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Green Port Pricing - A case study approach

by

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Acknowledgements

Over the past year, the entire journey of studying in Maritime Economics and Logistics program (MEL) has been likes a dream-come-true experience to me. Already since 2010 when I was working in Rotterdam, I could not stop thinking about my greatest wish to study at MEL. In 2014, the dream finally came true. Now, this one of most unforgettable times of my life will end up in the thesis. At the end of his wonderful journey, I would like to express my special thanks to people who helped me.

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Abstract

Nowadays, a lot of attention is paid to the environmental impact in the shipping industry. Ports play a vital role within the industry and have big influence on carriers' behaviour within harbour areas. In recent years, more and more ports introduced environmentally-friendly incentive schemes to encourage greener shipping and promote green ports. This research focuses on finding the crucial parameters to determine the best practice on environmentally-friendly incentive schemes.

In this study, an overview of the current practice on environmentally-friendly incentive schemes of 43 world leading seaports is presented. In order to define the most critical parameters on port pricing, this study carries out the case study based on three representing ports with different sizes: Port of Hamburg, Port of Gothenburg, and Free Port Riga. Besides the solid analysis of the ports, the scenario analysis has been carried out to have a better insight into the changes on the regular price level when the discount price level is adjusted.

In the case study, the turnover rate to ship owners was demonstrated in terms of three aspects: (1) the extra costs of building solely LNG-fuelled vessel recovered by the rebate granted from the LNG discount at port of Hamburg (2) the retrofitting costs of Selective Catalytic Reduction recovered by the rebate granted from the Clean Shipping Index discount at port of Gothenburg (3) the retrofitting costs of dual-fuelled LNG engine recovered by the rebate grated from the LNG discount at port of Gothenburg.

Additionally, this study also looks into how shipping companies react to current green port incentive schemes. For this purpose, we conducted interviews with seven senior managers from four different liner shipping companies.

In conclusion, we found that there is no one perfect formula of environmentally-friendly incentive scheme to apply to all ports. Each port should set up a scheme taking into account its own uniqueness. For this purpose, this research provided several parameters in assisting the ports to determine an appropriate incentive scheme.

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List of Abbreviations

AMP™	Alternative Maritime Power™
CAPEX	Capital expenditure
CARB	California Air Resources Board
CSR	Corporate Social Responsibility
CPV	Cost, Performance, Value
CSI	Clean Shipping Index
CIS	Commonwealth of Independent States
DPM	Diesel Particulate Matter
EIAPP	Engine International Air Pollution Prevention
ECA	Emission Control Area
ESI	Environmental Ship Index
EEDI	Energy Efficiency Design Index
EVDI	Existing Vessel Design Index
FPR	Free Port of Riga
GRT, GT	Gross register tonnage
GHG	Greenhouse Gas
HPA	Hamburg Port Authority
HHLA	Hamburger Hafen und Logistik AG
IMO	International Maritime Organization
LNG	Liquefied natural gas
MARPOL	International Convention for the Prevention of Pollution From Ships
M.V.	Motor Vessel
NRT	Net registered tonnage
NECAs	NO_x Emission Control Areas
OPS	Onshore Power Supply
OGV	Ocean Going Vessel
POLA	Port of Los Angeles
POLB	Port of Long Beach
PSC	Port State Control
SVIS	Ship Vetting Information System
SCR	Selective Catalytic Reduction
SECAs	SO_x Emission Control Areas
TEU	Twenty Feet Equivalent Unit
T/S	Transhipment
UNCTAD	United Nation Conference on Trade and Development
ULCS	Ultra-large containerships
WPCI	World Ports Climate Initiative

Chapter 1 Introduction

1.1 Background and Objectives

According to Chou (2010), global fleet's CO2 emission accounted for as high as 3.3% of global CO2 emission. Due to this fact, reducing greenhouse gas has become an important issue around the world. In order to reduce emission from vessels, some ports provide environmental rewards on port dues. However, how does a port decide a percentage of the incentive? How to make sure this incentive can bring largest interest to the public as well as to the port? Will the incentive attract carriers?

In 2014, Rotterdam port authority paid out EUR 1.2 million for a total of 1,413 vessels which have qualified score of Environmental Ship Index (ESI) (Port of Rotterdam 2015c). In order to encourage green shipping and to prevent huge loss of port, how big should be a discount on port fees while keeping in mind that the green incentive plays a crucial role in this issue.

In addition, based on the research carried out by Lin (2013), seven out of eleven interviewees from ports officials think that the reputation of green port is very important. Although promoting green port is very important and it is a good way to contribute to the reduction of negative environmental impact, it brings extra costs to shipping companies. For this reason, shipping companies are more passive in promoting green ports. However, ports offer some environmentally-friendly incentives that help to achieve a green port.

Although in many research papers there has been a lot of discussion on the port pricing, green port dues etc., it remains unclear how a port can decide on a perfect green port dues through thinking clear and logically. Hence, this research is motivated to find out a solution to meet this academic insufficiency.

1.2 Research Questions

The main objective of this thesis is to identify the best practices among the ports that are in favour of greener shipping. In order to achieve the objective, research questions listed below have to be answered.

1) Best practices in green port dues.
2) How do ports set up port dues incentive schemes to favour environmentally friendly ships?
3) How do shipping companies react to green port dues?
4) What is the optimal tariff for port authority to minimize loss from the environmental friendly incentives?

1.3 Scope and Limitations

The study mainly discusses how port authority sets up port charges according to its financial situation. We will look into pricing methods such as cost-based pricing, differentiated cost pricing, and strategic pricing. It will not consider special issue such as concession in this study. The study area is the Baltic Sea. The contribution to the business and society of this thesis is that ports can refer to the best concepts of pricing to set up the relevant tariffs favouring greener shipping. In this case, ports

can adjust the tariff to cover the costs in order to improve the environment in harbour areas. Reducing pollution in harbour areas is beneficial to the public and the society.

1.4 Methodology

The objective of the research is to find out what determines the best practice among port pricing model for favour of greener shipping. Since this topic is quite new, there is limited literature available on this topic. Therefore, this research was carried out by means of case study with focus on scenario analysis and interview.

Case Study

Eisenhardt (1989) concluded that the use of case study approach to a new topic area is especially appropriate. He built up eight steps for the process of case study: (1) Getting Started (2) Selecting Cases (3) Crafting Instruments and Protocols (4) Entering the Field (5) Analysing Data (6) Shaping Hypotheses (7) Enfolding Literature (8) Reaching Closure. He (Eisenhardt 1989) claims the hypothesis and theories gained by case study are often empirically valid , novel ,and testable because the process of case study is tightly and highly iterative linked to data. However, the complex data might lead to the difficulty of understanding in the results.

Yin (1993) considers that case study method can be used in getting a close understanding of a particular situation. By evaluating evidences from varied data source, case study helps to reduce the gap between the research and reality. He thinks the general principles include: (1) Using multiple sources of evidence (2) Creating a case study data base (3) Maintaining a chain of evidence.

Designing and Choosing Case Study

In order to achieve the objective of this research, we review existing literatures of transport and port pricing. We use the theories and concepts such as marginal cost pricing, strategic pricing that were derived from the literature review. And we evaluate the practical pricing theory by doing the case study.

According to the Baltic Marine Environment Protection Commission - Helsinki Commission (HELCOM 2012), the Baltic Sea has around 2000 ships in its area at any given moment and approximately 3,500-5,000 vessels across the waters of the Baltic Sea. The oil transportation is expected to increase by 40 percent increases and cargo/container flows is estimated to triple by 2017. It is also important to note that this area is heavily polluted (Kågeson 1999) which is an important factor for our study. We picked up three ports of the busiest ports which are located in or closed to the Baltic Sea area: port of Hamburg, port of Gothenburg, and port of Riga.

For the purpose of applying the results to different sizes of ports, three ports of different throughput size are chosen for this study: port of Hamburg represents a large size port, port of Gothenburg represents a middle size port, and port of Riga represents a small size port.

Port of Hamburg is one of the busiest European ports. Its port authority offers five different environmentally friendly incentives covering all shipping sectors: container, liquid bulk, dry bulk, tankers, cruises, and ferries. Additionally, considering its importance within the industry and variety of incentive schemes, this port is chose as studied case represents the large size port.

Swedish port authority has notable years of experiences in environmentally friendly incentive schemes. Some researches also use Swedish ports as example to prove the positive relationship between the reduction of ship emissions within the harbour areas and environmentally friendly incentive schemes. Therefore, we chose port of Gothenburg, whose throughput accounts for one third of the entire international trade volume in Sweden, as our second sample port. It introduced environmentally-driven port tariffs since 1998. It stands for middle size port in this research.

For the small size port, we take Freeport of Riga (FPR) as studied case. Dry bulk is the majority of traffic flow at FPR. It offers the incentive to the carriers with Green Award certificate which is designed specifically for bulk carriers and tankers. Therefore, FPR is a very good example to look into environmentally friendly incentive scheme towards bulk and tanker sectors.

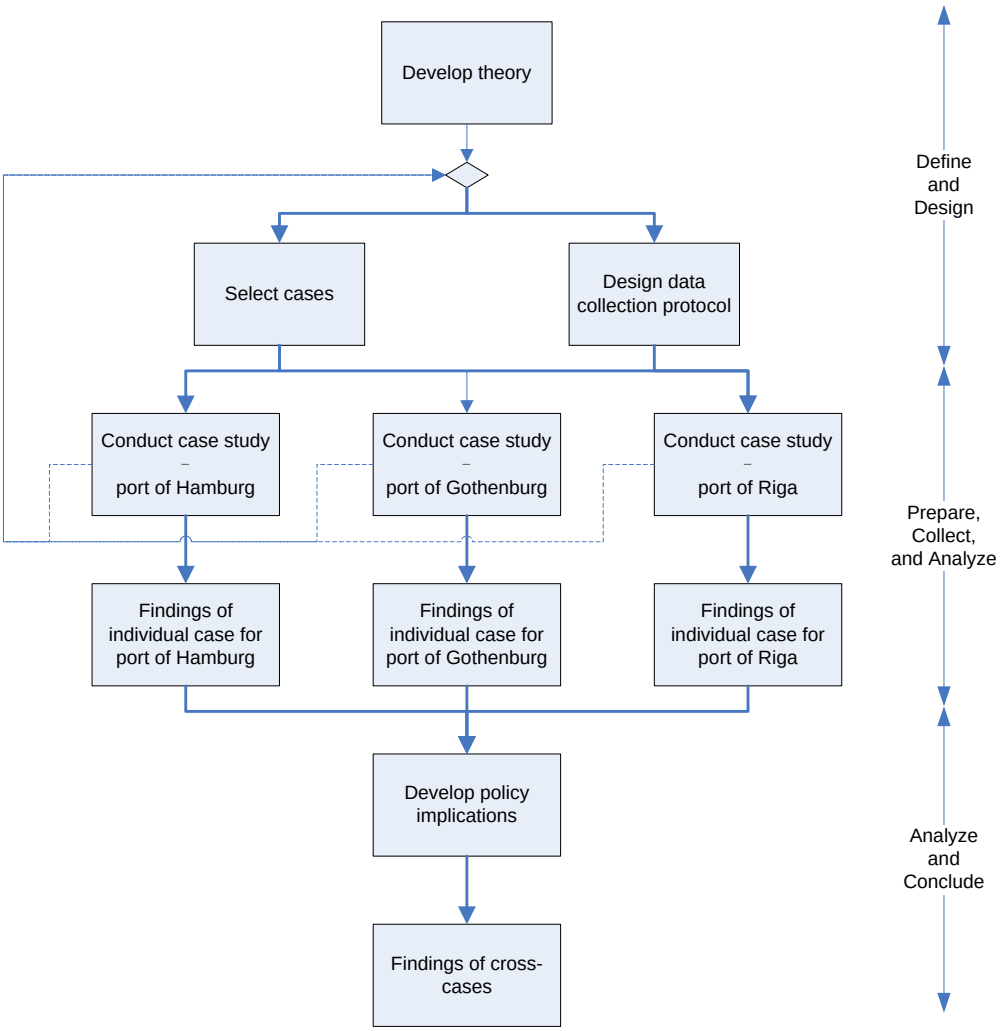
Scenario Analysis

Base on the simple formula (Jenny 2013): $a_1 * b_1 + a_2 * b_2 = c$, where "a" represents the price, "b" as the volume, and "c" as average price, a suitable formula has been developed for each studied case.

The average price is determined by real cases of green port dues at each port together with assumption of traffic volume in portfolio 1 under scenario I. The traffic volume is divided into two categories: the one charged with regular price, and the other charged by discount price. The regular price should rise if the average price of income is fixed regardless the changes of portfolio of traffic volume. We used this average price to examine the changes of regular price and discount price under different portfolio of traffic volume. To examine the changes of regular and discount price, the discount percentage of each green port dues was increased and based on the same portfolio in scenario II.

The case study structure is shown in Figure 1.

Figure 1 Case study structure



Source: (Yin 1993) and modified by the author

Interviews

Some interviews were conducted with department managers from shipping companies. The interviewees of shipping companies are the general managers who are responsible for port charges. Through these interviews we intend to collect real/primary data from practical business world which we can testify academically.

To ensure that all interviewees respond to exactly the same questions and the area we want, a structured interview was used for this study. Using a structured interview helps respondents to react to all the listed questions in a well-organised, easy, and quick manner. Besides, the questions of the interview were sent out to respondents prior to interview in order for them to better prepare.

Data Base

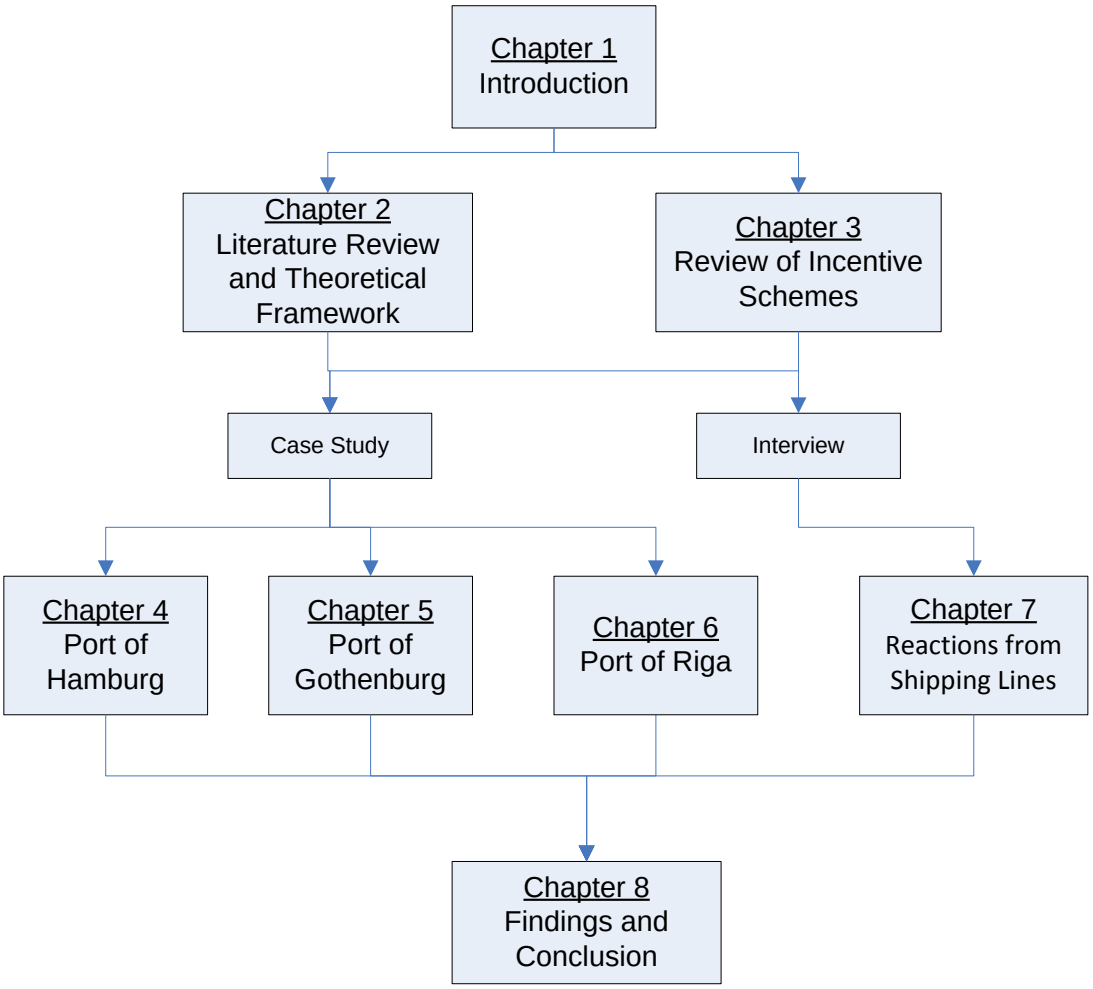
In order to have reliable and reasonable results, the data of this research are collected from three sources: (1) Internet research (2) Documentation (3) Interview.

Firstly, the internet research is used to collect secondary data for existing ship rating system and incentive scheme for greener shipping. There are several ship rating systems in the market for carriers to prove that their fleets have better performance than the minimum requirements of regulation. Moreover, notable amount of ports worldwide have introduced the incentive scheme for greener shipping to reduce environmental impacts.

Secondly, we look into some influential and representative documentation, both in English and Chinese, such journals, reports, and literatures, etc., in order to extract some useful data which can be of contribution to the analysis of this research.

Finally, a couple of interviews are carried out to collect primary data to answer the sub-research question: “How do shipping companies react to green port dues?”.

1.5 The structure of the thesis



Source: Elaborated by the author

Chapter 2 Literature Review and Theoretical Framework

2.1 Transportation Pricing

"Pricing is a method of resource allocation; there is no such thing as the "right" price, but rather there are optimal pricing strategies that permit specified goals to be obtained."(Button 2010) The optimal price may be different for achieving different objectives. For instance, the optimal price for achieving the maximum welfare will be significant lower than the optimal price for achieving the maximum profit. However, the pricing power of suppliers is highly dependent on the forms of market, such as perfect competitive and monopoly markets. Thus, the structure of the market should be taken into consideration in the pricing strategy.

Button (2010) discussed the following issues in his research for the pricing of transport services: matching supply with demand, marginal cost pricing, difficulties of "second-best" situations, price differentiation, pricing discrimination and yield management, pricing with stochastic demand, the problem of the peak, transport subsidies and operational objectives, market instability, suboptimal supply and the empty core, indirect pricing.

Private enterprises are traditionally motivated to pursue maximum profits. The price level depends on the form of the market. In free competitive market, the price level will be reflection of the interaction between supply and demand in the market. Thus, the price level in the long run will be equal to marginal (and average) costs of suppliers. No single supplier has the power to control price and no single supplier has the possibility to earn huge profits. In contrast, a profit-maximizing price which is above the marginal (and average) costs will be set by a monopoly supplier. In sum, social welfare can be maximized by setting the price level that equals to the marginal cost.

Whether short-run marginal cost pricing or long-run marginal cost pricing is more appropriate? Button (2010) states that the short-run marginal cost pricing can optimise the use of the existing capacity but the capital and any other fixed costs are not taken into account. On the other hand, Haralambides (2002) and Bromwich (1978) argue that in order to ensure port's economic viability, the pricing should be based on the long-run costs.

Not all prices in an economy are set up by equalling to marginal cost. There might be some prices which are higher or lower than their marginal costs in reality. Button (2010) assumes there are only bus and rail transport in the economy. Bus sector is controlled by a monopolist and the price is set up above the marginal cost. In this situation, the rail sector should set up price base on its marginal cost or any other alternative pricing strategy which can be adopted to maximize social welfare. This leads to the difficulties of the second-best situation for rail sector.

In many cases, the price differentiation and pricing discrimination help to increase the rate of utilisation for the capacity (Sorg 2011) and increase the revenues of the business.

2.2 Port Pricing

In academic literature there is a lot of discussion on port pricing, the port service pricing (Acciaro 2013). Some studies mentioned that port pricing should be based on infrastructure cost, while others think port competition is the goal of port pricing.

However, out of all the studies, we particularly focus on the ways to make optimal price for a port service. On the other hand, higher port prices may be at the risk of losing businesses. Carriers could suffer diminishing amount of fleets to call at this port. Although the demand shall not decrease too much in some specific ports attributed to their monopoly power on the market (Haralambides 2002), the high prices can lead to the loss on business by all means. Building a port requires a huge amount of sunk costs and social opportunity costs. If the demands of service are not as high as expected, the facilities and resources will not be fully utilised, leading to low efficiency in asset usage. In contrast, low port prices may attract many customers, but could result in congestion in the end. In addition, there wouldn't be enough margins or earnings to recover start-up investments such as infrastructure costs. Hence, port pricing is a complex dilemma but it is an important issue in the industry.

Port players, including port authorities and port operators, may have their own objectives to achieve. By adopting a proper pricing strategy, the objectives can be achieved much easier. Since ports can be divided into four main models: Public service Port, Tool Port, Landlord Port, Private Service Port (World Bank 2001), private sector has different degree of involvement in port activity as shown in Table 1 (Kruk 2005). Thus, the port model might be an important factor to influence the pricing strategy.

Table 1 Involvement of the private sector in port activity

Management Model	Infrastructure	Superstructure and equipment	Stevedoring
Public Service Port	Public	Public	Public
Tool Port	Public	Public	Private
Landlord Port	Public	Private	Private
Private Service Port	Private	Private	Private

Source: (Kruk 2005)

In H. Meersman et al. 's (2004) research, diverse objectives are found, including maximising throughput, maximising value added, minimising the welfare losses, efficient management of assets, and maximising employment. In addition, profit maximisation, regional development, minimisation of ship time in port, and promotion of trade are pointed out by H.E. Haralambides's (2002) research.

The research by Petteren-Strandenes and Marlow (2000) classifies five major pricing approaches for determining the port charges: (1) cost-based, (2) cost recovery, (3) congestion, (4) strategic, and (5) commercial pricing which is apply to privatised ports.

Cost-based Pricing

In UNCTAD's (1995) research, it is pointed out that the cost-based pricing is a traditional approach to pricing. The price is set up on the basis of the costs that result in providing the service or facilities. It includes three types of cost: fixed costs, variable costs, marginal cost of the service or facility. Firstly, fixed cost is the cost which not possible to avoid no matter the service or facility being used. For instance, the cost of the interest and capital from a loan is used to buy a gantry crane. Ports have to pay back the instalments even if the gantry crane is not used. Secondly, variable costs are the costs incurred by the use of a service or a facility. For

instance, the costs of electricity for operating gantry crane during cargo operation. On the other hand, the variable costs are avoidable if there is not cargo operation. Thirdly, marginal cost is the extra cost of service for additional time to the original agreed time period. For instance, in the case of the electricity costs for crane are the daily base rate plus hourly rate for an 8-hour shift. After 8-hour shift, the marginal cost will be an hourly rate per additional service hour.

In Heggie's (1974) study, port charges/dues can be split into two main parts: the dues levied on the vessels and the dues levied on the cargoes. Port dues on the vessels, mostly depend on the vessel's characteristics such as vessel length and/or tonnage, include: quay dues, harbours dues which apply to the dues for buoyage, anchorage, dredged channels, etc. Cargo-related dues, mostly measured by ton or the freight, usually include handling dues, storage charges after free time, further quay due. Based on the UNCTAD study (1995), some cost-based charges are listed in Table 2.

Table 2 Cost-based Port Charges

Charge Item	Function	Charging Unit	Differentiation
Pilotage	to cover the variable costs of pilots and the pilot boats	Vessel movement	-
Towage	to cover the variable costs of tugboats and crew	Vessel movement	Vessel GRT, NRT, Length*Beam*Draft
Berthing/unberthing, mooring	to cover the variable cost of the gangs	Vessel movement	Vessel GRT, NRT, Length*Beam*Draft
Stevedoring, wharf-handling, receiving/delivery	to cover the variable costs for the cargo-handling labour and equipment	Freight ton, metric ton, cubic metre, TEU, Box	Form of cargo
Equipment hire	to cover the fixed and variable costs for the equipment and its operators	Half-hour, hour, shift, half-day	Type of equipment
Cargo processing	to cover the variable costs for the cargo-handling labour and equipment	Freight ton, metric ton, cubic Metre	Form of cargo before and after
Fuel, utilities	to cover the direct cost for the amount consumed	Kwh, metric ton, cubic metre	Capacity provided

Source: (UNCTAD 1995) and modified by author

In addition, the cost-based charges may also link to the infrastructure-related charges such as channel charge and berth charge (Heggie 1974). Channel charge is for recovering and maintaining costs of dredging channel, turning basins. Berth charge refers to the costs of berth occupancy (Bandara et al. 2013). Thus, the cost-based pricing can at least ensure the fixed cost, variable cost, and the marginal costs can be covered.

However, Abbes (2007) argues the knowledge of short and long-run costs of using infrastructure can help port authorities in running port activities efficiently. It also helps port authorities use the best fitting techniques in finance and administration. Furthermore, proper investment decisions can be taken.

Method for Cost Recovery

In the study of Button (1979), he suggests three methods to recover the costs: subsidizing the port activity, applying discriminatory charges between uses, and two-part tariff.

Again, Button (2010) argues the Price Discrimination can be used as a method for recovering costs but the suppliers of transport such as railway manager, ship owner, airline operator should have great knowledge on the demand situation being faced. In addition, Bennathan & Walters (1979) pointed out the discrimination among cargoes not only helps to recovery costs but also helps to charge lower levies on low-value commodities.

Another method for cost recovery mentioned by IMO is that the important idea of a port dues system for hinterland transport is to introduce a cost-recovery based port dues scheme (IMO 1999).

Congestion

"*Ports are congested at times and congestion pricing has been advocated to obtain efficient exploitation of port capacities*."(Strandenes & Marlow 2000). Strandenes and Marlow mentioned the opportunity cost of vessel time is directly related to the main part of congestion costs. Both the capital cost of cargo and alternative income that a vessel postpones to the next berthing schedule are reflected by this congestion cost. The former relies on whether selling the cargoes is delayed or whether the storage time on land is only replaced by storage time on board. The latter one has been discussed by Bennathan and Walters (1979). Their research pointed out the practical difficulties of congestion pricing because prices vary seasonally. The mark up will be shifted to the port or to the shipping companies depending on the negotiation in prices between the port and the shipping companies (Strandenes & Marlow 2000).

Chen et al. (2011) evaluated the effects of introducing time-varying congestion tolls to influence the arrival times of trucks at a port terminal. A desirable model has been selected to determine the best time-vary toll pattern. As a result, while minimising the average toll the truck arrival patterns will be system optimised. Applying time-dependent queuing models with a time-varying port tariff pattern might be good to arrange port capacity to calling vessels (Voorde & Meersman 2014).

Strategic Pricing

By rapid developing technology in shipping, land transport and ports, some ports in the world face increased competition. Strategic pricing might be a good tool to counterbalance the competition. "S*trategic pricing can be broadly defined as the use of pricing as a mechanism for achieving competitive advantage*."(UNCTAD 1995) From the research of UNCTAD, there are several principal objectives summarised in Table 3.

Table 3 Principal Objectives of Strategic Pricing

Commercial
Increase market share in selected markets
Maintain market share in other markets
Performance
Enhance performance at congested facilities
Encourage more efficient use of facilities
Equate tariff rates with direct costs
Financial
Equate the charges for individual businesses with their stand-alone costs
Generate additional revenues to: - Meet current cash flow requirements - Fund future investments - Produce an acceptable return for investors - Satisfy mandated financial performance criteria

Source: (UNCTAD 1995)

The investments for new facilities and equipment can be achieved by strategic pricing. Thus, new facilities and equipment could increase the capacity of the port which will reduce the delays of vessels. In addition, new technology was applied on new facilities and equipment which help to shorten the operation time. Port operations become more efficient and port facilities are used more appropriately.

Furthermore, setting charges at the cost of the existing levels of traffic can help reduce the competition from other ports. What concerns ports with lower levels of traffic, they have to charge a higher price to cover their fixed costs for the facilities. As a result, competitions from other ports can be reduced.

Commercial Pricing

Strandenes and Marlow (2000) took an example for commercial port pricing from port of Grimsby and Immingham, the non-transparent structure of port pricing exists in its port charges by version 1998(Grimsby and Immingham 1998). The details of port charges are listed in Table 4. We can see it from the table that the goods dues are charged not only by the weights of cargo but they also strongly depend on the value of cargo. Thus, the charges are set to reflect the value of the goods not only to cover the handling costs. For instance, the goods due per tonne of fresh fish is twice more expensive than fish cakes.

Table 4 Example of "Commercial" Port Pricing, (UK)

Tonnage Related Dues	**Ship dues**	• Favour coastal shipping
		• For international trades dues are progressive with distance (Immingham only)
		• Increasing with length of port stay
	Berthing and mooring charges	• Similar across ship sizes

Cargo Related Dues	**Goods dues**	• Per tonne cargo, strongly differentiated depending on value of cargo
		• Favouring coastal trade.
	Related to cranes and equipment hire	
	Hire charges	• Obtained by application to the port manager

Source: Grimsby and Immingham (1998)

In addition to the above-mentioned pricing concepts, Meersman et al. (2004) summarised the most important pricing concepts and implementation for important studies between 1977 and 2000, these studies are presented in

Table 5.

Table 5 Pricing concepts and implementation

Author(s)	Pricing concepts and implementation
Gardner (1977)	● It is illogical to base pricing on the characteristics of a ship (e.g. length, draught, etc.) ● Port prices, traditionally levied partly on ships and partly on cargo, should really only be based on the goods themselves
Jansson and Rydén (1979)	● A plea in favour of a two-part tariff structure ● The tariff is divided into: ○ a charge per tonne of cargo that would be differentiated with respect to the elasticity of demand ○ a charge levied on the carrier to reflect the opportunity cost of using the facility
Button (1979)	● The users of the port should be charged the full marginal social opportunity cost of the resources that they use ● Some elements to be investigated: decreasing cost industry? What about financial deficits? How to recuperate capital expenditures (e.g. by two part tariffs)?
Bennathan and Walters (1979) Vanags (1977)	● A plea in favour of congestion pricing (note: intended mainly for ports in developing countries)
Arnold (1985)	● Port tariffs are based on a mix of pricing strategies designed to reflect the demand for port services, the competition between ports, and the cost of providing the services.
Meyrick (1989) Talley (1994)	● A plea in favour of a cost-axiomatic approach, defined as "a pricing mechanism which determines the prices of the outputs of multiproduct firms by allocating the full cost of production to all the outputs ● Further, it assumes that the demand for port services is relatively inelastic with respect to port prices
Unctad (1995)	● Considers port pricing to be a strategic issue ● Two basic approaches may be taken to pricing policy: one economic, the other financial. The former is grounded on marginal cost pricing, while the latter bases prices on accounting costs ● The 'cost, performance, value' (or CPV) approach allows port managers through tariffs to accomplish different sets of objectives. ○ cost-based tariffs can maximise the use of port services;

	○ performance-based tariffs can maximise throughput and reduce congestion ○ value-based tariffs generate sufficient revenue to cover the port's cost ● CPV indicates both the threshold and the ceiling of prices: the port must not charge less than the incremental cost of serving the user; it cannot charge more than the value received by the user.
Pettersen-Strandenes and Marlow (2000)	● Suggest a port pricing policy where price differentiation is not based on the value of the cargo ● Port prices should be differentiated on the basis of the quality of port services provided; relevant quality factors are the time in port, and the punctuality of handling the vessel and its cargo.

Source: (Meersman et al. 2004)

2.3 Green Port Charges / Environmental Friendly Incentive Schemes

In recent years, green house gas and all kind of environmental issues became more and more serious in our life. Most of industries are trying to contribute to environmental protections, and maritime industry is not an exception. Today, more and more transportation demands are derived from rapid changing technology. Among all types of transportation, sea transportation is the best solution in moving large quantity cargoes between two places. Since the economy grows rapidly and globally, the demand on seaborne transportation significantly increases as well (Bergqvist & Egels-Zandén 2012). In seaborne transportation, ports play vital role in the entire logistic chain. As a result, increasing port activities have incurred environmental impacts such as ships' emissions and noises in port areas. However, the corporate social responsibility (CSR) strategies and environmental strategies have been developed by ports. An important tool for implementing these strategies is to differentiate port charges associated with environmental impacts from vessels (Bergqvist & Egels-Zandén 2012) or to provide discounts on port charges for environmentally friendly ships.

The existence of environmentally related port pricing system is mainly aimed at the areas with high levels of air pollution (Swahn 2002)(Kågeson 1999)(Michaelowa & Krause 2000), and oil pollution (Carpenter & Macgill 2001).

Since pricing is a very complex processing and there would not be a uniformed system that suits all the ports, ports have to consider whether to introduce the green port dues. However, the stakeholders have certain power to influence the decisions / strategies of the ports. Bergqvist and Egls-Zanden (2012) summarized the assessment of different stakeholders on whether ports are likely to introduce green port dues which is presented in Table 6.

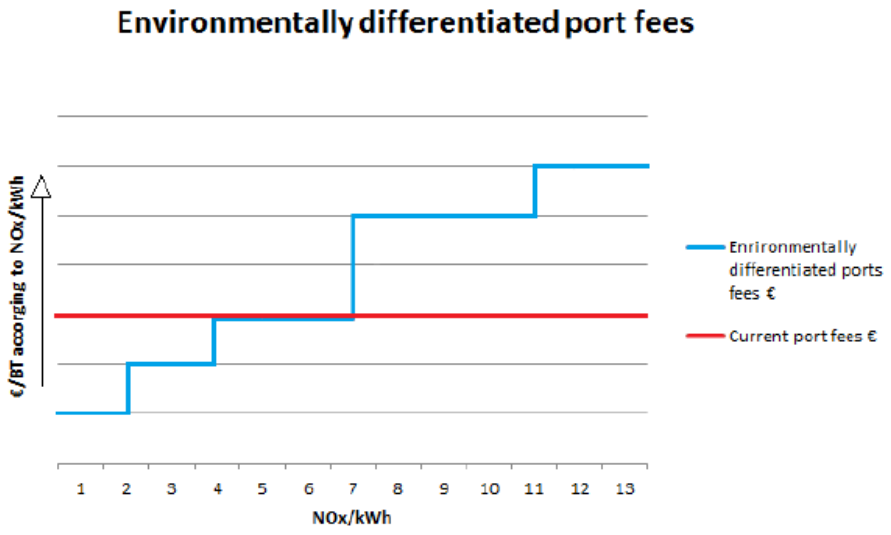
Table 6 Stakeholder assessment

Stakeholder	Likelihood of demanding green port dues "High/ medium/low"	Stakeholder salience "High/ medium/low"	Likely position if a demand of introducing green port dues is made "Positive/negative"
Owners	High (public) Low (private)	High	Positive
Local government	High	High	Positive
Transportation service providers	Low	High	Negative/neutral
Shippers	Low	High	Negative/neutral
Media	High	Medium	Positive
Labour unions	Low	Medium	Negative/neutral
NGOs	High	Low	Positive

Source:(Bergqvist & Egels-Zandén 2012)

Jenny (2013) shows the relationship between modified port fee system with NOx differentiation and current port fee in Figure 2 from the research of creating a cost-efficient pan-Baltic environmentally differentiated port fee system. She mentioned the way of determining the profile by the two most important questions: *"(1) How many ships with passage transport with possible NOx reduction technology visits the port (2) how many are irregular visits. Port fees should be flexible in case of changes in the profile."* (Jenny 2013) Three scenarios of different degree of discounts on port dues are being tested. According to Jenny K.'s study, the result shows *"the amount of granted discount has an important effect as an economic incentive to emission reduction and the system is possible to introduce so that it would not create an economic disadvantage to specific port."* (Jenny 2013) She also suggests that the given incentive should reflect the market's perception of a correct and proper amount of discount if the market-based port fee system is applied.

Figure 2 The relationship between modified port fee system with NOx differentiation and current port fee



Source: (Jenny 2013)

The environmentally friendly incentive schemes do not only increase port competitiveness but also encourage carriers to reduce environmental impacts by consuming greener fuels. In a report issued by port of Gothenburg in 2014 (Port of Gothenburg 2014), a total of 383 tons of sulphur emissions in Gothenburg has been reduced by conducting an environmental campaign from 2011 to 2014. The project of environmental campaign is founded from the program of Environmentally driven port tariffs, providing financial compensation for vessels powered by cleaner fuels in its fairways and vessels proved as green by the Clean Shipping Index. The report also shows environmental benefits in reducing nitric oxide, particulates, carbon dioxide from the environmentally driven port tariffs. Thus, the figures illustrate the positive improvements in environmental impacts by the environmentally friendly incentive schemes.

A big number of ports are providing environmentally friendly incentive schemes for the vessels having high performance of ship rating or approve system, such as the Clean Ship Index (hereinafter refer to as CSI) and Environmental Ship Index (hereinafter refer to as ESI). The overview focuses on some major ship rating/approve system and will be discussed in next subsection.

2.4 The Ship Rating/Approve System

2.4.1 Environmental Ship Index (ESI)

The ESI is one of the projects under the World Ports Climate Initiative (hereinafter refer to as WPCI) which was founded by the world's main ports in 2008. The goal of WPCI is to reduce greenhouse gas emissions while moving goods across oceans and within port areas(ESI n.d.). The ESI provides scores for identifying vessels' performances by means of assessing the emission amount of pollutants, such as sulphur oxide (SOx), nitrogen oxide (NOx), particulate matter (PM) and carbon dioxide (CO_2) from the vessels. The objective of the ESI is to award the vessels that have better performance than the IMO regulations. The SOx emissions contain a maximum 100 sub points and is mainly dependent on the engine properties; NOx emissions contains a maximum 200 sub points (range from 0 to 100) and is mainly dependent on the fuel's sulphur content; PM emissions is related to SOx emissions and is included in the SOx sub score; CO2 emissions contains 10 sub points and is mainly dependent on the amount of fuel used(WPCI 2013). Onshore Power Supply (hereinafter refer to as OPS) is fixed at 35 sub points as bonus points for shore power equipment irrespective of it use. ESI score can be calculated by summing up the sub scores of NOx, SOx and CO_2 sub points and divided by 3.1 with maximum 100 points. Mathematically, the formula of ESI score can be shown as: (2 * ESI NO_x + ESI SO_x + ESI CO_2 + OPS) / 3.1. According to the sum up points, a maximum of 345 sub points might be reached theoretically. However, the cap of the ESI score is 100 points.

ESI scores can be used by ports to differentiate port charges or rewards on vessels in order to promote green vessels and ports, either based on the total score or on each part of the score separately. Take port of Rotterdam for example, the Dutch authority offers 10 percent discount on port dues if vessel has ESI score of at least 31.0 points or more when calling at port of Rotterdam. In addition, if this vessel's individual ESI-NOx score equals 31.0 points or more, the discount will be doubled (Port of Rotterdam 2015a).

The ESI score of vessels are not only used to differentiate port charges by ports, but are also regarded as a performance indicator for vessel operators to improve their vessels. Moreover, the shippers or any other roles in the logistic chain can refer ESI score to choose greener vessels to transport their cargoes. By choosing vessels with better score of ESI, shippers participate in sustainable logistics and have positive consumer experience. On the other hand, ports or terminals benefit from greener vessels in terms of cleaner air in the harbour and better stakeholder acceptance.

2.4.2 The Blue Angel

"Do something good for people and the environment and look out for the Blue Angel when shopping. Help to shape the future!" said by Dr. Barbara Hendricks, Ferderal Environment Minister. The Blue Angel is a German environmental label marks services. There are around 1,500 companies and 12,000 environmentally friendly products approved by the Blue Angel up to date. When clients purchase something or demand some services with Blue Angel eco-labels, they are certain that the transactions will not bring significantly negative impacts to the environment.

(The Blue Angel 2015b) Ship operation and ship design are also included in the Blue Angel eco-label. The objective of awarding the Blue Angel eco-label to the ship's operations is to reduce the releases of pollutant emissions into to the seas air by the vessels. The assessment focuses on the ship design and equipment, management of shipping companies and vessels, and on the reduction of emissions, especially. The scope of the Blue Angel eco-label covers the operations on vessels with German or foreign flag, with the exceptions of the navy ships, sport boats, tank ships, and fishing vessels.

Furthermore, Eco-Friendly Ship Design (The Blue Angel n.d.) is another ship-related product under the Blue Angel eco-label. The objective of Blue Angel on ship design is to prevent the releases of pollutants into the marine environment by sea-going vessel during its planning phase. The criteria include the installation of an emergency towing system to measures for fuel tank protection and air pollutant reduction and the demand for on board waste and wastewater treatment. In this case, the Blue Angel eco-label is used to assess the authority, research, and merchant ships, excluding sport boats, fishing and naval ships.

Currently, port of Hamburg also encourages vessels to acquire the Blue Angel eco-label, launching an environmental discount incentive "Blue Angel" to grant 2% discount on port fees for qualified vessels (Hamburg Port Authority 2015).

2.4.3 Green Award

The Green Award system was built up in 1994 by the port of Rotterdam. "*The objective of Green Award certification scheme is to promote the safe and environmentally friendly behaviour of ships and crew/management.*" said by Green Award Foundation. The Bureau Green Award is the independent non-profit Green Award Foundation carrying out the certification scheme. The scheme is open for chemical tankers, oil tankers, LNG, dry bulk carriers from 20,000 Deadweight Tonnage and upwards, and inland navigation vessels. The Green Award certificate is subject to annual verification and valid for three years. By July 2015, 225 sea-going vessels, 30 incentive providing ports, and 23 incentive providers other than ports have participated in Green Award system.

The selection criteria of Green Award are not only related to environment but also to safety. For instance, exhaust emissions is the requirement related to environment, and mooring wire maintenance is related to safety. The Green award's criteria contain basic requirements (statutory elements related to ISM, MARPOL), ranking requirements (weighted items, minimum % to be attained), and visual inspection (such as good housekeeping) (Green Award n.d.).

The benefits of certification by Green Award include financial: 1) benefits such as Discount on port dues, Lower costs, Lower insurance premiums, Charter preference; 2) non-financial benefits like Continuous improvement, Acceptation by PSC / vetting inspections, Motivation and pride of crew, Less incidents, Quality more visible, Better image (Green Award n.d.).

The Green Award incentive providers include ports and non-port organizations. Most of Green Award ports provide notable discounts on port charges. For example, Port Metro Vancouver provides 23.4% savings over the base rate level of harbour dues for bulk carriers and oil tankers. (Green Award 2015) In particular ports of Belgium, Canada, Germany, Gibraltar, Japan, Latvia, Lithuania, New Zealand, Sultanate of Oman, Portugal, South Africa, and the Netherlands offer a considerable reduction of port dues to Green Award qualified vessels.

2.4.4 Clean Ship Index (CSI)

The CSI (Clean Shipping Index 2015a) is a tool for shippers to select sea transportation carriers with good performance in environment. The assessment for CSI is carried out by the non-profit association called CSI. They assess ships and entire carriers on their performance in environment based on five areas and environmental parameters: levels of emission of Carbon Dioxide (CO_2), Sulphur Oxides (SO_x) & particulate matter (PM), Nitrogen Oxides (NO_x), Water & Waste, and Chemicals, they give CSI score for vessels. Each area of emission contains a maximum score of 30. The system offers three levels: green level for a total score of 50% and up, yellow level for a total score between 20% and 50%, and red level for a total score below 20%. From the ranking of ships and carriers, global cargo owners can select ships and carriers with better ranking to deliver their cargoes.

As we have said in the review of the Green Award mentioned above, ships and carriers that participate in the CSI system receive both financial and non-financial benefits. Today, CSI system has 1,700 vessels, and these vessels are owned by 45 operators or shipping companies (Sköld n.d.). Some ports provide discounts on port charges to encourage vessels to have good performance in environment by higher level of CSI. For instance, Swedish Shipowners' Association offers a 10% discount on port tariffs for vessels achieving a "green level" in the CSI during the limited period between 2015 and 2018. Another example is the port of Gothenburg which provides a 10% discount on port dues if vessels are certificated by CSI as "green level"(Port of Gothenburg 2015a).

2.4.5 Right Ship

RightShip is an independent ship vetting and assessing organisation which does not belong to any governmental and private organisations. It was founded by two largest Austrian iron and coal companies: Rio Tinto and BHP Billiton in 2001(RightShip 2015c). RightShip builds up a unique and comprehensive vetting system, Ship Vetting Information System (SVIS), to assess ships' performance. The vetting system focus on ships used to transport dry bulk, petroleum, chemicals and gas.

The objective of the RightShip is to prevent avoidable incidents and to reduce ship's polluting emissions.

The Existing Vessel Design Index (hereinafter refer to as EVDI) developed by RightShip (2015a) measures a ship's CO_2 emissions per nautical mile sailed with relative to its similar type and size vessels. It gives vessel from A to G levels base on the ship initial data such as RightShip's SVIS. A vessel that receives EVDI level as "G" refers to the worst energy efficient vessel in its peer group, whiles level "A" represents the best one. However, the EVDI is used for existing ships, while vessels delivered from January 2013 should use Energy Efficiency Design Index (hereinafter refer to as EEDI) introduced by International Maritime Organisation (hereinafter refer to as IMO).

As a comprehensive vetting system, RightShip also offers two indications relating to ship's environmental ratings (so-called Port Incentive Programs) (RightShip n.d.): the Environmental Star Rating and the Greenhouse Gas (hereinafter refer to as GHG) Emissions Rating. These two ratings are generated by comparing CO2 emissions of a ship to its similar vessels.

The Environmental Star Rating is made up by three sections: Environment Risk Profile, Third Party Environmental Factors, and Environmental Rating Adjustment. The overall assessment will give rating from one to five stars, among which five stars refer to the best rating, and one stands for the opposite.

The GHG Emissions Rating is derived from RightShip's EVDI. The calculation of GHG rating is in accordance with EVDI, which is based on the design characteristics of that ship when built, to estimate the theoretical carbon dioxide emissions. These characteristics include fuel consumption, cargo carrying capacity and engine power. The size score and representing level are shown in Table 7.

Table 7 GHG Emissions Rating Key

GHG Emissions Rating	A	B	C	D	E	F	G
Size Score	> 2.0	> 1.0	> 0.5	> -0.5	> -1.0	> -2.0	< -2.0

Source: RightShip Incentives Program (RightShip 2015b)

In 2014, (RightShip 2015b) Prince Rupert Port Authority commenced using RightShip's GHG Emissions Rating for their incentive programme on port charges. In addition, Port Metro Vancouver can also exemplify a port which provides incentive on harbour charges based on the assessment of RightShip's Environmental Rating.

Chapter 3 Green Incentive Schemes

3.1 Green Incentive Inventory

In this study we have reviewed the port charges from a total of 100 ports worldwide (see Appendix II), among which 43 ports, or 43.0% have green incentive on port charges as shown in Table 8 (hereinafter refer to as green port), and the rest 57 ports, or 57.0% that have no green incentive on port charges. These ports are selected from the most active ports (World Shipping Council 2014). Website of ship rating system include Green Award (Green Award 2015), ESI (WPCI 2015c), CSI (Clean Shipping Index 2015b), RightShip (RightShip 2015d) and the Blue Angel (The Blue Angel 2015a). In order to ensure the ports listed on the website of ship rating system are still providing green incentive on port charges, the reviews were carried out not only to collect green ports from website of ship rating system but also double check with the port tariff document. Only the green reduction or awards of port charges from 43 ports which are mentioned on the port tariff document are taken into account.

Table 8 Overview on Green Incentive Scheme of Ports

Country and Port		Charge Item	Green Incentive Scheme	Ship Rating System
CA	Port of Prince Rupert	Harbour Dues	Differentiated Tariff	RightShip, ESI, Green Marine, EEDI, Green Award, CSI.
CA	Port Metro Vancouver	Harbour Dues	Differentiated Tariff	Shore power, vapour control or recovery system, eligible alternative fuels, eligible alternative technologies (other), ESI, RightShip, CSI, Green Marine, EEDI, Green Award, Ship Classification Society.
CA	Port of Montreal	Harbour Fees	Rebate	Green Award
CA	Port of Sept-Iles	Harbour Dues	Rebate	Green Award
U.S.	Port of Long Beach	Dockage	Reward, Rebate	IMO Engine Standard, Vessel Speed Reduction, Shore Power Connection.
U.S.	Port of Los Angeles	Dockage	Reward, Rebate	ESI, IMO Engine Standard, Vessel Speed Reduction, technology that reduces Diesel Particulate Matter (DPM) and NOx emissions.
U.S.	Port of New York / New Jersey	Reward	Reward	ESI, Vessel Speed Reduction.
LV	Free Port of Riga	Port Fee	Rebate	Green Award
LT	Port of klaipeda	Sanitary dues	Rebate	Green Award
BE	Port of Ghent	Tonnage dues	Rebate	ESI, Green Award
BE	Port of Antwerp	Port dues	Rebate	IMO Engine Standard
BE	Port of Zeebrugge	Tonnage dues	Rebate	ESI
GI	Gibraltar Port	Tonnage	Rebate	Green Award

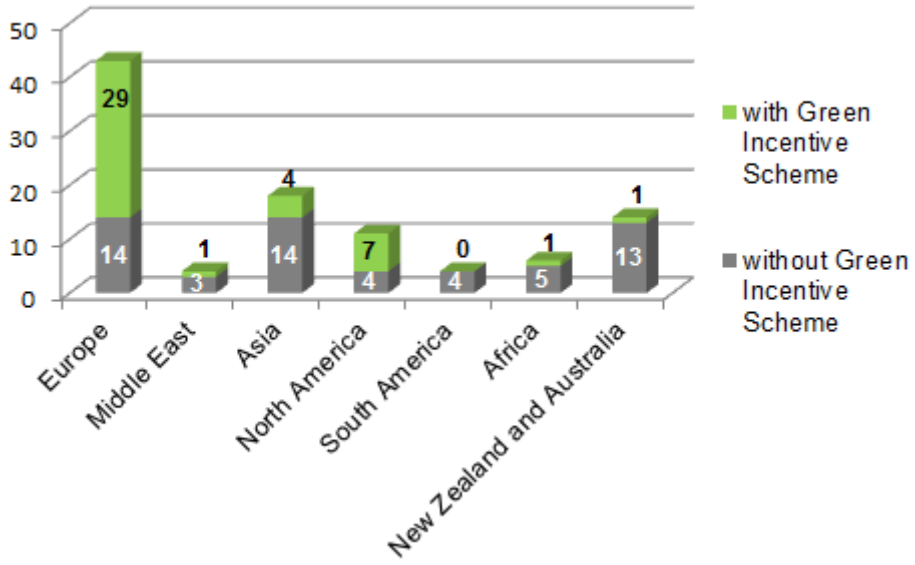
	Authority	dues		
NL	Port of Rotterdam	Port Fees	Rebate	ESI, Green Award
NL	Port of Amsterdam	Port fees	Rebate	ESI, Green Award
NL	Tata Steel IJmuiden Terminals	Port Dues	Rebate	ESI
NZ	Port Nelson	Marine Services	Rebate	ESI, Green Award
SG	Port of Singapore	Port Dues	Rebate	Approved abatement / scrubber technology or burn clean fuels (sulphur < 1.00% m/m), EEDI, Approved SOx scrubber technology exceeding IMO's emission requirements.
IL	Port of Ashdod	Reward and Additional Rate	Additional Rate, Rebate	ESI, Additional sea pollution prevention rates on lighthouse rates
SE	Port of Gothenburg	Port Dues	Rebate, Additional Levy	ESI, LNG Fuel, Vessel's structure (double bottom and double sides).
SE	Port of Stockholm	Port Fee	Rebate, Reward	LNG-powered Vessel, Nitric Oxide Certificate issued by Swedish Maritime Administration, Shore Power connection.
DE	Port of Jadeweser (Wilhelmshaven)	Port Dues	Rebate	ESI
DE	Port of Kiel	Port Charge	Rebate	ESI
DE	Port of Rostock	Port Dues	Reduction of Surcharge	ESI, Marine diesel with a sulphur content of ≤ 0.1%, LNG or a technology leading to equivalent emission levels, Shore Power connection.
DE	Niedersachsen Ports (Port of Cuxhaven / Port of Stade / Port of Norden / Port of Emden)	Harbour Dues	Rebate	ESI
DE	Port of Bremen	Tonnage Charges	Rebate	ESI
DE	Port of Hamburg	Port Fees	Rebate	ESI, LNG Fuel, Shore Power connection, Green Award Certificate, Blue Angel Certificate.
NO	Port of Oslo	Quay Charges	Rebate	ESI
NO	Norwegian Coastal Administration	Pilotage readiness fee	Rebate	ESI
NO	Port of Stavanger	Port Fees	Rebate	ESI
NO	Port of Bergen	Harbour Fee, Port	Rebate	ESI, LNG Fuel, Shore Power Connection.

		Charge, Wharfage Dues		
FR	Port of Le Havre / Paris / Rouen	Port Dues	Rebate	ESI
FR	Atlantic Port La Rochelle	Port Fee	Rebate	ESI
PT	Porto de Setúbal	Port Dues	Rebate	Green Award Certificate
PT	Porto de Sines	Tariff of port use	Rebate	Green Award Certificate
PT	Portos do Douro e Leixoes	Tariff for port use	Rebate	Green Award Certificate
PT	Porto de Lisboa	Tariff for port use	Rebate	Green Award Certificate
SA	National Ports Authority of South Africa (Richards Bay, Durban, Ngqura, East London, Port Elisabeth, Mossel Bay, Cape Town, Saldanha)	Port Dues	Rebate	Green Award Certificate
JP	Port of Tokyo	Port Dues	Rebate	ESI
KR	Port of Busan	Port Dues	Rebate	ESI
HK	Port of Hong Kong	Port Facilities, Light Dues	Rebate	ESI, Marine Fuel (sulphur<0.5%), LNG Fuel, Fuel approved by the Director of Environmental Protection, Greener Technology, Shore Power Connection.
ES	Port of Valencia	Vessel Charge	Rebate	LNG Fuel
ES	Port of Algeciras	Vessel Rate	Rebate	LNG Fuel

Source: Elaborated by the author according to port tariffs from every port

Figure 3 shows the implementation situation of Green Incentive Schemes by each area from the researched 100 ports. According to the records, most of green incentive providers are located in Europe, especially western and northern European ports. Although the environmental issues have drawn a lot of attention in maritime industry and have been included in port management, the green port incentive scheme is still not so widely accepted by many ports. All factors, both internal and external, have an important role in port pricing, including the model of ports, geographical location, port size, port strategy, objectives of port, and traffic of port.

Figure 3 The Situation of Implementation 'Green Incentive Schemes' in Each Area



Source: Elaborated by the author

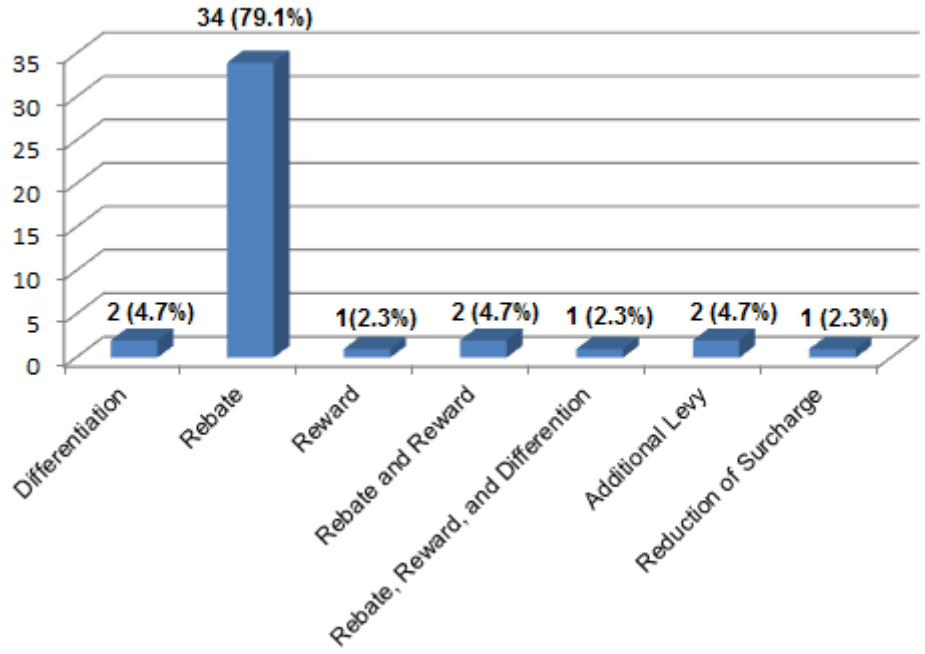
The overview on green incentive scheme of current port providers is as follows, further details are listed in Appendix I.

3.2 Green Incentive Scheme

After further research on the green incentive schemes of these 43 ports, some important findings have been discovered.

Firstly, the way of awarding ship owners. Among all the 43 ports 30 of them offer green incentive in the form of reduction of port fees, port dues, harbour dues, quay charges, and tonnage charges, etc. based on the ship's GRT. Conversely, the rest of the ports provide the incentive in the form of a fixed amount of rebate based on the different criteria, such as the relationship between ship's GRT and port stay time, the ship's ESI-score and tier awards according to ship's length, and the tier award on the levels of NOx emissions, with related to ship's volume. It is fair for the varied size of vessels to receive different levels of environmental awards according to ship's GRT. In Figure 4 we categorise all the green incentive schemes into four main groups: differentiated tariff, rebate, reward, rebate and reward, additional levy, reduction of surcharge. It can be clearly seen that a great majority of the researched green ports, 79.1% (34 out of 43 ports) adopt the green incentive scheme in the form of rebate on port charges.

Figure 4 Green Incentive Scheme



Secondly, a great majority of the green ports is landlord port. Amongst all 43 green ports, 41 of them are in the form of landlord ports, accounted for a great majority of 95.4%. Landlord port might be the trend of market. However, the reductions on port dues are the loss of port income. Based on the cost-based pricing, port dues are used to recover the costs of infrastructures. If a port is not willing to raise the price level due to the reduction of port dues, the port needs subsidies to cover the loss. Only government has ability to give a subsidy to the port. Among four types of port models, public port, tool port and landlord port are government-owned.

Thirdly, ESI is the most widely accepted measure by the green ports. Table 9 and Figure 5 illustrate the frequency of adoption for the qualifying reduction measures. Among all the reduction measures, the ESI ship rating system is most commonly adopted by 27 out of 43 ports, accounted for a majority of around 62.8%, far more than the second most common Green Award (39.5%). (Jenny 2013) The high adoption rate of the ESI system is partly due to its international nature and free participating cost. Most of these leading green ports are internationally oriented, thus it is easier for these ports to refer the internationalised ESI score as a qualifying reduction measure. The same reason applies to the Green Award certificates. In contrast, though Blue Angel is very popular in Germany, it remains rather a local label. As a result, only port of Hamburg's green incentive scheme adopts the Blue Angel system.

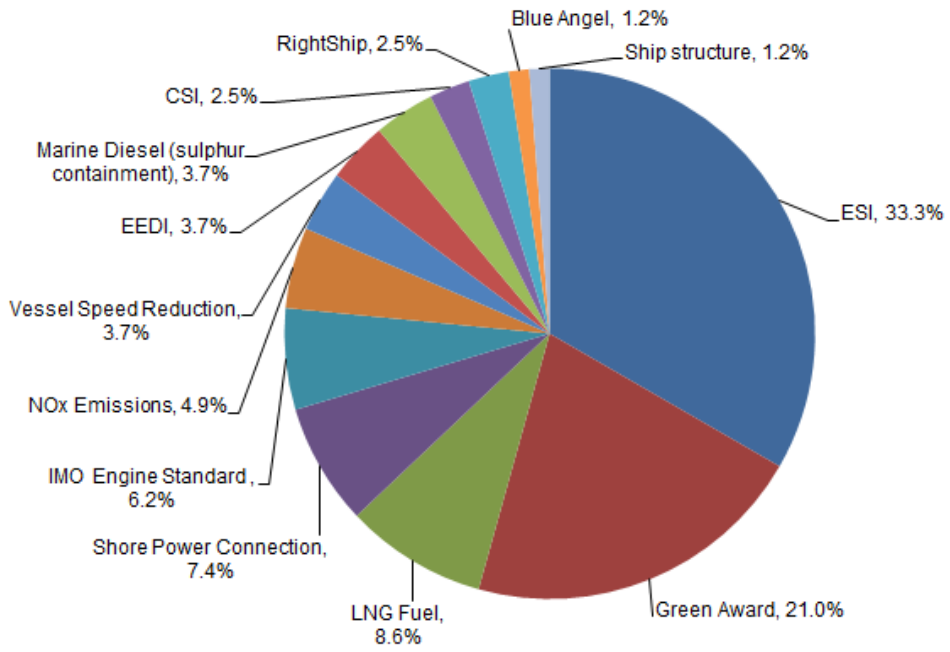
Fourthly, traffic of the port is also a crucial factor in deciding the qualifying reduction measure. For instance, a liquid bulk port might stress more importance on the Green Award certificate as a measure against its traffic, such as bulk vessels and tankers, for the green incentive scheme because the Green Award certificate focuses mainly on bulk carriers and oil tankers. Meanwhile, the measurements could also be used as a tool to promote a particular traffic in port's business.

Table 9 Qualifying Reduction Measures and Numbers of Adoption

Qualifying Reduction Measures	Numbers of Adoption
Environmental Ship Index (ESI)	27
Green Award	17
Alternative Fuel (LNG)	7
Shore Power Connection	6
IMO Engine Standard II or III	5
NOx Emissions	4
Vessel Speed Reduction	3
Energy Efficiency Design Index (EEDI)	3
Marine Diesel (sulphur containment)	3
Clean Shipping Index (CSI)	2
RightShip	2
Blue Angel	1
Ship structure (double bottom and sides)	1
Sum	81

Source: Elaborated by the author

Figure 5 The Percentage of adoption of the Measures



Source: Elaborated by the author

3.2.1 Green Incentive - Differentiation Schemes

In this scheme vessels are charged with differentiated port dues according to their degree of green performance. The cleaner a vessel is, the lower the rate of port dues will be charged on this vessel. Vessels with high pollution shall pay more fees to help port authority to recover and maintain the environment within the port areas.

The Port Metro Vancouver (2015) can best exemplify the differentiation of green incentive scheme. Based on the performance of vessels by the criteria including shore power, vapour control or recovery system, eligible alternative fuels, eligible

alternative technologies (other), ESI, RightShip, CSI, Green Marine, EEDI, Green Award, and Ship Classification Society, vessels will be charged harbour dues in four different tariff levels: Gold, Sliver, Bronze, Basic rate. When calling this port, ship owners can save 23.4% cost as bronze level, 35.1% as Silver level, and 46.8% when reaching highest Gold level over the basic harbour dues rate.

Another example is the port of Prince Rupert, which implement Green Wave Program offering four price levels of harbour dues: tier 1, tier 2, tier 3, and basic rate. The level of tiers is measured by the fuel quality, technological implementation, and management practices, and environmental certification. The port authority of Prince Rupert mentioned "*The aim of the Green Wave program is to incentivize Vessel Owners to increase their environmental awareness and continue to improve the performance of their vessels.*"(Prince Rupert Port Authority 2015)

The advantage of differentiation schemes is that vessels with bad performance are encouraged to improve step by step. If the standard of green incentive is set at very high level, the high-polluting vessels would easily to give up when perceiving huge gap of pollution level and high reform capitals.

However, Jenny (2013) pointed out the differentiation schemes may bring up the price level, leading to competitive disadvantage and resulting in a decrease in the amount of port calls for ports which introduced differentiation schemes. Despite that, Jenny's research still concluded that this situation is solved in Swedish ports because all of the major Swedish ports introduced differentiation schemes. Therefore, it is important for a port to refer to nearby or replaceable ports' charging schemes when deciding whether to introduce differentiation scheme in order to prevent possible competitive disadvantages.

3.2.2 Green Incentive – Rebate/Reward Schemes

Rebate Schemes are used by the most ports. In our research, 34 out of 43 green ports, accounting for 79.1%, introduced rebate scheme as shown in Figure 4. By means of rebate, port authorities encourage green shipping by providing reductions on port fees or award ship owners in a fixed amount. According to the port tariff data from these 34 ports, port authorities offer reductions between 0.5% and 50% discount on port dues for vessels having qualified performance based on several reduction measures such as ESI, Green Award, and national green incentive program.

Rebate by fix amount

Some ports give rebate by a fixed amount. In this case, the amount of annual budget for green incentive will be easily estimated. This case can be exemplified by the port of Los Angeles.

Port of Los Angeles (2009) offers three different programs. Rebate based on ESI score is divided into four tiers: $250 for ESI-score 25-29, $750 for ESI-score 30-34, $1,000 for ESI-score 35-39, and $1,250 for ESI-score 40 or greater. Second program is the Ocean Going Vessel 5 (hereinafter refer to as OGV5) for IMO Tier II or Tier III Standards: (1) An incentive of $750 per call OGV with an IMO Tier II main engine. (2) An incentive of $3,250 per call OGV with an IMO Tier III main engine. Additionally, Technology Advancement Program Demonstration, also named OGV6 program, is the third program implemented in this port. The port authority offers an incentive $750 per call for existing ocean-going vessels that demonstrate an

emission reduction technology which reduces Diesel Particulate Matter (DPM) and NOx emissions.

However, the disadvantage is that the rebate by fixed amount might be too less for huge vessels. If ports adopt green incentive scheme by rebate in fixed amount, there is no difference between large and small vessels. Therefore, the rebate amount becomes relatively small for large vessels in comparison with small sized vessels.

Rebate by percentage discount on port fees

In contrast to giving rebate by fixed amount, the estimation of green incentives by percentage is more difficult. For instance, port offers 10 percent discounts on port dues (EUR 0.05 per GRT) for an environmentally friendly vessel. The difference of rebate between a short sea vessel (M.V. Uni Prudent as an example, GRT 17,887 tons, 1,618 TEUs) and a sea going vessel (M.V. Ever Legacy as an example, GRT 98,882 tons, 8,000 TEUs) is EUR 405.00. So, the past records of calling vessels size shall be reviewed carefully in order to set up appropriate percentage of rebate on port fees.

The port of Amsterdam uses two individual incentive schemes for sea-going vessels and inland barges. Ship owners can be rewarded by presenting Green Award certificate for their vessels. (Port of Amsterdam 2015a) 6% premium on the port fees can be granted for sea-going ships: Crude oil/Product Tankers and for Cargo Bulk Carriers. (Port of Amsterdam 2015b) Different percentage of discounts can be granted by inland waterways on the basis of the type of Green Award certificate: Bronze by 5 percent discounts, Silver by 10 percent discounts, and Gold by 15 percent. An additional 10 percent discounts can be granted by the certificate issued before 17 Jul. 2014.

3.2.3 Green Incentive – Additional Levy and Financial Compensation on waste fees

Additional Levy

Most of the green incentive schemes positively encourage ship owner to transform their vessels into greener one. However, on the contrary, a port could also force vessels to do the same by means of negative discouragement. Port of Gothenburg, for example, charges additional cost for the tankers with single hulls which do not have a double bottom and double sides, regardless of segregated ballast tanks. In this case, a 100 percent increase in port dues will be levied for these vessels (Port of Gothenburg 2015a). Taking M.T. Anneleen Knutsen with GRT 24,242 tons as an example, its original port dues is SEK 72,484, equivalent to EUR 7,534 (by exchange rate EUR/SEK =9.6209, medium rate on 7 Aug. 2015). The additional cost is partly a reflection of high risks when handling these kinds of tankers. When they are damaged, it could lead to leakage of crude oil and bring great disaster to the environment. So it is very important for the tankers to have double hulls, and the objective of this charge is to push ship owners to improve their fleets.

Financial Compensation on Waste Fees

The port of Antwerp offers sea-going vessels a financial compensation on waste fees in order to encourage all kind of waste, delivering to the right facility in the port. The financial compensation consists of a fixed compensation per call and a variable compensation per cubic meter of waste. The port authority mentioned "*the collected*

waste fees are used to reduce the costs of each waste delivery significantly"(Antwerp Port Authority 2015b).

3.3 Changing Practices of Green Incentive Scheme

3.3.1 The impacts of Environmental Policy and Regulation

Both international and national environmental policy and regulations have big impact on green incentive schemes to ports. The most significant case is the new standard of sulphur oxides (SOx) allowed for marine fuel regulated by IMO MARPOL Annex VI which came into force on 01 Jan. 2015. The CEO of Gothenburg port authority Mr. Magnus Kårestedt states: *"For a number of years we have been applying an environmentally differentiated Port Tariff. Now that the conditions for sulphur-based fuels have changed in our region, we are launching a new environmental offer to shipping companies."*(Port of Gothenburg 2015a). So, the external influences (e.g. environmental policy or regulation changes) are very important factor when ports set up the structure of green incentive scheme.

3.3.1.1 IMO MARPOL sulphur regulations

The IMO MARPOL sulphur regulations have huge influence on marine fuels within the emission control areas (ECA). According to the IMO MARPOL Annex VI-Regulations for the Prevention of Air Pollution from Ships, the maximum amount of SOx and particulate matter (PM) emission allowed both inside and outside of ECA are regulated on schedule. Table 10 illustrated a schedule which set up a trajectory to lower the allowed maximum sulphur content of fuel oils being used on board of each vessel. Table 11 shows current ECAs, including the SOx Emission Control Areas (SECAs): Baltic Sea and North Sea, NOx Emission Control Areas (NECAs): North American, and Caribbean Sea.

Table 10 Emission Control Areas (ECA) – Maximum Sulphur Content of Marine Fuel

Outside an ECA established to limit SOx and particulate matter emissions	Inside an ECA established to limit SOx and particulate matter emissions
4.50% m/m prior to 1 January 2012	1.50% m/m prior to 1 July 2010
3.50% m/m on and after 1 January 2012	1.00% m/m on and after 1 July 2010
0.50% m/m on and after 1 January 2020*	0.10% m/m on and after 1 January 2015

* or 2025, depending on the outcome of a review, to be concluded by 2018. Source: (IMO 2015)

Table 11 Emission Control Areas (ECA)

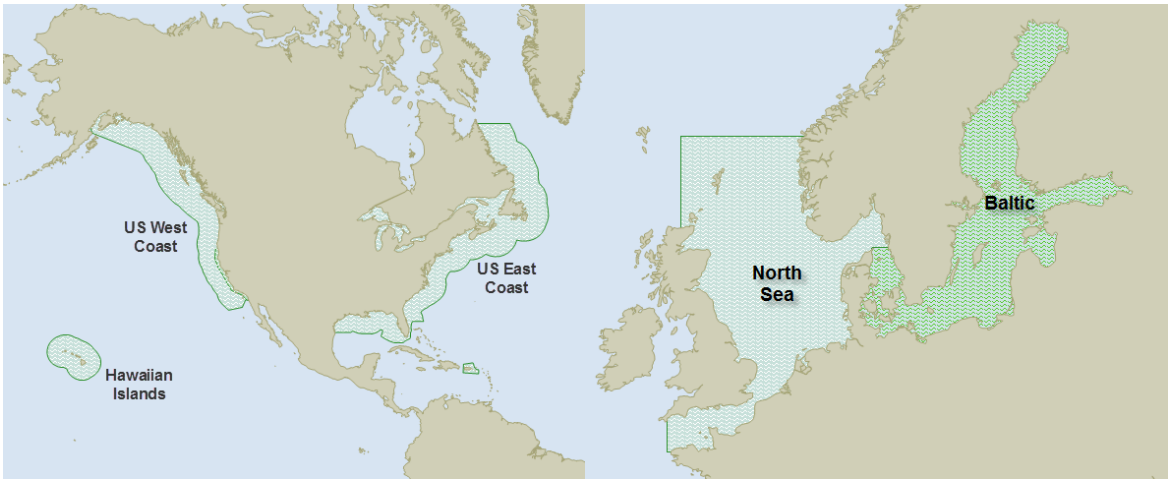
Area	In Effect From	MARPOL Regulation	Emissions
Baltic Sea area	19 MAY 2006	Annex I	SOx
North Sea area	22 NOV 2007	Annex V	SOx
North American area	1 AUG 2012	Appendix VII of Annex VI	SOx, NOx, PM
Caribbean Sea area	1 JAN 2014	Appendix VII of Annex VI	SOx, NOx, PM

Source: (IMO 2015) and modified by the author

In the old version of port tariff from port of Gothenburg by 2014 (2014), ship owners have to be levied environment-related dues. For these vessels which consume marine fuel containing more than 0.50 percent of sulphur by weight should be charged sulphur dues SEK 0.10 per GRT. The port also provides a green incentive scheme – Nitrous Oxide Rebates – for environment-friendly vessels. The scheme has three levels of NOx emissions measured by g NOx / kWh. The reduction of NOx

rebates for a container vessel by GRT within range 20,001-40,000 tons is 3.8 percent for emission level 6.6-9.9 g NOx/kWh, 7.5 percent for emission level 2.0-5.9 g NOx/kWh, and 15 percent for emission level 6.6-9.9 g NOx/kWh (Gothenburg Port Authority 2014). After implementing this scheme, the pollution is significantly lower than before. However, after new standard of IMO MARPOL Annex VI regulated maximum sulphur content 0.10% m/m of marine fuel came into force in 1 Jan. 2015 as it was mentioned in Table 10, the old green incentive scheme is no longer in effect. The Gothenburg Port Authority which is located within the Baltic ECA, as shown in Figure 6, removed the environment-related dues and launched a new green incentive scheme.

Figure 6 Emission Control Areas (ECAs)



Source: (AtoBviaC Plc 2015)

3.3.1.2 IMO MARPOL limits for NOx emissions of new-build engines

IMO MARPOL Annex VI has also regulated the limit of the emissions for the new building engines. The details are as shown in Table 12.

Table 12 IMO MARPOL limits for NOx emissions of new-build engines

Items	Entry into force	New diesel engines installed on ships	NOx limit in g/kWh
Tier I	2005	From 1 Jan. 2000 to 1 Jan. 2011	9.8-17.0
Tier II	2011	After 1 Jan. 2011	7.7-14.4
Tier III	Flexible form, 2016	Flexible, but only when operating in NECAs	2.0-3.4

Source: (WPCI 2015a)

3.3.2 National Regulation

A typical example of national regulation is the regulation launched in 2008 by the state of California Air Resources Board (hereinafter refer to as CARB) to reduce air pollutions from ships while staying in berth at most California ports. It requires that vessels shut down on board diesel engine and connect to shore power when docked at port of Los Angeles (POLA), Long Beach (POLB), Oakland, San Francisco, San Diego, and Hueneme(California Air Resource Board 2013). The requirements and compliance period of sea-going vessels are shown in Table 13.

Table 13 The requirements and compliance period of CARB regulation

Start Date	Requirement	Compliance Period
January 1, 2010	Shore-power equipped vessels that are part of an affected fleet must use shore power while visiting a compatible shore-power berth.	Applies at all times
January 1, 2014	1) 50 percent of the fleet's visits to a port must be shore-power visits* 2) Auxiliary engine power generated by the fleet must be reduced by 50 percent.	Quarterly**
January 1, 2017	1) 70 percent of the fleet's visits to a port must be shore-power visits* 2) Auxiliary engine power generated by the fleet must be reduced by 70 percent.	Quarterly**
January 1, 2020	1) 80 percent of the fleet's visits to a port must be shore-power visits* 2) Auxiliary engine power generated by the fleet must be reduced by 80 percent.	Quarterly**
* A shore power visit is a visit where a vessel connects to shore power within the time constraints of the regulation.		
** Although compliance is calculated quarterly, report are submitted annually to ARB. The first Annual Statement of Compliance, which is submitted by March 1st of 2015, discusses the fleet's compliance for each of the four compliance periods in 2014.		

Source: (California Air Resource Board 2013)

In this case, it might be unnecessary to provide green incentive for shore power connecting vessels.

3.3.2 The impact of the technical improvements on vessels

In Geogr and Wilmsmeier's (2007) research, the port of Sullom Voe mentioned that all vessels calling at the ports have complied with the Green Award requirements. So, the discount of 5 percent is no longer granted by the Green Award qualified vessels. The technical improvement of the vessels is an important factor which should be taken into account for the green incentive scheme.

Chapter 4 Port of Hamburg, Germany

4.1 Port of Hamburg, Germany

Geography

Port of Hamburg is one of most active ports in the world, as well as the second largest European port located between the Baltic Sea and North Sea. The port can be easily accessed through 70 nautical miles (around six hours sailing) channel of Elbe River from the North Sea. However, deep draft vessels have to follow the tide window to access the port – 15.1 meters (about 50 feet) during high tide and 12.8 meters (about 42 feet) during low tide. The geographic position for port of Hamburg is shown in the figure below.

Figure 7 Geographical Position of Port of Hamburg

Source: Google map

The port area covers the total of 7,399 hectares, including 4,331 hectares of land area, 919 hectares of port expansion area, and 755 square kilometres of urban area(Port of Hamburg 2015b).

Port model

Since 2005 the Hamburg Port Authority (HPA) plays a vital role in the port management. Because the institution is under public law, "*HPA is in charge of paving the way for the efficient, resource-friendly and sustainable implementation of infrastructure projects in the port"*(Hamburg port authority 2015b). In addition, HPA also plays a single contact window for any question relating to the navigational safety of vessel traffic, port property management, waterside and the landside infrastructure, and the economic conditions within the port area (Hamburg port authority 2015b). The terminals in the port of Hamburg are operated by private operators. For example, HHLA CONTAINER TERMINAL BURCHARDKAI is

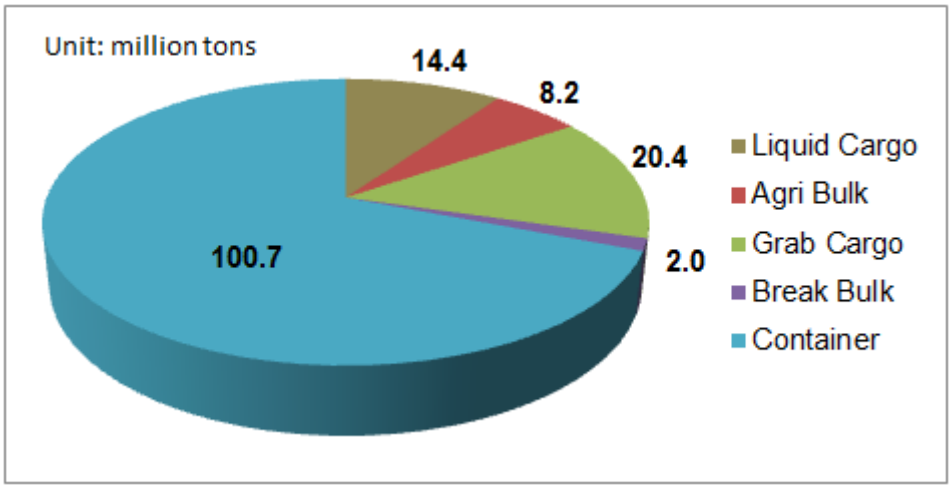
handled by HHLA Hamburger Hafen und Logistik AG, a German logistics and transportation company.

Economic profile

There are in total 42 terminals in port of Hamburg, including container terminal, multi-purpose terminal, bulk cargo terminal, and cruise terminal for handling container, project cargo, bulk cargo, grab cargo, liquid cargo, and suction cargo(Port of Hamburg 2015d). Since the size of vessels is getting bigger, vessels will only call at main ports. Neighbour countries' cargo will be transhipped by small feeder vessels, while inland countries' cargo will be transited by hinterland transportation such as railway, barge, and truck. Thanks to the good geographic location for the port of Hamburg, cargoes can be easily transited further to the entire Baltic Sea region and Scandinavia.

According to the records (Port of Hamburg 2015f), about 10,000 sea-going vessels call at port of Hamburg per year and more than 500 ultra-large containerships (ULCS) tied up in Hamburg in 2014. Throughout the year of 2014, port of Hamburg handled a total of 145.7 million tons goods as shown in Figure 8 below. In 2014, a total 103.7 million tons was transported by hinterland services of the port which composes of 47 percent by truck, 11 percent by inland-waterway vessels, and 43 percent by rail (Port of Hamburg 2015a).

Figure 8 2014 Cargo Handling in Port of Hamburg



Source: (Port of Hamburg 2015c) and modified by author

Figure 8 illustrate that container cargo accounted for a great majority of entire cargo flow in port of Hamburg. In 2014, port of Hamburg had 9.729 million TEUs container throughput, ranked as 15th of the world container ports (Port of Hamburg 2015e).

Corporate social responsibility & Environmental Policy

HPA has introduced environmental guidelines which aim at protecting and caring for the natural resources. Their essential corporate goals are the avoidance of waste, reduction on emissions and consumption, increases in efficiency, and the improvement of environmental performance (Hamburg port authority 2015a).

4.2 Environmental incentive scheme at Port of Hamburg

Table 14 shows the price elasticities of selected North Range container ports. The elasticity 3.1 for port of Hamburg is in the middle among five ports. Apparently, a change in the price has significant influence on the port traffic in this port. Some ports have monopoly power to dominate the price level of market, but container ports in the North Range do not have such power due to fierce competition in the area. Thus, in order to increase profits, ports within this range must struggle to increase in traffic to gain more incomes from port charges. However, according to the queuing theory, the berth occupancy rate for liner shipping between 40% and 60% would be a competitive traffic and will not have delay on traffic (Fourgeaud 2000). Therefore, port of Hamburg can not absorb port's traffic unlimited to increase profits, but must work on proper pricing strategy bring up profits.

Table 14 Price Elasticities for selected North Range container ports (10% price increase; simulation results)

Port	Elasticity
Hamburg	3.1
Bremen Ports	4.4
Rotterdam	1.5
Antwerp	4.1
Le Havre	1.1

Source: (Haralambides et al. 2001)

Being a landlord port, port of Hamburg is able to get financial support from German government for the loss resulting from environmental incentive scheme. The major activity in the port of Hamburg is container handling as shown in Figure 8. So, the port authority of Hamburg focuses on the container terminal and shipping traffic for the scope of green port (Hamburg port authority 2015c).

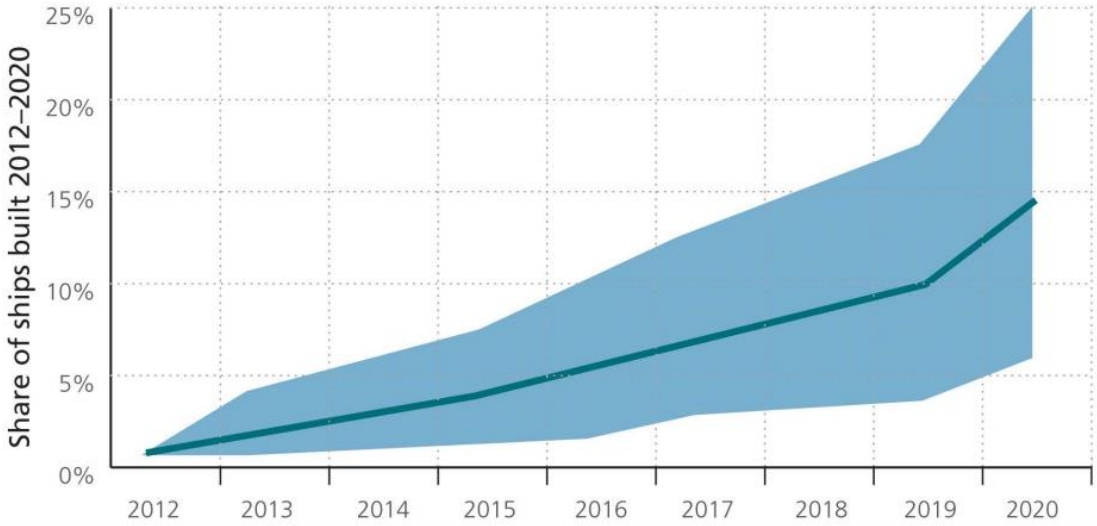
Currently, Hamburg port authority (2015) offers five different environmental discount incentives in port fees based on gross tonnage (GT) for vessels which contribute to reduction of air pollution. These reward schemes include: solely LNG-fuelled vessel, port power discount, Blue Angel certificated ships, ESI scores, and Green Award certificated ships.

4.2.1 Environmental discount incentive "solely powered by LNG"

HPA offers 15% discount on port fees for ships which are solely powered by LNG (ESI-SOx score > 99) and are registered with the IAPH (International Association of Ports and Harbours), maximum €2,000. The discount is not allowed to apply together with ESI discount and is valid until 31 Dec. 2018.

In 2013, there are only 20 – 25 LNG-fuelled vessels in operations excluding the LNG carriers (Adamchak & Adede 2013). Although the LNG fuel is the most efficient alternative fuel to reduce environmental impacts, the LNG-fuelled vessels still account for only very small portion within the maritime industry, even less than 1% of the overall commercial marine fleet. Today, the prognosis LNG fuelled fleet account only for less than 5% of total share of ship built between 2012 and 2020 (Tellkamp 2013).

Figure 9 Prognosis LNG fuelled fleet



Source: (Tellkamp 2013)

In view of such a low proportion, the LNG discount might not have much attractiveness to ship owners at this moment. Especially, the attractiveness of LNG fuel is significantly influenced by the differences in price between fuel oil and LNG fuel (one of shipping company stated, interview 22 JUL 2015) (Tork 2013). However, maximum amount of EUR 2,000 on port fees for solely LNG-powered vessel is still substantial for the ship owners. Nevertheless, the cap of award is still unfair to large vessels.

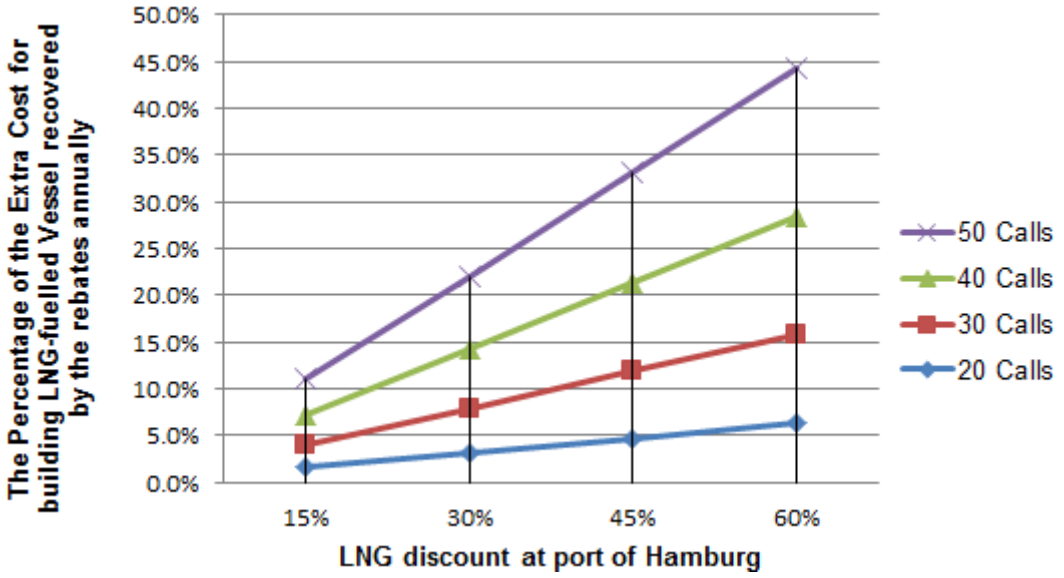
4.2.1.1 The LNG discount to ship owners

We use the following simple calculation to get more insight into the impacts of this discount. The building cost of a solely LNG-powered vessel is 20% higher than a marine fuelled vessel with the same GRT (cqshipping 2015). We take the new Ro-Ro Cargo Vessel "Kvitbjørn" (GRT 8,400 tons) as an example. The building cost of this ship is around USD 32.5 million or EUR 29.3 million (by exchange rate EUR/USD=1.1096 on 12 Aug. 15)(Rich 2015), with the 20 percent of total building cost EUR 5.86 million. Assuming the lifespan of this ship is 30 years, the additional cost for building a solely LNG-powered vessel is EUR 195,333 per year. Based on the port tariff under price category 34: other RoRo ships/ multi-purpose carriers (Hamburg Port Authority 2015), the original price of other maritime traffic is EUR 0.1223 per GT.

Four scenarios have been tested, including current practice 15% discount, 30%, 45%, and 60% discount which correspond to following different tariffs: EUR 0.1040/GT, EUR 0.0856/GT, EUR 0.0673/GT, and 0.0489/GT. The reward amount granted from the LNG discount is used to divide by the annual extra cost of building LNG-powered vessel. For instance, the reward amount EUR 153.72 granted from 15% discount is the difference between normal price and discount price (EUR 0.1223/GT - EUR 0.1040/GT) multiplied by ship's GRT 8,400 tons. Then, we can receive a percentage of reward of extra building cost for LNG-powered vessel by calculating the reward amount EUR 153.72 divided by EUR 195,333. Figure 10 shows the result and illustrates the positive relationship between the financial compensation from port and the extra building cost for a sampled LNG-fuelled

vessel to ship owner. According to the discount condition of HPA, the three discounts: ESI, solely powered by LNG, port power discounts cannot be applied in one vessel. Therefore, the result has been shown in the maximum award situation for “solely powered by LNG” discount.

Figure 10 Percentage of the Extra Cost for building LNG-fuelled Vessel recovered by the rebates annually



Source: (Jenny 2013) and elaborated by the author for the case of port of Hamburg

As seen in Figure 10, the graph indicates the importance of granting discount to ship owner in order for them to invest their fleet. While port offers 15% discount for a similar size of LNG-powered vessel, ship owner can receive a 1.6% financial compensation on its investment for the same vessel with 20 calls at port of Hamburg within a year. With the call frequency increased to 50 calls a year, a subsidy of 6.3% can be granted. In other words, 63% of extra cost for building solely LNG-powered vessel can be recovered in 10 years, only one third the lifespan of the vessel. Therefore, the number of calls is also a crucial factor in determining the discount of the environmentally friendly incentive.

Nevertheless, the vessel does not only receive LNG discount from HPA but also from any other calling port. Normally, vessels using LNG as marine fuel have high ESI scores and high level of Green Award certificate which can receive notable discount on port fees at the ports which provide green incentives. For instance, M.V. Bergensfjord has ESI score 97.1 points (WPCI 2015b). In sum, the incentive is quite attractive to ship owners for the long term investment.

4.2.2 Environmental discount incentive "port power discount"

The newest reward scheme “port power discount” was published on December of 2014. It offers 15% discounts on the GT portion of port fees for ships that use electricity provided by power barge or generated from alternative energy facilities instead of using their diesel engines while berthing. The deducted amount of the port fees has a maximum limit of €2,000 and it is not allowed to combine with LNG discount.

Port of Hamburg has introduced smart energy project to encourage the use of alternative energy. According to its plan, the first stage is the installation of shore power connecting facility for cruise ships at the terminal Altona (Hamburg port authority 2014). The landside electricity supporting system was scheduled to start operations in summer 2015. "*In addition, a pilot project will be initiated to supply external power to container vessels as part of the Green Shipping Line between the port of Hamburg and Shanghai*."(Hamburg News 2014) It implies the landside shore power facilities are not popular at port of Hamburg. So, the ship owners might have difficulties to receive the port power discount at this moment.

The advantage of the port power is that it could reduce the noise and air pollution efficiently. The NOx, VOC, and PM can be reduced significantly by using shore power comparing with the auxiliary engines (ENTEC 2005). In addition, Hall's study (Hall 2010) also proved the CO_2 emissions can be reduced by 14.90% by using shore power in Germany.

4.2.2.1 The shore power discount to ship owners

The typical total onboard installation cost for shore power connections is EUR 60,000 to EUR 140,000 including the transformer (0.5-2 MW) (Jivén & Ab 2004). Take MV. Ever Conquest (GRT 90,604 tons) as an example, this container carrier can receive maximum rebate of EUR 2,000 (regular GT price EUR 0.2156/GT*15%*GRT 90,604 tons = EUR 2,930) from every calling at port of Hamburg. Since the longest voyage of liner shipping service is 84 days between Asia and Europe (Bottema 2015), this vessel is expected to berth at port of Hamburg approximately 4 times a year. In this case, the reward amount of shore power is EUR 8,000 per year for this vessel. Assuming the onboard installation cost of shore power connections for this vessel is EUR 100,000 and its lifespan is 20 years, the annual cost for the equipment would be EUR 5,000, much lower than the expected yearly reward amount of EUR 8,000. In other words, ship owner can receive a notable reward already from a single port.

4.2.3 Environmental discount incentive "Blue Angel"

A 2% discounts is offered for carriers whose ship operations are proved as eco-friendly and vessels certificated by the "Blue Angel (Der Blaue Engel)". The Blue Angel is a German ecolabel for services and products that have taken eco friendly into consideration.

The Blue Angel certificate is relatively rarely used by ports for the environmental incentive scheme due to its rather localised nature. It is a German ecolabel for services and products and might not be aware by ship owners and port owners as popular as ESI-score system. Besides, the Blue Angel certificate can only be used at port of Hamburg. So, ports which use the Blue Angel certificate as measure may not be sufficient attractive to ship owners.

4.2.4 Environmental discount incentive (environmental and climate friendliness)

Based on ship's ESI scores, port of Hamburg provides variable percentage of discounts on port fees. While ships call at Hamburg with valid ESI score, carriers can receive variable discounts as shown in Table 15 (Hamburg Port Authority 2015).

Table 15 Percentage of discounts on port fees by ESI score

ESI score	Percentage of discount on port fees	Maximum reward amount
20-24	0.50 %	EUR 250
25-34	1.00 %	EUR 500
35-49	5.00 %	EUR 1,000
≥ 50	10.00 %	EUR 1,500

Source:(Hamburg Port Authority 2015) and modified by author

Major German ports mostly use the tier reward for different level of ESI scores. The only dissimilarity between port of Hamburg and nearby German ports is that port of Hamburg set up neither a cap of annual ESI award on vessel calls nor a limit on award vessel calls belong to same ship owner. Niedersachsen ports, including port of Cuxhaven, port of Stade, port of Norden, and port of Emden have awarded a limit of a maximum of 10 ships' calls per owner/operator for each port in certain time interval (calendar year)(Niedersachsen Ports 2015). In port of Bremen, the cap of ESI award is that only 25 ships with the best ESI score of at least 30 or more points can receive the discount(Port of Bremen 2015).

However, HPA might create a disadvantage to ship owners by setting a maximum reward amount on each reward level. A simple example could illustrate this point.

Given a container vessel with GRT 90,000 tons has ESI-score of more than 50 points. Base on the port tariff (Hamburg Port Authority 2015), the port fee in the part of GT is EUR 19,404 (GT price: EUR 0.2156 per GT) and the 10% discount is EUR 1,940. According to the maximum reward amount of this ESI-score level, only EUR 1,500 can be granted to this vessel. Therefore, it is not fair for the vessels greater than GRT 69,573 tons (EUR 1,500/0.1/EUR 0.2156) with ESI-score of more than 50 points because the maximum reward amount has been reached.

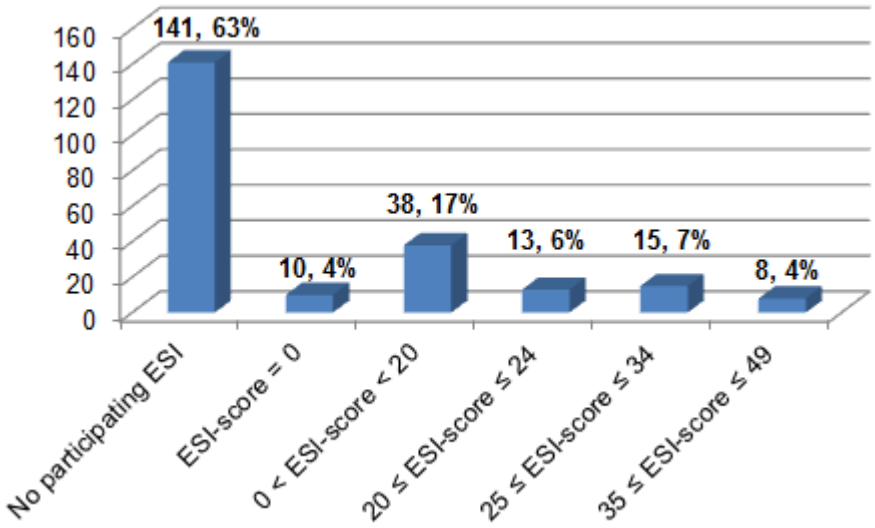
From the HPA perspective, on the other hand, the cap of the reward amount for each ESI-score level is to prevent unlimited loss of the port fees due to ESI discount. In this way, HPA can still partly compensate ship owners for investing into better technology on their fleet in greener shipping.

4.2.5 Environmental discount incentive "Green Award"

3% discount in port fees can be received by product and chemical tankers, crude oil, LNG carriers in any size which hold a valid Green Award certificate (Hamburg Port Authority 2015).

The research has been carried out through combining every individual vessel which is listed by Green Award certificate holding tankers, a total 225 vessels, with the list of participating ships on ESI website. The result is shown in Figure 11, illustrating the distribution of ESI score for the Green Award vessels. According to the distribution of ESI score for these vessels, a majority 141 out of 225 vessels, approximately 63%, do not participate in ESI system. Moreover, 138 vessels, or equivalent to around 83% of total Green Award certificate holders, have less than 20 points of ESI score. It means these vessels are not able to receive discount by their ESI score but entitled to the Green Award discount of 3% in port fees. Therefore, HPA's environmentally friendly incentive scheme does not only compensate the outstanding vessels financially but also encourages the vessels which do not participate in ESI system or have lower ESI score to improve their efficiency.

Figure 11 Distribution of ESI score for Green Award certificate holders



Source: (Greenaward 2015), (ESI 3015) and elaborated by the author

4.3 The impact of discount to Hamburg Port Authority

The condition of incentive discounts used by HPA indicates that some discounts are independent and can not be combined with other discounts. In this case, we assume one vessel is able to receive a discount from only one environmentally friendly discount per call.

Based on below equation, we are able to calculate the average price.

$$a_1 * b_1 + a_2 * b_2 + a_3 * b_3 + \cdots + a_9 * b_9 = c$$

Where, a is the volume, b is the traffic volume and *c* represents the average price. Details are shown in Table 16. The average price EUR 0.1210/GT is received by the calculation under the assumption of traffic volume based on current practice of incentive scheme. The traffic volume consists of the vessels entitled to eight different discounts and the vessels charged by regular price.

Table 16 The Coefficient of the calculation

Price		Traffic Volume	
a_1	Regular price	b_1	Regular Price Vessels
a_2	LNG Discount Price	b_2	LNG Discount Vessels
a_3	Port Power Discount Price	b_3	Port Power Discount Vessels
a_4	Blue Angel Discount Price	b_4	Blue Angel Discount Vessels
a_5	ESI Discount Price	b_5	ESI-score 20-24 points Vessels
a_6	ESI Discount Price	b_6	ESI-score 25-34 points Vessels
a_7	ESI Discount Price	b_7	ESI-score 35-49 points Vessels
a_8	ESI Discount Price	b_8	ESI-score ≥ 50 points Vessels
a_9	Green Award Discount Price	b_9	Green Award Discount Vessels

Two scenarios from current practice of incentive discount and higher discount have been tested. In order to have accurate hypothesis, three different traffic volumes

have been assumed for the analysis. The objective function of two scenarios is: $a_1 * b_1 + a_2 * b_2 + a_3 * b_3 + a_4 * b_4 + a_5 * b_5 + a_6 * b_6 + a_7 * b_7 + a_8 * b_8 + a_9 * b_9 = 0.1210$.

The constraints of scenario I are as shown in below table.

Constraint	Subject
$a_2 = a_1 * 0.850$	Regular price with 15% discount
$a_3 = a_1 * 0.850$	Regular price with 15% discount
$a_4 = a_1 * 0.980$	Regular price with 2% discount
$a_5 = a_1 * 0.995$	Regular price with 0.5% discount
$a_6 = a_1 * 0.990$	Regular price with 1% discount
$a_7 = a_1 * 0.950$	Regular price with 5% discount
$a_8 = a_1 * 0.900$	Regular price with 10% discount
$a_9 = a_1 * 0.970$	Regular price with 3% discount

Table 17 Calculated Regular and Discount Price Level by Current Practice with different volume

Scenario I	Portfolio 1	Portfolio 2	Portfolio 3
Regular Price	**0.1223 EUR/GT**	**0.1224 EUR/GT**	**0.1231 EUR/GT**
Volume	85%	75%	65%
LNG Discount Price (15%)	**0.1040 EUR/GT**	**0.1040 EUR/GT**	**0.1046 EUR/GT**
Volume	0.5%	1.5%	3%
Port Power Discount Price (15%)	**0.1040 EUR/GT**	**0.1040 EUR/GT**	**0.1046 EUR/GT**
Volume	0%	0%	0%
Blue Angel Discount Price (2%)	**0.1199 EUR/GT**	**0.1199 EUR/GT**	**0.1207 EUR/GT**
Volume	1%	2%	3%
ESI Discount Price (0.5%)	**0.1217 EUR/GT**	**0.1218 EUR/GT**	**0.1225 EUR/GT**
Volume	2%	3%	4%
ESI Discount Price (1%)	**0.1211 EUR/GT**	**0.1212 EUR/GT**	**0.1219 EUR/GT**
Volume	3%	5%	7%
ESI Discount Price (5%)	**0.1162 EUR/GT**	**0.1163 EUR/GT**	**0.1170 EUR/GT**
Volume	4%	6%	8%
ESI Discount Price (10%)	**0.1101 EUR/GT**	**0.1102 EUR/GT**	**0.1108 EUR/GT**
Volume	2%	4%	6%
Green Award Discount Price (3%)	**0.1186 EUR/GT**	**0.1187 EUR/GT**	**0.1194 EUR/GT**
Volume	2%	3.5%	4%
Average Price	**0.1210 EUR/GT**	**0.1210 EUR/GT**	**0.1210 EUR/GT**

Source: Elaborated by the author

The constraints of scenario II are shown in the table below.

Constraint	Subject
$a_2 = a_1 * 0.800$	Regular price with 20% discount
$a_3 = a_1 * 0.800$	Regular price with 20% discount
$a_4 = a_1 * 0.970$	Regular price with 3% discount
$a_5 = a_1 * 0.990$	Regular price with 1% discount
$a_6 = a_1 * 0.985$	Regular price with 1.5% discount
$a_7 = a_1 * 0.940$	Regular price with 6% discount
$a_8 = a_1 * 0.890$	Regular price with 11% discount
$a_9 = a_1 * 0.960$	Regular price with 4% discount

Table 18 Calculated Regular and Discount Price Level by higher discounts with different volume

Scenario II	Portfolio 1	Portfolio 2	Portfolio 3
Regular Price	**0.1227 EUR/GT**	**0.1231 EUR/GT**	**0.1242 EUR/GT**
Volume	85%	75%	65%
LNG Discount Price (20%)	**0.0981 EUR/GT**	**0.0985 EUR/GT**	**0.0993 EUR/GT**
Volume	0.5%	1.5%	3%
Port Power Discount Price (20%)	**0.0981 EUR/GT**	**0.0985 EUR/GT**	**0.0993 EUR/GT**
Volume	1%	2%	3%
Blue Angel Discount Price (3%)	**0.1190 EUR/GT**	**0.1194 EUR/GT**	**0.1204 EUR/GT**
Volume	1%	2%	3%
ESI Discount Price (1%)	**0.1215 EUR/GT**	**0.1218 EUR/GT**	**0.1229 EUR/GT**
Volume	2%	3%	4%
ESI Discount Price (1.5%)	**0.1208 EUR/GT**	**0.1212 EUR/GT**	**0.1223 EUR/GT**
Volume	3%	5%	7%
ESI Discount Price (6%)	**0.1153 EUR/GT**	**0.1157 EUR/GT**	**0.1167 EUR/GT**
Volume	3%	4%	5%
ESI Discount Price (11%)	**0.1092 EUR/GT**	**0.1095 EUR/GT**	**0.1105 EUR/GT**
Volume	2%	4%	6%
Green Award Discount Price (4%)	**0.1178 EUR/GT**	**0.1182 EUR/GT**	**0.1192 EUR/GT**
Volume	2%	3.5%	4%
Average Price	**0.1210 EUR/GT**	**0.1210 EUR/GT**	**0.1210 EUR/GT**

Source: Elaborated by the author

Two tables show that the changes of regular price level by increasing the percentage of the discount and the traffic volume are entitled to receive a discount at port of Hamburg. The average price level is the result of scenario I together with portfolio 1, and set to be fixed to test other portfolios.

Chapter 5 Port of Gothenburg, Sweden

5.1 Port of Gothenburg, Sweden

Geography

Port of Gothenburg is the largest port in Sweden as well as the Scandinavia. The geographic location gives the port a great advantage to connect the Baltic Region, Scandinavia, and Atlantic/North Sea. The quayside can be easily reached in 90 minutes from the open seas without ice and tide restrictions. Port of Gothenburg has roro terminal, container terminal, car terminal, energy port, cruises and ferries terminal supporting widely varied cargo flows.

Port model

The land and infrastructures in port of Gothenburg is owned by Gothenburg port authority. Expert terminal operators, such as APM Terminals, are allowed to deal with the handling of goods in the port area. So, the port of Gothenburg is a landlord port. The main business concept for Gothenburg port authority is to: "*Provide an infrastructure and an energy port, be responsible for safety, berthing and co-ordination, and promote the national and international marketing of the whole port.*"(Gothenburg Port Authority 2015)

Economic profile

According to the record from the port, there are over 11,000 vessel calls per year and approximately 30 percent of international trade in Sweden is handled through this port. The traffic within the port is greatly diversified. In 2014, the contents of throughput include 836,631 TEUs containers, 548,801 Ro/Ro units, 166,069 new cars, 1.82 million passengers, 19.23 million tons of oil, and 37.1 million tonnes of non-containerised freight (Port of Gothenburg 2015c). Being the largest Swedish port and the gateway of Scandinavia, port of Gothenburg not only offers wide ranges of routes but also provides strong rail system to support the markets of hinterland and nearby countries. To transport containerised goods by rail is an environmentally friendly option. Around 70 trains arrive and depart from port of Gothenburg on daily basis, and the strong rail system (Railport Scandinavia) offers a more complete network between port and inland destinations (Port of Gothenburg 2015c).

The cargo flow at port of Gothenburg is shown in Table 19 which illustrates the high volume of containerised goods transported by rail and the stable cargo flow in port of Gothenburg.

Table 19 Cargo Flow in Port of Gothenburg

Cargo Flow	Change in per cent, 2014	2014	2013	2012
Container(TEU)	-3%	836,631	858,000	900,000
Railway (TEU)	3%	405,836	393,000	411,000
Ro/ro units	0%	548,801	557,000	534,000
Cars	2%	166,069	163,000	163,000
Passengers	8%	1,820,738	1,692,000	1,674,000
Energy Products, Million tons	-6%	19.23	20.4	22
Cruise calls	87%	73	39	69
Total, Million tons	-2%	37.12	38.9	42

Source: (Port of Gothenburg 2015d)

Corporate social responsibility & Environmental Policy

The port of Gothenburg has implemented the sustainability scheme from the very early stage ahead of other world leading ports. The port is struggling to minimise the environmental impacts from shipping while contribute to the sustainability in the industry. For instance, it invests in shore side power connection for vessels to reduce air pollution, in rail shuttles to reduce pollution by trucks, and gas recycling in conjunction during the loading and unloading of oil. The port promotes the environmental work in all customers – land transport operators, shipping companies, and the terminals. In order for the customers to reduce their environmental impacts, port rewards and compensates customers for the green investments (Port of Gothenburg 2015b).

5.2 Environmental incentive scheme at Port of Gothenburg

Port of Gothenburg has carried out environmentally differentiated port tariff for a couple of years. The port introduced “environmentally-driven tariffs” in 1998, they charged higher fees on the vessels which run with high-sulphur fuels which contains more than 0.5% sulphur. Meanwhile, they also introduced another environmental reward scheme, offering discounts by different NOx emissions (Kågeson 1999). In 2011, port of Gothenburg launched a campaign to compensate vessels using cleaner fuels in its fairways. However, in order to comply with new conditions for vessels consuming sulphur-based fuels in Sulphur Emission Control Areas (SECA), the Baltic and North Sea, port authority has launched a new reward scheme taking effect on 1 Jan. 2015 (Port of Gothenburg 2015a). Since then, the Marine Environment Protection Committee of the IMO requested that the sulphur content of fuel must be below 0.1% in SECA (Ministry of Transport and Communications 2015). The environmental reward scheme is based on two scales: ESI and CSI, and an alternative fuel “LNG”.

5.2.1 Environmental discount incentive "ESI score"

Vessels that are registered in ESI and have a valid score of at least 30 points will be able to acquire a 10% discount on port dues. Among major Swedish ports, port of Gothenburg is the only port which offers ESI discount since 2015.

5.2.2 Environmental discount incentive "CSI certificate"

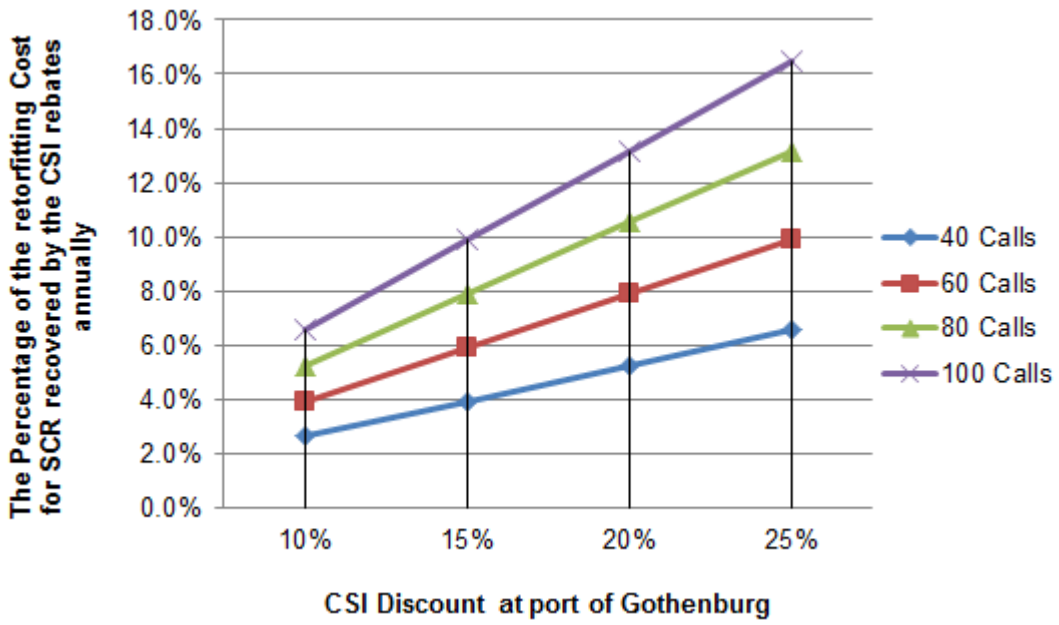
Vessels that have been certificated as “green standards” by CSI will be rewarded a 10% discount on port dues. The CSI discount incentive, as well as ESI discount incentive, is also carried out the first time in port of Gothenburg on 1 Jan. 2015. According to the verification guidelines of CSI (Clean Shipping Index 2015c), the air emission related parameters for vessel verification of scoring parameters are the SO_x & PM, NO_x, and CO_2.

The guideline states the solution against NOx emission: *“Office and onboard verification should take place. For engines installed after 1st Jan 2000, the data will be found in the EIAPP certificate. If the engine is older than that, or if NOx abatement technology is installed, NOx measurements could have been done according to the NOx Technical Code 2008.”*(Clean Shipping Index 2015c).

The Selective Catalytic Reduction (hereinafter refer to as SCR) can reduce NOx emission up to 75% for existing vessels (EPA 2015). Jenny (2013) in her research also shows the effect of granted discount from port of Stockholm to annual costs of SCR.

The same vessel, passage ferry (ropax) served on short route with frequent port visit which equipped with turbo-charged 4-stroke diesel engines: Wärtsilä16V32LN and has power 6560kW, is used to calculate the turnover rate in the case of port of Gothenburg. A ferry with GRT 3,924 tons was found under similar particular. Figure 12 shows the result for effect of granted discount from port of Gothenburg to annual retrofit costs of SCR. Given the tariff of port dues is SEK 1.27/GT or EUR 0.132/GT (by exchange rate EUR/SEK=9.6209, medium rate on 7 Aug. 2015) for ropax vessel under category 1-2 calls per week and service. In this calculation, only the typical cost of SCR equipment, operation and maintenance costs (operating, maintenance, urea nozzle costs, cost of replacement elements and other parts) are considered. The cost of urea consumption is excluded. Total purchase and installation cost for retrofitting four main engines is approximately EUR 720,000 with 12 years lifespan and the operation and maintenance costs are estimated to be EUR 20,000 per year (Jouni-Juhani 2012). The cost may vary due to different manufacturers and service providers.

Figure 12 Effect of granted CSI discount from port of Gothenburg to annual retrofit costs of SCR



Source: Elaborated by the author

The graph shows the turnover rate of SCR retrofitting cost is between 2.6% and 6.6% depending on the numbers of call under current practice 10 percent discount of CSI certificate holders.

5.2.3 Environmental discount incentive "LNG-powered vessels"

Vessels that are powered by LNG within the port area can be rewarded a 20% discount. This LNG discount is valid until the end of December 2018.

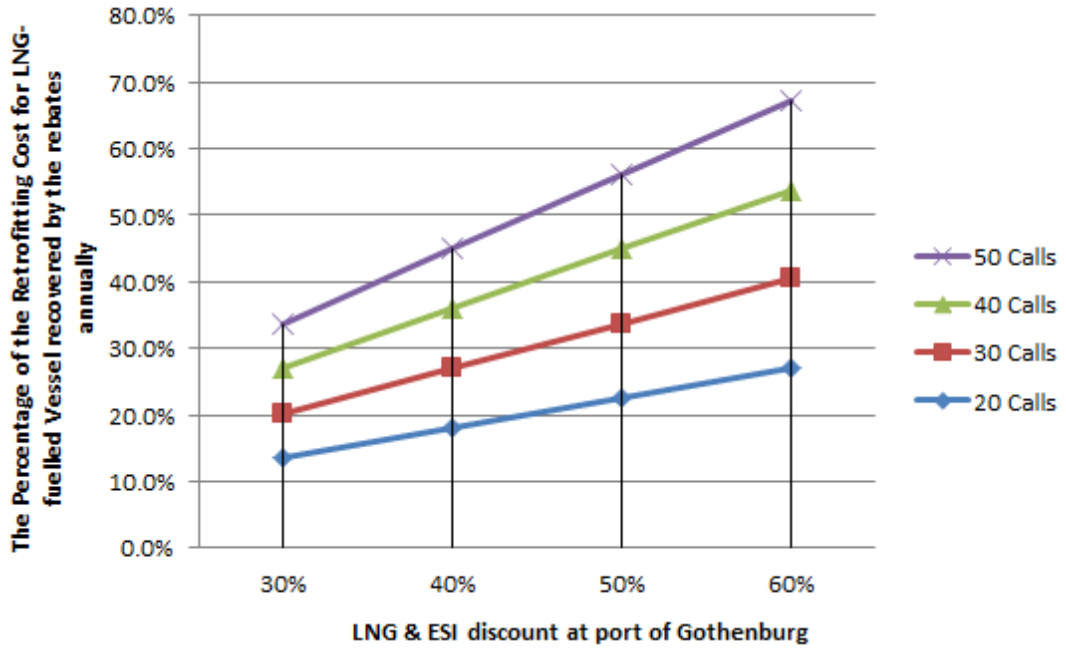
Port of Gothenburg differs from port of Hamburg in that the vessels can be rewarded by using LNG fuel only within the port area. In other words, the qualifying vessels are not necessarily solely powered by LNG but can be powered by dual fuel running with either marine fuel or LNG. In this case, the retrofit cost is the investment to ship

owner. In addition, the discounts of LNG and ESI can be granted together in one vessel call at the port of Gothenburg. Since the LNG-powered vessels have more than 30 points of ESI score theoretically, they can have two reductions which help ship owners to recover the investment rapidly.

The investment cost of LNG conversion for M.T. Nord Butterfly (GRT 24,066 tons) is USD 7,560,000 or EUR 6,782,832 (EUR/USD=1.1146 on 13 Aug. 2015) (Klimt-møllenbach et al. 2012). CAPEX is EUR 339,142 per year for the lifespan of 20 years. The regular tariff of port dues for this tanker under GT range 2,301-3,300 is SEK 2.99/GT or EUR 0.3163/GT (EUR/SEK=9.45 on 13 Aug. 2015) (Port of Gothenburg 2015a).

Since the LNG powered system might have higher ESI score of above 30 points, we assume this vessel can enjoy two discounts: LNG and ESI discounts. Four scenarios for the discounts of current practice 30% (LNG 20% plus ESI 10%), 40% (LNG 25% plus ESI 15%), 50% (LNG 30% plus ESI 20%) and 60% (LNG 35% plus ESI 25%) have been created in order to analyse the cost recover situation. The result is shown in Figure 13.

Figure 13 Percentage of the Retrofitting Cost for LNG-fuelled Vessel recovered by the rebates annually



Source: (Jenny 2013) and elaborated by the author for the case of port of Gothenburg

According to the analysis, 13.5% of retrofitting cost can be recovered by the financial compensation from port of Gothenburg on a 20 vessel call basis annually based on current 30% discount, including LNG discount 20% and ESI discount 10%. It means at least 40.5% (3 years) retrofitting cost can be recovered from the port of Gothenburg under the same numbers of calling until the end of LNG discount in December 2018. This amount of financial support from port is quite attractive to ship owners.

5.3 The impact of discount to Port of Gothenburg

Since there was no condition of incentive discounts mentioned that the discounts can not be combined with other discounts at port of Gothenburg, one vessel may receive two or more discounts in one call. So, the additional incentive “40% discount (20% of LNG plus 10% of ESI plus 10% of CSI)” for the LNG-fuelled vessels has been created.

Based on below equation, we are able to calculate the average price.

$$a_1 * b_1 + a_2 * b_2 + \ a_3 * b_3 + \cdots + a_5 * b_5 = c$$

Where,

a_1: regular price volume,
a_2: LNG discount price volume,

a_3: ESI discount price,
a_4: CSI discount price,
a_5: LNG +ESI + CSI discount price,
b_1: traffic volume charged by regular price,
b_2: traffic volume entitled to LNG discount,
b_3: traffic volume entitled to ESI discount,
b_4: traffic volume entitled to CSI discount,
b_5: traffic volume entitled to LNG +ESI + CSI discounts,
c: average price.

The average price EUR 0.1311/GT is determined under the assumption of traffic volume portfolio 1, 85% by regular price and a total of 15% by discount price from four incentive discounts. Three portfolios of traffic volume have been calculated and two scenarios include current practice and increases in discount have been analysed. The objective function of two scenarios is: $a_1 * b_1 + a_2 * b_2 + a_3 * b_3 + a_4 * b_4 + a_5 * b_5 = 0.1311$.

The constraints of scenario I are shown in the table below.

Constraint	Subject
$a_2 = a_1 * 0.80$	Regular price with 20% discount
$a_3 = a_1 * 0.90$	Regular price with 10% discount
$a_4 = a_1 * 0.90$	Regular price with 10% discount
$a_5 = a_1 * 0.60$	Regular price with 40% discount

Table 20 Calculated Regular and Discount Price Level by Current discounts with different volume

Scenario I	Portfolio 1	Portfolio 2	Portfolio 3
Regular Price	**0.1340 EUR/GT**	**0.1353 EUR/GT**	**0.1366 EUR/GT**
Volume	85%	80%	75%
LNG Discount Price (20%)	**0.1072 EUR/GT**	**0.1082 EUR/GT**	**0.1093 EUR/GT**
Volume	1%	2%	3%
ESI Discount Price (10%)	**0.1206 EUR/GT**	**0.1218 EUR/GT**	**0.1229 EUR/GT**
Volume	9%	11%	13%
CSI Discount Price (10%)	**0.1206 EUR/GT**	**0.1218 EUR/GT**	**0.1229 EUR/GT**
Volume	3%	4%	5%
LNG + ESI + CSI Discount Price (40%)	**0.0804 EUR/GT**	**0.0812 EUR/GT**	**0.0819 EUR/GT**
Volume	2%	3%	4%
Average Price	**0.1311 EUR/GT**	**0.1311 EUR/GT**	**0.1311 EUR/GT**

Source: Elaborated by the author

The constraints of scenario II are shown in the table below.

Constraint	Subject
$a_2 = a_1 * 0.70$	Regular price with 30% discount
$a_3 = a_1 * 0.85$	Regular price with 15% discount
$a_4 = a_1 * 0.85$	Regular price with 15% discount
$a_5 = a_1 * 0.40$	Regular price with 60% discount

Table 21 Calculated Regular and Discount Price Level by Higher discount with different volume

Scenario II	Portfolio 1	Portfolio 2	Portfolio 3
Regular Price	**0.1356 EUR/GT**	**0.1375 EUR/GT**	**0.1395 EUR/GT**
Volume	85%	80%	75%
LNG Discount Price (30%)	**0.0949 EUR/GT**	**0.0962 EUR/GT**	**0.0976 EUR/GT**
Volume	1%	2%	3%
ESI Discount Price (15%)	**0.1152 EUR/GT**	**0.1169 EUR/GT**	**0.1185 EUR/GT**
Volume	9%	11%	13%
CSI Discount Price (15%)	**0.1152 EUR/GT**	**0.1169 EUR/GT**	**0.1185 EUR/GT**
Volume	3%	4%	5%
LNG + ESI + CSI Discount Price (60%)	**0.0542 EUR/GT**	**0.0550 EUR/GT**	**0.0558 EUR/GT**
Volume	2%	3%	4%
Average Price	**0.1311 EUR/GT**	**0.1311 EUR/GT**	**0.1311 EUR/GT**

Source: Elaborated by the author

In sum, two important factors are discovered from above scenario analysis: (1) How many traffic volume were entitled to the discount in the past and (2) The potential traffic volume which are entitled to discount, should be taken into account when determining the discount for the green incentive scheme.

Chapter 6 Port of Riga, Latvian

6.1Port of Riga, Latvian

Geography

The official name of Riga port is “Freeport of Riga, FPR”. It is located on both banks of the River Daugava and is 15 kilometres long as shown in Figure 14. In 2014, around 3,797 vessels were accommodated in the port. Total harbour areas are 6,348 hectares including 1,962 hectares of land area and 4,386 hectares of water area. Total length of berths is 18.2 kilometres (Free Port of Riga Authority 2015c). The harbour type of FPR is river natural port without tide restriction.

Figure 14 Free Port of Riga

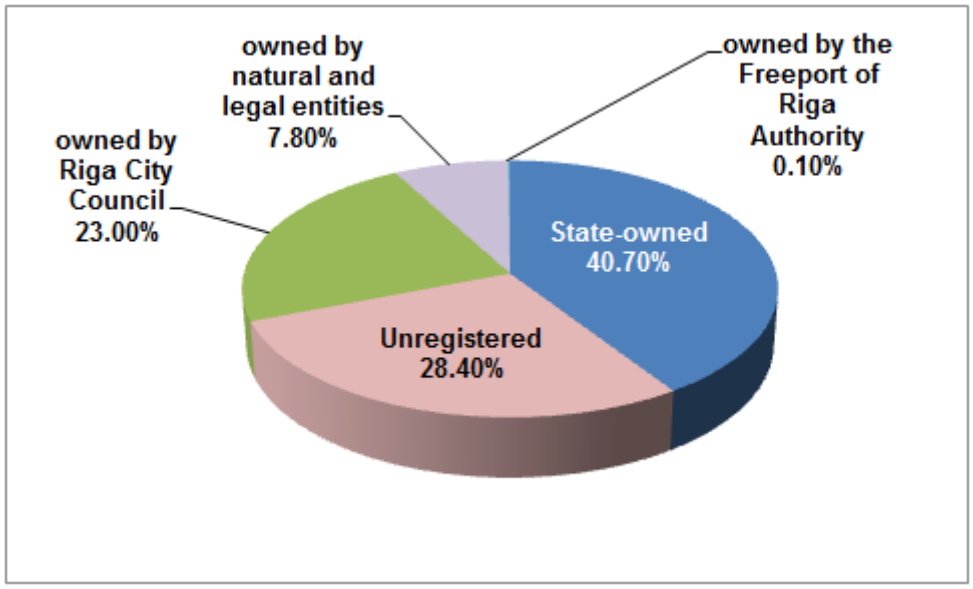
Source: (Free Port of Riga Authority 2015c)

Port model

FPR is a landlord port, so port authority plays an important role in maintaining the infrastructures, fairway, as well as the safety of navigation (Free Port of Riga Authority 2013). The authority also has regulatory function to make sure the maritime environment is safe and clean. In additional, levy of port fee and charges is also in charged by the port authority.

“The land belonging to the Port which has been transferred under the possession of the Freeport of Riga Authority is owned by the state and the municipality.” (Free Port of Riga Authority 2013) The detail of share of the land is shown in Figure 15.

Figure 15 Structure of ownership of the land of the territory of the port

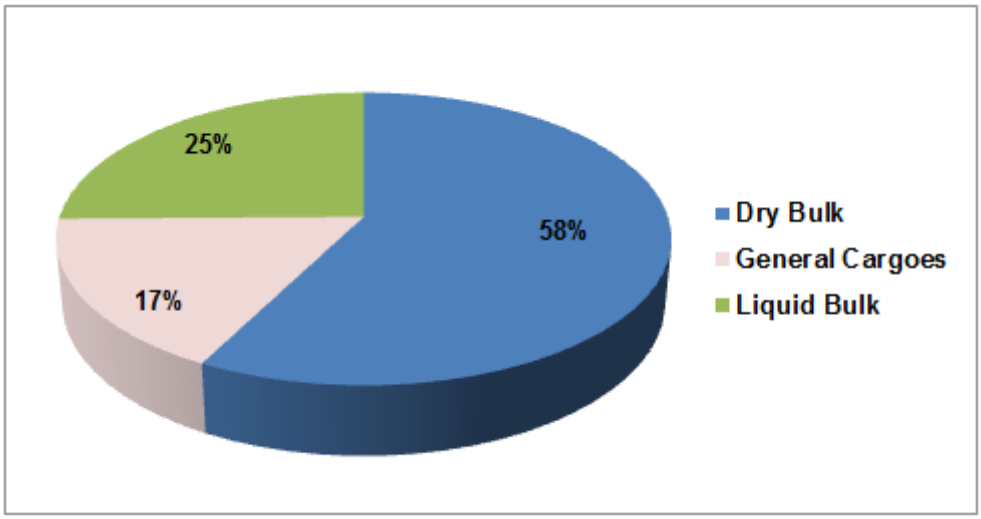


Source: (Free Port of Riga Authority 2013)

Economic profile

According to the record in 2014, FPR was the biggest port within the Baltic States with yearly cargo turnover of 41.1 million tons. The major cargo flows within Riga port consist of chemical cargo, various metals, timber, containers, coal, oil products, and mineral fertilisers. Among all kinds of cargo flow, approximately 80 percent cargo turnover is transited from or to the Commonwealth of Independent States (CIS). The cargoes handled by FPR are classified into three groups as shown in Figure 16.

Figure 16 Structure of cargo handled in 2014 in Free Port Riga



Source:(Free Port of Riga Authority 2015f)

The port has a reconstruction project on its railway station to connect railway track with port area in order to build up more complete hinterland network and to encourage greener transports. The project is expected to complete in 2021(Free Port of Riga Authority 2015b).

In addition to cargo flow, FPR also has numerous ferry passenger visits and cruise passenger visits. In 2014, there were a total of 677,025 ferry passenger visiting the port (Free Port of Riga Authority 2015f).

Corporate social responsibility & Environmental Policy

FPR takes part in several corporate social responsibility plans, such as the greenest port, social activities, alignment with the network of "Green Award Ports", etc. There is a large portion of the green areas covered in the port, so FPR keeps them for the nature habitat. FPR authority is one of the organisers of the All-Latvian Working Bee in 2010. The environmental quality in the entire port territory is monitored by the port authority. Moreover, port decided to align with the network of Green Award Ports in the end of 2009 (Free Port of Riga Authority 2015a).

6.2 Environmental incentive scheme at Port of Riga

Since 2009 FPR has introduced green incentive scheme aligned with the network of Green Award Ports. The port authority decided to offer a 10 percent rebate on all port charges and dues for the valid Green Award certificate holding tankers, vessels for reloading crude oil cargos in the FPR to promote green shipping (Free Port of Riga Authority 2015d). FPR believes this incentive scheme could attract greener vessels and reduce impacts for the aquatics in the port areas (Free Port of Riga Authority 2015a).

6.2.1 The impact of discount to ship owner

FPR offers discounts for Green Award certificate holding bulk carriers and tankers which is very attractive to the traffic. According to the cargo structure in paragraph 6.1, the majority cargo at FPR is dry and liquid bulks, accounting for 83% of total handling cargo. Since the Green Award certificate mainly focuses on the extra clean and extra safe bulk carriers and tankers, the environmentally friendly incentive is very useful for these ship owners.

6.2.2 The impact of discount to Free Port Riga

Based on the equation below, we are able to calculate the average price.

$$a_1 * b_1 + a_2 * b_2 = c$$

Where,

a_1: regular price volume,
a_2: discount price volume,
b_1: traffic volume charged by regular price,
b_2: traffic volume charged by discount price,
c: average price.

The average price EUR 0.9524/GT is determined by the calculation under the assumption of traffic volume portfolio 1, 90% by regular price, 10% by discount price, for each incentive discount according to current practice 10% discount for Green Award certificate holders. Three traffic volumes have been calculated and three

scenarios include current practice 10% discount, increase to 20%, and increase to 30% have been analysed. The objective function of three scenarios is: $a_1 * b_1 + a_2 * b_2 = 0.9524$.

The constraint of scenario I is:$a_2 = a_1 * 0.90$. For instance, 0.8658 came from the regular price EUR 0.9620 with 10% discount.

Table 22 Calculated Regular and Discount Price Level based on Current Practice of 10% discount by three volume portfolios

Scenario I	Portfolio 1	Portfolio 2	Portfolio 3
Regular Price	**0.9620 EUR/GT**	**0.9718 EUR/GT**	**0.9819 EUR/GT**
Volume	90%	80%	70%
Green Award Discount Price (10%)	**0.8658 EUR/GT**	**0.8747 EUR/GT**	**0.8837 EUR/GT**
Volume	10%	20%	30%
Average Price	**0.9524 EUR/GT**	**0.9524 EUR/GT**	**0.9524 EUR/GT**

Source: Elaborated by the author

The constraint of scenario II is:$a_2 = a_1 * 0.80$. For instance, 0.7775 came from the regular price EUR 9718 with 20% discount.

Table 23 Calculated Regular and Discount Price Level based on additional 10% discount increases on current practice by three volume portfolios

Scenario II	Portfolio 1	Portfolio 2	Portfolio 3
Regular Price	**0.9718 EUR/GT**	**0.9921 EUR/GT**	**1.0132 EUR/GT**
Volume	90%	80%	70%
Green Award Discount Price (20%)	**0.7775 EUR/GT**	**0.7937 EUR/GT**	**0.8106 EUR/GT**
Volume	10%	20%	30%
Average Price	**0.9524 EUR/GT**	**0.9524 EUR/GT**	**0.9524 EUR/GT**

Source: Elaborated by the author

The result shows that an increase in 10% discount will result in 1% rise in regular price under the same circumstance of traffic volume.

Chapter 7 Reactions from Shipping Lines on Green Incentives from port dues

7.1 The Questions

In order to fully understand the opinions from liner shipping companies, the interview questions are designed as a combination of open-and-closed questions. Hence, interviewees are able to give the answers to the designed questions but are not limited to answer only the questions listed up by the researcher.

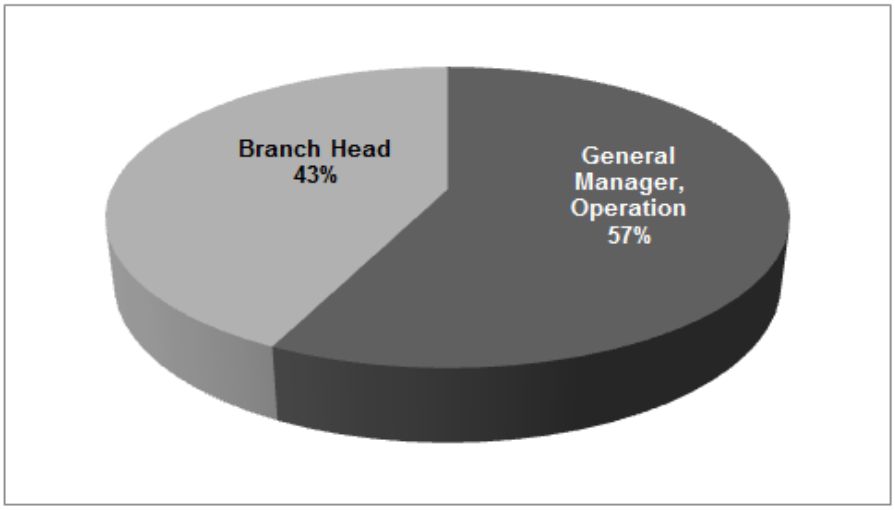
Since the interviewees are from the overseas branches, their opinions in some cases are rather private and could not represent the whole company. The questions have been sent to the interviewees few days prior to on-site interview. Although numerous amounts of port have introduced port green incentive schemes for a couple of years, it remains a relatively new topic compare to the studies of incentive scheme on a visit base. Therefore, in order to make sure that all interviewees are fully aware of this issue, the questionnaire is divided into two parts: 1) the background and objective of interview; 2) main questions. In part one, the background and objective is introduced to the respondents. Additionally, the green incentive scheme of port of Hamburg is exemplified to give a more detailed picture to the respondents.

7.2 The interviewees

In order to get a more representative response, the interview is targeted at the managing level of an organisation, at least the general managers responsible for operations or the head of the branch office can participate in the interview. All of the interviewees have worked for current companies for more than fifteen years. The experiences within the company may influence the understanding of the company's policy and strategy, as well as the value and accuracy of the interview. However, all respondents declared that the final decision will be made by the headquarters.

In the end, a total of seven respondents from four liner shipping companies were interviewed. The positions of the respondents are illustrated in Figure 17.

Figure 17 The Positions of Respondents of the interview



Source: Elaborated by the author

7.3 Liner Shipping Companies' attitudes towards the green incentive scheme on port charges

Most of the respondents content that the green incentive on port charges is very important and is a kind of tools to attract liner shipping companies to implement their social responsibility. From the social perspective, the green incentive scheme is a positive action to protect environment. However, from the economic perspective, the attractiveness of green incentive for shipping lines is not significant. The reductions of green port incentive scheme on port tariff can only be treated as an additional reward, but not interesting enough for shipping companies to improve ship's performance.

7.4 The importance of green incentive scheme for liner shipping companies when evaluating a new port

Despite the fact that most respondents agree that protecting environment is everyone's responsibility, only one out of four companies show strong interest in considering green incentive scheme when assessing a new calling port in the future. Another company said they will take this factor into consideration when assessing a new port, but this company would rather put more focus on its own business.

The other two companies, on the contrary, will not take green incentive scheme into consideration. They mentioned that rebate of green incentive is too less compared with the operational costs and voyage costs. The amount of rebate from green incentive can easily gained via good speed control of the fleet and good storage plan of the vessels. Good control over a vessel's speed can prevent unnecessary fuel consumptions. In addition, good storage plan can minimise the carry of ballast water. As a result, ship's capacity can be fully used.

Furthermore, these two companies mentioned that the most important criteria to select a new port are the cargo related factors (including T/S cargo, cargo flow), including total port charges, the distance of entry to the port, operational restrictions, and cargo handling charges. The green incentive is not an important factor in this case.

7.5 The importance of green incentives on port call decision

Is the green incentive important enough for liner shipping companies to change a port of call? To answer this question we assume that liner shipping companies are reflective to green incentive to some extent. Therefore, a total of five options with different percentage of incentives is provided to respondents in order to assess their attitudes on the importance of green incentives beyond decision making on the change port of call. Five options include: (a) It does not matter as we do not base our port of call decisions on port fees. (b) Very substantial (more than 50%) (c) We certainly would consider changing port of call already for incentives between 20 and 50%. (d) We certainly would consider changing port of call already for incentives between 5% and 20%. (e) We certainly would consider changing port of call already for any incentives even below 5%.

The result shows all interviewees consider the green incentive scheme of a port not a criterion for decision making in changing port of call by choosing option (a). One of the companies claims the incentive reward from green incentive scheme is too limited to influence their decision of calling ports. Furthermore he gives a calculation example to reinforce his opinion.

Given there is a 140,000TEUs vessel with GRT 148,667 tons, the port due for it is EUR 35,382 per call at port of Rotterdam. In case that the carrier gains green incentive of 50%, they can save EUR 17,691 per call. When considering the fair rate of EUR 1,000 per TEU for Asia-Europe line, loading of only 18 TEU containers can compensate for this saving, accounting for only around 0.01 % of the 140,000 TEU. Apparently this ratio is far insignificant, which can partly explain their non-interest in this scheme.

Another company also pointed out the difficulty of changing the port of call. In their perspective, every detail should be evaluated carefully and comprehensively. Changing the calling ports would incur additional costs which is also a kind of risk for shipping lines. This company points out three issues of changing port of call among two close ports need to be taken into account. The foremost issue is the geographical condition, such as the distance of the channel, turning basin, draft, etc. Because the largest vessel is deployed in the Asia-Europe routes, the accessibility of the port will be the first and most important issue when deciding for a substitute port. Secondly, the replaceability of the ports in the existing market. They will only consider a substitute port if this port has certain advantages and the market of original port can be replaced by this port. Thirdly, the total costs of the port charges and cargo handling charges. They do not only consider port dues but also the comprehensive costs of port and cargo handling charges. As a result, considering all these issues, they consider green port dues a rather minor factor behind their decision.

7.6 Liner Shipping Companies' attitudes towards adopting technical measures / operational measures, such as cold ironing, to improve the environmental performance of its vessels beyond compliance to gain access to port incentives

7.6.1 Technical measures

All respondents agree that companies adopt new technologies to improve fleet's engine efficiency, fuel consumption, and ship's sailing efficiency etc. in order to lowering the operational and voyage costs when designing new vessels. New technologies are developed rapidly from time to time such as the shape of bow for reducing ship's resistance. The later launched vessels are always more efficient and greener than the earlier ones. The purpose of liner shipping companies in adopting new technical measures is to improve the sailing and environmental performance of fleets in order to reduce the costs and environmental impacts rather than gaining green port incentives.

7.6.2 Operational measures

All respondents state that companies are adopting operational measures - cold ironing - to improve the environmental performance of the fleet. One company declares that all new vessels are equipped with Alternative Maritime Power™ (AMP™) facilities to connect to shore side power. This is to improve the environmental performance of fleets to reduce the environmental impacts rather than gaining green port incentives.

However, despite more and more vessels are equipped with AMP, not all ports in y Europe have cold ironing facility for vessels to connect to shore side power. Therefore, the fleets do not connect to shore side power at European ports. Additionally, the port stay time in Europe is relatively short when comparing with that

in U.S. ports. One of the interviewees mentioned that he is worried about damaging ship's engine if the power switching activities, including shut down ship's own diesel engine, connecting to shore side power, disconnecting shore side power, and restarting ship's own diesel engine, need to be done within 24 to 36 hours.

However, one interviewee suggests that ports offer discount on electric fares if the AMP™ facilities are available at ports in the future. This is a kind of subsidy for AMP™ facilities on board of vessels.

7.7 Liner Shipping Companies' attitudes towards adopting alternative fuels such LNG or methanol on fleet to gain access to port incentives

Among all interviewees, two out of four companies admit that they have assessed to adopt LNG as the alternative fuels. However, they didn't accept LNG on their new vessels in the end. According to the feedbacks from four companies, the reasons are summarised as followings: (1) Additional costs of adopting the alternative fuels for both existing vessels and new building vessels are too high. (2) LNG fuel needs to stow in a special tank of which will occupy the additional space. (3) There is still neither regulation nor incentive to persuade or enforce the use of alternative fuels.

Conversely, although the other two companies didn't consider the alternative fuels, all the four companies have common worries on the tank of LNG. LNG requires special tank to stow and the tank occupies a notable space on the vessel. An example is given by an interviewee that approximately 500 TEUs space is needed on a 19,000 TEUs vessels, accounting for almost 2.6% of overall space, and it has largely squeezed the space of cargo. Moreover, to adopt this new technology of alternative fuel requests additional costs for the existing fleet. Hence, one company said the new technology of these alternative fuels would be only likely to apply on new order vessels instead of existing fleet. Unfortunately, they do not have plans to build new vessels in recent years.

All in all, all interviewees do not plan to adopt the alternative fuels on fleet in the short term, let alone to gain green port incentives by this means. Additionally, they also argued that the benefits will be significant only when the fuel price spikes. If the fuel price remains at low level, there is no interest to spend extra costs to adjust existing fleet or to adopt this technology on new building vessels for the alternative fuels.

7.8 The importance of being considered as a greener company though certifications, such as Green Award, to the company and to its clients

All respondents agreed that it is important to be considered as a greener company though certifications for the company. According to them, some of the European clients request certain green performance from the service providers. One mentions some clients even requested to visit their fleet and office in order to check green performance. Therefore, the company can be easily recognised as greener company, if they have Green Award certificate.

However, another respondent argues that the interests are always first priority in doing business. According to his experience, indeed some clients request certain green performance when choosing liner shipping companies to transport their goods. Despite that, the requirement is not so strict. In this case, most of liner shipping companies can meet the requirement. In the end, clients will still choose the

cheapest carrier to transport their goods. Under this circumstance, the certificate does not have significant influence on the clients.

7.9 Conclusion

In view of the results from all sections of this chapter, liner shipping companies are fully aware of the green incentive scheme, but the reward of green incentive is very limited and is easily compensated by the savings of well-organised operations and well-managed fleets. So, the green incentive can only be considered as additional incentive but it is not essential enough to drive their behaviour on improving the efficiency and environmental performance of the vessels. However, the green incentive scheme is an important tool for liner shipping companies to implement their social corporate responsibility and contribute themselves to protect the earth. By introducing the green incentives, negative impact on environments can be reduced over seas and harbour areas.

Chapter 8 Conclusion

8.1 Answering the Research Questions

1) Best practices in green port dues.

In order to answer this question, we have looked into three cases of the leading port in Europe. However, despite our efforts to find out a best practice in green port dues, the results of the research shows that there is no best practices in a green port. The pricing scheme is tailor-made to every individual port based on its unique features, and particularly its objective. Although there is no single best practice, we have worked out some crucial parameters for assessing green port dues pricing. In total there are ten crucial parameters discussed in this research: geographical location, port model, economic profile of the port, market price level, price level of main competitors, cargo handling structure, pricing strategy of nearby ports, qualifying reduction measures, pros and cons of reduction schemes, and the changes of regulation. Among these factors, the regulation has the most decisive influence in order for ship owners to implement the environmental protections. The latest regulation is the new standard of IMO MARPOL Annex VI which came into force on the 1st of January 2015. It regulates the maximum sulphur content of 0.10% m/m of marine fuel within emission control area (ECA). With the enforcement of this rule, every vessel that sails inside ECA needs to switch to low sulphur fuel. In this case, the environmentally friendly incentive discounts which against the SO_x emissions is no longer necessary. Therefore, ports which have port charges differentiated as SO_x Emissions or the discounts based on the SO_x emissions should change its pricing or incentive scheme in order to precisely focus on the right target customers which have outstanding environmental performance.

2) How do ports set up port dues incentive schemes to favour environmentally friendly ships?

It is very important for a port to introduce proper and efficient incentive schemes to its environmentally friendly vessels. In case of Free port Riga (FPR), the only environmentally friendly incentive scheme is 10% discount on port charges to the Green Award certificate holding carriers which account to a great majority of overall traffic in the port. Since the Green Award certificate is delicate in dry and liquid bulk, the scheme can maximize its efficiency in FPR and bring it closer to the goal of encouraging greener shipping. So, in order to maximize the efficiency of the green incentives, port should analyse its traffic structure and most active operations before setting up an appropriate environmentally friendly incentive schemes. An accurate scheme can help not only effectively reduce environmental impacts in harbour areas but also maximise the attractiveness to existing ship owners or potential traffic.

3) How do shipping companies react to green port dues?

In this study we conducted interviews with four shipping companies in order to find out their reactions on green port dues. In our interviews, all respondents agreed with the importance of the carriers' responsibility to the environment. Furthermore, most of them stressed there should be more criteria to consider when evaluating a port: cargo flow, port facilities, port charges, geographical location and accessibility of a port. Based on the same cargo flow, their attitudes toward the green port dues are positive. However, out of all four interviewed companies, only two companies, or 50%, will seriously treat the green port dues as a criterion of evaluation of a new

port. The other two carriers state that the reward amounts granted from the green port dues are too low to be considered on top of total operational costs. They would rather focus on savings from other operational costs, such as speed control of fleet and stowage plan of a vessel.

In addition, these interviewed shipping companies argue that the main goal of their investment on new technologies and equipment on the fleet is to improve the ship's efficiency for cost saving purpose rather than to gain green port incentives.

4) What is the optimal tariff for port authority to minimize loss from the environmental friendly incentives?

The scenario analysis for the three cases in Chapter 4, 5, and 6 has illustrated the impact that raise in the percentage of discounts of environmentally friendly incentives will result an increase in the regular price level based on the fixed average price. Therefore, ports can not avoid creating the situation of a competitive disadvantage by increasing discounts for environmentally friendly incentives. Despite the fact that the port authorities can offer a small discount to greener vessels in order to minimise the potential income loss, they can consequently mitigate the attractiveness of the incentive scheme to ship owners. In this case, the incentive would become perverse with regard to encouraging greener shipping.

In Chapter 4 and 5 we demonstrate the turnover rate of extra cost on building solely LNG-fuelled vessels, retrofitting exist vessel to dual-engine powered by LNG and marine diesel oil, and retrofitting exist vessel with SCR. The annual CAPEX of these technologies need many years to recover via the annual reward amount from port dues. So, the percentage of the discount for the environmentally friendly incentive may lose its attractiveness if the reduction on port charges is too low.

In conclusion, in order to make optimal tariff to minimise loss from the environmentally friendly incentives, port authority has to determine tariffs by finding out its best competitive advantages.

8.2 Limitation of the Study and Suggestions for Further Research

The limitations of the study are as follows,

- The study is carried out through academic and desk research only.
- The data from ports is limited due to confidentiality reasons, which limits the development of further in-depth analysis of the research.
- The attitudes of shipping companies are overgeneralised due to insufficient amount of interviews:
  1) The numbers of interviews is insufficient.
  2) The interviews were carried out only in the offices based in the Netherlands.
  3) The headquarters of interviewed shipping companies are all from Asia, therefore, the attitudes toward green port dues presented in this study are seen only from the Asian perspective.
  4) The interviewed shipping companies are all from the container cluster.

The suggestions for further research against the above-mentioned limitations are as follows,

- Further interviews with ports could be carried out to test the hypothesis from this research.
- To collect real data from ports on regular price vessels and discount price vessels. With real data one can look into the effect of a change in the port dues discount on regular price.
- To carry out more interviews with wider quantity and sector of carriers. It would help to have a more neutral result. In this research, we found some European cruise and ferry companies that invested huge amounts of capital to improve their fleet in order to reduce environmental impact to zero. Therefore, it is highly recommended to interview European cruise and ferry companies for that reason.

8.3 Conclusion

This study has given an overview on the ship rating/proving system and existing environmentally friendly incentive schemes worldwide. In many practices, some incentive schemes are proved to have significant influence on the improvement of the environmental situation within the port area. Nevertheless, there is no one specific formula that can be applied to every port. Instead of finding a simple formula, this study proposes many crucial parameters which must be well considered by port authorities when assessing the use of green incentive schemes.

The interviews with shipping companies proved that the attitudes of shipping companies towards the green port dues are positive. However, ship owners must invest additional capital to make the fleet greener. According to the interviews, all four companies claim that the most important factor of a port is cargo volume. Carriers will decide to call a port only when it has sufficient cargoes. The ports will not be considered by carriers if these ports only offer environmentally friendly incentive schemes but without sufficient cargo volume.

Another important finding from the interviews reveals that the amount of rebate offered by incentive scheme is significantly low. In total, two out of four companies have positive opinions toward environmentally friendly incentive scheme when evaluating a port. Among these two positive ports, one company has strong interest in taking the green incentive into account when evaluating a calling port. Another company contends that they will consider this incentive as a factor, but would rather show more interests focusing on its core business. On the contrary, the rest two companies, which have negative attitudes, claim that they will not consider the incentive scheme as a factor of port selection. The main reason is that the rebate acquired from the incentive scheme is too less comparing with the operational costs. One of these two companies argues that the amount of rebate can be easily earned by well organizing its fleet. For instance, a good speed control of the fleet helps save on bunker cost, while a good storage plan of vessel helps make full use of capacity. So, only a certain level of discount could encourage greener shipping

To conclude, an appropriate environmentally friendly incentive scheme to a port is determined by the features of a port and its market. Ports should modify the incentive schemes from time to time according to the changes in all the parameters presented in the study. This could help port to prevent unnecessary loss from green incentive scheme and further work towards the goal of greener shipping and a green port.

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Appendices

Appendix I Overview of Environmentally Friendly Incentive Scheme from World Major Ports

Country / Location	Port	Charge Item	Environmenta-lly related Charging Model	Green Incentive Scheme	Port Model	Traffic / Cargo Flow
Canada	Port of Prince Rupert	Harbour Dues (Prince Rupert Port Authority 2015)	Differentiated Tariff	• Green wave program: Qualifying reduction measure: RightShip, Environmental Ship Index (ESI), Green Marine, EEDI, Green Award, Clean Shipping Index (CSI). The rate of harbour dues is specified into four differentiated tariff. (1) Basic Tariff is $0.0844 per GRT (2) $0.0759 per GRT - for Tier 1 of Green Wave Program (89.9% savings over basic tariff) (3) $0.0675 per GRT - for Tier 2 of Green Wave Program (80.0% savings over basic tariff) (4) $0.0422 per GRT - for Tier 3 of Green Wave Program (50.0% savings over basic tariff)	Landlord	• Containers • Cruise/ • Ferry • Bulk • Project Cargoes • Rail
Canada	Port Metro Vancouver	Harbour Dues (Vancouver Fraser Port Authority 2015)	Differentiated Tariff	According to the degree of performance for vessels on the criteria including shore power, vapour control or recovery system, eligible alternative fuels, eligible alternative technologies (other), Environmental Ship Index (ESI), RightShip, Clean Shipping Index, Green Marine, EEDI, Green Award, Ship Classification Society, vessels will be charged in four differentiated rate of harbour dues. (1) Basic Tariff is $0.094 per GRT. (2) 23.4% savings over the basic harbour dues rate for Bronze level vessels. (3) 35.1% savings over the basic harbour dues rate for Silver level vessels.	Landlord	• Containers • Cruise • Bulk

				(4) 46.8% savings over the basic harbour dues rate for Gold level vessels.		
Canada	Port of Montreal	Harbour Fees (Port of Montreal 2015)	Rebate	• "Green Award" Incentive Program: A 10% reduction on the standard harbour fees for bulk carriers, crude oil and product tankers; for bulk and tankers vessels, with a minimum dead weight of 22 000 metric tonnes and that have been granted a Green Award certification from the Bureau Green Award. Harbour Fees are calculated according to ship's GRT.	Landlord	• Liquid Bulk • Dry Bulk • Containers • Non-containerized cargo • Cruise Passengers • Ro/Ro Cargo
Canada	Port of Sept-Iles	Harbour Dues (Port of Sept-Iles 2015)	Rebate	• "Green Award" Incentive Program: A 10% reduction on the standard harbour dues for vessels that have been granted a Green Award certification from the Bureau Green Award. Harbour Dues are calculated according to ship's GRT.	Landlord	• Dry Bulk • Cruise Passengers • General Cargo • Liquid Bulk • Containers
U.S.A.	Port of Long Beach	Dockage (Port of Long Beach 2010)	Reward, Rebate,	• Engine Standard Tier II or III: (Green Ship Incentive Program) (1) An incentive of $2,500 per ship call for vessels with main engines meeting 2011 (Tier II) standards established by the IMO. (2) An incentive of $6,000 per ship call for vessels with main engines meeting 2016 (Tier III) standards established by the IMO. • Green Flag Incentive Program: (1) Tier I (20nm): 15% discount on dockage, per vessel visit, for the ocean-going vessels with weighted average speed 12 knots or less arrive/depart from the 20 nautical miles of the port. (2) Tier II (40nm): 25% discount on dockage, per	Landlord	• Containers • Break Bulk • Dry Bulk • Liquid Bulk

				vessel visit, for the ocean-going vessels with weighted average speed 12 knots or less arrive/depart from the 40 nautical miles of the port. • Incremental On-Dock Intermodal Incentive Program: Shipping lines can be paid $5 per TEU for new cargo either brought into or out of the Port by "on-dock rail," which helps eliminate truck trips on local roadways by rail-hauling containers to and from the wharf. • Vessel Dockage Waiver Program: The rewards complying vessel operators with "free parking." From July 2014 through June 2016, the Port will waive its dockage fees for vessels that both slow down 40 miles out from the harbour and plug into shore power, or use an equivalent emissions-reduction technology, at berth.		
U.S.A.	Port of Los Angeles	Reward (Port of Los Angeles 2009a) Dockage (Port of Los Angeles 2009b)	Reward, Rebate	• Environmental Ship Index (ESI) Incentive: (1) 40 or greater: $1,250 per call (2) 35-39: $1,000 per call (3) 30-34: $750 per call (4) 25-29: $250 per call • OGV5 – International Maritime Organization (IMO) Tier II or Tier III Standards: (1) An incentive grant of $750 per call OGV with an IMO Tier II main engine. (2) An incentive grant of $3,250 per call OGV with an IMO Tier III main engine. • OGV6 – Technology Advancement Program Demonstration: An incentive $750 per call for existing ocean-going vessels that are demonstrating an emission reduction technology that reduces Diesel Particulate Matter (DPM) and NOx emissions. • Vessel Speed Reduction Incentive Program (VSR IP):	Landlord	• Container • Dry Bulk • General Cargo • Liquid Bulk

				(1) Tier I (20nm): 15% discount on the first day of dockage, per vessel visit, for the ocean-going vessels with weighted average speed 12 knots or less arrive/depart from the 20 nautical miles of the port. (2) Tier II (40nm): 30% discount on the first day of dockage, per vessel visit, for the ocean-going vessels with weighted average speed 12 knots or less arrive/depart from the 40 nautical miles of the port.		
U.S.A.	Port of New York / New Jersey	Reward (Port Authority of New York and New Jersey 2012)	Reward	• Environmental Ship Index (ESI): Clean Vessel Incentive Program: (1) ESI Score of 20-29 points: $1,500 per call (2) ESI Score of 30 or more points: $2,500 per call • IMO Engine Standard Tier II or III: (1) Utilization of Tier II Engine: $1,000 per call (2) Utilization of Tier III Engine: $2,000 per call • Speed Reduction Program (VSR): Additional 5 points added to ESI score if vessel also participates in vessel speed reduction program	Landlord	• Containers • General Cargo • Bulk
Latvia	Free Port of Riga	Port Fee (Free Port of Riga Authority 2015e)	Rebate	• Green Award: A 10% rebate on all Port Dues and Charges shall be granted to tankers, carrying crude oil, that were awarded a Green Award Certificate. The calculation of port dues is based on ship's GRT.	Landlord	• Containers • General Cargo • Liquid Bulk • Dry Bulk • Ferries and Cruise
Lithuania	Port of klaipeda	Sanitary dues (Port of klaipeda 2008)	Rebate	• Green Award: Vessels, which have operational ship-generated waste processing system installed under international certificates ("Green Award"), and also apply other state-of-the-art systems for waste management whereby amount of generated waste is reduced and waste is recycled and sorted, shall be	Landlord	• Containers • Cruise Passengers • Ro/Ro Cargo • Dry Bulk • Liquid Bulk

				granted rebate on sanitary dues of 20%. Sanitary dues are calculated according to ship's GRT charged by the tier rate of staying days at port.		
Belgium	Port of Ghent	Tonnage dues (Port of Ghent 2015)	Rebate	The ship's tonnage (ST) is reduced if vessels are complying with below conditions. However, the reduction on the ship's tonnage when submitting a Green Award Certificate cannot be combined with the reduction that is obtained based on the ESI score. • Environmental Ship Index (ESI): 5% if it concerns sea-going vessels having an ESI score larger than or equal to 20 points, 10% for sea-going vessels that score at least 30 points on the ESI. • Green Award: (1) 15% if it concerns sea-going vessels for which a valid bulk Green Award certificate can be submitted; (2) 20% if it concerns sea-going vessels not used for Ro/Ro operations or recorded in Lloyd's Register of Shipping as "pallets carrier" for which a valid shortsea Green Award certificate can be submitted;	Landlord	• Containers • Ro/Ro Cargo • Dry Bulk
Belgium	Port of Antwerp	Inland Shipping Dues (Port of Antwerp 2015)(Antwerp Port Authority 2015a) Waste Fee (Antwerp Port Authority 2015b)	Rebate	• IMO Engine Standard II or III: A 7% discount on inland shipping dues is granted to inland barges for which equipped with CCR II-certified engines, as these have better environmental performance and produce less NOx and SOx emissions. • A 15% discount on inland shipping dues is granted to vessels for which proof is delivered that they use one of the following main engines: (1) diesel-electric main propulsion, in which the diesel engine adheres to the emission standard CCR phase 2; (2) LNG or dual fuel motor (LNG used as main fuel,	Landlord	• Containers • Oil, gases and chemicals • Dry bulk • Ro/ro • Break Bulk

				possibly using diesel as ignition fuel); electric motor driven by fuel cells with hydrogen (H2) as fuel. • Vessels that sail on engines that are powered exclusively by an environmentally friendly fuel (marine diesel, marine gasoil or LNG) can be granted a 50% of reduction in the waste fee.		
Belgium	Port of Zeebrugge	Tonnage dues (Port of Zeebrugge 2010)	Rebate	• Environmental Ship Index (ESI): A 10 % reduction is granted on the calculated tonnage due if the vessel scores 30 or more on the Environmental Ship Index (ESI), as published by the International Association of ports and Harbours, with a limit however of EUR 750 per call.	Landlord	• Containers • New Cars • Bulk • Natural Gas • General Cargo • Passengers
Gibraltar	Gibraltar Port Authority	Tonnage dues (Gibraltar Port Authority 2015)	Rebate	• Green Award: 5% reduction in tonnage dues to sustainable ships entering BGTW and calling at Gibraltar Port with a Green Award certificate.	Landlord	• Cruise and Ferry Passengers • General Cargo • Containers
The Netherlands	Port of Amsterdam	Port fees (Port of Amsterdam 2015b) (Port of Amsterdam 2015a)	Rebate	• Green Award: (1) 6% premium on the port fees for sea-going ships: Crude oil/Product Tankers and for Cargo Bulk Carriers. (2) Discounts on port dues for inland barges by level: Bronze - 5%, Silver - 10%, Gold - 15% Inland barges with certificates issued before the 17th of June 2014 are eligible for a 10% discount. • Environmental Ship Index (ESI): (1) If the ESI-score is above or equal to 31 points, an extra bonus will be applied. (2) The height of the incentive is depending on the gross tonnage (GT) of the vessel.	Landlord	• Containers • Dry Bulk • Liquid Bulk • Cruise and Ferry Passengers • Break Bulk • Ro/Ro Cargo • Vehicles

				The calculating formula of the height of the incentive is: (3) ESI-score > 20 points: score/100 multiplied by 'GT-class reward'. (4) ESI-score > 31 points: add ¼ of 'GT-class reward'. GT-class reward Amount 0 – 3,000 200 3,001 – 10,000 500 10,001 – 30,000 900 30,001 – 50,000 1,200 50,001 and up 1,400		
The Netherlands	Port of Rotterdam	Port Fees (Port of Rotterdam 2015b)	Rebate	• Green Award: (1) Sea-going Vessels: 6% discount of port fees (according to ship's GRT) or oil and oil product tankers and LNG tankers with a Green Award certificate with a deadweight of 20,000 tonnes and more. (2) Inland vessels: a. 15% discount for inland vessels with a Green Award certificate and a score below 400 points for the main engine. b. 30% discount for inland vessels with a Green Award certificate of after 17 June 2014 and a score of 400 points or more for the main engines. • Environmental Ship Index (ESI): 10% discount for the vessel must have an ESI score of 31 points or more. The discount will be doubled if the ship also has an individual ESI-NOx score of 31.0 or more.	Landlord	• Containers • Liquid Bulk • Dry Bulk • Ro/Ro Cargo
The Netherlands	Tata Steel IJmuiden Terminals (Port of	Port Dues (TATA Steel 2012)	Rebate	• Environmental Ship Index (ESI): The calculation formula of the height of the incentive is: ESI-score ≥ 20 points: score/100 multiplied by "GT-class reward":	Private	• Dry Bulk • Break Bulk • General Cargo

	Ijmuiden)			GT-class reward Amount 0 – 3,000 200 3,001 – 10,000 500 10,001 – 30,000 900 30,001 – 50,000 1,200 50,001 and up 1,400		• Containers
New Zealand	Port Nelson	Marine Services (Port Nelson 2015)	Rebate	• Green Award: Starting 1 December 2009, port offers a 5% discount off tariff price for marine services for all tankers and bulk carriers certified by Green Award. • Environmental Ship Index (ESI): Starting 1 March 2015, the port offers a discount on Marine Tariff rates of 5% for ships with a score between 20-30 ESI points. Discount on Marine Tariff rates of 10% for ships with a score higher than 30 ESI score.	Landlord	• Containers • Fish Catches • Vehicles • General Cargo • Dry Bulk • Liquid Bulk
Singapore	Port of Singapore	Port Dues (Port of Singapore 2015)	Rebate	• Green Port Programme: Ocean-going ships that use approved abatement/scrubber technology or burn clean fuels (sulphur < 1.00% m/m): (1) During the entire port stay of 5 days or less within the Singapore Port Limits (from the point of entry into Singapore Port Limits till the point of exit) will be granted 25% reduction in port dues; or (2) Only while at berth will be granted 15% reduction in port dues. • Green Ship Programme: Qualifying Singapore-flagged ships can enjoy a reduction of Initial Registration Fees and a rebate on Annual Tonnage Tax. (1) Ships that adopt energy efficient ship designs exceeding IMO's Energy Efficiency Design Index (EEDI) will enjoy 50% reduction of Initial	Landlord	• Containers • Oil Bulk • Non-Oil Bulk • General Cargo

<table>
<tr><td></td><td></td><td></td><td></td><td>Registration Fees and 20% rebate on Annual Tonnage Tax.
(2) Ships that adopt approved SOx scrubber technology exceeding IMO's emission requirements will enjoy 25% reduction of Initial Registration Fees and 20% rebate on Annual Tonnage Tax.
(3) Ships that adopt both energy efficient ship designs and approved SOx scrubber technology exceeding IMO's requirements will enjoy 75% reduction of Initial Registration Fees and 50% rebate on Annual Tonnage Tax.</td><td></td><td></td></tr>
<tr><td>Israel</td><td>Port of Ashdod</td><td>Reward and Additional Rate (Port of Ashdod 2015)</td><td>Additional Rate, Rebate</td><td>• Sea pollution prevention rates are charged at 25% of the lighthouse rates.
• Environmental Ship Index (ESI) Incentive:
Incentive will be granted to Container and Ro-Ro vessels with a valid ESI certificate (sent in advance to APC), and a total ESI score of 31 points or higher.
ESI Incentive Formula: Incentive (ILS) = ESI/100 * Maximum Amount.
<table><tr><th>Ship’s Length</th><th>Maximum Amount per Call</th></tr><tr><td>100 – 150 m</td><td>ILS 1,000</td></tr><tr><td>151 – 200 m</td><td>ILS 2,000</td></tr><tr><td>201 – 250 m</td><td>ILS 3,000</td></tr><tr><td>251 – 300 m</td><td>ILS 4,000</td></tr><tr><td>301 m and up</td><td>ILS 5,000</td></tr></table></td><td>Landlord</td><td>• Containers
• General Cargo
• Bulk
• Passengers
• Vehicles</td></tr>
<tr><td>Sweden</td><td>Port of Gothenburg</td><td>Port Dues (Port of Gothenburg 2015a)</td><td>Rebate, Additional Levy</td><td>• Environmental Ship Index (ESI) Incentive:
Vessels with an ESI score of at least 30 points, or that have been classified as ”Green” will be granted a 10 % discount off the port dues, based on GT.
• Vessels that are LNG-powered will be granted a 20 % discount off the port dues for vessels, based on GT.
• Increasing in dues for tankers with single hulls: For</td><td>Landlord</td><td>• Liquid Bulk
• Containers
• Ro/Ro
• Lo/Lo Break Bulk
• Cruise Passengers
• Cars</td></tr>
</table>

				vessels with a single hull, i.e. vessels that do not have a double bottom and double sides, regardless of segregated ballast tanks, a 100 % increase in port dues will be levied.		• Railway carriages
Sweden	Port of Stockholm	Port Fee (Port of Stockholm 2015)	Rebate, Reward, Differentiated	• The port fee for LNG vessels will be discounted by 0.05 SEK per unit of gross tonnage. • Rebate on port charges on goods for LNG. • Nitric oxide rebate: Vessels, which through different actions have reduced nitric oxide emissions to less than 6 grams per kilowatt hour, will be granted a reduction in harbour dues for vessels provided that the Swedish Maritime Administration has issued a valid Nitric Oxide Certificate in accordance with SJÖFS 2014:10. 0.00-0.49 g/kWh - rebate 0.22 SEK/GT 0.50-0.99 g/kWh - rebate 0.21 SEK/GT 1.00-1.99 g/kWh - rebate 0.20 SEK/GT 2.00-2.99 g/kWh - rebate 0.19 SEK/GT 3.00-3.99 g/kWh - rebate 0.18 SEK/GT 4.00-4.99 g/kWh - rebate 0.17 SEK/GT 5.00-5.99 g/kWh - rebate 0.16 SEK/GT • Electricity connection rebate: 1,000,000 SEK/vessel for Vessels that after 1 January 2015 are refitted to enable connection to the electricity grid at the quayside where such supply is available, fulfil the criteria for Liner Service, spend at least two (2) hours in port per call and connect to the electricity grid while at the quayside, are granted a one (1) million SEK rebate on condition that services operate for a minimum of three (3) years.	Landlord	• Containers • Ro/Ro and Ferry Cargo • Bulk • Cruise Passengers
Germany	Port of Jadeweser (Wilhelmshaven)	Port Dues (Jadeweser Port 2013)	Rebate	• Environmental Ship Index (ESI) Seagoing vessels with an ESI of 31 points or more receive a price reduction of 5% on the port dues (after deduction of the rebates under no. 7-9), but no more than EUR 750.	Landlord	• Containers

Germany	Port of Kiel	Port Charge (Port of Kiel 2015)	Rebate	• Environmental Ship Index (ESI) Ocean-going ships certified according to the ESI with more than 30 points are granted a discount of 10 % on the port charge.	Landlord	• Containers • Passengers • Cruise and Ferry • Bulk • General Cargo
Germany	Port of Rostock	Port Dues (Port of Rostock 2015)	Reduction of Surcharge	• As of 1 January 2014, a surcharge of 3% will be levied on the aforementioned port dues for financing environmental protection activities, unless: (a) The watercraft renders proof that it is using marine diesel with a sulphur content of ≤ 0.1%, LNG or a technology leading to equivalent emission levels in the port territory. (b) The watercraft uses shore electricity - as far as available at the respective berth in the port territory and thus refrains from the consumption of fuels to supply its own energy. (c) The watercraft submits a valid ESI certificate. On the basis of the stated ESI score the above mentioned surcharge is reduced according to the following: ▪ 3% reduction on surcharge for ESI score ≥ 20 ▪ 2% reduction on surcharge for ESI score ≥ 15 ▪ 1% reduction on surcharge for ESI score ≥ 10	Landlord	• Liquid Cargo • Bulk Cargo • General Cargo • Ferry / Cruise Passengers • Ro/Ro • Containers
Germany	Niedersachsen Ports (Port of Cuxhaven /	Harbour Dues (Niedersachsen Ports 2015)	Rebate	• Environmental Ship Index (ESI) A maximum of 10 ships' calls per owner/operator for each port, with an ESI value of ≥ 20.0 will be entitled to a discount every validity period (calendar year)	Landlord	• Containers • Bulk • Ro/Ro

	Port of Stade / Port of Norden / Port of Emden)			towards the payable harbour dues in the following increments: (1) ESI value 20.0 up to 30.0 = 2.5% discount (2) ESI value 30.1 up to 50.0 = 5% discount (3) ESI value > 50.1 = 10% discount		• General Cargo • Passenger motor vehicles
Germany	Port of Bremen	Tonnage Charges (Port of Bremen 2015)	Rebate	• Environmental Ship Index (ESI) A total of 25 ships with the best ESI score ≥ 30 will receive the following discount: (a) Ships with a score of between 30 and 40 ESI points will receive 5 % discount per port call; (b) Ships with a score of between 41 ESI points or more will receive 10 % discount per port call.	Landlord	• Containers • Dry Bulk • Cruise Passengers • Cars • General Cargo
Germany	Port of Hamburg	Port Fees	Rebate	• Environmental Ship Index (ESI) (1) 20 < ESI score < 25 = 0.5% discount on the GT portion of the port fees, maximally € 250 (2) 25 ≤ ESI score < 35 = 1% discount on the GT portion of the port fees, maximally € 500 (3) 35 ≤ ESI score < 50 = 5% discount on the GT portion of the port fees, maximally € 1,000 (4) ESI score ≥ 50 = 10% discount on the GT portion of the port fees, maximally € 1,500 If a discount under special tariff LNG is granted, no discount will be granted under special tariff ESI. • Solely powered by LNG: This discount is limited in time and ends on 31 December 2018. The discount is granted for ships that are solely powered by LNG, only use LNG for their own electricity needs and have an ESI SOx score of > 99 on the GT portion of the port fees of 15% maximally however € 2,000. • Port power discount: Ships that are not eligible for discounts under special tariff powered by LNG, which however are registered on the IAPH (ESI website) or for which a valid Green	Landlord	• Containers • Liquid Bulk • Break Bulk • Dry Bulk • General Cargo

				Award certificate has been submitted and which while berthing in the port mostly use shore power, will be granted a discount on the GT portion of the port fees of 15% maximally however € 2,000. • Green Award: 3% discount on the GT portion of the port fees granted for ships listed under these price categories for which a valid Green Awards certificate has been submitted to the HPA. • Blue Angel: 2% discount on the GT portion of the port fees applicable to seagoing ships for which a valid RAL-UZ 110 certificate (environmentally friendly ship operations) has been submitted to the HPA.		
Norway	Port of Oslo	Quay Charges (Port of Oslo 2015)	Rebate	• Environmental Ship Index (ESI) (1) A total score of 25 to 50 points are entitled to a 20% discount on normal rates. (2) Ships with a total score of 50 points or more are entitled to a 40 % discount on normal rates. The quay charge is calculated on the basis of the gross tonnage (GT).	Landlord	• Containers • Liquid Bulk Cargo • Dry Bulk Cargo • Cruise and Ferry • General Cargo • Passengers
Norway	Norwegian Coastal Administration	Pilotage readiness fee	Rebate	• Environmental Ship Index (ESI) Vessels with an official ESI Score of 50 or higher will be admitted 50% discount in the pilotage readiness fee (tier rate according to ship's GRT).	Landlord	
Norway	Port of stavanger	Port Fees	Rebate	• Environmental Ship Index (ESI) Ships with a valid ESI certificate and a total ESI score of 25 to 50 points are granted a 30 % rebate on port fees. Ships with a total ESI score of 50 points or more are granted a 50 % rebate. The discounts above can be combined and calculated separately	Landlord	• Cruise, pleasure craft and yacht Passengers • Liquid Bulk

				on the basis of regulations. Overall, the discount on port fees does not exceed 60 %.		• Fish catches Ro/Ro • Containers
Norway	Port of Bergen	Harbour Fee, Port Charge, Wharfage Dues	Rebate (Port of Bergen 2015) (Port of Bergen 2016)	• Cruise ships, pleasure crafts / yacht ships using LNG as fuel will be given a discount of 5% on the harbour fee. • 2016 version, vessels registered with the Environmental Ship Index (ESI), introduced by the World Ports Climate Initiative, are granted a port-charge discount of 20% for an ESI score over 30 and 50% for an ESI score over 50. • 2016 version, vessels compliant with the International Standard IEC/PAS 80005-3 for onshore power supply, or are using LNG as fuel, qualify for a 20% discount on the wharfage dues.	Public	• Containers • Cruise / yacht / pleasure crafts passengers • Liquid Bulk • Bulk • Fish catches Ferry Cargo
France	Port of Le Havre / Paris / Rouen	Port Dues	Rebate (HAROPA 2014)	• Environmental Ship Index (ESI) The ESI awarded by HAROPA can reach up to the equivalent of 10% of the port dues paid by ship owners.	Landlord	• Containers • Ro/Ro • Liquid Bulk • Dry Bulk • Cruise Passengers
France	Atlantic Port La Rochelle	Port Fee	Rebate (Atlantic Port La Rochelle 2015)	• Environmental Ship Index (ESI) The vessels with satisfied ESI score can be applied below reduction on port fees: (1) 20 ≤ ESI ≤ 30, 10% discount (max. €1,000) (2) 30 < ESI ≤ 60, 13% discount (max. €1,200) (3) ESI > 60, 15% discount (max. €1,500) The calculation of port fees is based on the volume V established, depending on its physical characteristics, by the following formula: V=L x b x T_{water} where V is expressed in cubic metres, L, b, T_{water} respectively represent the overall length of the vessel, the maximum width and maximum draught in summer and are expressed in metres	Landlord	• Liquid Bulk • Bulk • General Cargo • Cruise Passengers

				and decimetres.		
Portugal	Porto de Setúbal	Port Dues	Rebate (Port of Setubal 2014)	• Green Award: 3% reductions on port dues for vessels with Green Award Certificate / ISO 14001/ ESI (Environmental Shipping Index) superior to 30.	Landlord	• Containers • Liquid Bulk • Ro/Ro • Dry Bulk • Break Bulk
Portugal	Porto de Sines	Tariff of port use	Rebate (Port of Sines 2015)	• Green Award: 5% reduction Tariff of port use (TUP) for tankers which transport crude oil and/or refined petroleum that are holders of the Green Award Certificate and comply with the respective requirements. The tariff of port use (TUP) to be charged to non-covenanted ships and boats is calculated on the basis of gross tonnage (GT) and the relationship (R) between the amount of cargo loaded and unloaded in metric tons, and the said tonnage where (QT) is the amount of cargo handled at the scale in tonnes; and (K) is the value of the ratio of reference factor (R), by different type of ship.	Landlord	• Liquid Bulk • Fish catches • Containers • Dry Bulk
Portugal	Portos do Douro e Leixoes	Tariff for port use	Rebate (Administração dos Portos do Douro e Leixões 2014)	• Green Award: 3% reduction, translated into a Green Award, for tankers of 20,000 DWT or more, which transport crude oil and/or refined petroleum that are holders of the Green Award Bureau Rotterdam Certificate and comply with the respective requirements. The tariff of port use (TUP) to be charged to non-covenanted ships and boats is calculated on the basis of gross tonnage (GT) and the relationship (R) between the amount of cargo loaded and unloaded in metric tons, and the said tonnage where (QT) is the amount of cargo handled at the scale in tonnes; and (K) is the value of the ratio of reference factor (R), by different type of ship.	Landlord	• Dry Bulk • Containers • Liquid Bulk • Fish Catches • General Cargo • Cruise Passengers
Portugal	Porto de Lisboa	Tariff for port use	Rebate (ADMINISTRA	• Green Award: 5% expressed in a “Green Award” for ships or boats	Landlord	• Containers

			ÇÃO DO PORTO DE LISBOA 2013)	bearing the Certification issued by the Rotterdam Bureau Green Award or a certification within the scope of the ISO 14001 and that meet the respective requests, requested beforehand to APL, SA.		• Ro/Ro Cargo • Dry Bulk • Liquid Bulk • Break Bulk
South Africa	National Ports Authority of South Africa (Richards Bay, Durban, Ngqura, East London, Port Elisabeth, Mossel Bay, Cape Town, Saldanha)	Port Dues	Rebate (Africa & Richards Bay, Durban, Ngqura, East London, Port Elisabeth, Mossel Bay, Cape Town 2015)	• A reduction of 10% will be allowed to certify double hulled liquid bulk tankers, liquid bulk tankers equipped with segregated ballast tanks and liquid bulk tankers in possession of a "Green Award." The reduction is applied for any one certification or a combination thereof with a maximum of 10%. Proof of aforementioned needs to be submitted to the Authority prior to Vessel sailing. Port Dues are calculated according to ship's GRT and time of stay at port.	Landlord	• Dry Bulk • Liquid Bulk • Break Bulk • Containers
Japan	Port of Tokyo	Port Dues (Port Entry Fee)	Rebate (Port of Tokyo 2015)	• Environmental Ship Index (ESI) The vessels with satisfied ESI score can be applied below reduction on port dues: (1) ESI 20.0~29.9, 30% reduction (2) ESI 30.0~39.9, 40% reduction (3) ESI 40.0~, 50% reduction	Landlord	• Containers • General Cargo • Ro/Ro • Dry Bulk
Korea	Port of Busan	Port Dues	Rebate (Busan Port Authority 2014)	• Environmental Ship Index (ESI) Vessels that ESI score 31 points or higher will be able to receive a 15 percent discount on port dues from 2014.01.01 to 2014.12.31 while staying at the port of Busan.	Landlord	• Containers • Ferry Passengers • Liquid Bulk
Hong Kong	Port of Hong Kong	Port Facilities, Light Dues	Rebate (Port of Hong Kong 2015)	• 50% reduction can be gained by ship owners in port dues as below greener behaviours: (1) Marine fuel with sulphur content not more than 0.5%; (2) Liquefied natural gas; (3) Fuel approved by the Director of Environmental Protection (hereafter called the Director) under	Landlord	• Containers • Ferry Passengers • Bulk • Liquid Bulk • General Cargo

				section 11 of the Air Pollution Control (Ocean Going Vessel)(Fuel at Berth) Regulation (hereafter called the Regulation); (4) Technology for which an exemption has been granted by the Director under section 6(1)(a) of the Regulation; (5) Onshore power supply; (6) Any other technology that can achieve sulphur dioxide emission reduction at least as effectively as using marine fuel with sulphur content not more than 0.5% while berthing in the waters of Hong Kong and approved by the Director.		
Span	Port of Valencia	Vessel Charge	Rebate (Port of Valencia 2015)	• A reduction coefficient, with a value of 0.5, has been introduced in the calculation of the full amount of the vessel charge for ships that are powered by liquefied natural gas (LNG), or which use LNG or electricity supplied from the quay to power their ancillary engines during port calls. Basic charge of vessel charge: short sea shipping = €1.20, rest of shipping = €1.43 Correction coefficient for 2015: 1.20 Charge calculation: G.T./100 x hours of stay to be paid x the following amounts (in which the basic charge, correction coefficient, and charge coefficient are included)	Landlord	• Containers • Bulk Cargo • General Cargo • Fish catches and supplies • Cruise and Ferries Passengers
Span	Port of Algeciras	Vessel Rate	Rebate (Port of Algeciras 2015)	• A reduction coefficient, with a value of 0.5, has been introduced in the calculation of the full amount of the vessel charge for Liquid natural gas-driven ships on high seas or use of liquid natural gas / electricity at berth. Basic charge of vessel Rate: GT / 100 x Hours x Basic amount (B;S) x Weighting x Utilisation Rate x Discounts x Bonus	Landlord	• Containers • Dry Bulk • Vehicles • Liquid Bulk • Cruise Passengers

Appendix II Reviewed Ports

No.	Country	Port
1	Australia	Hedland
2	Australia	Melbourne
3	Australia	Sydney
4	Australia	Brisbane
5	Australia	Dampier
6	Australia	Ashburton
7	Australia	Anketell
8	Australia	Cape-Preston-East
9	Australia	Fremantle
10	Australia	Dampier
11	Australia	Newcastle
12	New Zealand	Taranaki
13	New Zealand	Centre Port Wellington
14	New Zealand	Nelson
15	North America	South Louisiana
16	North America	Houston
17	North America	Long Beach
18	North America	Los Angeles
19	North America	New York & New Jersey
20	North America	Seattle
21	North America	Oakland
22	Canada	Prince Rupert
23	Canada	Vancouver
24	Canada	Montreal
25	Canada	Sept-Iles
26	Brazil	Santos
27	Chile	Mejillones
28	Chile	Valparaiso
29	Peru	Callao
30	China	Tanjin
31	China	Shanghai
32	China	Ningbo
33	China	Guangzhou
34	China	Qingdao
35	China	Dalian
36	Japan	Nagoya
37	Japan	Tokyo

38	Malaysia	Port Kelang
39	Thailand	Laemchabang
40	Vietnam	Ho Chi Minh
41	Singapore	Singapore
42	Korea	Busan
43	Hong Kong	Hong Kong
44	Israel	Ashdod
45	Kingdom of Saudi Arabia	Jeddah
46	U.A.E.	Dubai ports
47	Oman	Sohar
48	Taiwan, R.O.C.	Kaohsiung
49	Taiwan, R.O.C.	Taipei
50	Taiwan, R.O.C.	Taichung
51	Taiwan, R.O.C.	Keelung
52	Denmark	Copenhagen
53	Finland	Helsinki
54	Estonia	Tallinn
55	Poland	Gdansk
56	Lithuania	Klaipeda
57	UK	Felixstowe
58	UK	Thamesport
59	Ireland	Dublin
60	Italy	Genoa
61	Greece	Piraeus
62	Greece	Thessaloniki
63	Latvia	Riga
64	Lithuania	Klaipeda
65	Belgium	Ghent
66	Belgium	Antwerp
67	Belgium	Zeebrugge
68	Gibraltar	Gibraltar
69	The Netherlands	Amsterdam
70	The Netherlands	Rotterdam
71	The Netherlands	Tata Steel IJmuiden Terminals
72	The Netherlands	Groningen
73	Sweden	Gothenburg
74	Sweden	Stockholm
75	Sweden	Malmo
76	Germany	Jadeweser

77	Germany	Kiel
78	Germany	Rostock
79	Germany	Niedersachsen Ports (Port of Cuxhaven / Port of Stade / Port of Norden / Port of Emden)
80	Germany	Bremen
81	Germany	Hamburg
82	Norway	Oslo
83	Norway	Norwegian Coastal Administration
84	Norway	Stavanger
85	Norway	Bergen
86	France	Le Havre / Paris / Rouen
87	France	Atlantic Port La Rochelle
88	France	Marseilles
89	Portugal	Setúbal
90	Portugal	Sines
91	Portugal	Douro e Leixoes
92	Portugal	Lisboa
93	Span	Valencia
94	Span	Algeciras
95	South Africa	National Ports Authority of South Africa (Richards Bay, rban, Ngqura, East London, Port Elisabeth, Mossel Bay, Cape Town, Saldanha)
96	Ghana	Tema
97	Ivory Coast	Abidjan
98	Nigeria	Lagos
99	Benin	Cotonou
100	Togo	Lome

Appendix III Questions of Interview Shipping Company

Part 1 Background and Objective

Background:

Currently, more and more ports offer discounts on port charges for those vessels which contribute to reduce pollution or show superior environmental performance. For example, Hamburg Port Authority offers discounts on port fees on the basis of four programmes, namely: the *Port Power Discount*, the *Blue Angel*, *Environmental Shipping Index* (ESI), *Green Award* certified ships, and solely LNG-fuelled vessels.

1. Port Power Discount: 15% discounts for ships that use electricity provided by a power barge or generated from alternative energy facilities instead of using their diesel engines while berthing.
2. Blue Angel certified ships: 2% discounts for carriers whose ship operations are proved as eco-friendly. The Blue Angel is an international ecolabel for services and products that are certified according to environmental and social criteria.
3. ESI: the port of Hamburg provides percentage discounts on port fees according to the following table.

ESI score	Percentage of discount on port fees	Maximum reward amount
20-24	0.50 %	EUR 250
25-34	1.00 %	EUR 500
35-49	5.00 %	EUR 1,000
≥ 50	10.00 %	EUR 1,500

   In addition, ships powered with LNG and registered with the International Association of Ports and Harbours (IAPH) will be awarded a 15% discount.
4. Green Award: 3% discount in port fees can be received by product and chemical tankers, crude oil, LNG carriers in any size which hold a valid Green Award certificate.
5. Solely LNG-fuelled vessel: 15% discount on port fees for ships which are solely powered by LNG (ESI-SOx score > 99) and are registered with the IAPH.

Objective:

To understand how carriers react to incentive scheme on port charges for environmentally friendly vessels.

Part 2 Interview Questions:

1. Interviewee background:

Q1. What is your position in company?

Q2. To what extent can you influence the company's decisions on ports of call?

Q3. Have you ever evaluated port charges for your company?

2. Main Questions:

Q4. What is your opinion on green incentive scheme for environmentally friendly vessels?

Q5. Does your company take green incentive scheme into consideration when deciding on calling at a new port?

a. Why, or why not, are green incentive scheme taken into consideration?

b. If you are not considering the green incentive schemes in you port of call decisions, do you think you will consider them in the future?

Q6. How substantial would incentives have to be to make you decide to change port of call?

a. It does not matter as we do not base our port of call decisions on port fees.

b. Very substantial (more than 50%)

c. We certainly would consider changing port of call already for incentives between 20 and 50%.

d. We certainly would consider changing port of call already for incentives between 5% and 20%.

e. We certainly would consider changing port of call already for any incentives even below 5%.

Q7. Would your company adopt technical measures to improve the environmental performance of its vessels beyond compliance to gain access to port incentives?

Q8. Would your company adopt operational measures such as cold ironing to improve the environmental performance of its vessels beyond compliance to gain access to port incentives?

Q9. Would your company adopt alternative fuels such LNG or methanol on its vessels to gain access to port incentives?

Q10. Do you think being considered as a greener company though certifications such as Green Award, is important for your company and for your clients?

3. Suggestions to this topic: