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Environmental, economic and legal analysis of different options

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Integration of Marine Transport into the European Emissions Trading System

Environmental, economic and legal analysis of different options

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16. Abstract

Marine vessels globally contribute to carbon dioxide emissions with approximately 3.3% (IMO 2009). International ocean shipping has been growing significantly over recent years. To date international marine emissions are not part of the Kyoto obligations and the member states at IMO have not implemented instruments that would have limited or reduced the amount of greenhouse gas emissions from ships. The European Union has announced that if no international agreement including reduction targets for seaborne emissions has been approved by the UNFCCC by December 31, 2011, the EC is tasked to submit a proposal for including international marine transport in European reduction targets and policy measures. An inclusion of international marine transport in the European Emissions Trading Scheme (EU ETS) is a likely scenario.

The study investigates three options for integrating international ocean shipping into the EU ETS based on: a last period; the last distance travelled and the distance the cargo has travelled. Basing the system on a *last period* is superior to basing it on *last trip* or *cargo* in terms of environmental effectiveness. However, the system would cover vessel activities in international waters, even potentially between two non-European ports, and thus the legal feasibility of this challenge is discussed. Another element of the study is the analysis of the economic effects of the integration of international seaborne greenhouse gas emissions into the EU ETS.

Overall it can be concluded that the integration of international ocean shipping into the EU ETS is a legally and technically feasible option with no significantly negative or even beneficial economic effects. The extension to vessel activity in international waters secures adequate coverage and environmental effectiveness. This extension to vessel activity in international waters is not only a prerequisite for adequate emissions coverage, but is also associated with the least legal obstacles, is easier to monitor and is administratively simple. Given the low-cost abatement options with ocean going vessels the integration into the EU ETS by 2015 would provide a possible policy target – particularly if no action by the IMO or UNFCCC has been taken by the end of 2011.

17. Keywords
Greenhouse gas emissions from international shipping; Marine transport and climate change; Seaborne freight CO_2 emissions; UNCLOS and climate protection; Emission trading and marine transport; Legal feasibility national maritime regulations; economic effects marine GHG abatement

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15. Zusätzliche Angaben

16. Kurzfassung
Der internationale Seeverkehr trägt mit ca. 3,3 % zu den globalen Treibhausgasemissionen bei (IMO 2009). Darüber hinaus ist der internationale Seeverkehr in den vergangenen Jahren überproportional angestiegen. Bis Heute unterliegen die CO_2-Emissionen aus dem internationalen Seeverkehr keinen internationalen Übereinkommen oder Regeln. Die Europäische Kommission hat verkündet, dass, sofern es keine von der UNFCCC gestützte Einigung über Reduktionsziele für den internationalen Seeverkehr bis 31. Dezember 2011 gibt, die Kommission damit beauftragt wird, Vorlagen zu Reduktionszielen und Politikmaßnahmen zu erstellen. Die Einbindung des internationalen Seeverkehrs in das Europäische Emissionshandelssystem (EU ETS) ist dabei ein wahrscheinliches Szenario. Die vorliegende Studie untersucht vertieft drei Varianten zur Integration des internationalen Seeverkehrs in das EU ETS. Diese Varianten basieren auf: Zeitperiode, Distanz von Schiff und Distanz von Fracht. Der Ansatz der sich auf eine Zeitperiode bezieht ist der vorzuziehende Ansatz. Allerdings ist mit dem Ansatz verbunden, dass sich ein solches Regime auf Schiffsaktivitäten in internationalen Gewässern und sogar zwischen zwei nicht-europäischen Häfen ausdehnen würde. Die juristische Machbarkeit eines solchen Ansatzes ist von daher einer der kritischen Fragen und wird im Bericht ausführlich diskutiert. Weiteres wesentliches Element der Studie ist die Analyse der wirtschaftlichen Auswirkungen einer Einbindung des internationalen Seeverkehrs in das EU ETS.
Zusammenfassend kann geschlussfolgert werden, dass die Einbindung des internationalen Seeverkehrs in das EU ETS rechtlich zulässig und technisch möglich ist, und keine negativen bzw. sogar positive wirtschaftliche Effekte für Deutschland und Europa zu erwarten sind. Die Ausdehnung eines europäischen Handelssystems, dass auch nicht-territoriale Seeverkehre einschließt, ist nicht nur Bedingung ausreichender Umwelteffekte sondern auch verbunden mit den geringsten juristischen Schwierigkeiten. Zudem ist es einfacher zu Überwachen und administrativ am einfachsten umsetzbar. Eine Einbindung des internationalen Seeverkehrs in das EU ETS bis 2015 stellt, angesichts der niedrigen Emissionsvermeidungskosten bei Seeschiffen, ein mögliches Politikziel dar – insbesondere wenn bis Ende 2011 keine von der IMO initiierte und von der UNFCCC akzeptierte Reduktion der Treibhausgasemissionen aus dem Schifffahrtssektor manifestiert ist.

17. Schlagwörter
Seeschifffahrt und Emissionshandel; Treibhausgasemissionen der Schifffahrt CO_2 Emissionen internationaler Seeverkehre; UNCLOS und Klimaschutz; Legale Machbarkeit von Politikmaßnahmen; Marine Treibhausgasminderung internationales Seerecht; Emissionshandel Seewirtschaft; EU Politikmaßnahmen im Seeverkehr

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List of Abbreviations

AIS	Automated identification system
AKN	Aktionskonferenz Nordsee
BAU	Business as usual scenario
BFDN	Bunker fuel delivery notes
CDEM	Construction, design, equipment and manning
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CO_2	Carbon dioxide
CO_2 eq	Carbon dioxide equivalent
dwt	Dead weight tonnage, to measure carrying capacity of ships
EC	European Commission
ECA	Emission control area
ECSA	European Communities' Shipowners' Association
EEDI	Energy Efficiency Design Index
EEOI	Energy Efficiency Operational Index
EEX	European Energy Exchange
EEZ	Exclusive Economic Zone
ERU	Emission Reduction Units
EU	European Union
EU ETS	European Emissions Trading System
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
HHLA	Hamburger Hafen und Logistik AG
HFO	Heavy fuel oil
IMO	International Maritime Organization
IWT	Inland waterway transportation
JI	Joint Implementation

lm	Lane meters
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LRIT	Long range identification and tracking system
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978
MCR	Maximum continuous engine rating
MDO	Marine diesel oil
MEPC	Marine Environmental Protection Committee (by the IMO)
MGO	Marine gas oil
MSC	Marine Security Committee (by the IMO)
MT	Million tonnes (metric)
NOx	Nitrogen oxides
OBL	Ocean bill of lading
OECD	Organization for Economic Cooperation and Development
R&D	Research and Development
ROI	Return on investment
RoRo	Roll-on-Roll-off vessels
ROS	Return on sales
RTK	Revenue tonne kilometres
SOLAS	Convention Safety of Life at Seas
SOx	Sulphur oxides
TEU	Twenty foot equivalent unit for containers
t-km	Tonne-kilometer
UBA	German Federal Environment Agency
ULBC	Ultra large bulk carrier
ULCC	Ultra large crude oil carrier
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNFCCC	United Nations Framework Convention on Climate Change

US EPA	United States Environmental Protection Agency
VHF	Very high frequency
VLCC	Very large crude oil carrier
VMS	Vessel monitoring system
WTO	World Trade Organization

1 Executive Summary

Marine vessels globally contribute to carbon dioxide emissions with approximately 3.3% (IMO 2009). International ocean shipping has been growing significantly over recent years with double digits, in particular in the container segment – the most energy intense ocean shipping segment. The growth forecast for seaborne trade today carries a high degree of uncertainty – particularly since the current financial and economic crises. However, assuming an economic recovery and strong demand in countries in transition such as India and China, a further growth can be expected.

To date international marine emissions are not part of the Kyoto obligations and the member states at IMO have not implemented instruments that would have limited or reduced the amount of greenhouse gas emissions from ships. However, greenhouse gas emissions from ships have been increasingly on the agenda at the IMO and recent developments have paved the way for designing innovative policy measures in the future. For example, an Energy Efficiency Design Index (EEDI) methodology has been developed and will be tested in the next years on a voluntary basis (MEPC 2009a). An Energy Efficiency Operational Indicator (EEOI) method has also been developed and may be used to gather experience from ships in voyage. Finally, vessel operators are being encouraged to implement energy efficiency goals in their environmental and ship management plans. However, in particular the EEOI is unlikely to produce vessel performance figures that allow for comparative assessments of vessels because it includes the real freight load and will thus result in large spreads of performances.

At the same time, scientific evidence on the urgent need to curb greenhouse gas emissions is strong and the sectoral contribution of marine transport emissions has risen in the past. The European Council recently expressed the aim of reducing greenhouse gas emissions by 20 % by 2020 compared to 2005 for the maritime transport sector. Furthermore, the European Union has announced that if no international agreement including reduction targets for seaborne emissions has been approved by the UNFCCC by December 31, 2011, the EC is tasked to submit a proposal for including international marine transport in European reduction targets and policy measures. An inclusion of international marine transport in the European Emissions Trading Scheme (EU ETS) is a likely scenario.

Seaborne freight is an economic driver worldwide. Around 90 % of the EU's foreign trade (by weight) is conducted by sea and 40 % in terms of ton-kilometre of its internal trade is seaborne (DG TREN 2009). Sea-related sectors in Europe produce an added value of around € 189 billion; this corresponds to around 1.65 % of GDP. Employment related to seaborne trade is estimated at 1.5 million people; 70% of who work onshore. Employment categories include: shipbuilding, naval architecture, science, engineering, electronics, cargo-handling and logistics.

European seaborne transport activity causes approximately 32 % of the global emissions stemming from international marine traffic. The share of marine emissions from international traffic that falls under the responsibility of European economic activity exceeds by far the share that is emitted within the 12 mile territorial waters or even 200 mile Exclusive Economic Zone. An effective policy regime would thus need to extend to marine activity in international waters. Coverage of around one third of the global seaborne emissions should be the goal of a European policy measure.

Furthermore, the ocean shipping sector offers cost effective ways to reduce greenhouse gas emissions. Those measures include operative and technical measures, which are not all applicable to every vessel. The German and European marine industry is in particular strong in terms of providing innovative and fuel reducing technologies. Thus, the European marine industry is one potential beneficiary of implementing efficiency standards in the marine sector.

The significance of seaborne greenhouse gas emissions and the options to curb emissions at relatively low costs leads to the conclusion that a rather tight emissions cap should be chosen. Moreover, the cap should be based on past emissions, for example in the 2004 – 2006 period which could be modelled with sufficient accuracy. One option would be to set the reduction effort for the maritime sector to the percentage level of the overall EU target in a post-2012 climate regime (30 %). This would correspond to a 20 % emission increase compared to 1990 and a 43 % emission decrease compared to business as usual emissions in 2020.

Due to the uncertainties in the projected growth of maritime emissions any target less ambitious than this could lead to a market with more allowances than emissions. A less ambitious target would not only stay below the low-cost emission reduction potential but also go against the need for urgent action to reduce GHG emissions in all sectors. Furthermore, as long as the scheme is only semi-open, not allowing the selling of “maritime” emission allowances to stationary installations, emissions trading will only function properly if the cap is set relatively strictly and the maritime sector does not become a ‘net seller’. The complete inter-changeability between aviation’s emission allowances and shipping’s allowances would improve the Emissions Trading Scheme in this respect and should be considered.

The study shows that auctioning is the easiest and fairest way to distribute allowances. Despite this, free allocation may be suited as the initial way to distribute allowances in the shipping sector in order to ease the integration of the maritime industry into the EU ETS. If so, the share of free allocation should be decreased annually and reach zero before the year 2030. Any free allocation should be based on a set of benchmarks for different types of ships. A new entrants reserve and closure provisions should be established to reflect changes in the group of responsible entities between the reference period used for benchmarking and the years after the start of the trading scheme.

The data that is necessary for the integration of ocean ships into the EU ETS is already available on board the ships. The necessary data include information on the fuel consumed and are backed up for verification purposes with vessel activity (distance travelled) data. Reporting could be made mandatory by the European Union using the authority of the Port State Control. Reliance on the manual submission of information would make for a low cost method of monitoring and reporting and is already available today. Electronic surveillance systems currently lack the technical capabilities and have some legal and economic obstacles to clear before they can be utilized for a policy instrument. However, a future remote monitoring system might be envisioned.

The study investigates three options for integrating international ocean shipping into the EU ETS based on: a last period prior to the port of call; the last distance travelled prior to the port of call; and the distance the cargo has travelled. Basing the system on a *last period* is superior to basing it on *last trip* or *cargo* in terms of environmental effectiveness. The *last period* approach would allow coverage of at least up to one third of the international seaborne emissions. Furthermore, monitoring would be simple compared to the other options because of the difficulty of delineating the *last trip* or the numerous data points and entities involved in a freight based approach. A system that covers *last period* would further include import and export trades within the period and thus would not face potential violations of international trade laws. However, the system would cover vessel activities in international waters, even potentially between two non-European ports, and thus making legal feasibility crucial.

A legal assessment of any version of an EU ETS that aims at the integration of marine transport under inclusion of emissions effected on the high seas or even on territorial waters of Non-EU states shows that the main difficulties with respect to legal questions lie in the field of jurisdiction. However, the use of extraterritorial jurisdiction can – with good arguments – be based on the principle of territoriality, as there is a direct and significant nexus between the causes to be regulated and the effects on the territory of the European Union. Furthermore neither UNCLOS nor MARPOL or GATT poses serious hindrances with respect to the integration of marine transport into the existing EU ETS. However, there are some aspects that have to be considered in the design of the EU ETS: Enforcement should exclude unreasonable monetary penalties or the detention of ships as such enforcement matters could possibly not be lawfully based on legislation regulating extraterritorial behaviour. Furthermore, especially with respect to GATT, it should be kept in mind that any discrimination between vessels must be avoided. And the system at last should not encompass the prescription of the Construction, Design, Equipment and Manning standards that travel with the ship as such a prescription would violate Art. 21 UNCLOS.

With regard to the economic effects, an integration of the maritime transport sector into the EU ETS would most probably cause little or no damage to the German and European economy if prices for allowances stay reasonable, i.e. if they do not constantly rise well above € 30 up to 2020. Some trades may face drops in demand if the prices for allowances reach a very high level (such as € 70). As price elasticity of demand is relatively low in the maritime transport market and the sector is partly characterized by cooperative price setting strategies, most, if not all, of the marginal cost increase will be passed on to the customers, at least in economically stable periods. In general, it cannot be ruled out that in some countries exporting or importing industries will be adversely affected from increasing freight rates. But looking at Germany's structure of merchandise trade no severe effects are expected.

The German sector of ship builders, which is currently undergoing shrinkage and restructuring, will very likely profit from the demand for more efficient vessels or retrofitting technologies as they already have several years of experience in this field. Emissions trading can help them to extend this lead over their strongest competitors in Asia as demand for emission reducing technologies will increase. The German machine building sector will profit as well.

Overall it can be concluded that the integration of international ocean shipping into the EU ETS is a legally and technically feasible option with no significantly negative or even beneficial economic effects. The reach of an EU policy measure such as the integration of vessels into the EU ETS need to extend to vessel activity in international waters in order to secure adequate coverage and environmental effectiveness. This extension to vessel activity in international waters is not only a prerequisite for adequate emissions coverage, but is also associated with the least legal obstacles, is easier to monitor and is administratively simple. Given the low-cost abatement options with ocean going vessels the integration into the EU ETS by 2013 would provide a possible policy target – particularly if no action by the IMO or UNFCCC has been taken by the end of 2011.

2 Zusammenfassung

Der weltweite Seeverkehr trägt mit ca. 3,3 % zu den globalen Treibhausgasemissionen bei (IMO 2009). Darüber hinaus ist der internationale Seeverkehr in den vergangenen Jahren überproportional angestiegen. Im Container-Schiff-Sektor, dem energieintensivsten Seetransportsektor pro Tonnen-Kilometer, betrugen die Zuwächse zum Teil zweistellige Prozentzahlen pro Jahr. Spätestens seit Beginn der Finanz- und Wirtschaftskrise in 2008 sind die Vorhersagen über die zukünftige Entwicklung des internationalen Seeverkehr zwar mit einigen Unsicherheiten behaftet, ein weiterer Anstieg ist aber unter der Annahme einer wirtschaftlichen Erholung und in Anbetracht der weiter stark wachsenden Ökonomien von Ländern wie China und Indien zu erwarten.

Bis heute unterliegen die Emissionen aus den internationalen Seeverkehren keinen internationalen Übereinkommen oder Regeln. Die internationale Staatengemeinschaft hat sich weder zum Kioto Protokoll von 1997 noch in den Gremien der Internationalen Seeschifffahrtsorganisation (IMO) auf Maßnahmen einigen können, die die Treibhausgasemissionen der Seeschiffe beschränkt oder reduziert hätten. Seit Mitte der 90er Jahren sind Treibhausgasemissionen von Seeschiffen jedoch verstärkt auf die Tagesordnung der IMO gerückt und die letzten Entwicklungen bei der IMO legen prinzipiell einen Grundstein, um Politikinstrumente für international verkehrende Seeschiffe umzusetzen. Beispielsweise wurde ein Energie-Effizienz-Design-Index (EEDI) entwickelt und wird in den nächsten Jahren auf freiwilliger Basis getestet (MEPC 2009a). Ein Energie-Effizienz-Betriebs-Indikator (EEOI) wurde ebenfalls entwickelt und kann unter Umständen dazu genutzt werden aus dem laufenden Betrieb von Schiffen Erfahrung und Daten zu sammeln. Zusätzlich sind Schiffsbetreiber aufgefordert, energieeffizienzsteigernde Maßnahmen umzusetzen und diese in deren Schiffsmanagement- und Umweltplänen zu verankern. Insbesondere der EEOI krankt jedoch daran, dass durch die Mitberücksichtigung der realen Frachtbeladung faktisch keine brauchbaren Vergleichswerte für Schiffe ermittelt werden können.

Gleichzeitig nimmt die wissenschaftliche Gewissheit zu, dass eine deutliche Reduzierung der globalen Treibhausgasemissionen aus Umweltgesichtspunkten notwendig ist. Der weltweite Seeverkehr ist hierbei ein wichtiger Verursacher mit zudem stetig steigendem Verbrauch fossiler Energien. Der Rat der Europäischen Union hat kürzlich Treibhausgasreduktionsziele für den maritimen Sektor formuliert. Diese sollen bis 2020 um 20 % gegenüber 2005 gesenkt werden. Darüber hinaus hat die Europäische Kommission verkündet, dass, sofern es keine von der UNFCCC gestützte Einigung über Reduktionsziele für den internationalen Seeverkehr bis 31. Dezember 2011 gibt, die Kommission damit beauftragt ist Vorlagen zur Reduktionszielen und Politikmaßnahmen zu erstellen. Die Einbindung des internationalen Seeverkehrs in das Europäische Emissionshandelssystem (EU ETS) ist dabei ein wahrscheinliches Szenario.

Der internationale Seeverkehr ist ein Motor der globalen Wirtschaft. Etwa 90 % des außer-europäischen Handels (nach Gewicht) und etwa 40 % des inner-europäischen Handels (nach Tonnen-Kilometer) ist Seehandel (DG TREN 2009). Die maritime Wirtschaft in Europa produziert einen volkswirtschaftlichen Wert von ca. 189 Milliarden Euro, was etwa 1,65 % des Bruttoinnlandsprodukts (nach Marktpreisen) entspricht. Die maritime Wirtschaft beschäftigt etwa 1,5 Millionen Menschen. 70 % der maritim Beschäftigten arbeiten in Industrien an Land. Arbeitsfelder der maritimen Wirtschaft sind dabei im Wesentlichen Schiffsbau, Schiffsforschung, -design und –entwicklung, Maschinenbau, Elektrotechnik, Frachtbeförderung und Logistik.

Der europäische Seehandel ist für etwa 32 % der globalen Treibhausgasemissionen aus dem Seeverkehr verantwortlich. Dieser Anteil an den Treibhausgasemissionen, der durch den europäischen Seehandel induziert ist, übersteigt bei weitem die Emissionen, die in den europäischen 12 Meilen Zone der Territorialgewässers und 200 Meilen Zone der erweiterten Wirtschaftzone (EEZ) von Schiffen emittiert werden. Es ist von daher notwendig, dass ein effektives europäisches Politikinstrument auf Seeverkehre zugreifen muss, die in internationalen Gewässern stattfinden. Die Abdeckung von ca. einem Drittel der globalen Treibhausgasemissionen aus dem Seeverkehr sollte das Ziel von europäischen Politikmaßnahmen bilden.

Darüber hinaus bietet die maritime Schifffahrt eine Reihe von kosteneffizienten Möglichkeiten, die Treibhausgasemissionen zu mindern. Zu diesen Möglichkeiten zählen sowohl betriebliche als auch technische Maßnahmen, die jedoch nicht alle auf jedes Schiff anwendbar sind. Die europäische und die deutsche Schiffbauindustrie ist dabei ein Vorreiter in der Entwicklung von innovativen und treibstoffsparenden Technologien. Nicht zuletzt dadurch ist die europäische Schiffbauindustrie unter Umständen ein Profiteur von strengeren Effizienzanforderungen an die internationale Seefahrt.

Die globale Bedeutung und die Möglichkeiten Treibhausgasemissionen bei Schiffen kostengünstig senken zu können veranlasst zu der Schlussfolgerung, dass eine potenzielle Emissionsgrenze (cap) streng zu bemessen ist. Zusätzlich sollte sich eine Emissionsgrenze an vergangenen Emissionen, beispielsweise als Mittelwerte aus dem Zeitraum 2004 – 2006, orientieren. Diese Emissionen ließen sich mittels Modellierung mit ausreichender Genauigkeit darstellen. Eine Option zur Festsetzung eines Reduktionsziels wäre die Orientierung an den gesamt-europäischen Reduktionszielen für Treibhausgase, die für ein Kioto-Folgeregime vorgeschlagen sind (minus 30 %). Dies würde für den maritimen Sektor basierend auf 2004 – 06 in etwa ein plus von 20 % der Emissionen gegenüber 1990 und eine Reduktion um minus 43 % der prognostizierten, fortgeschriebenen Emissionen in 2020 in einem ‚business as usual' Szenario bedeuten.

Aufgrund der Unsicherheiten über zukünftige Wachstumsraten im internationalen Seeverkehr könnte ein Reduktionsziel kleiner als die Größenordnung von 30 % zu ungewollten Effekten führen. So wäre eine Situation in der mehr Emissionszertifikate ausgegeben würden als Emissionen verursacht werden möglich. Ein geringer ambitioniertes Reduktionsziel würde unterhalb der Reduktionspotenziale liegen, die im Schiffssektor durch kostengünstige Maßnahmen umsetzbar wären. Es würde auch dem Ziel die Treibhausgasemissionen in allen Sektoren zu senken nicht Folge leisten. Darüber hinaus funktioniert das EU ETS nach Einbindung des internationalen Seeverkehrs und unter der Voraussetzung, dass der Seeverkehr nur Zertifikate kaufen, nicht aber an stationäre Emissionsquellen verkaufen kann (semi-open) nur dann, wenn die Emissionsbegrenzung relativ streng ist und die internationale Seeschifffahrt kein Netto-Verkäufer von Zertifikaten wird. Die Option einer uneingeschränkten Handelbarkeit von Zertifikaten zwischen dem Schifffahrts- und dem Flugsektor würde diese potenziellen Mängel der Einbindung mindern und sollte in Erwägung gezogen werden.

Die vorliegende Studie zeigt, dass die Auktionierung von Emissionszertifikaten der einfachste und der gerechteste Weg wäre die Zertifikate dem Sektor zu zuteilen. Allerdings könnte eine anfängliche freie Verteilung von Emissionszertifikaten die Integration der Schifffahrtsindustrie in das EU ETS politisch leichter umsetzbar machen. Falls eine anfängliche freie Verteilung gewählt würde, sollten die Anzahl der feien Zertifikate jährlich abnehmen und noch vor 2030 auf Null reduziert werden. Die freien Zertifikate sollten auf Referenzwerten (benchmarks) für verschiedene Schiffskategorien basieren. Spezielle Regelungen für neue Zugänge und für Abgänge aus dem Seeverkehr zum EU ETS sollten verankert werden, um den wahrscheinlichen Veränderungen am Markt und Rechnung zu tragen und Marktzutritte zu erleichtern.

Die Daten, die für eine Integration des internationalen Seeverkehrs in das EU ETS notwendig sind liegen bereits auf den Schiffen vor. Die notwendigen Daten umfassen beispielsweise den Treibstoffverbrauch, sowie Informationen über die gefahrenen Strecken zum Zweck der Datenverifizierung. Eine Berichtspflicht könnte unter Berufung auf die Hafenstaathoheit (Port State Control) von den Mitgliedsstaaten der Europäischen Union verpflichtend eingeführt werden. Die manuelle (u. U. elektronische) Übertragung der Daten stellt eine kostengünstige und sofort verfügbare Methode dar, die notwendigen Daten zu sammeln. Elektronische Fernüberwachungssysteme verfügen heute noch nicht über die notwendigen Kapazitäten. Zudem stellen sich derzeit noch einige offene juristische Fragen sowie Fragen zur Wirtschaftlichkeit von elektronischen Fernüberwachungssystemen, die zunächst geklärt werden müssten. Langfristig können diese Systeme durchaus zur Überwachung der Emissionen aus der internationalen Seeschifffahrt eingesetzt werden.

Die vorliegende Studie untersucht verstärkt drei verschiedene Varianten zur Integration des internationalen Seeverkehrs in das EU ETS. Diese Varianten basieren auf: einer vergangenen Periode vor dem Anlegen in einem europäischen Hafen; die letzte gefahrene Strecke vor Anlegen in einem europäischen Hafen; und die Distanz der transportierten Güter. Die Grundlage einer vergangenen Periode hat sich dabei als vorteilhafter gegenüber der Grundlage letzte Strecke herausgestellt. Der Ansatz einer vergangenen Periode würde es erlauben eine ausreichende Abdeckung von etwa einem Drittel der globalen schiffsseitigen Emissionen zu erreichen. Darüber hinaus wäre das Überwachen der Emissionen aus vergangener Periode im Vergleich einfacher, da eine Abgrenzung der letzten Strecke schwierig ist und beim frachtbasierenden Ansatz eine große Menge an Daten von verschiedenen Akteuren zu sammeln wären. Ein Ansatz, der sich auf eine vergangene Periode bezieht würde zudem sowohl Importe als auch Exporte innerhalb dieser Periode abdecken und würde dadurch Verletzungen des internationalen Handelsrechts vermeiden. Allerdings ist mit dem Ansatz der vergangenen Periode verbunden, dass sich ein solches Regime auf Schiffsaktivitäten in internationalen Gewässern und sogar zwischen zwei nicht-europäischen Häfen ausdehnen würde. Die juristische Machbarkeit eines solchen Ansatzes ist von daher einer der kritischen Fragen.

Die in dieser Studie vorgestellte juristische Bewertung der verschiedenen Optionen zur Integration des internationalen Seeverkehrs in das EU ETS zeigt, dass der wesentliche Aspekt, der eine Ausdehnung von Politikinstrumente auf Schiffe in internationalen Gewässern erlaubt, die Frage der Legalität extraterritorialer Maßnahmen ist. Die Implementierung von Maßnahmen, die extraterritorial Wirksam sind, kann nach Bewertung der juristischen Grundlagen auf dem Prinzip der Territorialität begründet werden, da eine direkte und wesentliche Verbindung zwischen den Verursachern von Treibhausgasemissionen und den negativen Effekten auf das Territorium der Länder der Europäischen Union besteht. Zudem stellen weder das internationale Seerecht (UNCLOS), das Übereinkommen zum Schutz der Meeresumwelt der IMO (MARPOL) oder das internationale Handelsrecht (GATT) ernstliche Hindernisse zur Einbindung des internationalen Seeverkehrs in das existierende EU ETS dar. Allerdings müssen einige kritische Aspekte bei der Ausgestaltung der Einbindung berücksichtigt werden: Die Instrumente zur Vollstreckung sollten unangemessen hohe Strafzahlungen und die Festsetzung von Schiffen als Strafmaßnahmen vermeiden, da diese unter Umständen geltenden Gesetzen zur Regelung extraterritorialer Angelegenheiten widersprechen. Zusätzlich muss eine Diskriminierung bestimmter Schiffe vor dem Hintergrund des internationalen Handelsrecht vermieden werden. Und schließlich dürfen nationale Instrumente nicht das Vorschreiben von sogenannten „Construction, Design, Equipment and Manning Standards“ – technische und personelle Standards die an das fahrende Schiff selber gebunden sind - beinhalten, da dies die Vorgaben des Artikel 21 d UNCLOS verletzen würden.

Die in dieser Studie diskutierte Bewertung der wirtschaftlichen Auswirkungen einer Einbindung des internationalen Seeverkehrs in das EU ETS kommt zu dem Schluss, dass eine solche Einbindung wenig oder nur geringe negative Auswirkungen auf die Volkswirtschaften Deutschlands und anderer europäischer Länder haben würde. Dieses Ergebnis gilt, solange die Zertifikatpreise im vorhersehbaren und angemessenen Rahmen liegen und etwa € 30 pro Tonne bis 2020 nicht übersteigen. Bei Zertifikatpreisen die deutlich über € 30 liegen – beispielsweise € 70 – wäre ein deutlicher Rückgang der Nachfrage auf manchen Handelsrouten zu erwarten. Da die Preiselastizität im maritimen Transportsektor vergleichsweise gering und der Sektor zum Teil durch kooperative Preissetzung charakterisiert ist, kann davon ausgegangen werden, dass der Großteil der zusätzlichen Kosten – wenn nicht sogar alle – an die Kunden weiter gegeben werden. Davon muss zumindest in wirtschaftlich vergleichsweise stabilen Perioden ausgegangen werden. Allerdings kann nicht gänzlich ausgeschlossen werden, dass einige import- oder exportabhängige Staaten von höheren Seefrachtraten negativ betroffen wären. Auf Deutschland bezogen sind solche negativen Auswirkungen jedoch nicht zu erwarten.

Der deutsche Schiffsbausektor, der derzeit eine Periode der Schrumpfung und der Strukturanpassung unterläuft, würde voraussichtlich von stärkeren Nachfragen nach Umwelttechnologien und effizienteren Schiffen profitieren. Die deutsche Schiffbauindustrie verfügt bereits über weitreichende Erfahrungen in diesem Bereich und fokussiert sich zunehmend auf den Spezialschiffbau. Die Einbindung des Seeverkehrs in den EU ETS kann helfen, die Führungsposition in Umwelttechnologien gegenüber den Wettbewerbern aus Fernost weiter auszubauen. Von solchen Dynamiken würde auch die deutsche Maschinenbauindustrie profitieren.

Zusammenfassend kann geschlussfolgert werden, dass die Einbindung des internationalen Seeverkehrs in das EU ETS rechtlich zulässig und technisch möglich ist, und keine nennenswerten negativen, sondern eher positive wirtschaftliche Effekte für Deutschland und Europa zu erwarten sind. Eine europäisches Emissionshandelssystem das auch Seeverkehre einschließt müsste allerdings auch auf Schiffsaktivitäten in internationalen Gewässern zugreifen, um eine ausreichende Umweltwirksamkeit sicher zu stellen. Eine solche Ausdehnung in internationale Territorien ist jedoch nicht nur Bedingung ausreichender ökologischer Effektivität sondern auch verbunden mit den geringsten juristischen Schwierigkeiten, einfacher zu Überwachen und administrativ am einfachsten umsetzbar. Eine Einbindung des internationalen Seeverkehrs in das EU ETS bis 2013 stellt, angesichts der niedrigen Emissionsvermeidungskosten bei Seeschiffen, ein geeignetes Politikziel dar – insbesondere für den Fall, dass bis Ende 2011 keine von der IMO initiierte und von der UNFCCC akzeptierte Reduktion der Treibhausgasemissionen aus dem Schifffahrtssektor verbindlich umgesetzt ist.

3 Introduction

Marine vessels contribute to global carbon dioxide emissions with emissions totalling approximately 3.3% (IMO 2009). While international air pollutant regulations at the International Maritime Organization (IMO) have limited the emissions of nitrogen oxides and sulphur, the greenhouse gas emissions of the vessels remain unregulated. Countries were so far not successful in integrating marine emissions into the international negotiations for the post 2012 climate policies and the member states at IMO have not implemented instruments that would have limited or reduced the amount of greenhouse gas (GHG) emissions from ships. However, greenhouse gas emissions from ships have been increasingly on the agenda at the IMO and recent developments have paved the way for designing innovative policy measures in the future. For example, an Energy Efficiency Design Index (EEDI, MEPC 2009a) methodology has been developed and will be tested in the next years on a voluntary basis. An Energy Efficiency Operational Indicator (EEOI, MEPC 2009b) method has been also developed and may be used to gather experience from ships in voyage. Finally, vessel operators are being encouraged to implement energy efficiency goals in the Ship Energy Efficiency Management Plan (SEEMP, MEPC.2009c)

On the other hand, scientific evidence on the urgent need to curb greenhouse gas emissions is strong and the share of marine transport emissions has risen in the past. The European Council recently expressed the aim of reducing greenhouse gas emissions by 20 % by 2020 compared to 2005 for the maritime transport sector. Furthermore, the European Union has announced on many occasions that if no international agreement including reduction targets for seaborne emissions has been approved by the UNFCCC by December 31, 2011, the EC is tasked to submit a proposal for including international marine transport into European reduction targets and policy measures (see for example EU 2009). The European Commission (EC) has issued a research project to examine policy measures. The integration of marine emissions into the EU ETS would be one option of policy measures by the European Union. With this study, the German Federal Environment Agency has issued a research project (FKZ 3708 41 107) to analyze possible ways of integrating shipping into the European Emissions Trading System (EU ETS) and its effect on the European, and in particular the German, economy.

The thesis of the research team is that a regional – European[1] – policy scheme a) can be environmentally effective because of the important role Europe plays in international trade; b) fosters cost efficient greenhouse gas emission reductions in shipping; c) if prices for allowances do not increase to an unexpected high level, has no severe impacts on the German sector of maritime transport and has few negative effects on the cost of goods transport; and d) may have a positive effect on the European ship build-

1 In the following "European" is used to potentially include Non-European Union members such as Norway.

ers and maritime supplies industry that is particularly strong in speciality markets such as innovative technologies.

The parallel EC project analyzes different policy options for the European Community and is thus broader in scope. The policy options include the integration into the European ETS, the establishment of an emission tax, mandatory efficiency limits, baseline and credit system, voluntary agreements and innovation subsidies. This document will take a different approach in that it aims to conduct a more in depth analysis of a limited number of design options integrating shipping into the EU ETS. The in-depth study will in particular assess the environmental effectiveness, monitoring schemes, economic impacts on the German economy and the legal feasibility of selected options.

This project will focus on ocean going, domestic and international, marine transport. Inland shipping is not considered in this study (for a brief description of inland waterway transport and its CO_2 emissions, see Annex I). Its emissions are already covered under the national Kyoto obligations and second it is structurally quite different from ocean going marine transport.

The study will rely on figures and background information from seaborne freight transport because marine freight transport is the largest contributor to marine transport emissions and consumes approximately 80 % of all marine fuels. Ocean going freight transport is an important motor of the global economy and about 90 % of the world cargo is shipped by marine vessels. Nonetheless, non-freight marine transport is implicitly covered within this project as well since most of the discussed policy options and measures can be adapted to all ocean going vessels regardless of their purpose[2]. There is no hindrance to expand the measures to, for example, ferries, cruise vessels and fishing vessels other than methodological adjustments of details. Only naval vessels, under military command are excluded here.

The following text presents an environmental, legal, and economic analysis of three possibilities for integrating international ocean shipping into the European Emissions Trading System (EU ETS). The analysis is under the premise that no international agreement would be reached for integrating ocean shipping into a post 2012 protocol or regulating greenhouse gas at the International Maritime Organization (IMO). Thus the aim is to identify solutions that could be implemented supra-nationally by the EU and nationally by its member states. The study will concentrate on means to directly integrate the shipping sector into the EU ETS.

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[2] In the case of a freight based approach, obligations to surrender emission allowances is primarily linked to the freight transported on vessels. Its direct applicability to non-freight vessels is limited. Other basis of assessments would need to be defined.

4 Integrating greenhouse gas emissions from ocean shipping into the EU ETS: Policy tools and major challenges

4.1 Policy tools for curbing marine CO2 emissions

4.1.1 Instruments for regulating emissions from ocean shipping

Several options to regulate GHG emissions exist besides tradable emission permits ("emissions trading"). These include other compulsory measures (e.g. direct regulatory instruments in the form of obligatory technical standards, rigid or flexible emission limits, or taxes) as well as voluntary measures (e.g. voluntary benchmarks, voluntary emission reduction agreements, or moral suasion) and subsidies (Hanley, N. et al 2007).

In principle, all these measures can be applied to emissions stemming from ocean shipping (IMO 2009; CE Delft et al. 2006; NERA 2005). Voluntary measures such as the Energy Efficiency Operational Index (EEOI) and the Ship Energy Efficiency Management Plan (SEEMP) may be helpful to encourage the reduction of emissions but are not sufficient to guarantee environmental effectiveness[3]. The same applies to the Energy Efficiency Design Index (EEDI) (Delft 2006). The key problem from an environmental perspective is that the EEOI includes the real freight loaded, which will result in large spreads of "efficiencies" regardless of the technical performance of a vessel and thus is unlikely to deliver usable values for comparing vessel efficiencies (Seum et al. 2010). EEDI covers the emissions from new ships only, thereby providing no incentives to lower emissions from existing ships. Accordingly, IMO and European efforts to reduce GHG emissions from shipping add a third pillar, namely market based instruments.

The applicability of market based instruments to maritime emissions has been extensively analyzed for sulphur oxide and nitrogen oxide emissions (e.g. NERA 2005; Sjöfartsverket Swedish Maritime Association 2007; Kågeson, P. 1999, Kågeson et al. 2009). While the multilateral regulation of SO_2 and NOx emissions from ships relies on mandatory standards (Rev. MARPOL Annex VI), some EU member states additionally use economic instruments to regulate emissions from maritime shipping such as environmentally differentiated taxes (e.g. Sweden) and subsidies. Currently the EU Commission aims to launch a voluntary pilot Emissions Trading System to cut sulphur emissions and nitrogen oxides in the Baltic Sea. (EC DG ENV 2009)

In contrast to direct regulatory measures ("command and control regulations") market based instruments promise to reach emission reductions at a significantly lower cost, as not every operator (owner etc.) is forced to implement the same costly mitigation measure. Instead, the decision maker (e.g. ship operator, owner etc.) is free to decide

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[3] The study uses the terms effect and effectiveness as environmental and efficient and efficiency as economically efficient and economic efficiency if no other determination is used.

on economic grounds whether to mitigate or pay taxes, use emission rights or to do without subsidies. Hence, emissions will be mitigated only if abatement cost is lower than the (opportunity) cost of emitting (Hanley, N. et al., 2007).

Current international documents mainly circle around two economic instruments: emissions trading or a GHG levy, the latter possibly combined with a fund, which may or may not provide subsidies to foster energy efficiency in the sector (IMO 2009). A third proposal was put forward by the US in 2009, namely to additionally apply the EEDI retroactively to all ships and to distribute carbon credits according to ships' efficiency (IMO 2009, MEPC 59/4/48). These efficiency credits could be traded. Ships with an efficiency below the envisaged average fuel efficiency can sell credits. Thereby incentives for increasing fuel efficiency of existing and to buy new fuel efficient ships are given without an overall emission cap but a “vessel specific cap”.

As the EU fears that no instrument will be implemented multilaterally in the foreseeable future, the EU considers to take unilateral steps and to possibly implement a regional scheme. Depending on the results of further multilateral negotiations and the results of ongoing research, the EU Council plans to take decisions in 2011 (EU 2009, Directive 2009/29/EC). To date the EU Commission has repeatedly articulated a very strong preference for a full integration of the emissions of ocean shipping into the EU ETS (Reuters 2009) in the case that no multilateral agreement is reached.

4.1.2 Emissions trading

4.1.2.1 Generally efficient and effective

The concept of emissions trading builds on the idea of setting an emission cap for a group of emission sources, usually below current levels or at least below business-as-usual (BAU) levels (as presented in IMO 2009). The volume of the cap is divided into units (tons of CO_2) and an according number of emission certificates, called “emission allowances” under the EU ETS. Those allowances are allocated to the emitters. The allowances can be traded in the market, e.g. via the European Energy Exchange (EEX) or other market places. If an emitter in possession of fewer allowances than he or she needs to continue emitting, the following mechanism starts: The emitter will decide whether to buy additional allowances or to bear the cost of reducing emissions. Those emitters with abatement costs below the market price of the allowances likely cut emissions and may even sell allowances, while others will buy emission allowances. If total emission reductions are too small to fulfil the emission cap, demand for allowances will exceed supply, thereby forcing prices up. This again will incentivise emitters to further cut emissions as long as their individual cost per cutting an additional tonne of CO_2 is below the market price of an allowance. Finally the cap is reached at lowest cost. Therefore emissions trading is usually referred to as economically efficient (Hanley, N. et al 2007). Although, in practice macroeconomic economic side effects (e.g. employment effects in supplying or consuming sectors, the economic impacts of evasion) as well as administrative expenses have to be considered in order to determine the economic superiority against other instruments. Additionally, the previous explanations mainly refer to static efficiency although dynamic efficiency – the capability to foster emission and cost saving technological progress – may be even more important in the long run. In principle, emissions trading can be regarded as dynamically efficient as well, at least under the conditions of functioning markets, in which competition forces producers to permanently increase efficiency and improve services (Parry, I.W.H. 1998; Niklisch/Zucchini 2005). Under this premise, only if investors judge the probability of extremely declining future allowance prices as high, they might refrain from costly emission saving innovations.

Before establishing an Emissions Trading System several issues have to be settled, among others the group of participants and the geographical scope. These matters will be discussed in detail in the course of the study. Another related matter is whether to limit the scheme to one sector ("closed trading scheme") or to incorporate other sectors ("open trading scheme") (Kågeson 2007). Since with regard to the effects on global climate protection it does not matter where and in which sector CO_2 is avoided, the economic advantage of allowance trading between as many sectors as feasible definitely makes an open system the favorite option from the perspective of static efficiency (IMO 2009; Kågeson 2007). However if the political goal is, for whatever reason, to lower emissions in a specific sector (e.g. shipping), an open system with complete tradability of emission allowances between all sectors may not lead to the desired outcome. As of today the Commission will likely suggest implementing tradable CO_2 emission permits for ocean shipping, either as an open or semi-open system, whereas semi-open refers to a system in which the maritime transport sector can become a net purchaser of emission allowances from the stationary sector but not vice versa.

4.1.2.2 EU ETS

In 2005 the EU ETS commenced operation as the largest multi-country, multi-sector CO_2 emissions trading system world-wide. So far approx. 11 000 installations of the energy sector and energy intensive industries are covered under the ETS; approx. 2 500 airlines will follow in 2012. The cap for stationary emissions for the third period (starting 2013) will probably be about 1 700 – 1 900 t CO_2 per year (EU 2009). The EU ETS permits interchangeability of allowances within the stationary installations and allows, to some degree, the surrendering of certified emission reductions (CER) and emission reduction units (ERUs), which are certificates originating from projects under the flexible Kyoto mechanisms Clean Development Mechanism (CDM) or Joint Implementation (JI). Covering different sectors and approx. 50% of the EU's CO_2 emissions (40% of all GHG emissions), the scope of the EU ETS can be considered broad enough to lead to high efficiency. In 2013 further GHGs and sectors are planned to be included thereby increasing efficiency further.

In principle, the full integration of ocean shipping into the EU ETS promises to be efficient and might, in theory, even increase the efficiency of the existing Emissions Trading System by lowering total abatement cost. But the example of international aviation shows that there are reasons for restricting the interchangeability of emission permits between the shipping sector and stationary installations. Interchangeability between aircrafts and stationary sources is restricted. The aviation sector will be allowed to surrender emission allowances which they have bought on the market, regardless of whether these were originally allocated to stationary sources or the aviation sector. But certificates originally allocated to the aviation sector cannot, at first, be used by stationary installations to fulfil their requirements. The rationale behind this restriction is that emissions from international aviation are not subject to the EU member states obligations to cut emissions, based on the Kyoto Protocol. If the allowances of aviation could be used to offset an increase of these emissions, the fulfilment of international targets would be threatened. It is recommended the same kind of semi-open emissions trading system be applied to the international shipping sector as the situation regarding the non-inclusion of the CO_2 emissions of international shipping into international emission reduction commitments is the same. One aspect should be mentioned, however: If emission reductions beyond the cap imposed on ocean shipping can be reached by ships at lower marginal abatement cost than by stationary installations, the concept has its disadvantages: Ship operators (or, whoever holds the responsibility for surrendering emission allowances) will not be allowed to sell their extra certificates to operators of installations. Restricting interchangeability will not lower the efficiency of maritime emission reduction, but a semi-open scheme means abandoning potential efficiency gains that the integration of ocean shipping could provide to the complete ETS.

In order to make the system for aviation more flexible when it comes to the single act of buying and selling emission allowances, the Commission plans to elaborate "whether a gateway system should be included to facilitate the trading of allowances between aircraft operators and operators of installations whilst ensuring that no transactions would result in a net transfer of allowances from aircraft operators to operators of installations" (EU 2008). The same should then apply to the emission allowances of shipping.

Marginal abatement cost in maritime transport appears indeed to be low compared to the stationary sector (see chapter 5.5), depending, of course, on the specific cap (i.e. the amount of emissions to be reduced) and mostly the future marine fuel prices. Therefore the issue of interchangeability should not be handled per se the same way as in the case of aviation, where CO_2 abatement costs are considered to be relatively high compared to the stationary sector (Öko-Institut 2004). Accordingly, this issue shall be addressed again in the course of this study (see chapter 13) including the option of allowing for complete interchangeability of emission allowances between ocean shipping and aviation.

4.2 Challenges of integrating maritime CO_2 emissions into the EU ETS

The European Emissions Trading System (EU ETS) poses an opportunity to integrate seaborne transport into greenhouse gas reduction policies. An integration would be a starting point for internalizing external climate related costs of maritime transport, bringing ocean shipping onto a more level playing field with other modes of transport that are already subject to internalisation efforts. European land-based transport is covered under the national emission targets of the Kyoto Protocol and aviation will be integrated into the EU ETS starting in 2012. A European approach, however, would have to overcome several key challenges.

A key demand of a successful instrument for curbing marine CO_2 emissions is its environmental effectiveness. Since the presented approach is the integration into a regional European instrument, the instrument needs to be designed accordingly. The EU ETS for aircrafts includes all aircrafts that land or depart from a European airport. By virtue of its technical and operational characteristics, all distances to the first landing port outside Europe are covered. The aim is to cover all distances that are related to a leg arriving or departing in Europe. If translated to seaborne freight, the aim would be to cover all distances of freight movements that relate to cargo arriving in or departing from a European port. However, vessels often call at multiple ports and the final voyage prior to calling at an EU port might be rather short. Another more comprehensive and environmentally more ambitious goal would be to cover all emissions from vessels entering or leaving EU ports, regardless of whether the emissions occurred on trips to Europe or not. The questions this report tries to answer include:

- Which vessel movements shall be integrated into the instrument? (landing, departing, passing, exterritorial, etc.)
- For which movements can an instrument be enforced – administratively and legally?

Related to the geographic coverage and environmental effectiveness is the question of what to take as baseline emissions and where to set the emissions cap. The identification of baseline emissions and the question of setting a CO_2 emissions cap for seaborne trade is not trivial because seaborne trade shows much larger fluctuations, is more flexible and is more difficult to monitor than airborne freight. The setting of a lax cap would quickly counter the potential impulse the Emissions Trading System could have.

- Which ships and movements shall be included for identifying emission baseline and setting the cap?
- How would the data be collected and the correctness monitored?
- How tight should a cap be set and how should it develop over time?

The GHG emissions from seaborne trade are in direct correlation with the fossil fuels consumed. The three Kyoto GHG gases which are most relevant are carbon dioxide, methane and di-nitrogen oxide[4]. Other (Kyoto) GHG do not play a major role – with some potential exceptions: the emissions of refrigerants. Their impact on seaborne GHG emissions, for example, should be further researched. CO_2 is so far the only gas covered by the EU ETS[5]. Other fuel based gases, in particular CH_4 and N_2O, also play

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4 This study will refer to CO_2 for direct carbon dioxide emissions and GHG for the CO_2 equivalent emissions taking CO_2, CH_4 and N_2O into account.

5 Starting in 2013, N_2O from the chemical industry will also be introduced into the EU ETS.

a minor role in the GHG effect of transport emissions, but are omitted in the EU ETS. The fuel consumption may be monitored directly, indirectly through distance and modelling or indirectly through cargo transport activities and modelling. Key questions with regard to the necessary monitoring schemes are:

- What technical capabilities to monitor fuel consumption on ships already exist?
- Can reporting fuel consumption be made mandatory?
- Would it be possible to monitor vessel movements remotely?

Another key challenge of integrating ocean shipping into the EU ETS is the expected economic impact. The integration aims to internalize some of the environmental costs of international seaborne freight and other marine activities into the price of services. Assuming that the integration would send a significant price signal, it may affect the maritime transport sector and international trade because long distance shipping may become more expensive. It is envisioned that the price signals translate into emission reducing innovations and the degree to which also trade and the economy at large might be affected is analyzed.

Last, the challenges of integrating seaborne transport are of a legal and political nature, the latter depending among other things on the economic impacts.

5 Emissions from German and European seaborne transport as the basis for evaluating environmental effectiveness

This chapter aims to roughly model the CO_2 emissions that are caused by German and European seaborne trade, in order to assess the effectiveness and efficiencies of selected options. It is important to determine who causes greenhouse gas emissions in order to argue for the ethical responsibility for those according to the polluter-pays-principle. However, as it will be discussed later (Chapter 12) the legal principle that allows the implementation of instruments is a principle of being affected by environmental damages. Those two angles pose no contradiction. A detailed quantification of emissions and emission reductions is outside the scope of this study. It should be noted that ENTEC (2002) quantified European seaborne emissions. IMO has recently updated its global GHG study (2009).

The focus of this report will be on freight transport and freight vessels. Besides those, there are passenger cruise vessels, Roll-On-Roll-Off (RoRo) vessels for cargo and both passengers and cargo, ferries, offshore supply vessels, and fishing vessels that are internationally travelling and that cause greenhouse gas emissions. Global CO_2 emissions from shipping are estimated to be 1 054 million tonnes CO_2 [6]. Of those, 212

[6] The figure 1 054 t is taken from tables 3-7 and 3-11 of IMO (2009), while in the executive summary of the report a figure of 1 046 is named without reference.

MT are from non-freight vessels. 7.6 % or 80 MT of the emissions are caused by ferries[7] (Buhaug et al. 2008). For the following discussion all pure freight vessels, all car carriers and half of the ferries are considered as international cargo shipping. This totals 842 MT or 79.9 % of the global CO_2 emissions from ships.

For cruise vessels, fishing vessels and off-shore supply vessels different approaches in baseline setting, monitoring, and enforcement may need to be developed. However, all instruments discussed here will apply to those vessels as well. Since they play only a minor role and their effect on the European economy would only be indirect, they are not directly discussed in this study.

5.1 Modelling of greenhouse gas emissions from seaborne transport

Ocean going vessels have been historically used to carry bulk cargo. Since the mid 1950s the containerization of goods has been introduced and is rapidly increasing. Even bulk commodities are increasingly transported in containers, e.g. loose coffee. Ocean going vessels were also important means of intercontinental passenger transport. Today, recreational cruise trips and short distance ferry passenger travel dominates. Other ocean going vessels include fishing vessels, off-shore supply vessels and research vessels. The major part of seaborne activity, however, is from freight carrying vessels. The fuel consumption and the corresponding emissions of carbon dioxide are mainly related to the vessel size, its service speed and the hull design.

lists the most common vessel types.

Crude oil tankers	Refrigerated cargo vessels
Products tankers	Container vessels
Chemical tankers	Vehicle carriers
LPG tankers	Roll-on-Roll-off vessels
Dry bulk carriers	Ferries
General cargo vessels	Cruise vessels (passenger)

Table 1: Common vessel categories

Source: IMO 2009. For definitions see Table 2-2, IMO 2009.

The rough modelling of greenhouse gas emissions from seaborne trade presented here provides estimates of the emissions from German and European seaborne trade. German and European seaborne trade is defined as any cargo that enters or leaves

7 As a convention in this report, ferry transport was allocated 50 % to freight and 50 % to passenger transport. There are no standard guidelines on allocating between passengers and cargo.

the free circulation of the EU at a German port or a port of another European country respectively. This includes inner European domestic and international trade as well as extra-European trade. Entering the EU's free circulation does not mean that the port states are the final destination or origin state of the cargo. The modelling provides emission figures that are sufficient to estimate potential impacts, emission reductions and cost efficiencies of technical measures and policy instruments. A bottom-up methodology was used for estimating the emissions. The methodology used is described in Annex 2: Methodology for modelling GHG emissions from seaborne trade. The principle bottom-up methodology is described in EPA (2006) and Buhaug (2008). US EPA (EPA 2006) published empirical technical average figures that were complemented by new findings published in the Phase 1 report of the updated Greenhouse Gas Study by the IMO (Buhaug et al. 2008). A highly accurate inventory of seaborne emissions would be outside the scope of this study. More detailed inventory figures for different geographic contexts can be found elsewhere. (ENTEC 2002, EC 2005)

The figures in Buhaug et al. (2008) are the basis for the updated IMO study on greenhouse gas emissions from ships (IMO 2009). However, there are inconsistencies that cannot be explained with the scientific approach. For example, the conclusion in IMO (2009) specifies 1 046 Mt CO_2 from global shipping whereas tables 3-7 and 3-11 of the same report stipulate 1 054. Furthermore, a figure of 870 Mt CO_2 is provided for international marine freight transport emissions in IMO (2009). Buhaug et al. (2008) came to the conclusion that international marine freight transport emissions were 843 Mt. Differences may stem from different CO_2 emission factors for marine fuels (see Annex 2: Methodology for modelling GHG emissions from seaborne trade). In Buhaug et al. new CO_2 emission factors are developed while the IMO in recent documents refers to CO_2 emission factors by the Marine Environmental Protection Committee (MEPC 2009b). In this study weighted average emission figures were developed for vessel categories based on average figures from Buhaug et al. (2008). In order to make the estimates compatible with the updated IMO report on greenhouse gas emissions from ships, the vessel class specific information in Buhaug et al. with a sum of 1 019 MT CO_2 was normalized to the IMO figure of 1 054 MT CO_2 emissions from global shipping.

Cargo type	**CO_2 eq [1000 t] Imported Goods**	**CO_2 eq [1000 t] Exported Goods**	**CO_2 eq [1000 t] All Goods**
Firm bulk	2 404	693	3 097
Liquid bulk	1 881	664	2 545
General cargo:			
of which project cargo	1 958	2 004	3 962
of which with carriers unspecified	1 753	2 450	4 203
of which main commodities in containers			
Europe	1 082	1 223	2 305
North America	482	902	1 384
East Asia	4 676	1 959	6 636
South-East Asia	742	829	1 572
South Asia	374	277	652
Latin America	348	447	795
Africa	152	510	662
Red Sea. Persian Gulf	127	616	743
Cargo on trucks (Ferries)	355	395	750
Cargo on railcars (RoRo)	49	49	98
Total German trade 2007	**16 384**	**13 020**	**29 404**

Table 2: CO_2 emissions from German seaborne trade 2007. Modelled based on trade data by EUROSTAT

Source: EC (2009) and technical data by Buhaug et al. (2008)

The study estimates that German seaborne trade, imports from the ports of loading and exports to the ports of discharge, caused in 2007 approximately 29 000 000 tonnes of CO_2 (Table 2). The modelling of German seaborne trade resulted in CO_2 efficiency factors that were used to extrapolate to European trade (Table 3). The CO_2 efficiency factors are expressed in tonnes of CO_2 per tonne of import or export and include distances and allocation of cargo types to vessel types. The utilization of vessels was averaged over the entire voyage of that trade (back and forth), which is in line with modelling transport emissions from other modes of transport. Both the import and export trade is linked with a particular pattern of goods (firm bulk, liquid bulk, containerized cargo, etc.) and sourcing or destination countries respectively. The distinct pattern of trade (see chapter 6.1) – for example the large import of crude and high export of vehicles – then results in the differences between import and export CO_2 efficiency factors for seaborne trade (t CO_2 per imported or exported tonne). While the CO_2 efficiencies in tonne CO_2 per tonne of cargo is higher for exports due to the shift towards commodities shipped in container vessels, the total CO_2 emissions of the exports are lower largely because of shorter distances to the destination countries (see also Table 4).[8] The imported goods accounted for 56 % and the dispatched goods for 44 % of the CO_2 emissions. Of all imports, more than one fourth is firm and liquid bulk cargo (14.9 % and 11.7 % respectively). Twenty-two percent were emissions from unspecified general cargo and 52 % from commodity imports[9]. Of the commodity imports, more than half originated in East Asia, mainly China. Still 2.5 % of CO_2 emissions stem from commodities that were shipped on ferries or roll-on-roll-off vessels, either on trucks or on rail cars. From all export emissions, only 5.4 % were firm and 5.2 % were liquid bulk. Unspecified general cargo exports accounted for 33 % and commodity exports for nearly 57 % of the CO_2 emissions (Table 2). The main receiving countries were European and East Asian countries (9.6 % and 15.3 % respectively) with the East Asian exports being less than imports from that region. North America, South-East Asia, Latin America and the Persian Gulf/Middle East received significantly more commodities than they dispatched.

CO_2 efficiency in t CO_2/ t of cargo			
Import trade from outside of the EU	**Import trade from within the EU**	**Export trade to outside of the EU**	**Export trade to within the EU**
0.1516	0.0345	0.1961	0.0366

Table 3: CO_2 efficiency of German seaborne trade in 2007.

The seaborne CO_2 emissions from German trade correspond to approximately 3.4 % of the global seaborne CO_2 emissions[10]. This represents 3.8 % of the seaborne imports and 3.0 % of the seaborne exports. The economic value of German trade was 8.5 % of global trade[11]. In a second step, the German figures were extrapolated to European trade based on types of goods imported and exported. Extrapolating from the German figures, the European seaborne trade in 2007 caused approximately 32 % of global CO_2 emissions from freight vessels. The share of Europe in terms of the global import

8 The major sourcing regions for imports, in particular consumer goods, are East Asia, dominated by China and Middle- and South America. For exports, trade with other European nations, the Americas and Africa dominates. Thus, export trades are usually associated with shorter distances than importing trades.

9 The classification of major commodity groups follows the Standard Goods Nomenclature for Transport Statistics/revised (NST/R) by Eurostat. According to this classification, special transport goods are defined as all bulk cargo which cannot be allocated to other categories.

10 Modelled with simplified assumptions from country of origin to region of destination. Empty traffic to reposition the ship back to the country of origin is only indirectly included through the application of cargo load factors.

11 The difference seem plausible because of the value added in industrialized nations with regard to material flows. Global European exports must be considered of higher value compared to the imports.

CO_2 emissions from ocean freight is thereby 49 %, whereas it only holds 15 % of all exported ocean freight[12]. This imbalance is due to the general trend of importing heavy weight commodities and bulk cargo[13] and exporting (comparatively light weight) manufactured goods, as well as importing cheap commodities from far away and exporting more to nearby destinations (Table 4) the EU imports generate more CO_2 emissions than the EU exports. However, per tonne of cargo the good CO_2 efficiency of bulk carriers is reflected in a better CO_2 efficiency per tonne of EU import (Table 3).

	Vehicles	Agricultural Machines	Electronics and other machines	Building constructions (metal)	Glassware and mineral products	Leather & Textiles	Other semi-finished goods & manufactures	Special transport goods
Main commodities								
EU	4.297	1.542	1.855	1.342	3.83	4.242	0.28	1.09
North America	2.231	0.543	3.318	2.511	1.519	2.026	1.115	1.713
East Asia	0.719	1	0.636	0.228	0.156	0.04	0.332	1.194
of which: China	1.186	0.333	0.625	0.202	0.077	0.023	0.238	0.792
South-East Asia	2.548	4.5	1.592	0.641	0.318	0.07	1.176	1.941
South Asia	0.455	2	1.55	0.5	0.957	0.086	3.372	0.043
Middle & South America	1.078	2.375	2.302	2.556	1.2	2.09	1.739	0.477
Africa	15.28	no info	15.27	7.556	4.364	0.606	2.841	1.497
Red Sea to Persian Gulf	4.117	10.5	23.77	3.303	6.375	0.787	25.38	0.284

Strong import commodity
Medium import commodity
Balanced im/export commodity
Medium export commodity
Strong export commodity

Table 4: EU Import / Export balance of major commodities 2007. Numbers < 1 indicate imports, numbers >1 indicate exports based on EUROSTAT

Source: EC (2009).

The amount of CO_2 emissions caused by German seaborne trade is a significant figure. It represents 4 % compared to the national total CO_2 emissions and 21.6 % compared to all national transport CO_2 emissions. Furthermore, it is about 3.4 times the amount reported from German marine bunker fuels (data from UBA 2008). To exemplify its sig-

[12] The bottom-up methodology for calculating seaborne trade emissions is based on carried goods. Empty returns and less than full utilization is taken into account through the emission factors.

[13] For each tonne of exported bulk cargo are three tonnes imported.

nificance it may be compared to CO_2 emissions from other sectors. For example, it exceeds the CO_2 emissions from Germany's chemical industry by more than 2 million tonnes.

The European seaborne freight transport is responsible for approximately 274 MT of CO_2. (Table 5) In addition to freight transport, passenger ships including ferries and cruise ships as well as fishing vessels and other vessels such as offshore supply vessels should also be included in a policy scheme. In IMO (2009) the total CO_2 emissions of seaborne transport are 1 054 MT[14] and thus 20 % above those from cargo carrying vessels. For Europe, the inclusion of non-freight vessels results in approximately 340 MT GHG emissions. (Table 5)

	World tonnage loaded in 1000 t	Imports in 1000 t	Exports in 1000 t	Imports in 1000 tonnes CO_2	Exports in 1000 tonnes CO_2	Seaborne freight in 1000 tonnes CO_2	Incl. non-freight CO_2
World	8 023 000	8 023 000	8 023 000	*425 816*	*425 816*	851 632	1 054 000
Europe	N/A	2 428 850	1 392 164	212 148	63 284	275 432	340 882
of which within Europe	N/A	1 161 890	1 179 592	20 037	21 606	41 643	51 538
Germany total	N/A	192 027	123 023	16 384	13 020	29 404	36 391

Table 5: Summary of European seaborne trade 2007 based on EUSTAT data and extrapolated from German seaborne trade

ENTEC (2005) analyzed the country shares of seaborne emissions in order to evaluate different national allocation options. Those figures provide other meaningful benchmarks for the assessment of policy design options.

	World freight transport *	EU27 flagged ships *	EU27 12 mile-zone *	EU EEZ (200 miles) *	European seaborne emisisons 2007	German seaborne emissions 2007
CO_2 Emissions MT/year	1 054	236.1	43.3	141.0	339**	35.7**
CO_2 Emissions % of world shipping emissions	100%	22.4%	4.1%	13.4%	32.1 %	3.8 %

* Comparative data for Scenario 2010; ENTEC (2005); Baseline emissions based on IMO 2009.

** Freight-borne emissions plus 20% non-freight vessel emissions.

Table 6: Comparison of CO_2 allocation schemes according to ENTEC (2005)

[14] See footnote 6 for the source of the figure.

The comparison in Table 6 shows that the policy measures of national allocation schemes, considered in ENTEC (2005)[15], would not have matched the emissions for which German and European trade are responsible.

5.2 Derivation of the evaluation criteria for environmental effectiveness

A policy measure can be considered environmentally effective, the closer it comes to integrate emissions under the responsibility of the entities in question (countries, industries etc.) and the better it serves to reduce those emissions in absolute terms over time. The European Council recently announced targeting a reduction in the global maritime sector of 20 % by 2020 compared to 2005. As stated, EU Parliament also has announced unilateral action if no international agreement has been adopted by the end of 2011. The benchmark for environmental effectiveness is therefore the inclusion and reduction of emissions caused by the area of influence – the marine traffic induced by Germany or Europe, respectively. This should include seaborne trade as the largest portion of marine activity (approximately. 80 % of entire marine emissions) as well as cruise traffic, passenger liner traffic, fishing traffic, and offshore service traffic.

Seaborne trade emissions are caused both from export trade as well as from import trade. An environmental effective scheme should cover both activities. However, as analyzed, the share of European import trade in terms of global marine trade emissions is at 49 % higher than the share of European export trade (15 %). Thus, capturing the import trade is more important for achieving a high environmental effectiveness than capturing the export trade. All other non-freight vessels are assumed to be stationed at or regularly call at European ports. Their inclusion would contribute to the environmental effectiveness with approximately 20 % of seaborne emissions.

In conclusion the integration of international ocean shipping into the EU ETS should aim to cover approximately 32 % of the global marine CO_2 emissions from trade (see Table 5) plus all passenger and non-cargo vessels that call at European ports. Recent studies have shown that the inclusion of the European 12 mile zone would cover approximately 4 % of the global seaborne emissions and that of the 200 mile zone approximately 13 % (ENTEC 2005) and thus cannot be considered sufficiently effective. A scheme to be environmentally effective has to be designed to integrate vessels that travel in international waters.

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[15] Those policy measures were schemes of national emissions allocation presented in the negotiations for the Kyoto Protocol. There is consensus among European countries today that a sectoral approach is superior to national allocation in the ocean shipping sector. See also: 2928th ENVIRONMENT Council meeting – Brussels, 2 March 2009

5.3 Reducing emissions from ocean shipping

Global climate change poses a serious threat to the global environment and development. Huge efforts are required in order to limit the changes to the climate. The latest IPCC report (Barker T. et al. 2007) assesses that a 50 – 85 % reduction of global GHG emissions by 2050 will be necessary if global warming should be contained within an average of 2 to 2.44 degrees centigrade.

International ocean shipping is a sizable contributor to global GHG and it has been growing significantly over recent years with double digits in some shipping categories (UNCTAD 2008). The increasing expansion of global production networks throughout the world was made possible through opening of markets, decreasing transportation costs and better communications. Growth forecast for seaborne trade today carries a high degree of uncertainty. Trade, in particular exports from South-East Asia, Europe and imports to the United States, slowed significantly in 2008, globally down to a 4.3 % growth from 6.3 % in 2007 (UN 2009). In general, long-term projections expect international trade to expand again in the future, implying a parallel increase in the volume of maritime transport services. On the other hand, the structure of trade to and from Europe may change in a way that reduces the weight and volume of cargo. For example, the share of heavy or bulky cargo may decrease because European economies become less dependent on mining products, raw materials, etc.

In principle two channels for reducing emissions exist. First, GHG emissions might be reduced by the suppliers of maritime transport services through technical and operational measures (e.g. improved fuel efficiency of ships) and smart logistics (e.g. land-route between SE Asia and Northern Europe). Second, GHG emissions from trade might also be reduced by a decrease of demand for trade (e.g. fewer imports of fossil fuels). As emissions trading will influence demand if it translates into higher freight rates, there will be a reduction of emissions resulting from the demand side. But as laid out in chapter 13.3, the chance of a significant drop in demand is rather small. Therefore the emission reduction through emissions trading will mostly result from reactions of the suppliers of maritime transport services.

As a consequence, environmental effectiveness will be assessed on the basis of feasibility and efficiency of measures induced under mostly unchanged transport demands and trade flow developments.

The machinery of ocean going vessels can be described as fuel consumption optimized traditional internal combustion engines. Marine transport is often described as the most fuel efficient means of transport on a tonne-kilometer basis, which does not make it the most fuel efficient way of transporting goods from point A to point B. Taking the real distances and factors such as utilization into account, other modes might be more fuel efficient on particular routes and services[16]. Furthermore, while marine ves-

[16] A good example is the land route by rail from East Asia to Europe (Deutsche Bahn AG 2005)

sels are efficient internal combustion engines, the possible ways for powering marine vessels are nearly limitless compared to any other mode of transport. Ocean transport already existed before the discovery of fossil fuels. Thus, alternative means of propulsion may be feasible again in the age after readily available fossil fuels, using wind power for example. Between the diesel driven tanker and the wind driven clipper there are probably multiple technical innovations – some of which them are already appearing.

The study will analyze how the different policy schemes under consideration may incentivize particular innovative technologies. It will look into the cost / benefit of certain technologies, including wind assistance, hull improvements, propeller improvements, etc. The chance of implementing those technologies depends on whether the cost of the emissions exceeds the cost for the technology or vice versa and how dynamically the Emissions Trading System is going to develop. If a system would want to go beyond these market driven dynamics, it needs to either prescribe certain technologies or establish a fund that offers financial incentives for developing innovative technologies. Both are possibilities that are discussed internationally. Several European Shipowners' Associations favor a fund approach (see Box 5), but these options are outside the scope of this study and will not be discussed further.

5.4 Technical and operational emission reduction options

The reduction of greenhouse gas emissions of seaborne transport is an important, but not the only relevant environmental aspect of ocean shipping. Ocean going vessels will need to comply with tightening international and national air quality standards in the future. Those standards include thresholds for nitrogen oxide (NOx) emissions (Table 7) and limits in the sulphur content of marine fuels. In order to comply with future NOx standards, engine controls and exhaust gas after-treatment will be necessary. Both will come with a fuel penalty, thereby increasing greenhouse gas emissions. The reduction of fuel sulphur levels may reduce direct greenhouse gas emissions if light diesel and gas oils are used, but may have higher overall greenhouse gas emissions if the life-cycle emissions are taken into account. In the case of after-treatment scrubbers are being used, a fuel penalty must be expected. Furthermore, other environmental requirements, for example ballast water treatment, may increase the fuel consumed and thus the greenhouse gas emissions of transport activity.

IMO NOx Emission Standard	In force for ships constructed beginning [date]	Expected fuel penalty *
Tier 1	2000	0 %
Tier 2	2011	1 % – 4 %
Tier 3	2016	?

Table 7: Nitrogen oxide emission standards, their year when they come into effect and expected fuel penalties.

Souces: IMO (2008), *AKN (2009); *MAN (2008a and 2008b)

However, the options for reducing the consumption of fossil fuels of vessels are theoretically nearly limitless and thus to reduce the greenhouse gas emissions from seaborne trade. It will be primarily the way of thinking and economic considerations that may limit the options available. Although, as with other mobile vehicles, technological innovations have improved the combustion processes and fuel efficiencies to some extent in recent years, future technical improvement potentials still exist. The large potentials for reducing greenhouse gas emissions appear when one looks outside the (common design) box. Ship hulls may have a slim design and be optimized to reduce wave resistance (AKN 2009). Wind power, solar power and wave energy may be used to provide additional energy for propulsion systems; advanced energy storage systems may allow electric or hybrid electric propulsion systems in the future. Beyond those measures, a ship design that sails without the use of fossil fuels can be envisioned for the future. One example of such a visionary vessel design is the e/c Orcelle by Wallenius Marine. The idea of the e/c Orcelle is that it is operated with electric drive, fuelled by wind, solar and wave power, utilizing fuel cell energy storage. (Wallenius 2007) Thus in the future, a near 100% reduction in operational greenhouse gases might be possible. Under today’s market condition, most of these technologies are not competitive and thus have little chance of being introduced – or even being developed. Thus a serious consideration of emission reduction options needs to also think about the means to change market conditions in order to promote innovative technologies.

The following list provides an overview of energy saving measures on ocean going vessels. Many of these technologies have not achieved market entrance or even a trial stage. Thus experience on the degree of fuel efficiency gains by those technologies is limited. Estimations on the potential GHG reductions via new technologies come from MAN and Wärtsila (diverse technical publications available on their Internet sites), Buhaug et al. (2008) and IMO (2009)[17]. Other conceptual measures such as the deliberate downsizing of ships, i.e. the reduction of the engine power to the cargo carrying ca-

[17] Further overviews are presented by Hypo Vereinsbank (2009) and Crist (2009).

pacity (in contrast to the voluntary and temporary[18] slow steaming of ships), provides large potentials for reducing greenhouse gas emissions from ships. (AKN 2009). Figures in parenthesis in the bullet list below represent the potential percentage of energy savings derived from the documents and engine manufacturers and used in this study. The energy savings effects may not be simply additional if multiple measures were to be implemented at once. Thus, if the implementation of multiple measures is considered, the overall bunker reduction effect needs to be adjusted accordingly.

Furthermore, some technologies should be considered standard technologies today and no emission reduction should be attributed to them. Those technologies include proven cost effective technologies that have been implemented on many, although not all, ships and that have helped to achieve the MARPOL NOx emission limits. It is also likely that those technologies will be sufficient for achieving the MARPOL Annex VI tier 2 NOx emission limits that come into effect in 2011. For example electronic engine controls and high pressure fuel injection is available from the shelf of engine manufacturers and has been introduced to new builds by several carrier companies. Other measures already implemented, which can be explained by fuel costs having risen, include shaft electric co-generation, regular anti-fouling hull and propeller maintenance, real-time coordinated vessel management, weather routing and voluntary slow steaming (reviewed environmental reports and statements from CMA-CGM 2009, Hamburg Süd 2008, Hanjin Shipping 2008, Hapag-Lloyd 2009, Hyundai Merchant Marine 2008, K-Line 2008, Maersk 2008, NYK Line 2008, OOCL 2009, Yang Ming 2008, BP Shipping 2006, TK Shipping 2009, and Wallenius Wilhelmsen 2007).

Engine-related measures

- Improvements of turbo-charging (on market, standard best practice[19])
- High pressure fuel injection (on market; for new ships; recent newbuilds, standard best practice)
- Shaft electric co-generation (on market; for new ships; recent newbuilds, standard best practice)
- Waste heat recovery (on market, for new high powered ships; up to 15 % reduction in fuel consumption)
- Propeller wings (market introduction; up to 4 % reduction)
- Fin-like propulsion system, e.g. Voith Schneider propeller (exists on smaller vessels; potential trials)

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[18] Communications with members of the industry indicate that the current practice of slow steaming is mainly market driven. Many ocean carriers, mainly container carriers, started slow steaming in 2008 when bunker fuel prices skyrocketed and the global trade showed signs of recession. Both increasing costs and over capacities seem to be the driving factor for slow steaming practices today.

[19] Best practice refers to practices that are readily available and depend on the quality of management of the ship operating company. Compared to sector leaders, neither additional GHG reductions nor additional costs should be expected from those measures. Companies with those practices should be the benchmark for setting goals and targets.

- Pod propulsion systems, wing thruster (exists on smaller vessels; 8-10 % reduction) and pulling thrusters (up to 15 % reduction)

Fuel-related measures

- Liquefied Natural Gas (LNG) as fuel (exists for LNG vessels and ferries, up 4 % reduction)
- Marine Diesel and Marine Gas Oils (MDO and MGO) instead of HFO – will not be considered because of the net zero or negative life cycle GHG emissions
- Hybrid diesel-electric propulsion (On passenger vessels, R&D; 5 – 8 %; up to 30% in some applications (Wärtsila 2009)

Hull and design-related measures

- Air lubrication (R&D; potential trials; tanker 15 %, container 7.5 %, ferry 3.5 % (Wärtsila 2009))
- Anti-fouling; hull maintenance; propeller maintenance (standard best practice; up to 10%)
- Wind-assisted propulsion (R&D, in trials; up to 30 %)
- Low-resistance hull designs, for example ducktails (R&D; Ducktail on ferry: 3-7 %)
- Dedicated downsizing for slower steaming (Containerships >40 % reduction possible, bulk carriers up to 35 % (AKN 2009; authors' own calculation; both based on 22 % speed reduction)
- Lightweight construction (~ 5 % Wärtsila 2009)

Operational measures

- Real-time coordinated vessel management; in-time arrival; weather routing (standard best practice
- Slow steaming

Long-term innovative measures

- Wave propulsion assistance (R&D)
- Intensive solar energy usage (R&D)
- Electric propulsion systems
- Fossil fuel-free sailing

Not all measures are suitable for all types of ships. For example wind supports are currently not suitable for ships above certain speeds. Furthermore, at current stage of development, feasibility might be limited by ship size. Other measures are not market ready. Furthermore, vessels might be in service for 30 to 40 years. Thus the introduction of new technologies will only slowly reduce the overall emissions. The real reduction also depends on future trade flows. If those increase as steeply as in the 1990s and early century, overall seaborne emissions will rise but fleet turnover will also be quicker. If trade flows' growth, slow or even decrease in the future, an overall emission reduction effect is possible, but the fleet turnover and thus the introduction of innovative technologies will be slow.

Since it is not part of the scope of the study to assess all technological options in detail or to project future emissions, but to provide a proxy for realistic emission reduction options and their cost, a simplified methodology is used. First, four example type vessels are chosen, representing vessels in size and types that are relevant for German seaborne trade. Second, the technologies that are suitable for those types of vessels are identified. Third, technical figures are calculated for each type of vessel by using a sample vessel. Fourth, effectiveness and cost efficiencies are researched and calculated. Last, a qualitative outlook is provided. Table 8 provides an overview of measures that can be envisioned for particular ship types.

Vessel type	**Size in dead weight tonnage (dwt), or twenty-foot equivalent unit (TEU), or lane meters (lm)**	**High pressure injection**	**Shaft co-generation**	**Waste heat recovery**	**Pod propulsion systems**	**Rudder / Propeller design**	**Propeller wings**	**LNG as fuel**	**Hybrid gas-electric**	**Hybrid diesel-electric**	**Air lubrication**	**Sind assisted propulsion**	**Flettner rotor and other**	**Low resistance hull**	**Slow steaming**	**Leight weight constr.**
Crude oil tanker SuezMax	120-199 999 dwt	X				X	X	X			X	X	X	X		
Bulk carrier Panamax	35-59 999 dwt	X				X	X	X			X	X	X			
General cargo, heavy lift	10 000+ dwt	X				X	X	X			X	X	X			
Container vessel	5-7 999 TEU	X	X	X		X	X	X			X			X	X	X
Roll-on-Roll-off small	2 000 lm +	X	X		X	X		X	X	X				X		

Table 8: Emission reduction technologies by sample vessel types.

The most important ship types in global trade are tankers, bulk carriers, general cargo and heavy lift vessels, container vessels, roll-on-roll-off (RoRo) vessels[20] and ferries [21]. Tankers can be sub-divided into crude oil tankers, which tend to be large (up to over 400 000 dwt), products and chemical tankers, which tend to be smaller (up to 60 000 dwt) and specialized tankers that carry for example liquefied gas. Bulk carriers are built

[20] RoRo vessels are ferry-like vessels with cargo ramps for fast loading and unloading operations. RoRo vessels may operate as pure cargo carriers or passenger cargo mixed carriers. The later are then called ferries. Ferries also encompass pure passenger carriers.

[21] Passenger vessels will not be specifically part of this study, because of their relatively small number and contribution to global GHG from shipping, and their non-essentialism for global trade.

to carry dry bulk goods and cover the entire size range. General cargo vessels and heavy lift vessels tend to be smaller vessels, often with both container slots and space for bulk and product cargo[22]. They often have their own loading gears to be independent from port facilities. Container vessels are designed to carry standardized containers and can carry from a few hundred (feeder vessels) to well over 10 000 twenty foot standard containers (TEU). Container ships are built for higher speeds (up to 26 knots). RoRo vessels and ferries are small to mid-size ships, designed to carry wheel-based cargo (trucks, rail cars). Their characteristics depend on the service. For example dedicated car carriers operate more like container vessels in liner services, delivering new cars as products around the world. Whereas most RoRo vessels operate in short distances ferry services, some are dedicated to cargo and some mixed as passenger / cargo ferries. Common vessel size classifications are Ultra Large and Very Large (e.g. ULCC – ultra large crude oil carrier) for bulk carriers; Suezmax, Aframax and Panamax according to the size restrictions of certain geographies. Table 10 identifies five exemplary vessel classes and their respective average technical data and GHG performance. As a simplification, the table focuses on technologies and their most promising applications. For example, slow steaming is suitable for nearly all ships, but most effective with container carriers. Wind support might further develop, but is today limited to slower steaming smaller sized ships. Waste heat recovery only functions with large power plants under heavy load; it would for example not function at low speeds.

State of the art measures shall not be the target of policy measures and therefore no cost abatement curves or environmental effects were calculated. Table 9 lists the measures considered in bold for the different types of vessels. Container vessels with their high power to weight ratio are well suited for waste heat recovery. They are also well suited for slow steaming due to their relatively high cruise speeds. Air lubrication and wind power might be suitable for some container vessels, but are more effective on slower moving vessels such as bulk and general cargo carriers. Furthermore, propeller wings can be applied to container vessels, but have been analyzed as an example for bulk and general cargo vessels.

Liquefied Natural Gas (LNG) is a viable option for reducing airborne emissions (SOx and NOx) as well as improving fuel efficiency. The potential GHG reductions are up to 70%. (AKN 2009) The biggest drawback is the space requirement to store the fuel onboard, which is approximately three times larger than that for conventional diesel fuels. Furthermore, LNG is not suitable for two-stroke engines and thus only applicable to the RoRo vessel in our list of vessels. Here, in particular in European waters that are regulated for SOx and NOx emissions through the emission control areas, and where LNG fuelling infrastructure might be developed, LNG may be a suitable technology. On a global scale the potentials of LNG are limited (IMO 2009). Therefore no abatement cost will be calculated for LNG as an alternative fuel.

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[22] Product cargo refers to bulky investment goods, from agricultural machinery to industrial equipment.

Vessel type	**Size**	**High pressure injection**	**Shaft co-generation**	**Waste heat recovery**	**Propeller / Rudder Imp.**	**Propeller wings**	**LNG as fuel**	**Hybrid power plants**	**Air lubrication**	**Windpower**	**Low resistance hull**	**Slow steaming**	**Light weight constr.**
Crude oil tanker SuezMax	120-199 999 dwt	1*			**4**				**15**	**20**	9		
Bulk carrier Panamax	35-59 999 dwt	1*			**4**				**15**	**20**	9		
General cargo, heavy lift	10 000+ dwt	1*			**4**				**15**	**20**	9		
Container vessel	5-7 999 TEU	X	X	**10**	2	X			X	(X)	X	**25**	7
Roll-on-Roll-off small	2 000 lm +				**12**	**4**	4	**2-4**			X		7

* High pressure fuel injection primarily aims to reduce particles and smoke at low loads. It also reduces fuel consumption at low loads but not at regular cruise speed.

Table 9: Considered emission reduction technologies and maximum percent reductions of particular technologies. Figures in bold were considered. Others were ignored because they represent the state of the art or could not be economically analyzed (hull design measures)

The potential fuel savings of the fuel reduction measures in Table 9 are maximum achievable figures under ideal conditions. Current knowledge of real reduction effects is limited. Thus, as a convention for this report only 70 % of the fuel savings were considered. Furthermore, the measures can not be expected to be fully additional. The figures below and the assumptions of reductions from additional measures are rough estimates. Further research and pilot testing are needed to verify any of the assumed emission reductions. The study is not meant to provide a comprehensive assessment of emission reduction strategies. It will however model some examples in order to assess cost efficiencies and reduction potentials. The project investigates the following ships and innovative reduction measures, based on assumptions of emission reductions (in parenthesis):

Crude oil tanker: Propeller/Rudder Improvements (-2.8 %); Air lubrication (-10.5 %). Combined (-12 %)

General cargo, heavy lift vessel: Wind power. (-14 %)

Container vessel: Waste heat recovery (-7 %); Dedicated slow steaming (-23.5 %[23]); LNG as fuel (-4%). No combination of the above measures.

Ro-Ro vessel: Propeller/Rudder Improvements (-8.5%); Propeller wings (-2.8%); Combined (-10%); Hybrid electric propulsion (-2.8%).

In order to assess the performance of technical measures, benchmark figures for representative example vessels[24] were calculated. Example vessels and key technical data are presented in Table 10. Those average performance figures were calculated by using the same methodology as for estimating the German trade-related emissions (see Annex 2: Methodology for modelling GHG emissions from seaborne trade).

Vessel	**Size**	**Main engine kW**	**Design speed km/h**	**GHG efficiency CO_2 eq [g/t-km]**
Crude oil tanker TK Asian Spirit	*151 700 dwt*	*16 847*	*15.0*	*4.34*
Bulk carrier TDW Dolphin	*48 000 dwt*	*9 480*	*14.2*	*6.39*
General cargo vessel Beluga N-Series	*9 821 dwt*	*3 840*	*15.5*	*18.25*
Container vessel NYK Apollo	*6 492 TEU*	*61 350*	*25.1*	*14.22*
Roll-on-Roll-off RoRo 2200	*2 166 lm*	*16 000 medium speed*	*21.0*	*61.07*

Table 10: Technical specifications of sample vessels. (authors' own bottom-up calculation based on technical data from Lloyds (2009))

The annual emissions of the sample vessels, under consideration of average performance figures, are presented in. Table 10 Those values are the benchmark values to assess performance improvements and efficiency used in this study. Table 11 exemplifies key data of the sample vessels' transport work, energy efficiency and greenhouse gas emissions for a one year period in order to better understand the performance difference of the vessel types.

[23] For slow steaming it is assumed that the engine rating is dropped from 90% of MCR to 60% of MCR. All gains can be utilized. However, the drop in speed reduces the cargo carrying capacity by approximately 10.3%. Thus the benefit of 25% is reduced to approximately 23.5%.

[24] Comparable sample vessels were also used to model the trade emissions.

Vessel	Million [t-km/a]	Fuel [t/a]	CO_2 [t/a]	CO_2 eq [t/a]
TK Asian Spirit	12 650	17 456	54 364	54 908
TDW Dolphin	4 015	8 157	25 406	25 660
Beluga N Series	1 015	5 889	18 342	18 526
NYK Apollo[25]	12 523	56 612	176 312	178 075
RoRo 2200	729	14 157	44 089	44 530

Table 11: Vessel activity and GHG emissions from sample vessels.

5.5 Cost of Reduction Measures

The marginal abatement cost[26] of certain technologies on certain vessels can provide an indication on the economic feasibility of introducing new technologies. In cases where marginal costs are negative, a market introduction can be expected if technical and operational constraints and risks can be overcome. If marginal abatement costs are positive, policy measures that internalize environmental costs may spur the introduction of advanced technologies. In the calculations below, the fuel cost was assumed to be $500 and $300 per metric tonne[27]. The interest rate was set at five per cent. Table 12 lists the marginal abatement costs for the select technologies and vessels.

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25 At 90% MCR, which represents cruise speed under constraint market conditions, Containers are assumed to be loaded with 10 t cargo. (IMO 2005)

26 Marginal Abatement Cost (MAC) reflects the cost of one additional unit or tonne of emission that is abated or not emitted. As the additional cost per each tonne of CO_2 that is abated cannot be estimated empirically when the whole fleet is looked upon, calculations turn to "average" marginal abatement cost. For example, if the first million tons of CO_2 can be avoided with a technology at total cost of 5 million Euros, the average marginal cost is 5 Euro per ton. Assume the second million tons of CO_2 to be avoided with a costlier technology with total costs of 8 million Euros. Now, average marginal cost of abating 2 million tons of CO_2 is 8 Euro per ton. In practice though, marginal cost of a 1 tonne reduction may well be below 5 Euro and the marginal cost of abating 1 million (2 million) tons may well be above 5 (8) Euro per ton. In the following, we use the term "marginal abatement cost", even if estimates refer to average marginal abatement cost. This is common practice in empirically based research.

27 Bunker fuel prices for heavy fuel oil (HFO) were below $200 per metric tonne at the beginning of 2005, steeply rising at the start of 2007 to over $700 in summer of 2008 and then dropping down to below $250 again in the time thereafter. Today, HFO has costs of around $470; marine diesel cost is around $650. Until 2025 when low Sulfur rules become bindingly effective, it can not be expected that a major shift from HFO to marine diesel would occur. The choice of $500 per metric tonne for MAC calculations is a realistic cost figure, potentially on the lower side, providing more conservative cost efficiency figures. The $300 example was used to find explanations of why certain measures have not been implemented today.

Vessel name	Technology	+ Investment costs	+ maintenance cost / a	- fuel savings ./ a	Average annual costs	Marginal abatement cost [Euro/t-$CO_{2\,eq}$]	Marginal abatement cost [Euro/t-$CO_{2\,eq}$]
						At HFO $500/t	At HFO $300/t
TK Asian Spirit	Propeller / Rudder combinations	8345 71	n/a	-166 914	-86 510	**-39**	**-23**
RoRo 2200	Propeller tip wing-let	559 951		-111 990	-58 043	**-39**	**-23**
NYK Apollo	Waste heat re-covery	7 500 000	16 200	-1 353 310 / -2 319 960 *	-849 224 / -1 815 874	**-35 to -44**	**-12 to -21**
TK Asian Spirit	Air lubrication +	2 170 000 / 3 255 000	46 273	-625 929	-438 494 / -367 913	**-39 to -33**	**-9 to -16**
TDW Dolphin	Air lubrication +	780 000 / 1 170 000	35 789	-292 490	-205 960 / -180 590	**-39 to -34**	**-11 to -16**
Beluga N Series	Air lubrication +	500 000 / 750 000	26 637	-211 165	-152 002 / -135 739	**-40 to -36**	**-13 to -17**
TK Asia Spirit	Kite Sail **	1 865 956	194 655 / 228 805	-834 571	-460 146 / -425 996	**-41 to -38**	**-7 to -10**
TDW Dolphin	Kite Sail **	662 510	44 395 / 58 055	-389 986	-281 763 / -286 103	**-54 to -51**	**-21 to -23**
TDW Dolpin	Kite Sail ***	1 165 000	175 000	-329 817	-42 579	**-10**	**+20**
Beluga N Series	Kite Sail **	345 598	17 075 / 23 905	-281 553	-231 182 / -224 352	**-62 to -60**	**-29 to -31**
Beluga N Series	Kite Sail ***	805 000	65 000	-150 602	-8 046	**-4**	**+26**

+ Investment cost for air lubrication was calculated based on the assumption that investment costs equals ca. 2-3 % of ship building costs (Wärtsila 2009). Ship building costs were taken from UNCTAD (2008)
* Emission reductions given by manufacturer are 12%; own calculation uses 7%
** Data from Buhaug et al. (2009)
*** Data provided by SkySails

Table 12: *Calculation of marginal abatement cost curves for select technologies and sample vessels. Right columns are calculated for marine fuel costs of $500 and $300 per tonne. Ranges stem from lower and upper estimates of investment and maintenance costs.*

The marginal abatement cost curve for slow steaming – an option that exists primarily for container vessels – is more difficult to predict, but is likely to be positive if the cargo demand side allows longer transit times. In terms of costs, a reduced fleet carrying capacity and longer transit times have to be considered. Most importantly might be the delayed return on investment for the longer transport period. With regard to savings, the fuel conservation directly translates into cost savings. With our example vessel, the NYK Apollo, a reduction of the average engine load from 90 % Maximum Continuous engine Rating[28] (MCR) to 60 % MCR would result in nearly 50 000 tonnes of CO_2 reduced in one year. At the same time the carrying capacity of the vessel would be reduced and the voyage time would increase by 14 %. A trip from Hong Kong to Hamburg would need 18 days and 22 hours instead of 16 days and 16 hours, in the case of 60 % MCR slow steaming.

The most noticeable finding is that most available emission reduction technologies on ocean vessels have a negative marginal abatement cost and thus are economically feasible under present or near future conditions. Other calculations have resulted in similar negative marginal cost abatement curves, either today (DNV 2009, see Figure 1) or in the near future (IMO 2009). Many of the measures presented by DNV (2009) are state of the art in well managed companies as stated in their environmental reports. However, it should be noted that the assessment is based on weak data and that other reasons for implementing or not implementing technologies, such as management and maintenance requirements, influence the decisions (see Box 1).

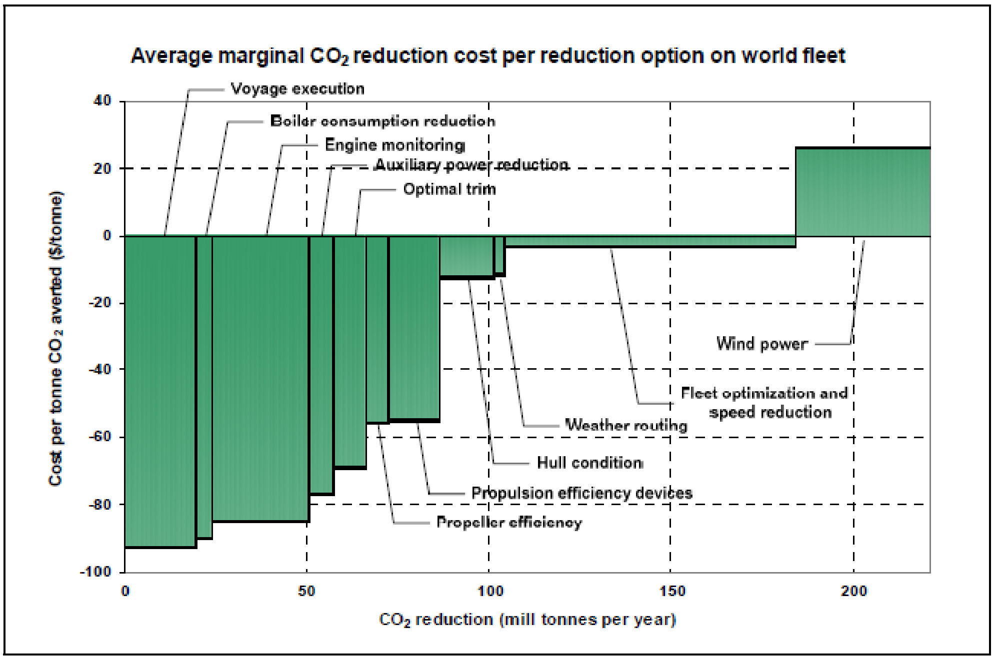

Figure 1: *Illustration of average marginal CO_2 reduction cost and reduction potentials for different technologies.*

Source: DNV 2009

28 Vessels are designed for a design speed that is achieved at approximately 90 % MCR to allow for a safety margin. The 90 % MCR can be considered as benchmark for emission calculations.

However, the assessment that ocean shipping is likely a growing emitter and a net-buyer of emission allowance certificates may need to be revised. Previous studies have expected that emissions from seaborne trade would continue to rise, "even if during the same time the shipping sectors makes use of all technological opportunities" (Kågeson 2007, ICCT 2007, IMO 2009) and that seaborne trade would likely be a net-buyer in an ETS. However, several factors indicate a reverse direction.

a) Calculations of marginal abatement cost curves, including our own, show many measures with potentially negative abatement costs, thus being profitable even at current conditions.
b) The bunker fuel prices are rising; they will further rise in analogy with crude oil price developments and depending on refining strategies that will shift towards deeper refining at higher cost/profit rates, reducing the amount of residual fuels produced.
c) Sulphur fuel regulations may push up marine bunker prices. IIASA (2007) states price premiums between $10 and $20 for sulphur-reduced heavy fuel oil (HFO) and up to $130 per metric tonne for the switch from HFO to marine diesel oils (MDO). Today's delta between HFO and MDO is approximately $180 per metric tonne. Because heavy fuel oil prices are bound to land-based coal prices, only a moderate price increase can be expected with HFO. However, refining economics may lead to a shift towards deeper refining of crude oil and thus a reduction in availability of HFO[29]. The real consequences and price effects in the marine fuel markets are difficult to predict. A (sulphur) emission control area (S)ECA) is set in the North Sea and Baltic Sea; the installation of a ECA around the USA and Canada practically makes the important EU – North America trade into a low sulphur HFO or distillate fuel region with a respective cost increase.

Thus, there is a large and attractive potential – technically and operationally – in the ocean shipping sector to reduce GHG (and other) emissions. The economic potential will directly correlate with the price of marine fuel; the higher the fuel prices, the higher the incentive to cut emissions. The integration of ocean shipping in an ETS can foster this potential by adding price pressure on carbon intense ocean transport and by setting a clear and steadilydedicatedly declining emissions cap. The cost benefits and planning security would make it much easier for the shipping industry to invest in innovative technologies than it has been in recent years with very cheap heavy fuel oils and large price volatilities.

[29] CONCAWE for example has warned that desulphurization is too costly and the profit margins with marine HFO too low to justify the large investment in refining technologies. It would make more sense for refineries to then shift their production towards distillate fuels. (CONCAWE 2007)

Box 1: Barriers to the implementation of fuel efficiency measures

Our own calculations and a number of additional studies confirm the existence of negative marginal abatement costs in international maritime shipping. In light of these findings it is surprising, that ship owners or ship operators have not yet shown more initiative to increase the fuel efficiency of their respective fleets. As it appears, certain barriers can hinder such improvements despite negative marginal abatement costs. According to IMO (2009), the implementation of fuel efficient measures is possible with regard to newly built ships as well as for an already existing fleet (i.e. upgrading) – although the latter largely depends on the age of the respective ship. Implementation measures concerning the design, such as hull design, power and propulsion systems, engines using low carbon fuels are applicable to new ships. In the case of existing ships, fuel efficiency measures can be introduced through upgrading (e.g. through modernizing engines and replacement of old turbochargers). Moreover, fuel efficiency can in some cases be enhanced through better fleet management and logistics as well as optimizing trade routes (IMO 2009).

One of these barriers can be found in existing low oil prices or the expectation of low oil prices in the future. As has been documented, after the two oil crises in the 1970s ship owners reacted swiftly by improving the fuel efficiency of their ships. The subsequent decline in oil prices has, however, stopped this process and, in some cases, even led to a reversed situation (CE Delft 2006). Hence, both the current level of oil prices as well as expectations on their future development exert a great influence on decisions regarding a fleet's fuel efficiency. If, therefore, the general sentiment is that oil prices are going to stay at fairly low levels, the likelihood of investments to increase fuel efficiency is correspondingly small. Moreover, the existence of fuel subsidies further aggravates this situation. Fuel subsidies are especially common in non-OECD countries and range from 1 % of a country's GDP up to 14 % of GDP (IMF 2008). The highest fuel subsidies thereby occur in oil producing countries. In most countries, the fiscal measures consist of a mix of a reduction in fuel taxes and tariffs and an expansion in (untargeted) transfers.

A second barrier has been found in so-called 'hidden costs'. These can occur in a number of circumstances and can range from the costs of information gathering or dissemination to cost in decision making (if a large number of stake-holders is involved) and training of staff members that can ensue as a consequence of technical changes. A recent poll among European ship owners found that there especially seems to be more need for better and easier dissemination of information regarding existing options on increasing the fuel efficiency of certain ship types (AEA 2008). With regard to the order of new ships, hidden cost can occur in the form of 'first time user' cost. In this case, ship owners might abstain from ordering new ships with improved technologies if these technologies are not yet well established since they can lead to unexpected follow-up costs due to an unknown learning curve.

Third, it seems that a certain threshold of fuel efficiency that can be achieved with a specific measure is a crucial factor in the decision on its implementation. Apparently, measures attaining an increase in fuel efficiency below 5 % are seen to be too small to justify an investment (AEA 2008).

Finally, the market structure in the international maritime sector can set disincentives for ship owners to enhance the fuel efficiency of their respective fleet. As noted below in this text (chapter 13.3 on price formation), the sector is characterized by an oligopolistic market structure. Hence, competition among ship operators is not very pronounced and there is a tendency for cooperative behavior. Such a situation creates the opportunity of passing on the costs of higher fuel prices to transport purchasers (CE Delft 2006). A higher level of competition, in contrast, would create the need to offer transportation at the lowest possible cost which in turn sets incentives to enhance a fleet's fuel efficiency in order to reduce overall operational costs.

6 Economic background of the German and European maritime industry

The following overview of the maritime sector shows how vital the sector is to the economy. It gives an impression of how regulations of the maritime transport sector may generate significant economic spill-overs beyond this sector.

6.1 Seaborne trade: overview

Shipping is an integral part of trade for and among EU member countries. Around 90 % of the EU's foreign trade (by weight) is conducted by sea and 40 % of its internal trade (by tonne-kilometre) is seaborne. (DG TREN 2009)

The gross weight of the total amount of goods handled in all ports in the EU27 in 2007 amounted to 3 402 million tonnes. Of these, 2 141 million tonnes were received and 1 261 were dispatched (EC 2009).

Categorized by type of cargo, outward and inward goods handled in 2007 can be divided into:

- Liquid bulk goods: 38 %
- Dry bulk goods: 26 %
- Large containers: 18 %
- Ro Ro Mobile Units[30]: 18 %
- Other cargo: 7 %

Sea-related sectors in Europe produce an added value of around € 189 billion; this corresponds to around 1.65 % of GDP in market prices in the EU and Norway (EC 2009).

In 2007, the total number of passenger passing through seaports in EU27 member states is estimated at 410 million, 44 % of which consisted of intra EU27 transport; 48 % consisted of national transport and 6 % consisted of extra EU27 transport (EC 2009).

Employment related to seaborne trade is estimated at 1.5 million people; 70% of who work onshore. Employment categories include: shipbuilding, naval architecture, science, engineering, electronics, cargo-handling and logistics (EC 2009).

6.2 The European and German marine industry

Since the mid-1990s, freight turnover in Germany increased on average by 3.6 %. Container shipping – the largest segment – expanded by 10.2 % per year at German seaports between 1995 and 2007 (EC 2009).

[30] Roll-on/roll-off units, i.e. wheeled cargo such as cars, trailers or railway carriages.

Germany has 390 commercial shipping companies which control a fleet of more than 2600 ships (equivalent to around 6.6 % of global commercial fleet and 5 % of total transport tonnage). Around 20 % of these vessels sail under German flag. More than 30 % of global container capacity is controlled by German shipping operators, which makes it the largest container fleet worldwide (Winter, 2008).

Germany's maritime industry can be divided into the following sectors

i. Maritime shipping
ii. Marine and offshore equipment supplier industry
iii. Shipbuilding

These three sectors combined generated a value added of € 47.7 billion in 2006, corresponding to roughly 2.055 % of GDP (Winter, 2008).

The largest sector of Germany's maritime industry is maritime shipping. In 2006 it produced a turnover of € 31 billion and employed 60 000 people out of the total workforce of 380 000 in the maritime industry. Germany ranked number 4 in the world merchant fleet in 2006 after Greece, Japan, and China with total deadweight tons amounting to 64 739 952 (Federal Ministry of Transport, Building and Urban Affairs, 2009).

In 2007, a total of 315 050 000 tons of cargo was handled in German ports, of which 192 027 000 were received and 123 023 000 were dispatched. Around 37.1 % of these consisted of containers (Eurostat, 2009).

As far as incoming goods are concerned, around 2% arrived from ports within Germany while roughly 98 % were shipped from foreign ports. The largest part (nearly 40 %) was shipped from other EU member states. The second largest volume was received from East Asia (10.26 %), of which China was the main trading partner with 7.2 % of total goods received. Third was Middle and South America (9.65%), followed by Africa (6.24 %) and North America (5.52 %). Distinguishing by commodity groups, the major share of received goods consisted of semi-finished goods and manufactures, electronics and machinery, leather and textiles and special transport goods. Taken together, these categories accounted for more than 80 % of all imported major commodity groups (Eurostat, 2009).

Focusing on the category of dispatched goods from German ports gives the following picture. Roughly 96.66 % of goods are shipped to foreign ports. The lion's share of the total amount of dispatched commodities, namely 46.8 %, went to other EU countries. The second largest recipient region of dispatched goods was North America with 10.68 %, followed by East Asia (9.39 %) 4.52 % of which went to China. The major share of exported goods consisted of electronics and machinery, semi-finished goods and manufactures, vehicles and special transport goods. Taken together, these commodity groups accounted for more than 90 % of all exported goods (Eurostat 2009).

The 5 major ports, through which incoming and outgoing cargo was shipped in 2007, were Hamburg, Bremen/Bremerhaven, Wilhemshaven, Lübeck and Rostock. With 37.51 % of all goods handled, Hamburg is Germany's most important port (Winter, 2008).

In 2007 a total number of 30 200 000 passengers were transported by sea. Around 57 % of these were transported within Germany. Of all passengers travelling to and from ports outside Germany, roughly 93 % were other EU destinations (Winter, 2008).

6.2.1 Maritime and offshore equipment supplier industry

Germany's marine and offshore equipment supplier industry comprises about 400 companies with up to 76 000 employees. In 2007 the industry's revenues amounted to € 11.9 billion, 13.8 % higher than the previous year. With regard to revenues Germany's marine and offshore supplier industry is number two in the world after Japan. With regard to exports it is number one (Ehmer et al. 2008).

Focusing on revenues according to federal state reveals that Germany's equipment supplier industry is not restricted to the coastal areas. Indeed, as Figure 2 below indicates, Baden-Württemberg's and Bavaria's supplier industry tops the list with those located in Hamburg and Schleswig-Holstein.

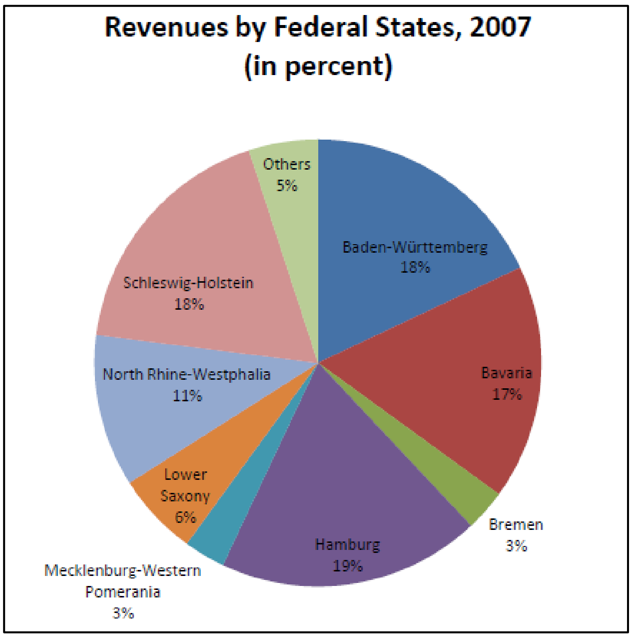

Figure 2: Share of revenues of maritime and offshore equipment supplier industry by federal state, 2007

Source: Ehmer et al., (2008).

The biggest market for suppliers is commercial shipbuilding followed by naval shipbuilding. Sales in offshore technology still play a minor role but are increasing in the markets for offshore oil and gas as well as offshore wind energy.

With a share of 62 % in total orders the biggest clients of the German supplier industry are shipyards, followed by direct sales to shipping companies with a share of 13 %. The third largest position is indirect sales to other suppliers with 12 %. Retailers (9 %) and business enterprises (4 %) play a minor role (Ehmer et al., 2008).

6.2.2 German shipyards – employment and utilized capacity

Until the end of 2008 utilized capacity and employment in German shipyards (the biggest client of Germany's maritime supplier industry) displayed a positive development. Overall employment increased by 1.7 % between September 2007 and September 2008. For shipyards located in East Germany, employment even increased by 3.0 % during that period (VDMA, 2008). However, this situation has changed dramatically with the current economic crisis (see Box 2).

6.2.3 Competition and market structure in international shipping

Developments in the liner shipping industry indicate a growing market concentration. This is illustrated by the fact that in 1995 16 liner operators accounted for 50 % of global total capacity whereas in 2007 only 7 liner operators made up 50 % of global total capacity. Indeed, the top ten liner operators accounted for 60 % of total TEU capacity in 2007. Of these, four liner operators are European-based with 37.82 % of total TEU share (UNCTAD 2008).

Disaggregated data by type of cargo shows that market concentration is rather high in container shipping. Here, the top 20 companies control 81 % of the market. With respect to tankers, the top 20 companies control 33 % of the market. In the case of bulk carriers, concentration is less pronounced. Here, the top 20 firms control 17 % of the market (UNCTAD 2008).

Overall, then, the liner shipping industry represents an oligopolistic market. The degree of oligopoly, however, varies by trade route. While the market structure in the liner shipping industry on the Europe – North American trade route constitutes a loose oligopoly, the liner industry on the Europe – Middle East / Far East trade route fulfils the characteristics of a tight oligopoly. Both transpacific-eastbound and transpacific westbound liner shipping is somewhere in between these extremes.

Box 2: The impact of the economic crisis on the maritime shipping sector

In the course of the financial crisis, real global output growth fell from 3.5 % in 2007 to 1.7 % in 2008. As a consequence real growth of world trade slowed down markedly to 2% in 2008 – compared to a growth rate of 6 % in real terms the previous year (WTO, 2009). As a decline of output by between 1 % and 2 % is expected in 2009, trade volume will decrease as well.

According to the latest revisions of the WTO, global trade will decline by at least 10 % in volume terms in 2009 (WTO, 2009). This would mark the biggest drop since the end of the Second World War. More specific, in developed countries, export volumes are expected to fall by more than 10 % whereas developing countries will experience a much smaller decline.

There are several factors contributing to this. First, world demand is slowing in all regions at once. Second, following the crisis in the banking sector, there is a shortage of trade finance. Finally, an increase in protectionism, often used as a measure for fighting an increase in domestic unemployment can contribute to a slow-down in trade-flows. A decline in world trade is worrisome, especially for an export-oriented economy like Germany's. In January 2009, Germany's export volume fell by 18.4 % compared to January 2008. The outlook for the rest of this year is equally bleak. German seaports report drops in container trade of up to 35 % in 2009 compared to the former year and up to 50 % for auto trades. (Handelsblatt 2009).

With regard to maritime shipping, two leading indicators confirm the slow-down in global trade. The Howe-Robinson Containership Index, which measures containership charter rates for all established categories, fell by 74 % within one year. Having reached a peak of 1 382 points in April 2008 it collapsed to a mere 360.5 points by April 2009 as the Figure 3 below indicates.

A second measure indicating the negative effects of the current crisis on the maritime shipping sector is the Baltic Dry Index which quantifies the cost of shipping bulk cargo by sea and is used to display changes in the global demand for manufactured goods. In the second half of 2008, the index fell by 94 %. While it has slightly recovered since, it still remains at an all-time low. Overall, achievable rates for shipping companies are only about a quarter of the rates gained a year ago.

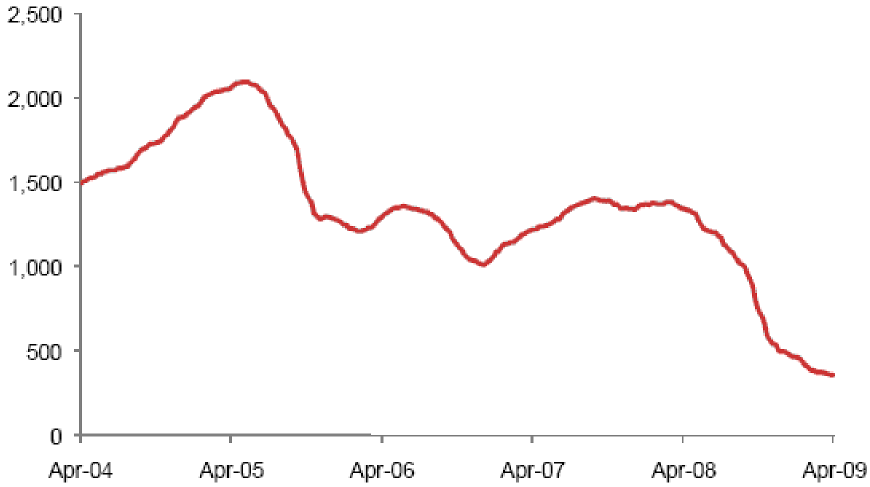

Figure 3: Howe-Robinson Containership Index, April 2004 to April 2009

Both the deterioration of the Howe-Robinson Containership Index as well as the fall of the Baltic Dry Index suggest a low demand for sea shipping due to the start of the financial crisis. Moreover due to a considerable boom in world trade in the years prior to the crisis, the industry had put in numerous orders for new ships, especially container ships. As a consequence, the market is characterized by large overcapacities putting further pressure on freight rates. At the end of April 2009, 506 containerships lay idle representing around 10.6 % of the entire fleet. As a result, charter rates fell drastically. At present, none of the big shipping companies is able to operate at a cost-covering level. The situation could deteriorate further if all the 11 400 container ships currently in the order books worldwide were built. While they would increase the global container fleet by 60 %, no increase in demand is in sight.

Consequently, there are also negative effects for shipyards. While orders for 2009 are expected to be completed, the outlook is bleaker for the years ahead. Usually customers make a down payment of 10 to 20 % for a new order with shipyards pre-financing the rest. In the current economic climate, however, shipyards find it rather difficult to get access to the necessary capital. As a result, their volume of orders is dwindling. Incoming orders are at their lowest level since 2001 and are likely to decline further. In Germany, this has already led to the insolvency of 4 shipyards with negative effects on the labour market.

In summary it can be noted that the current economic crisis has led to an overall slow-down in global production and global trade. Coupled with existing overcapacities in the maritime shipping sector, it resulted in declining freight rates and unutilized ships. Next to ship-owners, shipyards start feeling the negative effects as incoming orders fall and access to credit is being reduced.

7 Data sources and monitoring options

A key question is the monitoring and enforcement of the policy measure. The challenge of data needs and availabilities are situated in the triangle of international law, (supra) national jurisdictions and environmental ambition. Furthermore, the decision which emissions are considered the baseline for setting up the scheme also influences the data needs. In the following sub-chapters, the possibilities and data needs for identifying the absolute sectoral emissions and for setting the cap are discussed. Subsequently, the bases of assessment / trading and corresponding data needs and monitoring requirements for the three selected options are discussed in chapter 8.

7.1 Fuel consumption monitoring

Fuel consumption may be directly monitored or reported on the basis of fuel uptakes.

It is implicit that every vessel master (the captain) monitors its fuel consumption in order to plan voyages and fuel uptakes. The technical instruments for monitoring fuel consumption differ on board vessels. Contemporary fuel flow meters have accuracies of 2 % and better. Older and smaller vessels may monitor their fuel consumption with calibration tanks. Calibration tanks achieve high accuracy over a period of time. In any case the fuel consumption data are readily available on board ships. However, today no mandatory reporting mechanism is in place.

The bunker fuel delivery notes (BFDN), according to MARPOL Annex VI mandatory to be stored onboard ships for three years (IMO 2008), may provide the basis for reporting as well. The Bunker Fuel Delivery Notes that are based on the bunkers sold to vessels shall include information on the bunker port, date, quantities sulphur content and densities of the bunkered fuel. Information on the carbon intensity of the fuel is currently missing.

Until today, bunker fuel statistics, build on the bunkers sold, and emission inventories based on those (top-down approach) have not proven reliable. Buhaug et al. (2008) argues that bottom up modelling based on technical vessel characteristics and vessel activity produces more reliable results than top-down estimations based on statistics of fuels sold. Historic top-down estimations differed widely from bottom-up estimates (Figure 4; also see discussions in Corbett and Köhler 2003; Eyring et al. 2005; Endresen et al. 2003, 2007; Gunner 2007; Olivier et al. 2001; Skjølsvik et al. 2000; Corbett and Fischbeck 1997). However, it may be argued that the statistics will improve, in particular because the bunker fuel delivery notes were made mandatory only in fall 2008. Kågeson (2007) assumes that it will take at least until 2012 for reliable data to be available to European countries. Furthermore, the reporting would need to expand to include the carbon content of the fuel (Kågeson 2007), although deviations if using literature data would be small.

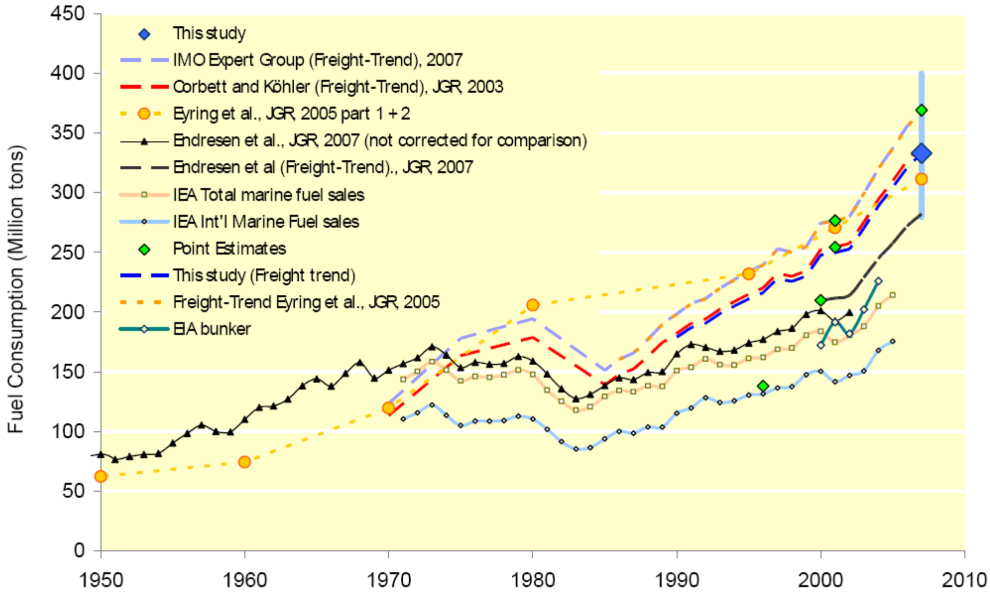

Figure 4: *World fleet fuel consumption based on different bottom-up estimates and statistics based on fuel sold*

Source: IMO (2009)

A significant level of uncertainties in bunker fuel reporting remains, despite the obviously improving data situation with the mandatory Bunker Fuel Delivery Notes (BFDN). As greenhouse gas reporting from vessels relies on only one parameter – the fuel purchased in a period of time – this level of uncertainty cannot be avoided. Therefore, a second backup control or a different primary data source needs to be established. The reasons for the uncertainties are the lack of controls of such reporting and the manifold opportunities to source bunkers outside the IMO MARPOL control. For example, offshore bunkering and thus the utilization of extraterritorial activities which are difficult to monitor remains common practice. Vessel masters may omit bunker amounts due to poor management or deliberately in order to avoid costs. Marine heavy fuel oil (HFO) may be sourced from stocks that were produced as other heating oil products and may thus circumvent marine bunkering reporting mechanisms. Furthermore, the reliability of BFDN has been questioned by industry representatives due to possibilities of corruption and falsification[31]. As a consequence, a risk of mismatching marine fuel consumption and BFDN amounts might persist in the future.

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[31] Personal communications with ocean carriers, fall 2009.

The amount of bunker fuels produced today is determined by refining economics[32] and not primarily by the demand side. What is being sold in marine bunker markets is residual fuel as a secondary recycling product from refining where the cost benefit analysis does not result in further refining (EC 2002). Thus, marine heavy fuel oils are not deliberately produced. The available refining 'by-product' will seek the most profitable market; for example low land-based demand may lead to additional capacities sold on the marine market.

The most plausible primary data source or secondary control is excerpts of the vessels' log-books. Each vessel is maintaining a log-book for its own management and to prove the compliance with manifold international and national rules and standards. Modern and large commercial vessels today operate with electronic log-books, often combined with sophisticated fuel and engine monitoring (see for example products by Kongsberg Maritime AS: http://www.km.kongsberg.com/). Older and smaller vessels maintain log-books manually. The measured or estimated fuel consumptions make up one entry in marine log-books for vessel management. Besides fuel data, other data is available on board vessels, in particular data on ports visited, cargo loaded and distances sailed. Both port data and cargo data could easily be verified – in the case of suspicion of falsification – by contacting port authorities or customs agencies. In conclusion, the data on fuel consumed and purchased is available on board ships and can be verified with data on distances sailed and ports visited. The question is whether a disclosure of log-book data could be made mandatory.

The US Coast Guard mandatory reporting requirement for ballast water management provides a precedence that mandatory reporting of existing data is legally possible. On June 14, 2004, the US Coast Guard published regulations on its mandatory ballast water management and reporting. A failure to comply may result in a daily fine of US $US $ 27 500. The reporting includes detailed information on the locations of the ballast water management practices of the vessel, its last and arriving port as well as where it took up, exchanged and discharged ballast water (http://invasions.si.edu/nbic/forms/NBICReportingForm.pdf) (see also Annex 4). It is therefore an example of the national state enforcing a reporting requirement that stretches into the extraterritorial voyage of a vessel.

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[32] Heavy fuel oil is a residual co-product after atmospheric distillation. The refining process is designed to maximize the yields from valuable products – namely distillate fuels. Thus, the amount of heavy fuel oil that enters the market depends directly on the cost of further refining those oils and the supply and demand balances in the residual and distillate segments. As an example: today's marine HFO prices are below crude oil prices (Prices on 26.07.2009: crude oil (Brent) = 485 US$/t; HFO380 Rotterdam = 400US$/t; HFO380 Singapore = 440 US$/t). The marine bunker prices are further determined by the gas and coal prices for land-based power plants, because heating oil – the dominant heating oil market – has to compete with those competitive fuel types. In tendency, the demand for heavy fuel oil is declining, that for distillate fuels increasing. Thus a continuous price down-ward pressure for HFO exists.

The EC could establish a mandatory reporting scheme that requires vessels on voyages to any European port to report – at least once per period – the fuel consumed. In order to verify information, the reporting should mandate:

- Amount of fuel uptakes (e.g. BFDN)
- Location of fuel uptakes (e.g. BFDN)
- Date of fuel uptake (e.g. BFDN)
- Carbon content of fuel uptake (measured – or by choosing default values)
- List of visited ports (via log-book entries)
- Distances travelled between ports (via log-book entries)
- Fuel consumed per distance travelled [t/nm] and while in ports [t/24h] (via log-book entries)

The reporting could be established electronically, via fax or paper and associated with a fine for non-reporting – similar to the procedures established by the US Coast Guard for ballast water reporting.

7.2 Monitoring of distances travelled

The monitoring of distances may be conducted through paper reporting or via electronic means of vessel tracking. A scheme that solely relies on distance monitoring would also need to establish vessel based efficiency factors, which would provide the emissions figures when linked with the travelled distances. The derivation of efficiency factors is discussed in chapter 9.1.3.

Similar to fuel consumption, it is evident that every vessel master knows its history and schedule of port visits and therefore also knows the past distances sailed. The vessels' navigation, whether conducted manually or satellite based, tracks distances, speed and directions of vessels. Thus, records of distances sailed including the ports visited already exist on board vessels.

The record of distance sailed could be falsified easily when no secondary control is used to verify the reporting. For example, certain voyages or ports of call could be omitted in the reporting. A logical secondary control is to focus on a period of time and back-up the reporting of distance sailed with the fuel used in the form of the bunker fuel delivery notes or log-book entries. In this case the distance monitoring is one part of a tandem monitoring system similar to a secondary back up of the fuel consumption reporting as described under chapter 7.1.

7.2.1 Automated distance reporting systems

The tracking and reporting of geographic locations of vessels has been established as a measure of marine safety. Today's available instruments are based on chapter V of the Convention Safety of Life at Seas (SOLAS). SOLAS hands the reporting of vessels in international waters to the International Maritime Organization (IMO). "The organization (IMO) is recognized as the only international body for developing guidelines, criteria and regulations on an international level of ship reporting systems." (SOLAS V, Regulation 11.2) Thus, while ship reporting systems might be developed by contracting nation states, their implementation may require action by the IMO. As a consequence, legal constraints might hinder the establishment of monitoring and reporting systems that would go beyond already established technical installations. On the other hand, SOLAS leaves room for national reporting systems not reported to and not disseminated by the IMO.

Regulation 19 (SOLAS Chapter V) lays out the requirements for ship-borne navigational systems and equipment. All ships with 300 gross tonnage and more, engaged in international voyages, all cargo ships of 500 gross tonnage and all passenger ships irrespective of their size have been required since 2002 to be fitted with an automatic identification system (AIS). In 2006 a second system was introduced to the SOLAS convention that establishes the Long Range Identification and Tracking System (LRIT). (MSC 2006a, 5.74 ff) The LRIT was established with the clear intention of also using the system for environmental purposes.

7.2.1.1 AIS – Automated Identification System

The AIS is an electronic device that automatically transmits information of the ship in regular intervals to receiving stations. The information transmitted allows the geographic tracking and distance monitoring of vessels. It includes the vessels' identity (IMO-number) and vessel type, its position, course and speed. Port of origin is not reported and only in some cases do vessels report the port of destination and expected time of arrival. (US Coast Guard 2002)

The AIS is a radio-based (VHF) signal with a limited range. The prime purposes of the AIS signals are to inform other vessels and shore-based facilities for safety purposes on the movement of the ship. The range of the AIS radio signal is approximately 100 km or 50 nm. However, it may depend less on weather conditions and the height of the antenna and receiver. Thus the existing net of shore-based receivers would not be capable of tracking and monitoring the vessel routes and distances in international waters beyond approximately 100 km offshore. A European network of base stations has been developed (EU 2002 and Figure 5).

However, the World's Radio Communication Conference allowed the two existing VHF frequencies AIS-1 and AIS-2 to be picked up by satellites as well. AIS signals can be picked up by satellites and aircraft surveillance, covering a much larger area than what would be possible by land-based receivers.

The capabilities of today's AIS and space-based receivers are nonetheless limited. The largest problem is the cancelling out of signals if too many signals are received or if vessels are too close to each other. Analyses of the ship density in European waters have shown that the system may be saturated and the ship detection may drops towards zero (Høye et al. 2006). The solution to this problem may be to use a more directional AIS antenna, limiting the field of view and thereby decreasing the number of ships simultaneously visible to the AIS sensor. Other options for converting the existing AIS to a functional global monitoring system are dedicated channels, shortening of messages, reducing reporting intervals and limiting the reporting vessels to those outside of land-based receivers in order to increase the capacity of the receivers (Høye et al. 2006).

A private firm – Com Dev International – based in Ontario, Canada, has announced that their experimental satellite NTS has successfully detected AIS signals, even in high density shipping areas. The system is supposed to begin full operation in 2010.[33]. The AIS system already has a long-range option providing the possibility for ships outside coastal areas to transmit their information via satellite (Inmarsat) Inmarsat C, mini-C or D+[34]. Reporting today would be on demand from coastal authorities and voluntary.[35] Whether commercially offered surveillance data could be used for national policy setting and enforcement remains is also a legal question.

Furthermore, while the open accessibility of AIS data may be used for environmental reporting purposes, the open accessability has been received as deficiency by governments. Concerns were raised in the Marine Security Committee (MSC) that openly accessible AIS data could be detrimental to the safety and security of ships and port facilities. The issue of concern is the use of data by terrorists, pirates and belligerent nations (MSC 2004, Kuhn 2009).

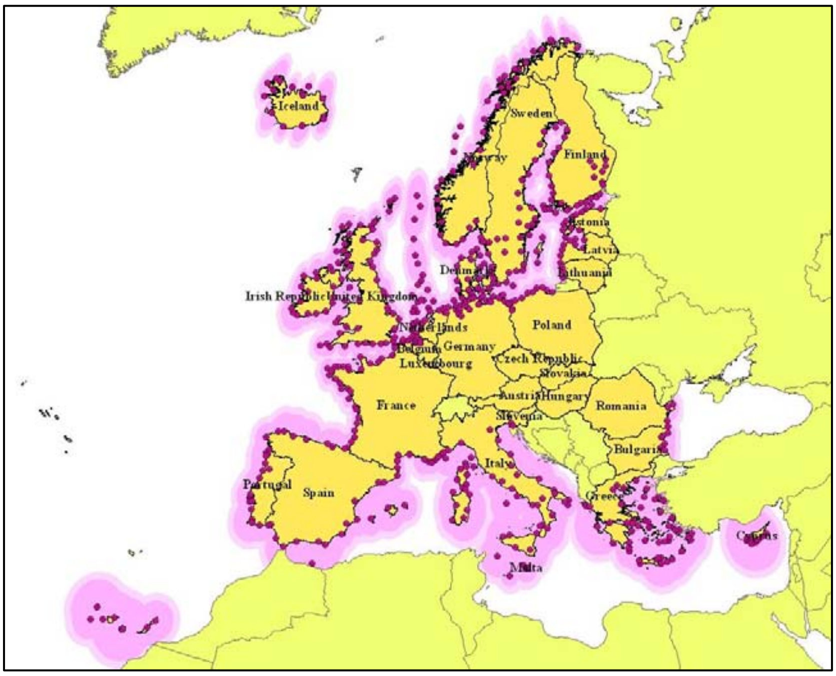

Figure 5: European AIS base stations and coverage.

Source: EMSA (2009)

33 http://micro.newswire.ca/release.cgi?rkey=1706104804&view=28380-0&Start=0

34 Inmarsat – International Maritime Satellite – was established in 1979 by the IMO. The purpose is to enhance the safety at areas at sea that are not covered by radio wave systems. Twelve satellites cover nearly the entire globe, except north and south of the 70th latitudes. Inmarsat C is a digital satellite communications system that can send and receive text and numeric data. Mini C is a compact mobile version of Inmarsat C. Most Inmarsat C and Mini C stations are integrated with Global Navigational Satellite Systems (GNSS), such as GPS, that provides continuous positioning and allows position reporting. Inmarsat D+ is a comparable system with lower transmitting frequencies.

35 http://www.inmarsat.com/Maritimesafety/lrti.html

7.2.1.2 LRIT – Long Range Identification and Tracking System

The Long Range Identification and Tracking System (LRIT) was made mandatory in 2006 in order to improve the safety at seas. It is applicable to the ship types defined in SOLAS Chapter V Regulation 19. LRIT establishes a multilateral agreement for sharing LRIT information for security, and search and rescue purposes, amongst SOLAS Contracting Governments. The LRIT information that ships are required to transmit includes the ship's identity, location and date and time of the position. One of the more important distinctions between LRIT and AIS, apart from the obvious one of range, is that, whereas AIS is a broadcast system, data derived through LRIT will be available only to the recipients who are entitled to receive such information and safeguards concerning the confidentiality of those data have been built into the regulatory provisions.

Contracting governments are entitled to receive LRIT information of their own flagged ships and of all ships which have indicated entering a port facility of that state, regardless of the location of that vessel. Vessels that have not indicated a call at a port facility are to deliver data if they are within 1000 nautical miles off the shores of the nation state and not within the jurisdiction of another contracting government (MSC 2006b). Vessels are protected from data requests if they are within the territorial waters of their flag state. In 2007, the MSC agreed that contracting governments may also request LRIT data for marine environmental protection purposes (MSC 2007). Today there are 62 contracting governments integrated into the LRIT system or which are awaiting integration (IMO 2009b).

7.2.1.3 Legal constraints regarding automated monitoring systems

As of today, vessels above a certain size transmit signals through their AIS transmitters in regular intervals. The vessel's position is automatically transmitted at pre-set intervals and may be received by communication systems on board other ships or on shore. The question arises of whether a port state can impose conditions on ships to use such a vessel monitoring system in order to use the information received through the AIS for the assessment of CO_2 emissions under an ETS regime. There is little doubt that port states are free to regulate that vessels have to fit their ships themselves with an AIS and that the AIS is used in the territorial seas and the EEZ (Treves 2007). However, the basis for the use of the AIS on high seas and third state territory is much more disputable, because the prescription of such use could be a violation of the principle of freedom of navigation.

The constraints in the use of data transmitted by a vessel monitoring system for the enforcement and control of an ETS regime shall be considered in more depth in chapter 12.

7.2.1.4 Discussion on automated vessel monitoring

The benefit of AIS data is their automatic generation and thus their potentially unrestricted access by nation states. Land-based receivers are technically sound and data could be freely utilized for environmental monitoring purposes. Whether the unrestricted access is legal under international law has not been finally resolved and access may be limited to territorial waters and vessels that have announced their intent to call at a community port.

Furthermore, a **ubiquitous coverage can currently not be ensured** because not all signals may be picked up by current satellite technology. Technically, the reception through satellites likely becomes feasible within some years. More significantly, the space-based use of AIS data is currently not regulated at the IMO level. Regulation may be forthcoming that either restricts or allows the use of AIS data. Until confirmation on the technical feasibility of satellite AIS reception and the legal use of such data, a 100 % monitoring and reporting of vessels by using their automated AIS data cannot be assured.

The LRIT data would be similarly sufficient for distance monitoring and a near global satellite reception exists. Its limitations are the current **legal limits through the guidance and regulations by the IMO**. The stated prime purpose remains safety and security. LRIT data can only be requested from ships sailing beyond 1000 miles off shore if they have indicated a port visit. Thus, under today's rules, it would be easy for vessels to deny the delivery of LRIT data to governments for large parts of their voyages. The provision to use LRIT data for marine environmental protection purposes may be interpreted to allow data acquisition for climate change protection purposes, but no details have been specified. Thus the design of a monitoring system needs to take the legal circumstances into account. It should be examined whether European countries, for example, could make the permission to call at a European port depend on the permanent exchange of LRIT data.

7.3 Monitoring of the distance of cargo movements

The distance of cargo in the context of linking it with greenhouse gas emissions should be the entire distance from the initial loading port to the unloading port. Data on both can be obtained through the Ocean Bill of Lading.

The Ocean Bill of Lading (OBL) serves as a receipt for goods, an evidence of the contract of carriage, and a document of title to the goods. The carrier issues the OBL according to the information in a dock receipt, or in some cases according to a completed working copy of the OBL supplied by the customs broker.

The OBL must indicate that the goods have been loaded on board or shipped on a named vessel, and it must be signed or authenticated by the carrier or the master (captain) or the agent on behalf of the carrier or the master. The signature or authentication must be identified as carrier or master, and in the case of agent signing or authenticating, the name and authority of the carrier or the master on whose behalf such an agent signs or authenticates must be indicated.

The OBL contains information on the port of loading, the port of discharge and the carrier. Thus, the theoretical direct route of the freight between the two ports may be derived. In liner services, deviations due to multiple port calls are possible, whereas bulk freight usually operates on direct routes.[36] The OBL are usually signed off and cargo is handed out at the receiving port once all bills and custom formalities have been cleared. The carrier acts here as the consignee of the transport contract that pertains the right to withhold goods until payment is made. The receiver of the goods and contract partner are the consignors that document their rightful access to the goods once all bills are paid.

Other options of cargo distance monitoring are the customs formalities that also provide the data entry for trade statistics. Those already established systems may be used to collect data on trade and distances. The European Union has established harmonized procedures for collecting trade statistics (EC 2006b). The guidance differentiates between general and special trade. For the general trade statistics all goods[37] entering or leaving the economic territory of a member state, except pure transit cargo, are recorded as imports or exports[38], regardless of whether they go into so called free circulation in the country of receipt or moves further to enter the free circulation elsewhere in the EU. Special trade statistics only record imports and exports at their final destination where they enter the free circulation of the EC. Statistics on extra-EU trade are compiled on the special trade basis. All intra-EU trade is based on Intrastat System Rules and recorded in the general trade statistics (EC 2006b). Intra-EU statistics do not cover any goods in transit that are stored in a country for purely transport reasons.

Each importer / exporter is obliged to register its goods at national customs agencies (Statistisches Bundesamt 2007). The customs agencies monitors the import formalities in order to issue potentially tariffs, anti-dumping fees, and collect import sales tax, exercise taxes and levies on certain goods. The registration and handling of import formalities might be handed to trading houses or freight forwarders. The actors might be similar to the consignee and consignor that enter the transport contract.

The European customs agencies are currently shifting to a sole electronic system, in Germany called ATLAS (Automatisiertes Tarif- und Lokales Zoll-Abwicklungs-System). The systems are directly linked to other government agencies and feed the country statistics. The information already captured may be used for other purposes including environmental purposes.

For all import goods that transfer through a port facility the country of origin and destination, final destination, the vessel at departure and at arrival, the packaging or con-

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[36] The deviation due to multiple port calls is compared to the overall length of the voyage small and could be covered with a deviation factor. Other reasons for deviations are weather routing, although potentially energy saving, safety concerns and costs – for example the detour around Cap Horn due to high prices of the Suez Canal Transit.

[37] The Guidance allows trade under certain thresholds not to be recorded, mainly from private individuals and in extra-EU trade if the trade does not exceed either one tonne or a value of 1000 Euros. However the amount of trade not recorded is generally below 1% of the total trade.

[38] The guidance defines “imports” as all flows from non-member to member state; “exports” all flows from member to non-member state; “arrivals” as all receiving goods from another member state; “dispatches” as all outgoing goods to another member state.

tainer number and the weight of the cargo have to be declared. Transport bills may be added to the import value calculations and may thus be required. For export goods, the country of destination, the vessel at departure, the packaging or container number and the weight of the cargo have to be declared.

Thus, the information necessary to identify the distance the cargo has travelled, its mass as well as at least the departing and arriving vessels already exist theoretically. It is furthermore captured electronically and could therefore be used to calculate emission footprints, assuming that potential legal obstacles of proprietary concerns can be overcome.

The enforcement of a reporting mechanism that is based on freight information also already exists because of existing customs requirements and responsibilities on the part of the importer. The importer can only gain possession of its goods after the end of all custom formalities and after all bills regarding the freight transport have been paid. Thus, the reporting for environmental purpose could be linked to those existing requirements. On the other hand, a similarly effective enforcement option does not exist for exports.

Any data of cargo movements would need to be linked with vessel efficiency figures. The possibilities for deriving those are discussed in chapter 9.1.3.

7.4 Conclusions regarding monitoring

The vessels' log-books are the best source for information. It was shown that, in principle, the monitoring of fuel consumption is feasible with high accuracy. In order to minimize false reporting, **a combination of fuel monitoring and distance monitoring shall be used**. Thereby the fuel and distance monitoring form a tandem monitoring system. The scheme then will be based on fuel consumption data and verified with distance data from the port of calls for a trip or within a period. A scheme only based on distance that then links with vessel efficiency factors is less reliable and more difficult to implement politically. Therefore, in the subsequent analysis, the options 'fuel based' and 'distance based' are examined together.

The reporting and monitoring of vessel data shall at **first be established through manual reporting (fax, e-mail, etc.)**, which is an immediately available option. When satellite surveillance of AIS data is reliably established, or when governments have agreed to use LRIT data, it might be switched to an automated satellite based electronic reporting system. The legality of using privately obtained AIS data for governmental purposes need to be assessed. The costs associated with establishing such a private system that relies on AIS data cannot be assessed in this report. LRIT data and the Inmarsat system would be the preferred choice, but require political action to amend the SOLAS regulations. The political process to amend the international agreements to allow for the use of LRIT data could be slow.

Monitoring and reporting of freight movement activities is also theoretically possible through already established customs systems. Alteration to the data use would be intra European and therefore feasible.

8 Different options to integrate ocean shipping into the EU ETS

8.1 Pre-selection of design options

Based on an interim report and project meetings three major and two minor design options were selected. The thoughts selecting those design options are presented in the following paragraphs as well as references to chapters where specific questions are discussed in more detail. The overall criterion of, the red thread leading through, the study is the environmental effectiveness. The aim is that international marine transport contributes to efforts to curb greenhouse gas emissions. Conclusions are presented in chapter 16.

In theory, emissions trading is an effective and efficient instrument for limiting emissions if certain conditions are met because it fosters cost efficient emission reduction measures. The conditions that have a major influence on the functionality of an Emissions Trading System includes, among others, the scope of the scheme, including geography and time, the character of trading (open, semi-open, etc.), monitoring options, enforcement capabilities and evasion risks. Monitoring and evasion has been discussed in chapter 7.

The principle structure of an Emissions Trading System is to identify participating entities and their baseline emissions, to set an emissions cap, decreasing in the future and establish rules for obtaining and trading emission allowances. Based on previous studies (Seum et al. 2007, Kågeson 2007) the maritime sector as a whole has been identified as the proper entity for approaching international seaborne transport emissions and not their allocation to national emissions. Regarding marine transport, legal questions are of great importance, because the actors and activities occur under multiple national and international authorities. In order to ensure an enforceable regime a legal contact person or persons behind the ship as the target to reduce emissions need to be identified. (chapter 15.1)

With regard to the basis of assessment two vessel-based options are examined that are grounded on the fuel consumed and the distance travelled respectively. An approach purely based on distance would need to be combined with a fuel-efficiency index in order to identify the carbon intensity of the activity. The temporal assessment basis could either a) be *last period*'s fuel consumption or distance travelled (e.g. in the last year), or b) the fuel consumption or distance travelled in the *last trip*. The focus on the *last trip* implies a focus on landing vessels and ignores sailing (sailing = port departing) vessels or in freight transport focuses on imports and ignores exports. This potential deficiency would need to be analyzed if a "last trip" approach were to be chosen. In contrast, a focus on last period would also cover sailing vessels if they left the EU during the last period. A third approach is a freight-based approach based on the rationale that in the end, it is mainly the cargo transported that is the cause of the majority of maritime transport emissions. Here too the question of covering imports as well as exports arises. Furthermore, non-freight activities would need to be dealt with separately.

The integration of only EU flagged ships is ruled out because it would likely lead to a re-flagging of vessels and it would result in a market distortion and competitive disadvantages for European countries.

Together with the German Federal Environmental Ministry and Environment Agency three main and two minor alternatives were selected. Those alternatives that all aim to integrate international marine transport emission into the European Emissions Trading System are:

A. System based on **fuel consumption** in a ***last period*** [A1] (fuel consumption & *last trip* as a secondary approach) [A2]
B. System based on **distance of ship** of the ***last trip*** [B1] (distance & *last period* as a secondary approach) [B2]
C. System based on the **distance of cargo** it has travelled the full trip (sender/port to port)

The geographic scope and evasion risks are discussed in chapter 88. This aspect together with the question of how to set the emissions cap is the subject of chapter 10. Moreover, the questions of allocation are key for all three alternatives (chapter 11).

The juridical situation will be discussed in chapter 12. Many legal questions apply regardless which option is finally chosen. The legal analysis in chapter 12 therefore does not differentiate between the options. The option's specific legal aspects can be found in the respective sub-chapters in chapter 13 (Economic analysis).

The same approach is taken when economic impacts are assessed (chapter 13). The analysis focuses on the example of Germany's core affected sectors. This approach allows conclusions on the political feasibility of different options and helps to assess overall economic efficiency. In principle, the economic assessment assumes that all *last period*'s emissions of vessels entering or leaving EU ports are covered, which corresponds to the approach A1/B2. The differences in economic impacts of options A2/B1 and C are discussed in chapter 13. As economic effects depend on, among other factors, whether emission allowances are initially grandfathered or auctioned, this matter will be briefly discussed.

Questions specific to the three options will be discussed briefly in chapters 13. However chapter 13 also serves to compile the findings and lead to certain conclusions and exclusions.

9 Geographical scope and the design of different approaches

9.1 Possibilities and difficulties of the selected approaches

In chapter 8 three different main approaches for integrating international ocean shipping into the EU ETS and two sub-approaches have been introduced. For this study five options for the scope have been considered. The next chapters focus on the possible and resulting geographic scopes of the five options. It also discusses the administrative design options and possible risks of evasion under each approach.

An instrument can be seen as environmentally effective the more emissions are covered and the larger the incentives are to reduce those emissions. European seaborne activity causes approximately 32 % of the global seaborne emissions (Table 6). A European regime should cover a similar proportion of global shipping emissions in order to take responsibility for European-induced maritime activities. Regarding geographical scope, it has already been shown above (chapter 2) that only the inclusion of voyages in extra territorial and international waters promise environmentally effective results. Seaborne transport emissions are caused by import and exports as well as non-freight activities (fishing, passenger, etc.). A scheme ideally would capture all those activities.

Furthermore, all ships regardless of their flag, nationality of ownership, etc. would need to be integrated in the scheme. If, for example, only ships under EU flags were covered, coverage would be limited (Table 6) and leakage effects would undermine the environmental effectiveness as well as the competitiveness of the maritime industry of the European Community. Covering all maritime transport activities ensures equal treatment of all ships and therefore adheres to the IMO rule of equal treatment, although it poses challenges in the context of the Kyoto's common but differentiated responsibilities.

The result is that the coverage of entire voyages of vessels entering and leaving the EU would be desirable if the ocean transport sector were to make an appropriate contribution to the targets of global greenhouse gas reductions necessary to limit the global warming to 2.4 degree Celsius (50%- - 85% reduction of GHG emissions by 2050).

9.1.1 *Last period* as a basis for fuel consumption (Option A1) or distance sailed (B2)

9.1.1.1 Principles

The variant "fuel consumption of the *last period*" aims for a global coverage of emissions related to all vessel traffic of ships that call at European ports at least once in this period[39]. This option would cover all trade (imports as well as exports), which occurred within the defined period of ship activity. It may also include emissions from trips between two or more non-European ports as long as they fell within the given period and the vessel called at least once at a European port. As laid out in chapter 7 the simultaneous monitoring of ship fuel consumption and distances is recommended. Thus the options fuel consumed (A1) or distance sailed (A2) are studied together as a tandem monitoring system.

9.1.1.2 Administration

In the base year (or base period[40]) each port in the European Union could require each vessel calling at the port to open an account and report distance and fuel consumption data for each trip in the base period. A central European register with one account per ship would streamline the process and would avoid double reporting in multiple harbors. The list of ships[41] established in the base year as well as the cumulative fuel consumed would be the basis of assessment for establishing the overall emission baseline and setting the cap (Kågeson 2007).

A de minimis rule and an exclusion of any vessel traffic that was covered by another comparable regime could be applied. For example, a de minimis rule could cover vessels that only call a certain number of times (one time or x times) in the base year/period at a European port[42] or whose emissions are below a certain threshold could be excluded from the reporting requirements. Furthermore, if other countries followed suit and entered the European Scheme, ships could be excluded from the obligations. However, a system that also focuses on the vessel's *last period* fuel consumption would need to be comparable here. Any delineation of coverage would be difficult if the other system were based on, for example, only particular voyages such as *last trip*s.

9.1.1.3 Evasion risks and other difficulties

In the approach of 'fuel consumed in the *last period*' some evasion risks exist. First, carriers might send the most fuel efficient ships to European ports, pushing less well performing vessels into other regions. However, GHG performance and size, and cargo

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39 The same applies if these emissions are estimated indirectly, using a distance-efficiency-index based approach that covers distances travelled in the *last period* (B2). All statements are therefore applicable to this option as well.

40 Kågeson (2007) suggests a base period of three to six months

41 The number of ships that call at European ports is difficult to assess. UNCTAD (2008) lists 97 481 vessels above 100 gross tonnage, of which 36 313 vessels are above 1 000 gross tonnage. The numbers of vessels calling at European ports or stationed at European ports is a fraction of those.

42 The number of calls a vessel makes at a European port differs widely. Container vessels in liner service between East Asia and Europe call approximately 7 – 8 times per year in Europe. Tankers from the Middle East may call 5 – 7 times in Europe per year. A port of call >2 can be assumed for all vessels that are in regular service to and from Europe.

carrying capacity are linked. The GHG efficiency of ships within one vessel type category can double or triple, but can at the same time reduce the cargo carrying capacity per trip up to more than tenfold. It is thus unlikely that shifts in vessel employment would be a feasible evasion approach on a large scale. Nonetheless, seaborne trade between non-EU members might become more emission intensive, even if only marginally. The risk here is a political risk: Non-European nations might object to the scheme and might prevent potentially necessary revisions of international law at the IMO level (e.g. revisions to the SOLAS requirements) and push for a global GHG regime at the IMO.

Second, carriers would have an incentive to limit the number of ships that call at European ports. For example, it might be advantageous to re-load long distance cargo close to Europe and conduct the final voyage in a shuttle service. The probability mainly depends on the costs of reloading and of obtaining emission allowances. The example used (see Box 3) suggests that the risk is actually lower than might have been expected.

Box 3: Example: Costs of reloading

If a carrier runs a container service from Shanghai to Hamburg with a 8 890 TEU vessel, its annual cruise emissions would be approximately 181 000 tonnes of CO_2 on 9 return runs between the two ports, with a TEU capacity of 56 000 TEUs to Europe (assuming a 70 % capacity utilization). If the vessel reloaded in Tangier to a 5 000 TEU vessel that would provide a ‘shuttle’ service to Europe, 16 return trips would be necessary to deliver the 56 000 TEUs, generating approximately 53 800 tonnes of CO_2 from Tangier. Assuming the highest total cost possible (no emission reduction measures and full auctioning of emission allowances), and a cost of € 30 per tonne of CO_2, the difference would be € 97 compared to € 29 per delivered TEU. This equals a € 68 savings per TEU, or 70 % lower cost, or around 5 % of average freight rates.[43] The additional time for reloading and additional cost for cargo handling will determine the likelihood of this risk.

The saved delta of € 68 per TEU does not necessarily indicate that re-loading would be lucrative. However, a cost saving becomes likely. The Hamburg container terminal (Hamburger Hafen und Logistik AG – HHLA) charges € 6.50 per 1 000 tonne of cargo. If its revenues in 2008 are divided by the TEU throughput, it results in € 43 per handled TEU.[44] Although handling costs might be lower in non-European countries,[45] the additional costs for vessel idle time and the risk of competitive disadvantages from longer transport times might be more significant. The incentive to re-load increases with increasing emission certificate costs. Having said that, it has to be kept in mind that we have assumed zero emission reduction measures. As many measures can be taken at costs below € 30 per tonne of CO_2, total cost will be smaller, indicating that reloading becomes less attractive.

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43 The method of how average freight rates were # calculated is shown in Annex 3: Development of bunker fuel prices

44 Data from HHLA Annual Report 2008 and financial information on the Internet site www.hhla.de.

45 The delta is € 68; Container handling operational costs are between $ 30 and $ 100 for terminals throughputs between 10 000 and 200 000 TEU/year.

Third, LRIT data might not be available for those voyages within the reporting period that do not have a scheduled European port of call under current legislative status. The monitoring and verification of “fuel consumed in the *last period*” requires a data exchange of voyages well beyond the land-based AIS reception range. Today, ships might object to exchanging LRIT data with European governments for that purpose. Therefore, amendments to SOLAS might be necessary. Paper records (BFDN and logbook entries) are the most reliable means of monitoring and reporting today.

Fourth, carriers might over-report in the base period or send more polluting vessels to European ports and then revert back to more economic practices. However, the operational and economical feasible possibilities are more limited, the longer the base period is. In addition, the higher the number of allowances that are auctioned, the lower the incentive to over-report or to purposely push emissions up.

9.1.2 *Last trip* as a basis for distances sailed (Option B1) and fuel consumed (A2)

9.1.2.1 Challenges

The option “distance travelled and fuel consumed in the *last trip*” aims to cover those voyages that deliver goods to European countries. This links the greenhouse gas responsibility more directly to the import trade to Europe. Export trade would not be covered. As argued in chapter 7, a reliable scheme would be based both on distance and fuel consumption monitoring. Therefore, the two options are treated together.

9.1.2.2 Administration

In the base year or period each port in the European Union could require each vessel calling at the port to open an account and to report distance and fuel consumption data for the *last trip* undertaken in the base period. A central European register with one account per ship would streamline the process and would avoid double reporting in multiple harbors. The list of ships established in the base year as well as the cumulative distance travelled and fuel consumed would be the basis of assessment for establishing the overall baseline emissions and setting the cap. LRIT data could be demanded under current legislation once the vessel has indicated that it will call at a European port.

Challenges arise to define the *last trip* and allocate the fuel consumed to this portion of operations (Kågeson 2007). For example, vessels in liner service carry cargo from several ports of origin to European ports. If the *last trip* is defined as taking place from the last port of call, the *last trip* prior to calling at a European port often only covers a sub-part of the voyage and not the entire distance the cargo might have travelled. Establishing any other ‘*last trip*’ definition than that of the last port of call would hardly be feasible because of the lack of verifiable bases of assessment.

A de minimis rule and an exclusion of any vessel traffic that was covered by another comparable regime could be applied. For example, a de minimis rule could cover vessels that only call a certain number of times (one time or x times) in a base year/period at a European port[46] or whose emissions are below a certain threshold could be excluded from the reporting requirements. Furthermore, if other countries would follow suit and enter into the European Scheme, ships could be excluded from the obligations.

9.1.2.3 Evasion risks and other difficulties

First, carriers might send the most fuel efficient ships to European ports, pushing less well performing vessels into other regions. The political implications of this process have been described above.

Second, carriers would have an incentive to limit the distance sailed of those ships that call at European ports by ensuring a last port call prior to a European port to be of close distance. Carriers might put in a stopover at a port near European ones – in reality or in the record – and thereby reduce the distance and emissions caused during the *last trip*. This risk must be considered to be significant because a real or fake stopover on voyage to Europe would be easy to carry out and would involve low costs. Options for stopovers exist in the Mediterranean, along the West Coast of Africa, and Russia providing at least this option for the Latin America, Africa, Middle East and Asia and Baltic trades. The North-American trade may not have a similar option, although Iceland, Norway and Greenland[47] could act as intermediary stopovers. One mechanism to avoid this risk of evasion is to establish the baseline emissions based on freight instead or in addition to distances travelled. This is discussed in chapter 9.1.3.

Fourth, carriers might over-report in the base period or send more polluting vessels to European ports and then switch to practices that result in lower emissions from '*last trips*'. The risk is much higher than in the case of an approach based on the *last period* because the 're-loading' practice and shortening of last distance is operationally easier to implement. Taking the above example of the Shanghai to Hamburg voyage into account, 127 200 tonnes of CO_2 could be 'saved' by the reloading and stop-over practice if emission certificates of 95 % of the base year (171 950 tonnes) were freely issued and had a value of € 30. Windfall profits from selling surplus certificates without reducing emissions can be above several million Euros. The additional time for reloading and additional cost for cargo handling will determine the likelihood of this risk.

Fifth, the multiple options to reduce the length of *last trip* may limit the monetary burden and thus shift the economic decision towards offsetting compared to abating emissions. If carriers are able to reduce their overall obligation, for which there are more flexible options under the "last distance travelled" approach compared to a "*last period*" approach, the most cost effective behavior is more likely to be the purchase of emission

[46] The number of calls a vessel makes at a European port differs widely. Container vessels in liner service between East Asia and Europe call approximately 7 – 8 times per year in Europe. Tankers from the Middle East may call 5 – 7 times in Europe per year. A port of call >2 can be assumed for all vessels that are in regular service to and from Europe.

[47] Since 1985, Greenland is not a member of the EU any longer.

allowance certificates. Thus technical and operational innovations in ocean shipping are less likely to be introduced under this scheme.

Sixth, a '*last trip*' would exclude export trips to outside the European Union. Thus the environmental effectiveness is diminished.

9.1.3 Distance of cargo as basis for CO_2 emissions (Option C)

9.1.3.1 Challenges

The option "distance of cargo travelled" requires a methodology for calculating the emissions associated with the transport activities. A calculation would need to combine cargo mass, distance sailed and fuel efficiency. In order to calculate CO_2 emissions based on cargo distance, the tonne-kilometres (or container-kilometres) have to be linked with vessel-type specific efficiency factors. A prerequisite would be to link cargo types with vessels types because it would be infeasible to link each freight shipment with the particular vessel(s) it has travelled on; moreover that would once again constitute a vessel-activity based approach. The categorization by cargo type could follow existing vessel type categories, such as containerized cargo, general cargo, project cargo, dry bulk and liquid bulk. More challenging might be the identification of appropriate vessel size averages or spectrums within a vessel category and their respective CO_2 efficiency factors. However, combining technical vessel data with trade data from, for example, UNCTAD (2008) allows for average CO_2 emission factors to be derived per vessel category that are type, size class and trade lane specific[48]. For example, the allocation of, for example, containerized consumer goods from Asia to an average vessel-type and trade-lane specific emission factor is possible.

9.1.3.2 Administration

The necessary data for monitoring the distance of cargo already exists and is processed by national customs agencies. The customs-related formalities are harmonized in the EUEU 27 and all import and export data are now registered, generally with automated systems, making the data processing easy. The establishment of a centralized data processing would foster the calculation of emissions. If Bill of Lading documents were used, new European-wide reporting systems would need to be established.

Each customs agency would categorize freight data and would forward such data to a centralized agency. The freight data (distance and weight) would be linked to an emission factor that is representative for the vessel category, size class and trade lane. Vessel performance efficiency values would therefore be developed. The linkage to vessel specific efficiency factors might be an option as well. The cumulative emissions

48 Trade lane specific emission factors which follow the bottom-up methodology used in IMO (2009) will be published by Öko-Institut e.V. and IFEU with the update and expansion of the online tool www.ecotransit.org in the first half of 2010.

from all cargos would present the overall emissions from European seaborne freight movements (Formel 1). This approach may be applied to imported goods as well as to exported goods. However, it might be easier to "cheat" on the distance of export cargo because there is no controlling of cargo in import trade zones.

$$Eci = Mci \times Dci \times VCefi \times Ui$$

Formel 1 *Whereas Ec = the Emission from cargo (i); Mci the Mass of cargo (i); Dci the distance travelled; VCefi the emission factor (efficiency [g/t-km] or [g/TEU-km] for the vessel category and trade lane that was used to transport Mci and Ui the specific utilization factor.*

A more fundamental question is who the responsible entity would be under a freight based approach and whether this approach could lead to real reductions in GHG emissions in seaborne trade. Theoretically, every cargo is signed off at the port of entry by the consignee and consignor who may act in lieu of the cargo owner, trader, forwarder, etc. This signing off can be used as enforcement mechanism whereby the consignee does not gain possession of the cargo unless all duties regarding emission certificates are paid off. What is missing is the link between the consignee and the vessel owners, operators, charterers, etc. While both might be identical in cases where logistics firms act as consignees of cargo, they will often be different entities when their own or chartered vessels are operated. If the cost for emission allowances is only a small fraction of the value of the imported goods, it is likely that the allowances would simply be purchased and no direct emission reduction effects would occur. The relationship between allowances prices and economic values will be further discussed in chapter 13.

9.1.3.3 Evasion risks and other difficulties

The evasion risks of a freight based scheme are small because it would require a complicated re-declaration of cargo, which would engage a complex set of stakeholders. Falsifying trade documents may also trigger much broader preliminary investigative proceedings because other legal aspects (tax issues, anti-dumping issues, etc.) may be affected. However, according to the German customs agency, there are indications of the origins of products having been falsified in order to avoid trade limitations. For example, the EU has currently anti-dumping regulations on shoes imported from China. Since then shoe imports from North Africa have increased while imports from China have declined. The customs agencies do not know whether these shoes have been produced in North Africa or only re-declared[49].

The obvious challenge is the amount of data points that need to be processed. Whether such a task could be handled by further developing the existing system and relying on commonly available electronic data infrastructure would need to be exam-

[49] Personal communication with German Customs Agency.

ined further. There is at least no reason to believe that this technical challenge could not be overcome.

A weakness in terms of environmental effectiveness is the linking to efficiency standards rather than to real monitoring of fuel consumed. However, modelling – whether on the basis of freight movements or vessel activity – is a credible and to date probably the most accurate method for estimating the emissions from seaborne trade. Due to the vessel's operating characteristics, modelling in marine transport is much more accurate than for any other means of transport. Thus, while it might not be sufficient as a basis for allowance trading, it is an appropriate method available today for setting the emissions baseline, setting the cap and for distributing a number of free allowances.

Furthermore, with a cargo-based approach additional methodologies would need to be developed for passenger and passenger/cargo mixed services.

9.2 Conclusions regarding regime design and geographic scope

Basing the system on a ***last period*** **is superior to basing it on** ***last trip*** **or cargo** in terms of the geographic scope. By covering all activities of vessels that call at European ports the extension of greenhouse gas emissions covered is the largest of all options. Imports and exports as well as some other transport activities would be covered assuming the definition of *last period* would be sufficiently long (i.e. 6 or 12 months). It appears that only a focus on *last period*s would be able to achieve such coverage. Coverage of up to one third of global GHG emissions from international shipping would be reasonable, regardless where those emissions occur. The "*last period*" approach further shows that monitoring is feasible and evasion risks are minimal. The focus on the *last period* would avoid complicated definitions (delineation of *last trip*) and would ease monitoring and verification.

Last period would also allow using modelling based on vessel calls for a reference period that lies in the past. Both the necessary data on vessels calling at EU ports and the technical data for those vessels are easily available from 1990 onward (IMO 2009). The modelling method is established including research to derive meaningful assumptions. The benefit of modelling over a time period is that the time at sea and in port can be estimated with high accuracy, based on the premise that carriers aim to avoid vessel idle times. And a principle benefit of modelling versus direct monitoring of base-year fuel consumption is the flexibility in terms of setting a base year in the past that prohibits cheating.

Last trip is less favorable as a basis because it would cover fewer vessel voyages and it would involve more evasion and cheating options. Today, the reporting of the last port visited might not be accurate and reliable enough. Amendments to existing reporting requirements (EU Directive 2002/59; SOLAS V) and the improved reliability of AIS data might be necessary. However, those data improvement could only materialize in the future and thus would not offer the reliable setting of baseline emissions – which should lie in the past.

The import and export of cargo has a theoretical comprehensive coverage of freight transport emissions. The fact that it would need to be linked with vessel efficiency factors removes the emissions further away from real fuel consumed and greenhouse gas emitted. Furthermore, the modelling of transport emissions for base-year calculations may be the least accurate or would at least require a large administrative burden. The data quality might be insufficient due to the manifold stakeholders involved (shippers, carriers, forwarders, cargo owners, custom agencies, etc.). Data gaps must be expected. However, further investigation in the data quality of cargo movements is warranted. Furthermore, data has already existed for decades and the data is easily obtained from national and EU authorities. Thus, this approach would have the advantage that a potentially sufficient approximation for calculating the reference year emissions might be carried out immediately.[50]

10 Setting the cap

10.1 Background

For a functioning Emissions Trading System, the cap must be stringent enough to ensure an overall scarcity of emission allowances in the market. If emissions remain below the cap during the commitment period, the carbon price (in a closed system) will drop to zero and the trading scheme will have little effect, as happened during the first period of the stationary EU ETS. To reach scarcity, the cap has to take, inter alia, historic and projected emissions and low cost abatement options in the sector into account. Other factors, such as the overall need to reduce greenhouse gas emissions to prevent dangerous anthropogenic climate change, a fair distribution of effort between sectors and the economic impacts in the sector, will also influence the cap setting. A cap can either be determined in absolute terms, as has been the case for the stationary ETS during the first two trading periods, or in relation to some reference year or period, as has been carried out for the aviation ETS. In the latter case, the relative target would have to be translated into absolute figures, i.e. would have to set an absolute cap as well. An EU maritime Emissions Trading System could commence operation in 2015[51];

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[50] The group of authors of this study have chosen a similar albeit simplified model of this approach (chapter 5). Seaborne emissions from European trade were extrapolated based on German import and export data that were linked to representative vessel types and average cargo distances. The authors are confident that the results are within +/- 20% of real emissions from seaborne trade.

[51] The Commission will propose EU legislation if by 2011 no international agreement has been reached and aims a coming into force in 2013. Based on experience gathered in the aviation sector, approximately one to two years are needed between a first proposal and adoption of a scheme. Another 2 to 3 years will be needed to adopt secondary legislation such as monitoring guidelines, establish the necessary institutions and collect all data needed for determining a cap and the distribution of allowances.

in line with the targets for the aviation and stationary ETS a cap for 2020 is discussed in this section.

Emissions from international ocean shipping have increased by 86 % from 1990 to 2007. However, due to the current economic crisis, global trade volumes have declined by 10 % in 2009 compared to 2008. Germany's export volumes in January 2009 were 18.4 % below those in January 2008. Cargo throughput in major German ports is down by 35 % in container trade and 50 % in auto trade (Handelsblatt 2009) (see Box 2 page 41). In the near future, trade is likely to expand again. Thus, it is fairly difficult to predict the future development of seaborne freight movements and emissions. Based on, inter alia, specific assumptions concerning the development of GDP, oil prices, trade, maritime transport demand, the structure of the global fleet and efficiency gains, IMO (2009) estimates that annual CO_2 emissions from international shipping (excluding military and fishing vessels) will possibly range between 650 million tonnes and 1 450 million tonnes of CO_2 in 2020 with a best estimate of 982 million tonnes. In comparison, the same study calculated 2007 emissions at 870 million tonnes of CO_2.

In the following sections, the effects of a non-ambitious cap in a closed scheme will be discussed. Sections 10.3 and 10.4 focus on the level of the cap and the calculation of emissions during the reference year.

10.2 Arguments for a tight cap or for more openness of the scheme

As described above (chapter 5.5), vessels have a large potential in terms of abating CO_2 emissions at negative marginal abatement costs. A reduction of emissions ceteris paribus goes hand in hand with cost savings if no regulation would be in place. This is reflected by the results of all studies known to us as well as by our own calculations. What differs is the share of GHG emissions from ocean shipping that is estimated to be avoided at negative costs. Estimations of no-cost emission reduction potential range between 10 and 25 percent of total emissions, depending, among other things, on the time horizon, the included vessels, state of the art definition, technologies and on bunker fuel prices as well as interest rates. It is difficult to understand why ship owners and operators have not implemented these cost saving measures already, which is why in

Box 1, page 37, we turned to several potential explanations.

The existence of negative marginal abatement cost has significant implications on the efficiency of emissions trading. To illustrate the causalities, it will first be assumed that

- maritime transport will face the same cap as aviation from 2013, that is 95 percent of the average emissions of the base years (assuming the base years to be quite recent years),
- the system is semi-open, i.e. land-based EU ETS participants may not purchase allowances from ship operators, but vice versa trade is allowed,
- all emission allowances are allocated freely.

Under this setting, there will hardly be any trading of "maritime" emission allowances in the medium to long term as the sector manages to cut emissions by the required amount (5%) over time without any cost. As long as the allowance price is positive, many actors would supply certificates to the market in which there is no sustainable demand because operators of land-based installations are excluded from using "maritime" allowances. Should prices eventually drop to zero, trade would break down. As a consequence, no additional incentives exist to further reduce emissions. Dynamic efficiency, in other words, would be zero. Even if emission permits were fully and repeatedly auctioned, the outcome would not differ significantly. As long as the sector can reach the cap at negative cost, the amount of allowances supplied by the authorities will exceed demand, bringing the price close to zero in the medium to long run.

In principle, at least two options can be considered to overcome this undesirable outcome. First, the cap could be tightened to a level which can only be reached with positive marginal abatement cost. For example, the cap is set at such a level that the price for "maritime" emission allowances equals the price of regular EU emission allowances. An appropriate cap is difficult to estimate but back-of-the-envelope calculations point to a cap of 40 – 60 % of current emissions (2005) in the case of an allowance price of € 30 (again depending on the assumptions of underlying cost estimates and emission projections). However, it seems questionable whether such an ambitious cap can be politically implemented in the short run: Even though there is a high potential for low cost emission reductions, initial adjustment costs (e.g. investment cost for retrofitting or even substituting old vessels by high efficiency vessels) clearly exist. Additionally, other sectors faced significantly lower caps at the start; thus it will be difficult to convince the shipping and relating sectors to be confronted with such a strict cap. But in the medium to long run, after some adjustment time, a tight cap is clearly recommended.

Second, the trading scheme can be fully opened. This would generate efficiency gains within the entire EU ETS because the maritime transport sector added has very low emission reduction costs, which would lower overall emission reduction costs. At the same time, allowing land-based emitters to offset their emissions via allowances from the maritime sector undermines the EU's international commitments to reduce GHG emissions in those sectors that are covered by the Kyoto Protocol as long as the maritime activities are not covered by the UNFCCC. However, any prediction on a post 2012 regime is currently speculative. Hence, allowing for complete tradability between all sectors can hardly be realized before an international solution is agreed upon. If such an agreement were reached, "maritime" emission allowances could be used by land-based emitters just as they can use Joint Implementation certificates to offset their emissions to some degree.

If the EU acts alone, one option is to allow for complete tradability between EU emissions trading for ocean shipping and international aviation. This may well be sufficient to give "maritime" emission allowances a price. Actually, this is most probably the case because marginal abatement cost in the aviation sectors is estimated to be between € 114 and € 325 /t in 2020, assuming a cap of 2005 emissions (EC 2006). This is much higher than in ocean shipping and in stationary installations, which means that the aviation sector will become a net buyer of certificates. Model based projections suggest that aircraft operators will purchase allowances for almost all of their emissions exceeding the cap (EC 2006). Being more optimistic about the economic feasibility of emission reductions within the aviation sector, we assume that this sector will cut its emissions exceeding the cap by 30 % and will buy the remaining 70 % on the market. Thus the excess demand of aviation will amount to allowances for 130 Mt CO_2 in 2020 (our own estimates based on EC 2006, table 3). This demand would seek supply on the market for “maritime” emission allowances as they are cheaper than certificates from the stationary sector. Therefore, the “maritime” certificate price will go up. It would need sophisticated modelling to quantify how ship operators will react to certain allowances price increases. But the probability is very high that aviation’s demand for “maritime” emission allowances is high enough and the maritime sector’s excess supply low enough to equalize the price of “maritime” emission allowances with the price of the EU ETS for stationary instalments. For example, this can be shown under the assumption that certificate prices increase to € 30 per t CO_2 and by applying IMO’s 2020 most optimistic estimates of marginal abatement cost in the shipping sector in 2020 as well as IMO’s emission projections. With these simplifications, ship operators could reduce emissions efficiently by a maximum of 30 % below BAU emissions, which is within the range of 60 – 90 Mt CO_2[52]. As a 95 % cap of current emissions is assumed as well, the remaining excess supply of the maritime sector will be a fraction of these 90 Mt CO_2. This is less than sufficient to satisfy the aviation sector’s demand. In other words, if these projections come true, aviation’s demand matching the maritime transport sector’s supply would equalize the price of emission allowances on the “regular” and the “maritime-aviation” market for emission allowances. Ideally, aviation would then be the perfect vehicle to link the submarkets together, offering the efficiency advantages of emissions trading.

It has to be noted, though, that little is known about actual marginal abatement cost in the aviation sector (ICF 2006) although studies are in the pipeline.[53] Additionally, more empirical research is needed to calculate the marginal abatement cost specifically for vessels entering the EU. Hence, it is beyond the scope of this study to make more than a rough guess on how prices of certificates on the semi-separated markets would actually develop in a trading scheme that allows complete tradability of allowances between the aviation and shipping sector only. Among other things, prices react to developments in the trading of emission rights of the land-based sector, which itself depends on numerous variables such as technological progress, the structure of power plants, policy measures, etc.

52 The range of 30 – 70 Mt is estimated as follows: It is estimated that CO_2 emissions by the maritime transport sector increase to 1400 Mt by 2020 (IMO 2009). Assuming that the share of emissions induced by freight transport to and from the EU stays stable at 25% of global emissions, it follows that these emissions will be around 350 Mt of CO_2 in 2020. IMO’s most optimistic marginal abatement cost curve assumes that approx. 26% of BAU emissions in 2020 can be avoided at a marginal cost below € 30 (i.e. approx. $ 40). 26% of 350 Mt equals 90 Mt. Legal or political infeasibilities, leakage effects or monitoring problems may lower the volume of emissions covered.

53 For example:see Omega 2009.

In summary, emission allowance prices for the maritime sector will very much depend on the cap implemented and its openness towards the EU ETS. Because maritime allowances should not be used to offset land-based emissions (at least if the Kyoto principles prevail) a cap would need to be strict enough to force marginal abatement cost for vessel CO_2 emission reductions up to approximately € 30 per ton. Then, since marine vessels would become net buyers, the price of “maritime” emission allowances would be equal with the price of “ordinary” emission allowances. If the cap is set too weak, certificate prices may be very low (if not zero) for the sector of maritime transport. If the aviation sector is allowed to buy emission rights from the shipping sector, prices may come closer to the regular EU ETS, even if the cap is not set very tightly.

10.3 The level of the cap

Based on the discussions above, three approaches for determining the level of the cap have been developed:

1. **Environmental necessity**:
   The IPCC estimated that industrialized countries need to reduce their GHG emissions by 25 - 40% in 2020 compared to 1990 if global warming should be limited to 2°C (IPCC 2007), which is the expressed aim of the EU. From an environmental point of view it could therefore be argued that the maritime GHG-emissions integrated into the EU-ETS should face a target within that range. Such a target would be similar to the efforts faced by installations in the stationary ETS in 2020 but much more stringent than the 5% reduction compared to average 2004 to 2006 emissions in the aviation sector. In line with the EU’s target under a global climate regime a reduction of 30% below 1990 levels would be appropriate from an environmental perspective and can be seen as the upper bound for a cap.
2. **Marginal abatement costs**
   The maritime sector still has a high potential for low-cost abatement measures; studies indicate that a range of approximately 10 - 25 % of 2020 business as usual emissions could be reduced at a negative cost (see section 5.5). The marginal abatement cost curve for the sector also shows that there is limited potential for reducing emissions at costs around expected carbon prices in 2020 (€30 – €70). Using the upper end of the range of the negative cost abatement potential and using the marginal abatement costs as the criteria, the cap would be 25% below 2020 emissions. This would be a very weak cap as all reductions could be achieved without costs and represents the lower bound of a possible target range. In a closed scheme this could easily lead to a long market with near-zero carbon prices, as happened in the first phase of the EU ETS. The economic impact of a maritime ETS on the sector depends not only on the cap but also on the allocation method and the openness of the regime which will be discussed in chapter 13.
3. **EU proposal for a global agreement**
   In the negotiations of a post-2012 climate regime, the EU proposed a global target for the maritime sector of 20% below 2005 emission levels. Such a target

is between the two boundaries above and could be applied to a European system as well.

Table 13 compares these three different targets. For comparison, the target in the aviation EU ETS for the 2013 – 2020 period is 95% of the average emissions of the 2004 – 2006 period. While the lower bound discussed here seems similar to the target in the aviation sector it is, in effect, much less demanding for the responsible entities in a maritime scheme. The entire reduction effort could be achieved at negative costs, i.e. operators would save more cost through reduced fuel consumption than they pay for the measures; emissions would not be reduced further than in the absence of an emissions trading system.

	1990	2005	2020
Upper bound: 30% below 1990	**-30%**	-59%	-67%
EU global target: 20% below 2005	36%	**-20%**	-35%
Lower bound: 25% below 2020	57%	-7%	**-25%**

Table 13: Different targets of an EU maritime Emissions Trading System

The choice of a reference year for the cap mainly depends on data availability. Although IMO has published emission figures for all years since 1990 the estimates for the most recent years are more reliable than those for earlier years. Using expected future emissions as a basis for cap-setting is less reliable due to the extra assumptions necessary for projections. Possible ways to model reference year emissions are discussed in the next section.

10.4 Determining reference year emission

For the aviation ETS different reference years were chosen for determining the cap and for distributing allowances for free. To avoid strategic behavior the cap is set in comparison to historic years; operators were not able to influence these emissions anymore when the legislation was proposed. Free allocation is based on 2010 data to ensure high data quality for a robust distribution of allowances. An error in the figures for determining the cap will not favor one airline over the other and, if relatively small, will not have a large impact on the overall scheme. However, basing free allocation on unreliable data could lead to significant distortions of competition within the sector. The same principles apply to maritime transport. For setting the overall cap it is not necessary to have reference figures of the highest accuracy. The cap could either be based on one single year or a range of years. The latter would have the advantage that annual fluctuations would have a lower impact on the target.

Modelling of vessel emissions is a possible and reliable method for determining the emissions associated with transport services (Buhaug et al. 2008). IMO concluded similarly: “Activity-based estimates provide a more correct representation of the total emissions from shipping than what is obtained from fuel statistics” (IMO 2009, p. 39). In a bottom-up approach, the direct greenhouse gas emissions from vessels, vessel by vessel, can be calculated quite easily. Data on main and auxiliary engines, cruise speed, cargo capacity, etc. are available, for example, through the Lloyds Register of Ships[54]. IMO (2009) assesses the technical vessel data from Lloyds to be held with very high confidence and well known. Uncertainties are moderate for the days at sea, in port and off service and for all AIS based load figures in the Lloyds database (Buhaug et al. 2008). Modelling based on Lloyds data results in emissions and performance figures of today's ship and engine families. Advanced emission control and fuel efficiency technologies are not considered, although limited information on those might exist.

Figure 6 shows the relationship between CO_2 equivalent emissions and dead weight tonnage for bulk, general cargo and gas carriers based on aggregate information (Buhaug et al. 2008). In addition to the emissions at sea, the emissions in port should be added based on technical and activity data. The graph shows the strong correlation between vessel power, cargo capacity and emissions. Thus, despite the fact that ocean ships are built individually or in small series (Kågeson 2007), their technical characteristics are similar and predictable. All necessary data are available, for example from Lloyds Register Fairplay or in aggregate form in Buhaug et al. (2008). Guidance on modelling the vessels' hoteling (while in port) emissions can be obtained from EPA (2006). Reliable global emission estimates now exist for the years 1990 to 2007 (IMO 2009). Possibilities for deriving emission figures for European seaborne trade are described below.

Emissions associated with European seaborne trade could be modelled for the three different geographic scopes discussed in chapter 8:

i. Modelling based on vessel calls – vessel specific for reference period (Options A1 and B2)

   A detailed list of vessel calls shall be obtained from each seaport in Europe for the baseline period. Technical data for each vessel will be obtained through a ship register. Modelling would use a set of particular assumptions:

   - For each vessel it is assumed that it operated the full baseline period.

[54] Lloyds Register Fairplay is officially contracted to allocate vessel IMO numbers. Based on this assignment, Lloyds Register Fairplay offers the most up-to-date and complete register of ships. The PC Register of ships (http://www.lrfairplay.com/Maritime_data/PC_Register/PC_Register.html?product=PCReg&i=1) contains information on 166, 000 vessels over 100 grt. However, it is available at rather high cost. Lloyds obtains copyright to those data and sometimes behaves possessively by limiting the use of the data. In case modelling were to become the basis, it is recommended that necessary technical data be made public.

- Each vessel operates at 90 % MCR and at cruise speed.[55] There are separate assumptions for RoRo vessels and ferries.
- Assumptions are made for each vessel category on days at sea and days in port.

ii. Modelling based on vessel calls – vessel specific for *last trip* (Options A2 and B1)

A detailed list of vessel calls shall be obtained from each seaport in Europe including the last port visited by each vessel. Although the information of the last port visited is a recommended part of the automated AIS information (IMO 2004), it is currently not required. EU Directive 2002/59/EC requires each vessel operator, agent or master to notify the destination port on its scheduled arrival. An amendment to include information on the last port visited – which is currently not required for vessels arriving from outside the EU – would be possible. Additionally the duration of port stay for each vessel shall be obtained. Modelling would use a set of particular assumptions:

- Each vessel operates at 90 % MCR and at cruise speed while at sea. Separate assumptions for RoRo vessels and ferries.

[55] As argued in chapter 5.1 the design values 90 % MCR and design speed shall be used as reference. Real performance shall be normalized to 90 % MCR to exclude temporarily lowering emissions from slow steaming. Permanent engine-down-sizing would be permitted as emission reduction measure.

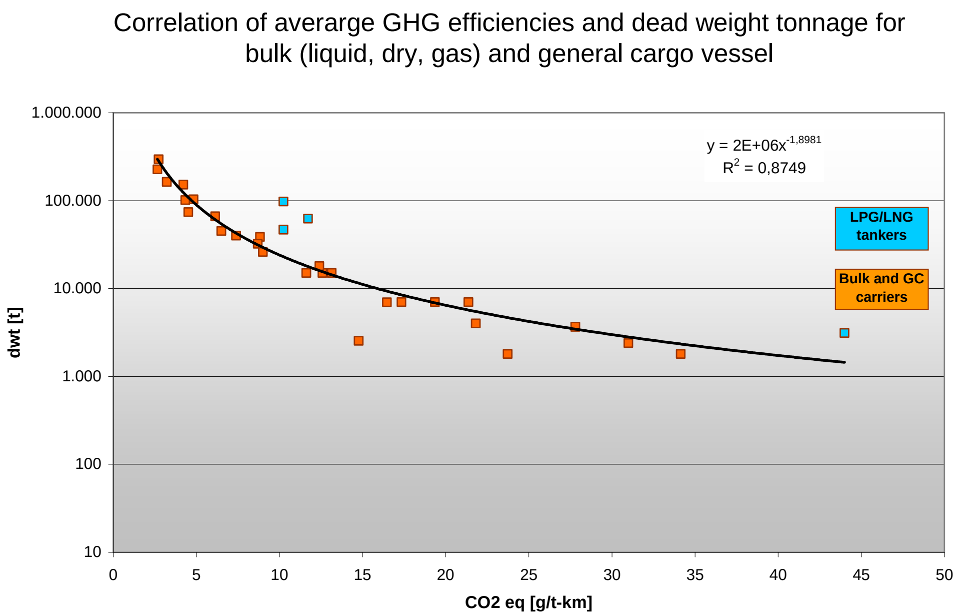

Figure 6: *Plotting of vessel efficiencies for bulk and general cargo vessel categories. Utilization is considered per category. Modelling based on data by Buhaug (2008) and EPA (2006)*

iii. Modelling based on cargo throughput and place of origin (Option C)

Data on cargo (weight, port of loading and discharge) shall be obtained from customs agencies, importers or exporters. Additional data on the cargo type, vessel type or vessel name would increase accuracy of modelling. Cargo and vessels are categorized and efficiency values are developed (GHG emissions on a t-km basis). The development of trade-lane and cargo specific utilization factors would enhance the modelling. Each imported (and exported) cargo is multiplied with its travelled distance and multiplied with the emission factor for the likely vessel category that carried the cargo.[56] Modelling would use a set of particular assumptions:

- Utilization factors for vessel types and potentially trade lanes.
- Average vessel types per cargo category.

Caps could also be based on real time monitoring of fuel and/or distance. Such an approach would push a regime well into the future since such systems have not yet been established. Furthermore, setting a cap based on real fuel or distance monitoring data

[56] A simplified version of this modelling was used in this study to estimate the German and European seaborne trade emissions.

may be a point of weakness for establishing the system at all since the monitoring and data access, although likely feasible, might be contested by other stakeholders on terms of jurisdiction. Baseline setting for a future year is therefore not recommended.

10.5 Conclusions regarding cap setting

In the end, an appropriate combination of reference year or period and reduction target will need to be chosen. Reference year or period emissions could be calculated for historic years; using future years is not recommended. In general, data gaps will increase the further back that one tracks. Establishing the reference emissions in the recent past is the best approach to overcome the monitoring challenges and to be assured of relatively accurate figures.

Due to the high potential for low-cost abatement measures the cap for the aviation sector should not be directly applied in the shipping sector. One option would be to use the same reference 2004 – 2006 period, but to increase the reduction effort to the percentage level of the overall EU target in a post-2012 climate regime (30 %). This would correspond to a 20 % emission increase compared to 1990 and a 43 % emission decrease compared to business as usual emissions in 2020.[57] Due to the uncertainties in the projected growth or maritime emissions, especially when considering that the IMO projections do not include the economic downturn in 2008 and 2009, any target less ambitious than this could lead to a market with more allowances than emissions. A less ambitious target would not only stay below the low-cost emission reduction potential but also go against the need for urgent action to reduce GHG emissions in all sectors.

11 Allocation of allowances

11.1 General considerations

A cap only determines the total quantity of emission allowances available in an emissions trading system; in addition, it is necessary to establish rules and procedures to allocate these allowances to the responsible entities. By far the simplest approach to allocation is a full auctioning of all allowances. Despite this there are several reasons why such an approach might not be the best for a maritime ETS at the beginning of the scheme: carbon prices are still relatively volatile, responsible entities are not used to dealing with carbon emissions and a sudden start might have higher negative economic impacts than a gradual introduction of auctioning (see chapter 13.3).

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[57] Such a cap would be very similar to the cap for stationary installations in the EU ETS. According to the Commission proposal for an effort sharing decision (EC 2008) the cap for stationary installations would be 36% below 2005 emissions in 2020 if the EU adopts the 30% target as part of a global climate change agreement. In contrast, the target for the aviation ETS is much lower but could still be adjusted in the review of the EU ETS.

Allocating emission allowances for free could minimize negative economic effects but would shift extraordinarily high rents to the maritime transport sector and requires substantially more effort from competent authorities and operators. Such an approach has been applied to installations in the stationary ETS. During the first trading period (2005 to 2007) there were only very few auctions across the EU. The share has significantly increased in the current trading period where many Member States including Germany auction a share of allowances; EU legislation only permits the auction of up to 10% of all allowances up to 2012. After 2013 installations for the public generation of electricity will face 100% auctioning while the share of auctioning is increased in most other sectors as well. In the aviation sector auctioning will be 15% of the cap. The overall aim is to move away from free allocation to a trading scheme with full auctioning.

For end consumers the allocation method makes little to no difference; in both cases it is expected that operators include the price of carbon in their cost calculations and therefore also in the price for their products, independent of whether allowances were allocated for free or not. The main difference is whether the operator or the state receives any profit from the additional costs which consumers have to incur (for a discussion of so called windfall profits see chapter 13.3). However, the possibility of passing on carbon cost to the consumer depends on the market situation of the operator and the trade exposure of the product. If there were competitors without the obligation to submit allowances for GHG emissions the risk of carbon leakage[58] occurs. In this case an operator under the scheme receiving free allocation could also chose not to pass on full (opportunity) costs onto consumers in order to stay on the market and defend market shares.

In the stationary ETS the major share of the allowances allocated for free were distributed on grandfathering; as of 2013 benchmarking will be used except for some minor special cases. In the aviation ETS airlines will receive all free allowances through benchmarking.

To allocate allowances, the following questions have to be agreed upon:

- share of allowances to be auctioned / issued for free; and the
- mechanism for the free allocation of allowances, especially grandfathering or benchmarking and the activity data on which the allocation mechanism is based.

All rules for allocation need to be harmonized across the EU. This could either be achieved by having only one central competent authority to administer the maritime ETS. Alternatively and in line with the aviation ETS, member states could be responsible for the administration but would have to apply the same rules. Differences in the treatment between member states could lead to incentives for changing shipping

[58] Carbon Leakage refers to the avoidance of carbon costs by moving operations and GHG-emissions outside the EU ETS.

routes to receive more favorable treatment and might start a race to the bottom between member states.

11.2 Free allocation

11.2.1 Grandfathering

Under grandfathering rules, responsible entities receive free allowances based on historic emissions during a reference period; historic emissions are reduced by a certain percentage to reflect the available share of allowances to be given out for free. In many member states different reductions were applied in the stationary ETS for energy related and process related emissions to reflect the different abatement possibilities.

To apply grandfathering it would be necessary to estimate the historic emissions during a specific reference period for each responsible entity and to verify these figures. The reference period does not have to be the same as the one used for determining the cap but should precede the adoption of any legislation to avoid strategic behavior such as the intentional increase of emissions during the reference period to receive more free allocation. One of the main difficulties in such an approach is that there might be significant differences in the composition of the responsible entities during the reference and the trading period. The main difference compared to stationary sources is that ships can switch their trades, schedules, flags and charterers relatively easy; if ships were chosen as the responsible entity there could be a considerable quantity of ships which might never enter the scope of the maritime ETS during the trading period but receive free allocation because they transported goods to the EU during the reference period and vice versa. If charterers were chosen, the differences between the reference and the trading period would most likely be smaller but could still be significant. These differences in the composition of responsible entities would not affect the environmental effectiveness of the scheme but would lead to distortions of competition between charterers and might discredit the entire scheme.

In general the EU is moving away from grandfathering and towards benchmarking as a mechanism for free allocation. Benchmarks can better reward operators that have taken early action to reduce emissions, would better reflect the polluter pays principle and would give stronger incentives to reduce emissions, as allocations would no longer depend on historical emissions (EC 2008b). In line with these considerations we do not recommend grandfathering as an allocation mechanism for the shipping sector.

11.2.2 Benchmarking

Under benchmarks free allocation is based on the CO_2 intensity of some activity or production and not only on historical emissions as when using grandfathering. According to the ETS Directive, the benchmark for stationary installations “shall be calculated for products rather than for inputs, in order to maximise greenhouse gas emissions reductions and energy efficiency savings throughout each production process of the sector or the subsector concerned” (EU 2009). In the aviation ETS, tonne-kilometres are used as the product for which the benchmark will be applied. The benchmark is calculated by taking the cap and subtracting the number of allowances which will be auctioned and the number of allowances in a special reserve and dividing this by the sum of all tonne-kilometres within the scope of the regime in the year 2010. This benchmark will then be applied to 2010 tonne-kilometres for each airline. The legislation intentionally only uses one average benchmark and does not distinguish between different types and sizes of aircraft. This provides a strong incentive to use the most efficient possible aircraft and avoids incentives to use less efficient models which could exist if the benchmark would differ depending on the aircraft type or size. The legislation also includes a factor to convert passenger-kilometres in tonne-kilometres instead of using two different benchmarks for freight and passenger transport.

A similar approach could be applied to the shipping sector as well using tonne-kilometres as the activity data on which to base the benchmark. It would be based on historic activity data and the available number of allowances for free allocation. Two differences arise due to the specifics of maritime trade.

11.2.2.1 Establishing the benchmark(s)

In the aviation sector is was sufficient to use one benchmark for all aircrafts and transport services as the industries' product. The impact of transporting of one person or one tonne of cargo by air is relatively homogeneous and less dependent on the aircraft, although emissions per unit of transport rise the shorter the flights are. The situation in the shipping sector is different: services provided by a bulk carrier cannot be substituted by a container ship, RoRo vessels cannot be replaced by tankers. This is also reflected in the emission intensity: large RoRo vessels emit 20 times more CO_2 per ton-kilometre than large bulk carriers (Table 14). It can also be noted that large vessels are considerably more efficient than smaller vessels providing the same services.

For stationary installations the starting point for the development of benchmarks "shall be the average performance of the 10 % most efficient installations in a sector or subsector" (EU 2009). One of the principles suggested when grouping similar products in one benchmark is that the emission intensity of state of the art installations within one benchmark should not exceed 20% (Ecofys et. al 2009). In the aviation sector the benchmark is based on the average historic emission intensity. For the maritime sector we propose to use the following principles to establish a benchmark:

1. To avoid a plethora of benchmarks, ship types should be grouped following the 20 % rule.
2. No differentiation is made between different size classes; the product (transport of one unit of a specific type of cargo) does not depend on the size of a vessel[59].

[59] This rule could increase the tendency to move towards larger ships. Although this is favorable from a climate perspective, larger ships could cause other environmental problems, demand for harbor space and deepening of shipping routes, e.g. the Elbe. These effects would need to be addressed through other legislation or provisions but not through the benchmarks for free allocation.

3. The total quantity of allowances which will be used for benchmarking is distributed across the different benchmarks according to the respective shares of the historic emissions of ships within the benchmarks during a reference period. The reference period might need to be updated periodically to reflect changes in global fleet composition/transport demand.
4. Responsible entities apply for free allocation and report serviced tonne-kilometres during the reference period for each benchmark.
5. Each benchmark is calculated by dividing the quantity of allowances available by the sum of respective serviced tonne-kilometres.

It is not suggested that the 10 % rule be applied as it is assumed that the quantity of allowances available for benchmarking will already be more demanding than the emission intensity of the best ships of a class; this is consistent with the approach for the aviation sector. Table 14 shows that this approach would lead to 6 different benchmarks; in practice there might be a need for a few more benchmarks, e.g. passenger ships are not included in the IMO figures on which the table is based. An estimation of the specific benchmarks is beyond the scope of this study and depends on many parameters which would need to be determined first.

Vessel type	Total CO2 efficiency in g/t-km			Benchmark
	minimum	weighted global average	maximum	
Bulk carrier (dry)	2.5	3.5	29.2	BM 1
Crude oil tanker	2.9	4.2	33.3	
Products tanker	5.7	8.9	45.0	BM 2
Chemical tanker	8.4	10.2	22.2	
LPG tanker	9.0	10.2	43.5	
LNG tanker	9.3	11.4	14.5	
General cargo vessel	11.0	13.1	19.8	BM 3
Container vessel	12.5	15.9	36.3	
Vehicle carrier	32.0	38.0	57.6	BM 4
Ro-Ro vessel (ferries)	49.5	51.0	60.3	BM 5

Table 14: Average maximum, minimum and weighted global average (based on transport work) emission intensities for different types of ships and proposed benchmarks

Source: Buhaug et al. (2008)

11.2.2.2 Activity data used for the allocation

As discussed above there might be a significant difference in the group of responsible entities during the period used to calculate the benchmark and during the trading period. Applying the benchmark to historic tonne-kilometres to calculate the free allocation for each responsible entity could therefore lead to responsible entities which do not operate within the Emissions Trading System but would receive free allocation and vice versa. If the period on which the allocation is based lies after the date of the adoption of the legislation it might even lead to responsible entities intentionally operating within the scope of the regime during that period. On the other hand new responsible entities which commence operation within the scope after that period will face a competitive disadvantage compared to incumbents. In principle two approaches are foreseen which could partly amend these difficulties

1. **New entrants and closure provisions** A special reserve could be established to provide new entrants with free allocation at a similar level as the benchmark. At the same time closure provisions could be used to limit free allocation to responsible entities which do not operate within the scope anymore, e.g. if no activity within the scope occurred during the previous year(s).
2. **Allocation based on activity during the trading period** Responsible entities would not receive their free allocation ex-ante as in the stationary and aviation ETS. Instead, each time one of their ship(s) enters the scope of the scheme it receives free allocation based on the benchmark and the activity data in the current period.

Both approaches are not without problems. Establishing new entrant and closure provisions would be in line with approaches in the stationary and aviation ETS. The difference in the maritime sector could be that the number of closures and new entrants might be significantly higher than in other sectors, especially if each ship is chosen as the responsible entity. This might lead to high administrative costs in competent authorities and responsible entities. If charterers are elected as the responsible entity this would less likely be a major problem as the most important charterers are not entering/leaving the scope of a maritime ETS on a regular basis.

The second approach would violate the ex-ante principle established in the emissions trading Directive. The idea behind that principle is that market participants have as much transparency as possible during the trading period to be able to better include emissions trading in their operations. In addition, such an ex-post approach would only incentivise the reduction of specific emissions but not the decommissioning of inefficient ships. Another issue in the second approach might be that the quantity of allowances would be used up sooner or later which would mean that ships entering the scheme towards the end of a year would not receive any free allocation anymore.

Despite the potential administrative burden the first approach is therefore recommended. This would require the establishment of a new entrants reserve, allocation rules for new entrants and closure provisions.

11.3 Auctioning

Auctioning has already been established in the Emissions Trading System and could easily be adapted to the maritime sector. If more than one competent authority would be established there would be the need to distribute the quantity of allowances for auctioning between Member States. This has been done for both the stationary and the aviation ETS; special rules for Member States without own harbors might be necessary as consumers in these countries would also pay the additional costs. Therefore, the issue of revenue sharing clearly needs more research and discussion.

11.4 Share of auctioning

In general, the EU is aiming to phase out free allocation. Stationary installations in the power sector will face 100 % auctioning in 2013; in other sectors a transitional system will be put in place. The share of auctioning will increase from 20 % in 2013 to 70 % in 2020 with a view to reaching full auctioning in 2027 (EU 2009). In the aviation sector initially 85 % of all allowances will be distributed for free. This share may be increased as part of the general review of the EU ETS Directive[60].

As argued above an immediate start with full auctioning in the maritime sector might lead to disruptions in the industry which could be avoided through a gradual increase in the share of auctioning, e.g. if owners and charterers need a transitional period to adapt their processes and investments to include the carbon price in their decisions. A maritime ETS would commence some years later than the third trading period of the EU ETS at the earliest; one option for the share of auctioning would be to apply the same transition as for stationary installations in the non-power sectors but with a delay of some years. This would mean that full auctioning would be reached a few years later than 2027. Alternatively the aim could be to keep 2027 as the year when free allocation ends. The annual increase of the share of allowances to be auctioned would be somewhat higher than in the stationary ETS; one justification for this more ambitious approach is that the overall knowledge of the carbon market will have increased considerably by then and the price will be less volatile making it easier for the shipping sector to include carbon in their calculations. In addition, any distortions of competition and other unwanted effects due to free allocation will be minimised with a decreasing share of free allocation.

With these considerations in mind it is suggested to commence with a moderate share of auctioning, e.g. 20%, and to increase this share gradually to 100% before the year 2030. Another approach to smooth the disruptions that initial full auctioning may cause, is to recycle a share of the revenues from auctioning in the first years to the sector, e. g. based on output (Faber et al. 2009). This would provide the maritime transport sector with financial resources for emission saving investments that capital markets may not provide in economically difficult times.

11.5 Conclusions

The analysis showed that auctioning is the easiest and fairest way to distribute allowances. Despite this, free allocation may be suited as the initial way to distribute allowances in the shipping sector. However, the experience in the stationary sector has

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[60] “From 1 January 2013, 15 % of allowances shall be auctioned. This percentage may be increased as part of the general review of this Directive.” (Directive 2003/87/EC, Art. 3d)

shown that operators used special rules for free allocation in ways not intended by the legislator; due to the complexity of free allocation in the shipping sector such behavior could be expected to repeat again.

If free allocation is used for a share of the total cap, it is recommended that:

- The share of free allocation be decreased annually and reach zero before the year 2030.
- Free allocation be based on a set of benchmarks for different types of ships. The benchmarks should depend on historic emissions, tonne-kilometre data and the total quantity of available allowances for benchmarking.
- a new entrants reserve and closure provisions be established to better reflect changes in the group of responsible entities between the reference period used for benchmarking and the years after the start of the trading scheme.

12 Legal analysis

12.1 Introduction

As has been discussed in chapter 3.1, in order to create a scheme that covers all emissions stemming from European-induced maritime activities, it is necessary to include emissions that are produced outside the territorial waters and the EEZ of the member states of the European Union. Depending on the design of the assessment basis an ETS system may (or even must) therefore not only cover emissions produced on the high seas, but also emissions discharged in the territorial waters and the EEZ of foreign non-EU states. And – in order to avoid a distortion of competition between EU and non-EU vessels – such a system should not only encompass emissions from vessels flying under the flag of a member state of the European Union, but of all vessels regardless of the flag flied.

Therefore, with respect to international law the question arises as to whether the European Union has – or its member states have – the right to enact legislation that covers activities outside the territory of the member states of the European Union.[61] Although such legislation certainly will be enforced in the ports of the European Union, it cannot be denied that any ETS that covers emissions produced on the high seas or in the territory of non-EU states aims – at least indirectly - at the regulation of behavior that takes place outside the territory of the European Union.

[61] In the following section the term “jurisdiction of the European Union” will be used as a synonym for the jurisdiction of its member states. The question, whether the European Union has the competence to use the jurisdiction of its member states for integrating marine transport into the EU ETS will be discussed shortly at the end of this chapter. As the European Union is a subject of international law as well as a member of UNCLOS and MARPOL there are no differences in the legal assessment of the situation between the European Union and its member states.

So as to assess the legal problems, it is thus necessary to have a more general look at the principles of jurisdiction in general (chapter 12.1.1) and the rules of jurisdiction as laid down in the International Law of the Sea and especially in the UN Convention on the Law of the Sea (chapter 12.1.2). The results of these introductory findings shall then be summarized in chapter 12.1.3.

12.1.1 Some basic remarks on the concept of jurisdiction

In order to assess possible risks or limits of the jurisdiction of the European Union, it should first of all be remembered that international law can be described as the standards of conduct, based largely on custom or practice, that have come to be accepted principles or norms in relationships between nations (Kintner/Joelson, 1974, see also footnote 61). With respect to the limits of state jurisdiction it is very important to keep in mind that there are some well accepted general principles; but there are also grey areas in terms of which international rules apply or which international rules are in dispute (Neale/Stephens, 1988). The reasons for this finding are easily identified: International law rests on consent of sovereign states. There is no law-making international or supranational authority that can compel a sovereign state to accept certain principles or rules. As the concept of jurisdiction must therefore be based on general accepted principles and customary law, it is very clear that due to the different interests of states, the exact content or limits of general accepted principles are often determined by states in different ways. One of such grey areas is the use of extraterritorial jurisdiction.

International law governing jurisdiction “describes the limits of the legal competence of a state […] to make, apply, and enforce rules of conduct upon persons. It concerns essentially the extent of each state’s right to regulate conduct or the consequences of events.” (Jennings/Watts 1992). Although there are various approaches for distinguishing different types of jurisdiction, the distinction between prescriptive and enforcement jurisdiction is the most common. Prescriptive jurisdiction can be defined as the authority of a state to make its law applicable to particular persons or circumstances. Enforcement jurisdiction refers to the authority of a state to use force in order to make sure that laws are complied with. Enforcement jurisdiction therefore refers to action such as convicting or punishing natural or juristic persons for breaking those laws (International Bar Association 2008). The differentiation between jurisdiction to prescribe and jurisdiction to enforce is relevant as the way a certain (extraterritorial) legislation is enforced is of relevance for the assessment whether the measure prescribed can be justified under international law.

Although there are different views with respect to the conditions that allow states to exercise prescriptive jurisdiction, in recent years the opinion predominates that states are only allowed to assert jurisdiction if there is a connecting factor or nexus between the state seeking to exercise legislative jurisdiction and the regulated person or conduct. With respect to enforcement jurisdiction, there is a general agreement that in principle a state may not exercise enforcement jurisdiction in the territory of another state without the second state’s informed consent.

The necessary nexus between the state and the regulated person or conduct for exercising prescriptive jurisdiction is established by one of the bases of jurisdiction. The bases broadly discussed are the principle of territoriality (extended by the so-called effects doctrine), the nationality principle, the protective principle and the universality principle.

The *territoriality principle* refers to the right of states to regulate any conduct within their territory. However, states have extended their jurisdiction on conduct clearly outside of the territory based on the so called effects doctrine. States have extended the limits of the territoriality principle to different extents and using different arguments. The core argument here is that the territoriality principle is already applicable if the effects of an activity occur in the state claiming jurisdiction. Disagreements arise over the closeness of the nexus between cause and effect (Neale/Stephens, 1988).

The *nationality principle* refers to the ability of a state to assert jurisdiction over its citizens. With respect to the law of the sea, the flag-state principle is the corollary of the nationality principle.

The *protective principle* refers to the right of a state to exercise jurisdiction over certain conduct outside its territory based on the protection of its security interests. The protective principle must be interpreted very narrowly and therefore applies foremost in the area of (military) security.

Finally the *universality principle* refers to the regulation of conduct committed outside the territory of a state and without any particular connection between the issue at hand and the state wishing to exercise jurisdiction. The universality principle is acknowledged especially in the field of criminal law, in cases where a certain offence is internationally condemned (e.g. in cases of genocide).[62]

Keeping these principles in mind it must be pointed out that – based on the concept of sovereignty – there is no need for an explicit competence of a state. In the leading case of the Permanent Court of International Justice from 1927 - the case of SS Lotus – the Court held:

> “It does not, however, follow that international law prohibits a state from exercising jurisdiction in its own territory, in respect of any case which relates to acts which have taken place abroad, and in which it cannot rely on some permissive rule of international law. Such a rule would only be tenable if international law contained a general prohibition to states to extend the application of their laws outside their territory, and if, as an exception to this general prohibition, it allowed states to do so in certain specific cases. But this is certainly not the case under international law as it stands at present. Far from laying down a general prohibition to the effect that states may not extend the application of their laws and the jurisdiction of their courts to persons, property and acts out-

[62] For a detailed analysis of the principles of international jurisdiction, see especially *Mann* (1984) and *International Bar Association* (2008).

side their territory, it leaves them in this respect a wide measure of discretion which is only limited in certain cases by prohibitive rules; as regards other cases, every state remains free to adopt the principles which it regards as best and most suitable." (cited according to Neale/Stephens, 1988).

It is obvious that there is a certain degree of tension between the territoriality and the nationality principle of jurisdiction, as cases can arise where the claim of one state to discipline their own nationals by reference to the nationality principle may conflict with the sovereign right of another state. The same is true in cases where jurisdiction is based on mere effects of activities that are located outside the territory. States may then disagree whether the nexus between cause and effect is strong enough to justify the execution of jurisdiction. As a result it can be stated that in many cases it is possible that two or more states claim jurisdiction on certain activities and try to protect their interests (Mann, 1984).

The only instrument of international law to solve such conflicts is the concept of "comity". Although it may be useful to remind that disputes should be solved under mutual respect of the parties involved the concept does not help to resolve contentious issues as the parties will differ correspondingly about the obligations flowing from the principle of comity. Therefore it becomes clear that the legislative acts based on the nationality principle or the extended territoriality principle may well be a source of conflict if the interests of the states involved differ (Neale/Stephens 1988).

Considering the proposed integration of marine transport into the EU ETS under inclusion of emissions from vessels flying non-EU flags and emissions produced on the high seas or in the maritime zones of other states it must be examined whether such a measure is extraterritorial in character and – if that is the case – under which circumstances the use of extraterritorial could be justifiable.

First of all, however, it is necessary to assess whether the general principles of jurisdiction are also applicable in the field of the International Law of the Sea.

12.1.2 The concept of jurisdiction under International Law of the Sea

In UNCLOS various aspects of jurisdiction have been codified. This applies especially for the jurisdiction over vessels as such as well as jurisdiction over vessel behaviour beyond the territory of the port state.

According to customary international law – as incorporated into the International Convention on the Law of the Sea (UNCLOS) – the nationality of a **ship** and its right to sail under the flag of a certain state depends on the registration of the ship in the territory of one state. Due to the historical development of the shipping industry over the last thirty years, many ships – although owned by companies registered in industrial economies – are registered in so called "flag of convenience" states that normally offer lower taxes, allow employment of cheaper crew and have lower regulation and/or enforcement standards (Birnie/Boyle 2007). The state of registration has full jurisdiction over the ship on the basis of such registration, and hence the nationality of the ship ("flag-state principle"). Art. 92 UNCLOS states in this respect that on the high seas, all ships shall be subject to the exclusive jurisdiction of the flag-state.

At the same time, there is no doubt that **ports** are subject to a state's absolute sovereignty. UNCLOS does not elaborate in detail on the degree of authority of a port state to enact and enforce its laws against foreign ships, so that the limits of port state jurisdiction must be defined by referring to the general principles of international law (Molenaar 2007).

From these findings it follows that with respect to ships registered in member states of the European Union, the European Union without any doubt has full legislation to enact legislation that covers any activities of vessels under the flag of an EU member state, notwithstanding the location of where these activities take place.

It is more difficult to assess the extent to which the jurisdiction of the European Union covers the right to regulate ships registered with foreign non-EU-flag states, but located in the port of a member state of the European Union. This assessment depends on the interpretation of how close the nexus between the cause and the effect (to be felt on the territory of the state claiming jurisdiction) must be.

12.1.3 Interim results

The character of any legislation providing for the integration of marine transport into the EU ETS will be enforced in port and can therefore be described as prima facie falling under the territoriality principle. With respect to vessels registered in member states of the European Union the nationality principle can also be evoked to justify a broader legislation. However, it is more difficult to assess the extent to which the jurisdiction of the European Union covers the right to regulate ships registered with foreign non-EU-flag states, but located in the port of a member state of the European Union.

However, neither the universality principle nor the protective principle is a suitable basis for legislative action aiming at the integration of marine transport into the EU ETS. The universality principle is particularly applicable to crimes which involve a high degree of mobility around the world (e.g. piracy or drug trafficking) or to serious war crimes. There is no state practice (and therefore no customary law) that could allow the extension of the universality principle to all kinds of global problems. The protective principle as well is not suitable for environmental legislation: It is strictly restricted to offences damaging vital governmental functions of the state claiming jurisdiction (Neale/Stephens, 1988).

As the international law of sea does not provide special rules on port state jurisdiction, the question of whether the European Union can claim jurisdiction depends on the limits of the (extended) territoriality principle. In that context it is necessary first to assess whether an ETS regime encompassing emissions of the high seas (or even of foreign territories) must be defined as an exercise of extraterritorial jurisdiction.

12.2 ETS regime as an extraterritorial measure?

In order to assess the nature of a certain measure, it seems necessary first of all to give an overview of the range of the territoriality principle with respect to a port state's jurisdiction over foreign vessels.

12.2.1 Access to ports

A coastal state has the right to close its ports if it deems it necessary to do so. However, the right must be applied on a non-discriminatory basis. There exists only one arbitral award, *Saudi-Arabia v. Aramco,* which raises the question of whether a state has an absolute right to close its ports (Churchill & Lowe 2001). In this award from 1958 the arbitrator held in an obiter dicta that international law requires that the ports of every state remain open and only close when a state's vital interests so requires. However, the opinion taken by the arbitrator since then has been rejected by state practice and scholars. Therefore it is clear that a port state is free to decide whether to close or open its ports, although unreasonable or discriminatory restrictions on access to ports may amount to an abuse of rights (Molenaar 2007a). States may restrict themselves by granting access to their ports pursuant to treaties, such as in bilateral treaties of friendship, commerce and navigation. However, such restrictions imposed by treaties on the basis of reciprocity cannot be interpreted as a general restriction of the right of a state to close its ports (Johnson 2004).

12.2.2 Conditions for entry into port as a measure for avoiding extraterritorial jurisdiction?

From the sovereign right to close its ports completely, it follows that a state is allowed to open its ports only under certain terms and conditions, if these measures are applied on a non-discriminatory basis. This right is a direct consequence of the location of the ship in the territory of the port state. With respect to greenhouse gas emissions produced outside the territory of a port state, the question arises as to whether the port state's authority suffices to impose port entry conditions that relate to conduct outside the territory of the port state. Some scholars argue that there are no reasons for restricting the port state's authority in that respect (Johnson 2004; Keselj 1999). As a port is an area of full sovereignty these scholars see no restriction of the sovereignty. Furthermore, they argue that ships that enter the port agree to be bound by any conditions, if these conditions are properly notified. Finally it is suggested that any regulations can be drafted so that the violation itself is not the actual activity occurring beyond the territorial sea, but the entry into port after a ship has engaged in such activity (Johnson 2004), so that any violation of rules is per definition territorial, not extraterritorial. Following this view, the question of extraterritorial jurisdiction would not arise if the obligation to provide emission allowances would be made conditional on the entry into port after emitting (a too high quantity of) greenhouse gases on the high seas and the EEZ.

However, such an interpretation of the port state's jurisdiction cannot be brought into conformity with the general principles of international law concerning the subject of jurisdiction: In order to decide whether a measure can be based on the territoriality principle as such or only under the effects doctrine, it must be taken into account whether the conduct to be regulated takes place within the territory of the state or not (Molenaar 2007a, b). If a measure aims to reduce the overall greenhouse gas emissions of all vessels by prescribing that such emissions are subject to an allowance, it is clear that the main focus of such a measure would be extraterritorial. A legislation that is drafted so that the violation itself is not the actual activity occurring beyond the territorial sea, but the entry into port after engaging in such an activity, would be an unlawful circumvention of the general principles of international law.

12.2.3 Interim results

To the extent European ports belong to their regular destination, the integration of maritime transport into an EU ETS would – if successful – have considerable effect on the behavior of maritime vessels notwithstanding their flag, their routes or their actual location. As such an effect is not only an inevitable consequence of the use of port jurisdiction but actually the intention of any integration of maritime transport into EU ETS, there can be no doubt that an EU ETS that covers emissions produced on the high seas and in the territorial waters of non-EU states is extraterritorial in character. A legislative design that circumvents the extraterritorial character of a far-reaching EU ETS cannot be brought into line with the general principles of international law and customary law.

Therefore it is necessary to examine under which conditions an extraterritorial ETS regime can be covered by the extended territoriality principle.

12.3 Justification of an extraterritorial ETS regime

Especially in antitrust cases both the United States and the European Union have a longstanding history in exercising extraterritorial jurisdiction (Neale/Stephens, 1988). For example, the European Commission extends jurisdiction to cartel cases outside the territory of the European Union if the economic effects of the regulated conduct are “direct, immediate, reasonably foreseeable and substantial”. With respect to antitrust cases the US Department of Justice prosecutes “foreign conduct that was meant to produce some substantial effect in the United States”. Sometimes the “effects-doctrine” is not only based on contact, but as well on a balance of interests (Mann, 1984). This means that the interest of the state that wishes to exercise its jurisdiction has to be balanced with the interests of other states affected by the relevant issue.

The experiences gathered in the field of business law as well as in the field of criminal law in literature have been transferred to the field of the environmental law of the sea, especially with regard to the question of under which circumstances port state jurisdiction on vessels may be used with respect to activities outside the territorial waters of the port state that is claiming jurisdiction. In order to define the quality of the nexus between activity and effect that is necessary for the establishment of an extended territorial jurisdiction, the following aspects must be considered to be of importance and have to be balanced when assessing the right of a port state to exercise extraterritorial jurisdiction:

- The significance of the effects on the state exercising jurisdiction
- The interests of the international community
- The interests of foreign states that are possibly effected by the use of extraterritorial jurisdiction (Molenaar 2007a)

Even if the result of the balancing test should allow the exercise of extraterritorial jurisdiction, the lawfulness of a certain measure still depends on the measures that are foreseen for the enforcement of the legislation.

12.3.1 The significance of the effects on the state exercising jurisdiction

For the purpose of this study the effects of climate change as such and the implications on the member states of the European Union can be assumed as known. Although the consequences of climate change may be worse for non-EU countries and especially for developing countries, there is no doubt that climate change will have a serious adverse impact on the European countries and that therefore the effects of the emission of greenhouse gases as such are of high significance. The total emissions of maritime transport account for 3.3 % of all global CO_2 emissions and are therefore not negligible.

The polluter-pays principle – although not customary law – also supports the integration of maritime transport into the EU ETS. If the emissions of maritime transport would not be covered by some kind of scheme to reduce CO_2 emissions, the overall effect of all efforts to reduce greenhouse gas emissions would be significantly reduced. Altogether it must be stated that the effects of uncontrolled CO_2 emissions from maritime transport are significant.

12.3.2 The interests of the international community

Although neither UNFCCC nor UNCLOS contains explicit (and concrete) obligations relating to the reduction of greenhouse gases emitted by international shipping, both conventions emphasize the strong interest of the international community in global climate and the marine environment respectively. However, even if UNFCCC and UNCLOS both entail obligations to protect the climate and the oceans respectively, neither treaty obliges member states to fulfil such obligations by regulating the greenhouse gas emissions of internationally operating vessels. But the change in the Earth's climate and its adverse effects are acknowledged in the UNFCCC to be the common concern of mankind. The concept of common concern of mankind makes clear that there is a strong and widely accepted interest of the international community to reduce all kind of greenhouse gases, regardless of whether they are produced in territorial waters or on the high seas. The concept of common concern of mankind furthermore contains the mandate of all states to take measures in order to avoid climate change. As a counterpart to the polluter-pays principle, a port state must therefore have the possibility to influence the volume of greenhouse gas emissions that are directly related to transports to and from that state. The responsibility of the state vis-à-vis the state community gives good reasons for not only reducing national emissions but also greenhouse gas emissions related to transports of or from a state.

Furthermore the international community has good reasons for aiming at a global coverage of CO_2 emissions. This is especially true for maritime transport as a reduction of CO_2 emissions can be achieved in this context at relatively low cost.

12.3.3 The interests of foreign states that are possibly affected by the use of extraterritorial jurisdiction

It is difficult to perceive which interests of third states could be affected by the introduction of an extraterritorial ETS going beyond the pure – and legitimate – interest of a state to regulate CO_2 emissions. Although the right of self-determination certainly is to be acknowledged, it has to be kept in mind that the right of self-determination must be interpreted in the light of the UNFCCC that establishes the protection of the climate as common concern of mankind. In legal terms this means that – if there is a conflict of competences or jurisdiction - the right of self-determination is limited if the right is used in a way that is not in line with the objectives of the UNFCCC. However, in practice the respect for the rights of third states to enact effective legislation at their own requires that EU legislation provides enough flexibility in order to avoid that certain emissions are regulated twice by different states and with possibly different or even contradictory obligations for the addressee of such legislation[63].

12.3.4 Summary

There are strong reasons for the introduction of an extraterritorial ETS. The interests of the European Union and of the international community are significant enough to allow for extraterritorial measures. As long as third countries do not enact any legislation that covers the greenhouse gas emissions of marine transport, the interests that can be invoked on the part of third countries are very weak[64]. This is especially true as long as non-EU states do not enact any legislation with respect to emissions of marine transport. The balancing test therefore supports the notion that an extraterritorial ETS for marine transport is justified in principle. However, it must be kept in mind that the actual form of enforcement of a legislative measure may have an impact on the justification of extraterritorial legislation as well.

But before this question can be examined in more detail, it is necessary to assess whether the use of extraterritorial jurisdiction is further limited by the international law of the sea.

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[63] This question will be discussed in more detail in Chapter 13.

[64] This conclusion is supported by the findings of Pache (Pache, 2008) with respect to an integration of aviation into the EU-ETS.

12.4 Extraterritorial prescription – restrictions originating in the International Law of the Sea?

If the introduction of an EU ETS regime under use of extraterritorial jurisdiction is allowed under the general principles of international law, it nevertheless remains open as to whether UNCLOS and / or MARPOL[65] permit their member states to enact legislation that entails standards or rules that are stricter than the "generally accepted international rules and standards". If there is a general rule or standard that CO_2 emissions are – for the time being – allowed without any restrictions or standards, the introduction of any scheme aiming at the reduction of CO_2 emissions could be "stricter" than existing rules or standards and therefore – with respect to the high seas – not in line with UNCLOS or MARPOL.

Pollution of the marine environment through the atmosphere is governed by Art. 212 UNCLOS[66]; the enforcement of vessel emissions is governed by Art. 222 UNCLOS[67].

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[65] UNCLOS is the United Nations Convention on the Law of the Sea and covers all relevant aspects of the Law of the Sea, including questions of jurisdiction and environment. MARPOL is the main international convention that covers pollution of the marine environment by ships.

[66] Art. 212 states:

Pollution from or through the atmosphere

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 organizations or diplomatic conference, shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control such pollution.

[67] *Art. 222 UNCLOS states:*

Enforcement with respect to pollution from or through the atmosphere

States shall enforce, within the air space under their sovereignty or with regard to vessels flying their flag or vessels or aircraft of their registry, their laws and regulations adopted in accordance with article 212, paragraph 1, and with other provisions of this Convention and shall adopt laws and regulations and take other measures necessary to implement applicable international rules and standards established through competent international organizations or diplomatic conference to prevent, reduce and control pollution of the marine environment from or through the atmosphere, in conformity with all relevant international rules and standards concerning the safety of air navigation.

However, through an incorporation of a reference to UNCLOS in MARPOL Annex VI, Regulation 11 (6)[68], the general regime of jurisdiction applying to pollution from vessels in general applies to pollution from and through the atmosphere, at least between the parties to MARPOL Annex VI (BAT 2000). This means that especially Art. 211 (3) UNCLOS[69] is of relevance for the question of whether UNCLOS does restrict its member states in enacting legislation relating to emissions on the high seas or the EEZ.

In addition even if there is no direct conflict with Art. 211 UNCLOS, there could be restrictions if and to the extent to which an ETS regime tries indirectly to influence construction, design, equipment or manning (CDEM standards), as Art. 21[70] and Art. 211

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68 Reg. 11 (6) MARPOL Annex VI states: The international law concerning the prevention, reduction, and control of pollution of the marine environment from ships, including that law relating to enforcement and safeguards, in force at the time of application or interpretation of this Annex, applies*, mutatis mutandis,* to the rules and standards set forth in this Annex.

69 Art. 211 (3) UNCLOS states:

3. States which establish particular requirements for the prevention, reduction and control of pollution of the marine environment as a condition for the entry of foreign vessels into their ports or internal waters or for a call at their off-shore terminals shall give due publicity to such requirements and shall communicate them to the competent international organization. Whenever such requirements are established in identical form by two or more coastal States in an endeavour to harmonize policy, the communication shall indicate which States are participating in such cooperative arrangements. Every State shall require the master of a vessel flying its flag or of its registry, when navigating within the territorial sea of a State participating in such cooperative arrangements, to furnish, upon the request of that State, information as to whether it is proceeding to a State of the same region participating in such cooperative arrangements and, if so, to indicate whether it complies with the port entry requirements of that state. This article is without prejudice to the continued exercise by a vessel of its right of innocent passage or to the application of article 25, paragraph 2.

70 Article21 states:

Laws and regulations of the coastal State relating to innocent passage

1. The coastal State may adopt laws and regulations, in conformity with the provisions of this Convention and other rules of international law, relating to innocent passage through the territorial sea, in respect of all or any of the following:

(a) …

(d) the conservation of the living resources of the sea;

…

(f) the preservation of the environment of the coastal State and the prevention, reduction and control of pollution thereof;

…..

2. Such laws and regulations shall not apply to the design, construction, manning or equipment of foreign ships unless they are giving effect to generally accepted international rules or standards.

3. The coastal State shall give due publicity to all such laws and regulations.

UNCLOS both acknowledge that the state's legislative competence to prescribe CDEM standards is restricted.

12.4.1 CO_2 emissions and pollution under UNCLOS and MARPOL

According to Art. 211 UNCLOS flag states are obliged to adopt rules and regulations to prevent, reduce and control marine pollution which "shall at least have the same effect as that of generally accepted international rules and standards". Furthermore, coastal states may "in exercise of their sovereignty within their territorial sea" adopt pollution laws and regulations concerning foreign vessels. However, in this context it is emphasized that coastal states' laws and regulation "in accordance with Part II, section 3, shall not hamper innocent passage of foreign vessels". The reference to Part II, section 3 of UNCLOS makes clear that the general provisions for the jurisdiction of coastal states, especially Art. 21 UNCLOS, shall apply to pollution from vessels as well. According to Art. 21 UNCLOS coastal states may adopt laws and regulations in respect of the preservation of the environment and the prevention, reduction and control of pollution thereof. Such laws and regulations however shall not apply for construction, design, equipment and manning (CDEM standards) of foreign ships "unless they are giving effect to generally accepted international rules and standards" (Art. 21 (2) UNCLOS). Yet Art. 211 para. 3 UNCLOS makes clear that port states are free to establish further requirements for the prevention of pollution as a condition of port entry. (BAT 2000).

The first question in this context is whether CO_2 emissions can be characterized as "pollution of the marine environment" in the sense of Art. 211 UNCLOS. Art. 1 UNCLOS defines pollution of the marine environment as follows:

> "'pollution of the marine environment' means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities;"

Some authors argue that – as greenhouse gases lead to a warming of the atmosphere and may in turn lead to a warming of the oceans – greenhouse gases would fall within

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4. Foreign ships exercising the right of innocent passage through the territorial sea shall comply with all such laws and regulations and all generally accepted international regulations relating to the prevention of collisions at sea.

the definition of marine pollution, as the emission of greenhouse gases results in the introduction of energy into the oceans. Furthermore, an “effects-based” view of marine pollution should include the release of any substance that causes harm to the marine environment (Doelle 2006, Jaén 2007)[71]. As UNCLOS aims at a comprehensive protection of the marine environment and with a view to the direct negative impact of increased CO_2 concentrations in the sea water (WBGU 2006) there can be no serious doubt that greenhouse gas emissions can be subsumed under the term “pollution”. Therefore the question of whether an ETS regime with extraterritorial aspects is justifiable has to be examined in the light of Art. 211 UNCLOS.

As MARPOL has so far been silent on the question of CO_2 emissions, it cannot be argued that MARPOL imposes any restrictions on member states not to impose any unilateral measures to regulate greenhouse gas emissions. However, due to the reference to Art. 21 UNCLOS, the following limitation of jurisdiction has to be respected: Unilateral laws and regulations shall not apply for construction, design, equipment and manning standards.

Therefore the question arises as to whether an EU ETS can be interpreted as **prescribing** construction, design, equipment and manning standards. Although an EU ETS may disincentive – depending on the design of the EU ETS – the use of certain CDEM standards an ETS can not be interpreted as to prescribe a certain CDEM standard. Vessels will remain free to use CDEM standards as they see fit under an EU ETS and. Although the EU ETS has only will have economic impact on the choice of the CDEM standards used, the EU ETS cannot be interpreted as prescription of a CDEM standard itself, even if certain standards will de-facto have to be used in order to reduce CO_2 emissions.

Neither UNCLOS nor MARPOL therefore restrict the introduction of an extraterritorial EU ETS scheme.

12.4.2 Restrictions stemming from bilateral treaties on navigation?

The very common treaties on navigation[72] should pose no problems with respect to introduction of an ETS regime, as these treaties generally do not guarantee an unrestricted right to visit ports of the other party. For example the treaty of friendship, commerce and navigation between Germany and the United States provides that both parties “shall have liberty on equal terms with vessels of the other Party and on equal terms with vessels of any third country, to come with their cargoes to all ports, places and waters of such other Party open to foreign commerce and navigation.” As the bilat-

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[71] The rising concentration of CO_2 in the seas does lead to severe acidification of the seas. The chemical causes and the implications are analyzed in detail in WBGU 2006. This means that CO_2 emissions have not only an indirect effect – global warming – but also a very direct effect on the marine environment.

[72] Most treaties on navigation provide for national treatment of the vessels of the other party in ports and territorial sea.

eral treaties are generally restricted to national treatment and most-favored-nation treatment, an ETS regime poses no problems as long as it is applied in a non-discriminatory manner.

12.4.3 Interim result

Although Art. 211 UNCLOS and Art. 21 UNCLOS are applicable to any regulation that aims at the reduction of CO_2 emissions, and therefore a unilateral prescription of CDEM-standards is not allowed, neither Art. 211 UNCLOS nor Art. 21 UNCLOS restrict their member states from enacting an ETS. Art. 211 UNCLOS does not prescribe certain CO_2 emission limits and is therefore neutral vis-à-vis an instrument like the ETS. As an ETS does not prescribe the methods that should be used in order to achieve the objectives of an ETS scheme there is no prescription of any CDEM standards. As MARPOL so far does not cover CO_2 emissions MARPOL does contain no restrictions for the establishment of an EU ETS.

12.5 Restrictions stemming from international trade law?

According to the General Agreement on Tariffs and Trade (GATT) 1994 the parties are obliged to grant to other contracting parties freedom of transit. According to Art. V (3) GATT 1994:

> “such traffic coming from or going to the territory of other contracting parties shall not be subject to any unnecessary delays or restrictions and shall be exempt from customs duties and from all transit duties or other charges imposed in respect of transit, except charges for transportation or those commensurate with administrative expenses entailed by transit or with the cost of services rendered.”

There have been several cases where Art. V (3) GATT has been invoked, but so far there are no decisions by the dispute settlement body. It could well be argued that the introduction of an ETS regime for transit traffic is a charge imposed in respect of transit and therefore not in line with GATT. This is especially true if the ETS regime would provide for a ban of vessels not participating in any ETS regime.

However, following the WTO shrimp-turtle case[73], unilateral trade measures can be justified according to Art. XX (g) of GATT 1994 if serious negotiation efforts do not lead to a multilateral agreement (Molenaar 2007 a). As the EU did try to find a solution to the problem within IMO as well as within the UNFCCC, the introduction of an ETS regime – in the light of the shrimp-turtle case – should be justified under Art. XX (g) of GATT 1994. Prerequisites are that the measure is suited to reaching the environmental goal, is necessary to reach the goal, is non-discriminatory and that the least trade distorting instrument is chosen. Given this, approaches based on the *last period* seem superior as they have a higher potential to contribute to climate change mitigation as more emissions are covered compared to *last trip* based approaches. Further, approaches based on the "*last trip*" discriminate imported goods and do not cover goods exports to outside the EU, which is a clear violation of the principle of national treatment (GATT, Art. III). This becomes very obvious in the case of a freight based approach covering imports only. But even a cargo based approach that covers both imports and exports may create conflict with GATT commitments: As it is the vessel that physically produces emissions and not the freight, doubts are justified in terms of whether any freight based approach can be considered as "the least trade distorting instrument". From this point of view, the fuel consumption or *last period* based approach seems the one most likely to conform to GATT. Nevertheless, there is still a considerable risk that a contracting party of the WTO could try to challenge a European maritime ETS regime by initiating a dispute settlement procedure with the WTO.

12.6 Restrictions with respect to monitoring requirements

The effectiveness of an ETS may well depend on the possibility of enacting respective monitoring requirements. Therefore a short look at the limits of monitoring requirements is necessary:

In principle port states are free to prescribe the installation of vessel monitoring systems (VMS) equipment on board of any vessel entering its ports or vessels running the port state's flag (Molenaar, 2000). More difficult is the question of whether port states can also prescribe the use of VMS in the EEZ and the high seas. In principle, the mandatory use of VMS equipment to record all trips within coastal sea, the EEZ and outside

[73] In the shrimp-turtle case (WTO, United States, Import prohibition of certain shrimp and shrimp products, WT/DS58/AB/R) the appellate body of the dispute settlement body held:
"The sea turtle species here at stake, i.e., covered by Section 609, are all known to occur in waters over which the United States exercises jurisdiction.[73] Of course, it is not claimed that *all* populations of these species migrate to, or traverse, at one time or another, waters subject to United States jurisdiction. Neither the appellant nor any of the appellees claims any rights of exclusive ownership over the sea turtles, at least not while they are swimming freely in their natural habitat -- the oceans. We do not pass upon the question of whether there is an implied jurisdictional limitation in Article XX(g), and if so, the nature or extent of that limitation. We note only that in the specific circumstances of the case before us, there is a sufficient nexus between the migratory and endangered marine populations involved and the United States for purposes of Article XX(g)."

the EEZ of EU-member states can be described as part of the prescriptive legislation that introduces an ETS regime. To the extent that the extraterritorial jurisdiction of an ETS regime is justified, the same should be true for the mandatory use of already installed VMS equipment. However, it must be kept in mind that extraterritorial jurisdiction should be used as restrictively as possible. Therefore the permanent use of VMS equipment may only be justified if it were not possible for another less grave measure to appropriately monitor the vessels under the ETS regime. In that context the control of bunker delivery notes seem to be less burdensome for the vessels concerned.

As a result, it may be worth thinking about a system that grants the vessels concerned certain discounts if VMS equipment is used on a voluntary basis.

With respect to bunker fuel delivery notes there are no concerns about the introduction of an obligation to provide access to the bunker fuel delivery notes and/or existing log book entries on entry of port. Depending on the details of an ETS regime such access can be based easily on the territoriality principle and therefore should not be contestable.

12.7 Possible measures related to the introduction of an ETS regime

If the introduction of an extraterritorial ETS regime can in principle be justified by the international interest to protect the world climate and if – as has already been shown – UNCLOS, MARPOL and GATT do not restrict the jurisdiction of its members states to do so, the lawfulness of an ETS regime depends on the enforcement measures that are applied in port in order to apply the ETS regime.

The following measures could be used in order to make sure an ETS regime is complied with (according to Molenaar 2007a):

1. The landing, transhipment or processing of cargo can be prohibited
2. the use of port services, such as refuelling or re-supplying could be prohibited
3. access to ports could be denied
4. inspection of vessels in port
5. detention of a vessel until legislation is complied with
6. monetary or other penalties (including confiscation of ship or cargo).

As states are free to impose any conditions on entry into its ports, it is clear that enforcement measures that deny access to ports or the use of certain port services unless a vessel is in compliance with the regulation of an ETS regime are fully justified under general international law. To the extent that an ETS regime is based on emissions produced on the high seas or the third state's territory, the justification of more draconian measures, such as the detention of a vessel and/or monetary or other penalties, depending on the severity of the penalty, may be much more difficult to justify as the extraterritorial basis for the jurisdiction of the member states is relatively weak. Therefore it is suggested that measures of enforcement be restricted to the measures 1 to 4. Alternatively it would be possible to require certain guarantees (e.g. by a bank) as a precondition for the participation in the EU ETS (and the entry into any EU-port).

12.8 Possible ways of challenging an EU ETS regime

The question arises as to how third states or shipping companies concerned could challenge the introduction of an EU ETS regime.

12.8.1 Action before the European Court of Justice

Any shipping company concerned could try to challenge the introduction of an EU ETS regime before the European Court of Justice. In the 308-06 (Intertanko) case five parties invoked regulations of UNCLOS and MARPOL against the directive on source ship pollution based on the reasoning that the directive was not in line with the conventions (König, 2006). However, the European Court of Justice (ECJ 2007) held that civil persons cannot invoke UNCLOS or MARPOL against acts of the European Union as neither UNCLOS nor MARPOL establish rules intended to apply directly and immediately to individuals and to confer upon them rights or freedoms capable of being relied upon against states, irrespective of the attitude of the ship's flag state. Following this decision, it seems more than difficult for private parties to challenge the validity of the introduction of a new ETS regime on the grounds that the ETS regime is not in compliance with international law..

12.8.2 Dispute settlement procedure under UNCLOS

Any member state of UNCLOS could try to challenge a new EU ETS regime relating to navigation before the International Tribunal for the Law of the Sea in Hamburg. The Tribunal has the power to give binding judgements to the parties concerned.

12.8.3 Dispute settlement procedure under GATT/WTO

In the case that an ETS is based on cargo rather than on vessels, it could be possible that a state starts a dispute settlement procedure under GATT/WTO. If the WTO decides in favor of the contesting state, it can allow the introduction of retaliating tariffs.

12.8.4 Retaliation

Even without commencing any dispute settlement procedures, it could be possible for third states to introduce measures of retaliation. Such measures could encompass restrictions and/or additional conditions for vessels flying under the flag of a member state of the European Union with respect to port entry in such third states.

12.9 Competence of the European Union

As the European Union has already enacted lots of legislative acts in the field of fisheries and in the field of the protection of the climate, there are no doubts that the European Union has competence vis-à-vis its member states for an integration of marine transport into the existing EU ETS. An EU ETS scheme for marine transport can be based on Art. 80 (Transport, Shipping) and Art. 175 (Environment and Climate Change) of the Treaty on the Functioning of the European Union[74].

12.10 Conclusions

A legal assessment of any version of an EU ETS that aims at the integration of marine transport shows that the main difficulties with respect to legal questions lie in the field of jurisdiction. However, it has been shown that the use of extraterritorial jurisdiction can – with good arguments – be based on the principle of territoriality, as there is direct and significant nexus between the causes to be regulated and the effects on the territory of the European Union. Furthermore it has been shown that neither UNCLOS nor MARPOL or GATT poses serious hindrances with respect to the integration of marine transport into the existing EU ETS. However, there are some aspects that have to be considered in the design of the EU ETS: Enforcement should exclude draconian monetary penalties or the detention of ships as such enforcement matters could possibly not be lawfully covered by extraterritorial measures. Furthermore, especially with respect to GATT, it should be kept in mind that any discrimination between vessels must be avoided. And at least the system should not encompass the prescription of any CDEM standards as such a prescription could violate Art. 21 UNCLOS, which is applicable in the field of emission control. Some further aspects shall be discussed when assessing the different options for the design of the EU ETS.

13 Economic analysis

The economic analysis of the integration of maritime shipping into the EU ETS is divided into two parts. First, the economic efficiency of options A, B and C will be briefly discussed in order to assess which option is the most promising in terms of reaching a reduction of CO_2 at lowest cost. Second, we analyze the economic impacts, especially on the German economy, distinguishing between impacts on the maritime transport sector and impacts on other sectors.

13.1 Economic efficiency

For the purpose of an efficiency analysis of design options, the term “economic efficiency” will be defined in a narrow sense, as is often done to assess instruments (Goulder/Parry 2008). In this narrow definition, efficiency encompasses:

a) **Static efficiency**: reaching a CO_2 target at lowest possible individual cost (technical abatement cost).

[74] The competence of the European Union with respect to climate change has been strengthened through the express reference to climate change in Art. 174 and Art. 175 of the Treaty on the Functioning of the European Union.

b) **Dynamic efficiency**: providing continuous incentives to foster climate friendly innovations in the field of ocean shipping including management innovation and thereby to permanently lower costs of climate protection.

c) **Administrative costs**: to what extent does the institutional infrastructure for managing the regime already exist? Can it be established at rather low cost or would it involve rather high (start up) costs?

As has been documented, integrating ocean shipping into an emissions trading system can be, in principle, very efficient (IMO 2009; Kågeson 2007). In practice, it has to be kept in mind that high static and dynamic efficiencies are only given under the condition that coverage and the assessment basis are adequate, monitoring is feasible and competition functions in a way that forces producers to constantly improve services and increase efficiency. Further, the statically efficient option of surrendering emission allowances from other sectors (including from stationary installations, aviation and international Kyoto mechanisms, e.g. CERs or ERUs) may lower the dynamic efficiency of the approach, as it weakens pressure to be technologically innovative in the shipping sector. It is recommended that this aspect be considered when setting the specific cap for the maritime sectors and the degree to which CERs/ERUs may be used to offset emissions. For example, stationary installations and international aviation are limited in the amount of purchasing extra-sectoral certificates.

The administrative practicability of a full integration into the ETS has at least two opposing facets: First, the mechanisms (trade, emission registers, emission accounts, etc.) already exist and international aviation can be used as a blueprint, which would make the establishment of a marine system easier. Second, the administrative start-up costs for the shipping sector may be significant as the entities have to register with national emission registers, open up emission accounts and become familiar with emissions trading. Depending on the concrete design of the policy instrument, the trading entities could have to implement additional mechanisms to collect and hand in sufficiently reliable emission and other data and have this data verified. However, as has been shown in chapter 7, the vast majority of the information needed for monitoring of any of the discussed design options is already in place and hence little extra cost will be incurred in this respect.

As stated above, efficiency will be defined in a narrow sense. Hence, other factors influencing overall economic cost such as effects on the (German) shipping sector, its suppliers, coastal regions and trade will be considered below (see chapter 13.4.1 and 13.4.2). Further, it is obvious that leakage effects following the evasion of a European climate protection regime for ocean shipping lower environmental effectiveness as well as simultaneously raising the overall economic costs for the EU and Germany.

Finally, in theory, efficiency is clearly not independent of an instrument's effectiveness (Endres 2007). Since efficiency can be measured as the ratio of output (benefit of emission reductions) to input (cost), it is obvious that the efficiency of different options for integrating ocean shipping into the EU ETS can only be assessed by taking the cost and the amount of emissions reduced into account. As a quantitative analysis is beyond the scope of this study, it will not be elaborated further, but as in many policy oriented studies the analysis of effectiveness and efficiency is strictly divided. Nevertheless, environmental politics should bear the link in mind. For example, if two options generate the same cost but different emission reductions, the efficiency differs.

13.1.1 Efficiency under fuel based obligation to surrender emission allowances

As CO_2 emissions are directly linked to fuel consumption, a fuel based emissions trading system would directly create incentives to avoid emissions at lowest possible cost. This applies to all options that include fuel consumption in the assessment basis. Not only will cost efficiency be reached within the shipping sector, but semi-full integration into the EU ETS theoretically allows for cross-sectoral efficiency.[75] In general, a fuel based scheme also promises to be efficient in a dynamic sense as it is expected to foster emission saving innovations, e.g. technical improvements of engines, the introduction of alternative fuel technologies and better managerial practices to optimize transport services.

Significant technical innovations might fail to materialize if operative measures prove more cost efficient than retrofitting or investing in more efficient vessels. In these circumstances, additional measures, such as minimum standards or subsidies, may be taken if emission reducing technical progress is considered as a policy objective on its own. In the case that marginal abatement costs in the shipping sector would be very much higher than in other industries, technical innovations in the shipping sector may not occur by the degree desired either. Instead, the maritime sector would buy allowances from other sectors. However there is a high potential for the maritime shipping sector to reduce emissions by marginal abatement costs that are much lower than in many other sectors included in the EU ETS (chapter 5.5). Accordingly, the shipping sector will most probably take many emission reducing measures including technological innovations in order to at least fulfill the cap. Thus this risk can be neglected.

The administrative costs depend on how costly it is to obtain data on actual fuel consumption and verify the information provided. Bunker fuel delivery notes which all ships above 400 Gt are obliged to keep are potential data sources. The administrative cost is rather negligible, increasing slightly if log books are examined in order to verify the validity of bunker delivery notes (see chapter 7.1). More sophisticated monitoring and estimating methods such as satellite surveillance would have significantly higher verification costs.

The risk of evasion appears comparatively low in a system based on fuel consumption over the *last period* of travel because high evasion costs would evolve when reloading

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[75] In practice, though, a semi-full integration poses some problems to emission trading within the maritime sector which may lead to a non-functioning of the market for "maritime" emission allowances. See chapter 13.3.1 for details and possible solutions.

cargo to short-sea travelling ships (see chapter 9.1.1). However, if prices for emission allowances turn out to be very high, savings may outweigh the costs from reloading.

13.1.2 Efficiency under distance based obligation to surrender emission allowances

The emission target will hardly be reached at lowest possible cost in the short run if a distance-based approach is chosen linked with a vessel efficiency index,[76] regardless of whether the vessel's *last trip* or *last period*'s trips are covered. Distance-independent emission saving measures will not be incentivized. For example, the study by DNV (DNV 2009) suggests that slow shipping is a more economic method to lower emissions than some technical measures. Assuming this is the case (although the IMO's study (IMO 2009) comes to other conclusions) a distance based system by itself will be a costlier option than a concept based on fuel consumption However, a distance-index-based approach has a relatively high potential of resulting in efficient technical improvements over time, lowering the average fuel consumption of the fleet. In this sense, the dynamic efficiency of a distance-index based approach may be considered to be relatively high.

The administrative costs will not differ significantly from those of the fuel consumption based approach as long as the monitoring is limited to already existing distance records, cross-checked on the basis of bunker fuel delivery notes. The additional cost of determining the efficiency index can be considered to be fairly low. But again, if more sophisticated automated distance reporting systems are to be used, implementation and monitoring costs will be significantly higher.

Evasion effects in a system that is based on *last trip* are extremely likely to occur as the obligation can be easily circumvented by simply stopping over at a port near the EU. Defining an original port of departure other than the last port of call proves impossible. Hence, high leakage destroys most of the theoretical efficiency potential of the approach.

13.1.3 Efficiency under a freight based obligation to surrender emission allowances

With respect to its economic efficiency, a freight based concept, which accounts for the distance the freight travelled and the ship's efficiency, can in principle be similarly assessed as a distance based obligation covering all trips within a period. Static efficiency may be rather low as certain mitigation measures such as slow steaming or, in this case, better logistic management to improve the vessel's capacity utilization are not or only indirectly incentivized. Again, dynamic efficiency might be fairly high due to an efficiency index, which stimulates technical innovations to increase the fuel efficiency of the fleet over time.

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[76] The option B2 where distance monitoring is backed up with fuel consumption data is not considered here because it would behave in a similar way to the fuel based approach.

One difference, though, is that in contrast to an approach based on the *last trip*'s distance it does not motivate docking or reloading at non-EU harbors if the cargo's total trip is chosen as an assessment basis. This can, especially for imported cargo, be determined on the basis of already existing custom documents. Legal evasion is therefore less likely to occur. Illegal counterfeiting of freight documents cannot be ruled out. For exports, new procedures would have to be introduced to avoid fraud.

Additionally, the efficiency of the incentive to reduce emissions must be challenged if the entity that surrenders emission allowances is not directly linked to the vessel. The cargo consignee may have little influence on the vessel's owner, operator and flag state to improve the technical efficiencies of the vessel or change operating practices. Cargo may be carried on vessels not owned or operated by the contracting ocean carrier. Even if the consignee could forward the pressure to its contracted carrier, whether the last carrier's operator has enough (market) power to make the former carriers or partner carriers reduce emissions cannot be predicted. And if so, the difficulties and transaction costs of doing so have to be taken into account. The transaction cost of making the antecessor reduce emissions might lead to a situation in which the legal entity prefers to buy certificates for reasons of simplicity even if a reduction in emissions would be economical. The fact that emitter and the party held responsible are not necessarily identical makes this approach less efficient than the ones discussed above.

The freight based approach also has an alien character when seen in the overall context of policies to internalize climate-related external costs of transport. All other options focus on the characteristics of the transport vehicle (e.g. emission performance). In the freight based approach freight would be a major component of the assessment basis.

The administrative costs would be higher than in the case of fuel consumption or distance based approaches. This is particularly the case if accurate emission data are desired, which is especially difficult in the case of exported freight. If outgoing freight is neglected, the scheme would definitely collide with international trade rules (see chapter 12), as it is clearly discriminatory. Further, if the incoming or outgoing freight is transported on a vessel other than the docking vessel, fuel efficiency indexes for all other carriers have to be known, which increases transaction costs significantly. The correlation between assessment basis and emissions would weaken, thus lowering the approach's efficiency further if the data is inaccurate.

13.2 Overview of economic impacts

The scope of the study is to analyze the economic effects of integrating ocean shipping into the EU ETS for the German economy. But many of the effects described are of a general nature and can be transferred to any European economy with a significant ocean shipping sector (see chapter 6).

In principle, numerous sectors are affected by the integration of ocean shipping into the EU ETS. Above all, the measure directly has potential economic impacts on the competitiveness in the maritime transport sector, as the obligation to obtain emission allowances as well as reducing emissions imply operational and investment costs to the ship operator or owner. Normally freight rates will ceteris paribus increase thereupon, possibly lowering demand for shipping services. Theoretically, demand may switch to alternative transport services such as other modes or to ships not covered by the Emissions Trading System (evasion/leakage). The impacts on cost, freight rates and demand will be at the centre of our analysis. They will be quantified and further discussed below.

It is likely that ship builders and other firms selling ship equipment (e.g. kites) will be impacted by an integration into the EU ETS. Harbors, local service sectors and entire coastal regions may be affected as well. A qualitative assessment of these effects is provided below, while quantifying those effects would be beyond the scope of this study.

Finally, if freight rates increase, either indirectly as described above or directly via a freight-based approach, international trade flows may be influenced. Focusing on Germany and its major export and import goods, a semi-quantitative analysis of the potential effects on Germany's export industries and industries that depend heavily on imports will be conducted.

The analysis of economic effects is first carried out on general grounds, assuming that all emissions from vessels entering or leaving the EU are covered by the Emissions Trading System. The findings can serve as a basis for assessing the three options of a fuel-based, a distance-based and a freight-based approach. Differences in the economic effects will be briefly discussed for each (see chapter 14).

13.3 Impacts on freight rates and competitiveness of the German maritime transport sector

In the following, the economic effects of the integration of ocean shipping into the EU ETS will be analyzed by applying three rather divergent certificate prices in order to incorporate the uncertainties regarding the formation of allowance prices.

13.3.1 Impact of Emission Allowances on Freight Rates

According to UNCTAD (2008), the three major trade routes in maritime transport are the transpacific (Asia to USA / USA to Asia), Europe-Asia and the transatlantic route, i.e. trade between Europe and North America. Given our focus on the linkage of maritime transport to the EU ETS, then, the analysis in this chapter will be limited to the Europe-Asia and the transatlantic route. Moreover, the examination in this chapter mainly concentrates on the liner shipping industry. The major rationale for this choice is the dominance of Germany in the global liner shipping industry and hence its significance for Germany's maritime economic sector. Liner shipping accounts for 35 % - 40 % of the ocean shipping emissions because of its particular technical and operational characteristics. Furthermore, data availability for this sector is superior to all others, thus allowing for a better analysis.

Data of freight rates per TEU were obtained from various issues of UNCTAD's Review of Maritime Transport. To account for movements in the business cycle, we consider the time period from 1999 to 2007 to calculate freight rate averages. All data were adjusted for inflation and expressed in constant prices. As data on freight rates are only available in US-dollars we subsequently calculated the corresponding rates in Euros using the average $/€-exchange rate.[77] The average freight rate per TEU for a shipment from Asia to Europe, then, yields 1 440 €/TEU. The freight rate for a transport from Europe to Asia amounts to 690 €/TEU. The average freight rate for maritime trade from Europe to the US is 1 295 €/TEU and shipments from the US to Europe yield 870 €/TEU.

In order to quantify the impact of the prices for emission certificates on marginal cost of the maritime transport sector we devise three scenarios. In scenario 1 the price for emission certificates is assumed to be € 70/t of CO_2, scenario 2 is calculated using a price of €30/t while in scenario 3 a price of € 5/t is applied. 5 € is chosen so as to take into account that only a little trade may occur in a semi-open system and a moderate cap may be set for political reasons.[78] € 30 is chosen as this figure lies within the range that is most often projected. € 70 is chosen as this is considered to be a reasonable estimate for the marginal social cost of one tonne of emitted CO_2 (UBA 2007, Krewitt 2006). In the following sub-chapters the three scenarios are laid out in more detail.[79]

13.3.1.1 Scenario 1 – Emission allowance price: €70/t of CO2

As mentioned above, the focus of this analysis is on the following major trade routes.

- Asia to Europe / Europe to Asia
- Europe to North America / North America to Europe

For the Europe-Asia route, two Asian destinations appear to be of great significance: first, the port of Hong Kong, which is at a distance of about 19 500 km from Germany; and second, the port of Singapore, which is about 16 600 km from Germany. For the transatlantic route, an average distance of 7 050 km is applied. [80]

Assuming an average CO_2 emission of 180 g CO_2/TEU per km for the global container ship fleet (This figure is a conservative figure, calculated on the basis of Buhaug (2008), but with different assumptions regarding the average load per container, which

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[77] The average exchange rate for the time period calculated here is €1 = $1.198 This figure is very close to the European Central Bank's estimation of a long-run $/€-exchange rate of 1.20 and thus appears to be a proper assumption.

[78] Such a low or even lower price may evolve if neither the stationary sector, nor aviation may buy "maritime" emission allowances

[79] For a more detailed description of the following calculations consult Annex 3.

[80] The choice of distances follows the simple modelling of German and European seaborne trade emissions (chapter 5). Particular distances were selected as representative distances for certain trades.

was set to 11 tonnes per TEU[81]). For details on the emission calculation methodology see Annex 2: Methodology for modelling GHG emissions from seaborne trade), the additional cost for a shipment on the Europe-Asia route to and from Hong Kong would amount to about 248 €/TEU while a shipment on the Europe-Asia route to and from Singapore would incur additional costs of around 212 €/TEU. A shipment on the transatlantic route would result in additional costs of about 90 €/TEU.

In order to give an impression of the magnitude of these increases in (marginal) cost, we compare cost increase and freight rates, without implying that freight rates necessarily reflect marginal cost of the shipping sector (see Box 4 on price formation). Keeping this and the volatility of freight rates in mind, the marginal costs for shipments from Asia to Europe would, on average, increase by between 14.6 % and 17.2 % of freight rates, depending on whether the point of departure is Singapore or Hong Kong, respectively. A larger impact would be felt on the routes from Europe to Asia. Here, marginal costs would increase by 30.6 % (destination Singapore) and 35.8 % (destination Hong Kong) of freight rates. On the transatlantic route, the increase in marginal costs would be comparatively smaller with a 10.3 % of freight rates on the route from the USA to Europe and a 6.9 % on the route from Europe to the USA.

13.3.1.2 Scenaio 2 – Emission allowance price: €30/t of CO_2

Applying a price of € 30 per tonne of CO_2 results in a marginal cost increase of around 106 €/TEU for shipments to and from Hong Kong while marginal transportation costs to and from Singapore would increase by roughly 91 €/TEU. On the transatlantic route, marginal cost would rise by about 38 €/TEU.

In this scenario, then, the marginal costs of shipments from Hong Kong would increase, on average, by roughly 7.4 % of freight rates while the cost of transport from Singapore would rise by about 6.3 %. Shipments from Europe to Asia would incur additional marginal cost between 13.1 % (destination Singapore) and 15.3 % (destination Hong Kong), respectively. On the transatlantic route, the marginal cost increase of shipments from the USA to Europe would amount to roughly 4.4 % of freight rates. The cost of shipments from Europe to the USA would rise by about 3.0 % of freight rates.

13.3.1.3 Scenario 3 – Emission allowance price: €5/t of CO_2

As the tradability of certificates between the maritime sector and operators of land-based installations will probably be limited, and marginal abatement cost in the maritime sector appear much lower, it is reasonable to expect that prices for "maritime" emission allowances will be much lower than regular EU ETS prices, unless at least the systems of aviation and maritime transport are completely opened towards each

81 Öko-Institut e.V. is currently conducting an extensive study on marine vessel emission factors based on individual vessels. The study will be published the first half of 2010 in the context of the expansion of the EcoTransIT tool to a global model.

other (see chapter 13.3). Hence, our third scenario is calculated using the low price of € 5 per tonne of CO_2, yielding the following results.

The additional marginal costs of shipments on the Europe-Hong Kong route would amount to about 18 €/TEU while the marginal cost of transport to and from Singapore would increase by roughly 15 €/TEU. The rise in marginal costs on the transatlantic route would amount to 7€/TEU.

Consequently, in this scenario the marginal cost of shipments from Asia to Europe would increase by 1.2 % of freight rates (departure from Hong Kong) and one per cent (departure from Singapore), respectively. Maritime transport from Europe to Asia would face a rise in costs of about 2.5 % (destination Hong Kong) and 2.2 % (destination Singapore). Transportation costs from the USA to Europe would increase by roughly 0.7 % of freight rates while maritime trade from Europe to the USA would incur a rise in costs of about 0.5 % of freight rates.

It should be noted that this brief analysis compares potential future certificate prices with historic freight rates. It is not possible to predict how those freight rates will develop into the future because they are dependent on too many factors. The future development of trade flows and capacities are some of those factors. Furthermore, future fuel prices are another factor that may weigh much heavier on the freight rates than any thinkable price for emission allowances. The future fuel prices are determined by the overall resource scarcity of fossil fuels as well as the development in the refining industries as the demand shifts towards more refined products. This demand shift originates both in increased demand from land-based sources as well as a declining demand for high sulphur residual fuels post IMO's new fuel sulphur regulations.

13.3.1.4 Implications of emissions trading on freight rates

Table 15 below summarizes the results of our three scenarios.

	Europe – Asia (Hong Kong)	Asia – Europe (Hong Kong)	Europe – Asia (Singapore)	Asia – Europe (Singapore)	USA – Europe	Europe - USA
Scenario 1 €70/t	35.75	17.17	30.59	14.67	10.30	6.93
Scenario 2 €30/t	15.32	7.36	13.10	6.29	4.44	2.97
Scenario 3 €5/t	2.55	1.23	2.18	1.05	0.74	0.5

Table 15: Ratio of cost of emission allowances to freight rates on major trade routes to and from Europe (per cent)

Our calculations show that the impact would be highest on the trade route from Europe to Asia. Depending on the price of the emission allowance, it ranges from 2.18 % to more than 35 %. On all other trade routes the impact is consistently below 20 % in all three scenarios, although the range is still rather sizable between the different prices for the emission allowances. Further calculations reveal that for a price for allowances below 20 €, the impact does not exceed 10 % on any trade route. With prices below 40 € the impact is above 10 % for the Europe – Asia route only.

What can be inferred from these results? As has been mentioned above, the maritime transport sector is characterized by an oligopolistic market structure. The transatlantic route is thereby characterized by a loose oligopoly whereas the Europe – Asia route constitutes a tight oligopoly. As a consequence, competition among suppliers is likely to be low and informal or formal cooperative price setting is to be expected in economically stable periods creating the opportunity to set prices higher than in a perfectly competitive market. More importantly, price elasticity of demand in international shipping is rather low due to a lack of proper substitutes in mode of transport. Hence, the chance that freight rates increase at least in line with increasing costs (i.e. price of allowances) is fairly high. (see Box 4, page 106, Ziesing 2007). This is especially true for the Europe-Asia route where a tight oligopoly prevails, which on the other hand would experience the highest relative increase in marginal cost. And although the transatlantic route is, in contrast, characterized by a loose oligopoly, the comparatively small impact of an increase of costs on freight rates here makes a shifting of a high share of these additional costs onto customers also quite likely.

Having stated that, high homogeneity of services may lead to intense competition between suppliers in periods in which supply exceeds demand (e.g. since the outbreak of the financial crisis). As it is easy to switch to another supplier, the individual supplier may then face difficulties to fully pass on increased costs in the short run. Due to predatory pricing caused by high irreversibilities (see Box 4, page 106,), ship operators may even consider passing on only a fraction of additional cost if their existing capacities are underutilized. Still, in the long run, when markets stabilize and capacity utilization has normalized, the textbook assumptions of cost pass will very likely apply. As a consequence of both cooperative price behavior and low price elasticity of demand, an increase in the costs of transportation due to the necessity to buy emission allowances is at least in the medium to long run likely to be fully or nearly fully passed on to customers, depending on the specific market structure, price elasticity of demand and cost increase. In other words, all or most of the additional costs will be added to existing freight rates with only little direct effects on the volume of transport. [82]

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[82] If perfect competition is assumed instead, the probability of cost pass on may be rather low in the short run in cases in which demand clearly exceeds supply due to complete inelasticity of short term supply (Faber et al. 2010, p. 83). Though, it must be emphasized that under these assumptions prices are already significantly above marginal cost. Hence, failing to pass on the additional marginal cost does not lead to losses in the sector. Further, no cost pass is a short term phenomenon only as long term supply is not completely inelastic.

It can be concluded that Germany's and the entire EU's maritime transport sector will not suffer any lasting severe disadvantages from the integration of ocean shipping into the EU ETS, if prices for allowances stay below 30€/t of CO_2. This conclusion implies, however, that all ships departing from the EU or arriving within the EU, respectively, are included in the scheme. If the new policy is only applied to ships sailing under the flag of an EU member state there would indeed be negative consequences for these operators as their competitiveness would significantly weaken as a result, especially on routes to and from Asia. Operators located within the EU might also argue that they are negatively affected by this policy when emissions from the *last period*'s trip are used as the basis of assessment since some of their competitors on routes outside the EU might never enter the EU at all. This problem appears to be rather small, however. For one, certain ship types usually operate on fixed routes determined by distance and type and volume of the transported commodity. Second, on routes which allow a switch to other ship types, EU-based operators are free to act in the same way as their competitors. By reallocating their fleet, then, they can offset any possible negative impacts.

If prices for allowances reach levels significantly above € 30, the picture changes especially on the routes from Europe to Asia but for the Asia-Europe route as well. Assuming a price of 70 € per tonne of CO_2, ship operators will face additional costs of up to nearly 36 %. This could result in a decrease of demand between 2 up to 9 %, meaning that in the medium run structural adjustment in the form of a reduction of vessels cannot be excluded. In any case, maritime transport demand depends much more on other variables such as infrastructure, GDP and volume of international trade (UNCTAD 2008, MTR 2007). Regarding trade volume, though, an increase in freight rates might, in turn, have an impact on the price of commodities transported on these routes, which may again influence trade volumes. This issue will further be discussed below when the impact on international trade in general and especially on Germany's exports and imports is being assessed.

Box 4: Characteristics of price formation in the maritime transport sector

Often, economic analyses assume that price formation follows the principles of perfect competition. Among other assumptions, producers and consumers both form polypolies, markets are transparent and fast reacting. Under perfect competition, it follows that the price of the product traded rather quickly equals marginal production cost unless, for example, the state interferes on the market. This mechanism is due to intense competition, profit maximizing actors and highly adjustable markets. In other words, if the impact of emissions trading on freight rates is to be estimated and marginal emission abatement cost is known, which again matches the market price of emission allowances, the increase in freight rates per tonne of CO_2 should equal the price of an emission certificate.

But the sector of maritime transport services can actually not be considered a "perfect textbook market" (EC 2005b). Two characteristics have to be pointed out. First, the sector is oligopolistically structured. Second, the sector faces high irreversible investments (ships).

Implications of market structure for cost pass on

For some trade routes, the market for transport resembles a loose oligopoly, for others it resembles a tight oligopoly and in many cases something in between (see chapter 6.2.3). Regarding price formation in loose oligopolistic markets, it does not, in theory, differ very much from perfect competition. Price adjustment to marginal production cost may take longer, but is a fair estimate in the medium to long run. In tight oligopolies on the other hand, one has to assume that producers act highly interdependently or even corporately when setting prices. As a result, prices do not necessarily match marginal cost but are significantly higher. The extent to which ship operators will be able to pass on increasing costs (e.g. cost of emission allowances) to their customers depends on the curvature of the demand curve which in turn is determined by the price elasticity of demand. In the case of a low price elasticity of demand, the demand curve is characterized by a convex function. Economic models suggest that in a market setting of a tight oligopoly it, then, allows price shifting by 100 % or more (Ziesing 2007, Hanson and Sullivan 2008). Given the fact that alternatives to maritime shipping are rather small – especially in the case of large quantities and heavy cargo – price elasticity of demand in this sector is fairly small. For example, the IMO greenhouse gas study (IMO, 2009) cites studies estimating elasticity to lie between -0.06 and -0.25 for international shipping. This means that if, for example, freight rates increase by 10 %, demand will subsequently decrease by approximately 0.6 % to 2.5 %. Hence, the chance that prices (i.e. freight rates) will rise by more than marginal cost is high, at least on some routes. Anti-competitive behavior (e.g. formal or informal price agreements, quota fixing cartels) aggravates this problem.

Implications of high irreversibility

Due to high start up investment costs, ship owners or long-term ship lessee (tenants) will carry on supplying transport services even if their costs, which contains investment costs, is not covered. That is, losses are made and freight rates drop below the total marginal production cost. In principle, a ship will be operated as long as prices cover operational costs (in practice, the actual cost of shutting down and leaving the vessel idle can even lead to a situation in which a ship is operated although not even the operational costs are covered). As a result, maritime transport can be regarded as a sector in which predatory pricing may occur, from which the whole sector suffers. This, by the way, appears to be exactly the situation during the current world economic crisis (see Box 2, page 37). Although the sector is an oligopoly in which cooperative price strategies may prevent predatory pricing, in this crisis the shipping companies did not manage to make headway against this price deterioration, despite the fact that several tried by unilaterally increasing freight rates, hoping that their competitors would follow (Financial Times Deutschland, 15.06.2009, p. 8).

International ocean shipping conference system

More than a century ago the shipping sector started to organize itself in several conferences which are or resemble cartels, mainly regarding price and price components, region and capacity (Parameswaren 2005). The ostensible aim is to prevent predatory price wars, specifically to stabilize freight rates, control capacity, and maintain adequate profit levels for the ocean carrier industry. But surely the cartels served to allow price setting above competitive levels and thereby to seek rents at the expense of customers (Clarke, R. L. 1997). Until the 1980s around 150 - 300 liner conferences had a share of approx. 90 % of total liner trade. Since then the share has dropped to below 50 % (Parameswaren 2005). But on some routes the share is much larger as, for example, the Far East Freight Conference (FEFC) accounted for approximately 72 % of total capacity of Asia-Europe container trade in 2007 (UNCTAD 2008). 28 liner conferences exist for trade routes to and from the EU (Paschke 2009). Though conflicting with the postulate of a market economy, liner conferences are not merely regulated but also approved by international law, namely the UN Convention for Liner Conferences, which entered into force in 1983. Accordingly, the signatory nations, including Germany and the Netherlands, exempted liner conferences from the general prohibition of cartels and other competition rules.

Generally speaking, functioning liner conferences have a similar effect on price formation as a tight oligopoly as it significantly increases interdependency and invites or even dictates cooperative pricing strategies. Therefore, the price mechanism in a loose oligopoly which is dominated by liner conferences can be treated similarly to that in a tight oligopoly. Having said this, the functionality of conferences has dropped in the booming years preceding the current crisis, in which freight rates exploded and eventually overcapacities were generated. Additionally, they failed to stabilize freight rates in recent months (see Figure 3 in Box 2: The impact of the economic crisis on the maritime shipping sector). In summary, price formation is likely to be significantly influenced by liner conferences mainly in already stable economic periods, but a stabilizing price effect during boom or depression is much more difficult to detect.

EU's banning of liner conferences

Recently, the situation for ships entering the EU changed quite drastically. The EU Commission decided in 2006 that from October 2008, any freight-rate binding conferences on routes to and from the EU are to be abolished as they will no longer be exempted from European competition rules.[83] Agreements regarding other parameters such as capacity are also restricted. Guidelines for the block exemption of shipping consortia are planned to be released in 2010. It remains to be seen how these changes will be reflected in price setting policies in the maritime transport sector. A careful suggestion may be that price formation, at least on routes that can be described as loose oligopolies, will become more free and "textbook" like.

13.3.2 Windfall profits

Our analysis shows that the European maritime transport sector will not experience a severe drop in demand or profits in the medium to long run from its integration into the EU ETS except in the case of very high prices of allowances. In principle, the maritime transport sector may even face windfall profits, depending on how emission allowances are allocated, on the price and the openness of the trading scheme. Windfall profits, or extra rents, will occur if increases of revenues, either from rising freight rates or the selling of allowances, exceed the increase of overall costs. The size of these extra rents mainly depends on the following parameters:

a. The amount of free allowances: the higher the amount of free allowances the higher the net gains (revenue minus cost) from selling allowances.
b. Cost-pass on: The easier it is to pass on the marginal cost increase to customers (i.e. to increase freight rates accordingly) without significant decreases in demand, the higher the windfall profits.
c. Price of allowances: The higher the price of allowances, the higher the potential windfall profits. Having said this, if prices are extremely high it may not be possible any longer to fully pass them on to customers. Instead, growing parts of the costs stay with the producer and turnover shrinks due to sinking demand for maritime transport. Therefore, starting at some price level windfall profits will decline again. Eventually, some suppliers may be forced out of the market.
d. Openness of the scheme: In the case of ocean shipping it was shown, that in an open system, price of allowances will most likely be higher than in a closed system.

83 COUNCIL REGULATION (EC) No 1419/2006 of 25 September 2006 repealing Regulation (EEC) No 4056/86 laying down detailed rules for the application of Articles 85 and 86 of the Treaty to maritime transport, and amending Regulation (EC) No 1/2003 as regards the extension of its scope to include cabotage and international tramp services

e. Marginal abatement cost curve: If freight rates increase by marginal abatement cost, the extra rent is the higher, the more options exist to reduce a high quantity of emissions below marginal cost. Applying the existing estimates of the marginal cost curve (chapter 5.5), chances seem high that significant extra rents are captured. Regarding an individual shipping company, the efficiency of its fleet and its individual marginal abatement cost curve influences its windfall profits.
f. Cap: The cap's impact on extra rents is not clear cut. On the one hand, a very tight cap leads to high prices for emission allowances, which in turn increases the chance of windfall profits. On the other hand, too tight a cap may generate such high prices for emission certificates that negative net effects on rents occur.

In order to give a very rough impression of possible increases in rents, we use the simplified example of a fictitious German shipping company which owns container vessels of the NYK Apollo type only. The company serves the transatlantic route only and transports on average 2 000 000 TEU (1 million in each direction at 70 % vessel utilization) with a freight rate of 1 000 €/TEU on average. Annual profits are assumed to total, on average, 100 million € (EBITA), reflecting a 5 % return on sales (ROS). The fleet generates approximately 2 million tonnes of CO_2 p.a. before emissions trading is introduced. Let us assume that all the emissions of the company's vessels can be covered by the trading scheme and that a cap of 95 %of recent emissions is implemented. The certificate price will stabilize at € 30. Further, transaction or hidden costs are considered to be low. In order not to run the risk of exaggerating windfall profits, a 90 instead of 100 % cost pass-on to customers is assumed. Freight rates will increase by 34.20 € per TEU or 3.7 % (see above). Demand decreases by 0.9 % to 1 982 000 TEU (assuming a demand elasticity of -0.25). Accordingly, CO_2 emissions decrease by approx. 0.9 % to 1.98 million tonnes, if for analytical reasons divisibility of vessels is assumed. Significantly increasing freight rates and a barely shrinking demand imply that total revenues from customers will increase by 50 million € (from 2 000 million € to 2 050 million €). Assuming average abatement cost of 3 € per tonne of CO_2, which is actually much higher than the expected negative cost of a 5 % emission reduction (see chapter 5.5), it is taken into account that some hidden costs must exist. Under these assumptions, total abatement cost of 4.1 % of total historical emissions (0.08 million tonnes of CO_2)[84] will total 0.24 million €. This leaves a rent of clearly more than 49 million €. But in order to calculate the net effects on the company's rent, assumptions must be made regarding the allocation of emission rights.

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[84] Due to a decrease in demand of 0.9% following the increase in freight rates, emissions decrease accordingly. Therefore only the cost of buying allowances for the remaining 4.1% of historic emissions is considered. Alternatively this effect, which is rather mid-term instead of short-term, can be excluded from the calculation as the price elasticity of demand, and hence the decrease in demand, is probably lower than 0.25% anyway. This would alter the result by roughly 1 million €.

13.3.2.1 Windfall profits under free allocation of emission rights and a 95 % cap of recent emissions

If, for example, emission allowances of an amount of 95 % of historical emissions are grandfathered to the company, the company either has to bear emission reduction costs or buy certificates. Buying certificates for the 4.1 % of historical emissions (0.08 million tonnes of CO_2) not covered by the grandfathered allowances, generates costs of 2.4 million €. This leaves a windfall profit of above 47 million €.

But given the low cost of emission reduction in the shipping sector, the company will most probably act differently and reduce emissions until marginal costs reach € 30/t. It is assumed that this leads to a reduction of 30 % of historical emissions or 0.6 million tonnes of CO_2, leaving the company with allowances for CO_2 emissions totalling 0.5 million tons which they do not need. Selling these results in additional revenues of 15 million €. To be on the safe side regarding hidden costs, etc., relatively high average abatement costs of 20 € per t of CO_2 are assumed, if overall reductions are cut by 30 %. Accordingly, abatement costs add up to roughly 12 million €. It follows that the profit from selling certificates is 3 million €. Added to the 50 million € estimated above, the overall windfall profit of the company equals 53 million € or 2.7 % of total turnover.

13.3.2.2 Windfall profits under full auctioning of emission rights and a 95 % cap of recent emissions

If emission permits were fully auctioned, the windfall profits would vanish as every tonne of CO_2 emitted incurs costs of € 30 to the company. If these costs were nearly entirely covered by increases in freight rates, rents would fall only marginally due to a slight decrease in cargo transported. Though, if the resulting extra cost of 38 € per TEU cannot be passed on to the customers (e.g. because of a general lack in demand and overcapacities) rents of the company will shrink. Compared to the company's net profits of 100 million € before emissions trading started, the return on sales (ROS) falls significantly. As a consequence, some vessels may leave the market.

13.3.2.3 Windfall profits of a company serving the Europe-Asia routes

Applying the same methods, allowance prices, average mitigation costs, and further assumptions for our fictitious shipping company serving the transatlantic route only, we reached the following result for a company serving trade routes from and to Hong Kong only:

Pre-emissions trading, CO_2 emissions are roughly 5 million tons per year, revenues are 2140 million € and profits are 107 million € (EBITA).

Emissions trading will lead to an increase of freight rates by, on average, 95.4 €, demand (and emissions) will decrease by 2.2 %, and revenue will increase by 138 million €. If emissions are cut back to 95 % of their historical level of 5 million tonnes of CO_2 the cost of mitigation equals nearly 0.5 million €, thus leaving extra rents of 137.5 million €. If allowances are grandfathered, and surplus allowances can be sold at € 30 per piece, we assume that emissions are cut back to 70 % of historical emissions. Profits from selling the superfluous allowances will be approx. 37 million €. Overall windfall profits will total a very significant 175 million € or more than 7.5 % of turnover, increasing profits by 160 %. If full auctioning is in place and cost pass on is limited, the shipping company may experience high losses which exceed former profits. A market decision may be to reduce the number of vessels on this trade lane.

Having gone through this exercise to calculate potential windfall profits or losses, it must be noted that the results can only provide a rough impression. This is, among other things, due to the assumptions made: The fictitious company is not diversified and it stays undiversified, therefore no cross-subsidizing and no reallocation of vessels is considered; the emission level at the time at which vessels are integrated into the EU ETS is the same as 2007; cost pass on to customers is mostly assumed to be 90 %, but in practice may be below (especially in periods of economic slowdown) or above, either lowering or increasing extra rents. Finally, the average abatement cost is assumed to be much higher than the estimates given in this study and other literature, meaning that windfall profits may actually reach higher levels, which is another reason why we suggest, in the medium to long run, setting the cap clearly tighter than 95 % of recent emissions as well as allocating a significant number of allowances through auctioning.

Box 5: *Summary of the positions of European shipowners' associations*

Nearly all national associations of ship owners as well as the European Community Shipowners Association (ECSA) have released statements on the regulation of maritime transport's greenhouse gas emissions. The common standpoint is that emissions have to be regulated, but on a multilateral scale instead of regional levels – which is also the standpoint of the German Ministry of Transport (DVZ 2009). Welcoming a regulation can be explained by image reasons; advocating a multilateral scheme also gives time.

The rationale behind the rejection of a regional scheme is that the ship owners fear clear competitive disadvantage over non-EU ship owners. Our analysis has shown that these fears are mostly unfounded if all vessels entering the EU are subject to EU regulation. All competitors on routes to or from the EU will be treated the same. Therefore transport demand on these routes will not switch from European to non-European suppliers. Additional costs can mostly be passed on to the customers, especially since demand is price inelastic (see chapter 13.2). Even if the EU choose a *last period*'s approach for calculating the vessels' emissions, it is unlikely that competitive distortions will occur. In the case of European vessels entering the EU to compete on routes outside the EU with vessels that never enter the EU, cost disadvantages can occur in theory. But ship owners and operators can deal with these by a reallocation of their fleet, i.e. to use one share of their vessels for trips to the EU and the other share for trips which do not enter the EU.

Regarding the instrument for regulating emissions, the associations prefer market based instruments, i.e. either a levy or emissions trading. The tendency clearly points to a levy on fuel consumption. This may seem surprising as a levy leaves little opportunity for windfall profits, but allows governments to capture extra rents. But on a closer look, it becomes clear that ship owners expect the revenue of levy to be used to directly or indirectly subsidize the shipping sector. The German association advocates for a global levy, linked to a fund to support the shipping sector (VDR 2009). The President of the Hellenic Chamber of Shipping even explicitly opposed any market-based instrument other than a levy-fund approach (Gratsos, G. 2009). The Royal Association of Netherland Shipowners, in its publications, identifies a fuel levy "as an option" (Royal Association of Netherland Shipowners, Annual Report 2008, p. 44). The British Chamber of Shipping, on the other hand, appears to have decided to advocate a global scheme of emissions trading (Making Waves 2009).

Not surprisingly, the European umbrella organization (ECSA) points out that so far no consensus has been reached among national associations on the approach to be advocated. All the same, the ECSA opposes any absolute cap which may hinder the maritime transport sector expanding. This does not necessarily imply that the ECSA tends to favor a levy but it means that they strongly oppose a closed system of emissions trading.

13.4 Impacts on German trade and ship related sectors

Our brief analysis of the probable impact of the inclusion of maritime transport into the ETS has shown that freight rates are very likely to increase as a consequence. Depending on the respective route and the price per tonne of CO_2, this increase can range from less than 1 % to more than 35 %. As has been noted, there is a high probability that ship operators will be able to pass on these costs to their respective customers since price elasticity of demand is rather low and the market structure in maritime shipping is characterized by oligopolistic patterns. Clearly, high prices for allowances will generate increases of marginal cost especially on trade routes from and to Asia, which can only be passed on to customers at the expense of significantly less demand. In these cases, ship operators might at first refrain from passing on a high share of additional marginal cost because the sector's high irreversibilities (see Box 4, page 106,) hinder ship owners reducing the numbers of vessels in the short to medium run. Not passing on additional costs implies diminishing profits. At second thought, windfall profits will most probably compensate for these losses. Hence, the direct consequences for ship operators are likely to be negligible. Having said that, if emissions trading is introduced during a period of overcapacities in the maritime transport sector and if all or most of the allowances are auctioned, the impact cannot be regarded as negligible any longer, especially if prices for allowances are rather high.

In the following, we will briefly assess potential consequences on the German economy in more detail. There will be a specific focus on the effects with regard to imports and exports in general. Furthermore, a second sub-chapter will show how ports, shipyards and the supplier industry might be affected. It is important to note, however, that a detailed quantitative analysis on these aspects is outside the scope of this study. For that reason, we provide brief qualitative assessments which are by nature rather general.

13.4.1 The impact on imports and exports

Like fluctuations in the exchange rate or changes of tariffs and non-tariff barriers, variations in freight rates have an impact on the demand for imported and exported commodities. An increase in freight rates thus translates into an increase in the cost of transportation raising the prices of traded goods. As a consequence, the demand for these goods will decline. The magnitude of this effect thereby depends on three specific factors. First and foremost, the extent of an increase in freight rates is decisive. Depending on trade route and the price for allowances, the effect will be larger or smaller. Second, the price elasticity of demand is a crucial factor. Low price elasticity of demand will result in a smaller decrease in demand whereas a relatively high price elasticity of demand will lead to a more pronounced reduction. As the price elasticity of demand is correlated with the type of the traded good, the nature of the traded commodity and the existence of viable alternatives are important. Finally, a country's infrastructure with regard to port facilities has a significant influence on freight rates and the efficiency of its maritime trade. The last two points shall now be addressed in more detail.

A number of studies highlight the importance of transport costs for external trade, many of which have a focus on developing countries (Sánchez et al., 2003, Radelet and Sachs, 1998, Clark et al., 2004, Redding and Venables, 2004). Hummels (2007) points out that in 2004 the aggregate costs of shipping for total US imports were three times higher than aggregated import tariffs paid. Focusing on trade between Latin America and the United States, Micco and Pérez (2001) find that, on average, tariffs add around 1.86 % of additional cost to imports from Latin America while transport costs add an additional 4.45 %. According to an analysis conducted by Limao and Venables (2001), an increase in transport costs by 10 % typically leads to a subsequent fall in trade volume by approximately 20 %. This estimated transport cost elasticity of trade refers to all transport cost from border to border, taking the cif/fob ratio as a rough estimate for transport costs. In the same article the authors state that, on average, sea transport only plays a minor part in explaining transport costs.[85] For example, transporting a 40 foot container over a distance of 1000 km is estimated to generate costs of 190 $ if transported by sea and of 1380 $ if transported over land (Limao and Venables, 2001). Accordingly, a moderate increase in sea freight rates only leads to a minor increase of total transport cost. Thus, trade flows' reactions will, on average, be limited, which corresponds to the estimates of price elasticity of maritime transport services that were cited above (-0.06 to -0.25). It appears, however, that the magnitude of the impact largely depends on the exported commodities and the volume of goods shipped. In this context, UNCTAD (2007) notes that freight costs as a percentage of import value have been continually decreasing since the early 1990s and amounted to a world total of 5.9 % in 2005. There are, however, pronounced disparities among world regions. For the group of developed countries, freight cost as a per cent of import value was 4.8 % whereas the same ratio stood at 7.7 % for developing countries. Even worse, for Africa the ratio was by far the largest at 10 %.

One rationale for these disparities is found in the value of goods transported. Compared to developed countries and economies in transition, the price per export unit

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[85] It has to be noted that this figure was not derived from cif/fob data but from transport costs of goods leaving Batlimore harbor going to selected destinations.

from developing countries tends to be comparatively low. This, in turn, leads to a larger influence of freight rates on export values (UNCTAD 2007). For the most part, the exports of developing countries consist of raw materials, agricultural goods and low-skilled manufactures, which in many cases have a rather high price elasticity of demand. Exports from Germany, in contrast, consist in most part of (high-skilled) intermediate goods and final consumer goods for which price elasticity of demand tends to be lower (UNCTAD 2008). A very similar pattern emerges for imports to Germany, with the notable exception of crude oil which also has a comparatively low price elasticity of demand.

A complementary explanatory factor for the relatively high impact of freight rates on the exports of developing countries can be derived from the Alchian-Allen conjecture, also known as the “shipping the good apples out” theorem (Hummels and Skiba, 2004). Producers of high quality goods may profit from transportation costs relative to producers of low quality goods as relative demand shifts from low quality to high quality goods because of changes in relative prices in favor of high quality goods. Hence, exporters of high quality products (i.e. developed countries) may have better chances of passing on transportation costs than exporters from low quality goods (i.e. developing countries).

An additional determining factor for the disparities of the effects of transport costs between developed and developing countries is the efficiency of transport infrastructure including port facilities (Sánchez et al. 2003). In general, developed countries possess better infrastructure which in turn enhances efficiency and leads to freight costs being lower overall. This helps to explain why existing empirical work on developing countries is only of limited use when inferring potential effects for developed countries.

It can be reasoned, then, that given the type of commodities imported to and exported from Germany as well as the comparatively high volumes traded, the effects on Germany’s foreign trade will be noticeably smaller than those established for developing countries. Its magnitude will, however, be influenced by the price of allowances and the respective trade route. As has been shown, though, the impact on freight rates is below 20 % and mostly below 10 % at a price for emission allowances of €30 per tonne of CO_2 or lower, which appears reasonable in the case of limited tradability of certificates with other sectors. The subsequent increase in transportation costs and its impact on the demand for import and export commodities, then, will also be quite modest. Importing relatively low cost mining or agricultural commodities may be an exception whereby very high increases in freight rates will be felt by importers and the processing industry or consumers. But, it should be kept in mind that price volatility of mining and agricultural products is already very high. Impacts from an increase in freight rates due to emissions trading will hardly be felt as price fluctuations stemming from the factors behind this price volatility of mining products will most likely overlay this effect significantly. Moreover, if the ETS scheme in maritime transport leads to the desired dynamic efficiency, freight rates might even fall in the medium term. A system that sets incentives for ship operators to make their fleet more fuel efficient will contribute to overall lower fuel consumption. This, in turn, lowers transportation costs for both developed and developing countries and can actually help to boost trade.

13.4.2 The impact on shipyards, the supplier industry and ports

An integration of ocean transport into the ETS system can have additional impacts on shipyards, the maritime supplier industry and ports. Regarding shipyards and the maritime supplier industry first, two opposing effects are possible.

As has been noted above, demand is very price-inelastic in the market for maritime transport services. Therefore only minimal effects on ship demand will occur directly from an increase of freight rates due to emissions trading. If prices for allowances are very high, there will be some negative effect on demand for maritime services and hence for new ships. Further, as has been explained in the sub-chapter above, an increase in freight rates due to an integration of maritime shipping into the ETS scheme could have a negative impact on the demand for imports and exports. It has also been mentioned that the magnitude of this effect largely depends on the price for allowances that will emerge under this scheme. A shift in the demand for imports and exports, then, can indirectly influence the demand for new ships. In the case of declining demand for import and export commodities, the overall volume of trade will fall. If this effect is large enough, the demand for maritime transport will also decline. Hence, the demand for newly ordered ships might also decrease with negative repercussions for shipyards and suppliers.

This effect, though, is likely to be small. If, as appears reasonable for a semi-open system, the allowance price is € 30 per tonne of CO_2 or less, overall trade is only slightly affected. As a consequence, the effect on the demand for new ships will be rather limited. In the near future, demand is likely to stay low for other reasons, however. First, the current economic situation led to a decline in overall trade which lowered the demand for newly build ships. Second, and more importantly, there has been a boom in shipbuilding in recent years, leading to high turnovers for shipyards and suppliers alike. This boom, though, came to an end in the latter half of 2008. In the subsequent market consolidation, German shipyards are being increasingly displaced by Asian competitors in the liner shipping market. Hence, the current crisis reinforces an existing trend whereby German shipyards are being forced out of the container shipping market, and are increasingly specialising in technologically more sophisticated ship categories such as cruise ships, super yachts, roll-on-roll-of ships and special supply vessels (Preuss, 2009). Future variations in the demand for container ships, then, are even less likely to have an impact on German shipyards and maritime suppliers.

A second, and in this case positive, effect for European shipyards and suppliers emerging from the international SO_x regulations as well as from the possible integration of maritime shipping into the ETS is actually more likely. When a cap on a ship's emissions is introduced, there will be a need for upgrading and retrofitting an operator's existing fleet as these options might be more cost efficient than ordering new ships. The increased demand for upgrading and retrofitting can prove to be an opportunity especially for the German supplier industry as they have already been offering special services in this area for the past few years. So far, their know-how with complex technologies is unmatched by their main competitors coming from Asia. It will prove profitable to further develop this area. Especially a future cooperation of suppliers and shipyards that specialize in sophisticated ship categories is seen to be fruitful (Schlegel, 2009, EC 2007).

Furthermore, German machine building is in the forefront when it comes to offering innovative, energy efficient marine engineering solutions. The two engine manufacturer (MAN and Wärtsila) that dominate the market for ocean going vessels still have a strong presence in Germany and Europe. German firms are also found in the market for innovative engine components, turbo chargers, waste heat recovery, hull design, rudder and propeller buildings and new technologies such as wind support. For all of those technologies an increase in demand can be expected (these firms include, for example, ABB Marine, Becker Marine Systems, Mecklenburger Metallguss, Piening Propeller, Siemens Marine, Sky Sail and Voith Turbo Marine). As a consequence, the impact on the German supplier industry and shipyards can be expected to be positive as the requirement for retrofitting and upgrading increases under an ETS.

A third entity that might be affected by an integration of maritime transport into the ETS scheme is German and other European ports. Currently, German ports are mainly in competition with French, Belgian and Dutch harbors. In the future, they are likely to receive more competition from southern European ports and harbors located around the Black Sea. Against this background, some see a requirement in harmonizing harbor dues and wharfage among ports in EU member states (FES, 2008).

A problem for European ports in the context of an integration of maritime transport into the ETS could arise through evasion. Depending on the approach to determining the sector's emissions, evasion methods will differ. But generally speaking, in trying to keep the additional costs on emissions down, ship operators might think of changing trade routes and means of transport. Having their ships discharged in harbors outside of, but in close proximity to, the EU they could be able to avoid additional fees and thereby undermine the whole structure of a maritime ETS. The remaining transport of the affected commodity into the EU could, in theory, be organized on road, on a number of smaller ships or by train. Against this background, concerns have been voiced about greater chances of evasion arising in the context of Economic Partnership Agreements (EPA) or Free Trade Agreements between the EU and other regions such as Russia or non-EU Mediterranean countries. A successful conclusion of these agreements could lead to a situation in which goods are first shipped to non-EU ports, then loaded onto trucks, trains or smaller ships and finally shipped, duty free, into the EU. As a consequence, the business for German ports could decline.

At least in the medium term, however, the likelihood of this scenario is rather small. First, it is unlikely that goods that were not produced in the partner countries will gain duty free access to the EU market. Second, the immense volumes of goods transported to and from the EU require ports with a very well developed infrastructure. Here, ports in EU member states have a high competitive advantage even to Asian ports. Overall, the costs for container handling within the EU are 2/3 lower than in East Asian harbors. Hence, the opportunity costs of having a container ship discharged in a port outside the EU are still rather high. In addition, the opportunity costs of transferring commodities onto trucks, trains and smaller carriers and the subsequent costs of transportation from countries located outside the EU are also likely to be rather high. The competitiveness of EU ports, then, appears to make evasion unlikely, at least in the medium term, as opportunity costs would prove to be too high for ship operators. Further, it has to be kept in mind that at the time being, around 45 % of goods loaded or unloaded at German ports, is intra-EU-trade. Regarding this cargo, evasion effects will hardly occur as the only rational evasion method to think of would be to switch to another mode of transport. Considering the very low price elasticity of demand, such behavior will hardly occur.

But in the context of a globalizing world beyond regional trade and the ensuing importance of maritime transport for global trade, however, it is imperative for EU ports to keep up their competitive advantage through regularly maintaining and improving their efficiency including investing in infrastructure and technology.

13.5 Summarizing the economic effects

An integration of the maritime transport sector into the EU ETS will most probably cause little or no damage to the German economy if prices for allowances stay reasonable, i.e. do not constantly rise well above € 30 up to 2020. But in case the prices for allowances reach a very high level (such as 70 €), suppliers of maritime transport services, especially on the routes to and from Asia, may face a significant drop in demand which in the long run might mean that the sector will shrink slightly.

As price elasticity of demand is relatively low in the maritime transport market and the sector is characterized by cooperative price setting strategies, most, if not all, of the marginal cost increase will be passed on to the customers, at least in economically stable periods. Furthermore, the literature as well as our own calculations come to the conclusion that average cost of emission reduction is very low in this sector. Given and presuming moderate hidden costs(see Box 1, 37), ship owners may even experience significant windfall profits in the medium to long run if the sector is integrated into the EU ETS. The amount of extra rent very much depends on the method used to allocate emission rights, the specific cap and the openness of the trading scheme.

The German sector of ship builders, which is currently undergoing shrinkage and restructuring, will very likely profit from the demand for more efficient vessels or retrofitting technologies as they already have several years of experience in this field. Emissions trading can help them to extend this lead over their strongest competitors in Asia as demand for emission reducing technologies will increase. The German machine building sector will profit as well.

Mostly ports and local firms providing port related services may face disadvantages from the integration of maritime transport into the EU ETS in the long term. Competition between ports could intensify due to the risk of evasion, making future port investments to maintain and improve the port's efficiency even more important if regional policy aims to foster coastal regions.

In general, it cannot be ruled out that in some countries exporting or importing industries will suffer from increasing freight rates. But looking at Germany's structure of merchandise trade no severe effects are expected. Ship and machine building, the latter being one of Germany's most important export industries, may indeed increase exports.

14 Consolidation of the findings

This last section will focus on aspects that are specifically different for the three options considered and are thus not covered in the general chapters. The options discussed are fuel consumption based on *last period*, distance based on *last trip* and cargo based. The other options – fuel consumption based on *last trip* and distance based on *last period* – are only combinations of the different modules. Thus, for any fuel consumption and *last period* option please refer to chapter 14.1 and for any distance-based and *last trip* option please refer to chapter 14.2. The cargo based option is discussed in chapter 14.3.

14.1 Assessment of Option A1: international coverage – fuel consumption – *last period*

14.1.1 Environmental effectiveness

The environmental effectiveness of option A1 is the best of all options considered, regarding the volume of emissions covered and the correlation between the emissions covered and actually emitted ones. The effectiveness of a scheme depends largely on the amount of seaborne trade that would participate in it. If all vessels calling at EU ports are integrated and are responsible for all emissions they emitted during the trading year, the reach would integrate export and import trade as well as distances travelled by those ships within the period with no connection to European trade as long as they call once at a European port within the trading year. Passenger vessels and ferries would be covered similarly.

The environmental effectiveness will be also determined by the emissions cap and the reference period the cap is based on. Due to the high potential for low-cost abatement measures a cap at approximately 30 % below emissions from the historic period 2004 – 2006 seems appropriate. Part of the emission allowances for the sector might be distributed freely – at least in the beginning of the inclusion. Free allocation of allowances may result in large windfall profits by the industry. While it is recommended to distribute a share of allowances for free, the numbers should be based on distinct vessel types and based on historic emissions and tonne-kilometre data. Europe is aiming to phase out free allowances and thus, free allocation should be decreased to zero before the year 2030.

Measures that effectively and permanently reduce CO_2 emissions include design for slow steaming and any technical and operational measure. By recognizing in-port emissions in the modelling of the baseline and allocation amounts, vessels would also be incentivized to reduce their emissions while in port, for example through cold ironing.

A minimal risk of evasion exists due to the possibility of re-loading vessels at non-European ports and limiting the number of vessels that call at European ports. However, the evasion risk of this option is the smallest of all options and unlikely to materialize as long as allowances prices are not extremely high.

14.1.2 Reliability of monitoring

The scheme proposed relies on bunker fuel delivery notes and for cross-checking on log-books to gather information on distances travelled and the CO_2 emissions in the respective trading year (or other time horizon if another reference is defined as 'last period'. This approach would require no additional data on board ships and monitoring would be fairly easy. First a manual reporting system and mandate should be established, transmitting last period's vessel voyage and fuel consumption data via fax or e-mail. Automated distance monitoring through satellite systems is not ubiquitously available today and thus the automated monitoring of a last period through satellites not possible. Some positive experience has been made with satellite AIS signal reception. However, technical, legal and economic constraints remain. Table 16 summarizes the data needs and possible sources regarding monitoring emissions during trading periods.

Data needs	Source	Data Quality
Fuel consumed and distances travelled in trading year / period when calling at a EU port	Vessel log-book; BFDN	High – good
Proof of emission allowance certificates from each vessel for the trading year / period	Vessel account	Very high

Table 16: Data needed during trading years (Option A)

Table 17 shows the data needs in the trading period. For baseline and cap setting it is recommended to utilize vessel activities in the past (e.g. period 2004 – 2006) to minimize cheating options. A full list of vessel calls and routes of the past might not be available. One option is to back-cast the emissions based on a list of vessel calls from a year after the inclusion has been decided, which can be made available through European ports. Our analysis has shown that back-casting with a bottom-up methodology likely produces sufficient emission figures to establish the emissions baseline and emissions cap.

Data needs	Source	Data Quality
List of vessel calling at European ports in a year post 2010; back-casting based on trade data	Ports, trade statistics	Very high, sufficient
Technical vessel by vessel data	Lloyds	Very high
Operational data by vessel category	Literature, trade statistics	Sufficient

Table 17: Data needed for back-casting baseline emissions and the allocation of free allowances (Option A):

14.1.3 Economic efficiency and economic impacts

Static as well as economic efficiency in static and dynamic terms of option A is high as the assessment basis is proportionately linked to emissions. Administrative costs are manageable as was shown when discussing the issue of monitoring.

The economic impacts discussed in chapter 13 mostly relate to this option. This implies that if prices for emission certificates do not significantly exceed € 30 per tonne of CO_2, and if a high share of certificates is allocated for free, no severe economic impacts on the German or European maritime transport industry is expected. This is especially the case as the fuel consumption based approach stimulates all abatement options that are open, including the ones at lowest cost, i.e. negative cost whereas, for example, the distance based approach does not stimulate all options to reduce emissions.

The inclusion of ocean shipping into the EU ETS offers more advantages than disadvantages for the European ship builders or other suppliers of equipment, because the demand for fuel efficient vessels can be expected to increase. European suppliers are increasingly focussing on advanced and special ship designs and energy efficiency technologies. (EC 2003 and EC 2007).

Further, option A hardly offers any incentives to circumvent the scheme by calling at extra EU harbors. Reloading to ships at ports nearby proves to be uneconomical as long as allowance prices do not clearly exceed € 30. Thus, competitive distortions between ports are unlikely. But the pressure on European ports to steadily invest in infrastructure and improved services may increase, though. Thus, coastal regions may suffer if these improvements do not take place. At the same time, as long as the cost of emission regulation incurred by the maritime transport service stays moderate, no severe negative impacts are expected. This is due to the price inelastic demand (with an estimated maximum of - 0.25).

Considering the relatively high value of Germany's exports the induced increase in freight rates is not expected to significantly lower global demand for German goods as the price of exports will rise by a minor percentage, even if the absolute price increase may be noticeable. A similar assessment holds for Germany's imports, except in the case of raw mining products and some agricultural goods, in which case high increases in freight rates will be felt by importers and the processing industry or consumers. But, it should be kept in mind that price volatility of mining and agricultural products is already very high. Price fluctuations stemming from the factors behind this volatility are more likely to have economic impacts than the increase of freight rates due to emissions trading.

However, it should be noted that in our general analysis we assumed that all emissions resulting from maritime freight entering or leaving the EU were covered. However, option A covers additional emissions as well, i.e. those of the vessels between non-EU ports. The problem is that on these entirely extraterritorial routes, the vessels will compete with vessels that are neither obliged to reduce emissions, nor to buy emission allowances. Hence, providers that are subject to EU emission regulations may come under pressure on these routes and will try to regain the cost of these emissions by increasing freight rates to and from the EU. As a consequence, the impact on freight rates and the economic impact on the German or European economy increase. On the other hand, if competition functions, there will be a tendency to relocate the vessels in such a way that vessels either only serve EU trade routes or vessels only serve trade routes. In the end, the findings of our general economic analysis will apply to option A after all.

14.1.4 Legal feasibility

It has already been stated that the use of unilateral measures should be handled with adequate caution and that the justifiability of extraterritorial measures is dependent on the strength of the nexus between the conduct regulated and the state asserting jurisdiction. In that context it has been pointed out that such a nexus is relatively strong with respect to emissions that are caused by transports to and from the relevant port state. It is clear that any system based on fuel consumption is directly linked to the aim of the port state to reduce emissions as the relation between fuel consumption and the emission of greenhouse gases is straightforward. More difficult to assess is the question of whether a system based on a “last period” approach provides a link that is close enough to justify the use of extraterritorial jurisdiction. Especially if ships are included in the ETS that have no other link to the port state than a single stopover in the European Union the argument could be raised that – depending on the term of the period included – most emissions of such a ship would have nothing to do with the European Union as these emissions are not caused by transport to or from the European Union. Having said this, it must be stressed that the possibility that ships are included which only have a weak link to the European Union in terms of transport to and from the European Union is quite unlikely. Ship operators will struggle to optimize the routes of their fleets in order to avoid unnecessary coverage of their ships by the ETS-regime. This means that a functioning ETS regime (i.e. an ETS which results in a considerable reduction of emission allowances) will itself optimize the coverage of the system in a sense that ever more transport covered by the ETS can be directly linked to the European Union, even if a relatively long term is chosen for the relevant *last period*. Although that does not necessarily mean that vessels with only a weak link will not be covered by an ETS-regime, the system as such can be justified as being suited and necessary in order to bring about the environmental effects.

Another problem of the "*last period*" approach is the inclusion of emissions that have been produced in the territory of third states. Two questions arise in this context. First: Can the inclusion of such emissions by the European Union be justified if another (third) state has regulations in place that aim at the reduction of emissions within its territory (and beyond)? This question has already been discussed in more depth in the context of the inclusion of aviation into the EU ETS (Pache, 2008). In such a case a justification for the exercise of extraterritorial jurisdiction becomes difficult. Therefore the ETS regime should provide for the possibility of it being suspended with respect to those emissions of affected ships that are already subject to measures of third states, if and to the extent that such measures have a similar effect as the ETS regime. The Directive 2008/101/EC which amended the existing ETS Directive so as to include aviation activities into the greenhouse gas emission allowances already provides for the possibility of adopting amendments to the directive if necessary in order to provide for "optimal interaction between the Community scheme and that country's measures" (Art. 25 a of Directive 2008/101/EC).

The second question is whether emissions that are produced in a third state's territory can be included at all. In that context it has to be kept in mind that port states are in principle allowed to regulate that special CDEM standards are complied with as a condition for entry on port. At least some of the measures introduced in chapter 5.3 contain CDEM-standards that due to their static nature are uniform throughout a vessel's voyage. Considering this, the use of an economic instrument such as the ETS has comparably less impact on the behavior of the shipping industry in third countries. Furthermore it must be pointed out that the obligation to reduce greenhouse gas emissions is global: All states are obliged to take measures in order to reduce greenhouse gas emissions. Therefore the inclusion of emissions produced on third state's territory can surely be justified under the effects doctrine.

As the "*last period*" option aims to include all greenhouse gas emissions that relate to transports destined to and originating from the territory of the member states of the European Union there is a very strong link to the responsibility of the European Union to reduce its emissions. Concerns about the strength of that link with respect to ships that only have a single, short stop in the European Union should be negligible if the ETS regime works as intended. In order to provide for adequate consideration of third state's measure with respect to international shipping, the ETS regime should provide for the possibility of adopting changes that give due regard to such measures. If this condition is fulfilled, there should be no legal obstacles with respect to the implementation of Option A.

14.2 Assessment of Option B: international – distance – last trip

14.2.1 Environmental effectiveness

The environmental effectiveness of option B is the lowest of all options considered. Since only *last trip*s are integrated into the scheme, only emissions caused by intra-EU trade and importing trade are included. If literally only *last trip*s are covered, even only a fraction of most transport movements into the EU will be captured because the *last trip* can only be securely defined from the last port of call, which will often not be the port where the cargo was loaded. Therefore, at least the distance from the port the cargo was loaded to the vessel should be chosen as the assessment basis – which then would be a freight based approach tracking the cargo and potentially the vessel. Another deficit of the difficulty to delineate last trip is that there will be less correlation between distance travelled and emissions generated than in option A. Even if the prices for emissions were high, due to the short distances that are covered, it would be likely that it would be more economical to buy off the emissions than reduce them.

The scheme based on *last trip*s cannot be recommended due to its very weak environmental effectiveness.

14.2.2 Reliability of monitoring

The challenge of this option is not its design, modelling or monitoring, but the difficulty of delineating the "*last trip*". In order to fully capture the route that imported cargo travelled on the vessel, freight bills have to be included to determine the distance of the *last trip* (see freight based approach). Matters are complicated if freight was loaded at different ports during the travel of the vessel. In general, the risk of ship operators concealing the correct assessment basis is greater than with option A.

The recommendation is to use modelling in order to calculate the emission baseline and set the emissions cap, similar to the proposal for the "*last period*". However, similarly to the monitoring during the trading year / period, it will be difficult to determine the last trips of a past reference year. The only reliable available data are likely vessel port of calls. The knowledge of the last port of call – although known to the vessel operators – can not be obtained in a reliable manner by ports or nation states.

Furthermore, as argued it is recommended to use real fuel consumption data for the distances sailed as the basis for assessment and trading. The alternative to solely measure last distances and then calculate the emissions based on efficiency factors for vessels is less reliable and bears larger risks of taking influence by the industry. The data is readily available on board ships and can be requested first through mandatory paper or electronic reporting to port states. Distance monitoring may be switched to satellite based monitoring, once such systems are available and functioning. (Table 18)

Data needs	Source	Data Quality
Fuel consumed of all distances travelled from *last trips* in trading year when calling at a EU port	Vessel log-book; BFDN,	Good but difficult because of delineation issue
Distance sailed in *last trips*, monitored through satellite surveillance if available	LRIT, AIS; Satellites	Potentially high, not yet available
Proof of emission allowance certificates from each vessel	Vessel account	Very high

Table 18: Data needed during trading years, Option B2

14.2.3 Economic efficiency and economic impacts

The static efficiency of the distance based approach is somewhat lower than that of the fuel based approach. Some emission reduction measures may not be taken even if they were at least cost. At the same time, distance and index independent measures such as slow speeding are not among the most cost saving measures, at least according to our own estimates and those of IMO (IMO 2009). Possibly only some operational management measures remain which would not be incentivized. All in all, static efficiency can therefore be assessed as fairly high. Dynamic efficiency is similar to that in option A as one component of the assessment basis is an efficiency index, fostering the use of less emission intensive vessels.

14.2.4 Legal feasibility

There are no reasons why option B should not be implemented without violating international maritime law, as the intrusion into the third state's jurisdiction is even weaker as under option A. For more details on this aspect, see chapter 11.1.4.

Quite differently, option B has a high potential to violate international trade law, e.g. the GATT provisions. This is due to the fact that if only imports are burdened, it violates GATT's core principle of national treatment. It is not perceptible how such a gross violation of the principle could be justified under GATT. An exception under Art. XX GATT can be ruled out, as the last-trip-design is not necessary in order to reach the aim of introducing an ETS for the CO_2 emissions stemming from ships.

The legal conformity of the option based on the distance of the *last period* with GATT provisions is higher than that of the option based on the distance of the *last trip* as the first does not discriminate between imported and exported freight.

14.3 Assessment of Option C: international – distance of cargo – full trip (sender/port to port – imports and exports)

14.3.1 Environmental effectiveness under simplified modelling assumptions

The environmental effectiveness of a cargo based approach is weakened due to the indirect character of the fuel consumed on board vessels. However, if a reliable connection to the vessel activity could be established, it at least offers a significant coverage of the target emissions. Other systems of assessment would need to be defined for shipping activities other than freight transport activities.

The weakness of the environmental effectiveness is the disconnection between the target audience (the freight consignees and consignors) and the actors that have direct influence on vessel design and operations. Thus, even if the coverage might be sufficient, it is unlikely that the scheme would provide incentives to reduce emissions. Instead it is likely that the emission burdens would be paid off by the responsible parties, thereby only indirectly contributing to GHG emission reductions.

14.3.2 Reliability of monitoring

As discussed above, monitoring would mostly have to depend on freight documents and information on distance travelled. A reliable monitoring can be envisioned for imported goods. Exported goods on the other hand offer more possibilities for leakage, because the location of the enforcement mechanism lies outside the European Union in the case of extra European exports and thus is ineffective for a European regime. Further difficulties arise when the freight does not travel all its way on the vessel entering the EU. Information would be needed on the vessels on which the goods travelled before and afterwards. If this approach was applied, assumptions would possibly have to be made regarding the freight's transport on other vessels.

Data needs	Source	Data Quality
Amount of cargo imported, place of origin, destination	Customs forms, Bill of lading (BoL)	Very good
Amount of cargo exported, place of origin, destination	Customs forms, BoL	Medium (cheating possible)
Data on vessel that carried goods	Customs forms, BoL	Low to medium
Vessel performance data	Reporting by vessels that call at EU ports; Lloyds	Medium (cheating possible)

Table 19: Data needed during trading years (option C)

The baseline setting would be possible through linking freight information from customs forms and freight documents with vessel efficiency standards.

As argued above, establishing the emission baseline for a last and next trip is possible through direct reporting and monitoring as well as through modelling, but may be rather inaccurate compared to option A and B because it would be based on modelling emissions on average figures. One key question is how to allocate the emission allowance certificates to the industry. The recommendation is to also use modelling in order to calculate the emission baseline and set the emissions cap, similar to options A and B2 for the "*last period*".

Data needs	Source	Data Quality
Freight data (country of origin and destination, weight, vessel etc.)	Customs forms, Bill of Lading	Good
Responsible entities	Consignees, consignors	Weak
Data on vessel activity	Customs forms, BoL	Low to medium
Vessel performance data	Lloyds Register of Ships	Medium likely based on averages

Table 20: Data needed to set baseline emissions and allocation of allowances (option C)

14.3.3 Economic efficiency and economic impacts

Compared to options A (fuel consumption – *last period*) and B2 (distance – *last period*), the economic efficiency of the cargo based approach is lower. Cost effective emission reduction measures such as an improvement of the vessels' utilized capacity would not be reflected in a lower need of allowances. This is due to the comparably weak link between freight and emissions. Due to the efficiency index applied, the approach would however offer incentives to foster technological innovations over time. However, this is also effectuated by the other approaches without the disadvantage of a significant loss of static efficiency.

Regarding the economic impacts on the maritime transport sector, ship builders, etc., our general analysis applies entirely since in our analysis we choose cargo units as a starting point for our calculations. Further, we assumed that the cost of emission regulation directly translates into higher freight rates as it is mostly passed on to the customers. Of course, if emissions cannot be monitored reliably, the implications would alter depending on whether cargo is overcharged or undercharged.

14.3.4 Legal feasibility

With respect to the problems of extraterritorial jurisdiction Option C poses no problems. The cargo based ETS regime would work like a charge on incoming goods and could therefore be based on the territoriality principle without any problems.

However, the option's conformity with the GATT provisions is quite doubtful if compared to option A (fuel consumption – *last period*) or B2 (distance – *last period*). The cargo based approach directly charges imports and exports. There are other options which are less trade distorting and more environmentally effective as the links between emissions and assessment basis is stronger. Though, the least tolerated approach by GATT members would be to burden imported cargo only, as this clearly violates Article III of GATT (principle of national treatment). As this approach would resemble an import tariff based on origin, Article I (most-favored-nation principle) would be violated as well. In addition, the discrimination of imported against exported freight cannot be justified on environmental grounds. The test carried out under the chapeau of Art. XX of GATT, the general exception covering environmental protection, can hardly be passed since the same (or better) results can be reached with measures that have a much more limited trade-distorting character.

With the freight based approach, an additional legal matter arises, namely the choice of the legal entity. Other approaches directly link the duty to surrender allowances to the ship, which strongly suggests choosing a legal entity that is directly linked on his or her part to the ship (see chapter 15.1). But the freight based approach may suggest linking the duty not directly to the ship but its freight. Therefore the group of potential legal entities widens to include, for example, consignees/consignors and customers. However, the closer the legal entity is linked to the products transported, the smaller their influence on the vessel's emissions and the higher the cost involved in doing so. Further, customers of goods being shipped outside the EU do not fall under the EU's jurisdiction. In this light, it is recommended that the ship be selected as a starting point, although this conforms less to the idea behind the cargo based approach, i.e. that demand of transport freight and thus customers are responsible for emissions caused by transporting goods.

14.4 Conclusions

The approach based on the fuel consumption of the *last period* (option A and B2) is superior to all other options discussed. Also, since reliable monitoring is feasible at tolerable cost this approach is recommended for the baseline emissions, cap setting and compliance under emissions trading. As recommended above, fuel and distance monitoring should go hand in hand to provide reliable data, although fuel monitoring may be easier to implement as distance monitoring probably would require some action at IMO level. Therefore, no differentiation is made between those two forms of monitoring. The other options discussed cannot be recommended due to their weaker environmental and cost performance and/or very limited legal feasibility.

In the long run, the maritime specific cap could be significantly tightened as, among other things, the economically feasible abatement potential of the sector is high. Further, as long as the scheme is only semi-open, not allowing the selling of “maritime” emissions allowances to stationary instalments, emissions trading will only function properly if the cap is set relatively strictly and the maritime sector does accumulate emission allowances. To avoid that trading does not function from the beginning when the cap is moderately set to provide ship owners time to adjust, we recommend allowing for complete inter-changeability of aviation’s emission allowances and shipping’s allowances.

15 Further issues

15.1 Subject of legal entity

There is no doubt that the vessel itself as the “installation” from which emissions stem and whose movements are regulated by international law must be at the centre of any regime to regulate the emissions of the shipping sector[86]. However, the ship itself is not a legal entity – or juridical person to address mandates and enforcement measures. Therefore adequate legal entities to address environmental requirements and enforcement measures have to be identified.

In principle, the following may be legal entities, e.g. legally responsible for ships to state communications and state to ships enforcement mechanisms:

1. Ship owner – individual or group of people; investment firms and ship brokers.
2. Ship operator/manager – companies specialized on operating single or multiple ships.
3. Flag-state agent – representative of the state under which flag the vessel runs.
4. Charterer – company that purchased the vessels’ services for partial, full, single, short term or long term operations.
5. Captain/Master – the officer onboard the vessel that is responsible for its safe and functional operations at sea.
6. The consignee and consignor – the parties that enter a contract for transporting goods.

The maritime sector is unique in its organizational structure. It is quite common that thousands of private investors buy shares of newly built ships; the ship is designed and

[86] The reason why the vessel itself must be in the centre is twofold: One: it is finally the amount of vessel activity and / or technical and operational abatement measures that may reduce greenhouse gas emissions. This is notwithstanding the design of the policy instrument (vessel-activity-based or cargo-activity-based).

managed by a ship broker who works closely with an investment bank to finance the ship building; the ship may already be under charter contract and the charterer may influence the vessel design according to his or her needs. Once built the vessel is operated by a carrier who may have ownership shares in the vessel as well. The flagging of the vessel is organized; the day to day operation, including manning and driving may be outsourced to another ship management firm. Finally the crew may be sourced from many different countries, adhering for example to employment laws of an international – extraterritorial – flag regime. Thus the legal structure of a vessel may ultimately be spread over many national jurisdictions. The question of the legal entity is thus a question of who to send the requirement and the enforcement notice to and who – in the case of violations – would pay the fine. The ship in itself is not a sufficient category to fulfil this demand. However, it will remain the centre object of the integration of shipping into the EU ETS and of initiating policy actions.

15.1.1 Alternative legal entities

15.1.1.1 Ship owner

- The ship owner is the key responsible party for the ship (and its GHG emissions). All GHG instruments that influence future designs should be directed towards the owner of the ship.
- The ship owner might be an individual, company or financial institution. The latter is often the case. This stems from the fact that most ships today are financed through funds and financial institutions. Some shipping lines might own a core stock of vessels.
- Ship owners might be non-EU residents. A European account might need to be established.
- The tie to the ship is fairly stable. However, ships may be sold.
- The ship owner is responsible for registering the ship under a flag and thus would also be responsible for registering the ship under an EU ETS and opening an account for trading.

15.1.1.2 Ship operator/manager

- Ships are often managed by shipping companies that organize the financing and the manning of the ship as well as managing the charter contracts.
- The ship operator is responsible for daily operations and adherence to international, national and local standards on board.
- Ship operators/managers are represented by the vessel's master who is a person on board the vessel that carries the responsibilities for the vessel. He or she is an employee of the vessel operating company.
- Ship manager and operator might not be identical. Management of certain tasks might be outsourced.

- Ship operators may be ocean carriers.
- Ship operators/managers might be non-EU residents. A European account might need to be established.
- The tie to the ship is somewhat stable.

15.1.1.3 Flag-state agent

- Flag states have the obligation to implement all internationally agreed upon CDEM standards set by the IMO. Flag states determine labour, social and tax standards for vessel operations. They also receive fees and taxes for each registered ship.
- Flag states operate flag state offices in many countries in order to manage the flagging of foreign owned ships. Thus flag state agents are present in many European countries.
- Flag states are clearly responsible for every technical standard on board ships, monitored by nation states under the Port State Control regime. Enforcement mechanisms are banning, denial of entry, quarantine, etc.
- The link between the flag state and the ship is weak. Ships can relatively easily change the flag under which they operate.
- Flag states have no obligation to follow rules that are not CDEM and IMO safety standards.

15.1.1.4 Charterer

- The charterer organizes the freight for customers. It might own/manage/operate its own vessels or part of its vessels, but not necessarily. Often charterer book spaces on vessels operated or organized by other charters and ocean carriers. Many charters (particularly in liner trade) operate in so called alliances together with other charterers.
- Charterers have the link to the freight and thus the importer/exporter. Their influence on the ships might be limited, especially because of the limited duration of charters (spot to long term charters).
- However, in liner shipping (e.g. container and car carriers) charterers often run long term charter agreements and even influence the initial design of newly built vessels. Thus they may play a key role in fostering innovative technologies.

15.1.1.5 Vessel master (captain)

- The ship operating/managing company (sometimes equal with the charterer) is the entity that hires the master and crew and thus links the master with the ship.
- With a full integration into the ETS the legal entity has to keep an account with the emissions trading register, etc. This might overburden the master.

- Thus the master acts as a representative of the ship operator who maybe hired by the owner of the ship to operate the vessel. The burden of registering the ship (under a flag or in this instance under the EU ETS) lies with the vessel owner.
- Coast guard and customs control structures are established.

It is interesting to note that the US Coast Guard has established a mandatory ballast water reporting program associated with heavy fines and civil prosecution in the case of non-compliance. Here it is the vessel master that finally may be prosecuted and even sentenced with a term in prison (see chapter 7).

15.1.1.6 Cargo consignee / consignor

- A freight based approach needs to link the enforcement mechanism to the freight rather than the vessels.
- Consignee and consignor are the legal persons that enter a contract for transporting freight. They enter the Bill of Lading contract that documents the transportation of goods and hands over the responsibilities from the carrier to the next forwarder or recipient at the ports. The consignee will hold on to the goods until all costs have been paid by the consignor. This includes custom charges and other fees. The consignor claims to be the lawful recipient or forwarder on behalf of the recipient. Thus, the release of cargo in the importing port is the logical mechanism of enforcement. A similar mechanism does not exist for exporting goods although consignees and consignors are similarly present.
- However, the consignee and consignor has no or only a weak link to the ship itself. The consignee is often the carrier company and while the carrying vessel is noted on the Bill of Lading, the enforcement mechanism would take place once the cargo has been unloaded. The relationship of the carrier to the vessel can be manifold, from owned and operated to chartered or chartered cargo space.
- The relationship of the consignee and consignor seems to be in many respects an indirect relationship to the GHG emissions from seaborne trade.
- Port facilities may be resistant to a freight based approach because it may mean that more cargo is stored on their facilities, which represents a cost to the port terminals. This additional involuntary cost would need to be recovered from the consignor, which may prove difficult.
- Targeting the consignee and consignor would not cover any non-freight vessel activity.

15.1.2 Legal aspects in relation to the legal entity

With respect to prescriptive legislation, the legal entity should be chosen in accordance with the polluter-pays principle. This means:

The main responsibility for the ship lies with the ship owner as the owner decides on any investments that may be necessary in order to reach a reduction of greenhouse gas emissions. If possible all obligations stemming from an instrument to reduce greenhouse gas emissions should be directed to the owner of the ship. However, if the ship owner is unknown or if the ship owner has his or her seat or permanent residence abroad, it may be convenient to direct obligations to the ship operator and the flag-state agent as well.

With respect to enforcement legislation, it must be discussed in more detail which sanctions are adequate in the case that a ship does not comply with the rules of an ETS. For example:

- Should entry into port be denied?
- Should the ship be detained in port until the necessary allowances are provided[87] (by captain, ship operator or owner)?
- Should the ship owner/operator directly held liable for missing allowances?

The master of the ship (since it is not sufficient for the ship alone to be the legal entity) is the legal entity that will be the addressee of most enforcement measures. Therefore the master must be empowered to receive administrative orders by the port state control on behalf of the legal entity chosen in the prescriptive legislation, probably the ship owner.

15.1.3 Economic aspects of the legal entity decision

From an economic point of view it is preferable to address the economic actor as legal entity who a) has the competence to implement cost efficient emission reduction measures and to initiate emission saving innovations, and b) has an economic interest in lowering emissions and in fulfilling legal obligations. Further, the person concerned should not be replaced too often so that there can be a stable relationship to governmental authorities and especially in order to have long-term incentives to switch to new emission saving ships. The smaller the number of actors addressed, the easier administrative handling becomes.

Hence the master does not seem to be an ideal candidate as his competence is at most, if at all, restricted to altering slightly the route or the speed of the vessel and he or she can be easily replaced. However the master acts as a representative of the vessel owner and operating company and thus might act as an intermediary between state and ship. Considering the charterer as legal entity, competence is again limited, and in the case of spot charters the motivation of bringing on changes is relatively low.

[87] For a discussion of the justification of enforcement measures see chapter 12.7

Whether the charterer has indirect influence on the ship's operator or owner to reduce emissions depends on the market situation, competitive structures (regarding supply and demand) and whether the climate policy is felt via charter and freight rates. The ship operator has a rather large interest in keeping freight rates low in order to maximize profits and gain market shares. Further the operators are responsible for daily operations and the compliance with operational standards. The power to enforce measures is sufficient. The tie to the ship is relatively stable but changes occur much more often than a change of the owners.

The fairly stable tie of the owner of the ship speaks in favor of the owner as legal entity. At the same time, the owner's interest in long-term investment in emission saving is not all that clear as ships are increasingly owned by funds which tend to value short term gains more highly than long term sustainability. Finally, the flag-state agent may seem a potential candidate as the flag state has certain responsibilities regarding taxing, technical and social standards but the link between the flag state and the ship is weak and flag agents will only have a low motivation to implement costly emission saving measures.

In summary, on economic grounds it is preferable for the legal entity behind the vessel to be addressed to be either the ship operator/manager or the owner. The vessel master is not an entity but may be the representative of the owner or operator for enforcement through the PSC.

15.2 Further research needs

15.2.1 Allocation of responsibilities and revenues

One question to be solved is the decision of how the emission entities of the maritime sector will be registered, either at national authorities or a newly established EU agency. Taking the integration of aviation into the EU ETS as a blueprint would mean allocating this task to the national emissions trading authorities that already exist. Further, it has to be decided which entities have to open up emission accounts with the authorities, e.g. ship operators (as is the case for aviation), ship owners, the vessel itself and if so, who on its behalf or others.

The next step is to decide which EU member state is responsible. Again, if aviation is the blueprint, the assignment would depend on the frequency of the operator's vessels calling at ports. The country in which the operator's vessels dock most frequently would roughly be the country where to register and the country to get any revenue from auctioning allowances. In contrast to aviation, several member states would not qualify as they do not have access to the sea. Instead, most operators would have to register in one of approx. 10 countries. More than 60% of sea freight is loaded or unloaded at the ports of five countries (the UK, Italy, the Netherlands, Spain and Germany). Accordingly, these countries would receive a very high share of the revenues from auctioning.

Then, the question of EU revenue sharing may arise. On the one hand, the countries of registration will have to bear the administrative cost of emissions trading. However, if all or a high share of allowances are auctioned, the revenue will clearly exceed these costs. Furthermore, customers and exporters all over the EU will carry the cost of internalizing the external cost of GHG mitigation, especially since it is very likely that there will be a large cost pass on to customers.

In consideration of this conflict, further research and discussion is needed regarding the distribution and use of revenues.

15.2.2 Linking the emissions trading of ocean shipping to other systems

The more sectors and countries are included, the more economic efficient the system becomes, allowing for complete interchangeability of allowances. Therefore more research is needed on how to make a semi-open system more open with respect to the land based sector without jeopardizing Kyoto targets or EU emission targets. Further, compatibility with non-EU (future) regulations of seaborne GHG has to be ensured, including a global sector specific regime.

15.2.3 Impact of refrigerants on marine GHG emissions

The degree to which refrigerants contribute to the GHG emissions from international shipping needs further research. Refrigerated cargo travels either on fully refrigerated ships or in refrigerated containers. In the former, artificial atmospheres are provided to forestall food rotting. In the latter several refrigerants are applied. It is largely unknown how fast those refrigerants enter the environment and what climate effect they may produce.

15.2.4 Legality of using AIS and LRIT data

The extent to which AIS and LRIT data could be officially used by nation states to observe international voyages and for law enforcement actions remains unclear. Although private companies increasingly offer satellite and land-based AIS data services using the freely accessible AIS data, it is not certain whether those services could be used by governments for official purposes.

16 Final conclusions

- A regional scheme best serves its purpose – to be environmentally effective – the more emissions it covers, not forgetting that a regional scheme cannot cover all global seaborne emissions. The EU’s ingoing and outgoing marine transport activities are responsible for approximately than one third of global seaborne GHG emissions. Therefore the integration of at least one third of global GHG emissions from ocean shipping is considered effective.
- All ships regardless of their flag state, ownership, etc. should be covered.
- A system based on *last period* is superior to a system based on *last trip* in terms of environmental effectiveness. Further, it is both easier to monitor and to enforce and evasion risks are smaller.

- A system based on *last period* is also superior with regard to its legal feasibility because of the decoupling of the measure from trade flows.
- The monitoring of fuel consumed and distance travelled is feasible. Both can be immediately established based on paper records (or electronically transmitted). In the future, automated systems may be established and used, but some open technical, legal and economic questions remain in this regard.
- The freight-index based approach cannot be recommended, because, among other things, monitoring outgoing freight may prove difficult, its economic efficiency is clearly lower and the approach collides with international trade law.
- Fuel consumption of the *last period* forms the superior assessment basis in terms of economic efficiency. From an environmental perspective, it also has advantages compared to the distance-efficiency index based approach as the correlation between fuel consumption and emissions is slightly higher than the link between distance and emissions. However, the backing of fuel consumption with monitoring data on distances sailed is recommended. Thus fuel consumption and distance sailed shall form the data to establish emission baselines, set caps and trade allowances.
- It is recommended that the emissions of past years be used as a reference for cap setting because using future years would invite strategic behaviour. It has been shown that bottom-up modelling of seaborne emissions is feasible for the "*last period*" approaches discussed, and that the bottom-up methodology offers reliable estimations of past and current emissions.
- With respect to the legal feasibility it is clear that an effective ETS regime needs to cover emissions of the EEZ, the high seas and the third state's territory. Therefore the rules regarding the use of extraterritorial jurisdiction apply.
- Due to the global character of the problem of climate change and under consideration of the duty to reduce greenhouse gas emissions under the UNFCCC and to protect the marine environment in UNCLOS, it can be argued that states are competent to take action on any emissions related to transport to and from their territory. Therefore extraterritorial measures can be justified if they are non-discriminatory and proportionate. An ETS regime that is based on fuel consumed or distance travelled is legally feasible, even if a "last period" approach is applied, which could include emissions that are not produced on transports to / from the European Union.
- With respect to an ETS regime based on cargo imported/exported, there are serious doubts as to whether such a regime can be reconciled with the principles of GATT/WTO. A cargo based approach can therefore not be advocated.
- The many emission saving measures with a negative abatement cost indicate that ocean shipping may become a net seller of allowances under current conditions. It has to be ruled out that operators of stationary installations become net buyers from the maritime sector as this would undermine reaching EU emission targets defined by the Kyoto Protocol. At first sight, the approach of aviation's integration into the EU ETS which uses a semi-open system may seem a solution as the emissions of international aviation emissions are not covered under the Kyoto Protocol's obligations either. This would mean allowing the shipping sector to become

a net buyer of allowances from the stationary sector but not vice versa. At second sight this approach poses one problem: Regarding the marginal abatement cost curve of the maritime transport sector, prices for "maritime" allowances may eventually drop to zero. In other words, emissions trading would not function properly. Accordingly, provisions have to be taken to guarantee prices for allowances well above zero.

- In order to generate adequate prices for allowances, the emission cap should be set rather tightly. As the initial adjustment cost for the shipping sector may be significant and opposition of the sector will be high when confronted with an initial cap much stricter than that of other sectors, it is all the same recommended that a moderate cap be used in the beginning but that it be announced at the same time that the cap will significantly decrease over time. This approach is especially recommended if emissions trading is introduced during a period of overcapacities in the maritime transport sector. In such times the pass on of cost increases to the customers is less likely, whereas under stable market conditions and in the medium to long run, full cost pass-through is fairly probable.
- Additionally, allowing for complete openness between emissions trading of the aviation and the maritime sector should be considered. In this case aviation would most likely become a net buyer of "maritime" emission allowances pushing the price up. Ideally aviation's demand for "maritime" emission allowances would equalize the "maritime" allowance price with that of the stationary sector, leading to efficiency gains for the total EU ETS.
- If emission allowances are allocated freely, significant windfall profits will occur in the sector of maritime transport as price elasticity of demand is low and high cost pass on to the customer is expected at least in economic stable times. In order to avoid too high extra rents, a high share of the allowances should be auctioned. In the short term, however, extra rents may be helpful to ease the adjustment process in this sector, especially if cost pass on is limited at the start of emissions trading due to an overall lack in demand (e.g. during economic slowdowns).
- The economic impact on the German and European economies very much depends on the price of emission allowances (and these depend on the level of the cap and the openness of the system). If prices do not significantly exceed € 30 per tonne of CO_2, no severe lasting effects will occur for the sector of maritime transport as the price elasticity of demand is low. Ports may come under stronger competition with non-EU harbors nearby. Regional policy may therefore decide to actively maintain and improve the economic attractiveness of coastal regions, e.g. by constantly investing in the infrastructure of ports.
- German ship and machine builders will profit as the stimulation of demand for emission saving techniques and ships will allow them to further develop their competitive advantage in this field.
- German exports and most of its imports will hardly be affected as freight rates only form a minor share of prices, due to the comparably high value of Germany's trade. Furthermore, there are many determinants of export and import demand that play a much more important role than freight rates (such as world GDP growth, trade liberalization measures, etc.).

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Annexes

Annex 1: Inland waterway transportation (IWT)

Approximately 5% of European freight is transported on inland waterways, which is 141 billion tkm compared to 2500 billion tkm that is covered by land based transport (road, rail and pipelines) (European Commission, 2009, EU energy and transport in figures, Statistical Pocket Book). With 46% Germany's share in European IWT's total tkm is the largest within the EU, followed by The Netherlands with 31% (ECORYS, 2009). Emissions from IWT are included in the national GHG inventories, following the territorial principle.

It is fairly difficult to estimate total CO_2 emissions per tonne-km in this sector as not only loading and vessel type have to be considered but also whether the journey is upstream or downstream (UBA, 2004, Bericht des Umweltbundesamtes I 3.1-69733/1 „Umweltwirkungen der Binnenschifffahrt im Vergleich mit Lkw- und Bahntransporten" vom 23.03.2004; IFEU GmH, 2005, Fortschreibung Daten- und Rechenmodell: Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1960-2030; Studie im Auftrag des Umweltbundesamtes, Heidelberg 2005; Planco Consulting GmbH, 2007, Verkehrswirtschaftlicher und ökologischer Vergleich der Verkehrsträger Straße, Schiene und Wasserstraße, Schlussbericht, Essen, November 2007; EU, 2007, CE Delft and others, Handbook on estimation of external cost in the transport sector, study commissioned by EU Commission DG TREN, publication no. 07.4288.52, Delft, 2007; IFEU, 2008, EcoTransIT: Ecological Transport Information Tool Environmental Methodology and Data, Update, Heidelberg). Although inland navigation is often cited as the most climate friendly modern way of transport, some studies come to the conclusion that rail transport is more favorable (IFEU, 2008). In the EU direct GHG emissions from IWT added up to 24 million t CO_2eq (2006), equivalent to around 0.5% of the transport sector's total territorial emissions (European Commission, 2009, EU energy and transport in figures, Statistical Pocket Book). CO_2 emissions have dropped during the past decades, mostly due to higher efficiency. But despite the ongoing modernization of the fleet, emissions of the sector may increase in the future, especially if the EU succeeds with its plans under the "Navigation and Inland Waterway Action and Development in Europe (NAIADES)" to very actively increase IWT (European Parliament, 2006, Session Document A6-0299/2006, 21.9.2006).

The European legislation to regulate emissions from nonroad (off-road) mobile equipment includes emission limits for diesel engines introduced to the market (European Parliament, 2004, Directive 2004/26/EC of the European Parliament and the Council of 21 April 2004). Until 2010 almost all larger vessels may not be newly equipped with engines that do not comply to these standards. Ships that fulfill these standards may not be refused passage. Additionally, EU transportation fuel standards apply. In most countries no further compulsory regulation exists to reduce GHG emissions from IWT. In many countries as for example in Germany, diesel for inland navigation is even exempted from taxing. As a consequence, the sector is not charged with the German ecotax.

European regulation of the sector primarily builds on two international agreements. One is the “Revised Convention for Rhine Navigation inland waterway transportation”, often referred to as the “Mannheim Act”. Its objectives include freedom of navigation, exemption from any taxes and duties based solely on navigation, and the absence of physical or administrative obstacles to navigation. Due to these objectives it is controversially discussed whether it is allowed to tax fuel, or introduce tradable emission certificates (UBA, 2005, Emissionshandel im Verkehr, Texte 22/05, Deassau). After all, the Central Commission for Navigation on the Rhine (CCNR) provides standards related to the fuel efficiency of vessel engines. The other relevant agreement is the less ambitious “Regime of Navigation on the Danube”, the so-called Belgrade Covention. Efforts to fully internalize the external cost of inland navigation as, for example, suggested by the European Economic and Social Committee (xx Quelle), will best take place within these two institutions as non-EU members are parties of these conventions (Switzerland, Russia and Ukraine).

Although, in principle, emissions from inland waterway transportation should not be neglected, this study will not elaborate on its integration into the EU ETS. Among other things the legal restrictions differ clearly from those of an integration of ocean shipping as other international conventions have to be considered. Further, studies exist on the abatement costs regarding ocean ships, but we do not have knowledge of similar estimates for inland water vessels. Additionally, cross-sectoral competition between inland waterway transportation and land based transportation services is much stronger than in the case of ocean shipping. Both modes of transport can be substituted fairly easy against each other, therefore price elasticity of demand is much higher than in the case of ocean shipping (IMO, 2009, Prevention of air pollution from ships, second IMO GHG study). Accordingly, we consider the question of integrating inland navigation into the EU ETS as being very different from that of integrating ocean shipping. In other words, the issue lies beyond the scope of this study and is therefore not discussed any further.

Annex 2: Methodology for modelling GHG emissions from seaborne trade

A bottom-up methodology was used for the modelling of seaborne emissions caused by German and European maritime activities. The bottom-up methodology is seen as a reliable method for determining global and local seaborne emissions. (EPA 2006, Buhaug 2008)

The emissions modelling for this analysis uses trade flows in and out of Germany in 2007. (Source: EUROSTAT) as a basis. European emissions were then extrapolated data for Germany based on European trade data.

A simplified bottom-up modelling was chosen, avoiding the research of all vessels that called at German and European ports. The principle approach is to allocate one exemplary ship type and one exemplary ship route per type of cargo. Commodity groups[88] that are categorizes as general cargo were further differentiate by the type of cargo as well as sources and destination regions. Of the general cargo category, 65% are reported to be transported in containers. The remaining 35% is assumed to be transported in vehicle carriers or general cargo ships. Table 24 lists the exemplary routes per cargo category.

	Total	Received	Dispatched	German translation
Total				Insgesamt
Bulk cargo				Massengut
of which: firm	3.097.469	2.404.417	693.051	fest
of which: liquid	2.545.242	1.880.985	664.257	flüssig
General cargo				Stückgut
of which: without carrier	3.730.730	1.843.357	1.887.373	ohne Ladungsträger
of which: with carriers	3.957.511	1.650.360	2.307.151	auf Ladungsträgern
of which: in Container	14.673.384	7.934.917	6.738.467	auf Containern
20-feet-Container		-		
40-feet-Container		-	-	
of which: on trucks	749.720	354.889	394.830	auf LKW
of which: on railroad freight car	98.389	49.499	48.890	auf Eisenbahngüterwagen

Table 21: EstimatedCO_2 Emissions from German seaborne trade 2007.

88 Vehicles, agricultural machines, electronics and other machines, building constructions, glassware and mineral products, leather & textiles, other semi-finished goods and manufactures, and special transport goods.

Shipping routes	Vehicles	Agricultural Machines	Electronics and other machines	Building constructions (metal)	Glassware and mineral products	Leather & Textiles	Other semi-finished goods & manufactures	Special transport goods (assumed bulk)
Total								
Within Germany								
Traffic with foreign ports								
EU	193.671,5	1.130,0	48.922,8	17.484,7	11.240,1	22.221,2	71.730,3	856.440,9
North America	435.469,0	8.649,2	129.236,2	27.934,0	15.491,8	12.283,7	241.669,4	31.434,0
East Asia	531.689,7	6.629,4	660.275,2	100.646,0	39.349,4	38.675,9	549.819,8	32.328,4
of which: China								
South-East Asia	127.097,4	4.433,5	273.940,9	44.681,2	14.526,1	12.947,3	341.176,0	10.600,5
South Asia	8.219,9	1.363,6	69.495,7	10.008,8	8.190,7	16.504,7	159.633,9	4.001,3
Middle & South America	148.283,4	3.011,4	88.903,1	15.289,9	6.231,5	30.694,5	103.634,5	51.055,9
Africa	181.133,2	1.179,9	79.703,5	14.021,7	10.308,8	5.440,5	47.372,1	170.803,7
Red Sea to Persian Gulf	141.428,7	3.885,5	137.933,6	21.147,6	10.305,8	12.285,5	271.300,5	17.615,3

Table 22: Estimated CO_2 emissions from German seaborne trade – major commodities exports, 2007.

Shipping routes	Vehicles	Agricultural Machines	Electronics and other machines	Building constructions (metal)	Glassware and mineral products	Leather & Textiles	Other semi-finished goods & manufactures	Special transport goods (assumed bulk)
Total								
Within Germany								
Traffic with foreign ports								
EU	42.380,7	673,8	25.012,8	11.496,6	2.492,9	4.249,5	242.712,9	752.852,3
North America	183.573,2	14.631,4	36.937,1	9.813,4	8.664,7	4.917,7	205.692,0	17.580,0
East Asia	695.416,7	6.094,9	984.851,9	389.505,7	214.158,3	788.568,8	1.571.892,8	25.931,3
of which: China								
South-East Asia	46.914,7	905,8	163.132,4	61.511,1	38.839,8	150.359,4	275.253,4	5.232,0
South Asia	17.005,8	626,8	42.504,4	17.657,2	7.272,8	155.693,9	44.935,7	88.598,5
Middle & South America	129.380,8	1.165,7	36.622,8	5.277,5	4.410,5	11.916,4	56.575,3	102.585,3
Africa	11.147,6	-	4.948,8	1.637,0	2.006,5	7.282,1	15.828,1	109.342,6
Red Sea to Persian Gulf	32.305,4	340,2	5.502,9	5.647,5	1.373,0	12.665,4	10.144,3	59.416,4

Table 23: Estimated CO_2 emissions from German seaborne trade – major commodities imports, 2007.

The distance for representative routes were measured and 5% deviation added. Adding 5% is common in bottom-up methodologies to account for deviations due to weather, multiple port calls etc.

Cargo type	Example routes from Hamburg	Representative ship type	Distance [km]
Firm bulk	Port Elizabeth, SA	Bulk Carrier Aframax	13,260
Liquid bulk	Jeddah, SR	Cruede Oil Tanker Suezmax	8,261
General cargo:			
Without Carrier	Rio de Janeiro, BR	Bulk Carrier Panamax	10,688
With Carrier	Wei. average commodities	Containership World average	7,090
Main commodities			
Europe	Helsinki, FI	Containership World average	2,059
North America	Houston, US	Containership World average	7,039
East Asia	Hong-Kong, CN	Containership World average	19,436
South-East Asia	Singapore, SN	Containership World average	16,609
South Asia	Sydney, AU	Containership World average	22,987
Latin America	Rio de Janeiro, BR	Containership World average	10,688
Africa	Port Elizabeth, SA	Containership World average	13,260
Red Sea, Persian Gulf	Dubai, AE	Containership World average	12,477

Table 24: Chosen example destinations and originating cities and the chosen distance to a German port.

Emission factors for ships were based on original data for 4002 container vessels as well as aggregate data published in Buhaug (2008) for other vessel categories. The method used to derive emission factors is a bottom-up methodology. A principle description may be found in EPA (2006). The bottom-up modelling is based on the vessel's engine power (main and auxiliary), load factor assumptions, resulting speed calculations, days at sea and days in port, fuel consumption allocations based on size and age of the vessel and the use of emission factors for the used fuels. Carbon emission of marine fuels was based on 3.114 kg/kg (IMO 2005). It was assumed that all vessels operate with 2-stroke diesel engines, fuelling heavy fuel oil, except ferries and Ro-Ro vessels that operate on 4-Stroke engines with marine diesel oil.

Sources for Emission Factors:		EF [kg/kg]	GWP
CO_2 / HFO	IMO 2005: MEPC Circ. 471.	3.1144	1
CH_4	IPCC Guidelines 2006	0.0002828	25
N_2O	IPCC Guidelines 2006	0.0000808	298

Table 25: Emission factors used for marine vessels.

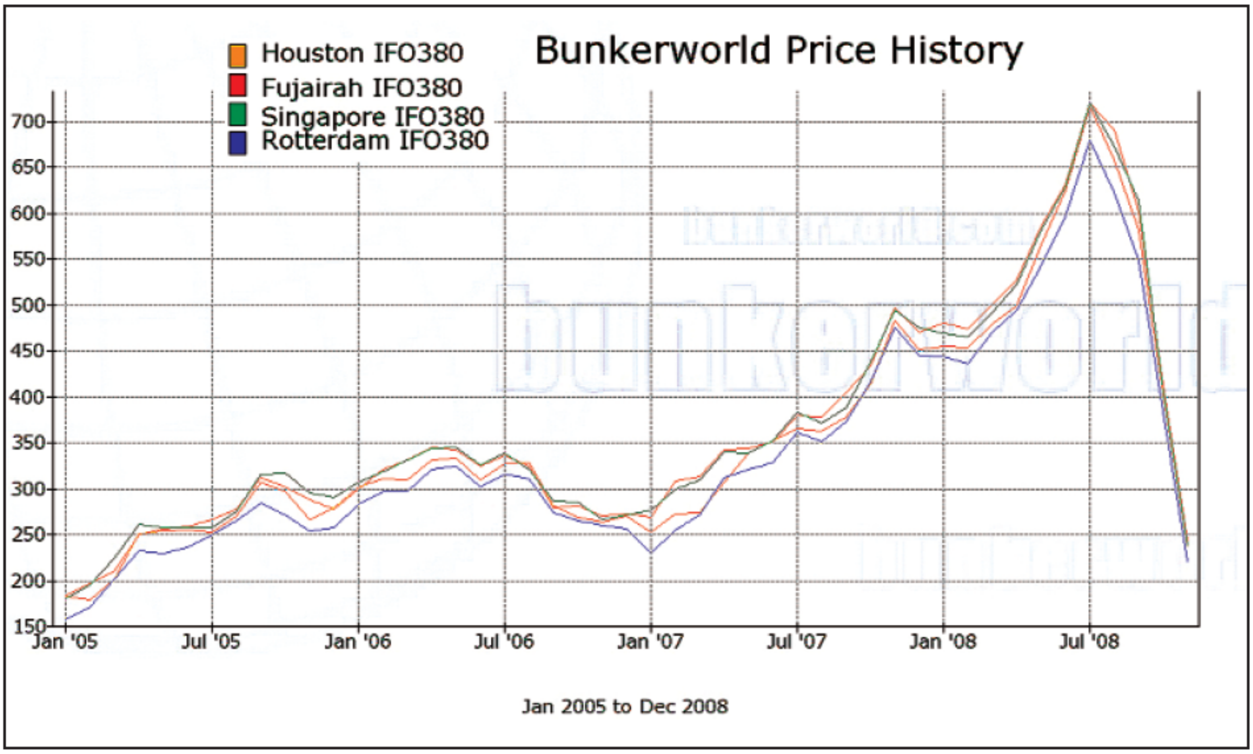
The following emission factors were derived from data by Buhaug (2008). It should be noted that those figures were corrected for discrepancies in IMO (2009), where in the summary a total emissions of 1 046 MT is quoted, but in tables the figure of 1 054 MT appears. Furthermore, the figures were derived from averages within a vessel class. The Öko-Institut e.V. is currently underway to develop more differentiated emission figures based on individual vessels in the context of a project to expand the EcoTransIT model (www.ecotransit.org) to a world-wide model. However, the emission figures were deemed sufficient to provide bulk park figures for assessing different policy options.

Vessel type	**g CO_2 / t-km**
Crudeoil tanker	4.37
Bulk carrier (dry cargo)	3.61
General cargo vessel	13.50
Container vessel	16.47
Vehicle carrier (large)	33.10
Roll-on Roll-off (large)	55.94

Table 26: Emission figures used in the estimation of German and European seaborne trade emissions.

Annex 3: Development of bunker fuel prices

Historic development of bunker fuel prices, 2005 – 2008.



Quelle: Bunkerworld January / February 2009. "Where to now for bunker prices?"

Annex 4: The impact of the price of emission allowances on freight rates

1. The focus of the calculations lie on the following trade routes:
   a. Far East to Europe with both Hong Kong and Singapore as points of departure
      i. Distance Hong Kong – EU: 19436 km
      ii. Distance Singapore – EU: 16609 km
   b. Europe to Far East → Distances as in a.
   c. The transatlantic route (EU to North America / North America to EU) with a distance of 7039 nautical miles

2. To account for movements in the business cycle, an average freight rate for the years 1999 – 2007 is calculated. The annual average freight rates for these years were adjusted for inflation according to the following table:

Harmonized CPI (2008 = 100)	
2008	1.0000
2007	0.9729
2006	0.9514
2005	0.9346
2004	0.9168
2003	0.9009
2002	0.8916
2001	0.8794
2000	0.8636
1999	0.8514
1998	0.8458

Calculating average annual freight rates in US-dollars adjusted for inflation (base year = 2008) yielded the following results.

Annual average freight rates US$ per TEU adjusted for inflation				
	Europe - Asia	Asia-Europe	US-Europe	Europe-US
1999	864.75	1825.52	1276.42	1270.26
2000	858.08	1876.55	1130.80	1393.95
2001	834.05	1558.66	1043.28	1423.35
2002	743.90	1315.07	933.45	1326.28
2003	831.64	1746.24	964.00	1543.95
2004	809.32	1932.76	873.94	1573.10
2005	872.59	1892.83	970.22	1761.49
2006	839.55	1551.92	1077.88	1912.18
2007	817.40	1853.48	1120.62	1756.61
1999-2007	**830.14**	**1728.12**	**1043.40**	**1551.24**

3. In order to obtain the corresponding values in Euros we first determine the average $/€-exchange rate from 2002-2007. Using the following values published by the ECB.

Annual Average $/€-Exchange Rates	
2007	1.370478039
2006	1.255598824
2005	1.244090272
2004	1.243902317
2003	1.131160392
2002	0.945573725

This yields a value of €1 = $1.198467 which is very close to the rate of €1 = $1.20 assumed by the ECB to be the long run Euro-Dollar exchange rate.

4. Using this exchange rate delivers the average freight rates per TEU in Euro
    a. EU to Far East: 692.67 €/TEU
    b. Far East to EU: 1441.94 €/TEU

c. USA to EU: 870.61 €/TEU
d. EU to USA: 1294.35 €/TEU

5. According to our calculations a characteristic container ship emits CO_2 to the amount of 182g/TEU/km (see Annex 2: Methodology for modelling GHG emissions from seaborne trade)
    a. This yields the following cost per TEU/km
        i. At €70/t CO_2: 0.01274 €/TEU/km
        ii. At €30/t CO_2: 0.00546 €/TEU/km
        iii. At €5/t CO_2: 0.00091 €/TEU/km

6. Hence, the additional cost per route amount to:
    a. At €70/t CO_2:
        i. EU – Asia Route (Hong Kong): 19436km * 0.01274 €/TEU/km = 247.62 €/TEU
        ii. EU – Asia Route (Singapore): 16609km * 0.01274 €/TEU/km = 211.60 €/TEU
        iii. Transatlantic Route: 7039 * 0.01274 €/TEU/km = 89.68 €/TEU

    b. Bei €30/t CO_2:
        i. EU – Asia Route (Hong Kong): 19436km* 0.00546 €/TEU/km = 106.12 €/TEU
        ii. EU – Asia Route (Singapore): 16609km* 0.00546 €/TEU/km = 90.69 €/TEU
        iii. Transatlantic Route: 7039km * 0.00546 €/TEU/km = 38.43 €/TEU

    c. At €5/t CO_2:
        i. EU – Asia Route (Hong Kong): 19436km * 0.00091 €/TEU/km = 17.69 €/TEU
        ii. EU – Asia Route (Singapore): 16609k m * 0.00091€/TEU/km = 15.12 €/TEU
        iii. Transatlantic Route: 7039km * 0.00091€/TEU/km = 6.41 €/TEU

7. This allows us to calculate the ratio of the additional cost on the respective freight rates. The results are given in the table below.

	Europe - Asia	Asia-Europe	US-Europe	Europe-US
Scenario A - €70/t				
Hong Kong	35.75	17.17	10.30	6.93
Singapore	30.59	14.67		
Scenario B-				

€30/t				
Hong Kong	15.32	7.36	4.44	2.97
Singapore	13.10	6.29		
Scenario C – €5/t				
Hong Kong	2.55	1.23	0.74	0.5
Singapore	2.18	1.05		

Annex 5: US Coast Guard Ballast Water Reporting Form

OMB Control Number 1625-0069

BALLAST WATER REPORTING FORM

IS THIS AN AMENDED BALLAST REPORTING FORM? YES ☐ NO ☐

1. VESSEL INFORMATION	2. VOYAGE INFORMATION		3. BALLAST WATER USAGE AND CAPACITY		
Vessel Name:	Arrival Port:		*Specify Units Below (m^3, MT, LT, ST)*		
IMO Number:	Arrival Date:		Total Ballast Water on Board:		
Owner:	Agent:		Volume	Units	No. of Tanks in Ballast
Type:	Last Port:	Country of Last Port:			
GT:			Total Ballast Water Capacity:		
Call Sign:	Next Port:	Country of Next Port:	Volume	Units	Total No. of Tanks on Ship
Flag:					

4. BALLAST WATER MANAGEMENT Total No. Ballast Water Tanks to be discharged: ☐

Of tanks to be discharged, how many: Underwent Exchange: ☐ Underwent Alternative Management: ☐

Please specify alternative method(s) used, if any: ____

If no ballast treatment conducted, state reason why not: ____

Ballast management plan on board? YES ☐ NO ☐ Management plan implemented? YES ☐ NO ☐

IMO ballast water guidelines on board [res. A.868(20)]? YES ☐ NO ☐

5. BALLAST WATER HISTORY: Record all tanks to be deballasted in port state of arrival; IF NONE, GO TO #6 *(Use additional sheets as needed)*

Tanks/ Holds List multiple sources/tanks separately	BW SOURCE				BW MANAGEMENT PRACTICES						BW DISCHARGE			
	DATE D/M/YYYY	PORT or LAT. LONG.	VOLUME (units)	TEMP (units)	DATE D/M/YYYY	ENDPOINT LAT. LONG.	VOLUME (units)	% Exch	METHOD (ER/FT/ ALT)	SEA HT. (m)	DATE D/M/YYYY	PORT or LAT. LONG.	VOLUME (units)	SALINITY (units)
				C										sg
				C										sg
				C										sg
				C										sg
				C										sg
				C										sg
				C										sg

Ballast Water Tank Codes: Forepeak = FP, Aftpeak = AP, Double Bottom = DB, Wing = WT, Topside = TS, Cargo Hold = CH, Other = O

6. RESPONSIBLE OFFICER'S NAME AND TITLE, PRINTED AND SIGNATURE: ____

Released 08-June-2004