Linking CO_2 Emissions from International Shipping to the EU ETS

Vikting Lines' Cinderella, one of the cleanest ships in the Baltic Sea

Per Kågeson, PhD
Nature Associates

2 July 2007

Commissioned by the Federal Environment Agency, Germany

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16. Abstract

The objective of the report is to analyse the feasibility of a cap-and-trade system for CO_2 emissions from international shipping linked to the European Emission Trading Scheme (ETS). The idea presented in the paper is to tie the permission for a ship to call at a port of a participating country to the vessels participation in a scheme for emissions trading under a common cap. The ship would be liable for emissions from fuel bunkered during, say, six months prior to a call at a participating port. With this design, emissions from the return voyages of ships involved in intercontinental traffic would automatically be covered, and shipowners and operators would gain nothing by calling at ports just outside the European Union. The geographical scope would thus be global, albeit limited to ships that call at ports of the European Union (and other participating states).

The fuel consumption, that the surrendered CO_2 allowances would have to match, could be declared by using the existing mandatory bunker delivery notes that all ships above 400 GT need to keep according to Regulation 18 of MARPOL Annex VI. The report discusses various ways for initial allocation of allowances and concludes that the least distorting method would be to sell them on auction and recycle all or most of the revenues to the shipping sector in a way that does not interfere with the objective of the trading scheme.

In the case where Maritime Emissions Trading Scheme (METS) is initially limited to the ports of the European Union, at least 6 200 million ton less CO_2 would be emitted over the 23 years between 2012 and 2035 compared to a business-as-usual scenario. However, a great part of this would be reductions in land-based sources paid indirectly by the shipping sector.

17. Keywords

Climate change, greenhouse gases, carbon dioxide, emissions trading, European Emission Trading Scheme, ETS, international shipping, shipping emissions, market-based instruments.

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1. Background

According to different estimates international shipping in 2001 is believed to have emitted between 428 and 913 million tons of carbon dioxide (CO_2). The wide range reflects uncertainty and the use of differing calculation methods. The lower figure is based on bunker fuel sale statistics, and the higher on activity data by a bottom-up approach. However, even the results based on the latter type of approach differ substantially from each other. International shipping thus accounts for somewhere between 2 and 4 per cent of global CO_2 emissions.

Due to economic growth and the effects of globalisation the increase in shipping emissions is fast. Recent estimates, based on ship activity and installed engine power, suggest that cargo ships alone consume more than 200 million metric tons of fuel (Corbett, 2006, referring to several studies). This translates into emissions of CO_2 in excess of 600 million tons. If military vessels, fishing boats and other non-cargo ships are included, the estimated global fuel consumption is approximately 280 million tons (Eyring et al, 2005).

International trade and transportation by ship are growing faster than GDP, and over the past two decades, ships serving all routes have increasingly become faster and larger (Corbett et al, 2007). This trend is likely to continue and may even accelerate under the influence of globalisation. Current estimates suggest that fuel consumption in international shipping will double within 25 to 30 years in a business-as-usual scenario (Corbett et al, 2007, and Eyring et al, 2005).

No international or European regulation is applied to fuel consumption or carbon emissions from shipping. Neither are fuels or emissions subject to any kind of tax or other market-based instrument.

Market-based instruments are needed for providing incentives to owners and operators of ships to make better use of technologies that improve fuel efficiency, and to choose operational speeds that take CO_2 emissions into account.

The European Commission confirmed in April that it will propose adding shipping companies to the European Union Emissions Trading Scheme (ETS) rather than wait for action at international level. The spokesperson said it was too early to say how and when the industry would be introduced into the scheme and how much of the world's fleet would be covered.[1] However, on subsequent occasions Commission staff have said they are considering other options as well.

1.1 UNFCCC and the Kyoto Protocol

In an amendment to the 1997 Kyoto Protocol, the Annex 1 states were asked to work through the International Maritime Organisation, IMO, in order to coordinate efforts to reduce emissions of greenhouse gases from international shipping. These emissions are thus not part of the national inventories under the Kyoto Protocol.

[1] Reuters, 16 April 2007.

As early as 1995, the Conference of the Parties (CoP) to the United Nations Framework Convention on Climate Change (UNFCCC) asked the convention's Subsidiary Body for Scientific and Technological Advice (SBSTA) to address the issue of allocation and control of emissions from combustion of international bunker fuels. At SBSTA 4 in 1996, the secretariat presented a paper, which included eight options for allocation of shipping emissions. They were:

1. No allocation
2. Allocation of global bunker sales and associated emissions to parties in proportion to their national emissions
3. Allocation according to the country where the bunker fuel is sold
4. Allocation according to the nationality of the transporting company, or to the country were the vessel is registered, or to the country of the operator
5. Allocation according to the country of departure or destination of a vessel; alternatively, emissions related to the journey of the vessel shared by the country of departure and the country of arrival
6. Allocation according to the country of departure or destination of passengers or cargo; alternatively, emissions related to the journey of passengers or cargo shared by the country of departure and the country of arrival
7. Allocation according to the country of origin of passengers or owner of cargo
8. Allocation to a party of all emissions generated in its national space.

SBSTA noted that there are three separate issues related to international bunker fuels:

- Adequate and consistent inventories
- Allocation of emissions, and
- Control options.

In reviewing the eight options, SBSTA in 1997 recommended that allocation options 1, 3, 4, 5 and 6 should be further considered.

The UNFCCC has in decision 2/CP.3 encouraged further elaboration on the feasibility of including international shipping emission in the national inventories.

1.2 IMO

In 2003 the IMO responded to the UNFCCC's request by adopting resolution A.963(23). With reference to article 212 of the United Nations Convention of the Law of the Sea (UNCLOS) the resolution invited IMO's Marine Environment Protection Committee (MEPC) to develop legally binding measures through the preparation of a new annex to the International Convention for the Prevention of Pollution from Ships (MARPOL). The resolution specifically asks the MEPC to undertake the following tasks:

- The setting of a greenhouse gas emissions baseline
- The development of a methodology for monitoring and reporting greenhouse gas efficiencies of ships in the form of a greenhouse gas index
- The development of guidelines for how such a greenhouse gas index can be implemented
- The evaluation of technical, operational and market-based measures to reduce greenhouse gases from ships.

So far the IMO has only presented a draft CO_2 index, which is currently being tested (see next section). Working through the IMO appears to be a very slow process and no internationally agreed standard or common scheme for market-based instruments is yet in sight. In November 2002, the European Commission presented an EU strategy to reduce emissions from ships (COM(2002)595 final). In this document, the Commission expresses a wish to work closely with the IMO to ensure that its strategy on greenhouse gases is concrete and ambitious. However, it says if the IMO has not adopted such a strategy by 2003, the Commission "will consider taking action at EU level to reduce ships' unitary emissions of greenhouse gases".[2]

1.3 The IMO's CO_2 index

The objective of the IMO's CO_2 index is to provide a formula by which the shipowner or operator can assess the emissions of a ship in relation to the transport work that has been performed. The emissions are calculated on the basis of total fuel consumption, including fuel used while a ship is berthed and during ballast voyages. The transport performed is calculated by multiplying a cargo unit by the distance travelled. In a trial, data has been collected from 364 ships representing eight of the 18 ship categories as defined by Lloyds Fairplay.

How the index should be used is still unclear. The most obvious application is for shipowners and operators to use it to make sure that they take advantage of all cost-efficient ways of improving a ship's environmental performance.

As results from further tests become available, the index will also help stakeholders improve their understanding of how energy is used in shipping and ways of improving the sector's performance in this respect. It is less clear to what extent the index will also be useful in the context of comparing individual ships with each other or as a basis for the establishment of legally binding baseline values. The latter would be complicated as it would require large amounts of data.

1.4 The world fleet

According to Lloyd's Register the global commercial fleet consists of close to 47 000 ships engaged in transportation of cargo and/or passengers. In addition there are around 40 000 vessels involved in other types of activities, including fishing vessels, tugboats, research vessels etc. The former are broken down by category in table 1.

Table 1. The commercial world fleet by category.

Ship category	Number of ships
LNG tanker	174
LPG tanker	1,020
Chemical tanker	2,970
Crude oil tanker	1,850
Product tanker	5,047

[2] COM (2002)595 final, p. 17.

Other liquids	365
Bulk dry	5,267
Bulk dry/oil	152
Self discharging bulk dry	166
Other bulk dry	1,205
General cargo	15,859
Passenger/General cargo	339
Container	3,283
Refrigerated cargo	1,242
RoRo cargo	1,959
Passenger/RoRo cargo	2,743
Passenger ship	2,873
Other dry cargo	240
Total	**46,654**

Source: From CE Delft et al, 2006 (based on Lloyds Register).

The installed power of this fleet exceeds 225 000 MW (Corbett, 2006).

1.5 Objective and delimitations

The objective of this paper is to investigate options for market-based instruments for reducing CO_2 emissions from international shipping, and to look closely at the design of a model for linking these emissions to the ETS. In undertaking the latter task it is essential to recognise that the conditions in the maritime sector differ to some extent from those in international aviation. For this reason it is not possible to duplicate the model proposed by the European Commission for the inclusion in the ETS of emissions from aviation. In some respects different solutions are needed where international shipping is concerned.

Engines of maritime ships emit a number of gases that have either positive or negative radiative forcing. The impact on global warming of emissions from shipping is not yet fully understood. The positive forcing is primarily caused by CO_2 and tropospheric ozone (formed with NOx as a precursor). However, the large amounts of sulphur aerosols emitted from ships running on heavy fuel oil have a negative radiative forcing. Some experts believe that the current mix of gaseous emissions might on average have a cooling effect. However, because of concerns over the effects on terrestrial ecosystems and human health from large emissions of SO_2 and particulate matter, attempts are being made to reduce these emissions by shifting to low-sulphur fuels. This will affect the balance between cooling and warming effects. Reducing emissions of CO_2 and NOx from international shipping is therefore a prime objective regardless of whether the current mix is negative or positive.

The focus of this paper is on CO_2. However, a short chapter is devoted to NOx.

2. Abatement measures

The first and second oil crises gave a boost to fuel efficiency improvement in maritime transport. However, as real oil prices started to decline in 1980s and 1990s, the rate of improvement fell and even reversed in some cases (CE Delft, 2006). Marine residual oils are sold well below the price of crude oil and even at current market prices the cost provides only a limited incentive to owners and operators to reduce fuel consumption in shipping.

With few exceptions, fuel represents between 20 and 60 per cent of overall shipping costs (Corbett, 2006).[3] Operators therefore generally have an incentive to operate ships efficiently and to use technologies that reduce fuel consumption. However, not all ship operators make use of all existing opportunities.

Increasing fuel prices and continuing technological development may open the door to additional measures. Abatement measures can be classified either as technical or operational. Improved maintenance can be regarded as a third category.

2.1 Technical measures

Large low-speed diesel engines have thermal efficiencies around 55 per cent, followed by medium-speed diesel engines and combined-cycle gas turbines with 40-45 per cent efficiency. Gas and steam turbines have thermal efficiencies between 30 and 35 per cent.

Table 2 summarises the fuel reduction potentials for different types of technical measures, according to a seven year old IMO report. Most of these may be employed only in the construction of new ships.

Table 2. Emission reduction measures in new ships and engines and their potential for reducing fuel consumption in shipping.

Measures	Per cent reduction
Improvement of hull design of new ships	5-20
Improved propellers	5-10
Efficiency optimisation in new engines	10-12
Innovative propulsion systems	5
Electronic injection	2-3
High pressure fuel injection	1-2
Improved turbo charger	5-7

Source: IMO (2000)

[3] The large range is explained by differences in capitalisation, labour costs and operating speed. For a relatively new and fast container ship with most crew members coming from low wage countries, fuel would represent more than 30% of total costs.

To use the exhaust gas heat in a supplementary steam turbine is not specifically mentioned in the table but may also be an option, unless this heat is already used for some other purpose. Innovative rudder and propeller systems, diesel electric systems, and co-shaft-generators are other options.

In the longer term wind-power and solar-power support may reduce fuel consumption even further.

2.2 Improved maintenance and switch of fuel

Table 3 shows the importance of maintenance for keeping fuel consumption low. A switch to distillate oil will improve the fuel-efficiency of the ship but at the expense of higher refinery CO_2 emissions. A life cycle analysis would show that the former can only partially balance the latter. The shift might nevertheless be socio-economically viable, as it would bring about other benefits, among them:

- A large reduction in emissions of sulphur and particulate matter
- Improved conditions for use of advanced emission control devices for NOx
- Simplified compliance monitoring and control
- Greater reliability of the machinery on board
- Lower costs for cleaning up accidental and deliberate oil spills
- Elimination of the need for various fuel treatment installations on board
- Reduced amounts of fuel-generated waste.

Table 3. Emission reduction from improved maintenance and fuel switch.

Measures	**Per cent reduction**
Hull maintenance, in particular anti-fouling	3-5
Propeller maintenance	1-3
Switch from HFO to MDO bunker fuels	4-5

Source: IMO (2000)

2.3 Operational measures

As reflected in table 4, improved fleet planning and utilisation of the carrying capacity of individual ships is a way of reducing fuel consumption per unit of cargo transported. However, market conditions often make it difficult to use of the full potential. The wide range given for improved fleet utilisation is an indication of the uncertainty of these figures.

Many ship operators already use services for weather routing available in the market, and increasingly they also consider the direction and strength of currents. The remaining net potential may therefore be lower than indicated by the IMO's report.

Table 4. Emission reduction potentials of operative measures.

Measures	**Per cent reduction**
Improved fleet planning and utilisation	5-40

“Just in time” route planning	1-5
Weather routing	2-4
Constant engine load (returns/min)	0-2
Optimum trim and minimum ballast	0-2
Optimum propeller and rudder positions	0-2
Reduced time in ports, better cargo handling	1-7

Source: IMO (2000)

Regular cruise speed is generally reached at about 80-85 per cent utilisation of engine capacity. Fuel consumption increases rapidly with speed as a result of hydro-dynamic forces. With increasing speed the share of energy lost in wave energy grows approximately by the square (the hull and all else being equal). Slow steaming would reduce fuel consumption substantially but is mostly avoided as a longer time at sea increases other operational costs and reduces the ship’s earning capacity. Currently, ship speeds are dictated by market forces, i.e. competition to be fast and reliable. However, when shipowners decide on the design speed of new ships, their expectations on the future price of bunker fuel is an important parameter.

3. Main market-based instruments

Potentially a large number of politically enforced policy instruments can be used for making international shipping reduce its emissions of CO_2. They can broadly be divided into two categories: those that affect the running of vessels and investment in new ships, and those that only affect investment decisions. Fuel taxes, cap-and-trade systems and schemes based on the IMO's CO_2 index belong to the first group, while baseline with tradable credits is an example of the latter type.

This report is focused on the feasibility of linking international shipping emissions to the European Emission Trading Scheme (ETS), which is a cap-and-trade system. However, before concentrating on the ETS it might be useful to make a brief comparison with other market-based options.

3.1 Fuel taxes

Taxing bunker oil for its content of carbon is technically feasible but politically difficult to introduce. A global fuel tax is probably impossible to agree upon. A regional scheme would give ship operators an incentive to buy fuel in states outside the area where the tax is enforced. As ships can carry large quantities of fuel without sacrificing too much of their cargo carrying capacity, the risk of tax evasion would be considerable if the tax were introduced unilaterally. Therefore taxation does not merit further consideration in the context of this report.

3.2 Cap-and-trade

In a cap-and-trade system, the state or a supranational body sets a legally binding limit on total emissions from a geographical area, a sector or a number of emission sources. Under the cap, participants are free to trade allowances with each other. In theory this will allow them to reach the target at least possible cost. The European Union's Emission Trading Scheme (ETS) currently covers CO_2 emissions from power plants, large boilers and fuel-intensive industries in the Member States. The European Commission has proposed that the ETS will be extended in 2011-2012 to include emissions from commercial aircraft, and it is considering the feasibility of including the shipping sector at a later stage.

An advantage of cap-and-trade systems is that the target will by definition be met. The cap is non-negotiable once it has been set. The other side of the coin is that the cost is not known in advance. A cap-and-trade scheme for CO_2 emissions from shipping would provide an incentive to shipowners and operators to consider different measures to reduce the cost of running the ship, as well as investment in existing ships (retrofitting) and new vessels.

A cap-and-trade scheme for emissions from international ships could be introduced on a global or a regional level. It could be a closed system or open for trade with other cap-and-trade schemes and other flexible mechanisms such as Joint Implementation and the Clean Development Mechanism.

3.3 Baseline and credits

A baseline is a legally binding emission limit that all entities covered by the scheme must comply with. By allowing those who underscore the limit value to sell credits to non-compliers, a baseline-and-credit system is more flexible and cost-efficient than a traditional technical standard. In international shipping the use of differing baselines for different types of ships, and possibly also different sizes of vessels, is conceivable. The baselines would be designed as specific emission limits, e.g. ton of CO_2 per Gross Tonnage (GT) kilometre, ton kilometre or some other parameter reflecting size and utility. There would be no cap on total emissions and the scheme would not target real life emissions, which are also affected by the quality of maintenance, the choice of operational speed etc. However, a baseline for real emissions based on the IMO's CO_2 index could also be considered, although it would be quite complicated in nature.

4. Previous work by CE Delft et al

The most comprehensive study on market-based instruments for reducing CO_2 emissions from international shipping is a recent report by CE Delft et al (2006) on behalf of the European Commission. This chapter offers a summary of some of the findings of the report. The parts with the highest relevance for this report are sections 4.6 and 4.7.

4.1 Examination of seven options

CE Delft examined seven different policy options:

1. Voluntary commitments
2. A requirement to calculate and report the IMO CO_2 index
3. A requirement to meet a unitary CO_2 index limit value
4. Inclusion of refrigerant gases in a regulation or the CO_2 index
5. Mandatory differentiation of harbour dues
6. Inclusion of maritime transport in ETS
7. Allocation of emissions from maritime transport to countries

One of these options, inclusion of refrigerant gases, falls outside the scope of this paper, and will therefore not be further elaborated on. The authors' considerations with regard to the other six will be presented in short summary.

4.2 Voluntary commitments

CE Delft notes that absolute reductions can hardly be achieved through voluntary agreements as this would require ship operators to undertake reductions even in cases of fast growth. The fact that shipowners and operators do not have control over the business cycle, which is the main determinant for the load factor of the ship, makes it difficult to base a voluntary agreement on the IMO's CO_2 index. Moreover, consultations with the industry showed CE Delft that several stakeholders would prefer regulation over voluntary agreements, as the former leaves less room for free riding. CE Delft's conclusion is that a voluntary commitment could not be expected to be effective, and that, furthermore, in shipping there seems to be no obvious partner for a voluntary agreement.

4.3 A requirement to calculate and report the IMO CO_2 index

Unlike the other options discussed by CE Delft, this option is not aimed directly at achieving greenhouse gas emission reductions since the index would not be regulated. The merit of this option is only to raise awareness among shipowners and operators, and to improve data availability and understanding of the index. This would in itself be important as lack of data is currently a significant bottleneck in the development of policy measures aimed at CO_2 reduction in shipping.

4.4 A requirement to meet a unitary CO_2 index limit value

Marintek, a partner of CE Delft, concludes in another section of the report that there are fundamental problems with setting a baseline for the CO_2 index as smaller ships will always be at a disadvantage,[4] and in times of lower market demand, the index will increase. Empty trips constitute a special problem and are sometimes unavoidable (e.g. crude oil carriers). An additional problem is that the CO_2 index is calculated over a year. When meeting the index limit value is used as a condition for being allowed to call at a port, ships not meeting the index might have to sail outside the area covered for some time until they have been able to take the operational and technical measures needed to reduce the index value over a full calendar year to the required level. This would limit competition on the market for maritime transport in the EU.

The authors note that the operational effectiveness of a CO_2 index depends on the limit of the target and the consequences of not meeting it, as well as on the number of ship classes distinguished and how to deal with the cyclical nature of the market for maritime transport. They also recognise that the feasibility of this option would improve if it could be made more flexible, for example by allowing trade in credits among ship operators. Other key issues are enforcement and compliance control and the scope for evasion. CE Delft's conclusion is that it is too early to determine the feasibility of this option.

4.5 Mandatory differentiation of harbour dues

Harbours have a large autonomy in establishing their dues, and as a result dues differ both in structure and levels. An advantage of using differentiated dues as a policy instrument is that the institutional arrangements for payment and enforcement are already in place.

CE Delft assumes that the differentiation of the dues would be mandatory for all EU ports and that the legislation would prescribe both the basis of the differentiation and the level. The basis could be a technical standard, a performance indicator or a management system. If the IMO's CO_2 index where to be used as a performance indicator, the scheme would have to take ship classes and ship size into account (see the above section for the problems connected with using the index).

CE Delft recognises that in a case where the level of the differentiation is relative, the incentive (or the burden) would be much higher in ports with high dues than in harbours that charge less. However, the authors do not consider the fact that a fixed rate would make up a significantly larger share of the due in the latter case. Nor do they consider problems that may occur if a port is predominantly visited by fuel-efficient ships which, in a case of absolute differentiation, would pay less than they currently do. To balance its cash-flow, such a port would have to increase the nominal level of its dues at the risk of losing price-sensitive high-emitting customers to competing ports. If this happens the fuel-efficient ships would end up paying almost as much as they did before the differentiation was introduced.

Another obstacle, not mentioned by CE Delft, is that real dues may as a result of commercial negotiations in individual cases differ greatly from the nominated rates.

[4] Large ships need less fuel per ton kilometre (all else being equal).

Large customers often enjoy special rates. Therefore, other ports or shipowners would not know to what extent the absolute differentiation of the dues prescribed by the EU had actually affected the deal. To force the market to publish all commercial agreements would, on the other hand, be a very far-reaching interference in business practices.

An alternative option, not considered by CE Delft, would be for the EU to decide on a mandatory charge on all ships calling at the ports of the Member States. The charge could be differentiated for environmental performance and thus provide an incentive to ships to become more fuel-efficient. However, a charge would have the character of a tax unless the EU decided on some common mechanism for recycling the revenue to the shipping sector.

4.6 Inclusion of maritime transport in ETS

Based on a brief analysis, CE Delft believes that the inclusion of CO_2 emissions from shipping in the ETS is possible under a design that is route-based, either for intra-EU routes or for all arriving vessels based on the route travelled from their latest ports. The trading entity would have to be the ship operator.

In order to be able to participate in the ETS, the shipping sector would have to be allocated emission allowances and these would have to be distributed amongst shipowners or operators. However, CE Delft notes that grandfathering allowances would distort the competitive market in the sense that it would penalise growth in transport to the EU by ship operators and reward shipowners who decrease their share of transport. The consequences would be more severe than for the land-based sources currently in the ETS, because of the larger volatility of the shipping sector. Auctioning allowances would not suffer from the same drawbacks, but would, according to CE Delft, place a considerable extra burden on shipping companies and distort the market so long as other modes do not face similar burdens. However, electric trains are already affected by the ETS, aviation is likely to be part of the ETS at an earlier point in time than international shipping, and road transport pays significant fuel taxes, though not enough so match its social marginal costs.

4.7 Allocation of emissions from maritime transport to countries

CE Delft makes a brief assessment of four of the five more promising of the eight options for allocation of ship emissions to Member States, identified by SBSTA (see section 1.1). The conclusion is that allocation of emissions is not by itself a policy to reduce greenhouse gas emissions from shipping. States would have to introduce policies and measures in order to control the emissions that have been allocated to them.

Where the four options are concerned, CE Delft notes that, under a unilateral policy, allocation according to the country where the bunker fuel is sold (option 3) suffers from the risk of tankering in non-participating countries. This risk should be equal to the risk of tankering from taxing bunker fuels used in international shipping. Allocation according to the nationality of the ship, the transporting company or the operator (option 4) is problematic as many ships regularly change flag and/or operator, and such practices can be used for evasion and may cause economic distortions. Allocation according to the country of departure or destination (option 5) or according to the country of departure or destination of passengers or cargo (option 6) may lead ships to

call at ports of non-participating countries.[5] The latter would, furthermore, require handling of large quantities of data, not least for vessels such as container ships carrying many types of goods. There would also be problems with allocating emissions between passengers and cargo in ferry services. Allocation of emissions from transport of empty containers is yet another example.

Options 4, 5 and 6 would require verification, based either on estimates of fuel consumption per nautical mile, or on the bunker fuel delivery notes. A problem with the bunker notes, though, is that they do not say how much fuel was used on the journey between particular ports. This may cause difficulties in particular for calculating emissions from linear services calling at several ports and tramp shipping.

In the context of allocations of emissions, CE Delft underlines that there are considerable inconsistencies in current bunker fuel statistics. One of the reasons may be offshore tankering, another that data from some countries may be unreliable. Recent activity-based estimates of CO_2 emissions from international maritime transport provide figures that are nearly twice as high as those based on official energy statistics.

4.8 CE Delft's conclusions

Based on their assessment, the consultants believe that three options stand out as operationally effective, feasible to implement and possible to monitor and enforce:

- A requirement to meet a unitary CO_2 index limit value.
- A mandatory inclusion of a CO_2 element in a differentiation of harbour dues.
- The inclusion of maritime transport in the ETS.

However, their feasibility warrants further study. Where the first option is concerned, CE Delft says its feasibility depends on the demonstration of a CO_2 index limit value that is not dominated by external factors – such as transport demand – and that takes the large variety of ships into account.

Where the mandatory inclusion of a CO_2 element in a differentiation of harbour dues is concerned, CE Delft seems to have overlooked the fact that port dues are often negotiated and that the resulting contracts are not in the public domain.[6]

Concerning the inclusion of maritime transport in the ETS, several design issues remain to be resolved, among them the geographical scope and an allocation method to replace grandfathering. CE Delft says auctioning could be a solution provided that a well designed method can be developed for ploughing back the proceeds in order to alleviate the financial burden on the shipping sector.

[5] In cases where country of departure is used.
[6] A mandatory charge, collected on behalf of the state, would be a way round this problem but could be seen as a tax.

5. Linking a cap-and-trade scheme to the ETS

5.1 Requirements on the scheme

In the design of a cap-and-trade scheme for CO_2 emissions from international shipping, a number of requirements must be observed. Such a scheme would, by definition, reflect real emissions and provide maximum abatement flexibility. However it must also be:

1. applicable to vessels of a variety of types and regardless of flag
2. transparent and non-discriminating
3. acceptable for non-Annex 1 countries and other non-participating states
4. acceptable in the context of inter-port competition
5. legally, politically and institutionally acceptable
6. easy to monitor and to enforce
7. possible to implement and administer at low cost
8. open for gradual expansion into a globally administered scheme

5.2 The Commission's proposal for aviation

The European Commission has presented a proposal for a directive (COM(2006) 818 final) on the inclusion of aviation in the ETS. The aviation sector will be required to stabilise its emissions of CO_2 at their 2005 levels.[7] The scheme will be limited to aircraft with a minimum take-off weight of 5.7 tons. Domestic aviation will be included in the targets.

The Commission found a route-based approach, defined on the basis of country of departure and/or destination, to be most simple and workable. The scheme will cover all flights arriving or departing from an airport in the Community as of 1 January 2012. Flights between EU airports will be covered from 1 January 2011.

The majority of aviation allowances will be allocated to the aviation sector free of charge and based on benchmarking and historic operations. During the first commitment period, auctioning will only be used for a share equivalent to the average percentage auctioned in the current ETS. During the second period, the degree of auctioning will depend on the results of the review of the ETS. New entrants will have to purchase allowances through an auction or via the market. However, for the subsequent allocation period they will be able to apply for allowances under the same rules as pre-existing operators.

Operators will be liable for submitting allowances equal to the emissions caused by their aircraft. In order to avoid duplication and an excessive administrative burden on aircraft operators, each operator, including those based in countries outside the EU, will be administered by one Member State only. Aircraft operators will also be able to use project credits – Emission Reduction Units (ERUs) and Certified Emission Reductions

[7] The Commission will by the end of 2008 put forward a proposal to address nitrogen oxide emissions from aviation.

(CERs) from the Joint Implementation (JI) and Clean Development Mechanism (CDM) respectively – up to a harmonised limit equivalent to the average of the limits prescribed by Member States in their national allocation plans for other sectors in the ETS.

Trade in allowances between the aviation sector and other ETS sectors will be permitted, but non-aviation operators will not be allowed to surrender aviation allowances. In practice, therefore, the aviation sector cannot become a net-seller of allowances.

5.3 Differences between aviation and maritime transport

It may be tempting to use the model the Commission proposes for the aviation sector also for the inclusion of emissions from international shipping. However, before deciding on that matter it is essential to consider some important differences between aviation and maritime transport.

Aircraft operations have for many years been closely monitored, and the relevant authorities have access to reliable fuel and emissions data. As noted in an earlier section of this report, the actual fuel consumption in international shipping is not known.

Whereas aviation is predominantly used for scheduled passenger services, international shipping is mainly occupied with freight transport. Ferries are different as they often carry both cargo and passengers. Aircraft used by commercial airlines are produced in large series by a few manufacturers. According to Lloyds Register, commercial ships can be divided into 16 main categories, most of them representing vessels of a large variety of sizes. Ships are often built individually, and where more than one is manufactured, the series is often short.

While aircraft make trips that seldom take more than 10 to 12 hours, voyages in transoceanic shipping may take weeks. To make the best possible use of their earning capacity, aircraft avoid carrying more fuel than needed. Large ships, on the other hand, can bunker large quantities of fuel without having to compromise with their cargo carrying capacity.

An additional concern in the maritime sector is that it is often difficult to identify the operator. Ships may be operated by the owner, a hired operator or a charterer, and in many cases the legal responsibility frequently changes hands. The same is true for the choice of flag. Some ships are used in linear services, while others frequently change operational routes. These circumstances make the allocation of allowances and liability more complicated in the maritime sector than in aviation.

5.4 Open or closed system?

A cap-and-trade system can be global or regional, and open or closed.

In an open system, trade is permitted with other sectors and possibly with other cap-and-trade systems. Use of credits from CDM projects may also be allowed. In a closed system no trade with other sectors or regions is permitted.

The fact that international shipping is growing fast and that its CO_2 emissions are currently estimated with a high degree of uncertainty make it difficult to know where to put the cap. In a closed system the cap would have to be more generous, as there would be no "emergency exit" available if it proved to have been set too tight. An open system has the advantage of allowing trade with entities in other sectors and other parts of the world that may face a lower marginal abatement cost than the shipping sector. The volume of allowances and the number of potential participants would also be much greater in an open system, which should benefit market transparency and trade. However, the number of trading entities would also be large in a closed system.

In the sections below, only open systems are analysed.

5.5 Allocation of responsibility

Earlier reports on the subject have analysed the problems connected with different ways of allocating responsibility within the shipping sector. All allocation models so far described appear to be problematic to a greater or lesser degree, and many of them would entail a lot of paperwork and considerable enforcement difficulties.

All earlier studies appear to have overlooked the possibility of making the ship itself the liable entity. The reason for neglecting this option is probably that the analysts have considered the ship a dead body rather than an entity that can be held legally responsible. However, in this paper the idea is to tie the permission for a ship to call at a port to the vessel's participation in a scheme for emissions trading under a common cap. Non-participating ships, therefore, would not be allowed to call voluntarily and to load/unload at participating ports.

With this principle of allocation, the ship will be denied any services at a port covered by the geographical scope of the trading scheme unless someone has surrendered allowances that match its fuel consumption. The person or organisation delivering the allowances could be the owner, the operator, the charterer, the ship's master or someone else. Change of flag state or ownership would not alter the liability of the ship. A company interested in buying or chartering an existing vessel would have to make sure that the shipowner does not have a deficit on the CO_2 account of the vessel in question.

5.6 Geographical scope

In the case of linking maritime emissions to the ETS, the least complicated and most feasible allocation principle appears to be based on voyages arriving in EU ports (Faber et al, 2006). In this case a ship would be liable for its emissions only for journeys ending in a port of the European Union. The model would require the operator to monitor fuel consumption in order to be able to split bunker oil deliveries between voyages to EU ports and other destinations. In order to minimise the number of CO_2 allowances that would have to be surrendered, this principle of allocation might cause a ship on a long-distance voyage to call at a port just outside the EU before proceeding to its final destination.

Some studies have recognised a need to gradually extend the geographical scope of the scheme for CO_2 emissions trading. It may be fair to start with freight transport carried out for customers in Annex 1 countries, but sooner or later the scope will have to be

widened to relatively advanced and rapidly growing economies such as those of South Korea, Brazil, China and India. A complication with only including emissions from voyages to ports of Annex 1 countries is that traffic in the opposite direction, which causes as much damage, is not covered.

A way of getting round these difficulties could be to make the ship liable for emissions from fuel bunkered during, say, the latest three or six months prior to a call at a participating port. With this design, emissions from the return voyages of ships involved in intercontinental traffic would automatically be covered, and shipowners and operators would gain nothing by calling at ports just outside the European Union. The geographical scope would thus be global, albeit limited to ships that call at ports of the European Union (and other participating states).

5.7 Method for calculating emissions

The underlying fuel consumption, that the surrendered CO_2 allowances would have to match, could be declared by using the already mandatory bunker delivery notes that all ships above 400 GT need to keep according to Regulation 18 of MARPOL Annex VI. The bunker delivery note must be retained on board for a period of three years after the fuel has been delivered. The information that as a minimum must be recorded in the note is:

- Name and IMO number of the receiving ship
- Port of bunkering
- Data and commencement of delivery
- Name, address and contact information of the marine fuel supplier
- Product names
- Quantity in metric tons
- Density at 15°C (kg/m^3)
- Sulphur content in per cent by mass (% m/m)
- A declaration signed and certified by the fuel oil supplier's representative that the fuel oil supplied is in conformity with regulation 14(1) or 4(a) and regulation 18(1) of Marpol Annex VI.

The objective behind the bunker delivery note regulation is to facilitate port state control of the (permissible) sulphur content of bunker fuel used in different seas. However, the delivery notes already contain all the information needed for a declaration of CO_2 emissions except the carbon content per ton of fuel, which would have to be added if the notes are to be used in a cap-and-trade system.

Copies of bunker delivery notes would in this case be sent to the database of the authority in charge of the cap-and-trade scheme. By allowing all ports access to the database, a port authority could easily see whether a ship approaching the port has surrendered allowances that equal the fuel delivered to the ship. There would be one account for each registered ship in the name of the ship's IMO number.

An alternative solution to bunker delivery notes could potentially be to use **the Automatic Identification System**, AIS, which automatically transmits the identity of all ships. The AIS is compulsory for all passenger ships and all cargo ships of 300 GT and more engaged in international voyages. The AIS system is able to transmit

information on the movement of ships to coastal centres on shore. The EU requires all coastal states in the Union to establish shore-based AIS infrastructure by 1 July 2007.

When the AIS system is used for checking the distance travelled by a ship, the CO2 emissions can be estimated by multiplying distance by specific fuel consumption per nautical mile at, say, 80 per cent engine capacity.

This method, however, has some shortcomings. It does not take account of the exact carbon content per unit of energy, which may differ between heavy fuel oil and distillate fuels. Furthermore it is only an indirect way of calculating fuel consumption and would thus not provide operators with any incentive to reduce emissions by slow-steaming, improved maintenance or other operational measures. It is also doubtful whether the AIS system will be able to be used for the collection of data in all seas of the world within a few years. Moreover, the coastal base stations cannot receive VHF signals from ships further than 60 nautical miles away from the shore. However, in the longer term an option might be to use satellites as relay stations to extend the range. Thus, for the next decade or so the AIS is not a viable alternative to the bunker delivery notes.

5.8 Grandfathering or auction?

The initial allocation of allowances to the shipping sector could in principle be done either by distributing allowances to individual ships free of charge based on their historic emissions (grandfathering) or by auction. A combination is also possible.

Grandfathering has proved problematic in the ETS. It has resulted in poor market transparency and contributed to high price volatility during the trial period 2005-2007. In addition it has given rise to large windfall profits in the power industry, while electricity-intensive industries that face global competition have been left without compensation. Most Member States have allocated more allowances than needed to the trading sector. One reason for a high cap has been to allow ample room for new entrants and for increasing production in existing factories and plants. This has made it possible for the power industry to invest in new coal-fired capacity with rising emissions as a result. Most of these difficulties were foreseeable.

Using the grandfather method in the shipping sector would mean having to decide on allowances for many different types of ship and for ships of different size. In this sector the problem with new entrants and the risk of rewarding companies that sell or scrap facilities is also more pronounced than with land-based activities. Ships are by definition movable. A ship that has received allowances based on grandfathering may be sold to a new owner that operates in waters where no allowances are needed. This kind of allocation of free permits makes the market entrance of new shipping companies more expensive and remunerates shipowners who close existing services.

The only good reason for grandfathering is to protect industries from losing market share to competitors in non-participating countries. This problem will not occur in shipping if all vessels calling at participating ports, regardless of flag and port of departure, must surrender allowances equal to the fuel used (based on deliveries received during the last six months). However, so long as land-based emitters receive all or some of their allowances for free, one could contemplate recycling to the sector some

or all of the revenues from the auction. How this can be done is discussed in a later chapter.

5.9 A future global regime

For international shipping a global solution would, of course, be the most appropriate way of addressing emissions of greenhouse gases. Before going on to discuss a regional scheme linked to the EU ETS, it is therefore worth considering how a global regime might be designed. The regional scheme should as far as possible be modelled in a way that makes a transition into a global system possible in the longer term.

Under a global regime, UNFCCC and/or IMO would set a cap on international transport emissions and take the decision that all Annex 1 countries must ensure that all ships calling at their ports have surrendered allowances to the common authority that match the carbon content of the fuel they have purchased. The common authority would in this case probably be the IMO or a subsidiary body under the IMO developed for this particular purpose. The system could over the years be gradually extended to include ports in advanced developing countries (ADCs). The common authority would be in charge of the auctions and would create CO_2 accounts for all ships with IMO numbers.

A global scheme designed in this way would stand a good chance of being recognised as being fair, as it would cover all emissions generated by ships above 400 GT travelling solely in the waters of Annex 1 countries and, in addition, all ships travelling to and from the ports of these countries on transcontinental voyages. This means that countries in other parts of the world would be affected only to the extent that they use shipping for trade with Annex 1 countries. The ports of these countries would not have to participate as the port state control would only take place in Annex 1 countries. Local and regional trade in non-Annex 1 areas would not be affected at all, and neither would long-distance voyages between two non-Annex 1 countries, unless the ship is also used for trips to Europe or other Annex 1 parties.

Annex I countries may also consider including emissions from ships in the range of 100-400 GT. Many vessels of this size and larger are used both in domestic services and for international transport. It would make it easier for nation states and the IMO if emissions from all such vessels were part of the international inventory, rather than split between national inventories and international shipping.

5.10 Regional cap and trade linked to the ETS

In the likely case where UNFCCC and/or IMO are not capable in the short term of taking a decision on the introduction of a cap on CO_2 emissions from international shipping, the European Union can introduce a scheme of its own, the *Maritime Emissions Trading Scheme* (METS).[8] In principle, the same type of system can be used as in the global regime presented above. However, in the case of a regional regime, only ports in the Member States and candidate countries of the EU would participate, at least

[8] In theory calls at ports of the EU could alternatively be made conditional on a payment of a charge that reflects the ships' emissions. When the quantity of fuel purchased is known, it is simple to calculate the fee. The difficulty lies in setting the level of the charge and avoid making it look like a tax (which would require a unanimous decision by the Council).

initially. The scheme would not be administered and monitored by the IMO, so the EU would have to create an agency of its own for this purpose.

The legal basis for a unilateral decision by the European Union on emissions from international shipping is discussed in chapter 9. To make it possible to gradually extend the scheme to other countries and finally turn it into a global scheme under the auspices of the IMO, the scheme should be introduced by an EU regulation rather than a directive. For the inclusion of the aviation sector, the Commission has proposed amending Directive 2003/87/EC, but where international maritime transport is concerned, a more appropriate solution might be to link a separate scheme for emissions trading to the ETS rather than extending the existing scheme to take account of emissions from ships. The reason for this preference is that the latter solution would make it difficult to extend the scheme to emissions caused by ships on journeys to ports in non-EU countries who may later want to join the system.

However, permitting a link between METS and the ETS may require an amendment to the current directive. The proposed act concerns an EEA matter and would therefore extend to the European Economic Area.

A problem with getting the scheme started is the lack of reliable fuel sales statistics. The sector needs to know how much fuel is used today in ships calling at the participating ports. One way of acquiring the data needed for setting the cap (and deciding on the number of allowances to be auctioned) could be to make all ships calling at these ports surrender bunker delivery notes to the common authority for year prior to the launch of the system. This exercise would not only provide data on actual fuel consumption, it would also be a test of part of the system required for making the cap-and-trade system work.

For aviation, the European Commission has proposed that the EU ETS cap should be equivalent to the average emissions caused on the relevant routes in 2004-2006. Where ships calling at EU ports are concerned, it will take at least until 2012 until the data is available. Given the fast growth that will take place between 2005 and 2012, the equivalent cap for the shipping sector would have to be something in the order of 80 per cent of its 2012 emissions.

All ships above 400 GT would be the entities responsible for complying with the obligations imposed by the scheme. Their owners and operators would be free to purchase shipping CO_2 allowances from auctions held by the common authority, maybe one per month, or to buy allowances from the EU ETS. They would also be able to use project credits – Emission Reduction Units (ERUs) and Certified Emission Reductions (CERs) – from the Joint Implementation (JI) and Clean Development Mechanism (CDM) respectively. Domestic shipping would also be included and treated in the same way as international shipping.

The proposed scheme would not directly have to apply to the Overseas Countries and Territories of the European Union, but ships travelling between them and Europe would be covered when the ship calls at a participating port. The same would apply to ships from the "outermost regions", namely the French overseas departments, the Azores, Madeira and the Canary Islands, in a case where these territories were not fully included in the scheme with the same status as full Member States or candidate countries.

The European Union would have to create a "common authority" for the administration of METS. Making the Member States responsible for this task would hardly work with thousands of ships belonging to shipowners in various parts of the world. It is better to create one common ships register for this purpose and to entrust the common authority with both auctioning allowances and controlling that all ships have surrendered allowances covering their emissions.

One option could be to ask the European Maritime Safety Agency (EMSA) to be responsible for this task; another would be to establish a new agency. The common authority would create a register for all ships wanting to call at ports of the participating countries and establish an account for the surrender of allowances for each of them. A company responsible for a fleet should be allowed to create a common account for them. The common authority would also be in charge of setting up and maintaining the necessary control system. The system would (automatically) notify the participating ports of ships that have not surrendered allowances for a while and that may be about to develop a deficit.

Methods for the verification of the authenticity of the bunker delivery notes are discussed in section 7.2.

Assuming that global emissions from commercial shipping calling at EU ports currently amount to at least 300 million tons of CO_2[9] and that allowances equivalent to 80 per cent of this will be auctioned (post 2012) at an average price of €20 per ton of CO_2, the revenue raised would be about €4.8 billion per annum. How the proceeds may be used is the subject of chapter 6.

5.11 Gradual extension of the geographic scope of the scheme

When establishing the proposed scheme, the EU should invite non-Member States to participate. Some may decide to join METS from the start. Others may follow later. To facilitate the entry of new participants, it is essential to design the scheme in a way that makes it easy to include additional countries and ports. When this happens the system must be able to adjust the cap accordingly and to allow the newcomers a proportional influence over the scheme and its administration. For this reason the rules should allow the European Commission to negotiate, on behalf of the Community, the adjustments needed, and the status of the common authority should allow membership of the authority's board to be open to representatives of non-EU Member States.

[9] OECD nations account for roughly half the international marine fuel consumption in recent years. Their share of ocean-going shipping is estimated to be around 85 % (Corbett, 2006)

6. Using the revenues

As shown above, the revenues from auctioning the allowances could amount to around €4.8 billion per annum (at an average price of €20/ton CO_2). The proceeds could be recycled to the shipping sector or used for any other purpose.

It is not self evident that the revenues should return to the shipping sector. A decision to auction the allowances, rather than allocating them in some other way, could be based on the ability of a sector to pass the costs on to customers. The electric utilities have been able to make their customers pay the marginal cost of the allowances (and made large windfall profits), thereby showing that they would not have suffered had they been forced to buy the allowances at an auction. Industries that face global competition, on the other hand, have problems in the ETS. Thus, the question is whether shipping would be able to pass on to customers the cost of buying allowances.

Where transoceanic shipping is concerned, a mandatory EU CO_2 scheme would have effects similar to those experienced in the electricity sector. Freight customers have no real alternative as all services are subject to the scheme, and operators would therefore be able to pass on the costs. For short-sea shipping in European waters the situation is different as ships are competing with land-based modes of transport. However, electric trains are also affected by the ETS and truck owners pay diesel tax.

Where the proceeds of auctioning aviation allowances are concerned, the Commission proposes that they should fund contributions to the Global Energy Efficiency and Renewable Energy Fund and measures to avoid deforestation and facilitate adaptation in developing countries. Many other ways of spending the money could be contemplated, including distributing it among participating states, perhaps in relation to population or GDP.

6.1 Need for a supplementary instrument

A reason for spending at least part of proceeds on shipping might be that the inclusion of the sector in the ETS will only affect investment in new vessels to a minor degree. A supplementary instrument may therefore be needed to make shipowners consider long-term CO_2 abatement requirements.

The background is that the price of CO_2 allowances cannot be expected to be particularly high during the first post-Kyoto commitment period. With a low price, most of the emissions reductions would take place in other sectors/regions, with shipping becoming a net buyer of allowances. If the market price of CO_2 allowances during the Kyoto period happens to be €20 per ton, this would raise the cost of bunker fuel by around 25 per cent in a case where the HFO price is $300 per ton. However, such a relatively limited increase in current prices would fall within the range of uncertainty of future oil prices and provide only a small incentive to shipowners to consider fuel costs when they order new ships. The incentive to manufacturers of engines, propellers and ships to develop fuel-efficient technologies would thus be limited, and shipping companies would hesitate to order new vessels that make use of technologies that pay for themselves only at a combined fuel and allowance price considerably above the

current fuel price. Such technologies may be needed for meeting longer-term commitments in a cost-efficient way. Given the long expected life of vessels, incentives are needed now for adjusting the fleets to the likely CO_2 prices related to future stringent climate change commitments.

Under increasingly more stringent targets, the price of CO_2 allowances could be expected to rise during the post-Kyoto commitment periods. However, the future price is difficult for the industry to predict as it is influenced by a large number of uncertain parameters. These include the rate of economic growth, the stringency of the commitments, the level of fuel and electricity taxation (which affect demand in other sectors), the size of the geographical area, the number of sectors covered by the trade, the use of other flexible mechanisms, and technological development (including the possible breakthrough of new technologies). For the investor this poses a dilemma as the expected commercial lifetime of a new ship is 25-35 years.

Some observers, notably from the environmental community, fear that the existence of "low-hanging fruit"[10] will make stakeholders postpone all more expensive and far-reaching abatement measures to a date far in the future and that therefore the process of developing new technologies that may be needed for meeting post-Kyoto commitments may not take off in time. Where passenger cars are concerned, the European Commission has, recognised the need for stringent CO_2 emission limit values for new vehicles, and such standards may also be needed for light and heavy duty trucks, aircraft and ships. In fact, the Commission has not stated an intention to scrap the baseline for CO_2 emissions from new cars in the event that the ETS is extended to the transport sector.

A similar baseline could be contemplated for the shipping sector as around three quarters of the mitigation potential appears to lie in new technologies.[11] However, ships vary by type and size and most of them are built individually or in small orders of a few identical vessels. This makes regulation difficult. An alternative option would therefore be to allow some of the revenues from the auctioning of allowances under the cap-and-trade scheme to finance grants for investment in technologies that reduce fuel demand well below current levels.

6.2 Grants to R&D and front-runners

A supplement to the inclusion of shipping emissions in the ETS would thus be for the European Union to promote the development and use of fuel-efficient technologies by spending some of the revenues from the auctions on grants. In Germany, the Federal Ministry for the Environment has funded the development of a feeder ship for operation in coastal and inland waters based on the Futura Carrier design concept. The project aims to demonstrate a 30 per cent reduction in fuel consumption compared to conventional ships (Friedrich et al, 2007). However, this is just one small carrier and much more development and demonstration is needed.

Grants could be given to R&D programmes and to front-runners who want to order and build ships that have properties which reduce fuel consumption substantially below best

[10] Inexpensive abatement measures.
[11] Conclusion based on figures provided in IMO (2000).

practice. Any shipowner with a vessel eligible for the cap-and-trade scheme would be eligible for grants, and the money could be given both for new constructions and for the retrofitting of, for instance, engines or propellers.

An additional way of recycling part of the revenues could be to give a fixed annual remuneration to all ships that make active use of the IMO's CO_2 index. This would make a growing number of stakeholders aware of the operational and technological options for making the ships consume less fuel. Supporting the use of the index would make shipowners provide valuable information that can be used for setting the levels of potential future baselines for fuel efficiency.

In order to provide sufficient incentives to bring about technological change, the R&D scheme must run for at least 10 years.

6.3 Other ways of recycling the money

To the extent that proceeds cannot be wisely spent on grants, the revenue from the auctions could be returned to the participating shipowners in relation to the number of GT kilometres[12] sailed. This, however, would require the ships to report, in addition to the data covered by the bunker delivery notes, on the length of the voyages they have undertaken. Sweden has developed a similar non-revenue-raising scheme for returning to the industry the net income from its charge on emissions of NOx from large combustion plants. The system works well and the administrative cost is very low.

If and when the Member States of the European Union (or the parties to other regional cap-and-trade systems) begin to auction an increasing portion of the allowances to land-based sources, the amount of money recycled to the shipowners could gradually diminish.

[12] Or some other parameter that reflects utility and does not create perverse incentives or distort competition.

7. Effects on competition

In the impact assessment of its proposal for including emissions from aviation in the EU ETS, the Commission concludes that the scheme is likely to have only a very small effect on forecasted growth in demand as airlines will be able to pass on, to a large extent or even in full, compliance costs to customers. The Commission also states that competition between airlines will not be significantly affected.

There are no reasons for believing that the outcome of the introduction of a cap-and-trade scheme linked to the ETS would be much different for the shipping sector. This chapter discusses some of the potential risks involved.

7.1 Risk of evasion and effects on inter-port competition

If shipping fuel were taxed, shipowners would try to bunker in non-participating ports. Evasion by this method would not work in a cap-and-trade scheme where allowances must be surrendered for permission to enter a participating port. However, by participating, ports run the risk of losing customers to nearby harbours that do not participate. To avoid evasion, the system thus has to attract a sufficient amount of participation. The European Union's Member States and candidate countries would almost certainly form the critical mass required for making the system work. The risk of losing customers to neighbouring ports would be small, even if Russia and the countries of northern Africa decided not to participate. In order to become free-riders, such ports would have to rely on ships that never call at participating ports.

Becoming a free-rider by calling at a non-participating port would also be conditional on the approval of freight owners who would have to consider potential negative side-effects such as delayed deliveries or incremental costs of extended land transport by truck or train. The road tolls on the German motorways, which after the revision of the "Eurovignette Directive" (2006/38/EC) may be followed by the introduction of distance-based charging on the roads of other Member States, is a cost that would have to be considered in this context.

One way by which non-participating ports could potentially gain at the expense of participating ports would be to try to establish themselves as hubs for intercontinental ships. In such a case, large ocean-going vessels would call at the hub, where the cargo would be unloaded and moved to participating ports by feeder boats. However, for this concept to work, two prerequisites must be met: the ships used in the intercontinental part of the voyage must be dedicated to this trade and never used for a purpose where they might have to call at a participating port; and the non-participating ports must be located in places where cargo owners do not lose time or money. Establishing new hubs takes time and requires investment. In the meantime additional ports may join the trading scheme, making it increasingly difficult to find other non-participating ports to trade with. In a case where Europe decides to break the ice by setting up a regional scheme, one can, for instance, envisage that North American and Japanese ports might join the club after a while.

7.2 Preventing fraud

The use of the bunker delivery notes for this new purpose will increase the risk of fraud as the money at stake increases. Cheating may occur already under the current regulation, but port state officers can check the sulphur content of the fuel by testing a relatively simple sample.

Monitoring the amount of fuel delivered to the ship cannot be carried out in a similar way. A better option might be to entrust a licensed consultant (perhaps classification societies) with this monitoring function. They can check the amount delivered against fuel payments made by the company in charge of the vessel, and also calculate the approximate fuel requirements for the voyages made based on a ship's log. The agency in charge of the scheme could work out a manual for how performance audits should be done. Alternatively, this exercise could be limited to random checks carried out by port state authorities.

In a case of surprisingly low fuel consumption one could suspect fraud, or an unusually successful operation strategy, perhaps involving slow-steaming. It should not be too difficult for a licensed controller or port state authority to distinguish between them. However, it may be hard to explain small deviations from the expected pattern, as a large number of parameters such as routing, weather conditions and ballast-trimming influence real consumption. Therefore operators might get away with not registering a small part of their consumption provided that they were able to buy the fuel from a provider they could bribe. However, anyone doing so would run the risk of being caught. To discourage fraud, the system should enforce a high penalty on cheating. The best deterrence might be to rule that a ship (identified by its IMO number), whose owner, operator or charterer was proven guilty of fraud, would not be accepted in any participating port during the subsequent five or ten years.

7.3 Effects on competition in the shipping sector

A merit of the proposed system is the equal treatment it offers to all ships regardless of ownership, flag, size and port of origin and destination. There is no way for a ship that calls at a participating port to avoid the scheme. This should guarantee non-discrimination and a level playing-field.

When the scheme is introduced, it makes sense to take account of fuel purchased from the day of entry into force. Newly built ships can, of course, only be liable for fuel bought from the day of their launch. All other ships, however, should be liable for fuel purchased up to six months before entry into the system when they join more than six months after the regulation comes into force.

The fact that a ship would be liable for CO_2 emissions from fuel bought during the last six months prior to its call at a participating port will affect the competitiveness of ships that are only occasionally involved in trade with ports in participating countries. The CO_2 liability will reduce their competitivity on other routes, if the owner or the charterer wants to keep the option open to use the ship at a later date for voyages to ports covered by the cap. However, most vessels used in transoceanic shipping are dedicated to specific routes, and if changing to other routes is considered a major problem, the design of the cap-and-trade system can limit the CO_2 liability to three or four months. The period, though, must be long enough to cover a return trip between Europe and

Southeast Asia, and the possibility of evasion by investing in larger bunker fuel capacity must also be considered in this context.

"European" ships that for some part of their voyages operate on routes in other parts of the world (not including calls at EU ports) would be negatively affected by the scheme when competing with ships operating only in regions not covered by the cap. However, ships based in such regions have a similar disadvantage if they occasionally tender for operations where customers want to move freight to Europe. As the geographical scope of the cap grows, an increasing share of the global fleet of commercial vessels will be affected and the disadvantages or advantages of being subject to the scheme will gradually diminish.

Derogations for voyages not affecting European ports could be contemplated but would entail considerable difficulties. It would cause evasion by ships calling at intermediate ports, e.g. in North Africa or Russia, where they would not normally have stopped, and it would require ships to break down their fuel deliveries into the different parts of long-distance voyages.

7.4 Effects on competition with land-based modes

The introduction of a cap on CO_2 emissions from shipping will give land-based modes a temporary competitive advantage, as maritime transport will for the first time have to take responsibility for its emissions. However, one should recall that the long-term intention is to extend the ETS to emissions from fuels used in road transport. The emissions indirectly caused by electric trains are already covered by the ETS. It may also be worth noting that the variation among Member States in their taxation of diesel fuel used by trucks is larger than the anticipated equilibrium price on CO_2 allowances. In the context of inter-modal competition, it is also important to note that, following the outline presented above, most of the revenues raised by auctioning the shipping allowances would be recycled to the sector.

The introduction of a cap on CO_2 emissions from shipping is not likely to cause any noticeable change in modal split. Seagoing vessels currently transport about 90 per cent of all cargo to and from Europe and this pattern will probably prevail. Short-sea shipping is competing more directly with land-based modes. However, its competitive position is likely to be strengthened by the introduction of road-pricing in some Member States and by the European Commission's proposal to raise substantially the harmonised minimum level for the taxation of diesel road fuels.

As more stringent commitments gradually influence the market price of CO_2 allowances, all modes will be affected, but maritime transport will be affected to a lesser extent than aviation, rail and road, as shipping is the most fuel-efficient way of moving cargo.

7.5 Vessels below 400 GT

Ships below 400 GT do not under current IMO rules have to carry a bunker delivery note. As these ships sometimes compete in short-sea shipping with vessels above 400 GT, they should either be covered by the cap or become subject to a harmonised minimum fuel tax. One option might be to allow them individually to choose between the two alternatives. If they prefer cap-and-trade to the tax, they would voluntarily have

to carry bunker delivery notes and have to report to the common authority. This would make sense for ships that are used both for domestic journeys and for international transport.

For ships and boats below 100 GT, national fuel taxation is probably the only feasible solution, while waiting for land-based modes and ships used on inland waterways to be included in the ETS.

7.6 Effects on non-Annex 1 countries

Non-participating countries may think it is unfair of the EU to unilaterally enforce an emission cap that affects their trade. However, other Annex 1 countries have little reason to complain as they have been asked by the UNFCCC to take action together with the IMO. It is their inaction that is forcing the EU to establish a regional scheme.

Non-Annex 1 countries may have better grounds for complaining. However, one should in this respect remember that the ships covered by the scheme are in most cases involved in dedicated trade between non-Annex 1 countries and Member States of the EU, and those ships cause as much pollution on their return voyage as on their trips to Europe. It is also important in this context to recall that in 2004, the eight largest Chinese ports accounted for over a quarter of the world's container traffic (ISL, 2005). This trade is a result of commercial deals which result in both consumer and producer surpluses. Finally, one should note that it is proposed that the majority of the proceeds from the scheme be recycled to the industry on the basis of GT kilometres sailed. Therefore the net burden for the average ship will be small, although high-emitting ships will, of course, have to pay considerably more than they receive back.

Another important fact is that it is only large ocean-going vessels sailing to Europe that will in reality be subject to the scheme, possibly together with some smaller ships operating in the immediate vicinity of Europe.

8. Effects on emissions

The impact on emissions from a cap-and-trade scheme depends on the geographical scope and the level of the cap. In an open system it would be possible to set the cap at a level that keeps emissions from growing. Under a business-as-usual scenario shipping emissions are expected to increase by 3-4 per cent per year.[13] Over a period of 20 years this is equal to an accumulated growth of at least 80 per cent. Even if during the same time the shipping sector makes use of all technological opportunities it is probably not possible to keep its emissions at today's level. However, in addition to undertaking measures in its own sector, the shipping industry can be expected to become a net-buyer of allowances from other sectors and thus help cut emissions elsewhere.

In the case where METS is initially limited to the ports of the European Union and its candidate countries, probably 40-45 per cent of global emissions would be affected. The emissions from EU-flagged ships alone have been estimated at 197 million tons in 2000 or 26 per cent of global emissions from maritime transport (CE Delft et al, 2006).

Under a global regime covering all ships that call at ports of Annex 1 countries, at least two thirds of all CO_2 emissions from international commercial shipping would be subject to the cap-and-trade scheme.

With a cap at 80 per cent of the 2012 level and the scheme restricted to the ports of the European Union, emissions would be reduced by around 50 to 60 per cent in 2035 compared to a business-as-usual scenario. This means at least 6 200 million tons less over 23 years. However, a great part of this will be reductions in land-based sources paid indirectly by the shipping sector.

Assuming that at least one third of the reduction takes place in the maritime sector, emissions of sulphur, NOx and particles will simultaneously be cut by significant amounts.

[13] Corbett et al (2007) forecast that world shipping activity and energy use will double from 2002 to 2030 (annual growth rate of 4.1%), while the growth rates of four different scenarios in Eyring et al (2005) fall in the range of 2.5-4.0% annually.

9. The legal feasibility of the instrument

For political and institutional acceptance, any scheme for emissions trading in the maritime sector must be in line with the United Nations Convention on the Law of the Sea (UNCLOS). The convention provides a universal legal framework for the management of marine resources and regulates international aspects of marine related activities.

UNCLOS Article 212 regulates the rights and duties of states where pollution from or through the atmosphere is concerned. The article reads as follows:

1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from or through the atmosphere, applicable to the air space under their sovereignty and to vessels flying their flag or vessels or aircraft of their registry, taking into account internationally agreed rules, standards and recommended practices and procedures and the safety of air navigation.

2. States shall take other measures as may be necessary to prevent, reduce and control such pollution.

3. States, acting especially through competent international organisations or diplomatic conferences, shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control such pollution.

The UNFCCC must be regarded as a competent international organisation with respect to emissions of greenhouse gases from ships. The IMO, which is normally seen as the competent international organisation with regard to any issues concerning international shipping, is also a body that can take a decision on a global regime for emissions trading in the shipping sector.

9.1 Decisions by port states

If the two relevant bodies under the United Nations fail to come up with a universal system for the abatement of greenhouse gases from international shipping, states can take unilateral action as long as they do not violate the "right of innocent passage" in the territorial sea and the EEZ. The way open to them is to act as port states.

Port states have a wide discretion under the "Law of the Seas" and are allowed to make voluntary port calls conditional on unilaterally enforced standards if they consider this necessary for the protection of their environment. However, the requirements must be proportional to the subject pursued and non-discriminatory. They can be enforced on all vessels regardless of flag.

States have on many occasions used the opportunity to enforce higher standards on ships calling at their ports. Examples of this are the United States Oil Pollution Act, the European Union's early ban on single-hull tankers, the 1996 Stockholm agreement on stability requirements for Roll-on-Roll-off ferries, the US ballast water requirements, the European Union's regulation on the highest permissible sulphur content in fuels used by ferries, the Community's requirement on ships not to use fuel containing more than 0.1

per cent sulphur while at berth[14], and the requirement by the Swedish city of Helsingborg that ferries must have installed SCR as a condition for entry into port.

9.2 The right of innocent passage

In establishing a regional cap-and-trade scheme for international shipping, the EU would respect the right of innocent passage (UNCLOS Article 24). Ships travelling through the territorial waters and the Exclusive Economic Zones of the Member States on their way to ports in non-participating countries would not be covered by the scheme.

[14] Enters into force in 2010.

10. Schedule for implementation

The IMO has so far only managed to produce a draft CO_2 index. Attempts by the organisation to decide on a policy applicable to all ships have been blocked by countries such as China, India and Saudi Arabia, referring to the fact that the Kyoto Protocol only imposes obligations on Annex 1 countries. Recently India and China have changed their position, but Saudi Arabia and the United States are still blocking any substantial progress. The only way forward therefore appears to be for the European Union to take unilateral action. In doing so, the EU can invite other states (or ports in other states) to participate. If after a few years a number of ports in North America, Australia and Japan decide to join the system, the difference between a scheme linked to the ETS and a global regime under the auspices of the IMO would be small.

10.1 A possible timetable

Assuming that the European Commission is able to produce a proposal for a regulation by mid-2008, it should be feasible for the Council of Ministers and the European Parliament to decide on METS and its link to the ETS before the end of 2009. If that happens, the Commission should be able to get the "common authority" up and running before the end of 2010.

There may not be data available for a decision on the size of the cap (i.e. the number of allowances to be auctioned to the shipping sector) in time for the Council's and the Parliament's decision on the system. One way of handling this dilemma and avoiding losing valuable time would be for the decision-makers to entrust the European Commission with the decision or, alternatively, they would have to return later to a final decision on this matter. As noted above, a way of acquiring the data needed for setting the cap could be to make all ships calling at EU ports surrender bunker delivery notes to the common authority during a year prior to the launch of the system. This exercise could be carried out in 2011 before the scheme enters into force, for instance, on 1 January 2013.

The authority in charge of the scheme would also need to spend some time on developing its ships register and the procedures and precise rules for using part of the revenues for grants to R&D and investment in fuel-efficient ships.

In the event of an extension of the system to ports in other parts of the world, the cap would have to be adjusted accordingly. This could be done in negotiations between the European Commission and the foreign states or ports concerned. If eventually the IMO decides on a global cap for emissions from international shipping based on the same or similar principles, it could at some point take over responsibility for the system from the European Union.

11. Instruments for reducing emissions of nitrogen oxides

Nitrogen oxides (NOx) is next to CO_2 the shipping sector's largest contributor to climate change by being a precursor for the formation of ozone, in particular in the high seas where no other sources of NOx exist. NOx emissions also play a role in the reduction of methane, which has a smaller cooling effect. The net effect is thus a significant radiative forcing. When emitted close to land, NOx emissions from shipping additionally cause acidification and eutrophication. There are therefore good reasons to enforce stringent NOx emissions standards on ships regardless of whether they operate in coastal seas or on transoceanic routes.

Emissions of NOx could be recalculated into CO_2 equivalents. A problem in this context, though, is that their radiative forcing varies depending on where the emission takes place. However, based on the average contribution to climate change from NOx, the emissions could potentially be included in a cap-and-trade scheme linked to the ETS. If so, the common authority would have to include data in its register on at least the main engines used by each ship and their specific emissions of NOx assuming an 80 or 85 per cent power utilisation.

Other options for the EU could be to introduce differentiated en-route charges or a baseline-and-credit scheme for NOx along the lines proposed for the Baltic Sea by Kågeson (2006). A number of technical abatement measures exist and most of them can be used for retrofitting, provided that the ship's remaining operational life is long enough to make the investment pay off.

A third option, which would require a decision by the IMO, would be to regulate NOx emissions from new ships above a certain tonnage at a level which represents a 70 per cent reduction below current levels from slow- and medium-speed diesel engines. Such a reduction can be accomplished by two competing technologies, Humid Air Motor (HAM) and Catalytic Selective Reduction (SCR). HAM reduces NOx by about 70 per cent with a small simultaneous reduction in fuel consumption, while SCR cuts emissions by at least 90 per cent. With SCR, urea has to be added to the exhaust fumes. A standard of this kind would cut NOx emissions from the concerned fleet by at least 40 per cent over 25 years in a case where the fleet and the traffic doubled during the period.

12. Summary and recommendations

The main objective of this paper is to analyse the feasibility of a cap-and-trade system for CO_2 emissions from international shipping linked to the European Emission Trading Scheme (ETS).

All models for allocating liability for the emissions appear to be problematic. However, earlier studies appear to have overlooked the possibility of making the ship itself the liable entity. The idea in this paper is to tie the permission for a ship to call at a port to the vessel's participation in a scheme for emissions trading under a common cap. Non-participating ships, therefore, would not be allowed to call voluntarily and to load/unload at participating ports. The person or organisation delivering the allowances could be the owner, the operator, the charterer, the ship's master or someone else. Change of flag state or ownership would not alter the liability of the ship.

The ship would be liable for emissions from fuel bunkered during, say, the six months prior to a call at a participating port. With this design, emissions from the return voyages of ships involved in intercontinental traffic would automatically be covered, and shipowners and operators would gain nothing by calling at ports just outside the European Union. The geographical scope would thus be global, albeit limited to ships that call at ports of the European Union (and other participating states).

The fuel consumption, that the surrendered CO_2 allowances would have to match, could be declared by using the existing mandatory bunker delivery notes that all ships above 400 GT need to keep according to Regulation 18 of MARPOL Annex VI.

The initial allocation of allowances to the shipping sector should be by auction. Using grandfathering in the shipping sector would mean having to decide on allowances for many different types of ship and for ships of different size. In this sector the problem with new entrants and the risk of rewarding companies that sell or scrap facilities is also more pronounced than with land-based activities. Ships are by definition movable. The only good reason for grandfathering is to protect industries from losing market shares to competitors in non-participating countries. This problem will not occur in shipping if all vessels calling at participating ports, regardless of flag and port of departure, must surrender allowances equal to the fuel used.

In the likely case of UNFCCC and/or IMO proving unable to take a decision on the introduction of a cap on CO_2 emissions from international shipping, the European Union can introduce a scheme of its own, the *Maritime Emissions Trading Scheme* (METS). When establishing the scheme, the EU should invite non-Member States to participate. Some may decide to join METS from the start. Others may follow later. To facilitate the entry of new participants, it is essential to design the scheme in a way that makes it easy to include additional countries and ports. When this happens the system must be able to adjust the cap accordingly and to allow the newcomers a proportional influence over the scheme. For these reasons, the scheme should be introduced via an EU regulation rather than a directive.

The European Union would have to create a "common authority" for the administration of the scheme. Making the Member States responsible for this task would hardly work with thousands of ships belonging to shipowners in various parts of the world. It is better to create one common ships register for this purpose and to entrust the common authority with both auctioning allowances and monitoring that all ships have surrendered allowances covering their emissions.

A problem with getting the scheme started is the lack of reliable fuel sales statistics. One way of acquiring the data needed for setting the cap could be to make all ships calling at EU ports surrender bunker delivery notes to a common authority for the year or two prior to the launch of the system.

The revenues from auctioning the allowances could be expected to amount to around €4.8 billion per annum (at an average price of €20/ton CO_2). The proceeds could be recycled to the shipping sector or used for any other purpose.

A reason for spending at least part of proceeds on shipping might be that creating METS and linking it to the ETS will only affect investment in new vessels to a minor degree. Most of the sector's adaptation will take the form of buying allowances from other sectors. A supplementary instrument may therefore be needed to make shipowners consider the CO_2 abatement measures required for meeting longer-term commitments in a cost-efficient way. Given the long expected life of vessels, incentives are needed now for adjusting the fleets to the likely CO_2 prices related to future stringent climate change commitments.

One option might be to allow some of the revenues from the auctioning to finance grants to R&D programmes and to front-runners who want to order and build ships that have properties which reduce fuel consumption substantially below best practice. An additional way of recycling part of the revenues could be to give a fixed annual remuneration to all ships that make active use of the IMO's CO_2 index. This would make a growing number of stakeholders aware of the operational and technological options for making the ships consume less fuel.

To the extent that proceeds cannot be wisely spent on grants, the revenues could be returned to the participating shipowners in relation to the number of GT kilometres sailed. If and when the Member States of the European Union begin to auction an increasing portion of the allowances to land-based sources, the amount of money recycled to the shipowners could gradually diminish.

In the impact assessment of its proposal for including emissions from aviation in the EU ETS, the Commission concludes that the scheme is likely to have only a very small effect on forecast growth in demand as airlines will be able to pass on, to a large extent or even in full, compliance costs to customers. The Commission also states that competition between airlines will not be significantly affected. The analysis in this report of the effects on shipping from being included in the ETS shows that they are similarly small. A merit of the proposed system is the equal treatment it offers to all ships regardless of ownership, flag, size and port of origin. There is no way for a ship that calls at a participating port to avoid the scheme.

The introduction of a cap on CO_2 emissions from shipping is not likely to cause any noticeable change in modal split. As more stringent commitments gradually influence the future market price of CO_2 allowances, all modes will be affected, but maritime transport will be affected to a lesser extent than aviation, rail and road, as shipping is the most fuel-efficient way of moving cargo.

In the case where the cap-and-trade system is initially limited to the ports of the European Union, at least 6 200 million ton less CO_2 would be emitted over the 23 years between 2012 and 2035 compared to a business-as-usual scenario. However, a great part of this would be reductions in land-based sources paid indirectly by the shipping sector. Assuming that at least one third of the reduction takes place in the maritime sector, emissions of sulphur, NOx and particles will simultaneously be cut by significant amounts.

For political and institutional acceptance, a scheme for emissions trading in the maritime sector must be in line with the United Nations Convention on the Law of the Sea (UNCLOS). The way open to the Member States is to act as port states. Port states are allowed to make voluntary port calls conditional on unilaterally enforced standards if they consider this necessary for the protection of their environment. However, the requirements must be proportional to the subject pursued and non-discriminatory. They can be enforced on all vessels regardless of flag. States have on several occasions used the opportunity to enforce higher standards on ships calling at their ports.

In establishing a regional cap-and-trade scheme for international shipping, the EU would respect the right of innocent passage (UNCLOS Article 24). Ships travelling through the territorial waters and the Exclusive Economic Zones of the Member States on their way to ports in non-participating countries would not be covered by the scheme.

Assuming that the European Commission is able to produce a proposal for a regulation by mid-2008, it should be possible to get the “common authority” up and running before the end of 2010. A trial year will be need for collecting data for taking a final decision on the size of the cap and the number of allowances to be auctioned. This exercise could be carried out in 2011 before the scheme enters into force, for instance, on 1 January 2013.

References

CE Delft et al (2006), *Greenhouse Gas Emissions for Shipping and Implementation Guidance for the Marine Fuel Sulphur Directive*. Report by CE Delft, Germanischer Lloyd, MARINTEK, and Det Norske Veritas.

Corbett, J. (2006), *Environmental Impacts of Ocean Shipping in a Freight Context*, A report to the OECD, Paris, November.

Corbett, J., Wang, C., Winebrake, J. and Green, E. (2007), *Allocation and Forecasting of Global Ship Emissions*. Prepared for the Clean Air Task Force, Boston, USA, January 11.

European Commission (2002), *A European Union strategy to reduce atmospheric emissions from seagoing ships*, COM(2002)595 final, Brussels, 2002

European Commission (2006a), *Proposal for a Directive amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emissions allowance within the Community*. COM(2006) 818 final.

European Commission (2006b), *Impact Assessment of the inclusion of aviation activities in the scheme for greenhouse gas emissions allowance within the Community. Accompanying staff document to the Proposal for a Directive amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emissions allowance within the Community*. SEC(2006) 1684.

Eyring, V., Köhler, H.W., van Aardenne, and Lauer, A. (2005), *Emissions from international shipping: The last 50 years*. Journal of Geophysical Research, Vol. 110, D17, 305.

Faber, J., Berk, M., den Elzen, M. and Lee , D. (2006), *Aviation and maritime transport in a post 2012 climate policy regime*, CE Delft, August.

Friedrich, A., Heinen, F., Kamakaté, F. and Kodjak, D. (2007), *Air Pollution and Greenhouse Gas Emissions from Ocean-going Ships*. ICCT, The International Council of Clean Transportation.

IMO (2000), *Study of Greenhouse Gas Emissions from Ships*. Final Report to the International Maritime Organization, prepared by Marintek, Carnegie Mellon University, Econ and DNV.

IMO (2003): Resolution A.963(23). *IMO policies and practices related to the reduction of greenhouse gas emissions from ships*. Adopted on 5 December 2003. London

IMO (2005), *Interim Guidelines for Voluntary Ship CO_2 Emission Indexing for use in Trials*. MEPC/Circ.471, 29 July.

ISL (2005), *Container and General Cargo Fleet Development. Supply/Demand Patterns and World Container Port Development*. Bremen, Germany.

Kågeson, P. (2006), *Economic instruments for reducing shipping emissions. A pilot project for the Baltic Sea.* Nature Associates. Presented at OECD, Environment Directorate, Working Party on National Environmental Policy, Working group on transport, Paris, 30 November 2006.