Discussion Paper No. 12-044

# Capped Steam Ahead

## A Case Study Among Ship Operators on a Maritime ETS

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and Jonathan Köhler

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# Executive Summary

In 2007, international shipping emitted 870 million tons of $CO_2$, which represents about 2.7 percent of worldwide $CO_2$ emissions and it is expected that the emissions from ships will continue to increase significantly in the near future. Against this background, the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) is currently discussing different approaches aiming at reducing emissions in the maritime sector, in particular market-based mechanisms such as a levy on bunker fuel or a maritime emission trading scheme (ETS).

In this paper, we assess potential implications of a maritime ETS on the organisation and operations of shipping companies, primarily by means of a case study involving ship operators. On the basis of our results, we discuss whether and how a maritime ETS needs to make special provisions to account for frequently raised criticisms in the context of cap-and-trade, for example high transaction costs and issues associated to a fixed cap on emissions such as high price volatility and excessive costs in times of unexpected high demand for shipping services.

Our results suggest that any additional costs for monitoring and reporting of emissions are expected to play only a minor role in the context of a maritime ETS, since for business reasons ship operators already undertake comprehensive monitoring and reporting efforts for bunker fuel usage. With regard to the costs for potential trading activities, it is to be expected that compared to other operational costs, the additional expenditures will be rather small. The issues associated to a fixed cap cannot be ruled out as easily and are also identified by the interviewed experts as potentially significant problems. However, such difficulties may be alleviated by adequate linking and/or banking provisions.

Overall, there appears to be no knock-out criterion why a cap-and-trade approach should not work in the shipping sector in practice. In fact, a maritime ETS has the potential to engage the maritime sector into cost-efficient emission reduction if designed to account for the special characteristics of the international shipping industry.

# Das Wichtigste in Kürze

Im Jahr 2007 hat der internationale Seeverkehr 870 Millionen Tonnen $CO_2$ emittiert, und es wird erwartet, dass die Emissionen von Schiffen in Zukunft signifikant steigen werden. Im Rahmen des „Marine Environment Protection Committee“ (MEPC) der Internationalen Seeschifffahrts-Organisation (IMO) werden daher verschiedene Instrumente diskutiert, mit denen die $CO_2$-Emissionen der internationalen Schifffahrt begrenzt werden sollen, unter anderem marktbasierte Instrumente.

Auf Grundlage einer Fallstudie unter Schiffsbetreibern untersuchen wir in diesem Papier potentielle Auswirkungen eines weltweiten maritimen Emissionshandelssystems (ETS) auf Betrieb und Organisation Schifffahrt treibender Unternehmen. Aufbauend auf den Erkenntnissen der Fallstudie diskutieren wir welche Rolle bestimmte Probleme, die mit einem ETS gern in Verbindung gebracht werden (z.B. hohe Transaktionskosten), im maritimen Sektor spielen können und wie man diese durch eine geeignete Ausgestaltung des ETS vermeiden kann.

Unsere Ergebnisse legen nahe, dass die zusätzlichen Kosten, die für die Überwachung und Berichterstattung der Emissionen in einem maritimen ETS zu erwarten sind, eher gering ausfallen werden, da Schiffsbetreiber bereits jetzt, aus betriebswirtschaftlichen Gründen viele der benötigten Daten erfassen. Auch im Hinblick auf die Kosten für eventuelle Handelsaktivitäten ist zu erwarten, dass verglichen mit anderen operativen Kosten, wie zum Bespiel die Aufwendungen für Treibstoff und der damit verbundenen Finanzdienstleistungen, die zusätzlichen Ausgaben eher gering sein werden. Schwierigkeiten die im Zusammenhang mit einer absoluten Mengenbegrenzung der Emissionen in Verbindung gebracht werden, zum Beispiel eine hohe Volatilität der Zertifikatepreise oder unverhältnismäßig hohe Kosten in Zeiten einer unerwartet starken Nachfrage nach maritimen Transportleistungen, lassen sich nicht direkt von der Hand weisen. Allerdings könnten diese Probleme durch eine Verknüpfung des maritimen ETS mit anderen ETS und/oder der Möglichkeit Zertifikate anzusparen gelindert werden.

Alles in allem scheint es kein K.O.-Kriterium dafür zu geben, dass ein maritimes ETS in der Praxis nicht funktionieren sollte. Vielmehr deuten unsere Resultate daraufhin, dass ein maritimes ETS für kosteneffiziente $CO_2$-Emissionsvermeidung im internationalen Seeverkehr sorgen kann, sofern die Besonderheiten dieses Sektors bei der Ausgestaltung des maritimen ETS berücksichtigt werden.

# Capped Steam Ahead

## A case study among ship operators on a maritime ETS

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**Abstract**

International shipping is an important emitter of greenhouse gases. The International Maritime Organization (IMO) is discussing different approaches to reduce maritime $CO_2$ emissions, in particular market-based mechanisms. In this paper, we assess potential implications of a maritime emission trading scheme (ETS) on the organisation and operations of shipping companies, primarily on the basis of a case study involving ship operators. Our results suggest that there is no knock-out criterion why a cap-and-trade approach should not work in the shipping sector in practice. A maritime ETS has the potential to engage this sector into cost-efficient emission reduction if designed to account for the special characteristics of the international shipping industry.

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# 1 Introduction

In 2007, international shipping emitted 870 million tons of $CO_2$, which represents about 2.7 percent of worldwide $CO_2$ emissions (IMO, 2009a). The overall development of $CO_2$ emissions of different transport modes are illustrated in Figure 1 and Figure 2. Moreover, it is expected that the emissions from ships will continue to increase significantly in the near future (IMO, 2009a). In the context of general international climate negotiations, international shipping is generally excluded from the discussions at UNFCCC and the Kyoto Protocol does not include international shipping in the national inventories but points to the International Maritime Organization (IMO) to find solutions to reduce $CO_2$ in this sector (UNFCCC, 1998).

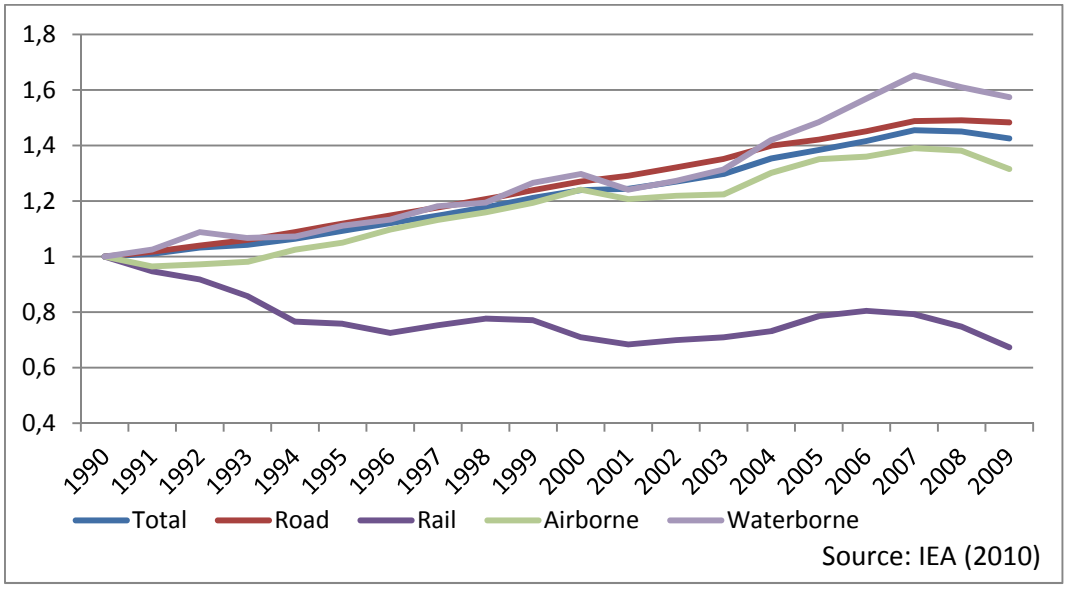


Figure 1: Change of Transport $CO_2$ Emissions (Index = 1990)

In its second greenhouse gas study the IMO acknowledges the role the maritime industry plays in combating climate change (IMO, 2009a) and the current debate on how global shipping emissions can be reduced mainly takes place at the Marine Environment Protection Committee (MEPC), one of the committees. As a first result of the discussion, MEPC adopted the Energy Efficiency Design Index (EEDI) in 2011 which requires new build ships to comply with a minimum energy efficiency level per capacity mile (IMO, 2011d). However, given the demand for significant emission reductions in the sector, the search for a suitable instrument at IMO continues and, among other proposals, MEPC is considering the implementation of market based mechanisms (MBM) such a levy on bunker fuel or a worldwide maritime emission trading scheme (maritime ETS) to incentives the abatement of maritime $CO_2$ emissions. While pricing carbon by means of a levy, tax or within cap-and-trade scheme has become a

standard tool of modern climate policy and is acknowledged by economists as an effective and cost-efficient instrument to fight the global increase of greenhouse gasses (GHG) (e.g. Stavins, 2003), implementing an MBM would be a novelty for IMO. In the past IMO has resorted mainly to technical and operational standards or regulations to tackle environmental issues. But in the context of global cumulative pollutants such as $CO_2$ emissions and in the face of a broad set of emission abatement options involving different costs, as they are present in the international shipping industry in form of different technical and operational measures, MBMs seem particularly suitable.

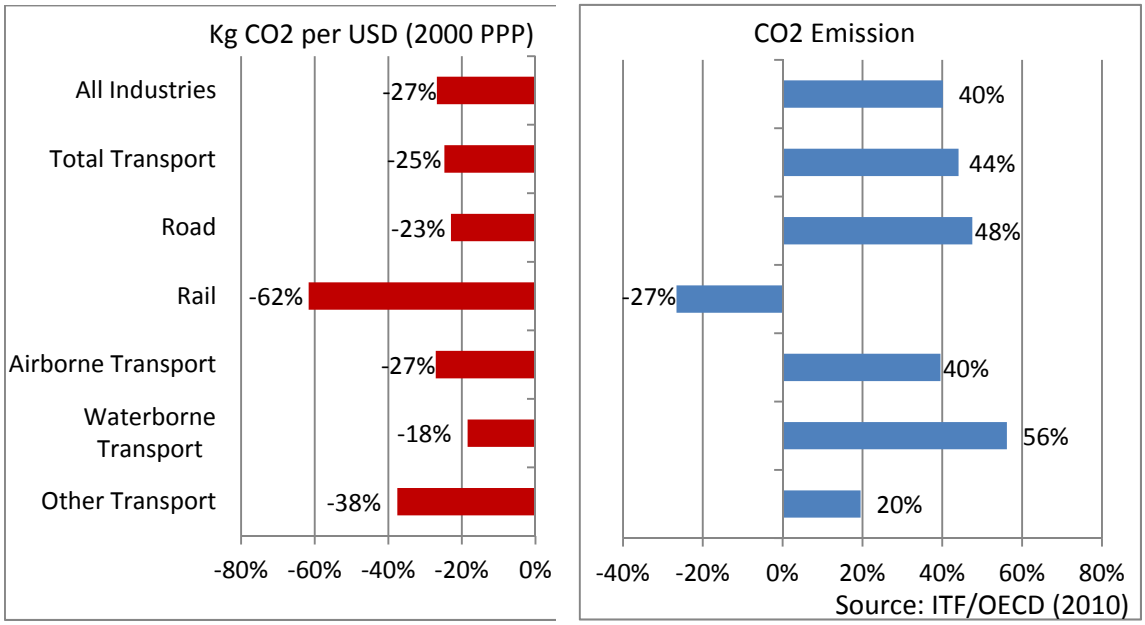


Figure 2: Emission Change 1995-2008

Against this background, we investigate the potential effects of a possible future maritime $CO_2$ emission regulation in the form of an MBM, in particular a maritime ETS – although most insights apply also to other MBMs establishing a financial incentive for $CO_2$ abatement. Given the fictional character of our object of study – after all, up to now no MBM targeting maritime $CO_2$ emissions has been implemented yet – we build on a proposal for a maritime ETS presented by Norway (IMO, 2010c). The Norwegian submission is to date one of the most detailed proposals for a worldwide maritime ETS in discussion at MEPC and can be seen as a good starting point for a future system. In this paper, however, we deviate from the Norwegian proposal in some areas in order study some design elements originally not envisaged in the original submission such as a limited scope of the ETS or alternative reporting schemes. Our analysis is based on a case study and relies on a series of interviews with experts that are active in a variety of different segments within the international shipping sector. We focus primarily on the implications on operations and organisations of international shipping companies.

More specifically, we discuss general design issues of a possible future regulation; the supply of allowances and use of revenues in a maritime ETS; monitoring, verification and reporting issues implied by a maritime ETS; and aspects of carbon management and mitigation. But, while the shipping operators' viewpoint with respect to a future maritime emission regulation is without doubt crucial, there are also other aspects that need to be taken into account in order to be able to establish a well-functioning scheme, including, inter alia, broader economic effects and the overall environmental effectiveness of the system. For this reason, whenever appropriate, we take a more global perspective and evaluate vital design elements not just from a ship operator's standpoint but also from an economic and behavioural point of view.

So far, potential implications of MBMs aiming at a reduction of maritime emissions have been mainly assessed from a macroeconomic and general sectoral perspective. CE Delft (2010) for instance discuss the consequences of a maritime ETS and primarily studies overall economic effects for the shipping sector and different regions in the world. Bäuerle et al. (2010) in turn investigate the macroeconomic effects of an inclusion of shipping in the European Emission Trading Scheme (EU ETS). A comprehensive analysis of the MBMs currently discussed at IMO is also undertaken by Miola et al. (2011). Furthermore – at least to our knowledge – the literature on the topic consists predominantly of rather theoretical discussions of individual design elements of MBMs and does not address the implications of such a regulation on individual stakeholders. With this paper we contribute to the discussion by not only assessing issues of a maritime ETS from a pure economic perspective but by complementing this with insights from the operators in the sector.

The remainder of our paper is structured as follows. First we explain the methodology employed in the case study. Next we present the insights from the case study. Subsequently we discuss if issues often associated to a cap-and-trade approach arise also in the context of a maritime ETS and outline how they can be addressed. We conclude with a brief summary.

# 2 Methodology

The empirical work within this paper is based on a case study among ship operators. Our data has been collected by means of semi-standardised expert interviews (Gläser and Laudel, 2009; Meuser and Nagel, 2005; Mayring, 2002). If appropriate, we complemented the different sections of the basic questionnaire with a brief introduction concerning the related design elements of a future maritime emission regulation. Hence, it was ensured that the interviewees understand the main design elements of such a system and are familiar with the market-based approach.

Prior to the actual interviews, a list of about 150 shipping companies from all around the world performing a wide variety of different maritime activities was compiled in order to identify potential experts for the case study. Subsequently potential interview partners were contacted via email and eventually via phone in order to determine their willingness to participate in the face-to-face interviews. As the relevant know-how is often spread over different experts within one company, where appropriate and possible, all persons most likely to be in charge with the mentioned issues of a future maritime ETS were included in the questioning. The average duration of the interviews was one and a half hours. To increase the shipping operators' willingness to participate and to allow for detailed insights into their organisation and operations, we assured that the actual interview scripts, personal information of the interviewees and company names are not published.

Overall, we conducted five in-depth interviews and one company provided a written statement instead of taking part in an interview. Four interviews were conducted face-to-face on-site and one via telephone. Our case study covers a wide range of different shipping activities. The six participating companies are engaged in multi-modal transport, tankers, cruise shipping, container carriers, bulk shipping, project based transportation and offshore activities. The sample is also diverse with respect to the size of the fleet of the participating ship operators, the smallest having a fleet of about 10 vessels and the biggest operating more than several hundred ships. All companies operate worldwide and have their headquarters in Europe, North America or East Asia. The interviewed experts themselves work mainly in departments responsible for corporate strategy, policy assessment or environmental projects. Of course, the results presented in the following hold first and foremost for the participating ship operators, and only give an indication of the effects that can generally be expected.

# 3 Insights from the Case Study

## 3.1 General Design Issues of a Possible Regulation

### Relevancy of Reducing Maritime Emissions

The success of any approach regulating emissions depends crucially on the entities acceptance of the new regulation and their willingness to actively participate and contribute to the overall objective of the system. Therefore reducing shipping emissions must be seen as a relevant issue by ship operators in order to allow a scheme to be truly fruitful.

All of the questioned ship operators acknowledge that reducing maritime emissions is a highly relevant and necessary task for the industry. That this issue is taken seriously can also be seen from the fact, that almost all of the interviewed operators have

already implemented some form of emission reduction targets on a voluntary basis or for example within their freely chosen commitments for ISO 14001[4]. This proactive action demonstrates also that the discussion of MBMs at MEPC itself has so far only a marginal influence on the operations of shipping companies and a part of the surveyed operators see themselves as acting in advance of any regulation MEPC is likely to decide on in the near future. This statement mainly arises from the general doubt that MEPC will succeed in deciding upon a binding emission reduction scheme in the next few years.

### Information Basis and Involvement

The identification and evaluation of possible implications of a maritime emission regulation for the shipping industry requires from the stakeholders a certain degree of knowledge and information on the discussion at MEPC and the regulation it is seeking to develop. As know-how and information often comes along with involvement, the operators were additionally asked whether they were involved in the process at MEPC or not.

Most of the interviewed operators are following the discussion at MEPC attentively and consider themselves involved in the process. Their involvement consists primarily in providing background information and consultation on actual effects of a possible regulation and takes place mainly through industry associations or lobbying groups. But before the industry can truly grasp and assess the consequences of regulating emissions, the different proposals to MEPC need to become far more tangible. Moreover, from an industry perspective it appears that there needs to be more reliable information on the different approaches to regulating emissions. To that effect, the operators fear that probably most of the industry has not yet understood the implications of the different methods and hence cannot truly asses their implications. In this context two interviewees explicitly demand more information from the IMO on the issue, but in this regard also see industry groups not carrying out their duty to supply information sufficiently.

### General Attitude towards the Different Market Based Instruments

In order to truly understand the responses and eventually also the motivation underlying the answers, before going into the details of a maritime ETS, the shipping

[4] Organisations certified by ISO 14001 are required to have an environmental management system in place and to target negative environmental effects arising from their business (see e.g. http://www.iso.org/iso/iso_14000_essentials for further information).

operators were asked about their general attitude towards the different market based methods.

With respect to emission reductions, there is a general openness towards market-based instruments. However, again, according to the shipping operators it is very difficult to have an opinion on this issue as long as the different proposals of MBMs at MEPC remain as vague as they currently are. As a result, only two of the questioned operators favour a particular approach, one being a worldwide maritime ETS (e.g., IMO, 2010c, 2009b and 2009c), the other a leveraged incentive scheme (IMO, 2010g) based on efficiency improvements. The rest remains open with regard to the specific instrument, only noting that in theory all approaches seem to work and the industry will live up to the new regulation as long as the approach is made sufficiently clear to all involved stakeholders. But in the eyes of the interviewees, the important question is, whether the instrument chosen by MEPC successfully establishes incentives to actually reduce shipping emissions.

### Cost-Pass-Through and Demand for Climate-friendly Services

For the operator concerned, or any other body designated to be liable for emissions from ships, one of the central aspects of any environmental regulation is if the additional costs caused from the regulation can be passed on, or whether the operator itself has to bear the costs of mitigation. This is independent of the chosen regulative approach, but depends mainly on the structure of the market the operator is engaged in. Generally speaking, the higher the price elasticity of demand, the smaller the share of additional costs that can be passed on. However, the shipping industry consists of a set of very different activities and hence various different markets, all having their own structure. As a consequence the ability to pass additional costs to the consumer varies considerably across the maritime industry. Thus the insights from this case study also vary depending upon the market segment in which the participating operators are active and the findings in this respect are limited to the core business of the interview partners.[5]

The shipping operator active in the consumer discretionary sector on the basis of a business-to-consumer-direct relationship states that passing on additional costs is very difficult in their market segment. Although consumers are aware of whether a company operates in an environmentally friendly way or not, this has only a marginal

[5] A theoretical investigation of the ability of cost-pass-through in a maritime ETS is also provided by CE Delft (2010). See Alexeeva-Talebi (2011) or Korinek and Sourdin (2010), for a more general discussion on the issue, including an empirical assessment of cost-pass-through in the EU ETS.

effect on demand. So far, consumers in this sector are not willing to pay extra for environmental activities and price is the decisive factor in choice of shipping service supply.

The interviewees from within the project based transportation, container and bulk cargo segment are of the opinion that in the long run, all additional costs will be passed on completely, in particular if the regulation is at a global scale. The tanker operator was not sure to which extent additional cost can be passed on, but assessed that they probably will be passed on in some form.

The operator offering services for offshore activities also predicts that all additional cost can be passed on to their clients. Similar to the extra costs generated by other regulations, the company will most probably link its additional costs to the fuel consumption of its ships and pass it through to its clients, as it usually does with fuel costs. However it must be noted, that for this market segment fuel costs and most likely emission cost are currently not a significant cost factor for the clients. According to the same company, to some extent there exists a demand for green offshore services. Its clients, mainly from the petroleum industry, are becoming increasingly aware of environmental issues and are passing this down their supply chain, including offshore shipping activities.

### Scope of the Regulation

Most proposals for MBMs presented at MEPC provide for a worldwide system regulating international maritime activities and define the single ship as the regulated entity. In particular in light of possible market distortions and possibilities for carbon leakage, maintaining the IMO principle of No More Favourable Treatment seems to be preferable. But in principal a less comprehensive scheme is also conceivable. The EU for instance is discussing whether shipping can be included in a regional emission regulation if the negotiations at MEPC in this context are not successful (EU, 2002), possibly similar to the inclusion of aviation in the existing EU emission trading scheme (EU ETS).

All operators interviewed agree that a worldwide approach to regulating shipping emissions is appropriate and more fitting for the task than a regional approach, in particular because the shipping sector is a truly global industry. According to the operators, limiting the regulation of shipping emissions to a certain region would provoke competitive distortions. Some of the interviewees explicitly argue that, for example, an inclusion of the shipping sector in the EU ETS would lead to movement away from business in Europe as international shipping is more flexible compared to international aviation with respect to route optimization. However, one operator is of the opinion that this should not be a problem, as consumers are ultimately located for

instance in the EU or regions most likely to regulate emissions and hence traffic can only change to a certain degree without losing clients. Unnecessary red tape (i.e. excessive formal rules and bureaucracy) due to more complex monitoring and reporting processes and reduced environmental effectiveness are also identified by the operators as additional challenges associated with a regional approach. However, one operator points to the fact that the shipping industry in many cases already faces different local regulations, for example in terms of fuel sulphur content or bilge water discharges. Moreover, given that it is the smallest possible entity and the original source of emissions, all operators agree to define the ship as the entity that is regulated. With respect to exceptions, the companies advocate to making as few exceptions as possible, possibly using the same scheme as other maritime regulations such as MARPOL.

## 3.2 Supply of Allowances and Use of Revenues in a maritime ETS

### Initial Allocation and Use of Revenues

In any ETS, it is necessary to initially allocate allowances to the regulated entities. Due to its numerous advantages, such as no need for entity specific data on historical emissions, equal treatment of all entities, a comprehensible price signal, facile inclusion of new entrants, simple closure rules and the provision of revenues to the administration, the auctioning of allowances is regarded as the method of choice for the allocation of allowances in an ETS (e.g. Tietenberg, 2006; Benz et al. 2010). The Norwegian proposal also suggests the auctioning of allowances as the main allocation mechanism in a future ETS for shipping.

#### Organisation and Resources for Procurement of Allowances

The question of how the procurement of emission allowances will be organised is currently being discussed in each of the surveyed companies. As expected, larger shipping companies plan to organise the procurement internally by a central unit, whereas smaller companies will most likely outsource this task to a third party. Those who indicated an internal concept expect lower transaction and information costs as well as an easier fulfilment of any taxation obligations by assigning a central unit to do this task.

As so far there has been no final decision regarding how maritime emissions shall be regulated, the additional resources that will be necessary for sourcing allowances have not yet been assessed. Nevertheless, based on their experience with the procurement of bunker fuel, one interviewed operator assumes that once the data collection is

automated at least three to six staff members could be needed to manage the system for a fleet of less than 75 ships (i.e. purchasing/trading allowances, possibly acquiring offsets such as CDM credits, and evaluating current and future demand). The operator managing a fleet of about 10 vessels however stated that no additional resources would have to be build up additionally and the tasks can be integrated in the infrastructure and processes the company already has. Another expert overseeing a group of several subsidiary companies also stressed that the distributed nature of an operators business may eventually increase the challenge of implementing a harmonised purchasing scheme, thereby substantially increasing required resources. The outsourcing by smaller companies aims at avoiding additional administrative burden and will help them to concentrate on their core business. One operator even reported from his experience of buying CERs for clients on a voluntary basis, that outsourcing will be easy and relatively cheap. This operator estimates extra costs of about 1 EUR per ton of $CO_2$ when buying it from an external service provider or intermediary.

### Use of Revenues

Auctioning of allowances generates revenues to the authority in charge of the allocation process. Apart from using the revenues to cover administrative costs caused by implementing the regulation, any authority has five fundamental non-exclusive policy options with respect to what can be done with the auctioning revenues (Pope and Owen, 2009): (1) redistribution to households, (2) redistribution to all or selected emitters (e.g. heavy emitters), (3) redistribution to businesses possibly carrying the burden of an emission regulation in the end, (4) earmarking for special purposes (in particular, for mitigation and adaptation efforts or the promoting technological progress), and finally (5) use as general revenue. In the context of a sectoral approach it is necessary to distinguish between revenue recycling within or outside the concerned sector. But given the five alternatives mentioned above, for the maritime industry only the options (2) redistribution to emitters, (3) redistribution to businesses possibly carrying the burden of an emission regulation in the end, and (4) earmarking for special purposes, are appropriate if revenues are to be spent directly in the sector.

All of the interviewed experts would welcome the recycling of revenues within the maritime industry. Thereby, a special focus should be given to the promotion of technological progress, in particular with regard to fostering environmentally friendly and more fuel efficient technologies. In their view, this would improve the realisation of the emissions reduction potential of the shipping industry. Moreover, such a focus would be in line with the overall objective of the regulation, namely reducing maritime emissions. Some of the operators suggest that in practice, the support of emission reducing technologies could be organised similarly to the revenue recycling organised

by the Norwegian $NO_x$ Fund, which raises its capital from a levy on $NO_x$ emissions in Norwegian territorial waters. In this scheme, shipping operators can apply for grants if they plan to invest in technologies reducing $NO_x$ emissions and can subsequently prove the effectiveness of their investment.

If however the revenues are used outside the maritime sector, for instance for mitigation, adaptation or general climate finance measures, in the opinion of some ship operators, the public must be made aware of the contribution the shipping industry is making to combat climate change. This would give shipping companies an additional argument for marketing purposes and would prevent that shipping being perceived as a dirty industry. Other operators on the other hand fear in such an event, the public might perceive the contribution of the maritime industry as an effort to buy itself out of its responsibility in reducing emissions, thereby giving the industry a negative image.

Although reinvesting the revenues may increase the acceptance of the scheme among the regulated industry and therefore might appear attractive, from an economic perspective, there is no reason to limit revenue usage options to the maritime sector. As the environmental efficacy of an ETS is already guaranteed by the cap, the problem of whether to prioritise in-sector spending or a global approach is mainly a question of cost-efficiency and distributional issues which, in turn, are strongly linked to the political feasibility of an emission regulation. In order to have the possibility to select the most cost-efficient revenue recycling option, the authority should be able to choose from the complete set of possible options of how to spend the revenues. Limiting the usage of the revenues to the shipping sector, however, would confront the authority with an additional constraint, and consequently, it might not be able to optimally spend the revenues (Tol et al., 2008; Brett and Keen, 2000). Hence, from a cost-efficiency perspective, it does not make sense to earmark the revenues exclusively for the maritime industry.

## Trading of Allowances

The possibility to trade allowances in an emission trading scheme allows for cost-effective abatement in the system. In theory, emitters with low abatement costs will sell their allowances on the market, whereas emitters with high abatement costs can acquire allowances at a price lower than their marginal abatement costs. This trade is beneficial for both sides and it guarantees that abatement of emissions occurs where it is the cheapest option. In principle, ship operators would not be required to participate in the trading and could simply source their allowances at the auctions. Possible reasons for trading activities include compliance through secondary markets, profit maximisation, or risk minimisation.

### Trading of Allowances – Organisation and Resources

With respect to the possibility of trading allowances, a similar picture emerges as for the procurement of allowances. That is, larger shipping companies are likely to seize the opportunity to trade emission allowances by an in-house unit, whereas smaller companies rather plan to outsource this sort of activity.

Again, given that so far there is no final decision regarding how maritime emissions shall be regulated, companies have not yet developed an overall concept for specific market-based instruments and are reluctant to truly evaluate the potentially necessary resources. Accordingly, the surveyed operators could only provide rough estimates. As mentioned above, one interviewed expert assumes that at least three to six additional staff members are needed to manage the arising duties for a fleet of less than 75 vessels while a different expert stated that for a fleet of about 10 vessels no extra resources appear to be necessary, always assuming that the data collection process is automated. Similar to the procurement of allowances, those companies which plan to trade will organise the trading activities in a centralised way. Depending on whether the allowances will be classified as pure financial instrument, this can be set at the company's finance department. Otherwise, trading is probably organised within the fuel purchasing department of the companies since that is where the reporting will come through. The motivation for trading activities that interviewees stated are compliance reasons, profit maximisation, and risk minimisation. None of the interviewed operators consider trading as an additional future core business for their companies.

### Issues Related to the Fixed Amount of Emissions within a maritime ETS

In any ETS the cap that defines the overall amount of emissions permitted, and thereby the quantity of allocated allowances in the system, is crucial for guaranteeing the environmental effectiveness of the scheme. But if the overall cap is not chosen adequately, in particular if it is set too stringent, it may pose problems for the shipping industry, and possibly also beyond the sector (for an example see Korinek and Sourdin, 2010). Potentially, a too strict cap on emissions induces cost risk and can be a growth limiting issue. Moreover, in the interplay of prices and quantities on the market for emissions, fixing the available amount of allowances also results in a situation where all adjustments are captured by fluctuating prices. To some extent, this may lead to a rise in planning insecurity for ship operators, although this might prove to be a minor issue.

In this context, the shipping operators identify basically two challenges. Most importantly, a fixed cap is considered as possible growth limiting issue if the supply of allowances is set too small. Given the expectations concerning the future development

of international trade and the associated increase in demand for transport services, the interviewed shipping experts apprehend that – depending on the actual cap – there will be not enough allowances on the market. In particular when the world economy is booming a fixed cap may cause problems. This is particularly true as a scheme must be able to deal with an increase in tonnage during the period for which an emission cap is defined. Secondly, a maritime ETS in general (and one without linking in particular) increases the uncertainty on behalf of the shipping industry due to volatile allowance prices. However, compared to the role that for example bunker fuel prices and bunker fuel price volatility play in shipping, the additional costs and risks associated with a maritime ETS are assessed as rather modest by most of the interviewees.

As a way out of this dilemma, the interviewees suggest allowing the usage of allowances from other systems like CDM (linking) and enabling the fungibility of allowances between years (banking). Linking and banking are also frequently stated in the economic literature, as design option with which an ETS can alleviate the issues associated to a cap (e.g., Rubin, 1996; Jotzo and Betz, 2009; Jaffe et al., 2010). Linking makes it possible to use allowances and offsets from other markets, such as the EU ETS or the CDM market, for compliance in the maritime ETS. Opening a maritime ETS to other trading schemes increases the amount of available emission allowances and market liquidity is improved, thereby curbing growth limiting issues and price volatility. Moreover, by linking different emission markets, the prices for emissions are harmonised across the different systems, which in the end improves the overall efficiency of global climate policy. A banking mechanism in a maritime ETS in turn allows ships to reduce emissions below the cap when mitigation is cheap and to save allowances for periods in the future when high reduction costs are expected. Such provisions bring two main advantages. First, it extends the core benefit of an ETS, namely the cost-efficient realisation of a predefined emission reduction, to an intertemporal setting. Secondly, similar to the logic of linking it can have a positive effect in reducing the volatility of allowance prices.

In particular with regard to linking the interviewees consider that these benefits could actually be realised in practice and state that if offsets could be used in a maritime ETS to be compliant with the regulation, this would most likely ease problems related to an absolute emission cap and the resulting fixed supply of allowances. Furthermore linking would allow a maritime ETS to secure additional mitigation options and hence decrease emission reduction costs within the scheme. Additionally they also see an advantage in an overall increase of demand and supply for allowances, which would lead to an increase in liquidity on the emission market. One of the operators would specifically appreciate links to project based offsets, because this would give companies the possibility to actively choose from where they source the offsets they eventually need to be compliant. The companies could then for example focus on

specific projects and eventually use them additionally for marketing or corporate social responsibility reasons. However some of the experts also acknowledge that linking the ETS to other instruments would make it more difficult to reduce emissions directly in the shipping sector and linking would make the design of the maritime ETS dependent on other players and would have to include more controls to prevent fraud.

## 3.3 Monitoring, Reporting, Verification of Emissions

### Monitoring and Reporting at Present

Any MBM requires that emissions are monitored, reported and verified for each legal entity. At present all of the interviewed companies already collect fuel consumption data and apart from two operators who have these figures available on a voyage basis, most operators gather the data on a daily basis. Generally the data includes bunkering activities, quantity of fuel used, fuel specification, sulphur content and sometime also emissions. Occasionally the data is also related to information regarding the cargo carried, distance travelled, ship type and cruise speed. The data is thereby based on the bunker delivery note[6] (BDN), active monitoring, tank readings or where applicable derivations using emission factors. All operators collect the data centrally using some form of database management system and most of them have the data communicated frequently from the ships to the headquarter via satellite link.

The motivation for the current monitoring and reporting efforts by the operators is mainly to monitor performance and costs as well as the operators' obligations in the framework of their commitment for ISO 14001 or other voluntary environmental commitments. In addition, in some cases these systems have been implemented partly as a result of demands from clients, who ask ship operators to report their environmental performance. Thus, some clients pass the environmental reporting duties within their organisation down to their suppliers, inter alia the shipping lines. But sometimes, such monitoring and reporting activities are also triggered through currently existing regulations for instance such as the Norwegian $NO_x$ tax arrangement. Because this regulation, as geographically limited in scope, it requires operators to collect very detailed data regarding the fuel consumption on the ships.

[6] Bunker delivery notes are records of fuelling transactions which must be available for inspection on ships on international voyages.

### Resources for Monitoring and Reporting – Company Level

In the view of the questioned shipping operators, the actual burden of a monitoring and reporting system is dependent on how accurate and how often measurements have to be taken and reported and whether the processes have to be verified. Thus the interviewed experts note that the additional burden can only be estimated roughly until the precise requirements of a regulation become public. Generally, because most operators would seek compliance using the processes they have implemented already, the additional burden is very much dependent upon how much the requirements differ from the company's current practice. In particular, if an automated report generated from a database is sufficient and the documents only have to be produced when vessels are in harbour so that a voyage-based system is sufficient, then the additional burden for companies will be small. If a daily report is required, then companies which do not have a fully automated system would face a considerable extra burden. Some ship operators consider the Norwegian proposal to demand an unnecessary level of accuracy and verification. This holds particularly true for the required surveys of the ship, which, in the eyes of the operators, would unnecessarily detain vessels from their usual operations. Most companies currently have one person who deals with environmental reporting. For a non-automated system, this is a full time job for an annual environmental report. In case the emission data from the ships is required more frequently, the additional burden increases accordingly. Automation can reduce the time required, if there is an automated system where each ship can enter its own information into the companies' database and the generation of reports is also automated.

### Resources for Monitoring and Reporting – Ship Level

Ultimately, the information for emissions monitoring has to come from the crew of each ship. Therefore, the requirement to monitor and report emissions represents an additional administrative burden for the crews. The ship operators are of the opinion that if the reporting follows a procedure based on the bunkering activities of the ships, for example by using the BDN, with a simple calculation of emissions = fuel use $\times$ emissions factor, which is constant for each fuel type and for each voyage, then the additional burden would be slight. But if the actual fuel consumption of each ship would have to be monitored and eventually reported, this would be very costly, as special measurement equipment would be necessary and very individual fuel-consuming units on board would have to be monitored and documented. Overall, daily and direct emissions reporting would represent a significant administrative burden for the crews. Disregarding equipment cost, according to one operator, this would amount to approximately one person working full time on the ship, unless the process is highly automated. If the monitoring and reporting process on the ship is part of a system in

which the crews log the respective data online and thereby transmit it to the company's central database directly, then the administrative burden would be minimised for both the ships' crews and the operating company. But again, the additional burden depends crucially on how much the requirements differ from the company's current practice. Overall, most of the interviewed experts estimate the additional burden from any new regulation to be small.

#### Potential Advantages to Companies from Monitoring and Reporting for an ETS

Detached from compliance with actual regulations, monitoring and reporting efforts may possibly allow for additional benefits to be realised. It is obvious for instance that without documenting the actual fuel use and emissions, efficiency gains are hard to be identified and implemented. Alternatively, given the wide variety of monitoring procedures that the different interviewed companies already have in place, a standardised approach to monitoring and reporting could be expected to improve the standard of environmental management in the industry as a whole. In other industries, such additional benefits have included inter alia, the direction of management attention to efforts to reduce fuel consumption in operations.

Most operators interviewed were able to give examples of positive effects of monitoring and reporting fuel consumption and emissions, which mainly related to awareness of the fuel consumption implications of operational practices such as running positioning systems for long periods of time instead of anchoring, or sailing with powerful deck lights switched on in daylight. However, the operators have doubts whether any additional benefits can be secured through new requirements, because most of the advantages of monitoring and reporting are already captured through their efforts within ISO 14001 or under other regulations, for example MARPOL, or through voluntary action.

## 3.4 Carbon Management and Mitigation

For ship operators, an active carbon management would be necessary not just merely to be compliant with the regulation of maritime emissions, but most notably to minimise the costs associated with a cap-and-trade system. This means in particular that regulated entities, respectively the operator responsible for compliance, assess their mitigation options and their potential to change to a low emission fleet.

### Assessment of Mitigation Options

All ship operators interviewed acknowledge that energy efficiency is already an important consideration in ship operations. Most of the companies had undertaken an assessment of their $CO_2$ mitigation options, technical as well as operational. One company had in fact initiated an intensive discussion process specifically including the crews of its ships and on the basis of a questionnaire developed a catalogue of options focusing in particular on how emissions can be saved during operations.

### Current and Past Activities to Increase Fuel Efficiency and Reduce Emissions

The interviewees reported a wide range of current and past activities aiming at the reduction of energy consumption and emissions. Besides operational measures, an important area for potential emissions reduction is in the modification of ship designs. Potential options in this area have been widely discussed among the operators and are well known in the industry. The same holds true for more radical options reducing the emission of new builds. In contrast to operational measures, the actual implementation of technical options has so far been limited. In the interviews ship operators identified several reasons for this. The lifetime of ships is reported to be in the range of 30-40 years. Potentially this implies a 30-40 years' period before a new technology is fully deployed. This length of time can only be reduced if the technology can be retrofitted at a docking. Moreover, the ship operators describe their influence on the design of new ship to this regard as limited. Since the shipbuilding industry is globalised and has relatively few major companies all offering products of similar performance and standards, small companies in particular have to buy off-the-shelf-designs or face a significant increase in investment costs. Finally with regard to the slow adaptation of new technologies, there is a need for support for further demonstration projects on a wider range of ships, to show whether these technologies can give fuel savings under a wide range of operating conditions on different routes before they will be deployed on a big scale. In fact several operators had been involved in various research and technology development projects, both for energy saving technologies and for emissions monitoring and reporting. Participation in technology development projects is intended to provide an assessment of how far the technology has been developed and to what extent it can be deployed in the fleet.

Besides technological mitigation options, some of the companies have also implemented organisational structures to reduce emissions from their processes. One company for example has introduced emissions intensity reduction targets, while another has organised an internal competition to reward low carbon operations. The achievement of carbon neutrality through carbon offsetting is also a part of some companies' environmental management strategy.

# 4 Discussion

After having presented our insights from the interviews, we now briefly recapitulate the main benefits and issues of applying a cap-and-trade scheme. Subsequently, we discuss whether problems often associated to an ETS arise also in the context of a maritime ETS and outline how they can be addressed. From an economical theoretical perspective, applying a cap-and-trade approach seems to be an ideal instrument to cope with negative externalities generated through economic activity and has been discussed extensively in the economic literature (e.g., Baumol and Oates, 1971; Montgomery, 1972; Atkinson and Tietenberg, 1982; Newell and Stavins, 2003; Stavins, 2003). Essentially, an ETS allows to secure two main benefits. First, the environmental effectiveness of the scheme is guaranteed. In an ETS, the cap defines the overall amount of permitted emissions in the system. Hence, policy makers can choose a priori an overall limit for emissions over a certain time period and can thereby effectively control the total amount of pollution arising from emissions. Second, it achieves a given environmental benefit at least cost, thus is a cost-efficient mechanism. By constraining the allowed amount of emissions, a scarcity is artificially created and a price for emissions develops. As a consequence, the cap ensures that regulated entities treat their emissions like a regular factor of production and deploy it rationally in their production process. The ability to trade emission allowances provides for the equalisation of marginal emission abatement costs across all involved entities. In theory, emitters with low abatement costs will sell their allowances on the market, whereas emitters with high abatement costs can buy allowances at a comparatively low price. In the end, both entities benefit from this trading activity, and mitigation of emissions takes place where it is the lowest-cost option.

Given these benefits, it appears to be reasonable to also consider an emission trading scheme as an instrument to reduce emissions from international shipping. But in practice the implementation of such a scheme may involve several difficulties. Emission trading is often associated with high transaction costs for the regulated entity (e.g., Stavins, 1995; Cason and Gangadharan, 2003; Heindl, 2012). These consist primarily of expenditures for monitoring and reporting as well as costs induced by potential trading activities. In reality, carbon leakage may pose another issue for an ETS. In the context of shipping, carbon leakage relates mainly to the problem of shipping firms changing their activities in order to avoid being subject to the regulation, for example by adapting their operation patterns. Last but not least, the cap itself is at times seen as a critical element of an ETS. The international shipping industry is acknowledged to be a highly cyclical sector (OECD, 2009 and 2011), and since the cap within an ETS sets a fixed amount of supplied emission allowances, a variation in the demand for allowances can heavily affect the price of emissions. This may result in increased price

uncertainty. In addition, in times of high demand for shipping activities, a too strict limit on emissions could result in excessive operation costs for ship operators.

If it is to be expected that such issues will arise in the context of a maritime emission trading scheme, they will also have to be taken into account in the design of the system. Here policy makers may benefit from the flexibility of a cap-and-trade approach with respect to different design elements and design the scheme while taking into account the particularities of the shipping sector.

Obviously, besides the intended emission costs to incentivise abatement, a maritime ETS will also entail transaction costs for ship operators. Our case study gives a first indication of how big these are. For business reasons, ship operators already undertake comprehensive monitoring and reporting efforts for bunker fuel usage and at date, most companies have fuel consumption data available, at least on a voyage basis. Hence, if a maritime ETS makes use of the monitoring and reporting processes in place at present, this would involve companies in almost no extra administrative effort for emissions monitoring and reporting, as there is a direct relation between bunker fuel use and shipping emissions. With regard to the costs for potential trading activities it is to be expected that compared to other operational costs, e.g. bunker fuel and financial services associated to it (e.g. hedging activities), the additional expenditures will be rather small.

Limiting the potential for carbon leakage is particularly crucial when regulating mobile entities and services such as it would be the case for international shipping. This calls for a comprehensive approach to maritime emission trading which is applied worldwide and makes as few exceptions as possible. Such an approach is also favored by the interviewed ship operators and they point out that this would additionally limit red tape compared to an emergence of multiple nonrelated regional schemes.The issues associated to a cap cannot be ruled out as easily and are also identified by the interviewed experts as potentially significant problems. However, they may be alleviated by adequate linking and/or banking provisions.[7] Linking makes it possible to use allowances and offsets from other emission markets, such as the currently existing EU ETS or the CDM market, for compliance in the maritime ETS. Opening a maritime ETS to other trading schemes increases the amount of available emission allowances and market liquidity is improved, thereby curbing growth limiting issues and price

[7] The economic literature acknowledges also the implementation of price ceilings and price floors as possibilities for cost containment, as it is for instance foreseen in the Australian emission trading scheme (Jotzo and Betz, 2009; Wood and Jotzo, 2011). Price ceilings and price floors introduce elements of price-based policy instruments in a quantitive approach, resulting in a hybrid model. However, in this study we focus on emission trading in its pure form and defer the discussion of a hybrid approach for the shipping sector to future research.

volatility. Moreover, by linking different emission markets, the prices for emissions are harmonised across the different systems, which in the end improves the cost efficiency of global climate policy. A banking mechanism in turn would allow ships to reduce emissions below the cap when mitigation is cheap and to save allowances for periods in the future when high reduction costs are expected. Such a provision brings two main advantages. First, it extends the core benefit of an ETS, namely the cost-efficient realisation of a predefined emission reduction, to an intertemporal setting (Ellerman et al., 2000; Stavins et al., 2003, Schleich et al. 2006). Secondly, it can also have a moderate effect on the volatility of allowances prices because in times of extreme prices, emitters can draw from saved emission allowances (Nordhaus, 2007). In principle, borrowing, the direct complement to banking, secures the same advantages (Nordhaus, 2007). But the risk of borrowing is that firms may never actually reduce emissions in the future or may undermine early emission reduction which can result in upwards pressure on future mitigation costs if future abatement costs are not substantially reduced. For similar reasons, also the interviewed ship operators oppose borrowing. Hence borrowing should only be permitted under strict conditions, for instance quantity or time limits (Brunner et al., 2009).

# 5 Summary and Conclusions

International shipping is an important emitter of greenhouse gases and given the expectations concerning the future development of international trade and the associated increase in demand for transport services, emissions of ships are likely to increase significantly in the future. How maritime $CO_2$ emissions can be reduced best is a hot topic, not only for the parities at IMO but also for ship operators. In this paper we assessed potential implications of a maritime emission trading scheme on the organisation and operations of shipping companies, primarily on the basis of a case study involving ship operators. Although we focussed on a maritime ETS, most of the insights in our paper apply also to other MBMs aiming at the reduction of maritime $CO_2$ emissions. On the basis of our results, we subsequently discussed whether and how a maritime ETS needs to make special provisions to account for three frequently raised criticisms in the context of cap-and-trade, namely high transaction costs, carbon leakage and issues associated to a fix cap on emissions. At large, there appears to be no knock-out criterion why a cap-and-trade approach should not work in the shipping sector in practice. In fact, a maritime ETS has the potential to engage the maritime sector into cost-efficient emission reduction if designed to account for the special characteristics of the international shipping industry such as already existing monitoring processes and long investment cycles.

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