible for indirect taxes ('taxes occultes') on an input that is fully consumed during production. A carbon tax, based on the energy consumed in the production of a product, falls squarely into the latter category. However, even if the BTA failed on the text of Article III, Article XX might still save the measure, although this is contentious (Charnovitz, 2003).

It may be more difficult to adopt a BTA for services, such as air travel. In this instance the General Agreement on Trade in Services (GATS) applies. Difficulties may arise in cases where domestic service providers are treated differently for tax purposes than foreign providers – which may happen in the case of cross-border services. The General Exceptions provision of the GATS is narrower than in the GATT and, in any event, may not cover the object of compensating for loss of competitive advantage.

5.3 CTE Contributions to combating climate change

The WTO Committee on Trade and Environment was created by a decision of the 1993 Marrakech Conference that adopted the WTO. The mandate of that committee listed a number of issues that have an impact on climate change policy. The overall objective of the Committee was to identify the relationship between trade measures and the environment, and to make recommendations on modifying the multilateral trading system as required to promote sustainable development.

During the first several years of the CTE, much of its energies were spent in quasi-negotiations. The 1996 Report of the CTE to the General Council contains several conclusions that were the result of negotiations, although none of them expressly called for modifications to the WTO.[14] Since 1998, the bulk of the CTE's meetings have involved exchanges of information and sharing of national experiences.

The areas of discussion that have been of most relevance to climate change policy include:

- Relationship between WTO and multilateral environmental agreements (MEAs)
- Relationship between the dispute settlement mechanisms in the WTO and MEAs
- The relationship between WTO rules and environmental taxes, standards and labelling.

There have been some other discussions that have also been interesting, such as on environmental reviews of trade-related policies, although this was not specifically part of the original mandate.

The most substantive discussions have been held on the first two points, noted above. The 1996 CTE report stated that MEAs were necessary and useful instruments for meeting global environmental challenges and that they could include trade measures. The CTE also encourages WTO members to first try to settle their disputes in MEAs prior to bringing them to the WTO. The relationship between WTO rules and environmental taxes, standards and labelling has been discussed in the CTE, but no conclusions were drawn. Some of the discussion has touched on climate change based taxation.

[14] WT/CTE/1, 12.11.1996.

The 2001 Doha Ministerial Declaration included a specific negotiating mandate on two issues of relevance: the relationship between WTO and MEAs and liberalisation of trade in environmental goods and services. At present, none of those negotiating tracks are even close to conclusion.

It should be noted that the negotiations on the relationship between WTO and MEAs would not resolve all the possible trade issues arising out of the Kyoto Protocol because the mandate under Doha is limited to "specific" trade measures and to issues between parties to the MEAs concerned. The trade issues mentioned in Section 3.2 would still be outstanding because Kyoto does not expressly contain trade measures (i.e. may not be "specific") and the main trade issues would likely arise between parties and non-parties to the Protocol. In any event, the Members have not yet agreed all the definitional controversies in the mandate, such as what constitutes a "specific trade measure". There is also fundamental disagreement about whether the WTO-MEA should be clarified, and how.

Although market access for environmental goods and services would potentially be helpful for implementation of the Kyoto Protocol, these negotiations are also similarly bogged down around the issue of what constitutes an environmental good or service. The organisation of these negotiations has been split: environmental services are being discussed in the CTE Special Session, while the negotiations on environmental goods are taking place in the Negotiating Group on Non-Agricultural Market Access (NAMA). However, since the NAMA negotiations have not yet turned to the issue of environmental goods, the CTE Special Session has also held discussions on environmental goods. At present, deep divisions exist among the Members in relation to the definition of environmental goods and the approach to be taken to liberalisation.

It can be inferred from this experience that the WTO CTE may be an appropriate forum for information exchange, but it has not been proven to be useful in negotiating actual changes to the WTO system. Part of this may be due to an absence of sufficient political will. But part of it may also be down to the lack of integration within the WTO system, whereby the CTE does not address all environmental issues (e.g. labelling has been discussed in the TBT Committee) and its results are not systematically fed into other parts of the WTO. Paragraph 51 of the Doha Ministerial Declaration calls for coordination between the CTE and the Committee on Trade and Development, but so far very little interface has happened in practice.

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Annex 1. Overview of key data sources for cost-change estimations

This annex provides a description and comparison of the two main sources used for the estimation of changes in unit costs due to the European ETS.

Smale et al. (2006) analyse the effects of the EU ETS on competitiveness in the electricity, cement, newsprint, steel and aluminium sectors. Their model investigates a short-run, a medium-run, and a long-run scenario with different allowance price levels.

Another important study in CO_2 emission trading and production costs was published by Reinaud (2005), who anticipates modest competitiveness losses of European firms in comparison with the business as usual case. The study investigated two emission trading scenarios, where the allocated allowances cover different levels of the industries emission needs.

The results of the two studies are influenced by the different cost effects and allowance assumed. For this reason the estimated cost effects in the particular industrial sectors deviate.

In the following, the main differences between the research work of Reinaud (2005) and Smale et al. (2006) are explained briefly.

- The results are strongly influenced by the chosen allowance assignment mechanism - whether it is “grandfathering” or “output-based”. The simulations of Demaily et al. (2006) indicate a higher production loss and CO_2 leakage rate under grandfathering than under an output-based allowances allocation system.

  The calculations of Smale et al. (2006) refer to a scenario, where the CO_2 emission allowances are fully grandfathered. In contrast Reinaud (2005) elaborated two scenarios with different allocation scenarios, in which the industry would be allocated allowances covering 90 and 98 % of the CO_2 emission demand of the production.
- Economic theory suggests that the electricity sector will pass on additional costs to customers (Smale et al., 2006), and therefore the ETS influences the production cost of energy-intensive industries twice. The results for the ‘total price increase due to indirect effects’ (Tables 2-5) are based on the assumption, that the full opportunity costs of the CO_2 allowances of the power generation sector can be passed on to the steel industry. Consequently the cost increases vary with the level of allowance price.
- In practice, only a part of the CO_2 opportunity costs of the energy sector is passed on, which reduces the indirect effects of the emission trading system on the total unit production costs. This assumption influences the ‘marginal product cost increase’ (Tables 2-5), which is mirroring the impact of opportunity costs of carbon allowances on the marginal production costs. Those costs refer to the marginal cost increase on production, according to Smale et al. (2006), which is defined as direct CO_2 costs and the increase in the electricity price level.
- Both studies agree that the additional costs evoked by the EU ETS can be separated into direct Kyoto Protocol compliance costs and indirect costs due to increased power costs (Reinaud, 2005). But they differ in the assumptions made in connection with the direct CO_2 abatement costs.
- The direct cost in the scenarios of Reinaud (2005) consist of internal CO_2 emission abatement costs, for example investments in less carbon intensive technologies and the purchase of additional 2% or 10 % emission allowances from the market. This direct cost calculation method also includes the possibility of allowance revenue. Whereas the direct costs in the scenarios of Smale et al. (2006) simply refer to the purchasing costs of CO_2 emission allowances. The values for ‘Total cost increase 2% scenario’ and ‘Total cost increase 10% scenario’ are taken from the study by Reinaud (2005).

Annex 2. Calculation methodology

In order to calculate CO_2 emissions related to production of industrial products, CO_2 emission factors are extracted from national emission inventories, which were submitted to the IPCC under the Kyoto Protocol.

However, it is important to note that although the IPCC reporting standards are more and more applied on the international level, especially developing countries and emerging economies still have a lack of complete and solid data and reporting. Therefore, some emission factors have to be handled with care – for comparability, where available, emission factors taken from other countries' inventories are given.

It is important to state that only direct CO_2 emissions related to energy use were included in the calculations, as a full life-cycle wide CO_2 assessment of different products would be beyond the scope of this study.

In order to calculate CO_2 emissions related to transport of the respective products from overseas to Europe and within the continent, an approach was applied which multiplies the distances of transport by CO_2 emission factors for the different transport modes. Distances are extracted from various distance calculators available on-line on the internet or from freely available literature, for example „Distances between ports“ (US Government, 2001).

Different modes of transport have considerably different intensities of CO_2 emissions per tonne kilometre (tkm) of transported freight (see above). We applied the transport emission factors as illustrated in Table 1 (Section 3.4). In the case of lorry transport, the most efficient category (36 t) was applied in all cases.

In each case study we compared the CO_2 emissions of transport by considering the use of different modes of transport. In the case of the agricultural products, for international transport, the key distinction is made between air transport and maritime shipping, as it is more likely that these products are transported by plane than in the case of industrial goods. For the European production scenarios, the choice between train and lorry has been considered.

Annex 3. Detailed calculations

In this Annex we provide the detailed calculation tables underlying the figures presented in the main text.

Aluminium

CO_2 emissions [kg/t] for production of one tonne of aluminium in Australia and France, and transport to Germany:

Aluminium	AUS-Lorry	AUS-Rail	FRA-Lorry	FRA-Rail
Production	1610	1610	1540	1540
Lorry	65		67	
Rail		18		18
Ship	322	322		
Total	1997	1950	1607	1558

Cement

For the transport of cement to Hannover - from China and within Germany - we compare the following transport-mode combinations:

- CHN-Lorry: ship-lorry: Tianjin-Hamburg-Hannover
- CHN-Rail: ship-rail: Tianjin-Hamburg-Hannover
- GER-Lorry: lorry: Oberusel-Hannover
- GER-Rail: rail: Oberusel-Hannover

The CO_2 emissions [kg/t] for production and transport of one tonne of cement are the following:

Cement	CHN-Lorry	CHN-Rail	GER-Lorry	GER-Rail
Production	640	640	530	530
Lorry	13		28	
Rail		3		8
Ship	360	360		
Total	1012	1003	558	538

Steel

The following transport scenarios have been calculated for the transport of steel to Hamburg - from China and within Germany:

- CHN-Lorry: lorry-ship: Jiangyin-Shanghai-Hamburg
- CHN-Rail: rail-ship: Jiangyin -Shanghai-Hamburg
- CHN-Ship: ship-ship: Jiangyin-Shanghai-Hamburg
- GER-Lorry: lorry: Hamburg-factory–Hamburg-retailer/construction site
- GER-Rail: rail: Hamburg-factory–Hamburg-retailer/construction site

The CO_2 emissions [kg/t] for production and transport of one tonne of steel are the following:

Steel	CHN-Lorry	CHN-Rail	CHN-Ship	GER-Lorry	GER-Rail
Production	3190	3190	3190	1050	1050
Lorry	15			2	
Rail		4			0
Ship	351	351	354		
Total	3557	3546	3544	1052	1050

Fertiliser

The following transport scenarios have been calculated for the transport of fertiliser to Florence - from the USA and within Italy:

- USA-Lorry: ship-lorry: New York-Genoa-Florence
- USA-Rail: ship-rail: New York- Genoa-Florence
- ITA-Lorry: lorry: Ravenna-Florence
- ITA-Rail: rail: Ravenna-Florence

The CO_2 emissions [kg/t] for production and transport of one tonne of fertiliser are the following:

Fertiliser	USA-Lorry	USA-Rail	ITA-Lorry	ITA-Rail
Production	900	900	1150	1150
Lorry	20		16	
Rail		6		4
Ship	104	104		
Total	1024	1010	1166	1154

Lamb

The CO_2 emissions [kg/t] for production of one tonne of lamb in New Zealand and Great Britain, and transport to Strasbourg, France, are the following:

Lamb	NZ-Ship	NZ-Plane	UK-Lorry	UK-Rail
Production	498	498	2720	2720
Lorry	0		7	
Rail		0		2
Ship	291	3		
Plane		11413		
Total	788	11913	2727	2722

Apples

The following transport scenarios have been calculated for the transport of apples to Strasbourg, France - from New Zealand and Germany:

- NZ-Ship-Lorry: ship-lorry: Nelson-Rotterdam-Strasbourg
- NZ-Ship-Rail: ship-rail: Nelson-Rotterdam-Strasbourg
- NZ-Plane-Lorry: ship-plane-lorry: Nelson-Wellington-Frankfurt-Strasbourg
- NZ-Plane-Rail: ship-plane-rail: Nelson-Wellington-Frankfurt-Strasbourg
- GER-Lorry: lorry: Freiburg-Strasbourg
- GER-Rail: rail: Freiburg-Strasbourg

The CO_2 emissions [kg/t] for production and transport of one tonne of apples are the following:

Apples	**NZ Ship-Lorry**	**NZ Ship-Rail**	**NZ Plane-Lorry**	**NZ Plane-Rail**	**GER Lorry**	**GER Rail**
Production	54	54	54	54	251	251
Lorry	48		19		7	
Rail		13		5		2
Ship	292	292				
Plane			11257	11257		
Total	393	359	11330	11317	258	253