CLEANSHIP

CLEAN BALTIC SEA SHIPPING

CLEAN BALTIC SEA SHIPPING

CLEANSHIP

CLEAN BALTIC SEA SHIPPING

CLEANSHIP

CLEANSHIP is part of the EU Strategy for the Baltic Sea Region, and was by the EU Commission selected as a strategic Flagship project in its mission to make the Baltic Sea a model region for clean shipping. CLEANSHIP encourages measures to reduce emissions from ships to the atmosphere and to the sea by elaborating on ways to promote the use of cleaner fuels, more effective infrastructure, shoreside electricity, and important port managerial issues addressing environmental development.

With 19 formal partners, including major Baltic ports, large shipowners, ship fuel manufacturers, coastal communities with own ports, authorities with shipping and environmental duties, and the respective stakeholders, supporting regional and branch organisations are in different forms represented in the project.

The project had a total budget of 2.8 million Euros and a duration of 3.5 years, 2010-2013.

EDITORS

Port of Trelleborg - Josefin Madjidian, Sten Björk, Agneta Nilsson, Tommy Halén

YEAR OF PUBLICATION

2013

WORDS FROM LEAD PARTNER

Shipping is the most important means of transport for the growing trade in the Baltic Sea Region, reflecting and contributing to the prosperity of the area. However, shipping also contributes to the severe eutrophication of the Baltic Sea through air and water pollution.

The problem has been addressed by several instances, for example, the five point action plan of the Baltic Sea States Sub-regional Cooperation, the EU Baltic Sea Strategy "To become a model region for clean shipping" endorsed through the Council of the Baltic Sea States, and the HELCOM Baltic Sea Action Plan. The problem is, however, not only seen by policy, but also by ports and the maritime industry itself. The heart of CLEANSHIP has been the future development of Baltic Sea ports, inspired to become a model region for clean shipping, including ports acquiring the tools needed to be able to state as best practice examples regarding environmental issues.

Shipping is to a great extent international; the objective of the project has been the joint development of a clean shipping strategy for the Baltic Sea, taking the diversity of Baltic Sea ports into consideration. CLEANSHIP has sought solutions to the problems by policy, strategy and technology in a harmonised and concerted manner and by standardisation. To raise the awareness of the challenges faced by Baltic Sea shipping, as well as potential solution to these, several outreach events have further been held to a wider Baltic Sea audience.

We send a warm Thank You to all project partners for a great teamwork and without whom the project would not have been possible. We sincerely hope that our collaboration whilst persisting to work for cleaner and more environmentally friendly shipping in the Baltic Sea will be regarded as meaningful and also carried on in different ways.

Finally, we wish to inform that a full report of the project, including complete studies, is available on our homepage, www.clean-baltic-sea-shipping.eu.

Sten Björk, Project Manager

Tommy Halén, CEO Port of Trelleborg

Agneta Nilsson, Communication Manager/Coordinator EU projects

Josefin Madjidian, Project Assistant

www.clean-baltic-sea-shipping.eu

Port of Trelleborg

CLEAN BALTIC SEA SHIPPING PARTNERSHIPS

CLEANSHIP was borne by a consortium of 19 formal partners that represent stakeholders along the triple helix concept, i.e., local and regional governments, port organisations, universities, and NGOs. CLEANSHIP is further strongly supported by its associated partners who, due to restrictions of the funding programme, could not become formal partners. The associated partners have supported the objectives of CLEANSHIP with own contributions as well as economically. Additionally, CLEANSHIP is supported by a number of supporting organisations/partners, not directly involved in tasks and activities, but which are of importance on the policy level.

FORMAL PARTNERS

Port of Trelleborg

Port of Trelleborg is the largest RoRo port in Scandinavia. The port is the owner of all port facilities, including real estate, and the company is responsible for investments as well as operation and maintenance of all assets. The company has two business areas: port and handling of goods. Today five ferry lines (13 RoPax vessels) connect Trelleborg with Germany and Poland, one to Swinoujscie, one to Sassnitz, two to Rostock and one to Travemünde. In addition, the port handles grain, fertilizers and oil/styrene. Environmental measures are an important characteristic of the company, with for example, port reception facilities for ship sewage, onshore power supply and collection of storm water.

City of Trelleborg

Sweden is divided into 290 municipalities with Trelleborg being the most southern, located at the heart of the two expansive regions of Öresund and the South Baltic Sea. Trelleborg Municipality is responsible for carrying out civic duties in the city and surrounding area. These duties include Municipal and Civil Administration, Technical Management, Recreation, Service Management, Cultural, Social and Emergency Services. With the Port of Trelleborg being at the centre of the town both physically and economically the municipality is particularly interested in the actions of CLEANSHIP and its developments. Especially in relation to the improvement of air quality in the port and the city, and for the future of shipping in the Baltic.

Ports of Stockholm

Each year more than 12 million passengers and around nine million metric tons of goods pass though the capital of Sweden's ports simply, efficiently and cost-effectively. Ports of Stockholm comprises of three ports – Kapellskär, Stockholm and Nynäshamn. The blue route is the green one to and from the Stockholm region. Our mandate includes promoting shipping and ensuring the supply of goods to the region. Our vision is to be the number one port in the Baltic Sea – a modern and a commercially advantageous business partner. Ports of Stockholm offer quay-berths, facilities and services for ferry, cruise and goods traffic. Ports of Stockholm are also responsible for the development and maintenance of inner-city quays and services for archipelago and other waterborne local traffic.

Port of Helsinki

Port of Helsinki is the most important general-purpose port in Finland, contributing to the business life and prosperity of the Helsinki area. It is one of the leading ports for unitized cargo and the busiest passenger ports in the Baltic Sea. Port of Helsinki comprises of three harbours – South Harbour, West Harbour and Vuosaari Harbour. Imports and exports at the Port of Helsinki are transported mainly in cargo units as containers, trucks, and trailers, along with roll trailers and other cargo units. The operations at Vuosaari Harbour have made it a central port for cargo traffic. Estonia is the most popular tourist destination, thanks to the frequent and fast ship connections with Tallinn.

Norwegian Shipowners Association

The Norwegian Shipowners' Association is an employer organization serving more than 160 companies in the field of Norwegian shipping and offshore contractor activities. Our members are the core and driving force within the Norwegian maritime environment. The members of the Norwegian Shipowners' Association's employ more than 55 000 seafarers and offshore workers from more than 50 different nations. The Norwegian Shipowners' Association's is working to help put Norwegian shipowners at the forefront of the development of a safe, eco-friendly and socially responsible global maritime industry.

Port of Kalundborg

Port of Kalundborg has a perfect location and top quality facilities and is a port on the increase. The port is Zealand's largest industrial port outside Copenhagen and one of the largest and deepest ports in Denmark. Our central location, effective infrastructure around the harbour and city and major utility companies nearby, has made Kalundborg port the first choice for several international companies. Port of Kalundborg is Zealand's grain export port. Freight handling is another large activity. The port has 5 km continuous quays with a draft of up to 15 meters. The high level of service has provided an annual cargo turnover of around 3 million tons.

Port of Turku

Port of Turku is the second most important port in Finland for general and unitized cargo. The overall cargo volume is about 3 million tons and passenger traffic is about 3.2 million passengers. The Port of Turku is located at the junction of the key traffic and goods flows of the Baltic Sea region. The Port of Turku has become the most important distribution center for Scandinavian traffic. The core of the Port's passenger traffic is formed by frequent ferry traffic that opens up the fastest route through Scandinavia to the rest of Europe.

Port of Tallinn

Port of Tallinn is the biggest port authority in Estonia and as far as both cargo and passenger traffic are taken into account, the biggest port of the Baltic Sea. In order to fit into the competitive environment, the port underwent a process in the mid 1990s by developing from a service into a landlord port. In 1999, the last cargo handling operations were given to private companies. The port maintains and develops the infrastructure of the port and leases territories to terminal operators through building titles giving the operators an incentive to invest into superstructure and technology. Port of Tallinn consists of five harbours: Old City Harbour, Muuga Harbour, Paldiski South Harbour, Paljassaare Harbour and Saaremaa Harbour.

City of Hamburg

In addition of being responsible for urban planning, housing, environmental protection, energy and the climate, Hamburg State Ministry of Urban Development and Environment is also the competent authority when it comes to clean air. Faced by the challenge of the close proximity of residential and commercial areas and the port, the City State of Hamburg has set itself the goal of achieving a good air quality status across the city and surrounding areas by 2020. Hamburg has already implemented several measures, including the establishment of an air quality partnership. Additional measures will be realised in ongoing "clean shipping" projects, involving the installation of shore-side power and LNG facilities.

Port of Rostock

The Hafen-Entwicklungsgesellschaft Rostock mbH is a private limited company owned by the city of Rostock and the federal land of Mecklenburg-Vorpommern. It owns the premises of the port and is responsible for the construction and maintenance of port infrastructure. Furthermore the company leases estate for logistic and industrial use. The port of Rostock is a universal port which has a high share of ferry traffic to Denmark, Sweden and Finland. Dry and liquid bulk cargoes are handled at dedicated terminals. It is organized as a landlord port. In addition to cargo handling terminals the Hafen-Entwicklungsgesellschaft Rostock mbH operates a cruise terminal with three berths in the seaside resort Warnemünde.

Baltic Sea Forum

As a non-governmental organization the Baltic Sea Forum is networking closely within economy, politics, culture and other institutional partners in all Baltic Sea states. The Forum's targets are to support the integration of the Baltic Sea states and to help international cooperation. The Forum is a strategic Partner of the Council of the Baltic Sea States (CBSS), it also has an observer status in regard to parliamentarians of the Baltic Sea as well as in Helsinki Commission HELCOM. It is a member with special consultative status since 2008 regarding the Economic Social Council (ECOSOC) of the UN.

Environment Development Association

Environmental Development Association (EDA) is a non-governmental organization based in Latvia. EDA believes that it is possible to create modern and convenient technology solutions which improves energy efficiency and which is harmless to the surrounding environment. Within various projects, EDA cooperates with experts from different sectors, solving many issues regarding sustainable and secure environment.

EDA's main aims are:

- to develop sustainable environment protection and development policy
- to encourage public understanding about various environmental topics, society involvement in environmental policy creation and decision making process
- to develop valuable international cooperation between representatives of different sectors.

Stadtwerke Lübeck

Apart from its obligations to supply the city with energy Stadtwerke Lübeck GmbH or SWL is, upon decision of the city council, actively engaged in reducing ship borne air emissions in Lübeck as well as in the ferry harbour Lübeck-Travemünde. Travemünde is also a well reputated seaside resort. There is permanent conflict between ship operations and touristic activities. Air emissions from shipping (40 arrivals every day) are at an unacceptable level. Since the early 2000s SWL is engaged in providing solutions to ship borne emissions. Within the BSR IR project NEW HANSA it developed shoreside electricity.

County Administrative Board of Skåne

Skåne is one of Sweden's 21 counties, each of which has its own County Administrative Board and County Governor. The County Administrative Board is the regional government authority and an important link between the people and the municipal authorities on the one hand and the government, parliament and central authorities on the other. The County Administrative Board is commissioned to monitor developments and inform the government of the county's needs.

Port of Klaipeda

Klaipeda State Seaport is the northernmost ice–free port on the Eastern coast of the Baltic Sea. It is the most important and biggest Lithuanian transport hub, connecting sea, land and railway routes from East to West. Klaipeda is a multipurpose, universal, deep-water port, providing high quality services. 17 big stevedoring companies, ship repair and ship building yards operate within the port as well as all types of marine business and cargo handling services. The annual port cargo handling capacity is up to 45 million tons. The main shipping lines to the ports of Western Europe, South-East Asia and the continent of America pass through Klaipeda port.

University of Klaipeda

Research of air pollution from ships is since 1996 conducted at Klaipeda University, when researchers established a specialized Air Pollution from Ships Research Laboratory. The material base of the laboratory consists of stationary and mobile complexes of research equipment for analysis of air and fuel combustion products by automated and wet methods, chemotological characteristics of fuel. The main research activities and objectives are:

-Air pollution from ships, abatement techniques and technologies
-Air pollution in sea ports, pollution sources and reduction opportunities
-Air pollution dispersion, long range transfer and physical-chemical conversion in the atmosphere
-Chemotological characteristics of fuels, usage of alternative fuel types in ships.

Maritime Institute in Gdansk

Maritime Institute in Gdansk is a Research and Development company with more than sixty years of experience. The Institute carries out complex research projects for the maritime administration and economy. The scope of work by its six research departments covers: maritime hydrotechnics, operational oceanography, protection and shaping of the environment, transport management and logistics, modernisation and exploitation of seaports, inland waterway shipping, tourism, database construction, monitoring of maritime processes and activities. The institute co-operates with many important international maritime institutions, ports and universities, and participates in several EU co-financed projects in the framework of the Baltic Sea Region Programme 2007-2013, Central Europe as well as EOG Funds.

Klaipeda Science and Technology Park

Klaipeda Science and Technology Park (KSTP) has more than 43 companies, public enterprises and branches of international companies acting in the innovation environment and the global market. During the ten years of work the Park has established a wide network of partners in all continents enabling boundless collaboration possibilities. The mission of the KSTP is to promote the development of modern scientifically susceptible technologies, to provide infrastructural and consulting services for innovative enterprises and business ideas in Lithuania. Within CLEANSHIP, KSTP closely cooperated with University of Klaipeda.

Port of Oslo

Port of Oslo is a municipality-owned company (KF) which reports to the City of Oslo's department for transport and environment. The port offers efficient and environmentally sound sea transport and monitors the traffic in the port area. Private enterprises are responsible for the operations at the terminals, with the exception of the cranes, for which the Port of Oslo is responsible. Port of Oslo is one of five Norwegian ports designated by the Ministry of Fisheries and Costal Affairs as especially important in the development of efficient and safe sea transport of passengers and freight.

ASSOCIATED PARTNERS

Swedish Maritime Administration

World Future Council

TT-Line GmbH

German Ministry of Transport

E.ON Gas Sverige AS

Maritimt Forum

State Chancellery of Schleswig-Holstein

Exmar BV

Baltic Subregional States Cooperation

Germanischer Lloyd

Nordic LNG AB

Gazprom

Rosmorport (Kaliningrad)

Stena Line

City of Swinoujscie

Vestfold County Council

Baltic Ports Organisation

Port of Gdańsk

Port of Nexø

German Shipowners Association

SUPPORTING ORGANISATIONS

Danish Maritime Authority

OKEANOS Foundation

Swedish Ministry of Infrastructure

HELCOM – Baltic Marine Environment Protection Commission

Swedish Ministry of the Environment

Ostsee Mineralöl – Bunker GmbH

Council of the Baltic Sea States (CBSS)

AIDA Cruises GmbH

Det Norske Veritas

German Hydrogeographic Org.

SIDA

Swedish Ministry of Enterprises

City of Lübeck

City of Gdańsk

For Europe and the Baltic Sea Region maritime transport has been a catalyst of economic development and prosperity throughout history because it enables trade and contact between all the European nations.

Almost 90% of the European Union external freight trade is seaborne. Short sea shipping represents 40% of intra-EU exchanges in terms of ton-kilometers. Overall, maritime industries are an important source of employment and income for the European economy.

As freight traffic will continue to grow, on land and sea, the important question for all the involved parties is how to ensure a long-term sustainability of such growth.

One problem with this development is the consequent growing negative environmental impact of shipping on the Baltic Sea, exacerbating its eutrophication status. It is vital to mitigate the eutrophication by, among other things, reducing the nutrient inputs from ships.

The CLEANSHIP project is looking into different environmental issues and potential solutions, and highlights some recommendations to try to mitigate the situation of the Baltic Sea as such, as well as its cities and ports. We believe in a joint strategy with all parties involved since environmental issues should not be used in a negative fashion, for example related to competition between ports or shipping lines. Importantly, emissions from shipping cannot be attributed to any particular national economy, and multilateral collaboration is the most appropriate means to address such emissions.

According to the seaside sector there are several problems for the future maritime transport in the Baltic Sea and some of the main concerns are;

- Environmental laws, regulations and recommendations having large impact on the ordinary business.
- Lack of technical solutions for ballast water treatment and scrubbers.
- Lack of alternative fuels and/or infrastructure for these fuels.
- High fuel cost will be a problem for all maritime transport, but especially for Baltic Sea, being a SECA-area and therefore first to abide to the IMO MARPOL Annex VI regulation on sulphur content in fuel <0.1% (cf. 1%).

As of today there are various options of alternative fuels, such as LNG and methanol, and their usage would lead to greatly reduced emissions in the Baltic Sea and its ports. However, there is much work to be done.

In the maritime transport sector ship size is important for the competitiveness because the unit cost of transport will be lower when large volumes are transported on a ship. The trend is therefore towards larger vessels, and ports must adapt to a new situation where the ships are getting bigger and longer and that the frequency goes down. This, in turn, could result in ports becoming parking lots while ships wait for a maximum fill to achieve maximum economic efficiency.

For ports, it is important to adapt to the new market conditions, for example by dredging, enlarging the port area, etc. At the same time, another important part of the ports is to prepare the berths for environmentally friendly technology, such as the possibility for ships to connect to onshore power supply as well as for waste water reception.

I am looking forward to the years ahead – the shipping sector will transform little by little and new innovative solutions and technologies will replace old.

TOMMY HALÉN
CEO, Port of Trelleborg

Our 3.5-year large scale strategic EU project, which the Port of Trelleborg as lead partner started in June 2010, is now in September 2013 going to be summarized in a Final conference, where we display our total results in terms of efforts and recommendations for how we, the maritime industry, can successfully carry on our voluntary efforts to make the vulnerable Baltic Sea a healthy and living sea, where we manage to turn the threat for a total eutrophication of the Baltic Sea into a nutrient balance, so that the Sea will survive, the biodiversity become preserved and the reproduction of fish and other maritime species become granted.

We have initially analysed and put better actions into practice, as forerunners in ports and coastal areas started to carry out a number of full scale investments in new technical and port managerial solutions. We have also managed to get a number of stakeholders on both local and also on EU Commission level to join and support us in our overriding tasks, to successfully begin combating of the eutrophication in all possible ways, making efforts to find the most successful, most cost effective and also most long term sustainable solutions.

It is right to say that we have managed to get attention from representatives of the entire Baltic Sea Region population, a necessity for a successful pollution combating and creating a greener maritime industry. But it is also right to say that not all parts of the population, a volume of totally some 100 million people living around our Sea, is yet fully aware of the necessity for all to participate fully and to undertake own personal efforts to stop all pollution that can be stopped.

In reality, now is the time when full scale implementations of pollution combating efforts are starting. Both by the maritime industry itself and by the users of this for all our economic development so utterly important tool for trade between our countries, the Baltic Sea.

The planning for new cleaner fuels as better alternatives for use in the maritime industry than old highly polluting fossil fuels, replacing polluting fuels by new green energy sources on board and ashore, are exciting novelties which are now under rapid development. Within the maritime industry itself, great efforts are voluntarily made by a large number maritime industry stakeholders, in order to create more efficient shipping link systems.

During the next EU implementation period, 2014-2020, CLEANSHIP project partners and our supporting organisation representatives, hope to effectively influence that the CLEANSHIP Final report with its recommendations will become adopted and used as a living instrument by the EU Parliament and its Commission.

Today such recommendations to adapt existing ship machineries to run on modern and clean fuels need a standpoint about the necessity from the nations of the Baltic Sea Region. We hope that it can become decided between the Baltic Sea Region nations concerned, that it should become much more costly to run transports on dirty fuels than on more clean versions, and are determined in the maritime industry to participate fully in undertaking all efforts to shape clean shipping.

We are now from the maritime industry and its partners depending on that our recommendations and forerunner solutions will result in strong and fully supporting actions being taken during the next period 2014-2020 in EU, here referred to, by the responsible governments and our international Supporting organisations, such as HELCOM, the EU Commission, the EU Parliament, the Baltic Sea Political Council and other likewise strong and influencing supporting organisations.

It is of high importance that all voluntary efforts by the maritime industry are fully supported by all Baltic Sea Region nations, thereby making successful national efforts to encourage an increased proportion of all transport of goods to be using our sea ways instead of the more energy consuming land transports over long distances.

STEN BJÖRK
Project Manager
CLEANSHIP

Port of Kalundborg

TABLE OF CONTENTS

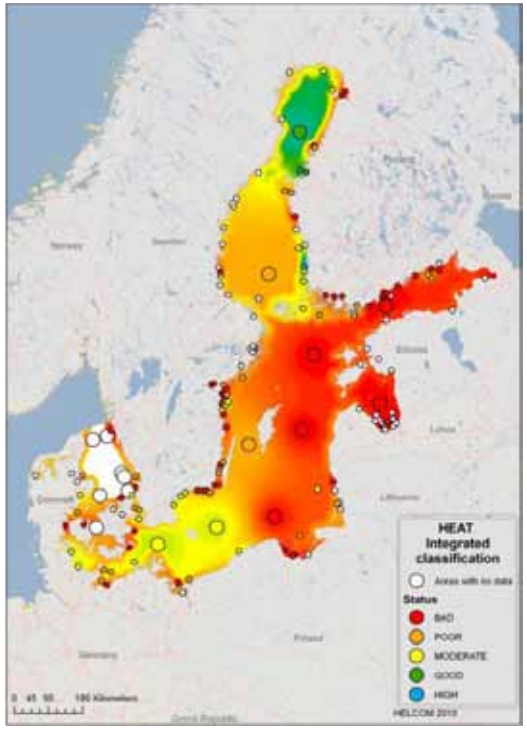
SECTION 1

INTRODUCTION TO SHIPPING IN THE BALTIC SEA

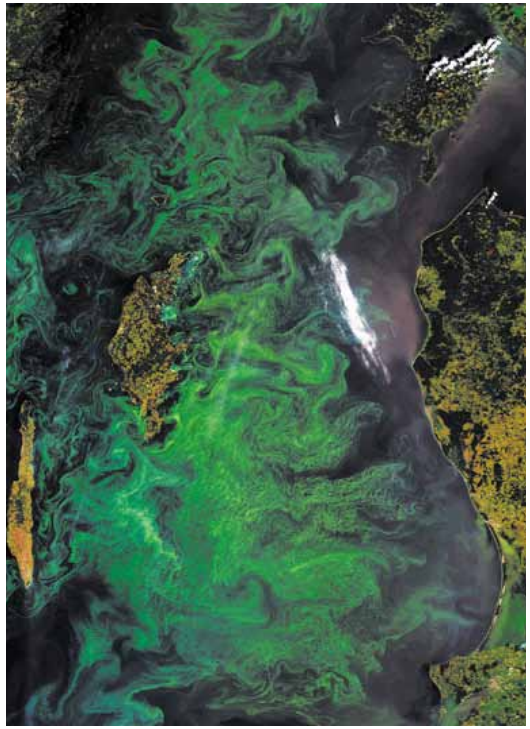
Port of Turku

SPECIAL ECOLOGICAL CIRCUMSTANCES OF THE BALTIC SEA

The Baltic Sea area, about 370 000 km², comprises the Baltic Sea proper, plus the Gulf of Bothnia, the Gulf of Finland, and the entrance to the Baltic Sea bounded by the parallel of the Skaw in the Skagerrak. In a global perspective the Baltic Sea is a small area, but is one of the world's largest reservoirs of brackish water and ecologically unique. The species populating the Baltic Sea live on the edge of their salinity tolerance limits (high or low). As a result the sea is highly sensitive to the environmental impacts resulting from human activities in its catchment area. The coastal regions surrounding the Baltic Sea are densely populated by more than 85 million people, imposing a vast magnitude of human activities on the sea and its adjacent catchment area. During the last ~100 years, the Baltic Sea has changed from an oligotrophic clear-water sea into a eutrophic marine environment. Eutrophication is today regarded as the most severe threat to the Baltic Sea. Indeed, the Baltic Sea holds the world's largest and growing human-induced dead zone, an effect of the adding of 20 million tonnes of nitrogen and 2 million tonnes of phosphorous over the past 50 years[1,2]. In open sea areas, nitrogen has in many direct and indirect studies been found to be the nutrient regulating primary production and hence, the overall eutrophication. About 75% of the nitrogen load and at least 95% of the phosphorus load enter the Baltic Sea via rivers or as direct waterborne discharges. About 25% of the nitrogen load comes as atmospheric deposition. Due to the narrow strait connecting the Baltic Sea to the North Sea, it is a semi-closed environment and the circulation time of water is long. Nutrients (nitrogen and phosphorus) and pollutants therefore accumulate easily, aggravating the negative circumstances.



a) The eutrophication status of the Baltic Sea based on average, data for 2003-2007 at 110 assessment units in the Baltic Sea. The assessments are based on an integration of the results from core set indicators on nutrient (nitrogen and phosphorus) concentrations, chlorophyll a concentrations, water transparency and zoobenthos communities using the HELCOM Eutrophication Assessment Tool (HEAT). The interpolated map has been produced in three steps: 1) the integrated status of coastal assessment units have been interpolated along the shores, 2) the integrated status of open sea basins have been interpolated and 3) the coastal and open interpolations have been combined using a smoothing function. The larger circles indicate the status of open sea assessment units and the smaller circles that of the coastal assessment units.[3]



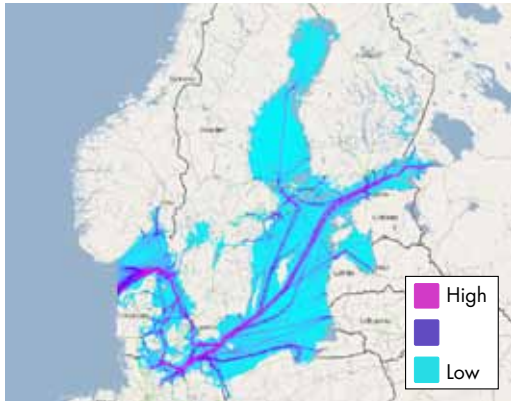
b) Cyanobacteria covering the Baltic Sea in green slime, spurred by flows of nitrogen and phosphorous[4].

MARITIME TRANSPORT IN THE BALTIC SEA - STARTING POINT AND CHALLENGES

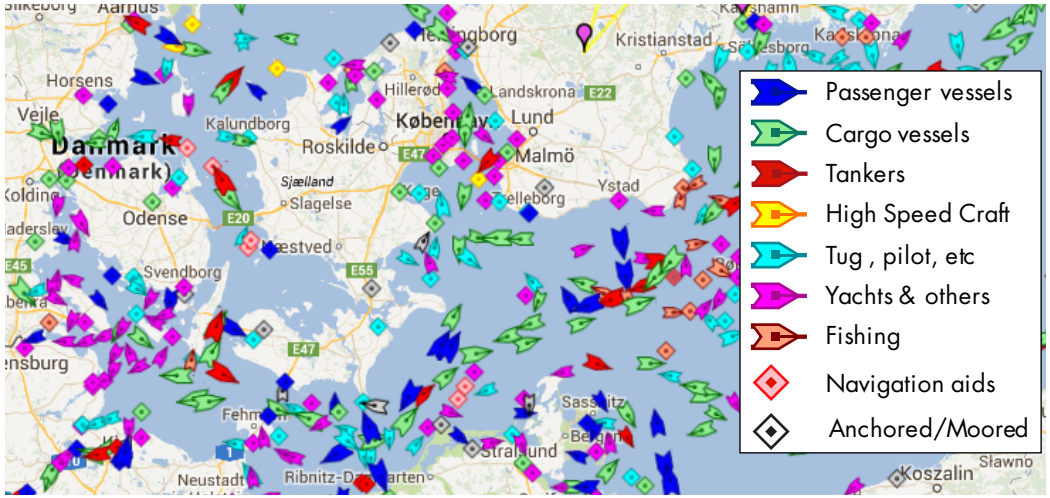
The Baltic Sea is essential for the Baltic Sea countries' economies and development. All 10 countries surrounding the Baltic Sea use the sea for transportation, fishing, recreation, tourism, etc. The maritime activity in the region comprises ships and shipping as well as more than the 100 ports located around the Baltic Sea.

The Baltic Sea is one of the busiest places in the world in terms of shipping. During the last decade shipping in the Baltic Sea increased, with both increasing number of ships and size of ships and the amount of maritime traffic continues to grow by around 5% per year. There are about 2 000 ships in the Baltic marine area at any given moment, and each month around 3 500–5 000 ships navigate the Baltic Sea, currently representing handling of up to 15% of the world's cargo traffic[5], that is, about one billion tons of cargos per year. More than 40% of the ships in the Baltic Sea are general cargo ships that for the most part stay inside the Baltic Sea or in Northern Europe. Interestingly, although passenger and RoPax vessels only accounted for approximately 5% of the ships operating in the Baltic Sea in 2007, they were accountable for approximately 27% of the air emissions.[6]

Given the predicted increase in maritime traffic, it is essential to not only tackle the environmental effects caused by today's shipping level, but also consider the effects of future shipping in the Baltic Sea. For example, when substituting fuel to alternative ones and when constructing expensive infrastructure it must not be hastened, but well researched and planned.



Automatic Information System (AIS) density, monthly average 2011 (HELCOM).



Live map of ship traffic (www.marinetraffic.com).

POLLUTION FROM SHIPPING AND INTERNATIONAL REGULATION

Shipping is one of the most environmentally friendly modes of transport referring to emissions per tonnes of cargo, yet, the increase in global shipping makes it a significant source of air pollution. Ships generate emissions of sulphur oxides (SO_X), nitrogen oxides (NO_X), particulate matter (PM) and carbon dioxide (CO_2) as a result of the fuel used to power them, and are the largest single emission source for NO_X, PM and SO_X emissions in the transport sector. Annual emissions from ships in the Baltic Sea region in 2011 were the following: SO_X 79 000 tonnes, NO_X 373 000 tonnes, CO_2 19 million tonnes[7]. These emissions correspond to all land based NO_X emissions and twice the SO_X emissions from Denmark and Sweden combined. HELCOM has estimated that for good environmental status of the Baltic Sea to be achieved, the maximum allowable annual nutrient pollution inputs into the Baltic Sea would be about 600 000 tonnes of nitrogen and 21 000 tonnes of phosphorous[8]. Reaching the agreed nutrient levels, i.e. close to natural levels, requires measures to reduce loading from all sectors, including shipping in the Baltic Sea.

As already acknowledged by the Kyoto Protocol, emissions from international shipping cannot be attributed to any particular national economy, but rather multilateral collaborative action is the most appropriate means to address such emissions. The International Maritime Organisation (IMO)* has developed global regulations governing the shipping industry's environmental performance. For example, the International Convention on the Prevention of Pollution by Ships (MARPOL), which has been ratified and enforced globally.

The European Commission has adopted a roadmap, "White paper 2011", of 40 concrete initiatives for the next decade to build a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. The proposals will dramatically reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050, including at least 40% cut in shipping emissions. According to the European Commission, the Commission, Member States and the European maritime industry should work together towards the long-term objective of 'zero-waste, zero-emission' maritime transport. Such an effort includes ensuring a steady progress towards a coherent and comprehensive approach to reduce greenhouse gas emissions from international shipping and overseeing the implementation of the amendments of MARPOL Annex VI (Prevention of Air Pollution from Ships). The Commission's proposals should further ensure that a 'back-shift' from short-sea shipping to road is avoided following the reduction of SO_X and NO_X from ships[9].

The Baltic Sea is also protected by the Helsinki Commission, or the HELCOM, a multilateral and intergovernmental co-operation between Denmark, Estonia, The European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden for the preservation of the marine environment from all sources of pollution. HELCOM is the governing body of the "Convention on the Protection of the Marine Environment of the Baltic Sea Area", known as the Helsinki Convention.

MARPOL - THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS

- Annex I: Regulations for the Prevention of Pollution from oil
- Annex II: Regulations for the control by Noxious Liquid Substances in bulk
- Annex III: Regulations for the Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form
- Annex IV: Regulations for the Prevention of Pollution by Sewage from Ships
- Annex V: Regulations for the Prevention of Pollution by Garbage from Ships
- Annex VI: Regulations for the Prevention of Air Pollution from Ships

CLEANSHIP mainly focuses on issues related to Annex IV and VI.

These linear patterns are know as ship tracks and are produced when fine particles from the ships' exhausts float into a moist layer of the atmostphere. (earthobservatory.nasa.gov)

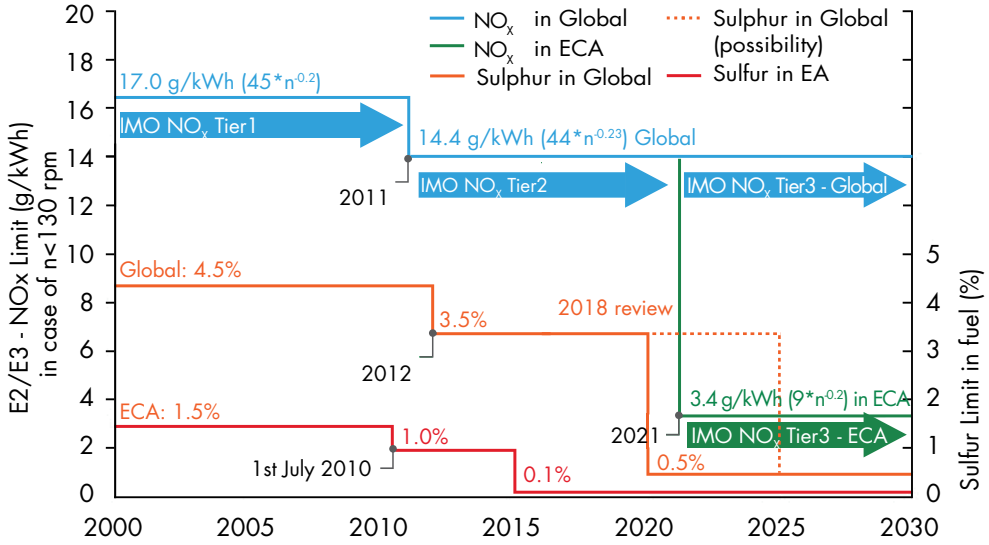
* United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships

THE BALTIC SEA VISION FOR MINIMUM AIR POLLUTION FROM SHIPS

The regulations in MARPOL Annex VI seek to minimize airborne emissions from ships and their contribution to local and global air pollution and consequent environmental problems. Annex VI entered into force on 19 May 2005 and a revised Annex VI with significant tightened emissions limits was adopted in October 2008 which entered into force on 1 July 2010. These requirements are being implemented gradually and will have full force in 2015 and 2021, leaving ship-owners a limited number of options for modifications to their ships for a continued trade in the Baltic Sea.

The IMO emission standards are commonly referred to as Tier I, II, and III. The requirements are split in two categories: global requirements and more stringent requirements applicable to ships in Emission Control Areas (ECA). As a response to the environmental challenges the Baltic Sea is facing, the Baltic Sea has been defined as an ECA in MARPOL. Moreover, the IMO has designated the Baltic Sea as a Particularly Sensitive Sea Area (PSSA)*, and is therefore recognized as an area that needs special protection through action by IMO.

The age of the ships operating in the Baltic Sea is fairly evenly distributed from new to about 40 years old, meaning there is a continuous replacement of old vessels, and that it will take about ten years to replace 25% of the fleet[6].



Enforcement	Reference	Legislation	Legislator	Area	Target
01 Jan 2010	2005/33/EC	Sulphur content in fuel <0.1 when at berth in EU ports and in canals	EU	EU	Sailing and new ships
01 Jul 2010	IMO Annex VI	Sulphur content in fuel <1% in SECAs	IMO	SECA	Sailing and new ships
01 Jan 2011	IMO Annex VI	Reduction of NO_x to Tier II level, approximately below 20% of Tier I level	IMO	Global	Newbuilds
01 Jan 2012	IMO Annex VI	Sulphur content in fuel <3.5%, progressively towards 0.5% sulphur by 2020 (maybe later)	IMO	Global	Sailing and new ships
01 Jan 2015	IMO Annex VI	Sulphur content in fuel <0.1% in SECAs	IMO	SECA	Sailing and new ships
01 Jan 2021	IMO Annex VI	Reduction of NO_x to Tier III level in ECAs, approximately 75% below Tier II level	IMO	ECA	Newbuilds

*Resolution MEPC.136(53)

SO_x

Emissions of sulphur dioxides react with water molecules to produce acids and, in turn, acid rain. Acid rain can have harmful effects on plants, aquatic animals, and also infrastructure. The Baltic Sea was designated by the IMO in 2005 as a Particularly Sensitive Sea Area and as the first special SO_X Emission Control Area (SECA) with limits on sulphur emissions under the MARPOL Convention (Annex VI). This decision aims at reducing SO_X quantities in ships fuel oil and can be an important step to minimize environmental impact from ships.

From 2015 all ships navigating in the Baltic Sea will be forced to run on fuel that emits 0.1% sulphur, a drop from today's 1%. On the other hand, this drastic decrease should be judged against the EU limit of 0.001% in road fuels. This regulation will press the advancement of finding new ship fuels, but could initially also have negative environmental effects if cargo will be transported on land rather than on sea. Given the slow but continuous replacement of old vessels, many ships in SECA areas must take measures in order to comply with the new sulphur limits as from 2015.

NO_x

Emissions of nitrogen oxides from ships most importantly contribute to the eutrophication of the Baltic Sea, but also cause acid depositions similar to SO_X, ground ozone formation and PM formation. Shipping (in both Baltic and North Seas) is among the largest contributors to NO_X deposition as about 25% of the total nitrogen input to the marine environment occurs through atmospheric deposition[10].

To reach a global reduction in NO_X emissions, IMO has specified existing and future NO_X emission limits for marine engines, following Tier I, II and III. The Tier II limit for NO_X emissions has from 1st January 2011 required a 20% reduction in NO_X emissions for new ships compared to the former Tier I standard. For the strictest NO_X emission standard to be enforced, Tier III, it is required that the sea is designated as an ECA. Tier III requires another 75% NO_X reduction for ships built after 1 January 2021.

HELCOM has finalized the documentation to the IMO to designate the Baltic Sea as a NO_X Emission Control Area (NECA) under the international MARPOL Convention Annex IV. In the absence of additional abatement measures, total NO_X emissions from ships are expected to increase by a factor of 1.6 to 500 000 tonnes (2008-2040) due to the estimated increase in ship traffic, and assuming a two per cent annual growth in traffic[10]. By becoming a NECA, ship emissions will instead come down to about 160 000 tonnes by 2040. For comparison, the NO_X emissions from all land-based sources in Denmark, Finland and Sweden combined added up to some 470 000 tonnes in 2008, and are projected to be nearly halved by 2030 under current legislation.

As of today two technologies are in use that are considered as having the NO_X reduction potential to achieve IMO Tier III compliance[11]:

- *Selective Catalytic Reduction* (SCR) exhaust gas after treatment and
- *Gas engines* for LNG

However, additional options for meeting the Tier III requirements are expected to become commercially available in the near future.

PM

The particulate matter (PM) in our ambient air come from many sources and in many different sizes, some natural and beyond our control. Particles can be carried over long distances by wind and then settle on ground or water. PM is for example emitted through ship exhaust gases directly, but also secondarily formed from the NO_X and SO_X emissions and their particulate matter derivative — sulfates and nitrates. By reducing SO_X and NO_X from ship exhausts there will be a simultaneous decrease in PM. The size of PM is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into the lungs and even into the bloodstream. Small particles of concern include fine particles as those found in smoke and haze, which are 2.5 micrometers (PM2.5) in diameter and smaller.

CO_2

Shipping is, compared to other transport modes, more energy-efficient, where the least efficient shipping carriers has a CO_2 efficiency of 60 g CO_2/ton*km, while for road transport the corresponding figure is 180. According to the latest IMO report on greenhouse gases, shipping is estimated to have emitted 1 046 million tonnes of CO_2 in 2007, corresponding to 3.3% of the global emissions the same year. In the absence of policies, it was in the same report calculated that ship emissions of CO_2 will grow by 150-250% (compared to 2007) due to the growth in shipping. It was also calculated that there is a significant potential for emission reduction, by 25-75%, through technical and operational measures, if these would be implemented[12].

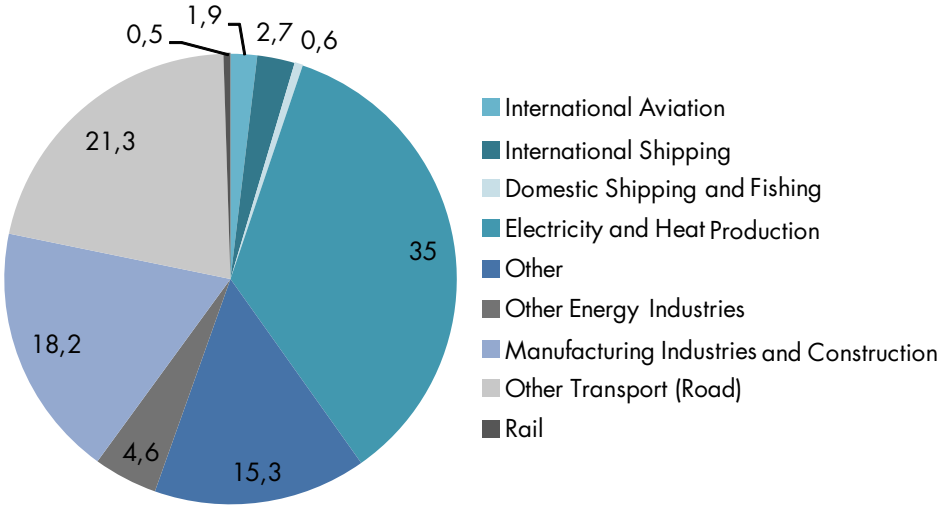
In July 2011, governments at IMO agreed on a comprehensive package of technical regulations for reducing shipping's CO_2 emissions, which entered into force in January 2013. The amendments to the MARPOL Convention (Annex VI) include:

- A system of energy efficiency design indexing (EEDI) for new ships. The IMO EEDI will lead to approximately 25-30% emission reductions by 2030 compared to 'business as usual'.
- A template for a Ship Energy Efficiency Management Plan (SEEMP) for use by all ships. The SEEMP allows companies and ships to monitor and improve performance with regard to various factors that may contribute to CO_2 emissions. These include, inter alia: improved voyage planning; speed management; weather routeing; optimising engine power, use of rudders and propellers; hull maintenance and use of different fuel types[12].

Because the growth of world trade represents a challenge to meeting a target for emissions required to achieve stabilization in global temperatures, IMO also works on the development of market-based measures as a complimentary means of achieving the required target for emissions.

Apart from CO_2's effects on climate change, effects on acidification of marine waters, including the Baltic Sea, have lately been measured[13]. Given the changed biogeochemical conditions[14], and the anthropogenically induced climate change the condition of assimilation of carbon has changed and more acid derivates are produced.

Within CLEANSHIP no formal task has been devoted to CO_2 emissions in shipping, although most pilot projects infer reductions in CO_2. See EU projects Green EFFORTS (www.green-efforts.eu) and COFRET (www.cofret-project.eu) for more information regarding CO_2 in transport and shipping.



Emissions of CO_2 from shipping compared with global emissions.[12]

SECTION 2 - CLEAN BALTIC SEA SHIPPING

Port of Oslo

A MODEL REGION FOR CLEAN SHIPPING

The Baltic Sea Region is a prosperous region that has every potential to become a model region for clean shipping. In order to fully realize clean shipping efforts, cooperation between different bodies is of foremost importance. There are several instances which support and strengthen such efforts in different ways, for example the EU, Baltic Ports Organisation, European Sea Ports Organisation, HELCOM and the IMO. Also see Funding mechanisms on page 80.

CLEANSHIP is a Flagship project of the European Union Strategy for the Baltic Sea Region's (EUSBSR) Priority area of Clean Shipping. EUSBSR is the European Union´s first macro-regional strategy and the strategy can be abbreviated to "Save the sea, Increase prosperity, Connect the region" and consists of several priority areas. The overall goal of the Priority Area on Clean Shipping is for the Baltic Sea Region "to become a model region for clean shipping". This objective is pursued through a political dialogue and through number of flagship projects. A priority area is supposed to initiate a dialogue and activities in the field concerned on behalf of the other countries of the Baltic Sea Region. As a Flagship project, cooperation with other EUSBSR projects is therefore essential, in the case of CLEANSHIP with the project, BSR InnoShip. CLEANSHIP has also cooperated with the Clean North Sea Shipping project (CNSS) of the North Sea Region Programme.

FROM PILOTS TO WIDESPREAD IMPLEMENTATION OF CLEAN SHIPPING TECHNOLOGY AND MARKET BASED INSTRUMENTS

CLEANSHIP was launched with the vision to create efficient shipping with small effects on the environment, and therefore mitigating the eutrophication of the Baltic Sea. The objectives have been the developing of tools and solutions for and by the shipping sector to state as best practice example. By emphasizing a broad perspective on potential ameliorations for cleaner shipping, CLEANSHIP demonstrates several options of constructive change, resulting in environmental benefits for the Baltic Sea Region. The findings and examples may be transplanted to other ecologically vulnerable maritime areas, thereby assisting in making the Baltic Sea a model region for clean shipping. CLEANSHIP has worked with the following targets in mind:

- Reduce ship borne air pollution at sea, in ports and in cities
- Reduce nutrient inputs to the sea
- Create a strategy for environmentally differentiated port dues and an Environmental Port Index
- Create technological pilot projects in full scale as best practice examples
- Create an interrelation concerning the project goals between all stakeholders

Technical level

On the technical level CLEANSHIP has developed best practice cases and technical pilot solutions regarding infrastructure for OPS and LNG supply, and sewage reception in ports. Our partners' achievements, as forerunners, are displayed from legal, economical, technical and administrative perspectives. The technical solutions in terms of pilot projects have shown that full scale solutions can become obtained in all parts of the Baltic Sea Region provided also suburban societies take their own responsibility to participate fully.

Strategic level

On the strategic level CLEANSHIP has addressed the harmonisation of environmentally related port fees, incorporating the environmental management of the logistic chain, and the development of an Environmental Port Index, for ports to benchmark their environmental status, and spurring further amendments.

Political level

By keeping important relevant political bodies involved and updated on aims, strategies, and willingness of the shipping sector to act in accordance with cleaner shipping, the partners in CLEANSHIP hopes to be able to influence decisions on policy level. The Final report and the Clean Baltic Sea Shipping Position Document will be widely spread in order to increase the awareness of the effects of shipping on the Baltic Sea, what measures are being taken and further must be taken, and, importantly, the different ways of implementing these measures.

ACTIVITIES, METHODS AND TOOLS

CLEANSHIP is erected on several comprehensive studies and analyses, from theoretical to full scale infrastructure projects, jointly creating the core of this Final report.

Supporting studies and feasibility analyses – These reports were prepared as means to expand on subjects connected to the pilot projects.

Pilot projects – These projects form the central part of CLEANSHIP, functioning as showcases of technological advancements as well as of port environmental management practice.

Work groups – CLEANSHIP was divided into four Work groups, each consisting of partners with a special interest in the subject of the group:

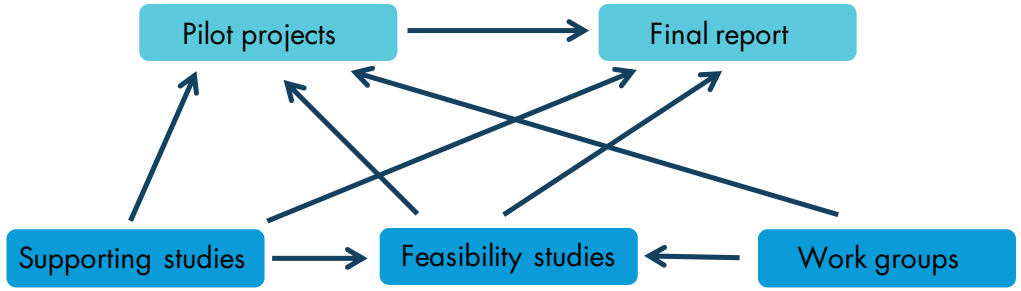
- Port environmental management
- Alternative ship fuels with a focus on LNG
- Regular traffic (ferries)
- Irregular traffic (cruise ships).

During Work group sessions participants had the possibility to visit different Baltic Sea ports and observe technical solutions.

Partner meetings – 9 partner meetings were held in locations around the Baltic Sea.

Russian seminars – In order to combine forces with the non-EU country Russia regarding clean shipping in the Baltic Sea, two seminars were organised, one in Sweden and one in Russia, with CLEANSHIP associated partners RosMorPort and GazProm.

Conferences – At a midterm conference in Riga project tasks were presented and invited speakers informed about their ideas about clean shipping in the Baltic Sea. During the Final conference in Trelleborg, the concluding outcomes of the project, including recommendations for clean shipping, will be presented.



Midterm conference in Riga.

CLEANSHIP STUDIES AND ANALYSES

In this Final report the comprehensive and magnifying studies prepared by individual partners of CLEANSHIP are summarized. Full-length reports can be found on www.clean-baltic-sea-shipping.eu. Below follows a list of all the reports:

Air pollution emissionsfrom ships in partner ports (task 3.1) – University of Klaipeda, Lithuania
Demand study port infrastructure (task 3.2) - Environmental Development Association, Latvia
European oil, gas, LNG and electricity markets (task 3.3) - Environmental Development Association, Latvia
Energy logistics and structure in Baltic Sea Ports (task 3.4) - Environmental Development Association, Latvia
Sustainable shipping and port development (task 3.6) - Klaipeda Science and Technology Park, Lithuania
Funding mechanisms (task 3.7) - Environmental Development Association, Latvia
Development of future changes for Clean Baltic Sea Shipping (task 4.1) - Maritime Institute in Gdansk, Poland
Port Reception Facilities for ship-generated sewages (task 4.5) - Port of Trelleborg, Sweden & Port of Helsinki, Finland
An analysis of Environmentally Differentiated Port Fees (tasks 3.5 and 4.6) - Ports of Stockholm, Sweden
Use of LNG and biogas in the Port of Trelleborg (task 5.5) - Port of Trelleborg, Sweden
Bunkering of ships that use LNG or dual fuel at Klaipeda State Seaport (task 4.4 and 5.6) - Port of Klaipeda, Lithuania
LNG for ferries and cruise ships (task 5.7) - Port of Rostock, Germany
Environmental Port Index - integrating port and shipping interests (task 5.8) - Ports of Stockholm, Sweden
High-voltage Onshore Power Supply in the Port of Oslo (task 5.9) - Port of Oslo, Norway

Work group excursion.

PRF hose at the Port of Helsinki.

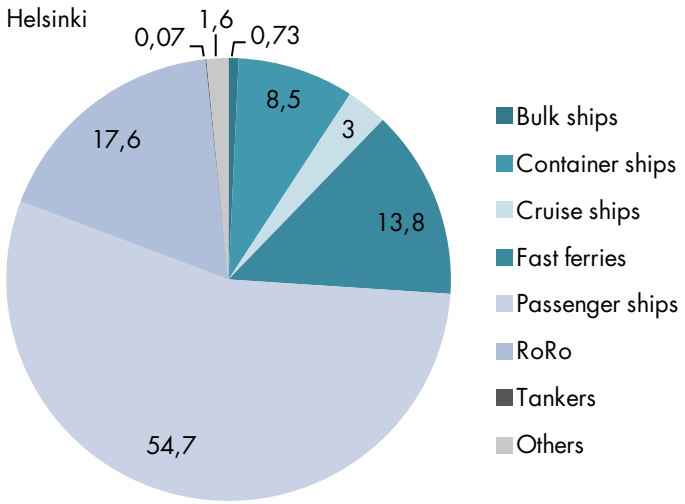
Russian seminar at Rosmorport, Kaliningrad.

DIVERSITY OF BALTIC SEA PORTS*

	Port	Geographic location	Export 2012 (million tons)	Import 2012 (million tons)	Passengers 2012
Denmark	Kalundborg**	Seaport	1.7	1.4	423 905
Estonia	Tallinn	Seaport	21.0	8.2	8 417 000
Finland	Helsinki	Archipelago	4.8	5.9	10 600 000
	Turku**	Archipelago	1.5	1.5	3 566 000
Germany	Hamburg**	River/Canal	50.8	70.4	245 761
	Lübeck**	River/Canal	11.1	13.5	412 130
	Rostock	Mouth of river	22.7***		1 927 000
Latvia	Riga**	Banks of river	27.3	3.1	764 000
Lithuania	Klaipeda	Seaport	26.6	8.7	340 067
Norway	Oslo	Seaport	0.8	4.8	6 740 066
Poland	Gdansk**	Seaport	17.3	9.9	164 331
Russia	Kaliningrad	Mouth of river/Canal	8.2	3.5	3 300*
Sweden	Stockholm	Protected coast	3.0	3.9	12 241 340
	Trelleborg	Seaport	5.7	5.1	1 540 000

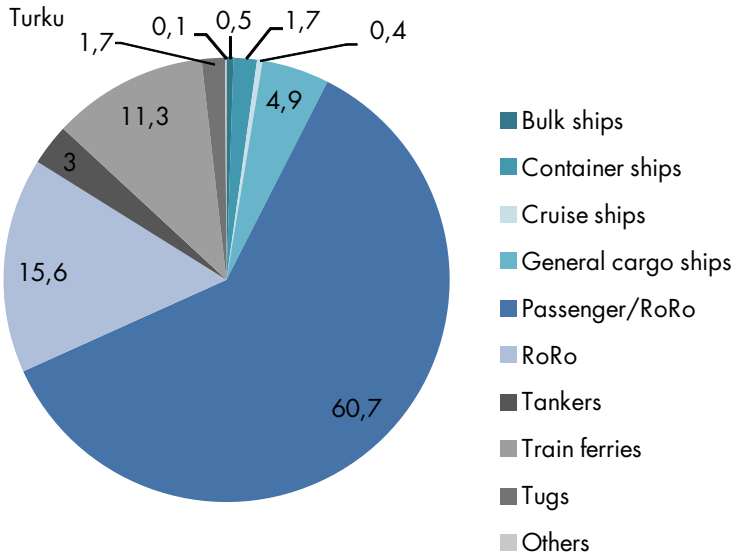
**Figures for 2010. ***Export and import.

The Baltic Sea is surrounded by 10 countries and ~200 ports, excluding smaller recreational ports. The ports are different in several ways; ownership, size, amount of traffic, type of traffic, infrastructure, etc. To get a grip of the differences between Baltic Sea ports, the 14 ports being partners in CLEANSHIP, or coupled to a partner, are described on this and following pages.

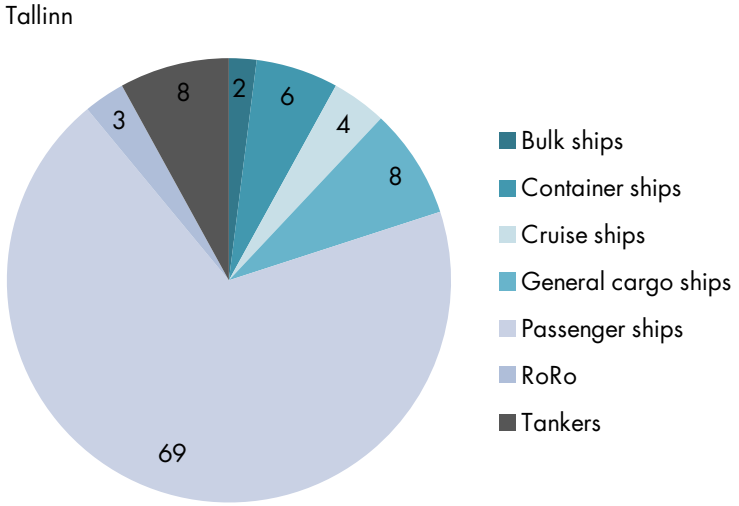


Percentage ship calls by ship type in the Port of Helsinki in 2012.

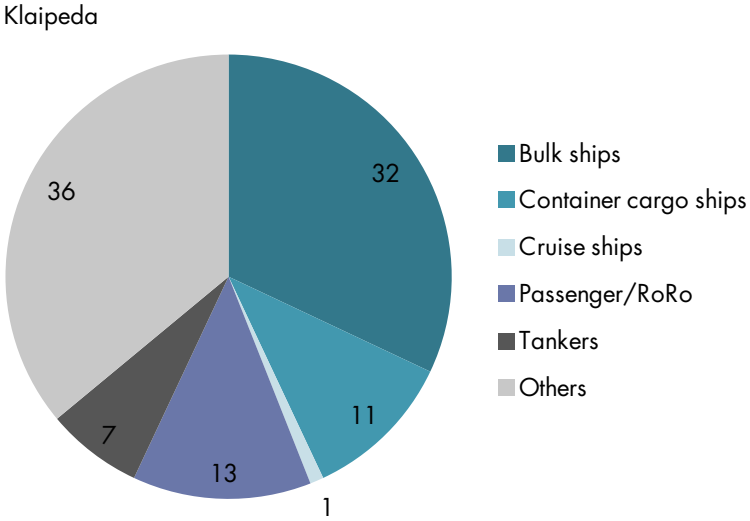
*Based on task 3.4, prepared by Environmental Development Association



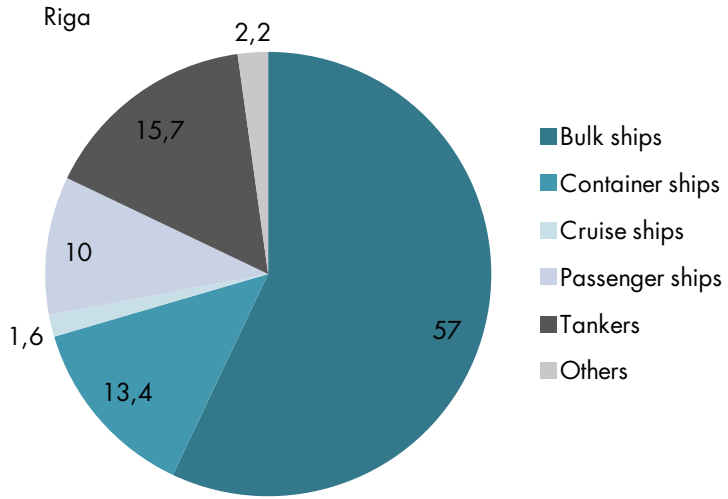
Percentage ship calls by ship type to the Port of Turku in 2010.



Percentage ship calls by ship type to the Port of Tallinn in 2012.

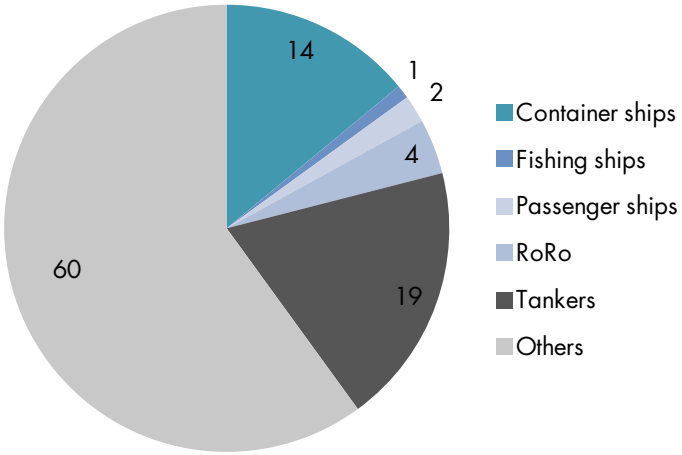


Percentage ship calls by ship type to the Port of Klaipeda in 2012.



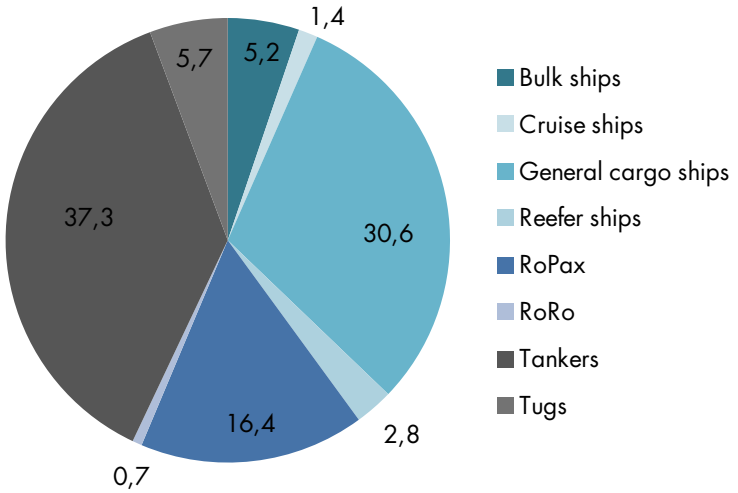
Percentage ship calls by ship type to the Port of Riga in 2010.

Kaliningrad



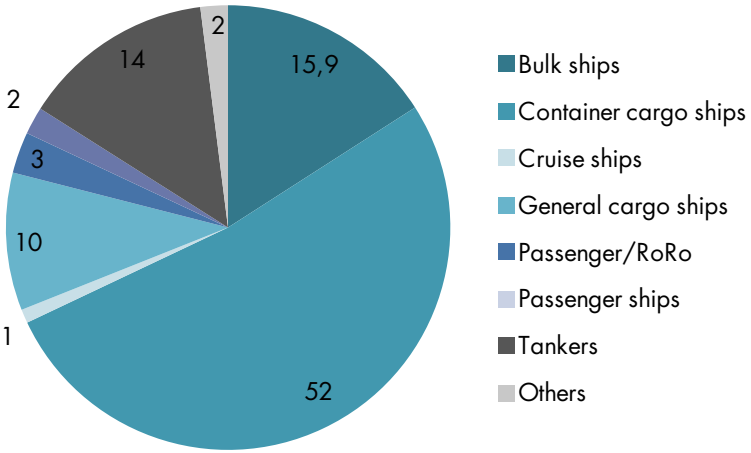
Percentage ship calls by ship type to the Port of Kaliningrad in 2012.

Gdansk



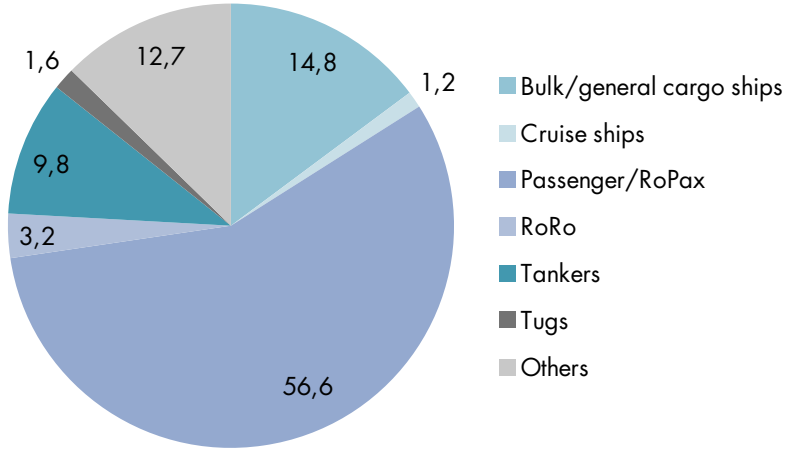
Percentage ship calls by type to the Port of Gdansk in 2010.

Hamburg

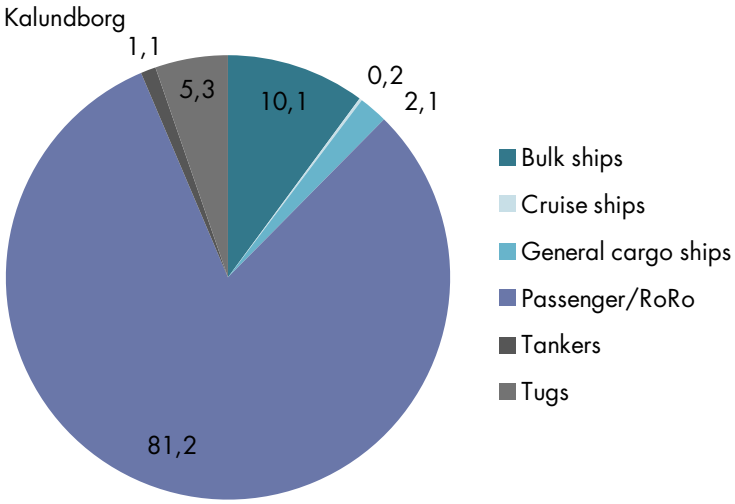


Percentage ship calls by ship type to the Port of Hamburg in 2010.

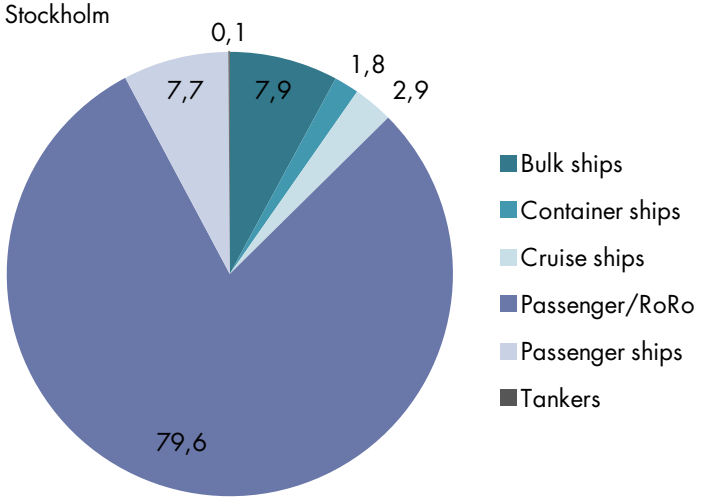
Rostock



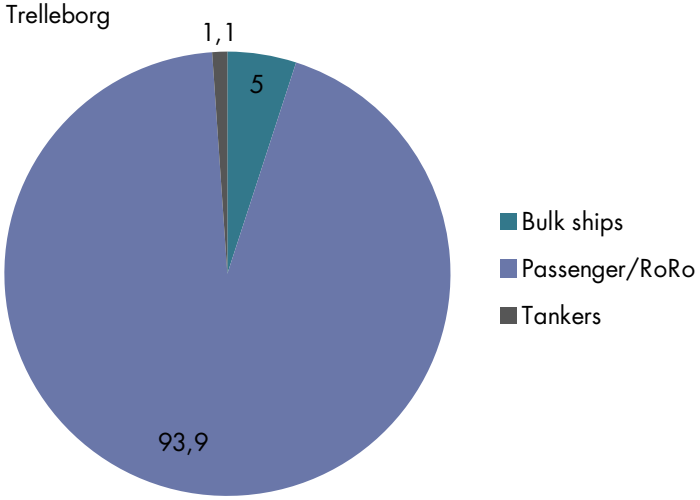
Percentage ship calls by ship type to the Port of Rostock in 2010.



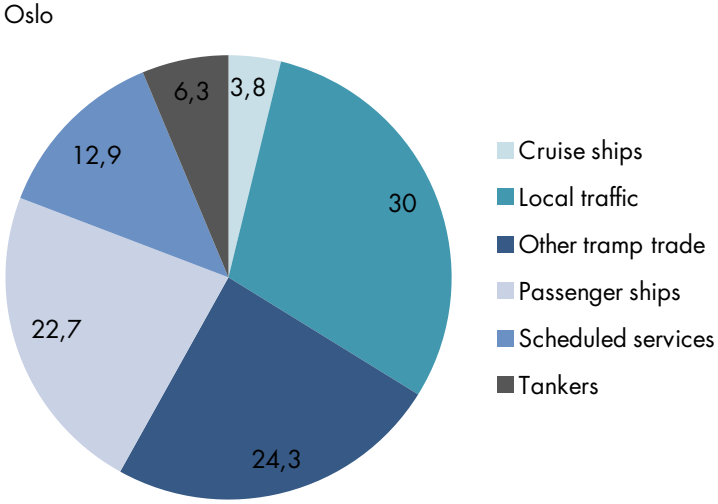
Percentage ship calls by ship type to the Port of Kalundborg in 2010.



Percentage ship calls by ship type to the Ports of Stockholm in 2012.



Percentage ship calls by ship type to the Port of Trelleborg in 2012.



Percentage ship calls by ship type to the Port of Oslo in 2011.

PORT MANAGEMENT

Because port activities have a significant effect on the environment, environmental issues in turn should be reflected as a major component of port management. National and international legislation and regulations are amongst the major forces that lead a port to invest in environmental performance, but ports may also find motivation from their own driving force to reduce the environmental impact of the port, and further from societal pressures, the need to improve port operations, and to gain competitive advantage. The environmental priorities of ports change over time, given upcoming regulations and hot topics in the society.

Shipping in general, representing a "borderless" industry, is exposed to extensive competition from operators world-wide. Moreover, short sea shipping is also exposed to competition from land based alternatives. This implies that in most cases an investment must be balanced within an acceptable pay-back time period, while increase in operational cost is avoided. Hence, any initiative to stimulate improved environmental performance should preferably either be neutral in the perspective of the owner/operator or provide some incentive or added value. A successful fulfilment of the environmental objectives can be achieved through the following of the five E:s of the ESPO Green Guide[15]:

Exemplifying: Setting a good example towards the wider port community by demonstrating excellence in managing the environmental performance of their own operations, equipment and assets

Enabling: Providing the operational and infrastructural conditions within the port area that facilitate port users and enhance improved environmental performance within the port area

Encouraging: Providing incentives to port users that encourage a change of behaviour and induce them to continuously improve their environmental performance

Engaging: With port users and/or competent authorities in sharing knowledge, means and skills towards joint projects targeting environmental improvement in the port area and the logistic chain

Enforcing: Making use of mechanisms that enforce good environmental practice by port users where applicable and ensuring compliance

In CLEANSHIP two means to improve the environmental work of a port have been studied: a common system of environmentally differentiated port fees for Baltic Sea ports and an Environmental Port Index.

The Top 10 environmental priorities of European and Baltic ports in 2009 and 2013.[15 and task 5.8]

European ports (122) 2009	**European ports (79) 2013**	**Baltic Sea ports (44) 2009**	**Baltic Sea ports (12) 2013**
Noise	Air quality	Noise	Noise
Air quality	Garbage/Port waste	Dredging: disposal	Energy consumption
Garbage/Port waste	Energy consumption	Air quality	Ship exhaust emission
Dredging: operations	Noise	Relationship with local community	Air quality
Dredging: disposal	Ship waste	Dust	Relationship with local community
Relationship with local community	Relationship with local community	Dredging: operations	Dust
Energy consumption	Dredging: operations	Energy consumption	Dredging: disposal
Dust	Dust	Ship exhaust emission	Port development (land)
Port development (water)	Water quality	Climate change	Climate change
Port development (land)	Port development (land)	Port development (land)	Ship waste

ENVIRONMENTALLY DIFFERENTIATED PORT FEES

Environmentally differentiated port fees are applied as a financial incentive to support and encourage shipping companies to try and reduce environmental impact themselves. Within CLEANSHIP a report on differentiated port fees was prepared with the objective to give background material for a system that could be common for the ports of the Baltic Sea*. The study includes:

- interviews with the nine formal port partners of CLEANSHIP,
- a literature survey and analysis of existing initiatives and indices for environmental classification,
- a technical description of the different regulations and techniques available to reduce the environmental impact from shipping
- an analysis of the impact on the environment and on the shipping sector from the different initiatives
- a suggestion for a common differentiation system for the Baltic Sea.

Port interviews

The interviews aimed at forming an opinion about which environmental aspects to prioritise in the scheme for a common system of environmentally differentiated port fees and also at receiving an understanding of the ports in general and ports´ environmental work. Most of the ports have RoRo and RoPax liner ships as their main customers but also wet and dry bulk ships, many ports further host cruise ships. All ports except one foresee an increase in transport; either larger ships or more frequent calls are expected. All of the interviewed ports are environmentally aware in the sense that they have or are in a state to implement an environmental management system according to ISO14001 standard. The environmental objectives of the ports seem to have a common focus on reducing emissions to air and noise. Indeed, air pollution from emissions to air can cause a variety of different environmental impacts, such as eutrophication, acidification, climate change and health risks. Port activities can be noisy, both from loading and off-loading operations and from engines and fans onboard. As noise is related to health effects for people living and working in the vicinity of the port local authorities or governments require noise levels to be lower during night time and can also place general limits on noise levels from port activities.

Different reasons of applying environmentally differentiated port dues. An interpretation of the stated reasons is that the ports seek to find increased possibilities to influence ship owners to perform better on environmental aspects in general.

Port of	Reasons for an environmental differentiation of port fees
Kalundborg	A differentiated fee should motivate a more environmentally aware behavior
Rostock	The main problem is noise and also air emissions in general. The port has special problems with cruise ships that berth more on the sea-side of the port and are much discussed by public due to air pollution problems. The port is already within legal limits but since the public is sensitive to these emissions the port fee is a way to achieve more.
Stockholm	Increase the efforts among ship owners to reduce their environmental impact, this can be done via economic incentives. It is the question of the port's position in these issues. In most ports, ships are the greatest source of pollution and as a port you need to apply all available measures.
Tallinn	Differentiated fees can result in a more environmentally friendly port by stimulating vessels to be less harmful for the environment.
Trelleborg	It is a way to distribute the costs of the services that the port provides its customers, which will make it cheaper for ships with better environmental status.
Turku	The most interesting pollutants to target with the differentiation are NO_x, particles and noise from ships.

* Task 4.6, Ports of Stockholm/Swedish Environmental Research Institute, IVL

Initiatives and indices for improved environmental performance of ships

Several initiatives with the purpose to assess and improve the environmental performance of ships exist around the world. The initiatives are diverse in their origin and their initiators could be port authorities, maritime administrations, classification societies, local authorities, economic funds, NGOs, cargo owner associations or combination of these. Other differences are their environmental scope – some grasp a wide variety of environmental impacts while others direct a single pollutant -, and whether the initiatives are limited to individual ships, single ship types or are more universal in their approach.

In order to assess general applicability of the initiatives to a port fee differentiation scheme the 50 found initiatives were evaluated against both obligatory and desirable criteria. The initiative should; address the environmental issues of most concern to the ports, not be coupled to a single classification society, and address and assess the main ship types in the ports. In order to provide a possibility to discuss and compare benefits of the remaining 14 initiatives they were sorted according to whether or not they affirm to following questions:

- Does the initiative include an assessment based on ship emissions of local air pollutants (SO_X, NO_X, PM)?
- Does the initiative include an assessment based on ship emissions of local air pollutants (SO_X, NO_X, PM) and also based on emissions of pollutants to sea (oils, chemicals, sewage, ballast water)?
- Does the initiative include an assessment based on ship emissions of local, regional and global air pollutants (SO_X, NO_X, PM and CO_2) and

	Includes local air pollution requirements	Includes local air poll. requirements and requirements for emissions to sea	Includes local/regional and global air poll. requirements and requirements for emissions to sea	Includes requirements only on CO_2 and on local air pollution	Outdated by legislation 2015?	Applicable for main ship types(roro/ropax/bulk/cruise)	Classification society notation/ index
Carl Moyer programme	YES	NO	NO	NO	NO	YES	NO
Clean shipping index	YES	YES	YES	NO	NO	YES*	NO
Environmental Ship index	YES	NO	NO	YES	NO	YES	NO
Green flag incentive programme	YES	NO	NO	NO	NO	YES	NO
Green marine environmental programme	YES	YES	YES	NO	NO	YES	NO
Green Ship Incentive programme	YES	NO	NO	NO	NO	YES	NO
Maritime Singapore Green Initiative: Green Technology Programme	YES	NO	NO	YES	NO	YES	NO
Norwegian NO_X fund	YES	NO	NO	NO	NO	YES	NO
SSNC eco label (Bra miljöval)	YES	NO	NO	YES	NO	YES	NO
Swedish incentive for diff fairway fees	YES	NO	NO	NO	NO	YES	NO
Swedish incentive for diff harbour fees / Finnish incentive for diff harbour fees	YES	NO	NO	NO	NO	YES	NO
The blue angel (RAL-UZ 141)	YES	YES	YES	NO	NO	YES	NO
The blue angel (RAL-UZ 110)	YES	YES	YES	NO	NO	YES	NO
Triple-E	YES	YES	YES	NO	NO	YES	NO

* Clean shipping index is not applicable for passenger transport

		High and comprehensive environmental ambitions	Easy to administer (based on number of environmental parameters and already existing information such as certificates)	Already used by ports for port fee differentiation
Funds	Carl Moyer programme			
	Norwegian NO_X fund			
	Mar. Singapore Green Initiative			
Eco labels	Good environmental choice (Bra miljöval)			
	The blue angel (RAL-UZ 141)			
	The blue angel (RAL-UZ 110)			
Instr. for cargo owners	Clean shipping index			
Instrument for ports	Environmental Ship index			
	Green Ship Initiative			
	Green flag incentive programme			
	Swedish/Finnish incentive for diff port fees			
Instrument for ship owners	Green marine environmental programme			
	Triple-E			
	Swedish incentive for diff fairway fees			

Yes To some extent To a little extent or no

also based on emissions of pollutants to sea (oils, chemicals, sewage, ballast water)?

- Does the initiative include an assessment based only on ship emissions of local, regional and global air pollutants (SO_X, NO_X, PM and CO_2)?

In the two tables on this page and on the opposite page, the remaining environmental initiatives and their coverage are listed and an overview of their environmental ambitions, estimates of their administrative burdens and indications of whether or not they are already used for port fee differentiation.

Based upon the initial evaluation procedure, the following five existing initiatives, all of which are considered to potentially satisfy the main condensed objectives for the CLEANSHIP ports, were selected for further assessment from a more detailed technical perspective:

1. The Clean Shipping Index, CSI
2. The Blue Angel Award for Environmentally Friendly Ship Operation, RAL-UZ 110
3. The Environmental Shipping Index, ESI
4. The Green Marine Environmental Program
5. The DNV Triple-E

In summary, many of the initiatives can be expected to result in reduced emission levels of NO_X and hence improve air quality and reduce eutrophication. Increased energy efficiency and reduced emissions of CO_2 are similarly addressed in several of the initiatives, in many cases the evaluation is built on the tools presented by the IMO, the EEDI, the EEOI and the SEEMP. Initiatives including evaluations of emissions to water are fewer and the number of parameters to include is high. Still, there are several options to achieve environmental improvements in all impact categories except in the noise category, which is only included in the Blue Angel initiative.

A common system for environmentally differentiated port fees in the Baltic Sea

The general idea was to outline a system that has the potential of being widely accepted by the ports in the region and at the same time has the potential of being embraced by a large number of ship owners and operators. A system that is not adopted in this way will have little impact on improving the environment. The common system of environmentally differentiated port fees applied for the ports in the Baltic Sea is discussed for a time-horizon of 2015-2016. The geographical restriction to the Baltic Sea means as mentioned that it is a SECA and by 2015 the maximum allowed sulphur content in marine fuels is this 0.1% by weight. For this time horizon it is also anticipated that the Ballast Water Directive has been ratified. This would mean that all ships must have effective systems to prevent the migration of alien species in ballast water systems. Further, the Baltic Sea has a No Special Fee-system for ship generated waste which means that cost of reception, handling and disposal of ship-generated wastes is included in the harbour fee as described in the HELCOM recommendation 28E/10. Thus, there is no need for further incentives in these areas at the moment.

Below follows several criteria that should be considered for a common fee system:

- The types of ships that visit the ports in the study must be covered. This implies that ferries and RoRo ships must be covered as well as container vessels, tankers and general cargo ships. Further it is also important to include the substantial traffic with cruise ships.
- There should be an element of fairness in the meaning that ship owners are not excluded from the system due to technical reasons.
- It is important to realise that the basis for joining a system is different for ships that regularly visit the ports in the system than for ships that just visit them occasionally. Hence, due consideration should be given the consequences on the implementation of such instrument, in particular with regard to passenger ship types, i.e. RoPax ships and cruise vessels.
- It is important that the system will result in real improvements for the important ship types, for example RoPax ships and cruise vessels. For cruise ships, due to high power usage and long times at berth, it is important to stimulate the use of shore-side electricity which is included in three of the four elements. This is also important for RoPax ships and, further, it can be noted that the use of LNG or fuels like methanol or DME would give credits in two of the elements.
- There should be realistic expectations for an impact, e.g. the level of subsidy in the system needs to be high enough for it to be economically beneficial for ship owners to invest in order to reduce the environmental impact.
- It is important that the model used contains data that are verifiable and transparent.
- For the system to be widely accepted it should be kept as simple as possible.
- Improvements in the environment can be estimated from the requirements in the respective indices. However, a crucial parameter is of course also the adoption rate; how many ships are likely to join or be part of a particular scheme?

The potential environmental improvement from the use of the studied initiatives in port fee differentiation can be of local, regional or global scope depending on the initiative. Local air pollution from ships is primarily related to emissions of NO_X, SO_2, particles, noise and chemicals and oils to water. As coming regulations will significantly reduce emissions of SO_2 by 2015, the other pollutants remain the relevant to target with differentiated fees. Emissions of primarily CO_2 and particles from ships have a climate impact and can by that be considered to be pollutants with global impact.

A system for port fees does not necessarily have to cover all aspects of environmental impacts but can target a few that are considered important. Given all stated requirements, the system boundary of the common system of environmentally differentiated port due for Baltic Sea ports was set to a local solution. It is suggested to comprise of four elements; emissions to air of NO_X, emissions to air of PM, noise emissions and emissions to water of chemicals. These elements reflect the main environmental objectives of the ports and the suggested construction of the environmental performance assessment is expected to include feasible efforts for the main ship types of the ports. The idea is to present a number of elements where the design and regulations can be decided commonly between the ports. In this way the ship operators need to produce documents, verifications etc. for one system that can be used in many ports. However, it is not necessary that all ports adopt all elements.

Pollutants important for different geographical areas.

Area	Main pollutants
Local environment	SO_X, NO_X, PM, noise, chemicals and oils to water
The Baltic Sea	NO_X, sewage
Climate	CO_2

Summary of an outlines system for environmentally differentiated port fees for the Baltic Sea.

Element	Aim	Construction
NO_x	To reduce NO_X emissions through an increased use of Selective Catalytic Reduction and other NO_X abatement techniques, onshore power supply and alternative fuels such as LNG.	Following the system currently used by the Swedish Maritime Administration with a stepwise incitement. Higher weight should be put on auxiliary engines.
PM	To reduce the emission of PM in ports through promotion of the use of onshore power supply or LNG and to stimulate the development of abatement technology for PM.	Rebate for the use of onshore power supply or LNG or other fuels with low PM emissions. Rebate for the use and trial of abatement techniques.
Noise	To reduce noise from ships and cargo handling through the use of onshore power supply or improved ship design. To establish measurement protocols and evaluate noise sources and abatement methods.	Rebate for the use of onshore power supply. Rebate for ships approved as Silent class or similar. Rebate for measurement and abatement program.
Chemicals	To reduce the impact on the marine environment through promoting the use of techniques to minimise leakage of oil and chemicals.	Follow the chemical part of existing initiatives, e.g., Clean Shipping Index or Blue Angel.

ENVIRONMENTAL PORT INDEX

The environmental responsibilities and liabilities of the port sector and shipping industry at the critical Port-Ship interface have traditionally been discussed and managed as largely separate entities even though they share many of the challenges and have a joint potential for resultant impacts of their respective activities. Where shipping must strive for compliance through set standards and regulation, the port sector's policy is that of compliance through voluntary, self-regulation. Increasingly, the merits and benefits of a collaborative approach are being recognized in terms of compliance, cost- and risk-reduction, environmental protection and sustainable development. At the same time, all marine operations and activities are coming under increasing scrutiny not only from legislators, but also from an ever-widening range of stakeholders with interests in quality and condition of the environment itself, and also in the standards and credentials of the management systems that attempt to control the commercial activities.

One way for a port to benchmark its environmental performance with other ports is to take part in an index. An environmental index could further help port management to understand which environmental issues to concentrate on and also is a way to educate the staff on environmental issues related to port activities. Moreover, it could be seen as a marketing tool. Within CLEANSHIP a proposal for an Environmental Port Index for Baltic Sea ports was established*. The focal objective of the Index was ensuring steady progress towards a coherent and comprehensive approach to reduce air emissions and greenhouse gas emissions from international shipping combining technical, operational and market-based measures. The purpose of the resultant index is to identify the major trends and overall environmental condition that will demonstrate progress and the magnitude of the effect that pro-active port and shipping management can achieve over time in achieving sustainable development. The Index was specifically developed to assist in raising environmental standards by identifying trends, conditions, and the magnitude of effects of marine operations, and to enable straightforward comparison of performance over time.

Context of the research programme

Indices of environmental performance are of increasing interest to a widening group of stakeholders as the significance of environmental conditions and the quality of the attendant environmental management quality come under increasing scrutiny. The imperative of compliance with environmental legislation and regulation is joined by the business objectives of reducing costs and risks, and the requirement to be able to demonstrate competence and a license to operate through the achievement of sustainable development. The port sector and the shipping industry have much to gain by an integrated and collaborative approach to their respective environmental liabilities and responsibilities.

The research pathway of the CLEANSHIP Work group on Port management identified appropriate Environmental Performance Indicators (EPIs) for the effective environmental management of port and associated marine operations. Performance Indicators quantify and simplify information for decision-makers and other stakeholders to assess how activities and operations affect the *direction* and *magnitude* of change in terms of social, economic, governance and environmental conditions. EPIs concern an organization's impacts on living and non-living natural systems, including ecosystems, land, air and water. EPIs can show clearly how the organization is performing, and provide a firm basis for future targets and improvements. The main criteria used in selecting the appropriate indicators are environmental relevance, international comparability, and applicability of the information provided by the indicator. The environmental indicators should:

- provide a representative picture of environmental conditions and pressures on the environment
- be simple and easy to interpret
- be based on international standards and provide a basis for international comparison
- be adequately documented and of known quality
- be updated at regular intervals in accordance to reliable procedures.

* Task 5.8, Ports of Stockholm/Cardiff University

The Index is designed to incorporate Key Environmental Performance Indicators (KPI) reflecting elements of both ports and shipping, and to include operational, conditional and managerial categories. The Index is configured not only as an indicator of port environmental quality and condition, but also as a measure of sustainability so that the completed Index will demonstrate the functional organization practiced by participating ports in delivering compliance with legislation and achieving a high standard of environmental quality in line with Clean Baltic Sea Shipping strategy and objectives.

The components of the Port Index include three categories of KPIs:

1) The port's own Environmental Management System (EMS)

The components of the port authority's own EMS are important in terms of demonstrating the standards of functional organization in place and therefore of setting an example for its tenants and operators. The EMS is a measure of capability and competence of the port authority and is essential for establishing and encouraging the culture of monitoring and reporting. A credible Environmental Management System may be considered as an effective EPI because the calculated Index can be used as a measure of the competence or preparedness of a Port Authority to actually deliver compliance with environmental legislation, cost- and risk-reduction, environmental improvement, and sustainable development.

2) Measures of environmental condition

In addition to management EPIs, the Index reflects the influence of measures of environmental condition such as those related to air, water, soil, sediment, noise, and ecosystems. It is widely acknowledged that the major objective of Environmental Management is to control the impacts of the activities, products and services on these media. Objectives require targets if confirmation of achievement is to be provided, and appropriate, science-based EPIs can deliver the evidence necessary to confirm compliance, demonstrate standards and illustrate trends over time towards sustainability. An appropriate Index may represent the sum total capability of a port authority in delivering sustainability.

3) Shipping Aspects

Shipping-specific features including shore-side electricity supplies, ship waste, exhaust gas emissions, speed reduction, Green Ship Promotion and reception facilities are all options considered within the Clean Baltic Sea Shipping Project. With its various legal liabilities and responsibilities, its status as a Landlord, and role as a crucial node in the Logistic Chain, it may be argued that a port authority is well-placed to influence, facilitate and coordinate the combined best efforts of the port sector and shipping industry to deliver environmental protection and sustainable development to mutual advantage.

Port Index

Components 1(i) – 1 – (x) listed in the first section of the Port Index table are key components of any reputable EMS and an auditor would expect to see these represented in the port's environmental management programme. In this project they are viewed as effective indicators within the overall Index of the port's own competence, and of its ability to influence and facilitate other initiatives in collaboration with shipping interests (Section 1 of the Index). The components selected to date are representative of existing good practice in EMS standards but they may reasonably be expected to be modified or adapted in the light of other CLEANSHIP results, future changes in legislation, or new demands from the ever-widening list of stakeholder expectations.

The indicators listed in Section 2 are measures of 'Environmental condition and sustainability'. They provide the opportunity for ports to present and report science-based evidence of trends and progress. The indicators are all relevant and significant to the objectives and targets of CLEANSHIP. By providing a list from which an agreed number of indicators may be reported, the Index recognizes the uniqueness of each individual port and the importance of targeted monitoring and reporting.

The Shipping aspects (Section 3) are arguably the most challenging to convert to some form of indicator that can be integrated into the Index. Nevertheless, the CLEANSHIP programme has demonstrated the multidisciplinary nature of the wide range of considerations inherent in such a project. The performance of the sector as represented by such an Index is bound to represent a combination of strategic, political, economic, social, scientific, cultural and technical components. Indicators 3 (i) – 3 (viii) represent some of the options that may be taken into consideration by some measure of the port's involvement.

The Baltic ports, as reviewed by the participants in this project, are performing well when assessed against the European benchmark in terms of the EcoPorts checklist of Environmental Management. It should be noted that the list is generic and that it mirrors the approach and pathway of the established environmental management standards such as the sector's own (and only port-specific) Port Environmental review System (PERS) and the International EMS standard ISO14001.

The Environmental Index of Environmental Management performance criteria based on those Baltic Ports included in the EcoPorts' data base (Sample of 12) provides an INDEX of 7.98 (cf with 7.25 for European value as a whole).

It may reasonably be stated that the Baltic Ports have demonstrated a positive response option to the adoption and application of key components of an EMS and that they therefore have the experience and credentials to influence the performance of port and shipping operations in terms of environmental impact, and that this in itself can form a justifiably significant component of the proposed Index.

Port index

ISSUES and ASPECTS		INDICATORS	INDEX	NOTES
1. Port Environmental Management System (EMS)	(i)	EMS: PERS/ISO14001/EMAS	1.50	All 10 components used in calculation of Index. Acceptability and feasibility validated during CLEANSHIP research programme.
	(ii)	Existence of Policy	1.25	
	(iii)	Reference to ESPO documents	0.75	
	(iv)	Inventory of legislation	1.00	
	(v)	Inventory of Aspects	1.00	
	(vi)	Objectives and targets	1.00	
	(vii)	Environmental training	0.75	
	(viii)	Environmental monitoring	1.00	
	(ix)	Documented responsibilities	1.00	
	(x)	Environmental report	0.75	
2. Environmental condition and sustainability	(i)	Air quality	5 x 2.0	Port Authorities could select any 5 indicators of condition or sustainable development.
	(ii)	Water quality		
	(iii)	Soil quality		
	(iv)	Sediment quality		
	(v)	Terrestrial habitats		
	(vi)	Marine/aquatic ecosystems		
	(vii)	Noise		
	(viii)	Port waste/garbage		
	(ix)	Ship emissions		
	(x)	Ship waste		
	(xi)	Carbon Footprint		
	(xii)	Energy consumption		
	(xiii)	Water consumption		
3. Shipping Aspects	(i)	On-shore power supply	2 x 1.25	Port Authorities may have less direct influence on these Aspects but they could be catalysts for action or have a critically important role in their implementation.
	(ii)	Green Ship Promotion		
	a)	Environmental Ship (ESI)		
	b)	Clean Ship (CSI)		
	c)	Energy Efficiency Design (EEDI)		
	d)	Differentiation of Port Fees		
	(iii)	Reception facilities		
	(iv)	Bunkering options		
	(v)	Vessel speed reduction		
	e)	Voluntary		
	f)	Virtual arrival		
	(vi)	Port infrastructure		
	(vii)	Automated mooring		
	(viii)	Vessel Traffic Services		

Port Index conclusions and recommendations

Conclusions

- CLEANSHIP has developed a viable and practicable Port Index based on a port authority's ability and competence to aid and assist in achieving the objectives of the project.
- The selected indicators are themselves acceptable and feasible to port professionals as well as having established status as meaningful measures of performance.
- The Index draws on the experience of recent EC-funded research such as the PPRISM project (www.espo.be) and it reflects the guiding principles of the sector's own policy making institution, the European Sea Ports organization (ESPO).
- The protocols of data and information collection and reporting, and considerations of appropriate confidentiality follow the standard operating procedures established over fifteen years of collaboration between the EcoPorts network and ESPO members.
- The Index has been evaluated and validated through peer review amongst port professionals, and populated with data received from several ports within the Baltic region.
- The Index recognizes the unique characteristics of each port yet offers a generic overview of the sector's performance.
- The Index would complement the proposed European Observatory (and 'Dashboard') as proposed and currently being developed by ESPO.
- The concept of the Index allows a snap-shot of the state-of-play in the Baltic, and because of its generic nature, it could readily be applied to the port sector on an international basis (It may be suggested that the time is rapidly approaching when international benchmark performance will be as valuable to the sector as national and own-port achievements in what is an overtly global activity).
- The index is deliberately and specifically designed to integrate the common interests and interrelationships between port and shipping interests, and the physical environment itself. Hence, EMS, Environmental condition, and Shipping aspects are combined into one measure of a port's influence and performance.
- Over time, and after initial application, the format of the Index lends itself to adaptation and changes as indicators (particularly in Section 3) themselves become obsolete or more significant options become available.
- The Index could readily be adapted and developed further to include aspects of the Logistic Chain as a more integrated approach to environmental protection and sustainable development is embraced by the key players.
- The CLEANSHIP Environmental Port Index offers a practicable and user-friendly option to the port sector and associated shipping interests to be applied as a useful tool to illustrate progress, indicate trends, and serve as a credible measure of performance for a range of stakeholders.

Recommendations

- In order to make an effective contribution to the objectives of CLEANSHIP and to assist in the implementation of EC policy concerning environmental condition and quality of the Baltic Sea, the Index should be promoted further through a series of conferences, port meetings, workshops and trade publications.
- Recognition of the merits of the Index and its potential to encourage collaboration and integration between port and shipping environmental interests should be promoted by the sector representatives and training initiatives.
- Certification societies, trade organizations, insurance companies and other, interested stakeholders should be informed of the sector's pro-active programme in developing and trialing the tool. Evidence throughout the port sector and shipping interests confirms the importance of recognition in terms of raising awareness, developing the culture and encouraging networked collaboration.
- The Index could be offered for further application, development and refinement through EcoPorts, ESPO and established training programmes.

AIR POLLUTION FROM SHIPS IN PARTNER PORTS

Air pollution from ships in the seas, especially along busy ship-faring routes and in ports, is constantly increasing, which eventually causes more and more problems for the coastal states and port cities. Its levels have become noteworthy in partially enclosed seas with intense shipping, such as in the Mediterranean, the Baltic and the North Sea, where some seashore zones and larger ports experience effects of increased pollution levels in the atmosphere stemming from maritime transport. The greatest number of ships is concentrated in port cities, known to be zones of increased emission amounts, which in turn also influences air quality in towns located nearby. Within the CLEANSHIP project a report* with the aims to calculate air emissions from ships visiting and operating in partner ports for the years 2005 and 2010, was prepared including a forecast of air emissions for 2015 and 2020. The presented results in this summary show changes of cargo and ship calls in the nine analysed ports** (formal partners of CLEANSHIP) together with technical characteristics and the amounts of emissions of air pollutants from the calling ships.

Data gathered about the number of ships visiting analysed ports showed, that in most ports, except Kalundborg and Rostock, the amount of ships is decreasing (figure 1). There could be various reasons that can influence these decreases, such as an economic crisis, changes in national legislations, actions of competitor ports etc. However, there is another tendency parallel to the decreasing numbers of ships having an effect on both air emissions and cargo loads, namely changing ship sizes (figure 2). Technical data gathered about the ships visiting the ports showed that the average ship size has increased in almost all ship types since 2005. For bulk and general cargo ships the increase is as large as 33 – 38% respectively. This infers that either the smaller older ships are being removed from service, or, that there has been an addition of new ships with greater gross tonnage that influence the average size. Yet, the former statement could in part be denied by the average ship age chart presented in figures 3, 4 and numbers of ships in figure 1; at the same time as the average size of ships is increasing the average visiting ship in ports is getting older, suggesting that there is no addition of new ships and that only smaller ships are being put out of service/changed their shipping area. In terms of emission increase, bigger ships are rather beneficial because with the increase of size the ratio consumed fuel/cargo carried decreases, in turn decreasing the amount of harmful air pollutants. In addition, it can be understood that many ships that are still operating in the Baltic Sea do not fall even under MARPOL Annex VI Tier I requirements for NO_X emissions (figure 5). According to the MARPOL annex VI regulations for NO_X emission from ships engines, NO_X regulation applies only to engines installed on ships constructed on or after 1st January 2000 and for those which undergo major conversions on or after 1st January 2000. In addition, the revised MARPOL Annex VI Tier I (entered into force October 2008) standards become applicable to existing engines installed on ships built between 1st January 1990 to 31st December 1999, with a displacement ≥ 90 litres per cylinder and rated output ≥ 5 000 kW. Therefore, the majority of ships, that were older than 5 years in 2005 and those that were older than 20 years in 2010 and that were not modified, were not governed by MARPOL NO_X regulations.

*Task 3.1, Klaipeda University

** Because of technical limitations not all ports were able to supply reliable data. Since addition of unreliable data to the analysis could give erroneous results not all ports were included in every analysis. It was our goal to cover all ports in the study and we included as much data from every port as was possible. Because of this, results presented in the charts represent data from different number of ports, which is noted below each chart.

Emission analysis

Many factors influence the rate and composition of exhausted gases, making it complicated to estimate emission quantities. Emission calculations were made according to the EMEP/EEA air pollutant emission inventory guide book. Emissions were calculated taking into account number of ships, ship type, duration of stay, port layout and ship main and auxiliary engine power. Following pollutants were evaluated: nitrogen oxides (NO_X), sulphur oxides (SO_X) non methane volatile organic compounds (NMVOC) carbon monoxide (CO), total solid particles (TSP), carbon dioxide (CO_2), and consumed fuel.

In figure 5 the results of NO_X emissions of the evaluated nine ports, divided by ship type, are shown. The total emission of NO_X from ships in these ports was 14 940 t in 2005 and 12 504 t in 2010 was. As it can be clearly seen in the chart the greater part of emission of NO_X (figure 5) and of other types of pollutants (figures 6, 7) in the ports come from RoRo ships and tankers. It should be noted that the greater air pollutant emission from RoRo ships is related to their increasing part in the total traffic of the analysed ports. For tankers there is also a technological factor of increased engine loads on main and auxiliary engine during cargo handling operations.

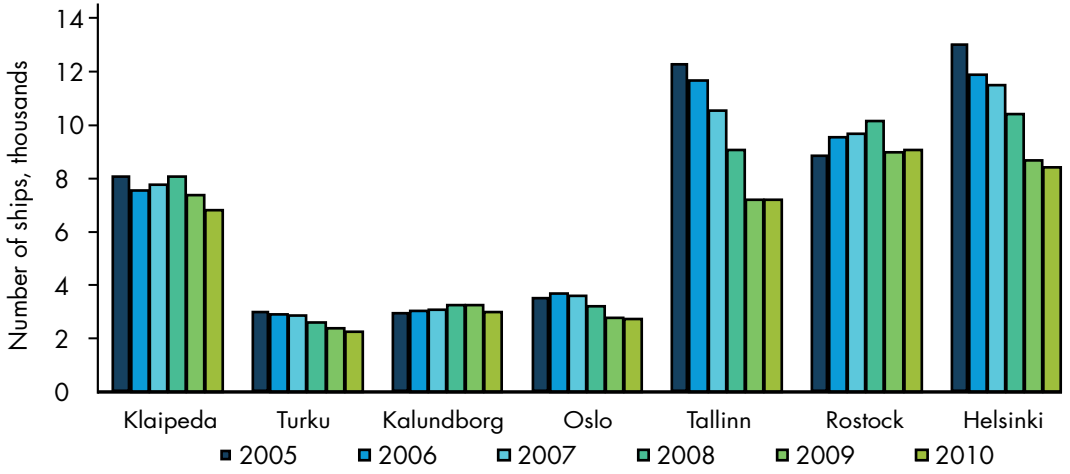


Figure 1. Total number of ships in 7 analysed ports.

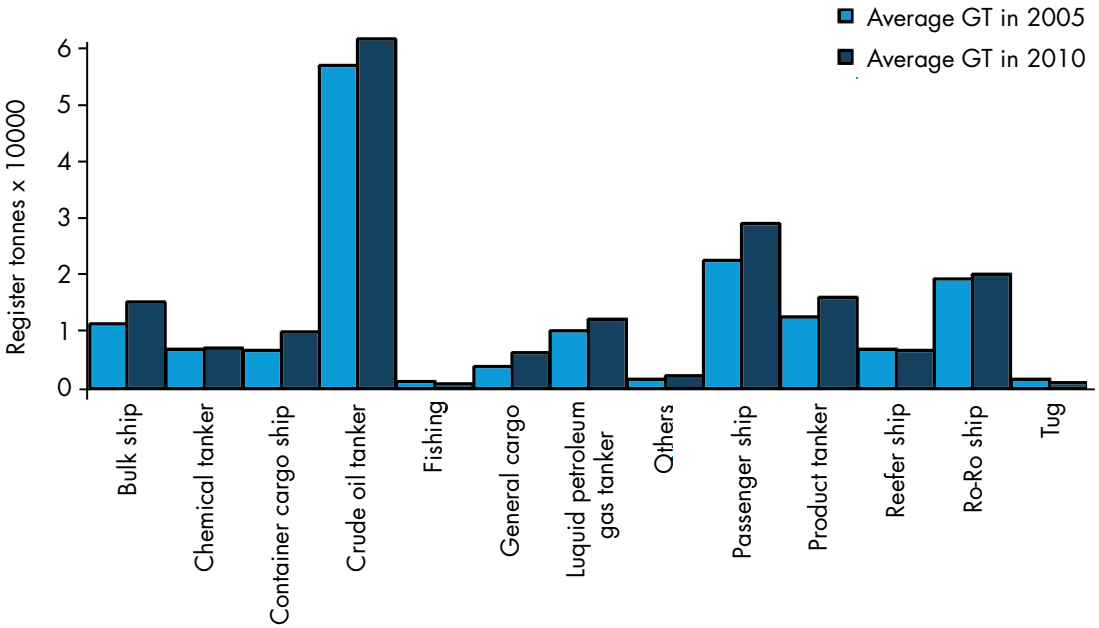


Figure 2. Ships gross tonnage comparison in the 6 analysed ports.

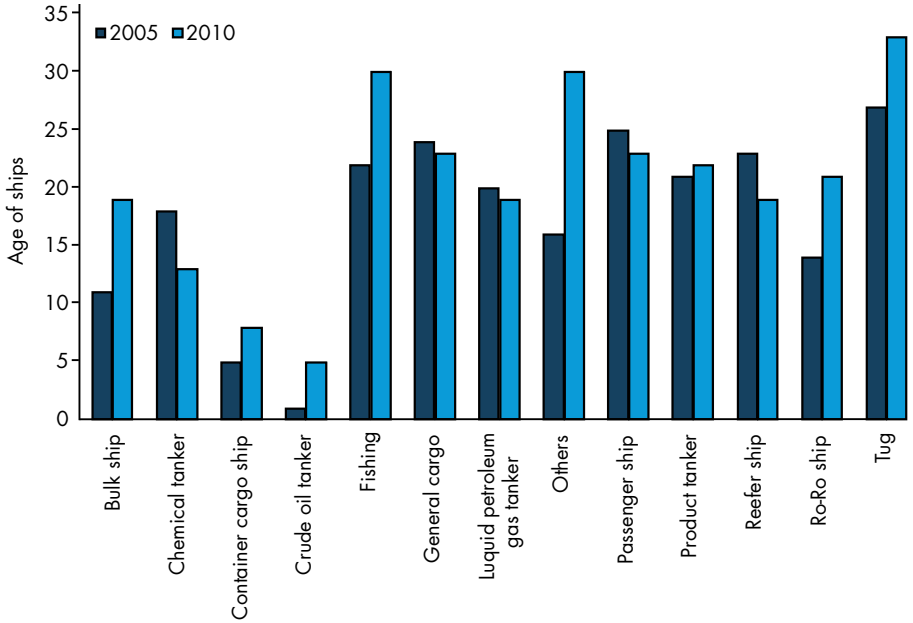


Figure 3. Average age of ships in 6 analysed ports in 2005 and in 2010.

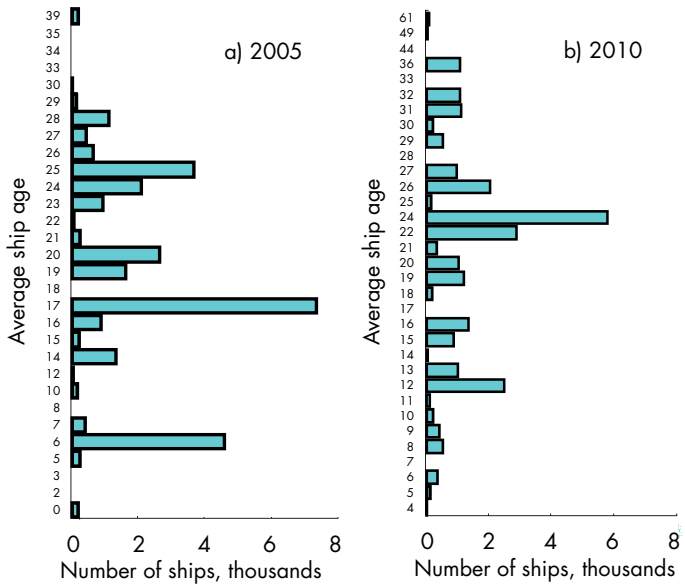


Figure 4. Average age of ships in 6 analysed ports in, a) 2005 and b) 2010).

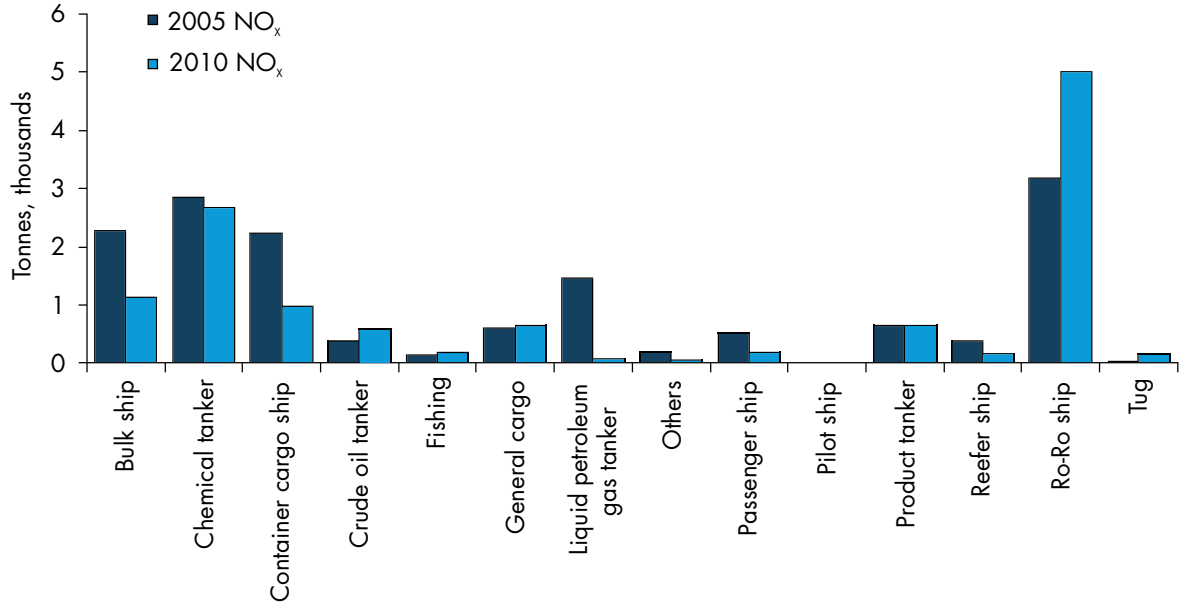


Figure 5. Total NO_x emission by ship type in 9 analysed ports.

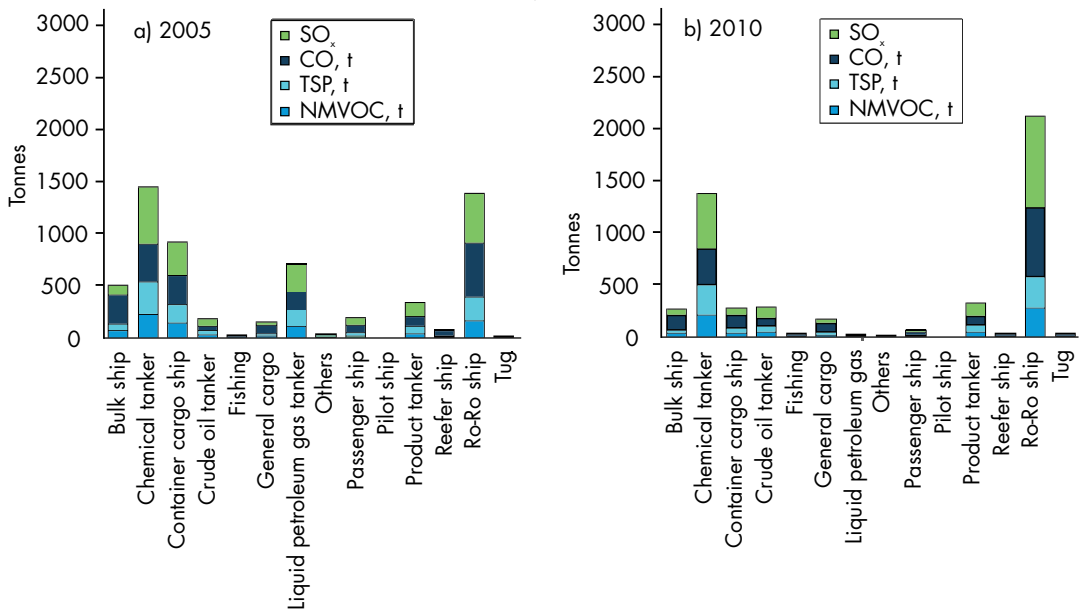


Figure 6. Total pollutant emission from 9 ports by ship types in a) 2005 and b) 2010.

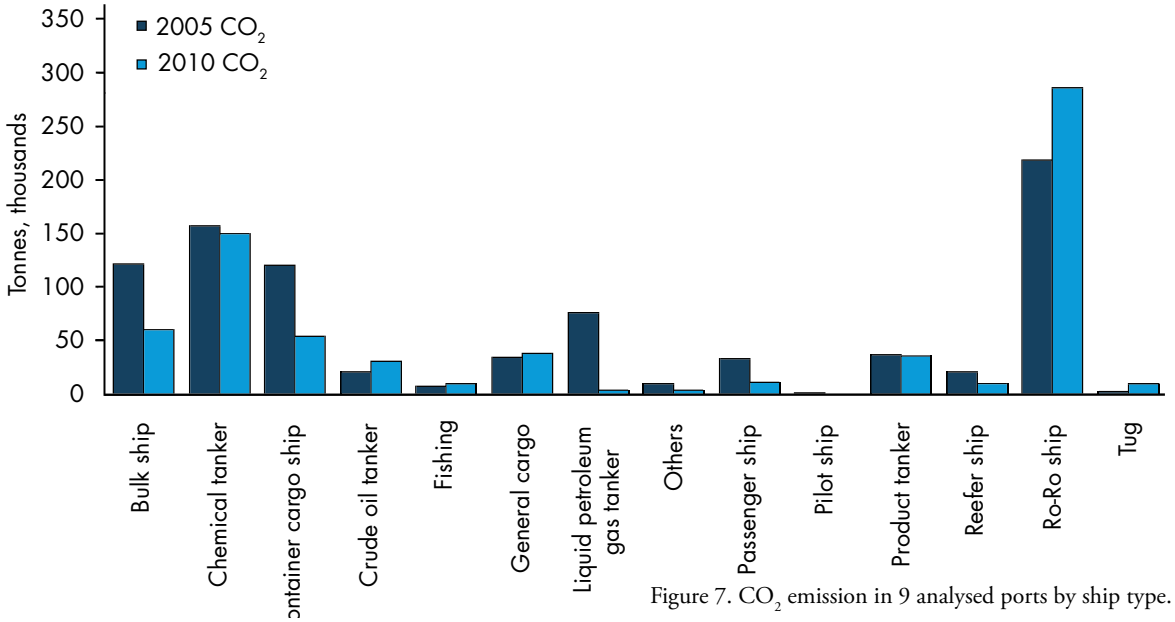


Figure 7. CO_2 emission in 9 analysed ports by ship type.

Future emission scenarios

Based on ship technological characteristics, the emission calculations, and data from other studies, a forecast for emissions in 6 ports (Kalundborg, Klaipeda, Oslo, Rostock, Tallinn and Turku) was made, including all mentioned emission elements. The emission forecasts for these ports were made according to three scenarios, each reflecting a different economic and technological development. The evaluation methodology was developed according to the regulations of MARPOL 73/78 Annex VI.

Future emissions scenarios for year 2015 and 2020:

S1 *No change scenario* was based on the changes of technological specifications (type, size etc.) and numbers of ships visiting every port in the five year period 2005-2010.

S2 *Global scenario* based on global economical and shipping development trends. Assuming that the average annual growth rate is 4.7 % for general cargo, container, reefer, passenger and RoRo traffic, 2.2% for the bulk carrier traffic and 1.4% for oil and gas tankers

S3 *Active growth scenario* based on the greatest growth of ships in current ports in a five year period

In figures 8 and 9 the trends of future emissions in the six ports are presented. In these results the influence of NO_X and SO_X regulations in the Baltic Sea can be clearly seen. Especially this is true for the SO_X emissions as even with the active economic development scenarios (S3), the emission growth is slowed down and severely lowered in the other scenarios. For the other pollutants the amounts are rather proportional to the changes in the intensity of ship traffic.

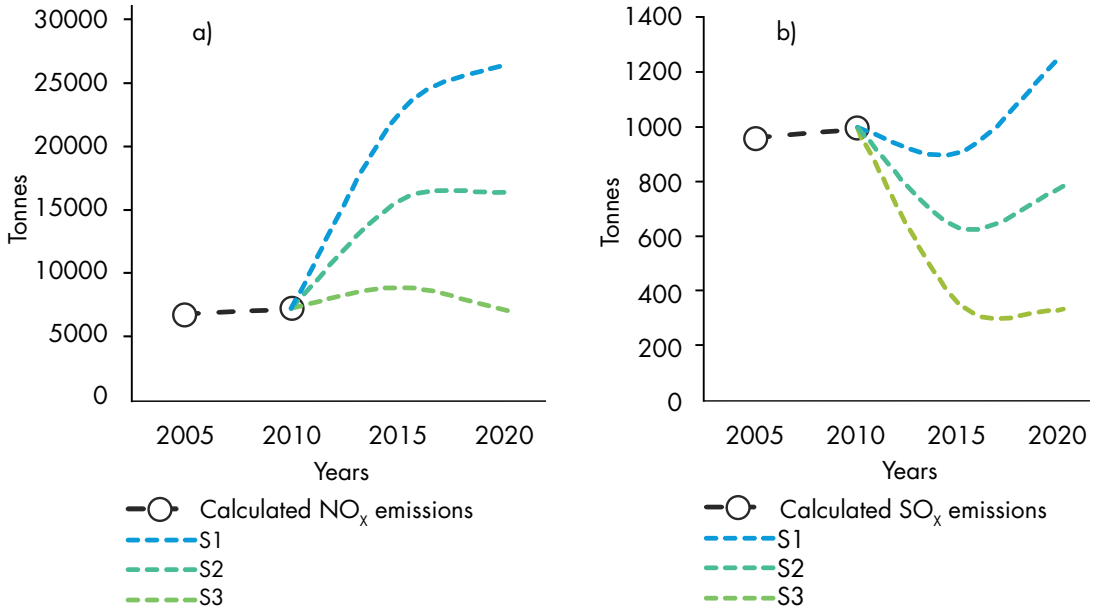


Figure 8. a) Nitrogen oxide (NO_X) emission and b) sulphur oxide (SO_X) emissions forecasts for 6 ports.

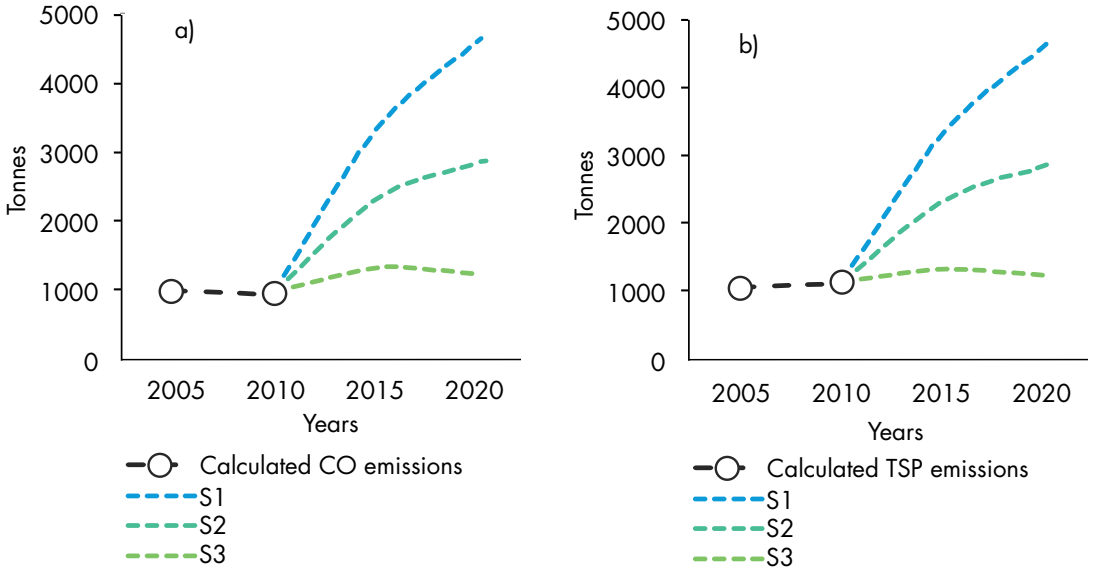


Figure 9. a) Carbon monoxide (CO) emission and b) total solid particles (TSP) emissions forecasts for 6 ports.

ALTERNATIVE SHIP FUELS AND OTHER MEASURES TO REDUCE AIR POLLUTION FROM SHIPPING*

To meet new regulations from the International Maritime Organization (IMO), which demands a decrease of sulphur content in maritime fuel in the Sulphur Emission Control Area (SECA) from 1.0% to 0.1% from 1st January 2015, shipowners and other stakeholders active in the Baltic Sea region must consider new solutions to develop competitiveness of short sea shipping and to avoid the modal shift from ships to land-based transport. The number of hours per year spent in the Baltic Sea SECA, the shipowner's financial requirements and the ship remaining lifetime are examples of factors that will affect which alternative solution a shipowner will choose to meet the sulphur directive. Currently there are three established possible alternatives[11] to meet the demand although other fuels are being tested and researched:

An exhaust gas scrubber can be installed to remove sulphur from the engine exhaust gas by using chemicals or seawater, while continuing to operate on high sulphur fuel oil (heavy fuel oil – HFO). Both wet and dry scrubbers exist. Scrubbers require additional tanks, pipes, pumps, and a water treatment system on board the ship. A sulphur-rich sludge is produced which must be disposed of at dedicated facilities. Moreover, scrubbers increase the power consumption, thereby increasing a ship's CO_2 emissions. Today there is very little experience on the market.

Marine Gas Oil (MGO) and Marine Diesel Oil (MDO) can be supplied with sulphur content below 0.1%. Switching to such fuel only requires minor modifications to the fuel system onboard the ships. However, the availability of low sulphur fuel is already limited and rising demand is expected to increase its price uncertainty. This alternative is still of fossil extraction and does not reduce CO_2 emissions.

Liquefied Natural Gas. When fuelling a ship with LNG no additional abatement measures are required in order to meet the ECA requirements. However, an LNG-fuelled ship requires purpose-built or modified engines and a sophisticated system of special fuel tanks, a vapouriser, and double insulated piping, making this alternative a costly one in a short-time perspective. The fuel oil volume has to be multiplied by factor of around two to achieve equivalent energy content for LNG. For practical reasons LNG as marine fuel is as a result most convenient for vessels which can re-fuel relatively often, that is, port service vessels and short sea shipping vessels (trading between fixed ports where LNG fuel is available).

Other fuels are also being researched and tested, for example biodiesel, ethanol and methanol. Indeed, recently, the shipping company Stena Line announced that their vision is that 25 of the company's ferries from 2018 must use methanol as main bunker fuel. Methanol may be made from fossil or renewable resources, in particular natural gas and biomass respectively. In general, ethanol is less toxic and has higher energy density, although methanol is less expensive to produce sustainably. It should be noted that conversion of wood, agricultural and municipal wastes to methanol can be an effective green-house mitigation as a substantial amount of these wastes generate methane (under anaerobic conditions), which is released to the atmosphere. Methane is a much stronger green-house gas than CO_2. Thus, direct conversion of these wastes to fuels and eventually to CO_2 through combustion can result in a decreased impact on climate change[16].

When investing in technology and infrastructure for new fuels it is of importance to have a long-term perspective making sure that the fuel complies with future environmental regulations (in this case NO_X and CO_2) – the cheapest option might not be the cheapest in the long run. Retrofits of existing ships are normally more expensive than similar installations in newbuilds. As a result, existing ships and newbuilds will go for different solutions to meet the demand of decreased sulphur content in fuel. To illustrate the magnitude of the fuel-usage in the Baltic Sea, it can be mentioned that, during 2010, ships sailing within these sea areas consumed around 12 million tonnes of fuel, primarily fuel oil with sulphur content of up to 1.0%[17]. Assuming a fleet growth rate of 2%, the use of more than 17 million tonnes can be expected within the Baltic Sea in 2030. Given that fuel oil volume has to be multiplied by factor of around two to achieve equivalent energy content for LNG, the figure would be greater for LNG.

The sulphur directive will change the shipping industry's demand for different fuels, which in turn will affect the fuel prices. The demand for a fuel type also depends on cost effective available technology[18] and infrastructure. In a recent

*See CLEANSHIP tasks 3.6, 4.1 and 5.6 for more information on the subject.

Swedish report on the consequences of the sulphur directive it was estimated that the majority of the maritime traffic in Sweden will be using low-sulphur MGO in 2015, although the price is likely to increase. Indeed, the Swedish Maritime Administration judge that 2 750 out of the 2 800 ships sailing in Sweden will use low-sulphur MGO, 20-30 ships LNG and 20-30 ships methanol. The development of a scrubber alternative is dependent on the technological advancements and the legal aspects of using scrubbers in the Baltic Sea region. It was estimated that around 10 ships will install scrubbers by 2016. It is also likely that increased prices of fuel will result in minor or major adaptations of the maritime traffic, for example new routes, changed frequency of departures, reduced speeds "slow-steaming", treatment of hull surface, larger vessels etc[18].

According to the same report, compared to 2013 the price of low-sulphur MGO is estimated to increase by 5-20% (by 340-480 US dollars) by 2015, which in turn represents an increased fuel cost of 50-75% (when compared to the HFO price in 2013). Even if the maritime industry can absorb a certain increase in costs, its relative competitive situation will be impaired, meaning that a part of today´s transport will be moved from sea to land. In Sweden, it is estimated that it is the railway which will get an increased demand primarily. Truck traffic is more complicated to foresee as an increased competition for low-sulphur MGO could increase the price of truck diesel[18].

Alternative fuel options [17]

Option	SO_x	NO_x	PM	CO_2	Cargo capacity	Capital investment	Other Pros and Cons
HFO/ Scrubber	+	--	+	+	Slightly restricted	High	+ Can use cheap and available high sulphur fuel - Requires additional energy during operation - Discharge of water/waste product
LNG	++	++	++	-	Restricted	Very high	+ Currently a cheap fuel - Fuel availability uncertain - Limited infrastructure - Retrofitting difficult
Distillate fuel (MGO)	+	-	-	-	Not restricted	Low	- Availability uncertain - Prices likely to increase
Methanol*	++	++	++	++	Restricted	Moderate	+ Can be produced from non-fossil feedstocks and by recycling CO_2 - Availability uncertain

++ very good, + good. – bad, – – very bad

* Stena Line has with a number of partners, including Wärtsilä and Gothenburg Harbour, gained in a pilot project to get the company RoPax ferry Stena Germanica flying between Gothenburg and Kiel, to use methanol as bunker fuel. The project is supported by the EU's Trans-European Transport Network (TEN-T)-program.

LIQEUFIED NATURAL GAS (LNG)

In the CLEANSHIP project the focus has been on natural gas in the form of LNG but to a small extent also as biogas. Natural gas is widely used around the world by industries, power plants, for heating purposes and for transportation on land and sea. By cooling it down to a temperature of -163°C at atmospheric pressure, the natural gas becomes liquid, containing more energy (600 times more) per liter, and is easier to deliver in the transportation chain, including storage and bunkering. It primarily consists of methane (typically at least 90%), is odorless, colourless, non-corrosive and non-toxic. The flammability range limits are 5 - 15% in the air.

LNG is the cleanest fossil fuel available and when compared to conventional diesel engines it has potential to reduce emissions as follows[11]:

NO_X – 92%

CO_2 – 23%

SO_2 – 100%

Particulate matter – 100%

It should be noted, however, that methane (CH_4) slip, that is, incomplete combustion of CH_4, will negatively influences the reduction of greenhouse gases significantly. In consideration of the fact that methane is more than 20 times more powerful than CO_2 as a greenhouse gas. Engine manufactures are aware of this challenge and research is being carried out to minimize the methane slip.

LNG and shipping

Over the past few years the technical and safety obstacles to implementation of LNG in shipping have been addressed and eliminated, and LNG as fuel has already been tested and proven on 35 ships currently sailing in Norwegian waters. In March 2013, Ports of Stockholm became one of the first ports in the world to offer a bunkering infrastructure solution for the provision of LNG to a larger passenger ferry (Viking Grace) owned by the shipping company Viking Line. Lately, several needed and influential reports on LNG as ship fuel have been written covering topics such as comparison with other alternatives, ashore and onboard technology, economical perspective, safety issues, and reviews of existing companies in the Baltic Sea Region operating along the LNG-chain. Also, several large-scale LNG-projects connected to shipping in the Baltic Sea are ongoing. Given the European Commission's Clean Fuel Strategy[19] from January 2013, there will be even more focus on LNG; the Commission is proposing that LNG refueling stations be installed in all 139 maritime and inland ports on the Trans European Core Network by 2020 and respectively 2025. These are not major gas terminals, but either fixed or mobile refueling stations. This would cover all major EU ports.

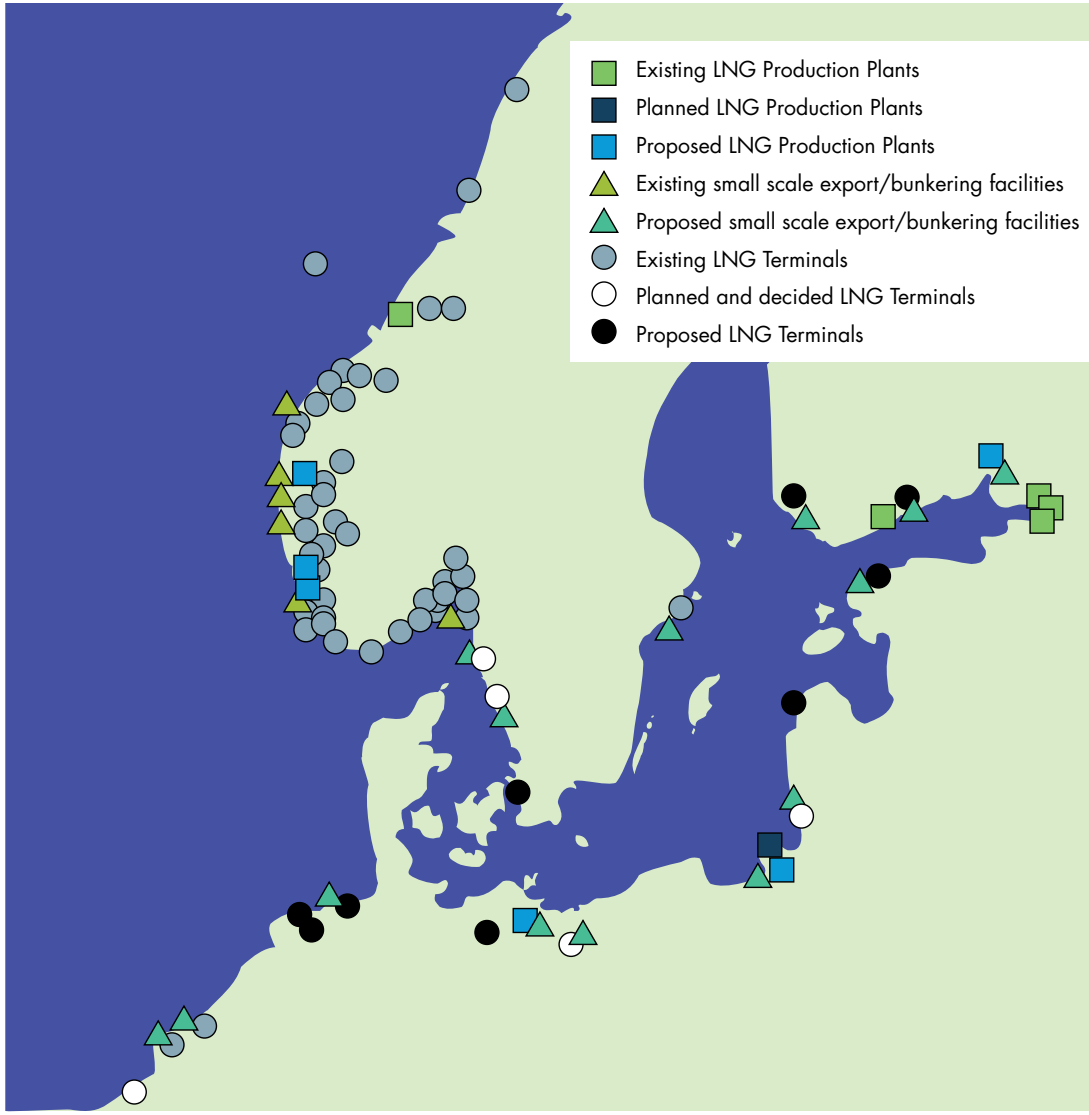
Infrastructure connected to use of LNG

The outstanding problems regarding LNG in shipping is the lack of bunkering infrastructure and worldwide regulations governing refueling operations. In Northern Europe, there is an existing LNG infrastructure to meet the current demand, but with insufficient solutions for delivering the LNG to ships. Hence, an LNG option relies on the development and establishment of LNG storage and filling station infrastructure, which in turn means large expenses. Today, an investment in LNG bunkering facilities is considered as undertaking a risk, because it is not known how fuel and LNG prices will develop in the future. Moreover, the price of gas is not transparent enough for private business, including shipowners, to make long-term decisions. Given that it has been predicted that the LNG demand will reach 4.2 million tonnes in 2020 and 7 million tonnes in 2030, 10-12 new small-scale LNG terminals will have to be established throughout the SECA in 2015, complemented by medium-sized terminals, tank-trucks and bunker vessels[17]. This represents a vicious circle; providers of natural gas will not establish an infrastructure until sufficient demand arises, while shipowners will not invest until natural gas is available[17].

In order for LNG to become a competitive fuel, more medium and small scale ports need to take initiatives aiming at establishing LNG bunkering facilities. The most practical solution would be to create a network of ports that will use a standardized LNG system. Within the proposed EU Directive, the Commission introduces an obligation for TEN-T Core seaports to be equipped by 2020 with publicly accessible LNG refueling points for both maritime and inland waterway transport. A similar obligation is introduced for core inland ports by 2025.

There are still several issues that need to be assessed for a smooth transformation of the maritime sector to offer LNG as bunker. Apart from technical, safety and regulatory aspects, aligned by financial and economic analyses, questions related to public awareness and a well functioning permit and consultation process are important questions that need to be solved.

LNG bunkering of the passenger ferry Viking Grace, Ports of Stockholm



Map of existing, planned and proposed LNG facilities in the Baltic Sea Region. Elaborated from [17].

LNG IN THE PORT OF KLAIPEDA

The objective of the feasibility study "Bunkering of ships that use liquefied natural gas or dual fuel (liquefied natural gas and oil products) at Klaipeda State Seaport" is to present optimum technical, financial, legal and environmental proposals for bunkering at LNG Klaipeda Seaport.

One of the main alternatives for the reduction of sulphur oxide emissions from ships planned to be applied is the use of LNG as vessel fuel. It is forecasted that by 2025 LNG will constitute about 25 percent of the total vessel fuel used. Taking into account that, in order to use LNG, ship engines using LNG are required, i.e. it is necessary to build new LNG ships or modernize the existing ones. In the short term, low-sulphur marine gas oil (MGO) and combustion gas filtering systems are planned to be used for existing ships.

Although the LNG sector in the maritime industry is considered viable, so far the works have been carried out on a more conceptual-preparatory level, prototypes are still more exceptions than rules. Therefore, there is no real demand; consequently, no investments are made into the LNG bunkering infrastructure, and unless there is infrastructure, it is not possible to re-orient ships to LNG fuel. It should be noted that at the majority of European ports (including Klaipeda Port) bunkering services are provided not by the port administration, but by third parties, the decisions of which depend on the attractiveness of the financial indicators of the bunkering activity.

Currently, there is also no single ship bunkering LNG practice at ports. The technical-regulatory framework is still being developed at the moment. With some exceptions (mainly Scandinavian countries, especially Norway), LNG infrastructure is not installed at ports. Nevertheless, orders for new LNG ships or for adapting ships to LNG are carried out. A number of ports declare that they will be ready by 2015–2020 for routine LNG ship bunkering. It should also be noted that the Baltic Sea is one of the regions under the strictest MARPOL regulations, LNG bunkering possibilities at Klaipeda Port become one of the competitiveness indicators of the port. If LNG infrastructure is not installed at Klaipėda Seaport on time, the ships using LNG can choose other ports of the Eastern Baltic coast.

The main ship LNG bunkering methods used or planned to be used at the ports of Denmark, Sweden, Norway, Germany, the Netherlands and Belgium are as follows:

- ship to ship near the quay or at sea (hereinafter, STS ship-to-ship bunkering);
- tank truck-to-ship (hereinafter, TTS tank truck-to-ship bunkering);
- LNG terminal-to-ship via pipeline (hereinafter, TPS terminal-to-ship via pipeline bunkering);
- LNG tank container-to-ship (hereinafter, TCS tank container-to-ship bunkering).

Based on international practice, the following is recommended:

- to use the STS ship-to-ship bunkering method when the LNG tank of the bunkered ship exceeds 100 m^3. The capacity of the bunkered ship should be 1 000–10 000 m^3. One bunkering LNG ship may be used only at ports where the bunkering process duration is relatively short;
- to use the TTS tank truck-to-ship bunkering method in the cases where a ship with low quantity if LNG needs to be bunkered, i.e. for ships with the tank capacity not exceeding 200 m^3;
- to use the TPS terminal-to-ship via pipeline bunkering method if there are regular LNG users and additional infrastructure, definitely for LNG bunkering from bunkering terminal;
- to use the TCS tank container-to-ship bunkering method in case of different LNG demand. The typical LNG container capacity is 25-45 m^3. If there is a need or a larger quantity bunkering, it may be performed from several containers. Bunkering may be performed both from the container located on the ship (barge), and from the quay. LNG container may be transported by sea, road and railroad transport. LNG container measurements match the ISO container measurements.

However, it should be noted that the most suitable LNG bunkering methods for Klaipeda Seaport should be determined not only based on the practice at other ports, but with respect to the infrastructure of Klaipeda Seaport, the number and composition of serviced ships and the expected Klaipeda Seaport development trend.

* Task 5.7, Port of Klaipeda

Assessment of the suitability of the possible LNG bunkering methods for Klaipeda Seaport.

LNG bunkering method	Possibilities of use at Klaipeda Seaport	Disadvantages of use at Klaipeda Seaport
STS ship-to-ship bunkering	1. Ships at all quays can be bunkered; 2. Ships at external terminal and basin can be bunkered; 3. Ship bunkering can be performed in connection with loading (having ensured safety requirements); 4. Ships can be fuelled with average quantity of LNG with high efficiency.	1. A quay should be equipped for refueling the bunkering vessel; 2. LNG bunkering vessels can aggravate shipping at the port.
TTS tank truck-to-ship bunkering	1. Ships at all quays can be bunkered; 2. Ship bunkering can be performed in connection with loading (having ensured safety requirements); 3. Tank truck refueling station can be installed at more remote port territories or outside the port territory; 4. Relatively lower investments and maintenance costs.	1. No possibility to bunker ships at external terminal and basin; 2. Tank trucks deliver a relatively low quantity of LNG, low bunkering efficiency; 3. In order to reach the specific quay, LNG tank trucks will have to drive on city streets close to residential areas.
TPS terminal-to-ship via pipeline bunkering	1. High efficiency can be reached and ships can be refueled with a high quantity of LNG; 2. Shorter bunkering procedures;	1. A separate 200-300 m long quay or pier is required where the largest ships could be accepted to be refueled with LNG; 2. No possibility to bunker ships at external terminal and basin; 3. No possibility to bunker ships during loading works, therefore the time of docking at the port is longer; 4. Additional moorage is required, thus increasing the expenses of ship service at the port.
TCS tank container-to-ship bunkering	1. Ships at all quays can be bunkered; 2. Ship bunkering can be performed in connection with loading (having ensured safety requirements); 3. Significantly lower investments and maintenance costs; 4. Possibility to transport LNG in containers by road, railroad, maritime and inland waterway transport.	1. A relatively low quantity of LNG is delivered by containers, low bunkering efficiency; 2. In order to reach the specific quay, LNG tank trucks will have to drive on city streets close to residential areas. 3. When bunkering from a container located at a quay, additional moorage is required, thus increasing the expenses of ship service at the port.

Technical model

In order to provide for the possibilities for ships docked at Klaipeda Seaport with LNG engines to refuel LNG from bunkering vessels, special tank trucks or special tank containers and other facilities adapted for the purpose, a technical model was developed. The following was analyzed in connection with the development of the technical model:

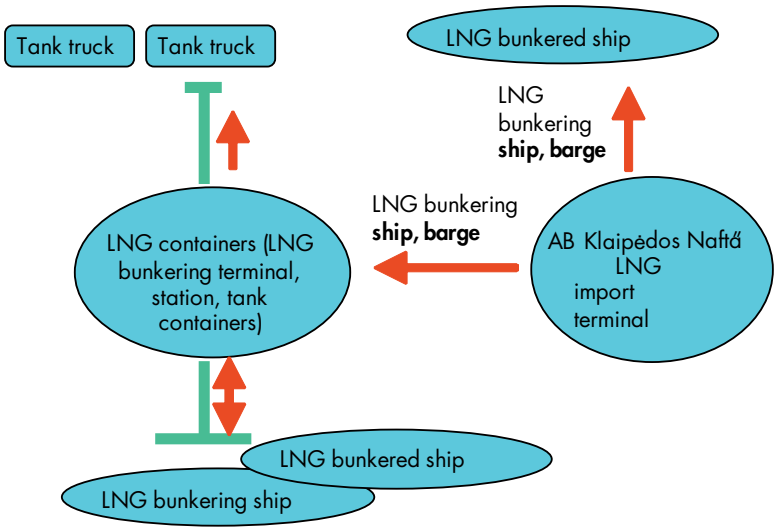
- LNG supply methods to ships with LNG engines docked at all Klaipeda Seaport quays, outside terminals and in port basin, taking into consideration the possibility to get LNG from the future LNG terminal;
- the possibilities for ships to get refueled with LNG depending on the docking location at the port, on the size of the ship and the duration of docking at the port;
- LNG warehousing, loading possibilities at the port in order to ensure bunkering of ships with LNG engines;
- possibilities of LNG bunkering for the port's secondary fleet and secondary motor transport.

Consideration was also taken of the preconditions applicable to LNG bunkering to ensure LNG attractiveness and efficiency:

- availability (required quantity at most ports);
- simplicity and speed (should not differ significantly from the usual bunkering);
- lower vessel fuel costs;
- safety.

In summary, the assessment data of the suitability of the potential LNG bunkering methods for Klaipeda Seaport, proposes that the most suitable bunkering methods for Klaipeda Seaport are STS (ship-to-ship), TCS (tank container-to-ship) and TTS (tank truck-to-ship). TPS terminal-to-ship via pipeline bunkering, i.e. ship bunkering from LNG bunkering terminal or LNG bunkering station, is not proposed as a solution for Klaipeda Seaport, since large investments are required into the infrastructure, Klaipeda Seaport lacks territories where 200-300 m quays could be installed, bunkering from LNG bunkering terminal does not enable full achievement of the set objectives (ship bunkering at the terminal and basin), additional mooring of ships is required that prolong the time of stay at the port, thus reducing the port operation and ship utilisation efficiency.

It is forecasted that LNG at Klaipeda Seaport will mostly be used in short-distance shipping, i.e. in container ships and RoRo, RoPax ships, small ships, since these vessels carry out a substantial part or all of their operations in the Baltic Sea and North Sea, i.e. where the strictest ship emission restrictions are applied. An LNG import terminal built at Klaipeda Seaport could be one of the main bunkering sources for LNG supply to ships. The bunkering ship could be moored at the floating storage regasification unit and load the required quantity o LNG. It should be noted, however, that despite the obvious advantages (low LNG price due to economy of scale), shortage of LNG supply from LNG import terminal would mean total dependence on the operation of the LNG import terminal. For example, in the case of repair or break-down of a floating storage regasification unit (FSRU), bunkering activities would be suspended as well. In order to ensure reliability of the terminal operations, alternative LNG supply methods and reserve containers should be provided for. One of the alternative LNG supply methods would be transporting LNG by LNG tankers from other European ports. In this case it would be required to install an LNG container (bunkering terminal) and a quay (or use the existing ones) to accept LNG tankers and bunkering ships.



The LNG bunkering model proposed for Klaipeda Seaport.

Bunkering infrastructure element	Characteristics	Note
LNG bunkering ship	700 - 2000 m^3 capacity, 300 m^3/h productivity	Would enable LNG bunkering both at the quays and at the terminal or basin. Prototypes of such ships are under development. The above bunkering ship could be filled directly from the LNG import terminal. Also, the containers of the above ship could be tank containers used to reload on the quays, bunker small ships from the quay or to LNG bunkering station.
LNG containers	1000 - 5000 m^3 technological-reserve container when there is a connection with AB Klaipėdos Nafta LNG terminal; 10000 - 20000 m^3 main container when the autonomous LNG bunkering terminal option is used; 300 - 2000 m^3 tank containers are filled in or delivered filled with LNG from LNG import terminal, other LNG terminals;	Taking into account the safety requirements, LNG containers should be installed at the port locations that are more remote from the city (northern or southern parts of the port). If the option with a connection to AB Klaipėdos Nafta is planned, the containers should be close to this terminal in the southern part of the port.
Mooring and loading spot or LNG bunkering ships, LNG small tankers	120 - 220 m long and 6 - 8 m deep mooring location (quay, pier, etc.) where LNG tankers with up to 10000 - 12000 m^3 capacity can be accepted and loaded.	Quays of other purpose can also be adapted, e.g. RoRo, secondary fleet, etc.). Depending on the security requirements, it should be installed at the port locations that are more remote from the city: the northern (quays 0-3) or the southern part of the port – Smeltė peninsular, Kiaulės Nugara island.
LNG bunkering tank trucks, tank containers	Tank trucks with approx. 50 m^3 capacity; Tank containers with 35 - 45 m^3 capacity	Initial option that allows the port to provide LNG bunkering services. Due to low productivity, it is intended mainly for short-distance shipping (RoRo and container ships). In order to avoid traffic of LNG tank trucks in the city, the tank truck filling station should be installed at the location where these terminals are concentrated, i.e. in the southern part of the port. One of the main proposed options to use container tank trucks. Use of container tank trucks would significantly reduce LNG warehousing costs, since container tanks filled with LNG brought by road (railroad) transport could be unloaded on the quay and used as a bunkering station, also on ships or barges and used for LNG ship bunkering.

The LNG bunkering model proposed for Klaipėda Seaport:

Refuelling of LNG bunkering ships directly from FSRU – enables to use the LNG for bunkering transported to AB Klaipedos Nafta LNG import terminal by the large tankers. Due to economy of scale, the LNG price should be lower than at the neighbouring ports where LNG is transported directly by small tankers. It would also enable better utilisation of AB Klaipedos Nafta LNG terminal;

- LNG containers (tank containers, bunkering station, bunkering terminal):
  1. perform a buffering role between the floating storage regasification unit tank truck refueling station, bunkering ship refueling station operating at different regimes;
  2. ensure autonomy of the bunkering system when AB Klaipedos Nafta LNG terminal does not operate, is under repair, etc.

- tank truck refueling station – refuels tank trucks intended for ship bunkering, port secondary ships bunkering, secondary transport bunkering;

- tank truck park – delivers LNG to the quay where the bunkered ship is moored in case of low LNG demand;

- mooring and loading spot or LNG bunkering ships, LNG small tankers:
  1. intended for refueling the LNG bunkering ship;
  2. enables to reload LNG from small LNG tankers to the LNG bunkering terminal, thus ensuring the alternative possibility for LNG supply;
  3. enables refueling small tankers – which would perform LNG bunkering functions at the neighbouring ports (e.g. Kaliningrad, Liepaja), which would result in better economical indicators of the LNG bunkering complex and loading indicators of Klaipeda Seaport.

- LNG bunkering ship – delivers LNG to the ship, bunkers ships at the quays and, if required and permitted by the conditions, at the terminal or basin.

Financial model

At the first stage LNG bunkering method would be proposed for Klaipeda Seaport – LNG bunkering by filling in bunkering ships with LNG from AB Klaipedos Nafta LNG import terminal using a bunkering ship and/or tank trucks with alternative supply possibility with small ships simplified option when a modernised LNG bunkering ship (modernised barge or ferry) filled with fuel from AB Klaipedos Nafta import terminal would be used.

A modernized barge or ferry should be used for ship bunkering by installing LNG tanks (700 m^3). The price of such ship adapted for LNG bunkering would be approximately LTL 20 million. The ship could also be used as LNG bunkering station for bunkering small ships. In such case investments into the implementation of the recommended bunkering model should decrease from LTL 170 million to the value of the investments required or the acquisition of a modernized ship, i.e. LTL 20 million.

Taking into account the international recommendations, when determining LNG bunkering prices, it should be aimed at receiving investments into bunkering infrastructure and equipment with 12 percent internal rate of return. Investments into the bunkering infrastructure and equipment should pay off after ten years, and the LNG bunkering price should depend on LNG bunkering scope and LNG bunkering method used.

In addition an (preliminary) assessment was performed of the potential LNG bunkering price of the Klaipeda Seaport model where a modernized LNG bunkering ship (modernized barge or ferry) is used for bunkering, i.e. filled in at AB Klaipedos Nafta import terminal under construction. The following assumptions were used for the calculations:

- investments (or the acquisition of a modernized LNG bunkering ship) – LTL 20 million;
- operating costs – 100 Lt/t;
- investment assessment period – 25 years;
- price applied for acquired LNG – LTL 1 520 (EUR 440);
- investment internal rate of return – 12 percent;
- investment pay off period – 10 years;
- bunkering turnover – from 8500 t (in the 1st year) to 16 900 t/year (in the 25th year).

It was established that the 12% internal rate of return and lower pay off period than ten years is achieved by using the LNG bunkering price of LTL 1 800 (EUR 553) per ton. It should be noted that the final LNG bunkering price will directly depend on the price of the bunkering ship acquired by the LNG bunkering operator (private investor), the operating costs of the ship and bunkering operator, the price of LNG acquired for bunkering and LNG bunkering turnover.

In order to ensure profitable LNG bunkering activities, it is recommended that Klaipeda Seaport acquires a cheaper bunkering ship or increases LNG bunkering turnover, i.e. carries out bunkering activities in other Baltic Sea ports (Liepaja, Kaliningrad, Ventspils). If a higher annual LNG turnover than 70 000 t is achieved, implementation of the proposed full bunkering model of LNG bunkering by supplying LNG from AB Klaipedos Nafta LNG import terminal, by using a bunkering ship and/or tank trucks for bunkering with the alternative option of small LNG tankers could be considered.

Legal model

The following was taken into account in the development of the legal model:

- Requirements of the International Maritime Organization;
- Requirements of the International Organization for Standardization;
- Requirements of the International Electrotechnical Commission;
- Standards of the Society of International Gas Tanker and Terminal Operators (SIGTTO);
- Guidelines and recommendations of the Oil Companies International Marine Forum (OCIMF);
- Requirements of the EU;
- Requirements of the standards of the European Standardization Committee;
- Requirements of the legal acts of the Republic of Lithuania.

On the basis of the requirements of the above legal acts, proposals were prepared for the legal acts regarding bunkering of ships, secondary fleet or transport using LNG or dual fuel (LNG and oil products), at Klaidpea Seaport with regard to:

- Requirements to assess LNG contents;
- Requirements to assess the fuel quality of LNG ships;
- Establishment of the distribution of responsibilities;
- Requirements or the issue of permits or LNG bunkering activities;
- Establishment of the requirements for LNG bunkering ships;
- Establishment of the requirements for LNG supply from the terminal;
- Establishment of the requirements for LNG bunkering from tank trucks;
- Establishment of the requirements for the management of extreme situations;
- Establishment of the requirements for the registration of LNG bunkering operations;
- Establishment of the requirements in emergencies;
- Requirements for fairway security and establishment of safe distances;
- Mooring of ships;
- Suspension of ship bunkering.

Environmental model

The prepared environmental model for LNG ship bunkering defines the risks of potential LNG bunkering accidents and their consequences. Proposals were prepared for the establishment of the requirements to reduce the risk of potential accidents.

It was established that in liquid state LNG is not an explosive substance, the methane gas discharged from LNG may explode or catch fire only at 5-15% methane concentration in the air. However, taking into account the fast evaporation of methane gas, the above concentration can occur only in very rare cases, i.e. in closed premises and due to a large source of fire or a cloud of vapour. It should be noted that burning LNG flames educe very large energy volumes - 220 kW/m^2, much larger in comparison to propane gas flames and 60% larger energy volume than the energy volume produced by petroleum flames. The main adverse consequences of LNG accidents, spills are the following: cold type of burns and injuries, break-down of equipment, choking, injuries from an explosion due to a sudden change in the physical state of the substance or a sudden fire.

STRATEGY FOR THE IMPLEMENTATION OF AN LNG BUNKER STATION IN THE PORT OF ROSTOCK

The goal of the task* within the CLEANSHIP project was to investigate the possibility for the implementation of an LNG bunker station in the Port of Rostock. The port serves many traffic groups that are typical for the Baltic Sea and therefore it is assumed that the findings regarding this specific port can be generalized in some aspects. These traffic groups are

- ferry and RoRo
- cruise ships
- bulk trade (intra and extra Baltic)

In a first step the demand side was evaluated in interviews with shipping actors as well as based on literature and knowledge of the consultants. The findings can be summarized as follows:

The operators of ferry and RoRo-links are to comply with IMO SECA-regulations from 2015 on. Some of them consider LNG the most appropriate technology. This is however only valid for newbuilds. In ferry and RoRo-shipping it is easier for the operator to provide LNG to the ships than in other sectors as ferries and some RoRo vessels use the same ports for years and on a regular basis. Cruise lines are under public pressure to reduce their emissions and are therefore looking into alternatives. Anyhow the switch to LNG will lower the available space within the ship as well as making it much more complicated to switch ships between destinations as LNG bunkering possibilities are not available in most cruising areas of the world. However, during port stay external gas supply is an interesting option to lower air emissions significantly while maintaining the highly efficient combined heat and power production onboard. This option is followed by some cruise lines. It is not expected that bulk operators switch to LNG due to a high share of traffic outside the SECA-areas. Other shipping related demand may origin from authority vessels, tugs and smaller vessels. However it is found that sightseeing boats already operate on diesel oil of road quality for years so that it is unlikely that they change to another fuel.

All potential customers do not see a possibility for retrofitting despite the technical feasibility. Based on this, from a ports perspective, the development of the demand side is very uncertain volume-wise as well as concerning the timeline. It may help to secure a stable level of demand to include shoreside energy consumers such as the local industry.

A technical description of available storage tanks was done and it was concluded that for the erection of a 'growing' tank farm, type C tanks are a favourable option up to an overall capacity of 10 000m³ LNG. Above this level flat bottom tanks would be the better option. For the Port of Rostock a tank size above 3 000m³ was identified as reasonable. Another topic that has to be taken into account is how to handle the boil off gas. Some alternatives were shown in the report. However, a decision can only be made with knowledge of the individual conditions in each port, for example, availability of a gas grid and steady demand from multiple sources. Each tank farm has to be permitted according to BImSchG (in Germany). There are no recommendations on EU level regarding for example safety which means that an individual analysis needs to be done.

Due to the different characteristics of the ships in port regarding used berth, lay time and needed volume, it is recommended to serve trailers, containers and bunker barges. For onshore customers rail access may also be useful. The premises of the Port of Rostock offer a location where these conditions can be fulfilled. In Rostock it is likely that for ferry connections with short berthing times (15 min the shortest on Rostock - Gedser link) a trailer solution will be used while other operators decide to bunker on a non-daily basis by bunker barge.

The bunkering process is not yet regulated although meanwhile EMSA has presented a study on that issue and first best practice examples can be shown for example in Stockholm. In Rostock a permission to bunker is needed by the harbour master. Anyhow there is not yet a guidance for the authority which requirements should be fulfilled prior to handing out the permit. It is expected that the federal state Mecklenburg Vorpommern comes up with a proposal on such regulations for the ports within this country in 2013.

* Task 5.7, Port of Rostock

USE OF LNG AND BIOGAS IN THE PORT OF TRELLEBORG

To improve the air quality within a port, the port authority has several options. On the one hand, many of the potential ameliorations must be taken as joint steps with shipping companies serving in the port while, on the other hand, a port often holds many heavy vehicles contributing to the local air pollution. Therefore, it is also of interest for a port to be able to provide alternative fuel options for these vehicles. Port of Trelleborg has within CLEANSHIP* studied the possibilities to use LNG and/or LBG on board for ferries, for internal transports in the port when handling containers between ship and shore, and as fuel for heavy lorries on transit between the Scandinavian countries and the European Continent.

Sources of air pollution generated in ports

Ships

A major source of local air pollution in a port is, naturally, moored ships using heavy fuel oil. Apart from changing to an alternative fuel, an excellent alternative for a ship is to connect to onshore power, if provided by the port.

Port vehicles

In a port several different kinds of vehicles operate, most of which are heavy vehicles, e.g. tug-masters and contchamps. Normally, such vehicles use diesel as fuel, but an option could be transforming engines to run on LNG.

Trucks

Trucks travelling on ships and that continue their mission on road could be seen as an indirect source of air pollution of ports and their cities. By providing LNG in the port, the trucks have the opportunity to continue with a cleaner fuel in their tanks.

Biogas

Biogas just as natural gas mainly consists of methane, however, it is of different derivation; Biogas is formed by organic matter extant on the surface of the earth while natural gas is of fossil origin, formed millions of years ago, thus not forming a part of the carbon cycle on our earth today. Biogas is therefore a sustainable source of energy as its combustion does not affect the climate as fossil fuels do. Biogas can be produced using different types of biomass, e.g. sludge and waste. A biogas plant may have several beneficial effects on the environment. First of all, its products, e.g. gas and manure, have positive effects on the environment. The amount of benefit depends on which energy source is being exchanged for biogas. By producing biogas using byproducts, there is further an indirect benefit on the environment, e.g., by anaerobic digestion of animal manure great losses of greenhouse gases can be achieved as the methane losses occurring when handling the manure is reduced.

Because biogas and natural gas have the same chemical composition these substances can be mixed. However, in order to use biogas as vehicle fuel it must be upgraded by removing CO_2, water and other impurities to reach a higher methane content (95%). Biogas may also be liquefied, LBG, i.e. chilled and condensed. LBG contains more energy per unit volume than biogas and is as a result more effective to transport and can also be used in heavier vehicles.

Large scale biogas plant for local and regional use

A new large-scale biogas plant is since 2011 under development in the municipality of Trelleborg, at Jordberga, a former sugar mill plant, placed 25 kilometer north of the Port of Trelleborg. The construction of the biogas plant was initially planned to be ready during the CLEANSHIP project period 2010-2013, but was delayed almost 2 years, due to German internal economical national problems, related to a politically decided stopping of nuclear power plants. This decision demanded that E.ON GMBH as part owner in the biogas plant momentarily, for 3 years, stopped all its planned further investments in Swedish biogas plants. The main ownership of the financing and planning for the biogas plant in Jordberga was then taken over by new main owners, including local farmers.

* Task 5.5, Port of Trelleborg

The Jordberga Biogas plant is now in its final construction phase, and will during February 2014 start to produce 110 GWH biogas per year and during the year increase to 200 GWH. During 2015-2016 the gas production is further planned to increase to 350 GWH/year. The total cost for the plant in its present size is calculated to 250 MSEK.

Regional Pipeline system for gas distribution

The biogas from Jordberga will be distributed via the gas grid as Compressed Natural Gas (CNG)/ Compressed Biogas (CBG) in the regional pipeline, which will from the start date in April 2014 be responsible for distributing the gas to all buses, lorries and vehicles owned by the municipalities in the Skåne Region. In Trelleborg municipality, a pipeline system for CNG/CBG is now under construction parallel to erecting the biogas plant. Presently, until the biogas production starts in February 2014, all municipal vehicles planned to use run on biogas when the production in Jordberga has started, are today served with CNG, which covers all municipalities in the Skåne Region from the gas grid system. (The main grid system for distribution of biogas/natural gas in Skåne has a maximum pressure of 60 Atm. The main pipe line between the Danish and Swedish systems has a diameter of 1 m, and the pressure used today is some 30 Atm). By 2015 it is estimated that more than 25% of all vehicles and all buses in the Region are going to use biogas/natural gas as the fuel for all public local and regional transports.

In principle, CNG/CBG can start to be used by the port trucks for moving trailers within the port and between ships and the port, when CBG has been made available for the Port in 2014 through the Jordberga and Region Skåne joint biogas grid distribution system now under construction. This is also true for heavier vehicles in the port used for lifting containers between railroad cars and roller platforms. However, though such very strong and large engines for CBG are available these have not been inserted in port vehicles so far.

Pre-study for eventual use of LNG/LBG for existing ferries

During 2011 a research of the possibility of making a logistic service chain for delivery of LNG and LBG for use on ferries was made, related to an eventual future demand by ferries with Port of Trelleborg and respective corresponding ports as users[20]. Three energy demand scenarios, related to future logistic chains for shipping, lorry traffic and railroad were drawn and studied. Different transport systems, based on trailers and standardized containers were evaluated in the land transport logistic links and, concerning shipping, different tanker capacities were studied. Parameters such as transport times, delivery frequencies, loading and unloading times were judged to have a large influence on choice and selection of transport and service chain and were therefore researched in the three different energy demand size scenarios.

Also different storing alternatives belong to the logistic chain demands, but only storing at the final customer site was evaluated within the research frame. Therefore, only dimensioning and demands on an eventual storing of LNG for the ferries, for lorries using Port of Trelleborg on their route to the EU continent and for Port of Trelleborg itself when moving containers and trailers in and between ferries and the port were investigated. Costs for transports and eventual storing related to the transports were calculated. With a calculated early flow, corresponding to 2.2 TWH, deliveries of between 168 and 987 m^3 LNG daily was judged necessary.

In the Maximum Scenario, a pressure tank with the dimensions of 10 000 m^3 LNG, with an investment cost corresponding to 0.012 KSEK/ KWh was seen as necessary. Deliveries would then preferably be made by tankers, with a capacity corresponding to the presumed Port storing tank capacity. Transport costs for LNG will then become some 0.06 SEK/KWh, and the total investment cost 0.072 SEK/KWh.

In the Medium Scenario, a string tank of 5 000 m^3 LNG was recommended. A stationed pressure tank and thermo-tank were both seen as convenient alternatives. The transport costs were lowest if tanker deliveries to Port were made by tankers with a tanker capacity corresponding to the presumed storing tank capacity. Costs were calculated to 0.08 SEK/KWh. The total investment costs for the port would reach between 0.097 to 0.104 SEK/KWh depending on of choice of storing tank.

The results of the Minimum Scenario indicates that a thermo tank would be most convenient. But with only 2 000 m^3 LNG, a storing tank will not be necessary. The lowest transport costs will be made by trailers, fuelling the ferries directly. If a

fuelling storing tank is used, the total investment cost would become 0.19 SEK/KWh.

Consideration concerning eventual use of LNG/LBG for ferries

LNG for ferry use on the fixed routes between Trelleborg and corresponding German and Polish Ports is estimated to become possible only for a next generation of ships. To convert existing modern ferries, with an estimated life length of some ten more years or more, will not pay the high exchange costs for shifting all engines into new main and auxiliary ferry machineries for LNG. However, for newbuilds it will most likely become a possible alternative, especially for the shorter routes which prevail in the Baltic Sea Region.

LNG/LBG driven lorries and port vehicles

A giant step forward in terms of decreased land transport pollution per ton-kilometer can become achieved if new lorries are at the same time being constructed for using LNG as main fuel. If this shall become possible or not, will to a large extent depend on if competitive land vehicles and further use of smart sea transport routes and surpassing land transport routes, where a smooth running of lorries on LNG can become combined.

Sweden is a stretched country in directions North-South, and on land lorry transports with LNG-driven lorries are made on highways which are much less congested than on the European continent. To run heavy lorries on LNG on fixed routes in Scandinavia can become foreseen as very economical, when lorry high quality diesels will become more costly. If corridors on the continent for LNG-driven lorries also can become available, with a few new LNG lorry refuelling places with agreed distance intervals on the European main land continent, on routes surpassing the high intensity traffic centras on their way south respective north and also east and west, a new intermodal, very effective and environmentally sustainable transport system can become arranged.

Methane driven lorry concepts

A good example of heavy trucks using biogas is the new Methane-Diesel driven heavy lorry concept with an explicit environmental profile, developed primarily for local and regional distribution by VOLVO (VOLVO FM MethaneDiesel). It is foreseen that other gas truck producers will follow, and a concept of this type in a near future be possible to see in increased numbers on the markets.

The chosen lorry concept is based on LNG, with a possibility to refuel with diesel, as LNG cannot be obtained in certain areas so far. We are here speaking about very heavy lorries, with an viable engine torque of 2 400 NM and a general GCW approval for 44 tonnes for each lorry.

The exchange of fuel to methane instead of diesel means both lower fuel costs and an obvious reduction of CO_2 emissions compared with regular diesel engines. When studying the present engine running profiles for these lorries, a mix with running on some 70-80% Methane and 20% diesel is foreseen. During constant running in full speed, the new lorries could run on 100% LBG. Therefore, with smarter transport routes, avoiding the necessity for low speed running intervals in the transit corridors, an even higher percentage direct driving on liquid Methane will become possible. With a number of heavy lorries in fixed smart new routes in sea-land transport corridors, as here described above, this new LNG-using heavy lorry type can compete with railroad transports concerning sustainability and flexibility.

Moreover, in our ports, heavy vehicles handling trailers, loading and unloading our ferries, might, following adaption of existing larger industrial engines, be able to use the same concept as the heavy lorries.

Summary of results of use of modern trucks and lorries combined with shipping

The payback time for these new heavy vehicles will depend on cost evaluations of how diesel fuels and railroad transport costs are foreseen to change after January 2015. The new concepts will depend on a positive cooperation with authorities and fuel providers. Initially it is believed that this is a market for selected areas and selected customers.

In CLEANSHIP we see these new technical solutions, making it possible and economically feasible to use heavy LNG-driven lorries on the European continent, as a new and viable market, with a foreseen rapid broad product development. A limited amount of new refueling stations on the continent will be necessary in order to increase the growth of LNG lorries rapidly. It certainly will at the same time boost the partner ports' environmental improvements during load handling in all ports, shore to ship and ship to shore.

ONSHORE POWER SUPPLY (OPS)

When berthed, ships require electricity to support activities like loading, unloading, heating, lighting and operation of other technical installations. Normally, the ships' propulsion engines are turned off when berthed and the power needed is provided by auxiliary engines that are running on diesel oil or other fossil-based fuel. Most of the new cruise ships, which are the biggest single sources for air emission in a port, use diesel electric propulsion system and get the all the electricity they need from the same generators. The exhausts from the auxiliary engines affect the environment negatively both locally and globally by emissions of CO_2 and other air pollutants. For example, long-term exposure to PM and NO_X have a significant effect on human health, in ports ultimately affecting the health of both port workers and nearby residents. Governments have therefore set air quality standards for air pollutants, which many port cities have problems to meet.

Since 2010 a European Union directive (2005/33/EC) limits the sulphur content in marine fuel to 0.1% (from 1%) for ships at berth (see directive for exemptions) in order to reduce the emissions discharge from vessels. Ships can either choose to use an alternative ship fuel while at berth, or to connect to shore-side electricity, that is, OPS.

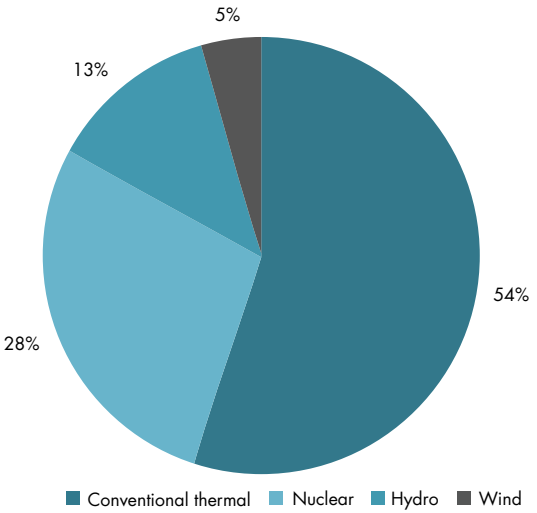
The use of OPS reduces the negative environmental effects of ships, such as noise and air pollution, since the ships' auxiliary engines can be switched off. Moreover, implementation of OPS provides an opportunity not only to improve air quality, but also to reduce emissions of CO_2, one of the main contributors to global warming. In that regard it is the electricity mix with the largest possible amount of renewable energy that is of greatest importance because this determines the effect on CO_2 emissions.

Using OPS is could be profitable for regular shipping lines that commonly berth at the same dock. On this assumption, most of the technological developments will take place at berths for ferries, RoRo and RoPax ships. Consequently, ports with many regular shipping lines are more interested in implementing OPS facilities. At container terminals, where vessels do not always dock at the same position, there is a need for more connection points, which makes the implementation of OPS facilities more complicated.

Provision of electricity necessitates OPS facilities in ports. Within a CLEANSHIP task*, 20 ports were interviewed regarding provision of OPS. Although almost all these ports have some kind of OPS facility, it is important to note that in most ports OPS is provided only for inland vessels and auxiliary fleet (that is tugs, pilot boats, barges, ice-breakers, etc), and that it is low-voltage electricity that is provided (see below). On the other hand, several ports are planning to introduce/expand the technology to more quays and for more types of vessels, or to implement OPS technology if this does not already exist. In certain cases all the expenses will be borne by the ports' authorities or by the city government, in other cases the construction of OPS facilities totally depend on private operators and ship owners.

Technical operation – different existing systems

The running of cables from an onshore electricity grid to small ships and boats at berth is no new phenomenon. Onshore power has been used for lighting, heating and for charging batteries on ferries and tugboats that are berthed overnight. As an example, the "Royal Yacht Norge" has been using onshore power for many years during winter storage at the Port of Oslo. Delivery of power when the ship is in port has been common practice for smaller vessel staying in port of other reasons than environmental ones. This has mostly been a case of



EU-27 Electricity generation by source in 2011 (%)[21].

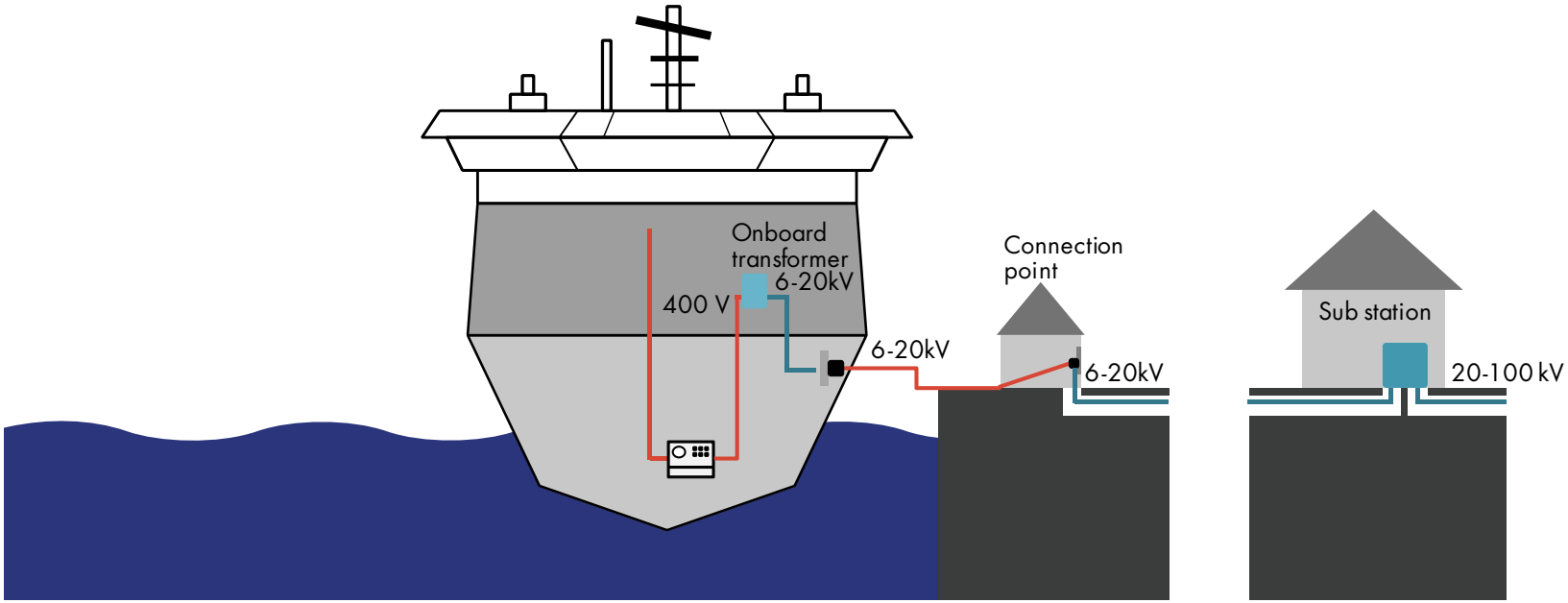
* Task 3.4, Environmental Development Association

some kilowatts, perhaps 50 up to 100 kW, which is about the equivalent for a large residential house or a small apartment block. This is power with the same voltage and frequency found on the regular grid, either 230 or 400 volts at 50 Hz. The OPS-facilities being built today are of a different caliber in order to suit the electricity demand of large ships.

When designing an OPS-system, many parameters need to be considered. Ports equipped with OPS have to take into account the variations in power, voltage and frequency levels in different parts of the world. Early low-voltage systems (typically 400-480 V) require numerous connection cables, while recent high-voltage systems (6.6 -11 kV) are easier to handle, but will need an onboard transformer.

- High-voltage OPS
  An OPS-system running on high-voltage electricity, generally ranging from 6 kV to 11 kV.
- Low-voltage OPS
  An OPS-system running on low-voltage electricity, generally ranging from 400 V to 690 V.

The frequency in the European grid is 50 Hz, but the frequency onboard ships may be either 50 or 60 Hz. Since the ships normally produce electricity using their own generators, there has been no need to take onshore frequencies into consideration. Two third of all ships are operating on 60 Hz frequency in their electric grid and almost all cruise ships. For delivery of OPS to ships operating on 60 Hz frequency, European ports operating on 50 Hz must install frequency converters. The capacity of a frequency converter is proportional to its size, for example, the space required for a converter that should convert 15 megawatts is estimated to be at least 350 m^2.



General design of high-voltage OPS facilities. An electrical cable is extended from the pier and plugged into the ship's receptacle to supply power to operate the machinery, allowing the ship to shut down the diesel engines that normally drive the electrical generators.

Table of high-voltage OPS facilities in CLEANSHIP partner ports.

Port	Type of vessel	High-voltage system		No. of berths with OPS	The number of substations/connections that require upgrading	Available output from shore
		kV	Hz			(kW)
Port of Hamburg *Under construction*	Cruise ship	11	60	1		9800
Port of Kiel	RoPax	11	50	1		4500
Port of Liepaja	RoRo and vehicle vessels	10	50	2	2	500
Port of Lübeck	RoPax	11	50	2	2	3500
Under construction	RoRo and vehicle vessels	11	60	2	2	3500
Port of Oslo	RoPax	11	50	1		4500
Under planning/ design	RoPax	11	50			4000
Under planning/ design	Cruise ships	11	60	2		11000
Ports of Stockholm *Under construction*	RoPax	11	50	*7*		
Port of Trelleborg	RoRo, railway and Cargo ships	10.5	50	6	*5*	1000-3600/berth

Low-voltage systems are today available in all above ports and following partner ports: Port of Gdansk, Port of Hamburg, Port of Helsinki, Port of Kaliningrad, Port of Kalundborg, Port of Klaipeda, Port of Riga, Port of Rostock, and Port of Tallinn. For a full table see Task 3.4.

OPS-plug in the Port of Trelleborg.

International standard and OPS facilities

In the course of research for the CLEANSHIP task*, it was found that ships have 27 different types of connecting points to OPS facilities. It would be impossible to equip every berth with so great numbers of connecting points and consequently impossible to supply all existing types of ships with OPS. However, since July 2012 there is an international standard for the plug used when connecting a ship to the port OPS facility. The plug is for high-voltage connection systems (HVSC) and the standard is named ISO/IEC/IEEE 80005-1:2012. According to the IEC the standard is applicable to the design, installation and testing of HVSC systems and addresses among other things shore-to-ship connection and interface equipment. It does not apply to the electrical power supply during docking periods, e.g. dry docking and other out of service maintenance and repair. There are no other international standards for OPS facilities.

Standardized plug for high-voltage connection systems.

* Task 3.4, Environmental Development Association

OPS market and electricity prices

The operating cost of OPS in ports will be due primarily to the electricity cost, also known as electricity tariff or the electricity rate. This cost varies widely between countries, and may also vary significantly within a particular country. The electricity cost depends on a range of supply and demand conditions, including the geopolitical situation, import diversification, network costs, environmental protection costs, government subsidies, regulations, severe weather conditions, or levels of excise and taxation. In the EU, Member States are obliged to send information relating to prices for different categories of industrial and business users, as well as data relating to market shares, conditions of sale, and pricing systems to Eurostat. Consequently, the transparency of electricity prices is guaranteed within the EU. The unit for electricity prices in Eurostat is Euro per kilowatt hour (€/kWh).

The electricity prices requested by ports further differ depending on, for example, whether the broker (port authority or terminal operator) mark up the price from the local grid owner. In some cases OPS prices are based on national grid operator general tariff and the type of consumer (long-term or temporary). Electricity supply contracts will also be affected by the maximum electricity level required at any one time. That is, a port with large fluctuations in electricity requirements may pay a higher electricity price than a more level electricity demand. In addition, a high maximum electricity level will increase the size and cost of electricity equipment such as transformers and cables. The electricity supply price may be reduced by using an interruptible supply contract. Electricity suppliers offer lower prices for interruptible electricity supply as it enables them to meet peak electricity demands by shifting electricity supply from interruptible demands to non-interruptible demands. Since the ships are always able to use their auxiliary engines, the port will be able to allow the additional electricity for OSP to be interruptible.

The electricity consumed in ports could include taxes, while the corresponding bunker fuel bought by the vessels is totally free of taxes (and environmental fees etc), an issue that could be a potential disincentive for ships to use OPS. A tax on electricity has a major direct impact on the cost effectiveness of OPS. Therefore, OPS is most cost effective where electricity is cheap, and where fuel costs are high. However, the European Commission[22] will propose a time-limited tax exemption for OPS in the forthcoming review of the Energy Taxation Directive as a first step and elaborate a comprehensive incentive and regulatory framework. A good example is the tax reduction in Sweden for the use of OPS in ports, in force since 1 July 2010. Moreover, compared to sharply increased marine fuel prices, the electricity prices are almost non-variable[21]. Consequently, the possibility to connect to OPS in ports is expected to be more profitable for ship-owners than the use of low sulphur marine fuel.

Country	Electricity prices Industry (per kWh)[21]		
	2010	2011	2012
Denmark	0.094	0.099	0.097
Estonia	0.112	0.125	0.078
Finland	0.133	0.154	0.155
Germany	0.112	0.125	0.128
Latvia	0.089	0.098	0.110
Lithuania	0.100	0.105	0.114
Norway	0.103	0.111	0.092
Poland	0.098	0.101	0.092
Sweden	0.081	0.089	0.081

OPS HANDBOOK FOR PORTS

Delivery of onshore power to ships requires significant investments. To get value for money it is important to find the targets that give the best results from an environmental perspective. A first step when having decided to look into the possibility of offering/using OPS is to take advantage of the experience and knowledge already available (ports, reports, and authorities on OPS).

CHECKLIST FOR A PORT

- What type of ships call to your port?
  Find out what vessel fleet in your port would be most suitable for OPS, preferably frequent-calling vessels with long port stays and offering the greatest emission reduction potential.
- What amount of electricity is needed?
- Where will the electricity come from?
  If possible, purchase energy produced from a renewable energy source to achieve a maximum environmental net benefit.
- What would be the environmental benefits of OPS?
  If the electricity is produced from fossil fuels the environmental benefits will be local, while if it is produced from renewable sources the benefits will be global.
- What type of connection suits your port best?
  Ship-to ship vs. shore-to-ship vs. automatic system. Determine the best technical approach by collecting data on electrical systems, voltages, frequencies, fuel quality and fuel consumption on the vessels in question.
- Where would the optimal placement of the OPS equipments on quay be?
- Which companies could install the facilities?
  The OPS technology must be implemented on both the quayside and the vessels.
- What will the approximate cost of implementation be?
- How will the price be set and how should the ships be charged? Is a fixed or a variable price to be preferred? Costs of local power supply. Agree on the commercial set-up between port authority, terminal operator and shipping company.

For a shipping company it is important to have a continuous dialogue with the port authority and consider following questions:

- Where will the electricity come from?
- What OPS facilities does the port have?
- Where should the connection be installed on the ship? A standardized solution would simplify shore installation.
- What does it cost to install OPS equipment?
- What will the electricity costs be?

HIGH-VOLTAGE OPS IN THE PORT OF OSLO

Onshore power supply for big passenger ferries and cruise ships has been an ongoing discussion in Oslo since the late 1990s. The basic objection was lack of standardization. During the first years after 2000 Port of Oslo started a huge relocation process of many port operations, building new facilities and it was not the time for investments in OPS without being certain of long term use. In 2007 it was time to start a planning process to see if the time was right for OPS. Today the Port of Oslo works towards offering onshore power supply to those shipping companies that are interested in this solution. There is a clear environmental benefit to be derived from connecting many international ferries and cruise ships to an onshore power supply. The ferry and cruise terminal in Port of Oslo are located close to the city center. None of them are more than 2000 m from the City Hall. It is obvious that use of OPS in these terminals is the future. OPS in the Port of Oslo is "green" energy from hydro-electric power production.

In 2008 the Port of Oslo received the report Environmental Audit on Onshore Power Supply, prepared by the consultancy group Civitas. The report concluded that it could make good environmental-economic sense to connect international ferries to onshore power supply when at berth in the Port of Oslo. Presented in the box below are some of the conclusions reached in the report Environmental Audit on Onshore Power Supply.

The report by Civitas shows that the most environmentally economic solution was to connect the passenger ferries Color Magic, Color Fantasy, Crown of Scandinavia and Pearl Seaways to an onshore power supply system. These ships call at the Port of Oslo at Hjortneskaia and at Utstikker II at Vippetangen on a regular basis. The ferries have predictable and scheduled visits. From a practical perspective, this is a key requirement for being able to benefit from OPS.

Because the cruise/passenger ferries calling Port of Oslo are sailing between two ports the need for standardization was less then with other ships calling once in a while. A natural start was therefore to search for a partner among the ferry companies. Color Line has rather new ships and under normal circumstances the longest depreciation time for investments in the ships. The two ships, Color Fantasy and Color Magic, which sail between Oslo and Kiel, make two-day round trips, so each ship is scheduled for arrival every other day, and berth between 10:00 and 14:00 in the Port of Oslo. The

CONCLUSIONS OF THE ENVIRONMENTAL AUDIT ON OPS

Onshore power supply to four ferries in the Port of Oslo is undoubtedly environmentally positive. It is also a socioeconomically profitable measure. The shipping companies also end up with a small profit, even when one takes into account that fact that, under the current schedule of charges, a charge is levied on electric power supplies.

Recommendations

Ferries (1): Negotiate and agree with the ferries' other ports of call in choice of onshore power solution.

Ferries (2): Proceed with establishing a onshore power supply for the ferries because it offers significant environmental benefits, it is socioeconomically profitable, and financially balanced.

Cruise ships: Await international standardisation of solutions before proceeding with establishing -onshore power supply for cruise ships.

Container ships: Proceed with studies on container ships. The preliminary studies we have conducted indicate that a solution based on 400 V has the best potential, given the size of the container ships that pass through the Port of Oslo. The solution is financially reasonable and, from a practical perspective, simple to implement. The environmental costs and benefits should be clarified before the final decision is made.

total weekly berth time in the Port of Oslo for the two ships together is 28 hours. Pearl Seaways and Crown of Scandinavia, which sail between Oslo and Copenhagen, also make two-day round trips. These ships arrive at the Port of Oslo (Utstikker II) every other day, and berth between 09:45 and 16:45. With the exception of a two-week period in January/February, when the ships are normally in dock, their daily lay time is 7.5 hours. Stena Line operates the Stena Saga between Oslo and Frederikshavn. These ships normally berth for only one hour a day at the Port of Oslo. It is less expedient to set up an onshore power supply system for ships with such short berth times.

After several meetings with the ferry lines in the Port of Oslo, Color Line decided to join in a preliminary project of OPS in the Hjortnes ferry terminal. After Port of Oslo joined the CLEANSHIP project it was decided that the OPS project should be a Pilot study*. The study report from the preliminary project was used as a baseline for the Pilot project and the design program.

Table 1. Ferries calling Port of Oslo - Fuel and energy consumption

Ferry	Fuel consumption at quays in Port of Oslo	Power load	Energy consumption while at berth in the Port of Oslo
	tonnes/year	kW	kWh/year
Color Line			
Color Fantasy	555	3 525	2 467 156
Color Magic	555	3 525	2 467 156
DFDS			
Pearl of Scandinavia	577	1 998	2 622 441
Crown of Scandinavia	579	2 004	2 630 381
Stena Line			
Stena Saga	264	2 200	1 210 323

*Task 5.9, Port of Oslo

Implementation of first OPS in Port of Oslo

The work with the design program started in the second half of 2010. The solutions where decided in the spring of 2011 in time for fitting out the first cruise ferry Color Magic for necessary equipment for receiving OPS during docking in April 2011. A special element is the choice of shore connection taken by Color Line, which is not in accordance with IMO standard. The connecting operation can be done without physical contact with the plug itself operating by remote control. The pilot project on OPS to Color Line's ferries was formally launched on 10 October 2011. At that time, one of the ships, Color Magic, was altered to receive OPS. The other ship, Color Fantasy, was altered during a shipyard stay in the spring of 2012, and the system on board was put into operation in the autumn of 2012.

When Color Line's ferries are connected up to OPS, the discharge of CO_2 will be reduced by 3 000 tonnes each year and NO_X discharge will be reduced by 50 tonnes each year in Oslo. This is similar to CO_2-emission from 1 700 cars for a whole year.

When a majority of cruise vessels can connect to OPS a similar or even bigger reduction of air emission will come to the benefit for the local environment in central parts of Oslo city.

The Color Line plug.

Cruise Ferry Color Magic in Port of Oslo – the first international passenger ferry using OPS in Norway.

Action Plan

During the process with the OPS project for Color Line, the Port of Oslo decided to make an Action plan for the future development of OPS in the port. The plan was completed and adapted by the Harbour board in November 2012. The main elements in this Action plan are:

"The Port of Oslo plans to build a main power station at our passenger terminal (Vippetangen) that can provide high-voltage OPS with a frequency of both 50 Hz and 60 Hz. This will provide flexibility, give us a leading position in Europe in this field, and offer good possibilities to provide onshore power supply in the future. Such flexibility makes the system complex and relatively costly, but this is the long-term solution. The complexity also makes it difficult to estimate the date of completion."

Phase 1

See the map for details. Four feeder cables have been laid to date, from Pipervika, point A to point C. One of the cables was extended to the other side of Skippergata. A 'private' cable and one 160 mm pipe were laid from point C to the other side of Skippergata. Two 'private' cables and one 160 mm pipe were laid from point C to point E. Two 'private' cables and one 160 mm pipe were laid from point C to point B.

Phase 2

Feeding of cables to the DFDS terminal, which can be located either in a building or as a freestanding structure, must be further elucidated. Especially in relation to the work on the zoning plan for the whole passenger terminal (at Vippetangen).

Phase 3

Planning and design for OPS for Cruise ships

- Building of the main power station with frequency transformers requires clarification of the location. This is the difficult part of the project, because a main power station may require as much as 400+ m² of space in an existing or new building.
- After that, the remaining piping and cabling can be run from the main power station to the quays at Søndre Akershuskai/Revierkaia.
- Sufficient time must be allowed for procurements. A converter of this size has never been built before. This means that we must take this into account when preparing a realistic progress plan.

Implementation plan for cruise ships

- Provided that the location of the main power station is clarified in the zoning plan and that the project is allocated the necessary resources, the goal is to be able to provide OPS for cruise ships from 2015.

Existing and planned cabling in the Port of Oslo.

Preliminary estimate of cost

The largest cost item in the project relates to the main power station, the transformer solution and necessary frequency converters. In total, the cost of the OPS at our passenger terminal (Søndre Akershuskai, Vippetangen to Revierkaia) is currently estimated to be NOK 60 million.

Due to the decision on the Fjord City project, the Port of Oslo has undergone major changes in recent years. Areas which once were used for port activities have been relocated and developed. The port has invested in new quays and installations in its core areas. As with other investments, it is prudent to invest in systems with long life spans. Large shore connection systems will be implemented as independent projects. In connection with upgrading of seafront areas and building of new sections in the port, etc. OPS can be included as part of a larger project and be budgeted for accordingly. The systems that are completed or started up are independent projects with their own financing. The cabling, which was recently finalized, has already taken in account the supply of onshore power to several ships simultaneously at Vippetangen. This means that large amounts of electricity will be available for ships to connect to. Reserving such large amounts of electricity can incur some costs on the Port of Oslo during the period before the system is ready to use. This issue has not yet been clarified.

The public enterprise Enova has approved a grant of NOK 8 million (13.3 per cent of the estimated cost) for the project for the period 2012-2015. Enova provides financial support or grants for environmentally friendly reorganisation of energy consumption. The grant is paid as the project is gradually realised. Grants from other funds and support schemes will be considered. As this will be a pioneer project by Norwegian standards, we hope others will want to be involved in realising it with us.

The principle of financial responsibility

Normally, public ports in Norway should recoup its investments in its projects over time. This is known as the financial responsibility principle. The ports' independent financial position, which is regulated by the Harbour Act, still applies, and infers that ports should be self-financing. The Port of Oslo is now working on establishing a clear overview of costs the Action Plan will generate, but what is more uncertain is what aspects of the OPS project will generate income. The Port of Oslo considers the establishment of OPS as a vital project for Fjord City. The OPS project has therefore been placed in a broader, socioeconomic perspective than one of financial responsibility alone.

Economical benefits from OPS in Oslo

Electricity in Norway can in general be purchased at affordable price. This is also the situation for OPS. But to make use of the OPS, investments have to be done, both on the portside and onboard the vessels. This has to be taken into account. All information on the economical benefits from OPS in Norway is based on the experience from Color Line. 2012 was the first full year with both ferries on OPS. Jan Helge Pile, Project Director in Color Line Marine A/S, describes the situation as follows in the box below.

Future customers of OPS in the Action Plan

The Port of Oslo is conducting a dialogue with DFDS with a view to establishing and using OPS for their ferries to Copenhagen. The supply of OPS to DFDS can be executed as a separate installation, though using the same trenches as for OPS to cruise ships at a later phase. The most appropriate user would be DFDS, which has 7.5 hours in lay time in our passenger terminal.

With respect to cruise ships, the Port of Oslo has a good dialogue with Holland America Line. Holland America Line has been using OPS for its ships for many years, and has also been involved in planning and developing the OPS system in Seattle and ports in Alaska. Due to the environmental benefit, Holland America Line was very quick to realise that if a cruise ship must lie in the middle of a city or a nature reserve in Alaska, then connection to OPS was the only solution. Holland America Line has been the largest provider of cruises to Alaska for many years.

"Holland America Line is pleased to work with the Port of Oslo on their plans to implement an onshore power supply," said Stein Kruse, President and CEO. "As a company, we are dedicated to reducing air emissions as part of our commitment to responsible environmental practices and support the efforts of our business partners to do the same."

"We have invested millions of dollars in outfitting our ships to take advantage of onshore power supply. We sincerely appreciate the leadership of ports like Oslo to set an example for others to follow."

Other shipping companies are also showing an interest in OPS, but so far few of them have ships that can use this solution today, among them Aida Cruises from Rostock.

In November 2012 the Port of Oslo made an acquisition for consultancy service for making a design plan for OPS for two cruise ship terminals and one ferry terminal. The consultant will deliver the final report primo August 2013.

Upcoming challenges

A key prerequisite for enabling ships to use OPS is that it is attractive to customers/users. It will be important that the financial benefits are favourable when compared to alternative options. Another important point is that it should be simple, both to connect to and to settle payment for power consumed. This means that the Port of Oslo must arrange for supplying the power and for payment settlement, which can be done in conjunction with invoices for charges and fees that are submitted to the ship's agent. This will particularly apply for cruise ships. This further requires the Port of Oslo to be a customer of energy suppliers and the local/regional licensee for purchasing energy and for grid rental. The Port of Oslo will then be able to charge a mark-up to cover the costs of its investments over time.

Which revenues can be expected through offering OPS depends on:

- how many ships take up the offer of OPS
- the price of energy
- what is considered a competitive price for OPS

This is where the Port of Oslo's profit margin will lie. This is provided that tax issues related to the supplying of power to ships in international shipping are clarified. Another very important matter is how to handle the tax situation for OPS relative to international trade of bunker/fossil fuel which is exempted tax.

"By switching to onshore power supply in the Port of Oslo, the ships use electrical energy from the Norwegian energy market instead of electrical energy generated by the ship's auxiliary engines burning marine gas oil. The price of electrical energy in the Norwegian (Nordic) market and the price of gas oil fluctuate over time. Since regular use of onshore power supply started up earlier this year (2012), the price of electricity in the Norway has been much cheaper than what we manage to generate with marine gas oil on board.

For example, the price we paid for electricity in August 2012 was NOK 0.42/kWh (with all variable and fixed charges included). With the current price of oil and the dollar exchange rate, the price of energy generated on board for the same month was NOK 1.26/kWh. (In June it was approximately NOK 1/kWh on board). This of course means significant savings at the moment, but in our budgets we take neither the currently very low price of electricity nor the high price of oil into account.

With an estimated annual consumption of up to 4 GWh, we expect to save up to 1 million NOK per ship per year in our budgets. Even if that figure could be slightly higher with today's prices, we don't have to go further back in time than the winter of 2010/2011, when the price of electric energy was so high that it was on the same level as the price for the energy we generated ourselves from marine gas oil.

With this relatively long repayment period, and from a purely business perspective, this is perhaps not an optimum project financially. Expecting the price of electric power to remain low for more than ten years ahead is a considerable business risk. But from the perspective of corporate social responsibility, this is clearly a positive initiative."

PORT RECEPTION FACILITIES (PRF) FOR SHIP SEWAGE

Sewage discharge from ships disappear quicker from the water surface than oil and chemical spillage, but are harmful in other ways, for example it gives direct input of nutrients to growing algea. Human sewage (black water) can further contain enteric bacteria, pathogens, diseases, viruses and eggs of parasites, while household water (grey water) contains pollutants such as detergents, oil, grease, pesticides and heavy metals. Within the CLEANSHIP project, a report concerning port sewage reception facilities* was included with the aims to 1) create a common understanding on technical and operational aspects on sewage delivery to Port Reception Facilities (PRFs), 2) suggest constructive solutions for functional and effective system for delivery, reception and treatment of sewage from passenger ships, using four case ports, and 3) discuss international and national regulations and policies and lift the economical perspective of providing adequate PRFs in a port.

National legislations that regulate the prevention of pollution from ships in the Baltic countries are based on the content of the MARPOL 73/78 Convention and all Baltic Sea countries are parties to this Convention. Since many of the international regulations don't apply to ports before they are part of the national legislation ports may have slightly different legislation. According to the current Annex IV of the MARPOL Convention, the discharge of sewage into the sea is allowed if a ship is discharging comminuted and disinfected sewage at a distance of more than three nautical miles from the nearest land. Other sewage can be discharged at a distance of >12 nautical miles from the nearest land. In July 2011 IMO (MEPC 62) approved the most recent amendments to MARPOL Annex IV, which entered into force on 1 January 2013. The amendments introduce the Baltic Sea as a special area under Annex IV and add new discharge requirements for passenger ships while in a special area; discharge of sewage into the sea from passenger ships will be prohibited unless the ship uses an approved sewage treatment plant, capable of reducing nutrients on board, according to established concentration standards. Alternatively, untreated sewage could be delivered to a PRF. From 2015 all new passenger and cruise ships are not allowed to release their sewage into the sea. From 2018, the same ban will apply to the rest of the passenger and cruise ships travelling in the Baltic Sea. The revised Annex applies to new ships engaged in international voyages of 400 gross tonnage and above or which are certified to carry more than 15 persons. The Baltic Sea special area will enter into effect when the Baltic Sea Countries via HELCOM notify IMO that adequate port reception facilities for sewage in their passenger ports are available. Each country undertakes to ensure that:

- facilities for the reception of sewage are provided in ports and terminals which are in a special area and which are normally used by passenger ships;
- the facilities are adequate to meet the needs of those passenger ships; and
- the facilities are operated so as not to cause undue delay to those passenger ships.

In Annex IV sewage is defined as:

- drainage and other wastes from any form of toilet and urinals;
- drainage from medical premises via wash basins, wash tubs and scuppers located in such premises;
- drainage from spaces containing living animals; or
- other waste waters when mixed with drainages.

Moreover, sewage sludge and bio-residues from on board Advanced Waste Water Treatment Plants (AWTS) and Marin Sanitation Devices (MSD) falls under the MARPOL definition of sewage. This type of sewage is of higher viscosity and usually consists of 1-3% solids as well as various polymers and coagulants used in solid separation. Because municipal waste water treatment plants are foremost designed to receive waste water from households and primary for reducing nutrients, it is probable that some sewage from ships will not be accepted in municipal waste water treatment plants. In such instances the sewage must be treated as industrial waste or any alternative manner, which is a more costly alternative. The cost should be levied on the ship following the polluter pays principle.

*Task 4.5, Port of Trelleborg, Port of Helsinki.

Thus, to achieve adequacy, the PRFs shall be capable of receiving the types and quantities of ship-generated waste and cargo residues from ships normally using that port, taking into account the operational needs of the users of the port, the size and the geographical location of the port, the type of ships calling at that port, etc. Adequate port reception facilities should meet the needs of users, from the largest merchant ship to the smallest recreational craft, and of the environment, without causing undue delay to the ships using them.

In some of the countries the costs for upgrading of the port´s and the municipality sewage reception systems are regarded as high and becoming principal obstacle for implementation. In short, in large ports, situated in smaller municipalities, further investments may have to be supported through federal aid in respective country, to facilitate mandatory sewage delivery, while in ports situated in larger municipalities, with existing sewerage and large waste water treatment plants there is less concern.

At another level, the countries in the Baltic Sea region must comply to EU-regulations regarding PRFs. Directive 2000/59/EC* of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues pursues the same aim as the 73/78 MARPOL Convention on the prevention of pollution by ships, which all the Member States have signed. However, in contrast to the Convention, which regulates discharges by ships at sea, the Directive focuses on ship operations in European Union (EU) ports. It addresses in detail the legal, financial and practical responsibilities of the different operators involved in delivery of ship-generated waste and cargo residues. The EU Directive 2000/59 requires Member States to ensure adequate PRF solutions and handling plans, including mandatory delivery for ship generated waste, advance waste notification, a fee system (functioning as an incentive not to discharge into sea) and inspections.

No Special Fee

Article 8 of the EC Directive regards fees for ship-generated waste and in short says that the costs of port reception facilities shall be covered through the collection of a fee from ships, that such a fee should follow the "polluter pays" principle, that these costs shall include the treatment and disposal of the waste, and that the collection of the fee is for Member States to ensure. Importantly, the cost recovery systems for using PRF shall provide no incentive for ships to discharge their waste into the sea. Moreover, the part of the costs which is not covered by the "indirect fee", if any, shall be covered on the basis of the types and quantities of ship-generated waste actually delivered by the ship, and a port may give reduction from fees if the ship's environmental management, design, equipment and operation are such that it produces reduced quantities of waste. The indirect fee (sometimes incorporated into the port dues or as a separate waste fee) is for some ports called the "No Special Fee" (Scandinavia), "Mandatory Fee" (some UK ports) or "Sanitary Fee" (Poland). Article 9 of the Directive allows to exempt ships engaged in scheduled traffic with frequent and regular port calls from the payment of fees provided there is sufficient evidence of delivery of sewage and payment of fees in a port along the ship's route.

In HELCOM Recommendation 28E/10, guidelines for the establishment of a harmonised fee system for delivery of ship generated wastes to PRFs can be found. According to the HELCOM NSF-system, a fee covering the cost of reception, handling and final disposal of ship-generated wastes is levied on the ship irrespective of whether or not ship-generated wastes are actually delivered. The fee should be included in the harbour fee or otherwise charged to the ship. The NSF-system should be applied in all Baltic Sea ports to oily wastes from machinery spaces, sewage and garbage, as well as litter caught in fishing nets. A ship may be exempted to pay if it is engaged in regular services and if it can ensure that the disposal requirements are met. As for today, this means that all regular service ships could be exempted for paying if either discharging their sewage at another port or at sea at a distance of >12 nautical miles from the nearest land.

Today the countries around the Baltic Sea apply the NSF-system in different ways, as both the EU Directive and the recommendations from HELCOM allow free understanding. A resultant dilemma is for example competitive disadvantage for ports applying NSF to a 100%. On the other hand, in countries applying a direct fee on discharge

*There will be a revision of this directive, probably during 2013.

of sewage, ships tend not to discharge sewage, and in turn it becomes meaningless for a port to go for building/updating PRFs. For a common 100% NSF-system, based on gross tonnage of ships, data on the amount of potential sewage from all types of ships needs to be counted and analysed. In the best of worlds, this amount would then be more evenly distributed between ports of the Baltic Sea region, naturally, also depending on what kind of traffic calls a port.

There are several issues that must be tackled before a common NSF-system in the Baltic Sea region can be feasible. One crucial issue is the definition of what the characteristics of sewage included in NSF should be, and in turn, what fractions of sewage could be charged separately according to the polluter pays principle. For example, how should water from SO_X scrubbers or ballast water be treated? Another related issue is the national and regional regulations regarding what sewage may consist of to be accepted in the municipal waste water treatment plants; these differences must be taken into account when defining sewage for NSF. It is of importance for a port to know what would happen when a waste water treatment plant rejects to receive sewage from a ship. As a result, compatibility between municipal waste water treatment demands on sewage composition and the composition of sewage from ships should be studied in more detail, if feasible on a port-by port basis. Also, solutions to the treatment of sewage containing atypical substances should be sought for in cooperation between shipping, ports and municipal treatment plants. The diversity of ports and ships conceivably necessitates several sewage categories, including set standards of composition and sampling of grey water, black water and a mix of the two.

CASE STUDIES OF PORT RECEPTION FACILITIES

Port of Helsinki

The majority of the waste waters received at the Port of Helsinki come from passenger ships. Cargo ships generate only small amounts of waste water due to the small number of passengers and crew members. There are sewers in all of the quays in all of the three harbours. All sewers are pressure sewers. The sewer pipes are mainly plastic pressure pipes. The receiving capacity of the reception facilities varies approximately from 60 – 120 m^3/hr depending on the solid content of the waste water.

Most of the hoses connected to vessels are 10 m long sections which can be connected approximately up to 100 m. The diameter of the pipeline is 4 inches. Vessels can be offered the opportunity to discharge waste water through two hoses, allowing the vessel to discharge twice as much waste water.

Waster waters are pumped from vessels via hoses in to the Port of Helsinki sewers and from there in to the general sewage system of the city (Helsinki Region Environmental Services Authority, HSY). The organic matter contained in the sludge produced in the waste water treatment process is exploited by digesting the sludge, and the biogas generated in the digestion process is collected for further use. Thanks to the energy produced from biogas, the treatment plant is self-sufficient in terms of heating and about 50% self-sufficient in terms of electricity.

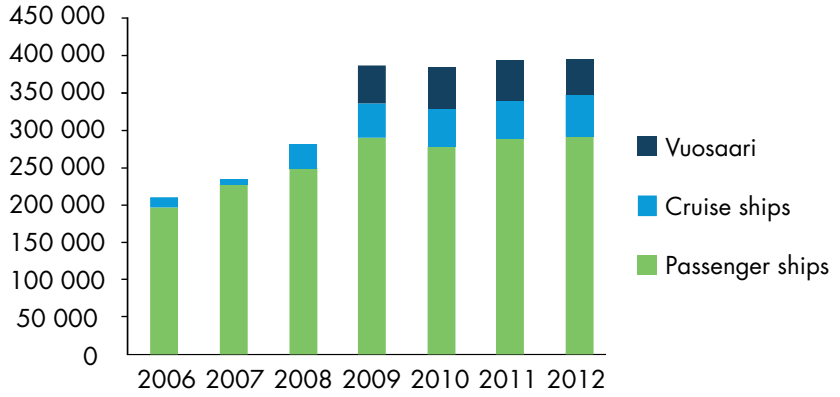
In the Viikinmäki waste water treatment plant, all solid and oxygen-consuming substances as well as 95 per cent of the phosphorus and 90 per cent of the nitrogen are removed from the waste water.

Port Reception Facilities for ship sewage at the Port of Helsinki.

From samplings of passenger ship waste water in 2012 it was found that the black water sample was considerably stronger than regular municipal waste water, but its nutrient ratios were similar to those of municipal waste water. Levels were compared to limit values presented in the Industrial Waste Water Guide 2011 published by HSY and Finnish Water Utilities Association (FIWA). The grey water sample was also stronger than regular municipal waste water in terms of organic matter, but the amounts of solids, nitrogen and phosphorus in the grey water were clearly lower than in regular municipal waste water. In terms of organic matter phosphorus content and solids content, waste water from the cruise ship was clearly more diluted than regular municipal waste water. Its nitrogen content, however, was equal to that of regular, fairly strong waste water. Samples from cruise ships showed that in terms of organic matter, phosphorus content, and solids the waste water was clearly more diluted than regular municipal waste water. Its nitrogen content, however, was equal to that of regular, fairly strong waste water.

Port of Helsinki receives waste waters, both black and grey, according to the NSF–system without any additional costs. No extra charge is taken for the emptying of waste water into the port's sewer system. If the waste water pumped into the ports sewers would be classified completely as industrial waste water, charge will be determined separately. These waste waters can still be pumped into the sewers.

The general waste management fee in Port of Helsinki is based on vessel's net tonnage and it is collected whether or not the vessel leaves any wastes to the port. A vessel in regular service can apply for an exemption from the mandatory waste delivery and waste management charges. The exemption is applied from TRAFI (Finnish Transport Safety Agency). Such exemptions may be granted on the condition that the vessel has concluded a waste management agreement with a qualified waste management company or port. Large majority of the vessels visiting Port of Helsinki have been granted this exception.



Received waste waters in Port of Helsinki. Amounts from Vuosaari are measured, amounts from Passenger and Cruise ships are based on information from vessels.

Results from waste water analysis results for cruise ship in Port of Helsinki in August 2012.

Cruise ship		Grey water
Waste water volume	m^3	800
Conductivity	mS/m	81
pH		7.4
BOD-7 ATU	mg/l	28
Total phosphorus	mg/l	0.97
Total nitrogen	mg/l	35
Solids	mg/l	21
sulphate	mg/l	19
grease content	mg/l	7
greases and oils	mg/l	<0.5

Results from passenger ship sampling in September 2012, Port of Helsinki, separate for black and grey waters.

Vessel 3		Black water	Grey water
Conductivity	mS/m	203	51.1
pH		7.2	9.8
BOD-7 ATU	mg/l	560	350
Total phosphorus	mg/l	14	3.4
Total nitrogen	mg/l	130	12
Solids	mg/l	710	64
Sulphate	mg/l	74	38
Grease content	mg/l	19	13
Greases and oils	mg/l	<0.5	<0.5

Port of Trelleborg

From 2012 the Port of Trelleborg has offered all RoRo ships, i.e. regular traffic, collection of sewage onshore. Since 2008 the Swedish ferries of former Scandlines, now Stena Line, deliver sewage at the port. The sewage consists of a mix of black and grey water, of which the black water is roughly 20%. The German ferries use onboard treatment, but following Stena Line recommendations, these ferries will be transformed for onshore sewage delivery.

The facilities of sewage delivery in the Port of Trelleborg function such that by each berth a pump pumps the sewage into the municipal sewer system. The pump can either be placed above or underground. Each pump station has a capacity of pumping 80 m^3/h and also has a depository of 8 m^3, which the Port of Trelleborg has dimensioned in mutual agreement with the shipping companies serving in the port. Once the sewage has passed the pump and the depository, it is sent out in the municipal sewer system and finally to the municipal waste water treatment plant. The waste water treatment plant in Trelleborg is able to handle the sewage from ships as long as it follows the regional directions of what sewage can contain. Any new shipping company that asks for discharging onshore must send a sewage sample for content analysis and approval to use the PRFs in the port.

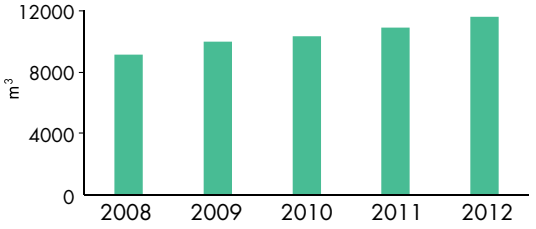
At the moment the Port of Trelleborg charges 9 SEK/m^3 (~1 EURO/m^3), which corresponds to the price that the municipality charges the Port of Trelleborg. The ferries of the other shipping companies serving in the port are exempted. Given the circumstance, the Port of Trelleborg does not include the price as a NSF.

Port of Turku

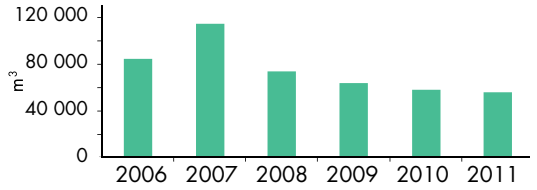
The collection of black and grey water in the Port of Turku started in 1984, when fixed sewer line connection was built for Silja Line passenger ferries. For Viking Line passenger ferries the fixed sewer line connection was built in 1988. In 2005 was the sewer line for Viking Line renovated and likewise the Silja Line sewer line was renovated in 2008. Both sewer lines are pressure sewers. The owner of sewer lines is nowadays Turku Municipal Waterworks Corporation. For cruise and cargo ships tank truck service is available. For emptying tank trucks there is a reception point located at the harbor area. The capacity of pressure sewers is 200-250 m^3/h for passenger ferries and these ferries stays at berth only one hour. At the moment the capacity of tank trucks is 24 m^3/h and the capacity of reception point for trucks is 90 m^3/h. The Turku Municipal Waterworks Corporation has some general limit values for the quality of sewage. There is in use also case-specific limit values for pH, solids, grease content and BOD.

Port of Turku receives waste waters, both black and grey, according to the NSF–system. The waste management fee in Port of Turku is based on vessel's net tonnage and it is collected whether or not the vessel leaves any wastes to the port.

Port Reception Facility for ship sewage at the Port of Trelleborg.



The amount of sewage per year discharged from two regular RoRo ferries serving Trelleborg - Sassnitz and Trelleborg - Rostock.



The amount of sewage per year discharged from passenger ferries serving Turku - Stockholm.

Ports of Stockholm

Facilities for offloading black and grey water in Port of Stockholm were first built in 1985 and 1987 at the terminals of Silja Line and Viking Line respectively. Today 14 stationary facilities are used in the daily operations of all of the shipping companies operating regular scheduled services. It is also possible to offload black and grey water at each of the quays used by cruise ships in Port of Stockholm. Work is being done in order to prepare for port reception facilities in the other two ports that comprise Ports of Stockholm. In Port of Kapellskär a treatment plant has been constructed and sold to the municipality. The construction of the port reception facility on the quays will start shortly. In Port of Nynäshamn investigations are conducted of how to handle black and grey water.

In Port of Stockholm there are permanent reception facilities for black and grey water, which are connected to the general municipal sewage system and the treatment plant in Henriksdal in Stockholm. The system is managed by Stockholm Water AB. The reception facilities are available at most berths in Stockholm, both in Frihamnen (Freeport) and Värtahamnen but also along the inner city quays. The capacity of the facilities varies between 50-350 m^3/h depending on the different quays and their use. Reception facilities are available both for large cruise vessels and ferries as well as for smaller boats used in the archipelago.

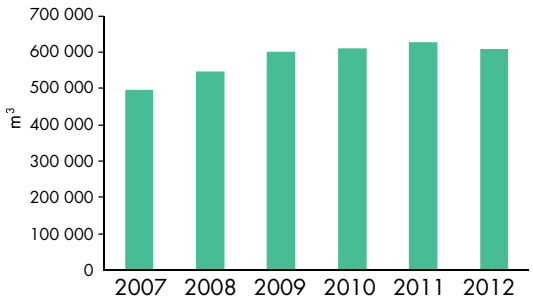
The facilities in Frihamnen have a capacity of up to 350 m^3/h. The capacity depends not only on the Port but also on the vessels' possibility to transfer/pump the black and greywater into the sewer system. The large amounts and the flow of waste generated from the cruise ships can be damaging for the general sewage system and therefore the flow is reduced in existing underground pipes before the waste enters into the system. On other locations where the water is pumped directly into the sewer system, more narrow hoses - 2.5 inches instead of 4 inches - are used in order to slow down the flow.

In Frihamnen, the reception facilities are located every 60 meters, implying that the distance to the vessel is never more than 30 meters. The hoses used consist of 10 meter sections that can be connected in order to reach full length. Since the hoses are handled manually however, there is a limitation of how many sections that can be connected before they become too heavy to lift for the staff.

Port of Stockholm has a variety of couplings in order to make sure different types of vessels can connect to the port reception facility. The couplings can easily be transported to all parts of the port when needed.

In cases where vessels cannot use the available reception facilities or on locations in the port where the fixed installations are missing, such as the container terminal, waste water is collected by truck.

Port of Stockholm applies the so-called "no special fee"-system implying that a special fee for offloading waste water may not be imposed; instead the service is included in the port fee. It is thus a general fee, based on the number of passengers, regardless of if the vessel offloads black and grey water or not. In situations when additional costs, beyond what is normal when a vessel is depositing waste, are incurred on the Port an additional charge will be applied.



Amount of waste water received in Port of Stockholm (m^3).

Components of Port Reception Facilities for ship sewage at the Port of Stockholm.

FUNDING MECHANISMS

The European Union has opened up the potential for the Baltic Sea Region ports to expand and become more competitive by providing financial and regulatory support so that ports can operate in a fair, open and efficient manner. This helps to attract more freight and passenger traffic, new customers and investments. Furthermore, by offering safe and green facilities and infrastructure, ports play a key role in providing transport operators with workable intermodal solutions, thus improving regional economy.

The EU structured financial assistance in support of efficient maritime transport, ports and environment for the current budgetary period has made a positive contribution. Taking into account the success of these projects and EU's intention to create a dynamic, efficient, sustainable and green environment for maritime industry, it is expected that the participation level in projects for the next budgetary period 2014 – 2020 will highly increase.

However, some aspects of funding mechanisms need to be improved and recommendations for the next budgetary period are hereby reflected. Hopefully, the consideration of these recommendations will ensure the appropriate and well-balanced stream of EU funding to the Baltic Sea Region.

Grounds of recommendations

Environmental Development Association in cooperation with BSR ports performed an analysis of EU co-financed funding mechanisms within the CLEANSHIP project*. The aim of the analysis was to develop basic recommendations for more effective implementation and execution of the EU financed programmes developed for the support of maritime transport, ports and environmental projects.

Funding mechanisms assessed

- COHESION FUND (CF)
  http://ec.europa.eu
- SEVENTH FRAMEWORK PROGRAMME (FP7)
  http://ec.europa.eu
- MARCO POLO
  http://ec.europa.eu
- TRANS-EUROPEAN NETWORK TRANSPORT PROGRAMME (TEN-T)
  http://ec.europa.eu
- EUROPEAN REGIONAL DEVELOPMENT FUND (ERDF)
  - Baltic Sea Region Programme 2007-2013
    www.eu.baltic.net
  - Interreg IV C
    www.interreg4c.net
  - Central Baltic Interreg IV A Programme 2007-2013
    www.centralbaltic.eu
  - Interreg IV B North Sea Regional Programme 2007-2013
    www.northsearegion.eu
  - South Baltic Cross-Border Cooperation Programme 2007-2013
    en.southbaltic.eu
  - Central Europe Programme
    www.central2013.eu

RECOMMENDATIONS FOR THE BUDGETARY PERIOD 2014 – 2020

PROBLEM: Administrative project management in all parts of the projects (application, reporting, financial issues, etc.) is overloaded and burdening. Due to heavy workload, applicants/potential beneficiaries/ stakeholders are excluded and reluctant to join – that is, parties that, perhaps, are in the greatest need of financial support.

RECOMMENDATION: New joint and standardized methods, forms and procedures need to be developed for the EU funding mechanisms.

PROBLEM: Due to heavy administration and long processes within the EU, usually, the payments are delayed. It can take more than 1.5 years to get the payment back.

RECOMMENDATION: To decrease administrative burden and to promote pre-payments to cover expenses during the projects.

PROBLEM: Parallel projects are not interrelated and there is no horizontal priority "green shipping" in planning and funding programs.

RECOMMENDATION: To improve coordination between funding mechanisms and between the projects. Identify the priorities.

*Task 3.7, Environmental Development Association

EU Funding Mechanisms 2014 – 2020[23]

The total European Commission proposed budget for the period 2014-2020 will be EUR 376 billion, including funding for the new TEN-T Connecting Europe Facility, which is designed to enhance cross-border projects in energy, transport and information technology.

This analysis sets out specific provisions of priorities and programmes of the ERDF and Cohesion Fund which will cover development of ports and shipping in 2014 - 2020.

ERDF and Cohesion Policy for 2014 - 2020

Every European region may benefit from the support of ERDF and an important priority for cohesion policy will remain to support less developed regions (GDP per capita between 75% and 90% of the EU-27 average).

European Regional Development Fund (ERDF)

While interventions in the less developed regions will remain the priority for cohesion policy, there are important challenges that concern all Member States, such as global competition in the knowledge-based economy and the shift towards the low carbon economy.

ERDF priorities which will support development of ports and shipping in 2014 – 2020 are:

- Shift towards a low-carbon economy;
- Climate change adaptation and risk prevention and management;
- Environmental protection and resource efficiency;
- Sustainable transport and removing bottlenecks in key network infrastructures.

Cohesion Fund

The Cohesion Fund will continue to make investments in Trans-European transport (TEN-T) networks and the environment. Part of the Cohesion Fund allocation (EUR 10 billion) will be ring-fenced to finance core transport networks under the new Connecting Europe Facility.

European Territorial Cooperation

European Territorial Cooperation will be a goal of cohesion policy and will provide a framework for the exchanges of experience between national, regional and local actors from different Member States, as well as joint action to find common solutions to shared problems.

New EU Funding Programmes

BONUS 2010 – 2016 Science for a better future of the Baltic Sea region is a new research and development programme launched with the aim to protect the Baltic Sea. It is supported by the European Parliament and is worth of EUR 100 million for the years 2010-2016. BONUS unite the research communities of marine, maritime, economical and societal research in order to understand the system of the Baltic Sea and then to solve the major challenges faced by the Baltic Sea region.

More information about the Programme is available at:

www.bonusportal.org

The EU Framework programme for research and Innovation - Horizon 2020 - is the financial instrument for research and innovation aimed at securing Europe's global competitiveness. It is running from 2014 to 2020 with a total budget of €80 billion. Horizon 2020 will combine all research and innovation funding currently provided through the *Framework Programmes for Research and Technical Development*, the innovation related activities of the *Competitiveness and Innovation Framework Programme* and the *European Institute of Innovation and Technology* in this way implementing uniformed and simplified system.

More information about the Programme is available at:

http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020

The European Fisheries Fund will be replaced by *European Maritime and Fisheries Fund (EMFF)*. EMFF will come into force from 1 January 2014 until 31 December 2020.

More information about the European Fisheries Fund is available at:

http://ec.europa.eu/fisheries/cfp/eff/index_en.htm

SECTION 3
PLATFORMS OF CONTACTS PUBLICITY AND DESSEMINATION OF RESULTS

Ports of Stockholm

PLATFORM OF CONTACTS

For a project like CLEANSHIP to succeed in conveying its key results and messages it is essential to operate in different arenas: within the own group of partners, together with related projects, presenting and promoting at conferences and hosting own conferences for a wider audience. It is also important to take part in political gatherings. CLEANSHIP has taken part in seminars and conferences held by the shipping sector and authorities and by that have spread CLEANSHIP results and standpoints. For example, CLEANSHIP was represented at the Baltic Sea Standing Committee meeting in St Petersburg 2012 and presented the project in connection with the 51 session of the General Assembly of the UN. During the CLEANSHIP midterm conference the project partners updated participating maritime industry organizations and authorities on their specific results.

Russian seminars

Although being an EU project, it is necessary that all countries around the Baltic Sea are involved in matters regarding the common Baltic Sea. A special task in CLEANSHIP has therefore been to have an interrelation with the associated partners Rosmorport and GazProm. During two occasions CLEANSHIP invited representatives from GazProm and Rosmorport for common discussions and briefings regarding clean shipping in the Baltic Sea.

Collaboration with sister projects

During the project period two other related projects were running, one being a sister project of CLEANSHIP and also a EUSBSR Flagship project, BSR InnoShip, and the project Clean North Sea Shipping, a project of the North Sea Region Programme. There are several issues and subjects that overlap within the projects and therefore we have tried to update each other continuously and take part in each other's seminars and the like.

For information about BSR InnoShip and Clean North Sea Shipping see:

www.baltic.org/bsr_innoship and *www.cnss.no/*

Midterm conference in Riga and Partner meeting in Kaliningrad.

RUSSIAN PERSPECTIVE ON CLEAN SHIPPING

General short information

There are seven Russian sea ports located within the Baltic Sea area

In the eastern part of the Gulf of Finland:

- Port of St Petersburg;
- Passenger port of St Petersburg "Sea Façade";
- Primorsk;
- Ust-Luga;
- Vyborg;
- Vysotsk;

In the eastern part of Gdansk Bay

- Kaliningrad

The total cargo turnover of Russian Baltic Sea ports in 2012 was 207.2 million tons, the number of ship calls in was 36 223 and the total passenger traffic was 556.6 thousand people, of which 76% belongs to the Passenger port of St Petersburg "Sea Façade".

Sewage treatment in Russian Baltic Sea ports

Sewage treatment in Russian seaports as well as any other ship-borne waste treatment is carried out in accordance with requirements of international legislation (MARPOL 73/78, HELCOM 74/92) and Russian national legislation:

- Federal Law on Environment Protection;
- Water Code of Russian Federation;
- Federal Law on wastes of production and consumption;
- Federal Law on sea ports;

Every ship upon arrival has to submit a special Waste Management Checklist which contains an information of presence of wastes onboard (each category) and the ship's intention to discharge them to port reception facilities. In the ports of Ust-Luga, Primorsk, Kaliningrad and "Big Port of St Petersburg" all costs related to discharging and further treatment of ship-borne wastes are covered by an environmental due, which is paid by shipowners as any others port dues, such as the shipping due, navigational due, pilotage due, canal due etc. Thus the "No Special Fee" principle is realized – a principle for stimulating ships to discharge all wastes to on-shore reception facilities but not to discharge illegally at sea. That principle is a part of HELCOM's Baltic Sea Strategy on Port Reception Facilities and Baltic Sea Action Plan. Furthermore, in Russian seaports a 50% rebate from the environmental due is provided if a ship has approved equipment for waste treatment onboard (such as separators, incinerators, sewage treatment facilities etc.) and which actually use such equipment and which have respective Certificates on pollution prevention by oil, sewage and garbage. Thus an economical stimulation for calling modern "green" ships is realized. There is no environmental due in the ports of Vyborg, Vysotsk and Passenger port of St Petersburg "Sea Façade". In these ports shipowners pay directly to the company which renders service on ship-borne waste reception and treatment.

Each Russian Baltic Sea port (except Primorsk and Passenger port of St Petersburg "Sea Façade") has the following technology on ship-borne sewage management: ship's sewage is receiving by special collecting vessels (barges) and after that transporting to municipal sewage treatment system. Port of Primorsk has its own sewage treatment facility while each berth of the Passenger port of St Petersburg, "Sea Façade", is equipped with stationary connection point for sewage discharge from ships, which is connected with the municipal sewage treatment system.

Environmental Port Index

As a result of participating in the Clean Baltic Sea Shipping project the Russian side have had the opportunity to meet the ESPO initiative EcoPorts and acquired information on a common Baltic Sea Environmental Port Index, which includes indicators of good practice in environmental management of ports and shipping interests.

The current Russian seaport management system is rather centralized and does not look like any other European seaport management system. All seaports in Russia have federal submission to Federal Agency of Sea and River Transport (part of the Ministry of Transport). In ports, direct state management is provided by two federal organizations – Federal State Institution "Maritime Port Administration" (which provides safety of navigation and order within the port area) and Federal State Unitary Enterprise "Rosmorport" (responsible for effective use, maintenance and development of port infrastructure, and collecting most of the port dues).

Taking into account all above mentioned, the Russian side needed to determine which state

organization – the Federal Agency of Sea and River Transport, or FSI "Maritime Port Administration" or FSUE "Rosmorport" – had to represent Russian sea-ports in EcoPorts and the resulting Environmental Port Index. Unfortunately, there is still no answer on that question. As a result, no Russian ports are present in EcoPorts and the CLEANSHIP Environmental Port Index.

Onshore Power Supply in Russian Baltic Sea ports

The total amount of berths in Russian Baltic sea ports is 334, which have a total length of more than 48 km.

None of the existing berths for merchant shipping (i.e. for cargo or passenger operations) is equipped with OPS facilities, except 2 berths of railway ferry terminal in the port of Ust-Luga (4 connecting points 400A each). Any other Russian sea port has OPS system only for port fleet i.e. tugs, supply vessels, pilot boats etc.

All merchant ships receive electric power for internal needs during stay at Russian sea ports from auxiliary engines, which burn fuel and exhaust contaminate the ports' air, which is often the air of the city where the port is situated. This statement is fair for ports as Big Port of St Petersburg, Passenger Port of St Petersburg "Sea Façade", Vyborg and Kaliningrad. The ports of Primorsk, Ust-Luga and Vysotsk have a more advantageous location in relation to settlements – all of them are located far enough from any settlement.

Taking into account the current European trend to install OPS systems primarily on berths for passenger ships and ferries, it could be assumed that Russian ports should start OPS installation in the same way. First of all it concerns ports within the cities. It could start from the following berths:

- Berths of Passenger Port of St Petersburg "Sea Façade" which are able to receive vessels with lengths up to 330 m; the ship turnover is 726 ships/year (310 cruise ships and 416 ferries);
- Berths of Big Port of St Petersburg, first of all berths of passenger terminal on Vasilyevskiy Island;
- Berth of railway ferry terminal in the port of Kaliningrad (Baltijsk) which is able to receive vessels with length up to 200 m, cargo handling capacity is 5.3 million tons per year.

Nevertheless, the question of OPS installation in Russian sea ports needs more serious and detailed studies. Of course best available practice of sea ports of EU should be taken into consideration.

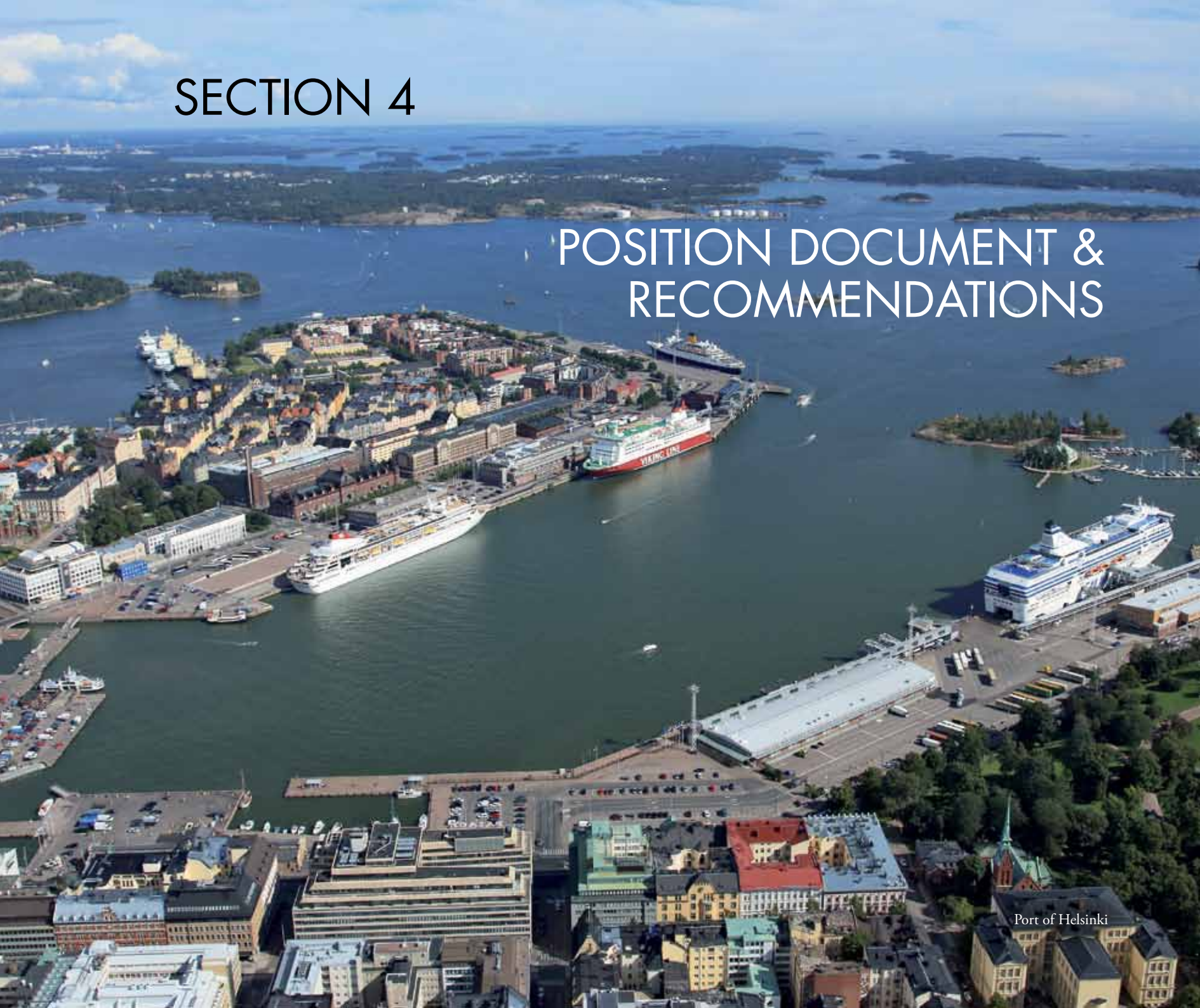
LNG as an alternative fuel for ships

Of course as every Baltic State Russia is also so concerned about what will happen in 2015 when the maximum sulphur concentration in marine fuel will decrease to 0.1%. Shipping and bunkering companies, ports and government authorities are looking for the way to survive under the new conditions. As well known, LNG is considered as one of the main alternative types of ships' fuels. However, despite the fact that Russia is one of the richest countries in the world on natural gas reserves, at the present time, there is no infrastructure for LNG supply and bunkering in the ports of Russian Baltic. There is no information yet about any ship reconstruction for use of LNG as a ship fuel. Let's hope that such information will appear shortly.

Port of St Petersburg

SECTION 4

POSITION DOCUMENT & RECOMMENDATIONS



Port of Helsinki

CLEAN BALTIC SEA SHIPPING POSITION DOCUMENT

The CLEANSHIP Position is to make an overview, and to describe and point out parameters in our society which the maritime industry judges will have a major influence on, and form the structural basis for the future shipping development in the Baltic Sea. These parameters have been researched by the project partners and are in our Position Document* described in principle. Together they give a perspective on the maritime industry´s own strategic basis for a successful developing factor in sustainable growth of the EU development.

The task was to identify all possible options for the shipping industry and port sector to undertake in order to make shipping more sustainable, cost-effective and even more useful for the development of a more sustainable world.

During the 3.5-year long project, we have in CLEANSHIP as forerunners developed new sustainable technical solutions on board ships, in our ports and onshore. Details are described in the Final report. It is a comprehensive list of successful undertakings of improvements and also full scale investments made by our project partners.

Together the CLEANSHIP undertakings give a thorough description of our present Position Document. It is our hope that this document can be used as an effective future tool for governments and stakeholders. Our joint main aim is to unify all powers, both political decision makers and branch stakeholders, to create cleaner shipping in the Baltic Sea, which will make it possible to keep on and further develop this strategically important transport link.

Background and aims of CLEANSHIP

- Reduce shipborne air pollution at sea, in ports and in port cities
- Reduce nutrient inputs from ships to the sea towards a zero-level
- Create a joint strategy for differentiated port dues
- Create pilot projects in full scale as best practice examples
- Create an interrealtion concerning the goals between all stakeholders

A core objective of CLEANSHIP was to abate the eutrophication of the Baltic Sea by reducing nitrogen emissions to air and water from ships, thereby assisting in making the Baltic Sea ecosystem sustainable. Another major objective was to facilitate for the Baltic Sea Region to become a model region for clean shipping, following new and coming international regulations and standards. This was done by presenting a broad spectrum of recommendations for ports and for the shipping industry in order for them to be able to select the most appropriate Best Environmental Practice Examples.

Maritime traffic in the Baltic Sea

The Baltic Sea Region counts 85 million inhabitants and is a busy maritime region with more than 2 000 ships operating at any given moment in the sea. The sea, especially the Baltic Sea, will become even more important as an economic area. As a trafficked area it accommodates sea roads and connects metropolitan areas, water and food resource, and further also functions as a recreation area for people - altogether it is a highly integrated area with huge demands from many stakeholders. A common understanding of all those stakeholders has to be the protection and sustainable growth of this sea. Indeed, there is a strong argument to undertake every effort to protect our environment and therefore the Baltic Sea: It is our living space, workshop, our connection to neighbours, business partners and friends – and it is the only one we have.

The sensitive Baltic Sea

In a global perspective, the Baltic Sea is a small area, but it is one of the world's largest reservoirs of brackish water and ecologically unique. At the same time it is a relatively shallow sea, which has a negative impact on the ability to rejuvenate. The Baltic Sea is one of the most congested shipping areas of the world. Only the English Channel shows a comparable traffic volume.

From 2015 fuel with 0.1% sulphur must be used by ships sailing in the Baltic Sea. Moreover, HELCOM has finalized the documentation to the International Maritime Organization (IMO) to designate the Baltic Sea as a NO_X Emission Control Area (NECA) under the international MARPOL Convention Annex IV, and from 2021 the strictest NO_X emission standard is to be enforced.

*Prepared by Baltic Sea Forum and Port of Trelleborg

This environmentally positive development has to be aligned to feasible technology and economic conditions to prevent an unwanted shift from sea to road. Indeed, for example, the lowered limit for sulphur in fuel has increased the demands for new technological innovations. Quite often sustainability and, as part of it, environmental protection, is perceived as a nuisance and just costly. This approach needs to be changed dramatically and there are good arguments to persuade doubters. Sometimes novel thinking and a different view on existing solutions can also help to create new concepts. Many innovative technologies available nowadays not only help to protect the environment but also have a positive impact on cost.

The transport sector can combine their environmental responsibility with new perspectives and opportunities for employment in the sector. For example, natural gas has become an attractive source of clean energy for transport, drawing new entrants into a global LNG market. This can stimulate record levels of growth in LNG infrastructure, technological innovation and job creation.

Becoming a model region for Clean Shipping

Being a closed area in the middle of well-developed industrial bordering countries, the Baltic Sea Region has a good chance to become a model region and to set standards for other areas worldwide. Initiatives such as the CLEANSHIP project rightly support both environmental protection and economic development, which have an impact on the social wealth as well - sustainability in its best form. Universities, science institutes and private companies as well as governmental and non-governmental organizations are joining forces to support such initiatives. The European Union member states have to provide financial resources to support such projects and to create support programmes.

The CLEANSHIP position is that other maritime regions should abide to the same regulations and implementation efforts, such as the best practice examples provided in the CLEANSHIP project for a cleaner maritime sector.

Importance of further national and international support of clean shipping efforts made voluntarily by the maritime industry

Shipping is a highly regulated but also integrated industry and ports and ships are much more linked than they sometimes recognize. For example, regulations under which shipping companies have to use low sulphur fuel have an increasing impact on fuel cost. Ports will also be confronted with the simple calculation that it will be more expensive to sail and it is probable that shipping companies will not hesitate to ask the port for compensation in form of reduced port fees or even stop operation.

It is of importance to attract the entire maritime industry to reduce its air emissions and to create further investments in new technology that stops pollution from ships at sea in the Baltic Sea Region. It is, however, not presently possible for maritime industry stakeholders entirely on their own to generate the necessary incentives needed to create a large scale implementation of environmental technology and alternative fuels. It has, however, become understood that political will on governmental level must become unified in this direction, especially between HELCOM nations in the Baltic Sea Region. It seems necessary today, in order to create full support for reducing ship air emissions, also to compare ton-kilometer costs for long range land transports contra sea transport links on equivalent routes. It is necessary to create economic mechanisms in order to get full environmental benefits of shipping compared to land transport routes. For example, public funding as an initial investment support may be appropriate.

This underlines the necessity for high level political influence at governmental and EU level, to come to a joint understanding and undertake decisions to create economic mechanisms that will make clean fuels and to convert the shipping fleet for this task a financially viable option.

Means to improve the total overall efficiency of all transports of goods in the European Union

Fast and effective sea transports between the different parts of the European Union's sea links are imperative for the growth of the entire EU. Increased land transports over long distances demands further costly investments in motorways on the European continent that already has a number of highly congested cities. This may be considered

as a good reason to use maritime transport as a means to pass congested areas via new routes. Moreover, the much lower energy consumption per ton-kilometer during ship voyages combined with a higher accuracy concerning preplanned arrivals to final destinations is a future development which can become foreseen. Further innovations need to be developed by the shipping transport sector itself in order to create an even more efficient sea transport link compared to land transports.

Further major investments in port infrastructure developments, the identification of Core Object ports in EU, and the effectiveness and efficiency of transport links on land to and from these ports via roads, railways and inland waterways must be major concerns for the decision-makers in the EU Commission and EU Parliament. Ferry operation forms an integrated link of this combined traffic and, given the regulations on reduced sulphur content in ship fuel from 2015, the specific competitive situation should be considered. Such infrastructure investments have to be given highest priority in the EU long-term budget 2014-2020.

CLEANSHIP supports TEN-T guidelines and its financial instrument, the Connecting Europe Facilities, and that ports should strive to become even more environmentally oriented by, for example, implementing good practices identified in the CLEANSHIP project. CLEANSHIP welcomes the port investments in intermodal transport combinations and efforts to open up alternative land transport routes leading to major ports and to decreased land transport congestions by investments in infrastructures around the ports, such as road links and construction of efficient and environmentally improved cargo handling.

Combinations of highly effective cargo handling in major ports, achieved through new and efficient integrated ship and port transport systems, and a major and more efficient steering of the flow of goods to preferred/best transported routes, will promote and lead to a more effective and faster growth development of the entire EU. Here, the Core Ports in the Baltic Sea and on the European Continent are well-placed to contribute very effectively to the transport efficiency and growth. The integrated approach to the environmental management of the Logistic Chain (in which shipping and ports are such key players) drawing on CLEANSHIP recommendations can make a substantive contribution to the optimization of transport routes, the reduction of pollution in the Baltic Sea, enhance environmental quality and act as a catalyst for sustainable development.

CLEAN BALTIC SEA SHIPPING RECOMMENDATIONS

The CLEANSHIP project is an entirely voluntary programme where a wide range of stakeholders including shipowners, major ports, coastal societies, local and regional governments, and special interest environmental pressure groups in the Baltic Sea Region joined forces to decrease pollution, encourage sustainable development and reverse the trend of impending eutrophication.

The CLEANSHIP recommendations reflect the actions necessary during the coming long-term EU Budget period 2014-2020, if as a society (including politicians, citizens and maritime industry professionals) the objectives of implementing a cleaner sea transport system (as part of the Logistic Chain) and addressing the challenges of global climate change are to be met. At the core of CLEANSHIP has been the joint elaboration of a clean shipping Final report, preparation of pilot activities including supporting analyses, and the harmonization and standardization of environmentally related infrastructure.

A total and integrated cooperation concerning environmental maritime issues between all concerned bodies is of great importance for the future of the entire Baltic Sea Region and all its shipping issues. Representatives from the maritime industry, partners of CLEANSHIP, have compiled a series of recommendations for evaluation and consideration for action by local, regional and national responsible authorities. It may reasonably be suggested that the environmental imperative will be best served by the full collaboration and support from all HELCOM nations.

PORT ENVIRONMENTAL MANAGEMENT

The Environmentally Differentiated Port Fees and the Port Index options were clearly identified in the Project objectives as substantive agenda items. They were researched in the context that the Port Index should act as a catalyst and indicator of good practice, and that the Index and Fee options should assist in the overall environmental management of combined port and shipping interests.

Environmentally Differentiated Port Fees

The potential common voluntary based system for environmentally differentiated port fees in the Baltic Sea will be valid from 1st January 2015 and the system boundary is air pollution of local influence. The four elements included in the scheme are: NO_X, PM, Noise and, Chemicals and there are to date no ideal/optimum Index/initiative to use.

Recommendations:

- CLEANSHIP recommends that a fee system must be compliance-lead, based on audited and certificated evidence, be user-friendly and practicable, identify appropriate index models and adapt as necessary, and also consolidate.
- CLEANSHIP recommends the following index/initiative or measures for the elements included in the proposed system:

NO_X: there are several options, e.g. Swedish Maritime Administration

PM: Rebate for LNG, OPS or low PM emissions

Noise: OPS, silent class, noise abatement programme

Chemicals: CSI or Blue Angel

Environmental Port Index

After development, evaluation and validation through a structured research pathway involving feed-back from port professionals and site-specific data, the following conclusions were reached:

- The index is feasible and practicable, would assist EC policy to practice.
- Baltic Ports are competent to populate Index and EPIs are validated.
- The Index has the potential to offer mutual benefits to port, sector and Society.
- The Index integrates port and shipping interests, with potential interest for the Chain
- The Index is generic in principle and adaptable to port-specific circumstances in practice.
- The Index can provide baseline and benchmark performance measures.
- The development of the Index has drawn on the EC PPRISM project, complements the dashboard initiative of ESPO, and has potential input and influence on the forthcoming PORTOPIA Project.

Recommendations:

- Consideration could be given to the active promotion of implementation of the index through the auspices of BPO/ESPO/EcoPorts.
- Recognition should be given to port authorities that adopt and contribute to the Index eg equivalent to 'EcoPort' status (see www.ecoports.com).
- Use existing mechanisms to calculate Index, offer training, and encourage monitoring and reporting eg through or in collaboration with BPO/ESPO/EcoPorts.
- Harmonize performance in the Baltic Sea.

ALTERNATIVE FUELS IN SHIPPING

There will be a need for a wide variety of alternative solutions to meet the upcoming IMO regulations on sulphur content in ship fuel because, for example, different ship types and ship ages will require different solutions. There are today three obvious options for meeting Emission Control Area (ECA) requirements: i) installing a scrubber, ii) switching to low sulphur fuel oil, or iii) to go for LNG as fuel and installing gas engines. Political support to LNG as a marine fuel was expressed by the EU Clean Fuel Strategy.

Recommendations:

- Shipowners and ship designers are encouraged to search for solutions which do not only decrease the sulphur content but minimizes all other combustion pollution in terms of NO_X and CO_2 gases and particles from engines.
- Shipowners should be supported through all stages of the decision-making process as they prepare to meet the IMO air emission regulations entering into force from 2015. The support should be defined by infrastructural development and changed management support tools.
- CLEANSHIP believes that LNG is a good option for newbuilds while methanol and scrubber systems could be good solutions for existing ships.
- Supporting LNG use in the Baltic Sea region by integrating the Clean Fuel concept of EU in an Environmental Port Fee should be taken into consideration.
- Governments should take actions to foster the public perception on LNG as the increasing public scrutiny poses a challenge to LNG stakeholders.

ONSHORE POWER SUPPLY (OPS) FOR SHIPS AT BERTH

By delivering all energy to ships in port from the shore side and shutting off auxiliary engines on board, the pollution form ship engines in port will be reduced to a zero level. The optimal reduction in pollution is delivered when the port provides OPS from renewable energy resources as demonstrated in Norway and Sweden.

Recommendations:

- CLEANSHIP recommends that all ports with regular commercial traffic investigate the possibility to implement OPS facilities, taking into account the CLEANSHIP OPS Handbook.
- Local and national governments should demonstrate an interest to support shipowners and port operators, and make OPS a natural solution. A number of our partner ports have managed to facilitate the necessary installations, but so far it is a very small amount of ports which are fully up to date and have full capacity to offer the shipowners high-voltage OPS.
- A particular challenge of implementation of OPS occurs in private ports where the society does not own the port and does not control the establishing possibilities. Port operators and port owners have to integrate their efforts and create a joint interest in servicing ships in ports with high-voltage OPS. This administrative problem needs to be overcome, and a joint understanding established.
- It is recommended that shipowners and ports should cooperate to find joint standpoints for future installations of subsequent technical connective solutions, as standardisation of high-voltage equipment and standardization of frequency are of help when seeking the most cost effective connection solutions.

PORT RECEPTION FACILITIES (PRF) FOR SHIP SEWAGE

The International Maritime Organisation (IMO) has decided that from 2016 all new passenger and cruise ships are not allowed to discharge their sewage into the sea (MARPOL Convention Annex IV). From 2018, the same ban will apply to all passenger and cruise ships travelling in the Baltic Sea.

Recommendations:

- An essential part of the PRF chain is the municipal waste water treatment plant. Ports and municipalities are therefore encouraged to cooperate in handling ship sewage.
- It is recommended that ports in the Baltic Sea Region investigate the possibility to implement PRF for ship sewage (black and grey water), and equip their port as soon as possible. The ports can then pump ship sewage into the municipal sewer system leading to a waste water treatment plant. A number of the CLEANSHIP partner ports have already done so, and act as forerunners. In smaller ports, where pumping to the municipal sewer system is not possible, other alternative solutions to collect sewage from ships should be installed.
- Food wastes are recommended not to be added to the grey water, but taken care of separately as garbage.
- In some cities the costs for upgrading of the port´s and the municipality sewage reception systems are high and becoming principal obstacle for implementation. In short, in large ports, situated in smaller municipalities, further investments may have to be supported through federal aid in respective country.
- CLEANSHIP recommends that the countries of the Baltic Sea apply a common No Special Fee directive, which would result in a more even distribution of ship sewage between the ports.

REFERENCES

1. Conley, D.J. 2012. Ecology: Save the Baltic Sea. Nature 486:463-464.

2. Gustafsson, B.G., Schenk, F., Blenckner, K.E., Meier, H.E.M., Muller-Karulis, B., Neumann, T. Ruoho-Airola, T., Savchuk, O.P. and Zorita, E. 2012. Reconstructing the Development of Baltic Sea Eutrophication 1850-2006. AMBIO 41:534-548.

3. HELCOM. http://www.helcom.fi/BSAP_assessment/eutro/HEAT/ (taken from internet 2013-07-18)

4. ENVISAT/ESA. https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/envisat

5. HELCOM. http://www.helcom.fi/stc/files/shipping/Overview%20of%20ships%20traffic_updateApril2009.pdf (taken from internet 2013-07-18)

6. Stipa, T., Jalkanen, J-P, Hongisto, M., Kalli, J. and Brink, A. 2007. Emissions of NOx from Baltic shipping and first estimates of their effects on air quality and eutrophication of the Baltic Sea.

7. Jalkanen, J-P., Johansson, L., Stipa, T. 2012. Emissions from Baltic Sea Shipping in 2011. HELCOM Baltic Sea Environmental Fact Sheet. http://www.helcom.fi/BSAP_assessment/ifs/ifs2012/en_GB/Ship_emissions_in_2011/

8. HELCOM. http://www.helcom.fi/ environment2/eutrophication/en_GB/action/ (taken from internet 2013-07-18)

9. European Commission. Strategic goals and recommendations for the EU's maritime transport policy until 2018. COM(2009) 8.

10. HELCOM http://meeting.helcom.fi/c/document_library/get_file?p_l_id=18971&folderId=1323170&name=DLFE-44907.pdf (taken from internet 2013-07-18)

11. DNV 2010. Greener Shipping in the Baltic Sea. http://www.dnv.fi/Binaries/Greener%20Shipping%20in%20the%20Baltic%20Sea_tcm146-429433.pdf (taken from internet 2013-07-18)

12. Second IMO GHG Study. 2009. Prevention of air pollution from ships. Marine Environment Protection Committee.

13. Edman, M. and Omstedt, A. 2013. Modeling the dissolved CO_2 system in the redox environment of the Baltic Sea. Limnology and Oceanography 58: 74-92.

14. Conley, D.J., Humborg, C., Rahm, L, Savchuk, O.P. and Wulff,F. 2002. Hypoxia in the Baltic Sea and basin-scale changes in phosphorous biogeochemistry. Environmental Science and Technology 36: 5315-5320.

15. ESPO Green Guide 2012. http://www.espo.be/images/stories/Publications/codes_of_practice/espo_green%20guide_october%202012_final.pdf (taken from internet 2013-07-18)

16. Bromberg, L. and Cheng, W.K. 2010. Methanol as an alternative transportation fuel in the US: Options for sustainable and/or energy-secure transportation. Massachusetts Institute of Technology.

17. The Danish Maritime Authority. 2012. North European LNG Infrastructure Project-A feasibility study for an LNG filling station infrastructure and test of recommendations feasibility study for an LNG filling station infrastructure and test of recommendations.

18. Trafikanalys 2013. Konsekvenserna av skärpta krav för svavelhalten i marint bränsle – delredovisning. Rapport 2013:7.

19. European Commission 2010. http://ec.europa.eu/commission_2010-2014/kallas/headlines/news/2013/01/clean-fuel-strategy_en.htm (taken from internet 2013-07-18)

20. Bakosch, A. 2011. Undersökning av försörjningskedjor för flytande naturgas utifrån energibehovet i Trelleborgs Hamn. Linköping University.

21. Eurostat. http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/

22. Strategic goals and recommendations for the EU's maritime transport policy until 2018. http://ec.europa.eu/transport/themes/strategies/2018_maritime_transport_strategy_en.htm, (taken from internet 2013-07-18)

23. Cohesion Policy 2014-2020 – Investing in growth and jobs. 2011. http://ec.europa.eu/regional_policy/sources/docoffic/official/regulation/pdf/2014/proposals/regulation2014_leaflet_en.pdf (taken from internet 2013-07-18)

LIST OF ABBREVIATIONS

BSR – Baltic Sea Region

CBG – Compressed Biogas

CNG – Compressed Natural Gas

CO_2 - Carbon Dioxide

EMS – Environmental Management System

EPI – Environmental Performance Indicator

ESPO – European Sea Ports Organisation

EUSBSR – The European Union Strategy for the Baltic Sea Region

HELCOM – Helsinki Commission

HFO – Heavy Fuel Oil

IMO – International Maritime Organisation

KPI – Key Performance Indicator

LBG – Liquefied Biogas

LNG – Liquefied Natural Gas

MGO – Marine Gas Oil

NO_X - Nitrogen Oxides

OPS – Onshore Power Supply

PM - Particulate Matter

PRF – Port Reception Facility

PSSA – Particularly Sensitive Sea Area

RoPax – Ships rolling goods and passengers.

RoRo – Roll on roll off, i.e. vessels taking cargo on board as truck trailers or other rolling items.

SO_X - Sulphur Oxides

LAYOUT AND COVER ART
Märka design, Lund, Sweden

PRINTED AT
Exakta Printing, Malmö, Sweden

CLEANSHIP

CLEAN BALTIC SEA SHIPPING

Flagship project of Priority Area 4 of EUSBSR

CLEAN BALTIC SEA SHIPPING

CLEAN BALTIC SEA SHIPPING

Baltic Sea Region Programme 2007–2013

Part-financed by the European Union
(European Regional Development Fund
and European Neighbourhood and
Partnership Instrument)

EUSBSR
EU STRATEGY
FOR THE BALTIC
SEA REGION