International Transport Forum

Reducing Shipping Greenhouse Gas Emissions

Lessons From Port-Based Incentives

Case-Specific Policy Analysis

OECD

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The International Transport Forum

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Case-Specific Policy Analysis Reports

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Table of contents

Executive summary

What we did

This report reviews port-based incentive schemes to reduce shipping emissions, such as environmentally differentiated port fees. Greenhouse gas emissions from shipping currently represent around 2.6% of total global emissions, but this share could more than triple by 2050 if measures are not taken to help speed a transition in this sector too. Following the Paris Climate Agreement, discussions are on-going at the International maritime Organization (IMO) to agree an Initial Greenhouse Gas (GHG) Strategy by 2018 that will stipulate significant measures to mitigate emissions.

Many of these measures focus on ship design and operations. However, ports also have a crucial role to play in facilitating the reduction of shipping emissions. This report assesses the extent to which financial incentives at the port level could provide important lessons for the design of decarbonisation policies for the maritime sector. It identifies the port-based incentives currently in place, explores their features and assesses their impacts. Importantly, it explores how the experiences with existing measures could inform international carbon-reduction negotiations for shipping and help to increase the effect of port-based environmental incentives.

What we found

A number of port-based financial incentives to mitigate GHG emissions are already in place today. The most common financial incentive used is the environmentally differentiated port fee. This is applied in approximately 28 of the 100 largest ports in terms of total cargo volume handled (in tonnes) and container volumes handled (in standard containers, or TEUs). In practice, this takes the form of a reduction of port fees for ships that are considered environmentally friendly, usually based on an index related to ship characteristics. Some US ports have introduced financial incentives for ships reducing speed when approaching the port. The Panama Canal Authority has a scheme that provides priority slot allocation to greener ships. Spain includes environmental incentives in the tender and license criteria for the towage services provided in ports. Shanghai has an emission-trading scheme in which ports and domestic shipping are included and in Norway an NO_x tax is in place.

Despite the prominent place of such incentive schemes, very little is known about their actual impact. Public information on how many ships use these schemes is scarce and there is no port that has proven GHG emission reductions as a result of such policies. The only scheme for which serious impact studies exist is the vessel speed reduction scheme in Los Angeles and Long Beach in the United States.

The dearth of data notwithstanding, it is clear that the impact of port-based incentives on global shipping emissions is marginal. The number of ports deploying financial incentives is still fairly low and where they are applied only a handful of ships are benefitting from the schemes – often less than 5% of the ships calling the port. Moreover, the difference in fees for the dirtiest and cleanest ships is usually small, normally in the order of 5% to 20%. Currently only five ports use indices in which GHG emissions provide a substantial part of the index criteria. Any incentives ship-owners may currently have to order more efficient ships with lower emissions can only to a very small extent be a result of savings from port-based incentives.

Yet, ports clearly play a hugely important role in helping the shipping sector to manage the transition to clean shipping. Port-based incentives for GHG emission mitigation could provide an important supporting role. The first lesson learned therefore is that ports are players in this context, and that they are taking actions - to both incentivise cleaner ships and to increase the efficiency of their operations, which can also have an effect on shipping emissions. Furthermore, the existing port-based measures establish that market interventions are needed to reward clean performance. The fact that financial incentives have been chosen implies there is support for flexible measures to drive behavioural change.

However, more emphasis is needed on monitoring, reporting and verification of the impacts of these measures. More could also be done to enshrine the "polluter pays" principle. Higher rates of differentiation between vessels based on their environmental performance could drive more and faster change. It is possible within the policies to differentiate fees according to type of vessel enabling the economic activities that can afford to pay to take more of the responsibility for acting.

What we recommend

Acknowledge the important role of ports in mitigating shipping emissions

The role of ports and port-based incentives deserves acknowledgement in the IMO Initial GHG Strategy, due in 2018. Its inclusion could also signify the first step towards expansion and a more mandatory character for port incentives. The role of ports in mitigating GHG emissions should also be clearly identified in the updates of the nationally determined contributions (NDCs).

Expand port-based incentives for low-emission ships

Green port fees could be much more effective if more ships and ports were covered by such schemes. Much wider application of other port-based incentives, such as green berth-allocation policies, green procurement and carbon pricing schemes could substantially mitigate shipping's GHG emissions. The expansion of these instruments needs to go hand-in-hand with enhanced assessment of the impacts of these instruments, so as to improve their effectiveness. Not enough data exists to properly assess the real impact of port-based decarbonisation incentives. Efforts should be stepped up to ensure better monitoring, reporting and verification as a precondition for steering policies towards the most effective outcomes.

Link port-based incentives to actual emissions

None of the existing green port fees takes actual GHG emissions as a base for the fee reduction. Improved data collection at the ship level makes it increasingly possible to assign accurate estimates of GHG emissions to individual ships. This opens the possibility of financial incentives at the port level based on actual GHG emissions of the ship during its voyage. Port fee deductions have been based predominantly on local air pollutants; it would make sense to integrate GHG emissions to avoid perverse incentives to increase GHG emissions whilst addressing local air pollution.

Move to a more harmonised application of green port fees

Higher rates of differentiation between vessels based on their environmental performance could drive more change and help the maritime sector to decarbonise faster. It is possible within the policies to differentiate fees according to type of vessel, which might be relevant within the context of country trade impacts. The "polluter pays" principle should be applied to all ships via a system of environmentally differentiated port fees, rather than as rebate for the greenest ships. Currently, port authorities that can

afford it are prepared to offer rebates for green ships with low emissions but are unwilling to introduce systems in which these rebates are paid for by ships with worst emission performance. Agreed principles should guide the practices of ports and major port countries. A harmonised index or score assigned to all ships could be effective. It would be used as the basis for differentiated fees in all ports and used by shippers to report on their carbon footprint.

Introduction

Though a relatively efficient way to move people and goods shipping's GHG emissions are substantial due to a reliance on high carbon fuels. International shipping's GHG emissions amounted to 906 million tonnes in 2012, representing 2.6% of total global emissions, according IMO's Third GHG Study (Smith et al. 2015). The same study projects shipping's GHG emissions to grow with 50-250% by 2050. In the latter case, shipping's GHG emissions might present up to 17% of total global emissions by 2050, although some studies predict more moderate emissions growth.

Shipping can and should be seeking to align itself with the Paris Climate Agreement[1], which seeks to achieve net zero emissions before the end of this century. With effective support for the financing of investments in emissions reductions, shipping emissions could be put on a sustained declining trajectory with a goal of achieving at least a halving of emissions by 2050 and full decarbonisation (meaning no net emissions) before the middle of the next half of the century. Shipping emissions have increased strongly over the last decades, and although they declined by 10% between 2007-12, they seem to have gone up again recently, with an observed 2.4% increase between 2013-15 (ICCT 2017). Emissions in 2008 however continue to be the peak year.

The main focus of global regulation in relation to climate change has so far been to regulate the energy efficiency of ships. This has taken the form of the Energy Efficiency Design Index (EEDI). New ships need to conform to this index that becomes gradually stricter over time. In that regard, a large share of new-build ships in 2017 already complies with the 2025 standard (T&E, 2017). Regular reviews of the EEDI standard and new supporting policies and measures will be needed to sustain and absolute reduction in GHG emission in the shipping sector.

Discussions are taking place at the global level that will result in an Initial IMO GHG Strategy by 2018 and a Revised Strategy by 2023. There is a range of candidate measures that could be usefully introduced into this Strategy, which will need careful design and evaluation. Options include policies related to ship design, operation and efficiency, and support for uptake in cleaner and alternative fuels and propulsion. This report focuses on the particular sort of instrument of financial incentives, which could be deployed at the port level, and the lessons learned for policy design from that instrument. An additional ongoing debate with regards to this IMO Strategy is whether the strategy should only include global measures or reference measures at other intervention levels, for example national measures and measures at port level. Our findings also aim to inform this debate.

Ports could provide a key supporting role in decarbonising maritime transport in various ways. Ports are directly impacted by shipping's emissions: these emissions in most ports represent the main source of air pollution. Port solutions to reduce these emissions, such as shore power facilities, could also help to reduce the GHG emissions of ships whilst in ports. This represents a fairly small part (around 5%) of the total GHG emissions from shipping (ITF/OECD, 2014), but ports could also have a more fundamental role in reducing shipping emissions. That is to say: they could "nudge" shipping companies towards a decarbonisation pathway. This is, in many cases, motivated by their societal responsibility or that their owners, mostly national or local governments. This report gives an overview of a particular set of instruments that ports have at their disposal (namely financial incentives), considers their features, assesses their impact and identifies crucial pre-conditions for their effectiveness.

1. Overview of port-based practices

Approximately 30 of the world's top 100 ports apply financial incentives to decarbonise maritime transport, mostly within OECD member countries. In addition, some of the smaller ports also deploy such instruments. By far the most common incentive is a green port fee, usually based on sort of an index that indicates environmental performance of the ship calling the port. Other financial incentives, such as incentives to reduce speed, green berth-allocation, green procurement and local or regional carbon pricing mechanisms are rarer.

Categories of port incentives

The subject of this report is port-based incentives. These are port-based, which means that these can be imposed by port authorities or implemented at the port level. Incentives are different from regulation: they leave actors the possibility to do something and be rewarded or penalised for their behaviour. Within many domains, including environmental policy, financial incentives are considered effective instruments because they provide flexibility, require less enforcement than regulation, and can incentivise the actors where mitigation is possible with the lowest costs. Like regulation, setting of the right incentive is fraught with uncertainty: incentives are less effective if costs are insignificant and/or can be passed on and when the incentive seeks to nudge actors to do something that they are planning to do anyway.

Port incentives could be categorised according to the sort of incentive and the sort of behaviour that they try to influence. The sort of incentive is related to the functions and responsibilities of ports, namely the provision of infrastructure and their pricing, selecting cargo handling and maritime service providers and regulating ship traffic to the port, including allocation of berths. Accordingly, we distinguish the following sorts of incentives: green port fees, green port procurement and green berth allocation. In addition, we will also treat carbon pricing schemes that incorporate port and shipping activity. A second way to categorise port-based incentives is according to the sort of behaviour that the incentives want to stimulate, such as low emissions, energy efficiency of ships, use of low-carbon fuels or alternative energy and low speed. Combining both categories provides an overview of the sort of port-based incentives that could theoretically exist. We will assess below which instruments exist in practice.

Table 1. **Categories of port incentives**

	Emissions	Energy efficiency	Speed	Low-carbon fuels/energy
Green port fee				
Green procurement				
Green berth allocation				
Carbon pricing				

Green port fees

Ports charge fees to ships to cover infrastructure-related costs. Green port fees are fees that take into account environmental performance of ships. Such port fees tariffs can come under different names – such as port tariffs, dockage fees - and can cover different elements, which is only logical as ports do not always provide completely similar infrastructures. We distinguish port fees from terminal handling charges, which cover the costs of handling cargo in ports. In most cases this is done by port terminal operators, but in some cases port authorities also act as terminal operators, in which cases the distinction between port fees and handling charges become blurred. In some countries, ports do not have autonomy in setting port tariffs but might have autonomy over tariffs of certain services, e.g. waste services. This for example is the case in Italy, where some ports provide rebates (related to ship emission performance) on the waste collection fee (COGEA, 2017).

The principle of green port fees – or environmentally differentiated port fees - is to charge lower fees to ships that are less polluting. In most cases this means that the cleanest ships get a deduction of the regular port fee, either a fixed amount or a proportional deduction (e.g. a 10% rebate on the port fee). As most port fees are somehow related to ship size, the deductions could be considered more or less proportional to ship size. Some ports apply different charging schemes according to the type of vessel. There are a few examples of ports that apply different tariffs according to the group (tiers) of vessel, i.e. according to environmental performance.

There are 28 of the major world ports that apply green port fees. These are ports that belong to the largest hundred world ports, either measured by their volume in tonnage or by their volume in containers (Table 2). In addition to these ports, there are various smaller ports that apply green port fees, e.g. as listed in COGEA (2017) for European ports, but these are not included in Table 2 below. Most of the ports that apply green port tariffs are located in OECD member countries. Sweden was a frontrunner in this respect with environmentally differentiated fairway dues introduced in the late 1990s and green port tariffs in ports such as Stockholm since 1991. Ports that followed in the early 2010s were the US West Coast ports, such as Los Angeles, Long Beach, and the North European ports of Rotterdam (Box 1), Antwerp and Hamburg. Nowadays, green port fees are more widely used and their application continues to grow. In many ports, introduction of green port fees forms part of a broader interest of the port authority in improving its environmental footprint, so green port fees are often embedded in an explicitly formulated environmental policy of the port authority. Green port fees are in practice linked to green ship indexes, use of alternative fuels and energy and vessel speed.

Table 2. **Global top 100 ports with environmental port fees**

Europe	Asia	Americas	Africa
Rotterdam (Netherlands)	Singapore	Los Angeles (US)	Durban (South Africa)
Antwerp (Belgium)	Shenzhen (China)	Long Beach (US)	Richard's Bay (South Africa)
Amsterdam (Netherlands)	Hong Kong (China)	New York/New Jersey (US)	
Hamburg (Germany)	Busan (South Korea)	Vancouver (Canada)	
Bremerhaven (Germany)	Ulsan (South Korea)	Montreal (Canada)	
Le Havre (France)	Tokyo (Japan)	Buenos Aires (Argentina)	
Zeebrugge (Belgium)	Yokohama (Japan)		
Sines (Portugal)	Nagoya (Japan)		
Valencia (Spain)	Kitakyushu (Japan)		
London (UK)	Ashdod (Israel)		
Bergen (Norway)			

Note: This table includes the largest hundred ports (in tonnage) and largest hundred container ports (container volumes handled).

Box 1. **Rotterdam's Green Port Fees**

The Port of Rotterdam applies differentiated port tariffs based on ship environmental performance. It rewards vessels that have a high ESI score and those with a Green Award certificate through discounts on the port dues. Vessels that score high on the ESI (with a score of 31 or more) and perform better than the legal norm will be rewarded a 10% discount on the gross tonnage part of the port dues. Since January 2015, it is possible to double this discount based on low NOx emissions (if the ship has an individual NOx score of 31 or more). The Port selects eligible vessels every quarter and grants discounts for up to 20 individual calls per quarter. The Port offers a 6% discount on port dues already paid, for oil and oil product tankers, and for LNG tankers with a Green Award certificate provided that the vessel have a deadweight of 20 000 tonnes and more. It also offers a 15% discount for inland vessels with a Green Award Certificate score below 400 points for the main engine and a 30% discount for those with a Green Award Certificate delivered after June 17 2014 and a score of 400 and above. The port of Rotterdam does not produce data on the impact of the scheme in terms of emissions reduction. However, the port reports that in 2013 and 2014 ESI certified ships represented 19% and 21% of total calls, while ships that got rebates (i.e. with a score equal to or higher than 31) were around 7% of total calls (COGEA, 2017).

Green ship indexes

Most of the green port fees are based on one or more indexes that express the environmental performance of an individual ship. The scores on these indexes are used as justification for the amount of the reduction of the regular port fees. There are four main indexes that are widely used: the Environmental Ship Index (ESI), the Green Award, the Clean Shipping Index (CSI) and the GHG Emissions Rating of RightShip.

The indexes have a different focus, different intended users and different methods for collecting the information on which the score is based:

- The widest focus is related to the Green Award Certificate that takes into account fifty different criteria, ranging from safety and service quality to environmental performance. The narrowest focus is applied in GHG Emissions Rating, which only focuses on the energy efficiency of ships. In between the two extremes, there are the Environmental Ship Index which focuses on air pollution and the Clean Shipping Index which assesses air emissions (CO_2, SO_x, NO_x and PM), chemicals, waste and water.

- The main target groups of these indexes differ (Table 3), which might also explain the different angle of these indexes: e.g. local air pollution is a strong concern for ports, whereas energy efficiency of ships is of more interest to charterers and shippers.

- The data collection processes on which the index scores are based are more or less vigorous: both for the ESI and the CSI data are provided by ship-owners, with some ex post controls. In the case of ESI, this could be done by the ESI bureau of the International Association of Ports and Harbors (IAPH) that administers the scheme, and by port authorities that use the ESI. In the case of CSI third party verification by accredited verification companies is required in order to obtain a CSI certificate. In order to get a Green Award certificate, ship-owners also have to submit documentation, which is followed by an audit and surveys of individual ships, carried out by the Green Award Bureau. The GHG Emissions Rating is not based on applications by ship-owners, but assigns a score to vessels based on a hierarchy of sources ranging from EEDI scores, to ship characteristics, yard data and IHS Fairplay Maritime databases.

Table 3. **Main green ship indexes and their criteria**

Index	Main criteria	Main target group	Scores determined by
Environmental Ship Index	NO_x, SO_x, CO_2, shore power	Ports	Self-assessment ship-owners, some audits by ports
Green Award	Safety, service quality and environmental performance	Ports, banks, maritime service providers	Audits and verification by Bureau Green Award
Clean Shipping Index	NO_x, SO_x, PM, CO_2, chemicals, water and waste.	Shipping companies, shippers, ports and authorities	Submission by carriers, verification by verification companies
GHG Emissions Rating	Ship energy efficiency	Charterers, shippers, banks, ports, terminals	RightShip based on variety of sources

In most of these indexes, GHG emissions from shipping only play a fairly small role. In both the ESI and Green Award, GHG emissions only account for a small share of the score: 10% at the maximum in ESI and marginally for the Green Award. The inclusion of CO_2 emissions in the ESI is only recent (2016); for the moment 5 points can be collected if the shipping company reports three years in succession on the Energy Efficiency Operational Indicator (EEOI) of its ships, with maximum 10 additional points depending on the progress reported on this indicator.[2] For the Green Award Certificate ship-owners are required to assess their current emission levels and "make efforts to reduce emissions based on that reference". A more specific way to incorporate CO_2 emissions is in the Clean Shipping Index, where actual emissions per ship are compared to a reference ship in the same ship category; scores are assigned based on how the ship compares to the reference ship. Finally, in the RightShip index a

hierarchy of data is used which includes how ships score on the IMOs Energy Efficiency Design Index (EEDI) or on an Existing Vessel Design Index (EVDI) similar to it, to determine energy efficiency compared to the average ship of same size and type[3] (Table 4). The core measure for comparing the relative efficiency of the world's fleet is grams of CO_2 per tonne nautical mile. The order of preference of data for the RightShip index is EEDI, ship-specific data, yard data, with IHS Maritime ship-data being least preferred.

Table 4. **Main green ship indexes and their CO_2 related criteria**

Index	**CO_2 related criteria**	**Weight of CO_2 criteria**
Environmental Ship Index	To report on EEOI datasets	10%
Green Award	To assess current emission levels	marginal
Clean Shipping Index	Emissions compared to reference ship	20%
RightShip	EEDI or EVDI	100%

None of the indexes (with the exception of the Clean Shipping Index) is fully goal-oriented. Schemes want to incentivise certain measures, e.g. to increase uptake of shore power facilities. A truly goal-oriented index would treat every emission reduction equally, irrespective of the measure that leads to this reduction. There is a variety of measures that could help to mitigate GHG emissions from shipping. A recent overview is provided in Bouman et al. (2017), summarised in Figure 1. A combination of these measures could help to make significant steps towards decarbonisation of maritime transport. Only a few of these measures are covered by the current indexes.

Figure 1. **Measures to reduce shipping's CO_2 emissions**

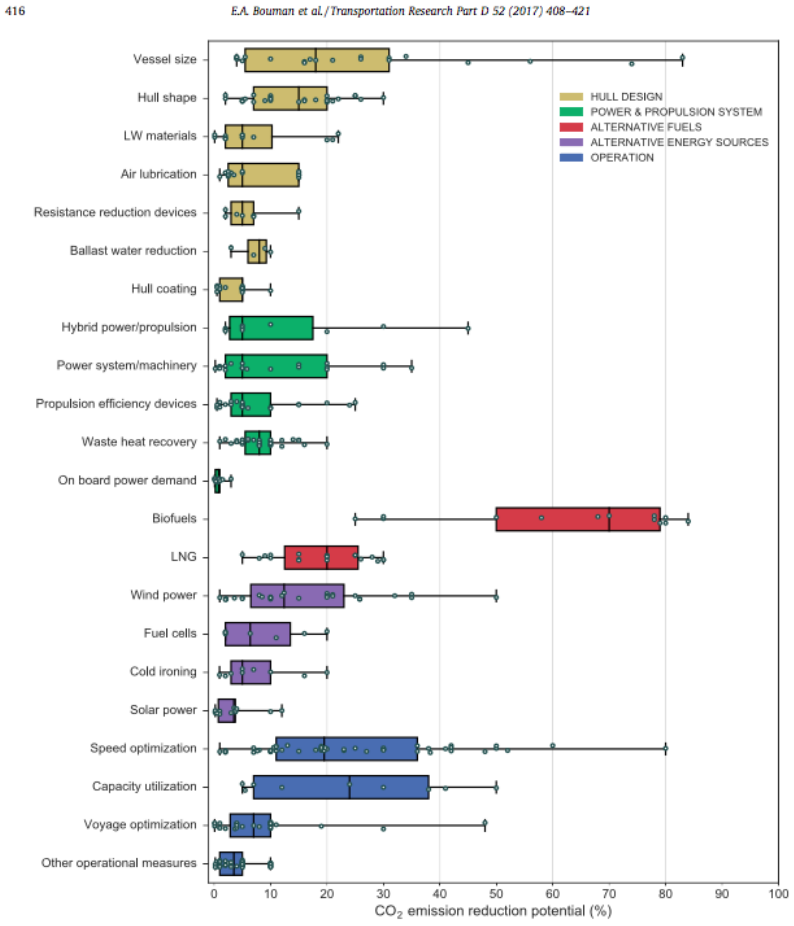


Fig. 2. CO_2 emission reduction potential from individual measures, classified in 5 main categories of measures.

Alternative/clean burning fuels

Alternative fuels and energy provide another angle for port-based incentives. In the recent past the focus was on sulphur emissions from shipping, with ports promoting voluntary fuel switch programmes, consisting of incentives for shipping companies to switch to low-sulphur fuels. Examples of such schemes were the Fair Winds Charter in Hong Kong, the Green Port Programme in Singapore and schemes in Seattle, Houston and Vancouver amongst others (ITF/OECD, 2014). Stricter regulation on sulphur emissions from shipping, both at regional and global level, has made such programmes less relevant than before. Yet, similar schemes could emerge related to mitigation of GHG emissions.

Some ports provide a deduction of port fees for liquefied natural gas (LNG)-powered vessels. This includes ports such as Singapore, Hamburg, Antwerp, Rotterdam, Bremerhaven, Gothenburg, as well as the Panama Canal Authority. This financial incentive often goes hand in hand with other efforts by the port to accommodate LNG-powered vessels, such as LNG bunkering facilities to stimulate uptake of LNG-propulsion. A more uniform requirement is provided in incentive schemes of Los Angeles and Long Beach in which IMO Tier III engines is one of the criteria, instead of a specific technology.

In the same vein, some ports provide financial incentives for ships using shore power facilities. This can take the form of discounts on port fees (in Vancouver), a subsidy (Stockholm), but also via the price

of electricity offered – in various cases lower than the price for industrial users. Another way in which uptake of shore power facilities in ports can be stimulated is via tax exemptions, which were put in place in Sweden. This is an exemption from the electricity tax; an exemption that applies for shore power facilities.[4] The European Commission has, at the request of Sweden, allowed these exemptions on the grounds that it does not distort competition and that it is in line with EU goals to prevent air pollution.

Vessel speed reductions

Speed is relevant to shipping emissions: a ship that sails slower will emit much less, due to the non-linear relationship between speed and fuel consumption assuming all other factors are equal. There is a fairly wide set of studies on the effects of slower vessel speeds on shipping's GHG emissions. The drop in global GHG emissions from shipping can to a large extent be attributed to slow steaming by the sector (Smith et al. 2015) and speed limits for ships are frequently mentioned as one of the operational measures that could reduce shipping's GHG emissions. Most ports apply a speed limit for ships approaching the port for reasons of safety, environment and to avoid waves. This speed limit could cover port access channels or rivers leading to the port.

In a handful of ports, there is an incentive programme related to vessel speed (Table 5). Frontrunners were the ports of Los Angeles and Long Beach; they introduced a vessel speed reduction programme as early as 2001, which was subsequently adapted and expanded. A key element of the programme is a reduction of port fees for vessels that consistently slow down to the maximum speed of 12 knots within a limit of 20 nautical miles (nm) from the port (Point Fermin) and an even larger reduction is given to vessels that slow down to this speed within a 40 nm limit. This discount of port fees is only given to ships that have shown at least 90% compliance for 12 consecutive months. The speed limit refers to the average speed in the zone; compliance is monitored by the Marine Exchange through its vessel traffic monitoring and reporting system (VTS). More details on the scheme are provided in Box 2. Few other US ports have also introduced a vessel speed reduction programme, but with different rewards. In the case of San Diego, complying vessels are acknowledged publicly, but it does not translate into a reduction of port fees. In the case of New York-New Jersey, lower vessel speeds lead to additional points to the ESI score that might translate in reductions of port fees. The port of Vancouver (Canada) currently carries out a trial with speed reduction to 11 knots in a designated zone close to the port (Haro Strait) aiming to reduce underwater noise and impacts on whales.

Table 5. **Port fee differentiation related to vessel speed**

Port	Start	Speed limit	Distance from port	Fee rebate
Los Angeles	2001	12 knots	20 nm - 40 nm	15% - 30%
Long Beach	2001	12 knots	20 nm - 40 nm	15% - 25%
San Diego	2009	12 knots	20 nm	none
New York-New Jersey	2010	?	20 nm	Additional ESI points

Box 2. **Long Beach's Vessel Speed Reduction scheme**

Through the Vessel Speed Reduction Programme (VSR), the ports of Los Angeles (POLA) and Long Beach (POLB) aim to reduce emissions from ocean-going vessel by slowing their speeds as they approach or depart the port. Since 2005, the ports have applied rewards for the ships that voluntarily lower their speeds within the harbours to a 12-knot speed limit. In return for their participation of at least 90% of the time in a calendar year, shipping lines get 15% off for compliance with the speed limit at 20 nautical miles from Point Fermin, 30% off (POLA) and 25% off (POLB) at 40 nautical miles. The VSR Programme is part of the wide San Pedro Bay Clean Air Action Plan (CAAP), a comprehensive strategy to reduce air pollution emissions from port-related cargo movement at the largest seaport complex in North America.

The scheme consists of a positive incentive since it does not force shipping lines into compliance and enables them to save on port dues. Yet, speed reduction comes at a cost for vessel operators. For example, some engines are designed for specific speeds and sailing at a different speed may increase their depreciation and maintenance costs. The California Air Resources Board surveyed ship operated in the region and found that the increase in daily operating costs from slowing vessels down by 1 hour ranged from USD 250 to USD 600 as reported by operators. Speed-reduction costs are further increased if late arrival causes delays and scheduling difficulties with onshore labour (Zis et al., 2014). These costs need to be compensated by the incentive scheme for ship operators to join the program. A risk of such incentive program is that vessels could comply and speed up outside the zone to make up for lost time in the zone, which could in turn lead to an increase in CO2 and other emissions.

According to the Port of Long Beach Compliance Report for year 2016, compliance is over 96% at 20 nautical miles and over 88% at 40 nautical miles. The rates published by the port are calculated by dividing the number trips during which speed reductions were achieved by the total number of trips. However, this method does not imply that all these vessels have qualified for discounted dockage fees since the scheme requires that each single operator respects the limit on at least 90% of the trips it makes in the port area. The California Air Resource Board (CARB) analysed vessel speed reduction's impacts from Californian ports assuming that all ships reduce speed to 12 knots. It found that if all ships were required to sail at that speed 40 nm outside the ports, the emissions of PM, NOx, SOx and CO2 would be reduced by 31%, 36%, 29% and 29% respectively. In 2008, the Port of Long Beach estimated that the program led to the reduction of CO2 equivalent emissions by 26 000 tonnes. NOx, SOx and PM emissions were respectively reduced by 678, 453 and 60 tonnes.

Based on compliance in the 40 mn range from 2009 to 2011 in Long Beach, Ahl et al. (2016) found that discounts provided have a positive effect on compliance to the VSR for bulk, containership, general, tanker and mixed-cargo vessel operators. They however note that the effects vary greatly by operator type, suggesting a role for differentiated pricing strategies to better motivate compliance and improve the results in terms of air emissions (Ahl et al., 2016).

One of the key ingredients of the success of the program is cooperation. The Ports have signed a Memorandum of Understanding with the US Environmental Protection Agency (US EPA), the California Air Resource Board (CARB), the South Coast Air Quality Management District using AIS and radars. SCAQMD), the Steamship Association of Southern California and the Pacific Merchant Shipping Association (PMSA). The Marine Exchange of Southern California provides the vessel speed data for both ports. Voluntary participation from shipping lines also contributed to making the program more popular than if it was binding even though an important part of the high compliance rate is due to the monetary incentive provided by the ports, which apparently supersedes the costs of operating vessels at lower speeds. Overall, the VSR is a simple approach to reduce many air pollutants and possibly easy to monitor via AIS. High compliance rates could suggest that the program provides high enough incentives, is easily administered or both.

Multiple indicators

Various ports have incentive schemes that include multiple indicators and bases that can sometimes be cumulated. Arguably the most comprehensive port financial incentive scheme is the EcoAction programme, operated by the port of Vancouver (Canada) that not only combines a wide set of criteria (Table 6), but also provides substantial reductions (up to 47% discounts). It uses all the four indexes described in this section, as well as an additional one the Green Marine Index, which is only used in North America. In addition, ship-owners who are not participating in any of these schemes could get a discount if their ships have a favourable EEDI index. A similarly flexible programme is applied in another Canadian port: the Prince Rupert Port.

Table 6. **Criteria included in the port discounts of port of Vancouver in 2017**

Initiative	**Criteria for ships to qualify for different levels of discount**		
	Bronze (23% discount)	Silver (35% discount)	Gold (47% discount)
RightShip GHG Emissions Rating & Qi Rating	GHG C & Environmental 3+ stars	GHG B & Environmental 3+ stars	GHG A & Environmental 3+ stars
ESI	20 =< score < 31	31 =< score < 40	Score => 40
Green Award	Award certificate		
CSI	Score of Red	Score of Yellow	Score of Green
Green Marine	Level 3 GHG & min. Level 2 others	Level 4 GHG & min. Level 2 others	Level 5 GHG & min. Level 2 others
EEDI	Attained EEDI 5% better than required EEDI	Attained EEDI 10% better than required EEDI	Attained EEDI 15% better than required EEDI

Source: Port of Vancouver (2017)

Despite the sophistication of some green port fee schemes, none of the ports have managed to create green port pricing based on actual GHG emissions. All green port fee schemes use some sort of a proxy for GHG emissions, mostly in the form of energy efficiency design features. Yet, calculations of GHG emissions per trade lane, shipping company and ship type – based on emissions from individual ships – are in principle available, e.g. for containerships in the database of the Clean Cargo Working Group.

Green procurement

Ports have potentially large leverage over the service providers in the port. One could argue that the procurement of services has become one of the main tasks of most port authorities, following the emergence of the "landlord port model", which consists of privatising cargo handling and other services, with the public port authority in charge of regulatory functions, provision of common infrastructure and all other function related to being a good landlord, including finding tenants, operators and service providers. Considering the desire of many port authorities to market themselves as responsible actors with respect for the natural environment, green procurement could be considered a promising tool for port authorities. Green procurement is here understood to be a procurement process in which environmental criteria play a role in determining which firm gets the service contract.

Ports regularly engage in green procurement with regard to their terminal operators. European ports regularly take environmental criteria into account when awarding concessions to terminal operators. A relatively famous case in this respect is the call for proposals for the Maasvlakte 2 port extension in Rotterdam. In this procedure, one of the covered criteria related to modal shifts of hinterland transport from ports. Although GHG emissions from port terminals and hinterland transport do not enter into the calculations of shipping GHG emissions, we mention these examples because it points to the potentially

important role of ports and port authorities with regards to their procurement relations with service providers in the port. A similar greening of procurement and contracting relations could be undertaken with regards to maritime services that enter into the calculations of shipping's GHG emissions, such as towage and dredging.

The towage sector is gradually moving towards lower carbon intensity, but this is hardly ever driven by procurement from ports or governments. There are already hybrid tugboats (diesel-electric) but their development seems to have been mainly driven by innovative shipbuilders. There are two ways in which ports or governments could facilitate the transition towards lower carbon intensive towage operations: via the license needed to operate in a port/country and via a concession for towage services by the port. Licenses are the most common instrument that enables towage companies to enter certain markets. A quick evaluation of existing arrangements reveals that environmental performance, such as low carbon intensity, hardly ever form part of the criteria (Spain is an exception). In some ports, towage companies need to win a concession to be able to operate in that port. Concession criteria for towage services have, for the moment, as far as we are aware, not included GHG emissions from tugboats.

The situation for dredgers is more or less similar. There are maintenance dredging contracts that hardly ever take into account the GHG emissions from dredgers. The dredging that forms part of new port development projects could also be taken into account in criteria for awarding contracts for new port development projects. Also in the dredging sector, new low-carbon dredgers are being developed whose development and uptake could be stimulated by more green procurement by port authorities or government bodies in charge of ports.

Green berth allocation policies

Ship waiting time presents a substantial financial disincentive over which ports have some influence. Waiting time presents a cost for shipping companies because it means that they cannot utilise their asset while continuing to run their main or auxiliary engines. These costs could be considerable: e.g. the increase in daily operating costs from slowing vessels down by one hour at the Californian coast ranged from USD 250 to USD 600 as reported by operators (California Environmental Protection Agency Air Resources Board, 2009). Idling ships also contribute to GHG emissions, so trying to minimise ship-waiting times could help in reducing GHG emissions from shipping. Ports have leverage over this via their berth allocation policy.

Ports' berth allocation policies are beginning to focus on reducing waiting times. Traditionally, the berth allocation policy was based on the principle that the ship that arrived first would be served first. In dedicated or semi-dedicated terminals the ships of companies affiliated to the terminal will have priority. In various ports, there is slot allocation based on projected arrivals, which are updated when new information becomes available. However, in most cases this is still problematic, as it requires information sharing by a range of different actors that currently does not occur yet. Academic literature has described such smooth and optimal berth allocation as "virtual arrival policy", which could increase supply chain efficiency and reduce shipping emissions.

Such policies are hard to implement due to an asymmetry of costs and benefits. Reducing waiting time and turn-around time in port mainly benefits vessel operators, but they need port authorities and terminal operators to reduce these that do not necessarily have an incentive to do so. The motivation of ports is important, because they are in a position to implement pre-booking systems and make sure that pre-berth delays are minimised, e.g. by making sure pilots, tugboats and berths are available, cargo-handling equipment is ready etc. This is necessary for virtual arrival policies to work effectively.

Berth allocation policies could also explicitly introduce green criteria, which is uncommon in ports. The only example that we are aware of which applies this principle is the Environmental Premium Programme in Panama, introduced in 2017. This programme complements the ranking system for customers, based in part on how often a vessel operator uses the canal. The Environmental Premium Ranking allows ships to gain additional points in that booking system, which means that greener ships get priority in the allocation of slots.[5]

Ports in carbon-pricing schemes

Carbon pricing is generally considered an effective tool to mitigate emissions. The idea of a price on CO_2/ GHG emissions is that firms have a financial incentive to reduce their GHG emission intensity: by pricing carbon, the negative effects on climate change become internalised in the price of a good. Such a market-mechanism is generally considered to be more effective than regulation, as it requires less enforcement and is more flexible: a well-designed scheme makes sure that the largest reductions are taking place in areas where the potential for reductions is the largest. For example, in emission trading schemes firms can sell their rights to emit to other firms; in this way, firms with the lowest abatement costs could sell their rights to firms that have great difficulties in achieving the same goals. Schematically, carbon-pricing schemes can be categorised in two models: a carbon tax and an emission-trading scheme.

There is a wide variety of carbon pricing schemes, at different government levels. Some countries introduced carbon taxes, in some cases already decades ago, e.g. Sweden. Other countries have focused on emission trading schemes, e.g. China. There is also a considerable amount of carbon pricing at the sub-national level, e.g. in states, provinces and sometimes even at the level of cities. One of the most ambitious emission trading schemes is operating at the supra-national level, namely the European Union Emission Trading Scheme (EU-ETS) covering 11 000 large installations.

Most of these schemes do not include port or shipping activities. The main reason for this is leakage effects. In the case of shipping, it is complicated to assign GHG emissions to nations or regions, as the ship-owners of a nation can be headquartered elsewhere and often have registered their vessel in registry that has no relation to the nationality of the ship-owner. Carbon pricing schemes in a port could cover ships of all nationalities that call their ports, but in that case there is risk that ships will only call ports where the carbon pricing does not apply.

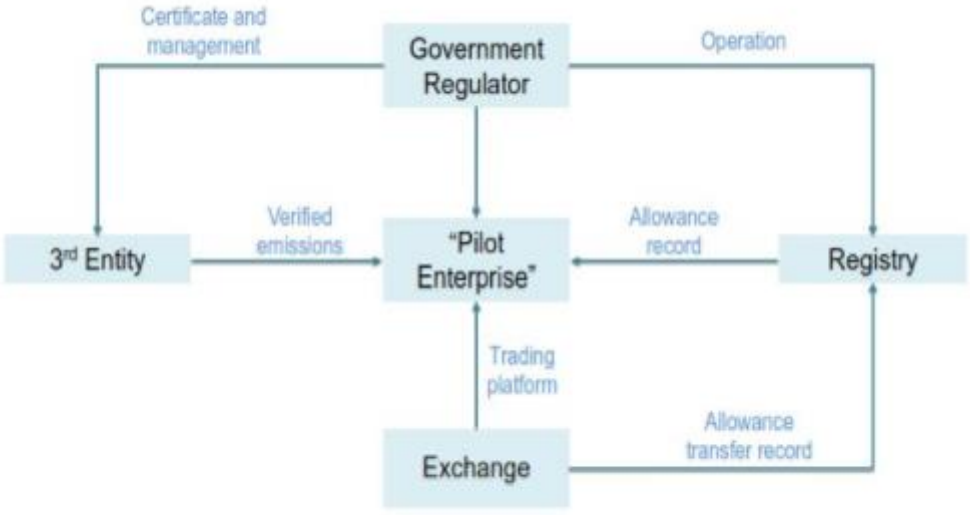
A notable exception is the case of Shanghai. This is one of the Chinese regional pilots on emission trading schemes, introduced in 2013. In the case of Shanghai both ports and domestic shipping are included (Box 3). This means that firms such as Shanghai International Port Group get assigned a certain amount of GHG emission rights that cannot exceed, unless they buy additional rights from firms that manage to reduce their GHG emissions. The leakage effect could be considered to be small considering the inevitable position of Shanghai when it comes to port activity (Shanghai has the world's largest port) and domestic shipping.

A possible model for port-based carbon pricing could be based on the Norwegian NO_x Fund. In this scheme, all ships operating in Norway pay a fee that goes into the NO_x Fund. Shipping companies can apply for a subsidy from the same fund to get innovative shipping projects funded that would help to reduce NO_x emissions from their ships (Box 4). These experiences have constituted the inspiration for the proposal for a European Maritime Climate Fund that was proposed by the European Parliament and was discussed between European Parliament, Council and Commission in 2017.

Box 3. **Shanghai emission trading scheme**

Shanghai was the second Chinese region, after Shenzhen, to start a pilot ETS in 2013 as part of the step-by-step development of the China national ETS scheme. The pilot covers more than half of the city's emissions, sixteen sectors in total, including power, industrial and non-industrial sectors like building, aviation and shipping. 368 entities were liable as of 2016 and its coverage is expanding. The Shanghai Development and Reform Commission (DRC) regulates the scheme and the Shanghai Environment and Energy Exchange was designated as the trading platform. Companies are required to monitor and report their CO_2 emissions every year and to have it verified by a third-party. The DRC has developed released guidelines for monitoring and reporting per industry sectors included.

Shanghai is the only pilot region that includes the aviation and port sectors in its ETS. It is also the only pilot ETS region that adopted different inclusion thresholds for industrial and non-industrial sectors. The inclusion thresholds for transport companies are 10 000t CO_2/year (or 5 000 tce/year) for aviation and ports, and 100 000t CO_2/year or (50 000 tce/year) for shipping, considering both direct and indirect emissions. There are free allocations based on sector-specific benchmarks (power, heat, car glass manufacturers), historic emissions intensity (industry, aviation, ports, shipping, and water suppliers, generally based on 2013-15 data) or historic emissions (buildings and commercial sector, generally based on 2013-15 data).



Source: Shanghai Environment and Energy Exchange

Penalties for failing to submit emission reports or verification reports on time or providing fraudulent information range from EUR 1 309 to EUR 6 544 (CNY 10 000 to 50 000). Penalties for non-compliance range from EUR 6 544 to 13 088 (CNY 50 000 to 100 000). On top of the financial sanctions, further sanctions may be imposed. The system achieved full compliance for three years in a row. In 2016 Shanghai further expanded its ETS coverage. Assessment of the impacts it has had on each business sector still to be produced. There is no data on the overall GHG emissions per sector but the target of the scheme is to reduce the overall CO_2 emissions by 20.5% compared to 2015 levels (originally -19% in 2015 compared to 2010 levels) with an absolute cap of 155 MT of CO_2 equivalents for 2016. The current price per ton per CO_2 equivalent approximates to USD 1.08.

Initially, the seven Chinese pilot ETS were scheduled to end after three compliance years and be replaced by the national ETS in 2016. However, as the national ETS should start in second half of 2017, the pilots will continue operating until then and probably also beyond. Shanghai has indicated a second 3-year phase to run until 2018, with the announcement of the transition plan for the Shanghai Emissions Allowances (2013–15) to be banked to Phase II 2016–18.

Box 4. **Norway's NO_x Fund**

In 2007, the Norwegian Tax Administration introduced a NO_x tax applicable to domestic shipping emissions. It is levied on energy production from propulsion machinery (total installed capacity over 750 kWh), motors, boilers and turbines (total installed capacity over 10MW), flares on offshore installations and land facilities as well as from waste incineration (since October 2010). The NO_x fund was created in parallel in 2008 so that companies can choose to pay a NO_x fee to the Fund instead of paying the NO_x tax (EUR 2.32 per kilo of NO_x emitted in 2017). Shipping and industry businesses affiliated to the fund pay EUR 0.50 and oil and gas producers pay EUR 1.5 per NO_x tonne they produce. Companies are exempt from the tax for a period of up to three years, but in return they are committing to investigate investments required to reduce their NO_x emissions and to report back to the board of the fund every quarter (which is proof-checked by DNV-GL).

Funds collected this way are put into the NO_x fund which is administered by 15 business organizations that have signed the Environmental Agreement with the Ministry of the Environment for the period from 2018 to 2025 (as an extension of the two former agreements for 2008-10 and 2011-17). These member business organizations are exempt from the NO_x Tax in return for their obligation to facilitate concrete NO_x reductions. Between 2011 and 2017, yearly emissions had to be reduced by 16 000 tonnes, with specific target reductions per year. In the new agreement, caps on total NO_x emissions (from sources covered by the agreement) per year in Norway have been introduced for every two year period. The cap for 2025 is 162 000 tonnes. The fund's support scheme is being reviewed with expected adjustments to come in the by 2018. Companies affiliated to the fund can apply for funding of up to 80% of the investment costs for emission reduction projects they want to implement. The Fund selects the most cost-effective projects and can also decide to support some operational measures. Its yearly budget is around EUR 80 million available to support NO_x reducing measures. Its total revenues from 2008 to 2016 have amounted to EUR 620 million. The Norwegian Pollution Control Authority oversees compliance to obligations set out each year. The Agreement can be terminated if reductions achieved are more than 25% lower than the obligations set, which automatically leads to a termination of tax emptions effective from the following 1st of January. If there is a deviation of more than 10% from the emission obligations for a given year, a collective sanction applies with companies in question requested to pay the NO_x tax for the percentage of the obligations to which the non-compliance applies.

The number of companies taking part in the fund has been steadily increasing since its creation with 938 companies supporting it in 2016. It has enabled the reduction of NO_x emissions in Norway by 34 000 tonnes by the end of 2016. Shipping is by far the main source of emissions reductions. It is projected that in 2017, 60.3% of NO_x emissions reductions will be attributed to it, while 32.6% will be to the oil and gas industry. The NO_x fund remains focused on NO_x and provides little data on other emissions reduction. However, DNV GL estimates that efforts of the NO_x Fund will have contributed to reducing annual CO_2 emissions by 670 000 tonnes at the end of the contract period in 2017 (Annual Report 2016, 2017).

The fund helped push the Norwegian fleet towards more sustainable forms of energy, contributed to advance technologies and to show others it is possible to run vessels cost-effectively without HFO on a significant scale. For instance, when the fund started in 2008, there were only three ships in Norway other than ferries using LNG to propel themselves but by 2015, the fund had granted support for 49 newbuilds and retrofits and there were 75 LNG powered ships in Norway. Inevitably, greater adoption of green ship technologies will contribute to further emission reduction from all sources. The use of LNG-propulsed ships already leads to a reduction of 10-20% in CO_2 emissions (Lloyd's Register, 2012). The range of alternatives investigated through the NO_x Fund funded projects is growing with developments in battery technology, biodiesel that have a much larger impact on CO_2 emissions reduction than LNG does. Yet, NO_x emissions reductions related to these options remain very small for now (Annual Report 2016, 2017). The Norwegian government is also discussing the creation of a CO_2 fund modelled after the NO_x fund to focus specifically on reducing greenhouse gases emissions.

Norway benefits from strong business involvement and cooperation and from an already progressive environment with early movers in the business sector driven by high consumer sensitivity and political support. Norway's economy also relies heavily on shipping and energy and would be strongly affected in case of regulatory changes, which can explain part of the reason its businesses are anticipating by getting involved to find solutions before others are. Therefore transitioning to LNG powered ships comes at a lower cost that in many countries and sustains the national energy market.

Overview of measures used in practice

The number of instruments used is fairly limited. Green port fees are used most frequently, in particular those based on green ship indexes, which tend to look mostly at energy efficient ship design. Four US ports deploy incentives for vessel speed reductions close to the port, and a handful of ports use port fee rebates to stimulate alternative fuels, in particular LNG. No green port fee scheme is currently based on actual GHG emissions from ships. Green procurement of maritime services practically does not take place, with the exception of Spain, yet the existing green ship indexes could be used for this as well, e.g. CSI, ESI or Green Award ratings could be used as preconditions for bids. Berth allocation in which environmental criteria are explicitly taken into account is only taking place at the Panama Canal, as far as we are aware. A carbon pricing mechanism in which shipping emissions are taken into account is currently functioning in Shanghai.

Table 7. **Categories of port incentives**

	Emissions	**Energy efficiency**	**Speed**	**Low-carbon fuels/energy**
Green port fee		28 of top 100 global ports	LA/LB, NY/NJ, San Diego	Singapore, Hamburg, Antwerp, Rotterdam, Bremerhaven, Gothenburg
Green procurement				
Green berth allocation		Panama Canal		
Carbon pricing	Shanghai			

2. What are effective measures?

Although port-based are fairly wide-spread, relatively little is known about their impacts. This chapter assesses the existing data and finds that even basic information, such as the uptake per port, is mostly unknown. Only for the vessel speed reduction incentives in Los Angeles and Long Beach do reliable impact studies exist. These seem to indicate that financial incentives can indeed help to "green" the behaviour of shipping companies.

Criteria for effectiveness

An assessment on the effectiveness of port-based incentives would ideally be able to state to what extent the programme has contributed to reduction of GHG emissions and to what other beneficial effects, against which costs. In such an assessment it would be important to establish a link between the measure and the effects and filter out other elements that might have contributed to GHG emission reductions. Such quantifiable impact analysis of policies is rare within the field of ports policies, indeed within most policy areas, so any assessment of policies ends up analysing other bits and pieces of evidence that could help to construct – or deconstruct - the case for policy intervention.

We assume that port-based incentives can only be effective if the incentive is substantial enough for shipping companies to change their behaviour and reduce GHG emissions. The incentive could be substantial dependent on four conditions: many ships are covered by the programme, many ports apply a scheme, the difference between fees for best and worst performing ships is large, and there are no leakage effects via port competition. These elements will be assessed below.

What does the evidence say?

There is very limited information available on the impact of port-based incentives. What exists most frequently is information on uptake of the programmes, although even this is not all that frequent. Some ports (and other organisations) also measure the amount of shipping emissions impacting air quality in ports, in particular SO_x and NO_x, sometimes on a yearly basis, but there are hardly any instances where port incentive programmes have been proven to reduce GHG emissions from shipping. Cost indicators are also relatively rare, so that it is practically impossible to conduct a cost-benefit-analysis of port-based incentives.

Uptake of green port fees

A fairly marginal share of the ships calling ports with green port fees actually gets a deduction of the port fee. This is difficult to ascertain, as few ports release data on the number of ship calls that were subject to a deducted port fee. Follow-up research could try to bring more clarity into this issue. The number that we have been able to find, suggest large differences in uptake (Table 8), ranging from 3% in Singapore to 18% in Vancouver. It should be realised that both Vancouver and Rotterdam are at the forefront of greening their port fees, so their numbers are probably not representative for all 28 top 100 ports applying green port fees. Some additional insight in the uptake is provided by the number of vessels that have been assigned with one or more of the indexes. The most popular index among ports is the Environmental Ship Index (ESI): in 2016, 47 ports used this index, which includes the top 100 seaports, smaller seaports, as well as inland ports. In that year, 5 500 ships had an ESI score that could be used as basis for a green port fee (Table 9). This represents approximately 6% of the total global

fleet, but the share of ships covered by ESI is rapidly increasing. It is also important to note that not all ships with an ESI qualify for a port fee rebate, as their score might not be high enough. The RightShip Index covers all ocean-going vessels, but it is only used by two ports.

The impact of green port fees on shipping's GHG emissions is negligible, as the indicators in which CO_2 emissions have substantial weight (CSI and RightShip) are only used by five ports. In the Clean Shipping Index, actual CO_2 emissions per ship count for 20% of the score. In the RightShip index, ships are scored for 100% according to their Energy Efficiency Design Index (EEDI) or Existing Vessel Design Index (EVDI) to determine energy efficiency compared to the average ship of same size and type. There are only five top 100 ports that use these indicators in their green port fee mechanism, as both indexes were developed with charterers in mind, rather than ports.

Table 8. **Application of green port fees in selected ports**

Port	Ship calls with reduced port fees	Share of total ship calls (%)
Singapore	3 700 (2016)	Less than 3%
Vancouver	561 (2016)	18%
Rotterdam	1 712 (2014)	7%

Table 9. **Uptake of main green shipping indexes**

Index	Ships covered	Number of ports using it
Environmental Ship Index (ESI)	5 500	47
Green Award	835	33
Clean Shipping Index (CSI)	2 300	5
RightShip	76 000	2

There might be an issue related to the accuracy of the scores assigned in some of the indexes. This is particularly the case for programmes where the score depends on self-reporting by shipping companies. There are some indications that there could be issues in this respect: 12.5% of vessels were found to be non-compliant during the ESI audits. This means that the ships were less environmentally performant than reported by the shipping company. In other words, it cannot be excluded that some shipping companies use ESI self-registration to receive discounts without actually having made the effort to reduce emissions (Becqué et al. 2017). There seems to be some inverse relation between coverage and rigorousness of scores. For example, the number of validated ships with Green Award is comparatively low because of the high cost of audits companied to the potential benefit of a certificate with three year validity, in addition to the high standards they are setting which means many ships would not be able to comply. Most of the validated ships with Green Award are inland vessels, for which the costs for registration, application and auditing were subsidised by the Netherlands of Infrastructure and Environment as a way to lower the barrier to entry.

The extent of incentives in green port fee schemes

The vast majority of ports apply rebates that range from 5% to 20% of the port fees. The maximum rebates range from 3% to 50% (Table 10). Many ports have tiered reductions, e.g. 10% reduction in Rotterdam if ESI score is higher than 31; this is doubled if the sub-score for NO_x is also higher than 31. In some ports, the rebates are absolute amounts rather than proportions of the port fee. In most ports with a rebate for LNG-powered ships, this rebate is larger than the regular rebate.

Table 10. **Green port fee rebates in a selection of ports**

Port	Basis for rebate	Maximum rebate
Antwerp (Belgium)	ESI LNG/scrubbers	10% 10%
Zeebrugge (Belgium)	ESI	10%
Rotterdam (Netherlands)	ESI, Green Award LNG, large catalysts	30% 20%
Le Havre (France)	ESI	10%
Hamburg (Germany)	ESI, Green Award, Blue Angel LNG	2-3% 15%
Bremerhaven (Germany)	ESI	50%
London (Britain)	ESI	5%
Oslo (Norway)	ESI	50%
Kiel (Germany)	ESI	10%
Ghent (Belgium)	ESI, Green Award	15%
Stockholm (Sweden)	NOx LNG OPS	SEK 0.22/GT SEK 0.05/GT SEK 1 million/vessel
Gothenburg (Sweden)	ESI, CSI LNG	10% 20%
Riga (Latvia)	Green Award (tankers only)	10%
Valencia (Spain)		20%
Setubal (Portugal)	ESI, Green Award	3%
Vancouver (Canada)	Multiple indicators	47%
Los Angeles (US)	ESI, Low Sulphur Marine Fuels IMO Tier III Engines VSR	USD 2 500/call USD 5 000/call 30%
Long Beach (US)	IMO Tier III Engines VSR	USD 6 000/call 25%
New York-New Jersey (US)	ESI, VSR	USD 2 500/call
Panama	ESI, EEDI, NOx, LNG	20%
Buenos Aires (Argentina)	ESI, Green Award	10%
Busan (South Korea)	ESI	15%
Tokyo (Japan)	ESI	50%
Yokohama (Japan)	ESI, Green Award	15%
Singapore	EEDI, scrubbers	50%

In all of the cases we have seen, there is a positive incentive (a reduced tariff) but not a negative incentive; in none of the ports is there a higher tariff for the more polluting ships. One of the exceptions – although not a port fee – is the Swedish scheme of fairway dues, in which ships are categorised in different classes, according to their environmental performance, with different fee levels: the more polluting ships pay higher fees than the cleaner vessels. In its system of fairway dues, the Swedish Maritime Administration uses the Clean Shipping Index (with its 1-5 star classification) to differentiate vessels. The differentiation in the environmental part of the fairway due is substantial, with the best performing ships (category A) paying 10 times less than the worst performing ships (category D/E). Especially for ship-owners with frequent calls to Sweden, this has the potential to drive real changes.

One could argue that ports raise their general tariffs in order to pay for the discounts. In practice however, there is no such direct link: most ports seem to adjust spending priorities rather than explicitly raising port tariffs to finance green discounts. If there is a negative incentive for ship-owners this is diffused in most cases. It should also be noted that port dues represent a small share of ship running

costs, but a relatively large share of port revenues, e.g. half of the revenue of European ports (ESPO, 2015).

Although some of these schemes provide ship operators with the possibility to practically halve port fees, these occasions are rare. This is again difficult to establish, considering lack of precise public information on how many vessels have received the maximum rebates in different ports. There is also a lack of publicly accessible data on budgets that were dedicated to the port fee rebates, although some ports are willing to provide data on request. Some of the budgets quoted in the literature are for Antwerp and Civitavecchia (both EUR 0.5 million) and Amsterdam (EUR 135 000) (COGEA, 2017). In the case of Antwerp, this would mean that the average rebate given to the ships that qualify for a rebate is in the order of EUR 1 000. Evidently, the rebate is dependent on ship size and ship type. COGEA (2017) elaborates that on average in EU ports a 10% rebate of port dues would represent EUR 5 818 per call for a VLCC, EUR 2 792 for a 13 000 TEU containership and EUR 439 for a large ferry ship.

Most of the port fee reductions remain marginal in relation to total costs of running a ship. According to Stopford (2009), port costs (which include port dues) represent less than 10% of these costs; the impact assessment of the EU Port Regulation (EC, 2013) indicated that port fees represent 5-10% of the port-related costs, so port dues likely represent less than 1% of total ship running costs. In practice port fee reductions only represent a fraction of this. This is caused by four factors. First, most ports that the ships calls do not have green port fees. Second, the difference in port fees for best and worst performing ships is very small. Third, virtually none of the ports apply port fee reductions based on GHG emission reductions. And fourth, it is not actually very clear if the ship-owner gets the benefit of the port fee reduction. There are different arrangements to ship cargo; depending on these arrangements (the sort of charter agreement) it is the ship-operator or the charterer that pay the port fees.

Leakage effects of port competition

It is sometimes claimed that market-based mechanisms applied to regional or local level could lead to leakage effects. This is not the case for the existing port-based incentives. The reason is that the schemes are essentially paid by ports, not by the "polluter". In a way, one could consider green port fees a way of port authorities to attract shipping companies by offering them an additional rebate – and one wonders if in some markets this could not actually be qualified as market distortion. Leakage effects because of port competition are the main reason why there is no effective environmental differentiation of port fees, as ports know that if they "penalise" the worst performing ships with a higher fee than competing ports, these ships might be diverted to these ports. So there is a "market failure" with regards to the application of the polluter-pays-principles in port-based incentives.

Effectiveness of vessel speed reduction incentives

Vessel speed reduction schemes for ships near port areas are generally considered to be effective instruments. The participation from shipping companies has been very high: according to the Port of Long Beach Compliance Report for year 2016, compliance is over 96% at 20 nautical miles and over 88% at 40 nautical miles. In 2008, the Port of Long Beach estimated that the program led to the reduction of CO_2 equivalent emissions by 26 000 tonnes. NO_x, SO_x and PM emissions were respectively reduced by 678, 453 and 60 tonnes. Based on compliance in the 40 mn range from 2009 to 2011 in Long Beach, Ahl et al. (2016) found that discounts provided have a positive effect on compliance to the VSR for bulk, containership, general, tanker and mixed-cargo vessel operators. They however note that the effects vary greatly by operator type, suggesting a role for differentiated pricing strategies to better motivate compliance and improve the results in terms of air emissions (Ahl et al., 2016).

The average delay for a ship slowing down to 12 knots within 40 nm of the ports of LA/LB is close to two hours, which is within the expected time window of arrival, but could represent a cost for the ship operator. The reason why ship operators are willing to sacrifice this time is related to the regulation in California that vessels within 24 nm of the shore have to use low-sulphur fuel. As this fuel is considerably more expensive than heavy fuel oil, the ship operator can cut down its consumption of this more expensive fuel by slowing down close to the port area and at the same time get the reduction of port fees related to the vessel speed reduction programme.

Modelling impacts of green berth allocation policies

Modelling indicates that virtual arrival policies could bring large benefits in terms of emission reductions. Jia et al. (2017) indicate that reduction of idling time in ports could bring fuel savings from 7% (with 25% reduction of 'excess' port time) to 19% (with reduction of all inefficiencies in ports). This corresponds to USD 39 000 to 105 000 per voyage. If 50% of the estimated waiting time could be avoided, the consequential slow-down in average sailing speeds could lead to an average reduction of 422 tonnes of CO_2 per voyage (Jia et al. 2017). A study on EU ports in the Baltic Sea concluded that the potential benefits in that region of green approaches – that is: speed adjustments instead of anchoring – could reduce fuel consumption by EUR 27 million per year in a scenario where 15 000 anchorings by ships waiting for berth are replaced by a green approach 12 hours prior to arrival, reducing speed by 25% (Andersson & Ivehammar, 2017). Such a scenario could lead to annual CO_2 emission reductions of 65 665 tonnes. Several ports are working on initiatives to reduce waiting times, but the effectiveness of these initiatives requires collaboration along the whole maritime logistics chain.

3. Lessons learned: Conditions for policy effectiveness

Although impacts are difficult with imperfect information, it is fairly safe to say that the effectiveness of port-based incentives to reduce maritime GHG emissions remains pretty marginal. Yet, the principles on which these measures are based are very instructive and their wider application could have huge potential, provided that certain conditions are met. Port-based incentives could have more impact if they were wider applied, if the financial incentives were larger, if the schemes stimulated technological innovation, if schemes focused on carbon, and if they could become more harmonised. The lessons from port-based incentives are summarised below.

Ports are taking actions which can have an effect on shipping emissions

These actions incentivise cleaner ships, but also increase the efficiency of operations, which can have an effect on shipping emissions. The previous sections have provided evidence of the various practices applied in major world ports. These practices form an illustration that the important precedent that market interventions are needed to reward clean performance is established through port-based measures. The fact that financial incentives have been chosen implies that there is support for flexible measures to drive behavioural change.

This important role of ports needs to be acknowledged in government policies and global climate negotiations. It deserves to be stressed more in the nationally determined contributions (NDCs) where relevant. Virtually none of the INDCs submitted prior to the COP21 negotiations refer explicitly to the ports sector. This is despite the fact that decarbonised shipping could provide an effective modal shift away from less efficient long haul road transportation. The updating of NDCs by 2020 provides an opportunity to explicitly stress the role of ports in reducing emissions within port areas, but also their potential role in facilitating a transition towards a low carbon transport sector.

Port-based incentives deserve to be recognised as potentially useful measures in the IMO Initial GHG Strategy due for 2018. As such, it could express the desirability of solutions at different intervention levels (polycentric) rather than just the global level, considering the opportunities it provides for dealing with complexity and uncertainty in the face of global climate challenges (Ostrom, 2010). The main advantage of location-based policies, such as port-based incentives, is that they engage a broader range of actors with a direct stake in reducing GHG emissions, such as port administrations or cargo-owners (Gritsenko, 2017). Recognition of port-based incentives in the IMO Strategy could also help to expand their use and facilitate the move towards application of the polluter pays principle in these instruments.

More emphasis is needed on assessing the impacts

One of the key observations of this report is the lack of empirical evidence on the impacts of most of the port-based incentives. We argue that the impact on GHG emissions from shipping is likely to be very small but that there are potential benefits to be gained under certain conditions. Considering that public port budgets are being spent on these incentive schemes, governments might be interested in the value for money of the schemes, particularly considering the expanding nature of these. We referred to possible irregularities on the self-reporting of ship-owners on certain of the green shipping indexes. This might suggest the need for stronger auditing of certain schemes and consideration of enforcement or sanction mechanisms to avoid misuse of the index and the related port incentives.

Higher rates of differentiation could drive more change

Green port fees can only work if they create a large enough incentive in relation to the operating costs of shipping companies; that means: if the difference between fees for "green" and "dirty" ships is large enough and clear up-front. We assume this is currently not the case, in line with Van den Berg et al. (2017). Most of the port fee reductions remain very marginal in relation to total operating costs of shipping companies. This implies that port fees could at best reward certain quick-wins that might have happened anyway, but not fundamental changes in behaviour, such as retrofits or ordering of greener ships that may require additional investment that somehow needs to be covered without impacting competitiveness.

The impact of green port fees could also be much larger if there would not only be a positive incentive (for the greenest ships), but also negative incentives for the ships with worst emissions performance. In practice, green port fees currently function as public subsidies rather than as a cross-subsidy from "worst performing" to "best performing" ships. In other words, some ports might use public funds to finance green port rebates to increase their cost competitiveness vis-à-vis other ports in the region. Port fees would be much more powerful instruments if the whole fleet would be subject to environmentally differentiated port fees. This could be done by introducing different tiers of ships (ranging from "worst performing" to "best performing") that have their own tariff, so that the ships with the worst emission performance cross-subsidise the reduced fees for the ships with best emission performance. One way would be to require those not participating to be classified as "worst performing", therewith subject to higher port fees. This would be a way in which the polluter-pays-principle could be applied to port fees. Such a practice would be similar in principle to other cross-subsidies that ports provide to ships, e.g. regularly calling ships are often cross-subsidised by the occasionally calling ship, and bigger ships by smaller ships (ITF/OECD, 2015). In this sense, environmentally differentiated port charges should not be considered as the assignment of taxing power to a port authority, but rather the extension of already existing practice of cross-subsidisation via port fees.

Critical pre-condition is to increase the cooperation between ports, so that competitive pressures between ports will not hinder them from imposing higher tariffs on the ships with higher emissions. Despite the existing cooperation between ports, e.g. via the World Port Climate Initiative that stood at the basis of development and expansion of the Environmental Ship Index, no joint initiative to develop some sort of a "malus" to complement the current "bonus" has been taken.

The transition of shipping to a low-carbon pathway requires incentives – such as certificate based or market-based mechanisms and port-based incentives – but also the roll out and development of feasible technological solutions. Although many innovative ideas have been put forward to fully decarbonise shipping, many of these ideas still need to be commercialised and be tested by frontrunners and financial support for deployment will be necessary in order to reduce risk for firms and banks to invest. In other words, the decarbonisation transition requires the opening up of new markets for new technologies. Port-based incentives could also play a role here.

The transition path towards low-carbon shipping could be accelerated if there would be positive incentives related to technological innovation. The current green port fee rebates might or might not translate into the use of new innovative shipping' technologies or applications; most likely they just provide a bit more budget margin to shipping firms, as the rebate is not earmarked for innovation. This is different in schemes like the Norwegian NO_x Fund, where all ships pay a fee, depending on their NO_x emissions, but where the firms operating these ships can apply for subsidies for innovative solutions that would help to reduce shipping's NO_x emissions.

Similar schemes are likely to emerge to mitigate shipping's GHG emissions. Current examples include the proposal of the European Parliament for a Maritime Climate Fund, designed along the same principles. Transport agencies in Sweden have recently proposed the creation of a CO_2 Fund for shipping (ITF/OECD, 2018). Such initiatives could help to drive technological change and create markets for new low carbon shipping technologies in these regions. Early designs can and should help to inform the development of a global strategy.

It would make sense to increase focus on GHG emissions

Port-based incentives could be more effective in mitigating shipping's GHG emissions if they would be more clearly focused on GHG emissions. Instead, most of the port-based incentives have multiple environmental objectives, in many cases related to local pollutants, noise and dust. This tends to dilute the potential impact that incentives could have on mitigating climate change. Although the emphasis on local air pollution makes sense for ports, many of which are either under control of local governments or under scrutiny of local population, most of the local pollutants are increasingly being taken care of by regulation. Sulphur emissions from shipping are subject to a global cap, to emission control areas in certain parts of the world and to national or supra-national regulation, such as the EU sulphur directive. This means that the value added of port-based incentives on mitigating sulphur emissions is likely to be small.

The GHG emission focus of port-based incentives could be increased by aligning more closely to actual GHG emissions from ships. None of the green port fees takes actual GHG emissions as a base for the fee reduction. Improved data collection at the ship level makes it increasingly possible to assign accurate estimations of GHG emissions to individual ships. This opens the possibility of financial incentives at the port level based on actual emissions of the ship during its voyage. If air quality and GHG policies are not aligned there is the potential for air quality mitigation to increase emissions of GHGs it is therefore essential that the two policy areas are aligned to give the shipping industry unambiguous signals. Ways in which the focus on GHG emission mitigation could be increased is: increase the weight factor for GHG emissions in the port schemes or green ship indexes, replace some of the local pollutants by GHG emissions in the indexes because of new regulation, or change the way in which local pollutants are being incorporated in the index, e.g. from rewarding good performance to penalty for non-compliance.

There is potential to achieve more through wider, more harmonised and coordinated application

Most shipping companies – particularly those in liner shipping – use a network of ports, so the effect of a green port fee would be much higher if all ports in the network applied it. Despite recent increases in the number of ports with green port fees, there are simply not enough ports with green port fees to make it a real powerful instrument. Some trade lanes – such as Far East-North Europe – start to develop into a string of "green" ports, but there are still too many ports without green incentives. In order to avoid that port fee reductions turn into a commercial instrument of ports to attract shipping companies by providing "aid", it is essential that the reductions are financed by the less-performing ships, rather than from other port revenues, such as income from port concessions and rental income.

Whereas the development of green port fees has started to create some critical mass, this is certainly not the case for the other instruments discussed in this report. The use of these instruments needs to expand for port-based incentives really to have an impact. Vessel speed reduction incentives have remained a US West Coast speciality, but there is a priori no reason why other port ranges would not be able to replicate the scheme. The Panama Canal Authority has introduced an innovative idea to give

priority slots to green vessels; a similar idea could be much more widely applied in ports, as waiting time is arguably a large disincentive for shipping companies. More generally, better-timed ship arrivals could save time and emissions, but would require intense cooperation between many stakeholders, including a network of ports. Ports already have experience with introducing environmental criteria in terminal concessions; this experience could be used to apply similar "greening" of the licensing, procurement and tendering of services such as towage and dredging. Finally, some places have started to introduce shipping into carbon pricing initiatives, which could also be wider applied.

Port-based incentives could be simplified and harmonised. The current framework for green port fees consists of a multiplicity of indexes, indicators that altogether result in fairly marginal financial incentives for shipping companies. This can be explained by the experimental character of most of these schemes and the simultaneous development of more or less similar schemes. Now that the instrument has proved viable and workable, a more coordinated approach would be warranted with regards to its further roll out and scaling-up. Although many stakeholders might have invested human capital in the development of different specific indexes or solutions, the effectiveness of port-based incentives could arguably be increased by converging existing indexes and instruments into one harmonised and simple index that could be applied in all world ports.

Another condition for effective port-based incentives is to share benefits between actors that are needed to deploy measures. E.g. the benefits from virtual arrival would accrue to ship-owners, whereas it involves a lot of work for a port authority to arrange for a smooth arrival. It would be important in this respect to explore how a virtual arrival policy could be designed in such a way that interests from ship-owners, charterers and port authorities are aligned – that is: how fuel savings from implementation of virtual arrival – and from reduction of waiting times more generally - could be shared among stakeholders (Jia et al. 2017). Development of win-win benefit sharing schemes could be explored that might be rolled out globally. Reduction of port demurrage (waiting time compensation) could be used as a motivational element for port commitment, as suggested by Gibbs et al. (2014).

Most port-based incentives have so far been voluntary schemes and carried out because of the environmental consciousness of certain port authorities, or the willingness to increase port attractiveness via port fee rebates, financed with public money. Yet, current practice is still far removed from full-fledged application of the polluter pays-principle. If one agrees that climate change requires urgent policy responses and that widespread deployment of port-based incentives could help to decarbonise maritime transport, there is a need to apply this polluter principle via a system of environmentally differentiated port fees, applied to all ships, not just a rebate for the greenest ships. In the context of port competition, port authorities that can afford it are willing to provide green port fee rebates, but not to introduce systems in which rebates are paid for by the ships with worst emission performance. In order to overcome this market failure, commonly agreed principles would need to emerge that would guide the practices of ports and major port countries. An effective mechanism might consist of a harmonised index or score assigned to all ships, taken as basis in all ports for a differentiated port fee, and used by shippers in their reporting on the carbon footprint of their supply chain.

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Notes

1 Officially called Paris Agreement under the United Nations Framework Convention on Climate Change.

2 As the maximum ESI score is 100 points, the weight of CO2-related indicators is 15%.

3 EEDI (Energy Efficiency Design Index) measures the theoretical CO_2 emission performance of new ships over 400 gross tonnes and is calculated from ship design and engine performance data. This is a regulatory requirement for new ships developed by the IMO (and applied on an ad-hoc basis to existing vessels). EVDI (Existing Vessel Design Index), developed by RightShip, also measures a ship's theoretical CO_2 emissions per nautical mile travelled. However, the EVDI can be applied to existing vessels as well as new builds where EEDI is not available or applicable.

4 The electricity tax rates that should normally be paid are SEK 293 (EUR 33.94) per MWh or SEK 185 (EUR 21.43) per MWh in Northern Sweden). Swedish authorities apply SEK 50 (EUR 5.79) per MWh of electricity tax to shore-side electricity.

5 Vessels with EEDI efficiency numbers 20 percent below baseline get the qualification “Level 1”; ships 30 percent below baseline receive the qualification “Level 2”. There are similar provisions for the Environmental Ship Index and for NOx emissions, and any vessel with an LNG-fueled engine qualifies for Level 2. Vessels that qualify for Level 1 receive an additional 10 percentage points for each transit through the Canal towards their overall customer ranking, and vessels that qualify for Level 2 receive an additional 20 percentage points per transit to improve their rank.

International Transport Forum

Reducing Shipping Greenhouse Gas Emissions

Lessons From Port-Based Incentives

This report reviews port-based incentive schemes to reduce shipping emissions, such as environmentally differentiated port fees. Greenhouse gas emissions from shipping currently represent around 2.6% of total global emissions, but this share could more than triple by 2050. Ports have a crucial role to play in facilitating the reduction of shipping emissions, alongside the ship operators themselves. Which incentives are currently used? What are their impacts? How could positive effects be increased? The report also explores lessons learned that could inform international negotiations on the reduction of shipping greenhouse gas emissions.

This report is part of the International Transport Forum's Case-Specific Policy Analysis series. These are topical studies on specific issues carried out by the ITF in agreement with local institutions.

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