



## Διπλωματική Εργασία

# **Reduction of Greenhouse Gas Emissions from ships through a non-technical approach**

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## Summary

This thesis deals with describing the current state of affairs regarding air emissions from ships, the legal and regulatory framework. Firstly the Kyoto Protocol and the obligations emanating therein are discussed, especially with respect to carbon trading. Consequently, the GHG air emissions from the Transport Sector and the relevant EU policies are analysed, before moving on to describe the actions taken by the IMO. The EU-ETS and other market-based measures proposed are presented and a brief analogy with the Aviation Industry is drawn. Finally, an online questionnaire is set-up and dispatched to shipping companies, providing some insight into the views held by shipping professionals on the issue of air emissions.

## Περίληψη

Η παρούσα διπλωματική επιχειρεί να περιγράψει την σημερινή κατάσταση σε ότι αφορά τις εκπομπές αερίων ρύπων από την ναυτιλιακή δραστηριότητα καθώς και το σχετικό νομικό και κανονιστικό πλαίσιο. Καταρχήν συζητείται το πρωτόκολλο του Κυότο και οι υποχρεώσεις που απορρέουν από αυτό, ειδικά σε σχέση με την εμπορία δικαιώματων εκπομπής διοξειδίου του άνθρακα. Στη συνέχεια, πριν αναφερθούμε στις δράσεις του Διεθνούς Ναυτιλιακού Οργανισμού, αναλύεται το θέμα των εκπομπών αερίων του θερμοκηπίου από τον τομέα των Μεταφορών και οι σχετικές πολιτικές της Ε.Ε. Παρουσιάζεται το ευρωπαϊκό σύστημα ανταλλαγής δικαιωμάτων εκπομπής διοξειδίου του άνθρακα και γίνεται ένας σύντομος παραλληλισμός με την περίπτωση της αεροπορικής βιομηχανίας. Τέλος, ένα διαδικτυακό ερωτηματολόγιο αποστέλλεται σε ναυτιλιακές εταιρείες, δίνοντας μια ιδέα για τις απόψεις των επαγγελματιών του χώρου σχετικά με τις αέριες εκπομπές ρύπων.

## Keywords

EU-ETS, carbon trading, MEPC, GHG, CO2 index

Ευχαριστώ όλους όσους με στήριξαν αυτά τα δύο χρόνια και ιδιαιτέρως τους γονείς μου, τον καθηγητή μου κ. Τσελέντη και τους συμφοιτητές μου Νίκο Λιβανό και Έφη Βαβλαδέλλη για τα καλά τους λόγια, τις συμβουλές τους και την έμπρακτη στήριξη τους σε δύσκολες στιγμές.

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# Introduction

Let's get some of the basics out of the way. Global warming is a *real* issue. It is not a figment of the imagination, it is not trivial and - yes - we cannot act upon it one day too soon. In fact, one could argue that it is *the* most important issue in the planet's environmental agenda, with food crisis registering as a close second. Its consequences are extremely well documented and any elaboration evades the scope of this document. Suffice to say that a possible "runaway" global warming phenomenon could very well result in our extinction. Although much effort has been made to alert nations, industries and individuals alike, not everybody has come to realize just how close we are to bringing about irreversible changes on the planet. Naysayers do still exist and arguments against the validity of the data supporting the case for global warming are still being made. However, the consensus is picking up momentum day by day, forcing governments and policy - making international organisations assume clear positions and undertake commitments. After giving a very short presentation of the facts concerning global warming and greenhouse gases, this thesis will concentrate on the Transport Sector and most importantly Maritime Transport. It will aim to describe the current state of affairs in a thorough and unbiased manner. In this the aid of a field survey will be valuable. The survey will be conducted through an online questionnaire dispatched to a number of prominent shipping firms, in the hope that the analysis of its results will shed some light on the internal workings taking place in the industry. Bear in mind that we will only concern ourselves with non-technical solutions to the emissions problem, meaning that it is out of our scope to evaluate things such as engine combustion chamber improvements or more efficient propellers. We shall concentrate on market based measures (such as emission trading schemes or carbon taxes) and operational measures (such as slow-steaming , weather routing and optimum fleet management minimizing ballast voyages). Thereafter, all things considered, an attempt will be made to draw a rough roadmap of actions that ought to be taken in the near future.

## The Kyoto Protocol

### Global warming

Global warming is pretty much attributed to the increasing presence in the atmosphere of gases, widely known as GHGs (Greenhouse Gases), mainly through the burning of fossil fuels and

deforestation. These gases, which include *Carbon Dioxide, Methane, Nitrous Oxide* and some groups of *fluorinated gases such PFC's*, although both natural and anthropogenic with respect to their source, have seen sharp increases in their concentration since the beginning of the industrial revolution and have now been shown to possess a very nasty quality. They trap heat into the atmosphere, inducing a global increase of temperature. By the way, this is not a local effect. Greenhouse gases, especially CO<sub>2</sub> will act globally, regardless of where exactly they are released. This, however, has led to some quite shrewd economics as we shall later see.

It is not therefore surprising that the single most important development in the fight against global warming has been the “Kyoto Protocol”, which entered into force on the 16<sup>th</sup> of February 2005. Let us briefly discuss its content and its - far reaching indeed...- implications.

### **Obligations under the Kyoto Protocol**

The protocol is an agreement made under the *United Nations Framework Convention on Climate Change*, affectionately known as UNFCCC. It has thus far been ratified by 182 parties (including entities such as the European Union), however, not all of these parties have agreed to exactly the same things. The so called “developed” nations, referred to as Annex I countries, assuming responsibility for the bulk of greenhouse gas released into the atmosphere, have agreed to what is the core of this extremely complex document, namely the commitment to cut back on their CO<sub>2</sub> emissions by a substantial percentage or submit an appropriate number of emission “allowances” for every ton of CO<sub>2</sub> they fail to abate during the first commitment period (2008-2012), acquired through one of the mechanisms custom built for the purpose. In fact, they have agreed to reduce their emissions to pre-1990 levels, which is no easy task. No wonder that their mood, as far as all the others are concerned, is hardly sanguine. These “others”, referred to as Non-Annex I countries mostly belonging to the “developing” world, have not assumed any obligations other than monitoring and reporting emissions. The United States, a special case in their own right, represent the most glowing exception among developed nations. They have as yet not even ratified the agreement, although they are by far the single biggest emitter of GHG's, a fact that can be argued to set a timeless example of irresponsibility and ill judgement.

## Carbon credits

As one might expect, business opportunities are embedded deep in the Kyoto framework. Such is the nature of things in a world where almost every nation under the sun has embraced capitalism. The key to doing business in this brave new “carbon” economy lies in the mechanisms through which “allowances” are acquired.

As aforementioned, through the Kyoto Protocol, developed nations are obliged to reduce their emissions to something like 95% of the 1990 level (92% across the EU). Considering that these nations had largely already put in place much more elaborate and costly mechanisms than their “developing” counterparts, just to restrain emissions, one can readily deduce that the extra effort required will hardly come cheap. Although many possibilities have still been left unexploited, governments have been forced to recognise that further reductions might not even be possible without resulting to ultra high cost solutions. This is where “flexible” mechanisms come in. You estimate that buying or developing the technology needed to further abate emissions is not worth your while ? No problem, just invest your cash someplace where it is still cheap to reduce them. This is the essence of both the *“Clean Development Mechanism”* and the *“Joint Implementation” schemes*. In brief, if you fail to hit your emissions reduction goal you will need “credits” to make up for coming up short. The sources of Kyoto credits are the aforementioned schemes. The CDM allows the creation of new carbon credits by developing emission reduction projects in Non-Annex I countries, while JI allows project-specific credits to be converted from existing credits within Annex I countries. CDM projects produce Certified Emission Reductions (CERs), and JI projects produce Emission Reduction Units (ERUs), each equivalent to one AAU or “allowance”. National governments that have a net deficit of allowances, will buy credits for their own account, mainly from JI/CDM developers. These deals are occasionally done directly through a national fund or agency, as in the case of the Dutch government's ERUPT programme, or via collective funds such as the World Bank's Prototype Carbon Fund (PCF). The PCF, for example, represents a consortium of six governments and 17 major utility and energy companies on whose behalf it purchases Credits. However, although these caps are national-level commitments, in practice most countries will devolve their emissions targets to individual industrial entities, such as a power plant or paper factory. This means that the ultimate buyers of credits are often individual companies that expect their emissions to exceed their quota. Typically, they will purchase credits directly from another



party with excess allowances, from a broker, from a JI/CDM developer, or on an exchange. Another option is a “cap and trade system” such as the EU-ETS.

This is exactly where entrepreneurs will expect to make to make a handsome buck. Since allowances and carbon credits are tradable instruments with a transparent price, financial investors can buy them on the spot market for speculation purposes, or link them to futures contracts. A high volume of trading in this secondary market helps price discovery and liquidity, and in this way helps to keep down costs and set a clear price signal in CO<sub>2</sub> which helps businesses to plan investments. This market has grown substantially, with banks, brokers, funds, arbitrageurs and private traders now participating in a market valued at about \$60 billion in 2007. “*Emissions Trading PLC*”, for example, was floated on the London Stock Exchange's AIM market in 2005 with the specific remit of investing in emissions instruments.

## **Greenhouse Gas Emissions deriving from the Transport Sector**

### **Is Transport responsible ?**

So, in a world faced with the prospect of a “green” economy, how does the Transport Sector perform ? To be honest, not so well. Transport accounts for a really big chunk of the emissions pie, estimated at about 40% and the only light at the end of the tunnel seems to be the one belonging to the oncoming train. Railway people will please excuse the usage of their eco friendly medium in this metaphor. Two are the main reasons for this unfortunate fact. Firstly, world trade has flourished in this globalised economy of ours resulting in more goods being carried over longer and longer distances every day. The advent of China, India and the rest of the rapidly developing nations across the globe (*see BRIC...*) in the world trade scene, has made sure that enough raw materials and finished products are transported to dwarf the corresponding numbers of maybe ten years ago. Everybody and everything is on the move and currently it seems as though nothing can stall this structural change of epic proportions.

## **Road transport**

Road traffic clearly provides the largest net contribution to warming through its large emissions of CO<sub>2</sub> (e.g. in the order of 20% of total EU emissions) and significant emissions of ozone and soot. Total warming from road traffic is estimated to be about 0.19 Watts per square meter (W/m<sup>2</sup>), or about seven percent of the total climate forcing, because of the increase in the concentrations of ozone, soot, and greenhouse gases included in the Kyoto Protocol. This surprisingly low percentage results from road traffic having a shorter history than other emissions sectors, and thus having less responsibility for the accumulated concentrations of long-lived greenhouse gases. This share will increase in the future. EU's many attempts towards inducing a modal shift favouring the least energy intensive modes of transport have failed blatantly. With each passing year more and more trucks inhabit the roads, hauling ever increasing quantities of cargo across borders, as intermodal door-to-door services are not yet up to the task due to interoperability problems or excessive cost. In fact, EU railroads are barely now moving about as much freight as they did twenty years ago. No signs of imminent improvement can be found in the private car arena either. Car manufacturers are certain to miss their voluntary 2008 emissions targets, causing the EU to move towards the direction of introducing binding regulations. However, industry lobbying, especially on the part of Germany, the EU's largest manufacturer of luxury vehicles, has forced the procedure into a stalemate.

## **Aviation and Shipping**

And what about aviation and shipping ? We know that ships are unbeatable when it comes to carrying massive payloads over great distances due to the economies of scale inherent in the medium. We also know that airplanes have the edge for long-haul international travel, although the recent surge in the price of oil has made aviation fuel a huge liability for the sector. In a climate context, emissions from ships and planes are in a special category. Not only are they not covered by the Kyoto Protocol, but – more fundamentally – these emissions contain components with short lifetimes that have specific local effects.

Ship emissions are growing rapidly and are forecasted to continue to do so. Most current estimates place them somewhere between 2% and 4% of total CO<sub>2</sub> emissions and most forecasts agree to the fact that NO<sub>x</sub> and SO<sub>x</sub> emissions will be on par with land-based sources by 2020. Two particular

conditions stand out: the use of sulfuric heavy oil that causes the formation of sulfate particles, and emissions of NO<sub>x</sub> in areas with little other pollution. Ship emissions of NO<sub>x</sub> in unpolluted areas have a particularly large effect on ozone formation compared to, for example, emissions from road traffic or land-based industry. The analysis from CITS shows that if the indirect effect of sulfate particles in clouds is included, then emissions from ships up to the present have had a net cooling effect on the climate (this is however a contentious claim...). This picture will nevertheless change in the future because the cooling sulfate particles have a short lifetime in the atmosphere, while the contribution of CO<sub>2</sub> increases slowly but surely.

Air traffic is the sub-category within the transport sector that shows the most rapid increase in emissions (with a temporary pause after 11 September 2001). As is the case with ship emissions, air traffic emits NO<sub>x</sub> in areas that are relatively clean, which has an especially large effect on ozone formation. More recent research in the period after the 1999 report from the Intergovernmental Panel on Climate Change (IPCC) on air traffic suggests that the occurrence of ice clouds (cirrus) at flying altitudes is increasing in areas with heavy air traffic because the contrails, under the right meteorological conditions, can expand. Cirrus clouds at altitudes of 8-12 kilometers have a warming effect on the climate because their greenhouse effect is stronger than their cooling effect through the reflection of light. This is because the temperature at this height is very low.

All this goes to show that we are - at least presently - stuck with two modes of transport that despite their corresponding competitive advantages boast a heavy carbon footprint which cannot be ignored any longer. This disquieting fact has mobilised policy makers in what is to this day the most environmentally sensitive socioeconomic entity in the globe, the EU.

## **EU Policy on Greenhouse Gas Emissions, EU-ETS**

### **The EU-ETS in a nutshell**

The European Union has clearly put environmental protection very high on its agenda and so have the people that make it up. That is to say, that stringent emissions regulations have been put in place for several industries. Nonetheless, the most interesting and novel (at least as far as its scale is concerned) bit of policy is the “EU-ETS”. Quoting from the European Commission’s website: “In

January 2005 the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas emission trading scheme world-wide. The scheme is based on Directive 2003/87/EC, which entered into force on 25 October 2003.” This claim is well supported. The idea behind the EU-ETS is that if allowances can be bought and sold by participants in the open market, then the overall cost of compliance with the Kyoto targets will (assuming markets really price commodities in an optimum way or near-optimum way) be restricted to a bare minimum. The scheme covers 11,500 energy-intensive installations across the EU, which represent close to half of Europe’s emissions of CO<sub>2</sub>. These installations include combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper. All these stakeholders have been awarded a number of AAU’s (at a national level these must equal the emissions “cap” when added up...) to fire up the process so to speak, through “National Allocation Plans” or NAP’s, drawn up by each member state. Thereafter, scarcity takes over and ergo a market for AAU’s appears. That is of course subject to the degree to which allowances were efficiently allocated in the first place, an issue that caused a heated debate all the way through the first trading period (ended 31/12/07). Needless to say that the scheme is quite complex by nature and requires a healthy dose of administrative excellence if it is to retain any credibility. Let us also note that although the EU-ETS does not regulate how and where the market in allowances takes place and companies with commitments may trade allowances directly with each other, via a broker, bank or other allowance market intermediary, it does however provide for an electronic registry system that keeps track of the ownership of emission allowances as they change hands in the market. This registry system is separate from trading activity - not all trades result in changes in ownership of allowances, but where a trade culminates in a change in ownership, there is a transfer of allowances between accounts in the registry system.

Currently, the most prominent exchange for emissions allowances within the EU, is the “ECX” or European Climate Exchange, a derivatives market dealing in Futures and Options contracts. These types of transactions represent about 95% of all carbon trading going in the EU, with the spot market accounting for the remaining 5%. The ECX appears at this time to be the most liquid market of its kind.

A recent development has been the completion of a “test” trading phase where the EU's Community Independent Transaction Log (CITL) and the UN's International Transaction Log (ITL) were linked,

enabling companies to transfer allowance units, in this case CER's issued under the CDM, to their Member State's registry.

This brief introduction concerning the EU-ETS will assist us in making some important points about the possibilities of reducing GHG emissions from maritime transport, but more of this later. For the moment, we will only draw attention to the fact that the aviation industry is literally at the threshold of the EU-ETS and many are contemplating on the particularities of the sector as well as the likely adversities which may follow suit with aviation's inclusion in the scheme.

## **Greenhouse Gas Emissions from Ships, IMO and EU.**

### **Work under the IMO**

Opinions still vary when it comes to quantifying the maritime sector's GHG emissions and especially CO<sub>2</sub>, this mainly being due to the divergence between different parties' estimates of global bunker fuel demand. In spite of this, the industry has seen a lot of activity both at an EU level and globally, under the aegis of the International Maritime Organisation (IMO). Their efforts have on many occasions been less than perfectly coordinated. A lack of alignment between the EU and the IMO has plagued the issue for some time now. Apart from those two institutions, various international organisations representing the stakeholders have involved themselves in the discussion, e.g. BIMCO, INTERTANKO, INTERCARGO and others.

At the IMO level, discussions are mainly taking place under the auspices of the Marine Environment Protection committee (MEPC) and - quite recently - the "Working Group on Greenhouse Gas Emission from Ships", which has undertaken the responsibility to advance much of the necessary preparatory work before the MEPC's sessions take place. Work in the IMO really got under way in 2000, with the IMO study on Greenhouse Gas Emissions from Ships, which highlighted the fact that although shipping held the undisputed track record for low GHG emissions when compared to other transport modes, it would still soon need to address the problem. Consequently the Assembly adopted in December 2003 Resolution A.963(23) on "IMO Policies and Practices related to the Reduction of Greenhouse Gas Emissions from Ships", urging the MEPC to identify and develop the mechanisms needed to achieve limitation or reduction of GHG emissions

from international shipping and to consider the methodological aspects related to reporting them. The Assembly resolution requested the IMO Secretariat to continue co-operating with the Secretariats of UNFCCC and the International Civil Aviation Organization (ICAO).

## **Ammending MARPOL**

The focus of this work up to the present day has been the amendment of MARPOL's renowned Annex VI, "Regulations for the Prevention of Air Pollution from Ships" which entered into force in May 2005 and has, so far, been ratified by 49 countries, representing approximately 74.77% of the gross tonnage of the world's merchant shipping fleet. Under MARPOL, a cap had been put in place on the sulphur content of bunker fuel in order to control sulphur oxide emissions. This cap is more stringent in areas referred to as Sulphur Emissions Control Areas (SECAs) which have been deemed to be more sensitive environmentally - these currently being the Baltic and the North Sea. After intense negotiations at the MEPC's 57th session (31-4/04/08) there was unanimous agreement on the tightening of standards. In more detail:

- I. 2010 – Emission Control Area (ECA) limit reduced to 1%
- II. 2012 – Global limit reduced to 3.5%
- III. 2015 – ECA limit reduced to 0.1%
- IV. 2020 – Global limit to 0.5% but a review in 2018 (with the authority to delay implementation) will determine if this is achievable.
- V. 2025 – Global limit to 0.5% notwithstanding the result of the 2018 review.

MARPOL also stipulates what the maximum allowed NO<sub>x</sub> emissions should be and the NO<sub>x</sub> technical code gives guidelines on how to measure emissions and what test cycles engines should be put through. Marine engines are categorised into three "Tiers" depending on their date of installation. NO<sub>x</sub> regulations for new engines after MEPC 57 have been agreed as follows: Tier I applies to a diesel engine which is installed on a ship constructed on or after 1 January 2000 and prior to 1 January 2011 and represents the 17 g/kW standard stipulated in the existing Annex VI. For Tier II, NO<sub>x</sub> emission levels for a diesel engine which is installed on a ship constructed on or after 1 January 2011 would be reduced to 14.4 g/kWh. For Tier III, NO<sub>x</sub> emission levels for a diesel engine which is installed on a ship constructed on or after 1 January 2016 would be reduced to 3.4 g/kWh, when the ship is operating in a designated Emission Control Area. Outside a designated

Emission Control Area, Tier II limits apply. Regarding standards for existing engines the MEPC agreed to a NO<sub>x</sub> emission limit of 17.0 g/kW for a diesel engine with a power output of more than 5,000 kW and a displacement per cylinder at, or above, 90 litres installed on a ship constructed on or after 1 January 1990 but prior to 1 January 2000.

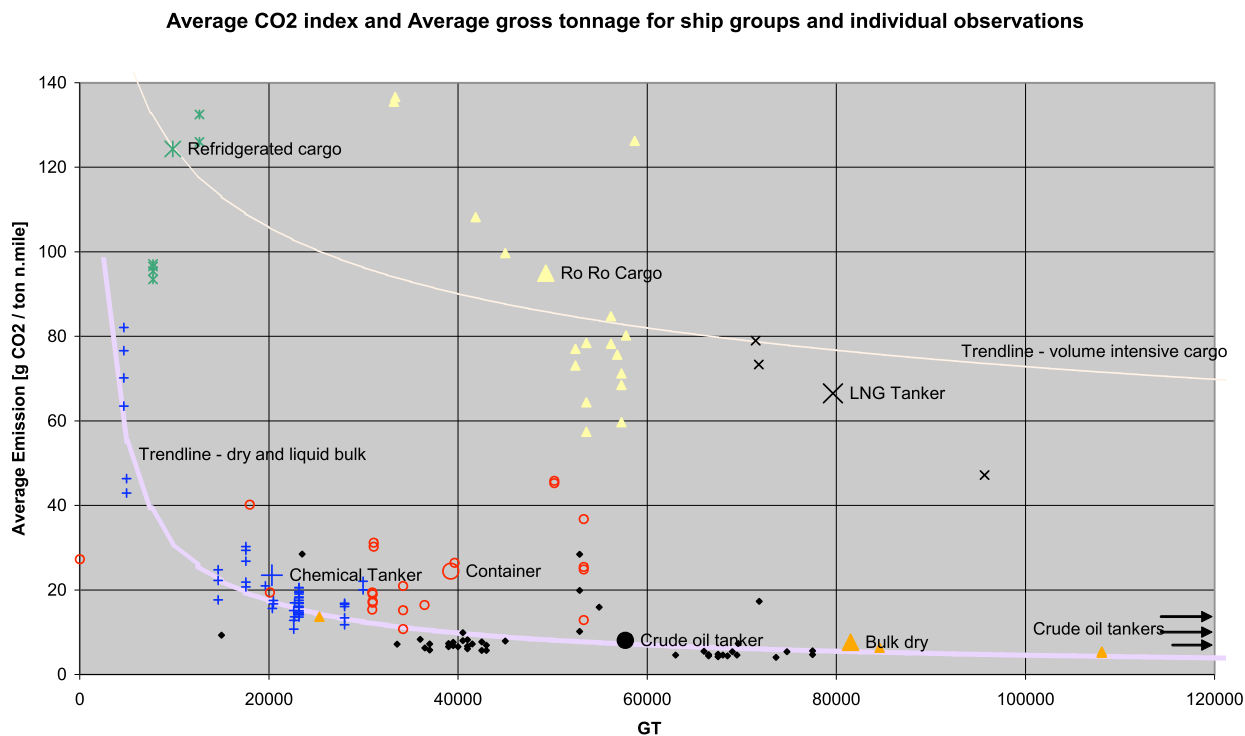
## The CO<sub>2</sub> index

Quite noticeably there is one thing missing from these resolutions. A clear-cut roadmap to address the issue of CO<sub>2</sub>. This exact point has been the culprit of the IMO's policy on GHG's according to the EU Commission and more specifically the DG Environment. As we have already explained the EU has shown a special interest in the Kyoto Protocol and the associated mechanisms and has to that end developed the EU-ETS. Within the EU ships are widely believed to be the most steeply rising source of air pollution. This has meant that the Eurocrats (on request of whom many reports on market based schemes to reduce emissions have seen the light in recent years) seem now to advocate en bloc the inclusion of the maritime industry in the ETS, a formidable task indeed. Much pressure has been put on the IMO to take action and thus keep a local EU-wide scheme from being introduced without a global consensus in place. In this scope, the Working Group on Greenhouse Gas Emissions from Ships has sought to take advantage of an idea already on the table for some years, the "IMO CO<sub>2</sub> Index", develop it further and add to it a few new concepts in the way of a "CO<sub>2</sub> Emissions Baseline". These efforts have helped to lift the impression of stagnancy and pave the way for bolder steps in the near future. Let's review these developments in a little more detail.

Firstly, it should be made clear that unless decided differently at MEPC 58, due for October 2008, all CO<sub>2</sub> Indexing is done on a purely voluntary basis. The existing index is purely operational and although it has greatly contributed to bringing in vast amounts of data, it is fraught with problems. The way it is calculated (MEPC 53 in 2005, circular 471) is as follows:

$$\text{Index} = \frac{\sum_i FC_i \times C_{Carbon}}{\sum_i m_{cargo,i} \times D_i} \quad (\text{gram CO}_2/\text{tonne identical mile})$$

meaning that we are essentially doing is dividing the product of (total fuel consumption x carbon content) with the product of (distance travelled over ground x payload carried). As one can easily observe from the following diagram, observations using this index vary greatly:



**Figure 1 - IMO CO<sub>2</sub> index**

The reasons behind these variations can be summarised as follows:

- I. Ship size
- II. Cargo requirements
- III. Utilisation of cargo space
- IV. Speed
- V. Length of ballast voyages
- VI. Ship condition (hull and propeller fouling, engine condition etc...)
- VII. Weather and currents
- VIII. Estimation and measurement errors

A recent study by the Laboratory for Maritime Transport, NTUA, commissioned by the Hellenic Chamber of Shipping (HCS), helps quantify some of these shortcomings. Utilizing data from the Fairplay world fleet statistics as well as other sources, this study has shown that faster and smaller



ships emit more CO<sub>2</sub> per tonne-km. An interesting piece of information is that containerships are by far the single most important source of CO<sub>2</sub> emissions, both in absolute and per tonne-km terms. All these serve to show that without reference levels or benchmarks the index is of no practical use. The gap between the actual performance of a ship and the reference level can then be estimated and used to create incentives or e.g. generate emission credits.

## **The Oslo meeting**

In the frame of its Oslo meeting (23-27/06/08) the Working Group on Greenhouse Gas Emissions from Ships took steps towards the development of a design level CO<sub>2</sub> Index. Quoting from the press release: “The meeting developed further a formula and the methodology, as well as draft text for the associated regulatory framework, for a proposed mandatory CO<sub>2</sub> Design Index for new ships. Once finalised, the index will serve as a fuel-efficiency tool at the design stage of ships, enabling the fuel efficiency of different ship designs, or a specific design with different input such as design speed, choice of propeller or the use of waste heat recovery systems, to be compared. The design index will contain a required minimum level of fuel efficiency related to a baseline, which will be established based on fuel efficiency for ships delivered between 1995 and 2005. The actual minimum level, and the frequency with which the limit will be tightened, are among the matters that will be considered by MEPC 58 in October. The Oslo meeting thoroughly considered the different elements in the formula to avoid so-called "paragraph ships", meaning future ship designs optimised for certain conditions but which do not actually deliver greater fuel efficiency. The different correction factors to make the formula relevant for all ship types were given extensive consideration, as was verification of the design index, as there might not be a Flag state dedicated to the ship at the design stage.” With regards to the operational index, observations by stakeholders were reviewed and a draft index is to be submitted to MEPC 58 for approval. In spite of this progress, the discussion on economic instruments with potential to reduce GHG emissions, such as a global bunker fuel levy or an emissions trading scheme did not conclude on specific proposals to be presented before MEPC 58. It seems that circumstances within the IMO maybe yet not be mature enough for such a sensitive issue to become the subject of public commitment.

## **The Aviation Industry vs. Shipping**

Before we proceed to examining different market based instruments designed to reduce shipping's GHG emissions let's briefly contemplate on the similarities and the discrepancies between the maritime and the aviation industry. This is no exercise in futility. Aviation, as we mentioned earlier is very close to becoming a part of the EU-ETS and many of the hottest topics discussed in hallways in Brussels could very much form the basis of similar discussions on shipping.

## **The similarities**

Both sectors are just about on a equal footing as far as their carbon footprint is concerned, roughly 20% of emissions within the Transport sector, just about 3.5% of total GHG emissions. Here's a brief list of attributes pertaining to both shipping and aviation:

- I. They contribute to climate change through different emissions (carbon dioxide, nitrogen oxides, etc...)
- II. Although both industries have made improvements to engine technology and efficiency, reductions in greenhouse gas emissions (GHG) made thanks to these investments have not been sufficient to compensate for the rapid growth of traffic.
- III. To date, neither the aviation sector, nor shipping, have not been required to do much to address climate change. Indeed, the Kyoto Protocol excludes both and merely requests countries to work towards reducing emissions in these sector through the International Civil Aviation Organisation and the International Maritime Organisation.
- IV. A global solution, especially a global emissions trading scheme, although in principle endorsed by many, is not yet in place. However, as aforementioned aviation is probably going to be included in the EU-ETS soon.

## **The adversities common to both sectors**

A global emissions trading scheme is hardly an easy thing to set up. Many of the difficulties that make their appearance when aviation is considered are pretty much inherent to shipping as well. Namely:

- I. Are international flights (almost all of shipping is international...) to be included ? What if some nations do not consent ?

- II. How is the total emissions cap to be determined and who is to apply it ?
- III. How will the allowances be allocated ? An unfair allocation would greatly distort competition.
- IV. What will happen to possible revenues resulting from a regulation scheme ? Will they be recycled to the industry ?

### **Airplanes may float, but ships won't fly...**

That is to say, not everything here is about similarities. Those two industries are two quite different beasts after all. Let's make a few points to elaborate.

- I. Merchant shipping, in its "tramp" version, not only represents the great majority of shipping activity across the globe, but is also (excluding a few niche markets) the closest thing to a "perfectly competitive" market in existence. Shipping companies are literally in the range of thousands and they do pretty much offer the same product, while at the same time being "price-takers". No shipping company has the ability to single-handedly affect the rates and no alliances with such an ability exist either, with the exception of liner shipping. All this means that if you increase the cost of operation, profits go downhill and eventually disappear, unless the emissions trading scheme really introduces zero distortion to the competition.
- II. Almost *all* shipping, Short Sea and Coastal shipping included, is international. Quite of few issues arise from this fact. Without detailing them at this point, it seems pretty clear the unilateral action is really a last resort. After all, the enforcement of any measure not backed by a global consensus may prove to be an arduous task. A notable exception however is the USA's "Oil Pollution Act", known as OPA 90, which not only did not result in an isolation of US ports, but in fact promoted similar legislative efforts at an international level. Even so, international maritime law (codified in the form of UNCLOS - United Nations Conference on the Law of the Sea) including inter alia the "Right of Innocent Passage" add up to the difficulties. Even today's SECA's burden operators with complex bunkering decisions as they need to steam through areas with different caps on sulphur fuel content.
- III. Most shipping companies are not floated and more importantly they are largely off-shore establishments, with founding place, headquarters and owner's base often comprising three different nations. A corporate entity, especially if its shares are traded in one of the world's big exchanges is a relatively transparent thing. Shipping companies are a far cry from that.

IV. The main business in the maritime sector is not the carriage of passengers. It's the transfer of goods. Put mildly, if the cost of shipping goes sky-high, world trade may very well come to a standstill. In the case of aviation, one risks to bankrupt a few ultra-high cost state airlines, or if a worst case scenario comes to pass, further the trend of consolidation already present in the industry. With shipping, the risk of structural change in the way the world currently trades is true enough.

## **Market based measures in the shipping industry**

The prevailing notion that technological advancements are not able in the own right to bring emissions down as much as needed has many things going for it. Day by day policy makers are realising that unless technology delivers the goods and rids us of the need to burn fossil fuel, some really tough decisions will be unavoidable. One may, albeit with some risk, state that considering shipping's inherent requirement for proven and trustworthy technological solutions (nobody wants to get stuck in the middle of the ocean...), a big change in what is considered state of the art in engine and hull design is not around the corner. That leaves us with market based mechanisms. Quite a few of those have been proposed in recent years, not least in studies ordered by the European Union, BIMCO and others. Whatever the mechanism, there are certain requirements that will need to be satisfied and they are laid down very clearly by the IMO.

### **The requirements**

As stated by the MEPC 57, a GHG emissions reduction scheme would have to be:

- I. effective in contributing to the reduction of total global greenhouse gas emissions
- II. binding and equally applicable to all flag states in order to avoid evasion
- III. cost-effective
- IV. able to limit - or at least - effectively minimize competitive distortion
- V. based on sustainable environmental development without penalizing global trade and growth
- VI. based on a goal-based approach and not prescribe specific methods
- VII. supportive of promoting and facilitating technical innovation and R&D in the entire shipping sector
- VIII. accommodating to leading technologies in the field of energy efficiency
- IX. practical, transparent, fraud free and easy to administer

All these are nothing but elaborations on this simple notion: We need a scheme that actually reduces emissions, is not too complex, doesn't kill the market and does not favour anybody in a scandalous way. Well, it's not easy. Firstly, because as we analysed earlier, the shipping industry is quite different from aviation (which is already troublesome) and secondly because not everybody's interests lie on the same side of the equation. Nations boasting huge merchant marine fleets are naturally averse to the implementation of such a scheme and one can see why. It would place quite a bit of administrative work on their shoulders as flag or port states and would also undermine the prospect of continuous windfall profits for shipowners signalling a decrease in currency inflow. On the other hand, nations whose economies don't rely on shipping or whose governments are not under any significant pressure emanating from shipowners lobbies are much more inclined to endorse such schemes. Nonetheless, MEPC 57 was rather a success. It proved that whatever the inhibitions, a global consensus is not out of reach. Let us now review a few of the proposals that have seen the light in the new millenium.

## **A review of mechanisms proposed**

At this point a clear distinction has to be made. One can have *emissions trading* schemes, *emission charging* schemes (effectively carbon taxation) or even both. In fact the approach is highly dependent upon what your views are on market efficiency. A Wall Street Journal Survey in February 2007 found that 54 percent of economists favor a carbon tax over all other approaches finding it to be the most sector-neutral. One could argue that It doesn't favor or disfavor one part of the economy over another. We will begin by looking at *emissions charging schemes*.

## **Emissions charging schemes**

Most emissions charging schemes are essentially based on data on bunker fuel sold, given that the amount of CO<sub>2</sub> released into the air when say a ton of fuel is burned, can be determined. A problem with this approach is the inaccuracy associated with sales data. It is likely that ships may bunker off shore or in states that are not IMO members and thus attempt to evade the charge. Any ship wanting to call at a participating port would have to submit evidence in the interest of proving that an emissions charge has paid with the port state authorities. This charge may be rendered payable to the IMO, where a fund might also be set up to e.g. invest on new "clean" technologies.

A couple of variants to this type of charge are a “Design emission standard” and an “Operational emissions standard”. These may be used independently or in combination. A “Design emissions standard” would mean that classification societies would have to issue some kind of certificate, verifying that a particular vessel is built accord to such specifications that its emissions will not exceed an “expected” level, linked with the ship’s type and particulars. Of course this means that “standards” would have to be created for all sorts of ships, mainly based on data collected from vessels already in navigation. An added worry is that unfortunately the way a ship is operated greatly influences its emissions, making it likely for a design emission standard to allow for ships that are operated in an environmentally poor way to continue to sail due to their sufficiently eco-friendly original design. On the other hand, an “Operational emissions standard” would mean that shipowners may choose to operate their ships in such a way that emissions goals are met, regardless of the vessel’s design attributes, for instance by slow-steaming. In this case of course “real” emissions would have to be measured. This scheme resembles a “pure” charge one, only in this case shipowners will have to pay only for those emissions that exceed the standard. If however a ship is found to emit less than the standard, it may receive carbon credits which may consequently be sold to other shipowners or the open carbon market. The IMO CO<sub>2</sub> Index, if improved slightly, may be used to this end. It is also likely that *both* a design and an operational standard are jointly applied.

This kind of scheme is also characteristic of the type of measures considered in the MEPC 57, where quoting from the IMO website, the following was contemplated upon: “Short-term measures include a proposal to establish a global levy scheme on marine bunker fuel to achieve GHG emission reductions. Under this scheme, all ships engaged in international voyages would be subjected to a bunker levy established at a given cost level per ton of fuel bunkered. With such a scheme in place, a baseline of fuel used and CO<sub>2</sub> emissions would be obtained. The prospect of a global levy/credits scheme contributing to a GHG emissions reduction from ships was found promising, although it was noted that several aspects would need to be clarified and worked on...”

One final version of emission based charging reviewed here, is the differentiation of port dues with respect to emissions. The charges would be structured so that they would reward vessels with lower emissions by applying lower dues obligations, whereas they would impose higher dues on vessels with higher emissions. In general, port or harbour dues are set at the discretion of individual ports and are applied to ships that rely on the ports’ services, thus making such a scheme a rather painful prospect for ports wanting to attract traffic on the basis of an aggressive policy of undercutting

competitive ports' pricing policies. However, ports such as Rotterdam or Hamburg *have* implemented programmes of this sort whereby they reward environmental awareness and high standards in the form of reductions in port dues.

## **Emissions trading schemes**

Emissions trading schemes are all more or less based on the same concept. Some entity, be it a single ship or a shipping company (quite often one and the same thing anyway) is somehow allocated emission allowances, which it then proceeds to trade - if it so wishes - in a "market" or over the counter. At the end of a specified period, the entity in question has to surrender to the scheme's regulators a number of allowances equal to the emissions it was shown to responsible for. The idea behind this is simply that the "market" for emissions, if the "cap" (meaning the targeted sum for emissions and therefore the total number of allowances issued) is set at the right level, will put a price tag on them that will ensure the overall cost-effectiveness of compliance to the target.

Achieving this is nonetheless quite a complex task. Many parameters need to be fine-tuned to ensure that the overall effect will be the desired one. Let's examine the options available more closely:

First, the allocation of emissions before the inauguration of the trading period. One option is the so called "grandfathering" of emissions. This could involve the allocation of emissions by an authority, usually based on statistical data available for each type of vessel e.g. reports of the interim operational IMO CO<sub>2</sub> Index. However such "free" allocation of allowances can easily lead to market efficiency distortions (a disincentive to invest in new measures to reduce emissions). "Grandfathering" can also be considered practically equivalent to giving away free cash, since allowances may be traded so that profits are made. A more favoured solution is the auctioning of allowances. However, in case the auctioning income is kept by the marine sector (e.g. IMO), it must be handled and redistributed in a way that minimizes disincentives in the next round. It is of course quite likely that auctioning will face strong resistance from shipping companies as it will be thought to place a strain on their cost structure.

The next issue arising is whether the scheme will be "open" or "closed", meaning whether the shipping industry will be permitted to buy allowances from other sectors or sell allowances *to* other

sectors. Buying and selling are not at all the same thing. Shipowners could foreseeably be allowed to purchase emission allowances from other sectors, or via the CDM and JI mechanisms. This would even lead to a more cost-effective solution since more sectors face the same price on emissions. However, if shipowners were allowed to sell emission allowances, the Kyoto targets would be compromised for these allowances would be *additional* to the cap determined under the Protocol. A global climate policy treaty beyond 2012 may, however, fully include marine transportation, and may also allow trading for a wider group of countries than the present Kyoto Protocol. In this case there would be no restrictions on trading between the marine sector and other sectors.

Finally such a scheme would have to be administrated and, more importantly, enforced. A registry will be created with the task of keeping track of emissions, stock of allowances and trading to certify that the allowance obligation for each ship is fulfilled for the specified accounting period(s). Emission calculations can be based on fuel consumption. Consequently each ship owner must take care to comply with his emission cap and allowance obligation in the trading period. Bunkered fuel must be reported so that CO<sub>2</sub> emissions can be calculated. During each accounting period (usually lasting one year) a ship owner must keep account of emissions, the stock of allowances (as well as CDM and JI credits), and take steps to purchase if there is a deficit or sell if there is a surplus. In case of surplus, allowances can alternatively be saved and used for compliance in the next accounting period. After the accounting period is ended a ship owner must surrender allowances equivalent to emissions, under the surveillance of the operator of the trading system. If there is a deficit in number of allowances, the operator can claim a fee per ton of CO<sub>2</sub> to be paid by the ship owner, and the ship owner has to buy missing allowances and surrender these.

### **Combined “cap and charge” schemes**

This particular type of scheme was initially proposed to the IMO by Norway. It comprises three elements:

- I. A cap on total CO<sub>2</sub> emissions from international shipping, agreed by the IMO.
- II. A charge on CO<sub>2</sub> emissions.
- III. A fund is established under the IMO, to which the emission charge is paid to.



The idea is that the fund will be used to pay for R&D so as to reduce emissions, buy CO<sub>2</sub> credits in carbon markets (in case emissions exceed the cap) and contribute to climate change adaptation in developing countries through the UNFCCC.

## **Inclusion of shipping in the EU-ETS**

It is no secret that the EU has on many occasions threatened to take unilateral action on the issues of emissions trading for the maritime sector. The obvious route is the inclusion of shipping in the EU-ETS. There is some merit to this solution. The EU-ETS is an established system, with trading places already developed and a fair amount of experience acquired. However, the scheme is less than trouble free. Firstly, with its implementation being less than global, ships would have to be made liable for their emissions between two consecutive calls at participating ports, for a maximum period of say six months (so as to safeguard against the possibility of ships making short bunkering trips to a non-participating port and then returning to the EU). It has been suggested to use bunkering notes, which are mandatory for all ships above 400 GT, as proof of the amount of fuel bunkered and oblige the ship's master, acting on behalf of the shipowner or manager, to hand in allowances corresponding to the bunkering notes on board. A penalty would be due in case this condition fails to be met, possibly set at the same level as today's penalty for a ton of CO<sub>2</sub> under the EU-ETS (about 100 euros per ton in the second trading period).

Notwithstanding the EU's environmental commitments, legal issues may be raised. However, there are precedents to such actions, e.g. the EU ban on single hull tankers or the EU sulphur limit while at berth. It seems almost indisputable that although EU states may not act as Coastal State without violating UNCLOS, they may act as Port States. The states concerned can form an alliance on the principle of subsidiarity.

Many voices have been raised to avert the EU from going ahead with its plans. One cannot underestimate the value of a global solution, given the international nature of shipping. All in all, some coordination between the IMO and the Commission will have to take place if things are to be seriously expedited.

That said, complaints about the EU-ETS's effectiveness cannot be overstated. In spite of the high expectations, after more than two years of operation, the EU's carbon trading market is at a crossroads. Initially, allowances to emit CO<sub>2</sub> traded for around 10 euros per ton. A year later, the

price for allowances had risen to 30 euros per ton. At that price the market was being widely hailed as a success, as higher prices would be an incentive for companies to work seriously at cutting their emissions. Then, in May 2006, an audit showed that several EU governments had issued permits for 66 million tons more CO<sub>2</sub> than was actually being emitted. Everyone realized that the supply of permits was not scarce, so the price of carbon promptly collapsed to less than 9 euros per ton. By February 2007, an allowance to emit a ton of CO<sub>2</sub> could be had for less than a euro. The market has since recovered, with an AAU nowadays trading for something in the order of 22 to 23 euros per ton. Of course, one would need to admit that these problems are hardly unique to the ECX of any other exchange devoted to carbon trading. After all, carbon trading is hardly a mature market and it may very well conduct itself quite a bit more rationally in the near future. The establishment of the link between CDM generated CERs and the EU-ETS AAUs, already mentioned in a previous chapter of this document is due in December 2008. One could only speculate as to how the market will react and some turbulence is to be expected. However, this development might mean that a global “EU-ETS type” scheme regarding shipping and administered by the IMO can be considered less of a longshot than before.

Make no mistake about it though, aviation is certainly closer to being included in such a scheme and much needed experience will be accumulated in the process. This is subject to the provisions under which the inclusion will take place, since there will be no surprises if the sector is only allowed to buy and to sell emissions to others or if the cap is placed at a very “relaxed” level.

### **Slow boat to China and other possibilities**

It is not uncommon these days to encounter people holding key positions in the shipping industry, such as DNV’s Chief Operating Officer Tor Svensen, stating that slow-steaming could provide plenty of solutions when it comes to GHGs emissions reductions, with a 20% speed reduction resulting in a 40% cut back on emissions according to his estimates. Although not a policy instrument per se, slow steaming has proved increasingly popular, especially among liner operators, whose enormous box-ships have been accused of emitting more tonnes of CO<sub>2</sub> per tonne-km than any other vessel. China Ocean Shipping (Group) Company (COSCO) last week became one of the latest major fleet operators to say it was reducing the cruising speed of its ships. It said it was planing to cut its vessels' cruising speed by 10%, after a slow-steaming pilot scheme launched at the start of the year yielded “impressive” results. Any of these alleged reductions have yet to be proven

in a consistent and scientific manner and while faster ships certainly do emit more GHGs than slower ones, the arguments made claiming huge reductions may not be entirely plausible.

Another type of service widely available today and aimed towards fuel economy, implying emissions reductions is weather routing. Weather routing consists in providing a ship's master with real-time data concerning weather conditions as well as currents and waves information, allowing him to tailor his vessel's course to the circumstances. This should result in reduced fuel consumption as taxing weather conditions and bad sea states may be avoided. In practice more than 50% of the vessels utilizing this kind of service have seen significant reductions in MFO consumption in addition with savings in total trip duration.

## **The industry's own thoughts - a brief survey**

In order to closely follow the industry's sentiment as closely as possible on the issues discussed in this thesis, a survey was carried out using an online questionnaire set up at this url: [http://www.surveymonkey.com/s.aspx?sm=6ALb4rwleLdE\\_2fda2qED7yA\\_3d\\_3d](http://www.surveymonkey.com/s.aspx?sm=6ALb4rwleLdE_2fda2qED7yA_3d_3d)

### **Methodology**

One hundred e-mails were sent out to shipping companies, asking them to take a few moments and complete the questionnaire. These companies come from all segments of the industry. A little less than half of them are public companies, with their shares trading in the NYSE, NASDAQ or another major stock market. The e-mails were sent out to companies using their generic e-mail address and without any previous consultation. The questionnaire itself was structured so as to provide us with information around four basic pillars:

- I. General Information on company operations
- II. Environmental and regulatory awareness
- III. Views on proposed policies
- IV. Company practices

This would theoretically give us some insight on what is the profile of the companies that demonstrate the highest levels of environmental awareness and also provide clues as to whether

individual companies have started to actively participate in the discussions concerning emissions reductions, making them a part of their agenda.

## **The questionnaire**

Here we shall present the questionnaire used in detail and describe briefly the logic behind each question:

### ***Page 1 - General Information on company operations***

1. ***What type of business is your company into ? (so that we can determine which industry sector is more involved in the debate)***
  - a. Bulk (Dry)
  - b. Bulk (Wet)
  - c. Containers
  - d. General Cargo
  - e. Passenger transportation
  - f. Short Sea Shipping
  - g. Coastal Shipping
  - h. Other (please specify)
2. ***How many vessels does your company own or manage ? (will help to discern between the stance of small vs large companies)***
3. ***What is the average age of your company's fleet ? (will show whether companies managing older vessels are more likely to be negative towards environmental commitments)***
  - a. 1 to 5 years
  - b. 5 to 10 years
  - c. 10 to 15 years
  - d. more than 15 years
4. ***What is the average DWT-weighted age of your fleet ? (we ask this so as not to do injustice to companies managing many small but old vessels in conjunction with a few large new ones, in which case most of the tonnage is relatively new...)***
  - a. 1 to 5 years
  - b. 2 to 10 years
  - c. 10 to 15 years

- d. more than 15 years

**Page 2 - Environmental and regulatory awareness**

1. ***How would you describe your level of awareness regarding the following ? (meant to evaluate the general level of awareness where the environment is concerned)***
  - a. Global Warming
    - i. I am very much aware
    - ii. I know a few things
    - iii. Very basic, don't know much about it
    - iv. Never heard of it
  - b. Greenhouse Gases (same answer options as 1.a.)
  - c. Kyoto Protocol (same answer options as 1.a.)
2. ***Shipping is considered to be responsible for about 2% to 4% of the global CO2 emissions and about 20% of the total emissions coming from the Transport Sector. Are you aware of the regulatory framework concerning air emissions from ships ? (in order to assess whether there exists and in-house knowledge base on regulatory issues)***
  - a. I know it in great detail
  - b. I know it exists but I don't know much about it
  - c. I don't have clue
3. ***Which of these bodies you think should be involved in policy making concerning air emissions from ships ? (Here we aim to evaluate the company's attitude towards international bodies, mainly looking for any signs of pro-IMO & against-EU corporate culture)***
  - a. International Maritime Organization (IMO)
  - b. European Union (EU)
  - c. United Nations Conference on Climate Change (UNFCCC)
  - d. Each State on its own
  - e. No one
  - f. Other (please specify)
4. ***Are you satisfied with the regulatory progress made on air emissions from ships by the IMO and the EU ? (complementing the previous question)***
  - a. IMO
    - i. Very much
    - ii. Moderately so
    - iii. Not so much

- iv. Not at all
  - b. EU (same answer options as 4.a.)
5. ***In June, a newly formed IMO working group entitled "Working Group on Greenhouse Gas Emissions from Ships" met in Oslo. Are you aware of what they agreed concerning the following issues ? (An important question as it demonstrates whether anyone within the company is actually following the international developments on the issues at hand)***
- a. NOx emissions
  - b. SOx emissions
  - c. CO2 emissions
  - d. CO2 operational index
  - e. CO2 design index
  - f. Bunker fuel levy
  - g. Emissions trading schemes
6. ***Has your company ever used the interim IMO CO2 index ? (More or less a "sanity check" as companies closely following events would normally be expected to have at least attempted to calculate the index voluntarily)***
- a. Yes
  - b. No
  - c. Not applicable because (please explain)
7. ***Are you familiar with emissions trading schemes ? (This attempts to introduce the concept of ETS early on in the survey and at the same time provide some insights on whether EU policies are discussed in the company)***
- a. Yes
  - b. Moderately so
  - c. What's that ?

***Page 3 - Views on proposed policies***

1. ***Please rate each of the following on its merit as a policy instrument for the reduction of air emissions from ships: (This will normally only be answered by an informed executive who has developed a more or less clear attitude towards the proposed policies)***
- a. Bunker fuel levy
    - i. Ineffective
    - ii. Would help

- iii. Should prove adequate
  - iv. A good solution
  - v. The optimum choice
  - vi. N/A
- b. Some kind of emissions trading scheme (same answer options as 1.a.)
  - c. Direct charge on emissions (same answer options as 1.a.)
  - d. Slow steaming (voluntary) (same answer options as 1.a.)
  - e. Switch to MDO even outside berths (same answer options as 1.a.)
  - f. Other (please specify) (same answer options as 1.a.)
2. ***The European Union has recently stated that it is considering the inclusion of shipping in the EU-ETS, its emissions trading scheme which has been in operation since 2005. Do you feel that this would be a step in the right direction ?(A question targeted at those who understand the ETS, at least in rough terms, and feel strongly either in favor of its implementation or against it.)***
- a. Yes, definitely a step in the right direction !
  - b. The idea is fine but it need to be global, the IMO must manage this
  - c. I strongly disagree with any emissions trading scheme
3. ***If shipping was indeed included in the EU-ETS how much do you feel the following would be affected ? (Wants to identify the main worries behind the inclusion of the maritime industry in the ETS)***
- a. Competition (among shipping companies)
    - i. Very much
    - ii. Moderately
    - iii. Not much
    - iv. Not at all
  - b. Competition (between shipping and other transport modes) (same answer options as 3.a.)
  - c. Cost of operation (same answer options as 3.a.)
  - d. Industry growth (same answer options as 3.a.)
4. ***What would be the effect on the previous items ? (This question follows suit with the previous one)***
- a. Competition (among shipping companies)
    - i. Positive
    - ii. Negative

- b. Competition (between shipping and other transport modes) (same answer options as 4.a.)
  - c. Cost of operation (same answer options as 4.a.)
  - d. Industry growth (same answer options as 4.a.)
5. ***Are shipping companies ready to adapt to a "green" economy ? (Posing now the question in a more generic way, so as to extract some kind of answer in case the previous questions were left untouched for want of willingness of ability to answer)***
- a. Yes
  - b. Moderately
  - c. No
6. ***Do you believe that your company could profit from carbon trading or generally acquire a competitive advantage after more stringent regulations have been put in place regarding air emissions from ships ? (Attempts to diagnose any positive sentiments on the issue and plant a seed within the person surveyed in the direction of the existence of business opportunities in the ETS and carbon trading in general)***
- a. Yes, sure !
  - b. Maybe
  - c. Not really
  - d. No way !

***Page 4 - Company practices***

1. ***Does your company have a clear and outlined environmental policy or taken any commitments in this direction ? (Returns to a more general discussion and particularly to a line of questions designed to detect any internal processes which have been initiated concerning the environment)***
- a. Yes
  - b. Not, but we plan to
  - c. No, it is not yet within our scope
2. ***Who do you turn to when you need information or advice regarding environmental issues and more specifically air emissions ? (Mainly to evaluate the image of different organizations among shipping executives)***
- a. Universities
  - b. Consulting groups
  - c. Organizations such as BIMCO, INTERTANKO etc.
  - d. Classification societies



e. Other (please specify)

3. *All things considered do you feel you are doing all that you can to minimize your environmental impact - carbon footprint ? (A concluding question, aimed at recapping the spirit of the whole survey)*

- a. Yes
- b. Moderately
- c. No

### Results analysis

We will now proceed to summarise the results obtained in some of the key questions posed.

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping		
What is the average age of your company's fleet ?		
Answer Options	Response Percent	Response Count
1 to 5 years	11.1%	1
5 to 10 years	33.3%	3
10 to 15 years	22.2%	2
More than 15 years	33.3%	3
answered question		9
skipped question		1

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping		
What is the average DWT - weighted age of your fleet ?		
Note: DWT - average age = $\Sigma$ (each vessel's DWT x its age) / Total Fleet DWT		
Answer Options	Response Percent	Response Count
1 to 5 years	0.0%	0
5 to 10 years	50.0%	4
10 to 15 years	12.5%	1
More than 15 years	37.5%	3
answered question		8
skipped question		2

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**How would you describe your level of awareness regarding the following ?**

Answer Options	I am very much aware	I know a few things	Very basic, don't know much about it	Never heard of it	Response Count
Global Warming	4	1	1	0	6
Greenhouse Gases	1	2	0	0	3
Kyoto Protocol	3	2	2	0	7
<b>answered question</b>					<b>9</b>
<b>skipped question</b>					<b>1</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**Shipping is considered to be responsible for about 2% to 4% of the global CO2 emissions and about 20% of the total emissions coming from the Transport Sector. Are you aware of the regulatory framework concerning air emissions from ships ?**

Answer Options	Response Percent	Response Count
Yes, I know it in great detail	50.0%	4
I know it exists but I don't know much about it	37.5%	3
I don't have a clue	12.5%	1
<b>answered question</b>		<b>8</b>
<b>skipped question</b>		<b>2</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**Which of these bodies you think should be involved in policy making concerning air emissions from ships ?**

Answer Options	Response Percent	Response Count
International Maritime Organization (IMO)	100.0%	8
European Union (EU)	50.0%	4
United Nations Conference on Climate Change (UNFCCC)	62.5%	5
Each State on its own	25.0%	2
No one	0.0%	0
Other (please specify)	0.0%	0
<b>answered question</b>		<b>8</b>
<b>skipped question</b>		<b>2</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**Are you satisfied with the regulatory progress made on air emissions from ships by the IMO and the EU ?**

Answer Options	Very much	Moderately so	Not so much	Not at all	Response Count
IMO	2	4	1	0	7
EU	1	2	3	0	6
<b>answered question</b>					<b>7</b>
<b>skipped question</b>					<b>3</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**In June, a newly formed IMO working group entitled "Working Group on Greenhouse Gas Emissions from Ships" met in Oslo. Are you aware of what they agreed concerning the following issues ?**

Answer Options	Yes	No	Response Count
NOx emissions	3	4	7
SOx emissions	3	4	7
CO2 emissions	2	5	7
CO2 operational index	2	5	7
CO2 design index	1	5	6
Bunker fuel levy	2	4	6
Emissions trading schemes	1	5	6
<b>answered question</b>			<b>7</b>
<b>skipped question</b>			<b>3</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**Has your company ever used the interim IMO CO2 index ?**

Answer Options	Response Percent	Response Count
Yes	16.7%	1
No	83.3%	5
Not applicable because:	0.0%	0
<b>answered question</b>		<b>6</b>
<b>skipped question</b>		<b>4</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping		
Are you familiar with Emissions Trading Schemes ?		
Answer Options	Response Percent	Response Count
Yes	42.9%	3
Moderately so	28.6%	2
What's that ?	28.6%	2
answered question		7
skipped question		3

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping								
Please rate each of the following on its merit as a policy instrument for the reduction of air emissions from ships:								
Answer Options	Ineffective	Would help	Should prove adequate	A good solution	The optimum choice	N/A	Rating Average	Response Count
Bunker fuel levy	3	1	0	1	0	0	1.8	5
Some kind of an Emissions Trading Scheme	3	1	1	1	0	0	2	6
Direct charge on emissions	3	2	1	0	0	0	1.66667	6
Slow steaming (voluntary)	2	2	1	1	0	0	2.16667	6
Switch to MDO even outside berths	1	3	0	0	1	1	2.4	6
Other (please specify)								1
answered question								6
skipped question								4

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping		
The European Union has recently stated that it is considering the inclusion of shipping in the EU-ETS, its emissions trading scheme which has been in operation since 2005. Do you feel that this would be a step in the right direction ?		
Answer Options	Response Percent	Response Count
Yes, definitely a step in the right direction !	0.0%	0
The idea is fine but it needs to be global, the IMO must manage this	66.7%	4
I strongly disagree with any emissions trading scheme.	33.3%	2
answered question		6
skipped question		4

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**If shipping was indeed included in the EU-ETS how much do you feel the following would be affected ?**

Answer Options	Very much	Moderately	Not much	Not at all	Response Count
Competition (among shipping companies)	1	3	2	0	6
Competition (between shipping and other transport modes)	0	4	2	0	6
Cost of operation	1	5	0	0	6
Industry growth	0	2	2	2	6
<b>answered question</b>					<b>6</b>
<b>skipped question</b>					<b>4</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**What would be the effect on the previous items ?**

Answer Options	Positive	Negative	Response Count
Competition (among shipping companies)	2	4	6
Competitions (between shipping and other transport modes)	2	4	6
Cost of operation	0	6	6
Industry growth	0	6	6
<b>answered question</b>			<b>6</b>
<b>skipped question</b>			<b>4</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping

**Are shipping companies ready to adapt to a green economy ?**

Answer Options	Response Percent	Response Count
Yes	50.0%	3
Moderately	33.3%	2
No	16.7%	1
<b>answered question</b>		<b>6</b>
<b>skipped question</b>		<b>4</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping		
<b>Does your company have a clear and outlined environmental policy or taken any commitments in this direction ?</b>		
Answer Options	Response Percent	Response Count
Yes	85.7%	6
No, but we plan to	14.3%	1
No, it is not yet within our scope	0.0%	0
<b>answered question</b>		<b>7</b>
<b>skipped question</b>		<b>3</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping		
<b>Who do you turn to when you need information or advice regarding environmental issues and more specifically air emissions ?</b>		
Answer Options	Response Percent	Response Count
Universities	0.0%	0
Consulting Groups	0.0%	0
Organizations such as BIMCO, INTERTANKO etc...	71.4%	5
Classification Societies	71.4%	5
Other (please specify)	28.6%	2
<b>answered question</b>		<b>7</b>
<b>skipped question</b>		<b>3</b>

Department of Maritime Studies - Survey on the Reduction of Greenhouse Gas Emissions from Shipping		
<b>All things considered do you feel you are doing all that you can to minimize your environmental impact - carbon footprint ?</b>		
Answer Options	Response Percent	Response Count
Yes	57.1%	4
Moderately	28.6%	2
No	14.3%	1
<b>answered question</b>		<b>7</b>
<b>skipped question</b>		<b>3</b>

One cannot escape a few conclusions at this point. Firstly the response rate (equalling 10%...) was at best disappointing. Despite the fact that many reminder e-mails were sent, no more than 10 answers were obtained, some of which were not complete, much less thorough. This in itself indicates that the environmental issues are hardly a top a priority concern among shipping companies. The explanation may lie in the fact that ship managers have over the years acquired a taste for doing business in the most cost-effective way and are highly reluctant to sacrifice resources when it comes to complying to non-obligatory measures. It is also evident that emissions trading

schemes are not exactly popular in the industry, nor are the relevant EU policies. Slow steaming or switching to MDO fuel even outside berths are seen as much more effective. All in all, it is interesting to see that the industry seems to believe that although there is room for improvement, much is being done to minimise the environmental implications of its activities.

## **Conclusions - Recommendations for future work**

The aim of this thesis has largely been to illustrate the state of affairs regarding air emissions from ships and their abatement. The 58th MEPC session, due to take place early in October, is expected to act as a springboard for further developments. The online survey attempted has proved that even listed companies, managing fleets whose value amounts to several billion dollars, have not yet put in place any internal mechanisms to closely monitor the developments regarding the environment and their line of business, much less act upon them. To summarise:

1. The ETS or other emissions trading schemes are highly regarded of in the EU and are beginning to look favourable from the IMO's point of view as well. However, the industry is extremely reluctant to uphold any such scheme.
2. Slow steaming is popular within the industry and the classification societies. Not so much with the EU.
3. A bunker fuel levy is not regarded as a particularly easy scheme to administer and does not seem very likely to be implemented in the short-term.
4. In general, the view within the industry is that although the outside pressure may increase, stringent environmental regulations concerning air emissions are not in the orderbook just yet.
5. Most seafaring nations will push for a global solution and are not at all prone to accept an EU-based set of measures.

Future work on the subject might go in two directions:

1. Perform a much more thorough survey via personal interviews, so as to extract a larger number of responses. Consequently, try to identify the trends in different market segments, such as dry bulk, wet bulk, etc.
2. Develop an eco-friendly business strategy for shipping companies, which might for example include investments in CO2 derivatives, and will largely be aimed at preparing them for a "green" economy.

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