BONUS Research Project

Call2014-41

Deliverable 1.1, type RE

Drivers for the shipping sector

Due date of deliverable: project month 8

Actual submission date: project month 8

Start date of project: 1 April 2015 Duration: 36 months

Organisation name of lead contractor for this deliverable: Ecologic Institute

Scientist responsible for this deliverable: Benjamin Boteler

Organisation name/names responsible for revision: SDU

Scientist(s) responsible for the review: Knud Sinding

Revision: [1]

SHEBA

Sustainable Shipping and Environment of the Baltic Sea region

BONUS Research Project

Call 2014-41

Deliverable 1.1, type RE

Drivers for the shipping sector

30 November 2015

Due date of deliverable:	project month 8
Actual submission date:	project month 8

Start date of project: 1 April 2015 Duration: 36 months

Organisation name of lead contractor for this deliverable: Ecologic Institute

Scientists responsible for this deliverable:

Benjamin Boteler, Jenny Tröltzsch, Katrina Abhold, Manuel Lago (Ecologic Institute), Thong Tien Nguyen, Eva Roth (SDU), Erik Fridell, Hulda Winnes (IVL), Erik Ytreberg (Chalmers), Markus Quante, Volker Matthias (HZG), Jukka-Pekka Jalkanen, Lasse Johansson (FMI), Jakub Piotrow, Uszula Kowalczyk (GDA), Kaimo Vahter, and Urmas Raudsepp (MSI)

Organisation name/names responsible for revision: SDU

Scientist(s) responsible for the review:

Knud Sinding (SDU), Jana Moldanova (IVL), and Erik Fridell (IVL)

Revision: [1]

1 Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

LIST OF ABBREVIATIONS

BDI	Baltic Dry Index
BSAP	Baltic Sea Action Plan
BWMC	Ballast Water Management Convention
CBD	Convention on Biological Diversity
CFP	Common Fisheries Policy
CO_2	Carbon Dioxide
COP	Conference of the Parties
CSI	Clean Shipping Index
dwt	deadweight tonnes
EC	European Commission
ECA	Emissions Control Area
EEDI	Energy Efficiency Design Index
ESI	Environmental Shipping Index
EU	European Union
GDP	Gross Domestic Product
GES	Good Environmental Status
GHG	Greenhouse Gas
GT	Gross Tonnage
GVA	Gross Value Added
HELCOM	Baltic Marine Environment Protection Commission - Helsinki Commission
IMO	International Maritime Organisation
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MARPOL	International Convention for the Prevention of Pollution from Ships (MARPOL)
MRV	Monitoring, Reporting and Verification
MSFD	Marine Strategy Framework Directive
MSY	Maximum Sustainable Yield
NO_X	Nitrogen Oxides
NSF	No Special Fee
PM	Particulate Matter
SEEMP	Ship Energy Efficiency Management Plan
SO_X	Sulphur Oxides
TAC	Total Allowable Catch
TEN-T	Trans-European Transport Network
TEU	Twenty-foot Equivalent Unit
UNFCCC	UN Framework Convention on Climate Change
WFD	Water Framework Directive

D1.1 Drivers for the shipping sector

1 Introduction

The objective of this report is to assess the current policy and socioeconomic drivers affecting shipping and other vessels globally and in the Baltic Sea region. The report provides a 'baseline' reference of key policy and socioeconomic drivers against which potential future changes to vessel activity can be assessed.

This assessment is conducted within the BONUS project Sustainable Shipping and Environment of the Baltic Sea region (SHEBA), Work Package 1, *Policies, Activity Data and Scenarios*, Task 1.1 *Drivers and policy for the shipping sector*. The results of this Task will be used to help create the scenarios in Task 1.3 *Future scenarios.* The different realisations of potential developments in the maritime sector based on the drivers discussed in this report will be later analysed in Task 1.3. The basic scenario will consider decided legislation and expected transport demand to construct a scenario that describes ship types and size, shipping routes, fuel mix in the sector and the use of technologies relevant for the environmental impact (scrubbers, NO_X-abatement, ballast water systems, underwater noise, etc.).

1.1 Report structure

An overview of the report's structure is provided here, and a short background is presented in the Section 1.2.

- **Section** 2 describes the **approach and methodology** taken to assess the current state of vessel traffic in the Baltic Sea with respect to its policy and socioeconomic drivers impacting air, water and noise pollution.
- **Section 3** presents the **current policy context affecting shipping and other vessels** both globally and in the Baltic Sea. Therefore, in Section 3.1 this work presents the current implementation of international, European Union (EU) and regional (i.e. for the Baltic Sea) policies, while national policies are presented in Section 3.2. The focus is on policies to manage water and air emissions as well as noise. This 'snapshot' describes the different policy instruments that will or could be applied to achieve the main policy objectives of the Baltic Sea Action Plan, the EU Marine Strategy Framework Directive, among others.
- **Section** 4 presents **socioeconomic drivers affecting shipping and vessel traffic**. It identifies and provides a brief assessment of socioeconomic drivers of vessel activity globally and in the Baltic Sea region in Section 4.1. It uses available data and statistics to help support this description. Sector specific drivers separated into demand and supply side drivers are discussed for shipping vessels (Section 4.2), for fishing vessels (Section 4.3), and leisure boats (Section 4.4).
- **Section** 5 gives a brief overview of **random shocks and unexpected events** that may cause significant impacts on vessel activities and traffic. These events are impossible to identify or determine, but are highly important to consider and are included as they can bring the system out of balance and can happen on different scales.

- **Section** 6 is used to discuss the **potential outlook** for shipping and vessel traffic. It is based on previous sections as well available forecasts and data for the policies and sectors.
- **Section** 7 builds on the previous sections to provide the main lessons learnt and **key messages** as bullet points.
- In addition, **potential indicators** for policy and socioeconomic drivers, which will be useful for similar future assessments as well as the SHEBA project, Task 1.3 **are collected and described in the Annex**.

1.2 Background

Shipping is an important economic sector both globally and within the EU,[1] and continues to grow each year (UNCTAD, 2014). Over recent decades, globalisation, EU enlargement and the steady growth of developing economies (i.e. China) contributed to significant increases in both the import and export of raw materials and commodities. This resulted in unprecedented growth in shipping and its supporting industries (Douglas-Westwood Limited, 2005). Despite a substantial decline in production, trade and shipping activities caused by the global financial crisis, European ports (gross weight of seaborne goods handled in European ports) experienced a clear recovery in 2010, demonstrating that shipping is continuing its growth (Eurostat, 2010). In 2013, the vast majority of goods in the EU were shipped via sea transport, amounting to 75.3% of all imported and exported goods by weight (or 1,690.2 million tonnes) (EC, 2015a). The value of this transport mode to overall trade equated to 1,733.7 billion EUR, or 50.7% of trade in the EU (EC, 2015a). The Baltic Sea is a major trade route for the export of Russian petroleum and it is estimated that about 2,000 ships are at sea at any one time, while 150—200 large oil tankers are harboured in twenty ports around the sea each day (HELCOM, 2010a). In addition to transporting goods, the Baltic Sea also has some of the highest passenger rates, with eight of the top twenty ports for passengers embarking and disembarking located in the Baltic region (Eurostat, 2015).[2]

There has been a general decreasing trend in Europe's fisheries resources over the past 50 years and many fish stocks are overexploited today. There has been a reduction in fishing effort in the Baltic Sea since 2005, especially with respect to larger trawlers and beam trawlers (EC, 2013a). Data shows that Baltic Sea fishing fleet[3] is comprised of 6,256 active vessels as of 2013 and that collectively they spent 384,000 days at sea for the year (STECF, 2015).

European residents[4] own an estimated 6 million recreational boats (EC, 2006).[5] Recreational boats are predominantly sold in four Member States, Germany, France, Italy and the United Kingdom, accounting for 63% of industry revenues. Yet per capita boat ownership is almost ten times higher in Scandinavian countries than in Europe, and these countries account for over 14% of industry revenues (EC, 2006). Some 3.5 million leisure boats in the Baltic Sea use the coastal areas for recreational boating (CHANGE, 2015). Seaports and recreational boating generate 284,000 and 253,000 jobs respectively, with a 13-14% share of total employment each (EC, 2006). The recreational boating market in Europe is expected to grow faster than North America in coming years (Research and Markets, 2015).

[1] EU 28 countries, since 2012
[2] Eight Baltic ports in the top twenty for passengers embarking and disembarking: Helsingør (Elsinore), Rødby (Færgehavn), Puttgarden, Tallinn, Helsinki, Turku, Helsingborg, and Stockholm.
[3] Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden.
[4] Including Norway, Switzerland, Croatia, Romania, Bulgaria and Turkey.
[5] Excluding kayaks, sailboards and other small boats (those under 2.5 m or lightweight inflatables)

This heavy amount of vessel traffic, in combination with other environmental pressures such as coastal tourism, urbanisation, fishing and climate change, has resulted in increasing environmental problems in the region. These include air pollution, water pollution and underwater noise.

Air pollution from shipping result from the combustion of sulphur-rich heavy fuel oil or marine diesel oil, both in transit and while idling in ports and harbours. Some of the most important exhaust pollutants from ships—sulphur dioxide (SO_2), nitrogen oxides (NO_X) and particulate matter (PM)—have negative effects on human health and ecosystems, resulting in increased human mortality and morbidity, as well as acidification and eutrophication of freshwater and marine waters.

Water pollution is another serious issue in the Baltic Sea; eutrophication from excess nutrient input within the catchment area, linked to harmful algal blooms, as well as shipping accidents that release pollution into the Baltic Sea. Furthermore, introduction of invasive alien species through ballast water and hull-fouling vectors can induce changes in ecosystem dynamics, hampering both economic and ecosystem functioning (HELCOM, 2013, 2010a). From 2000 to 2010, an estimated thirteen new invasive alien species were introduced to the region, with nearly half of these species introduced from shipping activities (EEA, 2015). Other sources of contaminants/hazardous substances from ships include bilge water and sewage that can be regarded as chemical cocktails, which contain various stressors both from the waste itself as well as the treatment method (Stamper et al. 2008).

Lastly, scientific results unequivocally suggest that marine animals react to shipping-induced noise, sometimes with devastating results, but more commonly with strong avoidance reactions (Yang et al., 2008; Moore et al., 2012). Recognising the problem of underwater noise, the European Commission (EC) included sound as the eleventh descriptor in the MSFD, making it analogous to pollution. It is likely that underwater noise levels and their subsequent effects on marine ecosystems have been increasing since the advent of steam-driven ships, although very few studies that have quantified such changes.

Policy makers are faced with a complex challenge to integrate environmental and economic goals into shipping and maritime vessels. Moreover, maritime activities are often cross-border activity, involving two or more countries or regions. Thus it is necessary to consider and evaluate shipping, fishing vessels, and recreational boating in order to plan for the future, according to the state and expected growth (or decline) of these activities.

2 Approach and methodology

The approach taken in this study collated information gathered from a literature review, results of a stakeholder workshop, as well as expert opinions from national contacts in Denmark, Estonia, Finland, Germany, Poland and Sweden. This information was then used to assess the current state of shipping and vessels in the Baltic Sea, with respect to its policy and socioeconomic drivers. The focus was on legislative and voluntary obligations to reduce the environmental impact of shipping- and vessel-induced air, water and noise pollution.

A literature review of existing shipping environmental legislation, as well as academic and grey sources, provided a foundation upon which to develop and pose questions to workshop stakeholders and country experts. This review covered international, EU and Baltic environmental policies which affect the shipping industry. The initial search delved into previously identified policies, relevant to the focus areas, including: the Baltic Sea Action Plan (BSAP); the EU Marine Strategy Framework Directive (MSFD); the EU Water Framework Directive (WFD); the EU Green Book on transport; I, IV, V and VI of the International Convention for the Prevention of Pollution from Ships (MARPOL) of the International Maritime Organisation (IMO); the IMO Ballast Water Management Convention (BWMC); Annexes and the EU Air Quality Framework Directive. A general web search complimented these findings to provide an idea of possible future expectations for the shipping industry's environmental performance (i.e. technical adjustments, noise legislation, fuel alternatives, ballast water technology, etc.).

The initial results of the literature review helped frame the questions posed to workshop stakeholders, which can be found in Annex 1.1 Questions Posed to Stakeholders at Workshop. The workshop, held from 29-30 September 2015 in Hamburg, Germany, aimed to validate research conducted, as well as elicit experience and knowledge of the stakeholders.[6] External participants spanned a wide group, including port authorities, shipping industry representatives, government officials, leisure boating representative, coastguard service, and university researchers and scientists. The consultation utilised the World Café method, a creative process to facilitate knowledge and idea sharing as well as collaborative dialogue. In groups of 4-8, participants discussed sets of questions around café tables covered in sheets of paper for note-taking, moderated by a table host and expert from the project. At regular intervals, participants moved to a new table where a different set of questions were posed and where the table host provided a summary of the previous conversation to the new group. This method ensures that the proceeding conversations are cross-fertilised with the ideas generated in the former ones. There were three policy sessions, which focused on the current policy mix, the future of shipping policy (focus on international and EU policy), and shipping in the Baltic. At the end, the main ideas were summarised in a plenary session and follow-up possibilities were discussed.

In addition to framing the questions posed to stakeholders, the initial results of the literature review also helped frame questions posed to national experts in the Baltic. A template (see Annex 1.2 Template Sent to Country Experts) was developed and sent to experts in Denmark, Estonia, Finland, Germany, Poland and Sweden to fill out and send back. The responses to these templates were then incorporated and cross-checked with the results of the literature review and stakeholder consultations with respect to the current state of shipping in the Baltic Sea.

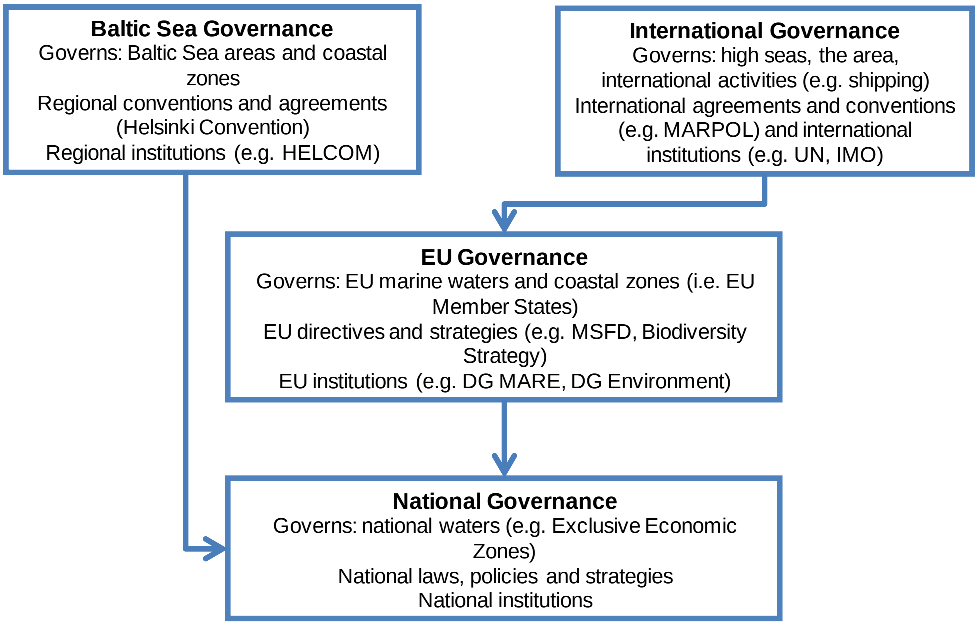
3 Key policies affecting shipping

Due to increased awareness of environmental issues and significant vessel traffic both globally and in the Baltic Sea regions, a number of policies have been established in an effort to reduce shipping-induced environmental pressures. Because of the global nature of shipping, the International Maritime Organization (IMO) and their regulations are of key importance, while environmental protection in the Baltic Sea also results from the Baltic Marine Environment Protection Commission - Helsinki Commission (HELCOM) and the EU, in addition to different national, regional and local policies adopted in different Member States. The main purpose of the IMO is to develop an international regulatory framework for the shipping industry. It is a specialised agency of the United Nations and the regulations underpin global standards. HELCOM, on the other hand, has a regional

[6] Twelve stakeholders from Denmark, Germany, Poland, Sweden and Latvia attended the workshop.

focus in the Baltic Sea area and is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area. Country-specific policies usually focus on fairway dues, leisure boats and port fees, which in some countries or regions have environmental-related components. See Figure 1 for an overview of marine governance levels.

Figure 1: Overview of Marine Governance Levels



Source: Authors

Some of the most important regulations come from the IMO, including the International Convention for the Prevention of Pollution from Ships (MARPOL). In addition to MARPOL, the IMO also drafted the International Convention for Control and Management of Ships' Ballast Water and Sediments (BWMC) in 2004, which aims to act as the global instrument to regulate the management, treatment and release of ballast water. Currently, the BWMC has not entered into force, as it requires more country ratifications (EEA, 2015). Increasing environmental performance standards, such as included in the BWMC, may pose a challenge to the shipping industry, as IMO regulations are transferred to EU directives and national level regulations.

The IMO has also adopted regulation on air emissions concerning energy efficiency and greenhouse gas emissions (GHG), nitrogen oxides (NO_X), sulphur oxides (SO_X) as well as water emissions, such as the antifouling convention or regulations concerning invasive species. Noise emissions are not yet regulated at the level of IMO.[7] Regional legislation mainly comes in the form of the Baltic Sea Action Plan (BSAP), which aims to restore the good ecological status of the Baltic Sea by 2021. Other important policies include regulations on sulphur in marine fuels and the possibility to use scrubbers, the possible future introduction of a NO_X Emissions Control Area (ECA) in the Baltic Sea and the pressure on the shipping sector to reduce its CO_2 emissions. Furthermore, due to the stringent environmental regulations for leisure boats proposed in Directive 2013/53/EU, national policies such

[7] Though the IMO did adopt voluntary guidelines to reduce underwater noise from commercial ships in 2013: http://ocr.org/pdfs/policy/2014_Shipping_Noise_Guidelines_IMO.pdf

as environmentally differentiated port dues and fairway dues are included as well as private initiatives for transport service buyers such as the Clean Shipping Index.

3.1 International, European, and Baltic Sea Region Legislation

In this chapter the international, European and Baltic Sea region regulation regarding environmental protection from maritime shipping in the Baltic Sea is described. Due to the multiple environmental pressures associated with shipping and marine vessels, as well as growing interest in environmental protection, willingness to address these pressures at all levels of governance has increased. Therefore, over recent decades, multiple regulations have passed and come into force. These especially focus on SO_X, NO_X, PM, GHG, alternative fuels, ballast water management, antifouling and recreational crafts.

MARPOL is the main international convention regarding environment pollution of ships – adopted by the IMO in 1973. Through the years, different Annexes were added and amended; see Table 1.

Table 1: Overview of the MARPOL Annexes

MARPOL Annex	Objective/coverage	Date of entry into force
Annex I Regulations for the Prevention of Pollution by Oil	Prevention of pollution by oil from operational measures as well as from accidental discharges via double hulls for tankers.	2 October 1983
Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk	Details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk. 250 substances are listed, their residue discharge is only allowed to reception facilities.	2 October 1983
Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form	General requirements for the issuing of detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifications of harmful substances.	1 July 1992
Annex IV Prevention of Pollution by Sewage from Ships	Requirements to control pollution of the sea by sewage.	27 September 2003
Annex V Prevention of Pollution by Garbage from Ships	Deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of.	31 December 1988
Annex VI Prevention of Air Pollution from Ships	Limits on sulphur content in fuel and nitrogen oxide emissions from ship; mandatory technical and operational energy efficiency measures.	19 May 2005 (amendments expected 1 September 2015)

Source: IMO (2015a)

Different international and supranational policies on air emissions are also influencing MARPOL processes. The Convention on Long Range Transport of Air Pollution (UN/ECE 1979) with its protocols was translated into several EC directives. To reduce the impacts of air emissions the European Commission's Thematic Strategy on Air Pollution (TSAP) (EC, 2005) includes health and environmental interim objectives for 2020. The health objectives of TSAP are a reduction of life years lost (YOLLs) from air pollution by particulate matter and a reduction of premature mortality cases from ozone. Objectives of TSAP regarding effects on ecosystems are reductions of ecosystem areas where deposition of eutrophying and acidiphying species exceeds critical loads of these areas. In 2008 the Air Quality Directive 2008/50/EC (European Parliament and the Council, 2008) merged existing legislation for all groups of air pollutants, including a new regulation for PM2.5. The MARPOL process on establishing ECAs with more ambitious emission's levels was initiated by TSAP. The Air Quality Directive is also an important driver for the regional and local regulations and initiatives concerning emissions from shipping.

The following sections describe the multiple policies used to address pressures on the environment. These include: SO_X, NO_X and PM; GHG; waste; invasive species (Ballast Water Convention); anti-fouling systems; pressures from recreational crafts; non-regulatory initiatives; and general marine policies such as Baltic Sea Action Plan, Marine Strategy Framework Directive and Water Framework Directive.

3.1.1 Policies to improve the marine environment

This section describes general policies at the EU and regional level which seek to improve the state of the Baltic Sea.

The EU Marine Strategy Framework Directive (MSFD)[8] represents the environmental pillar of the Integrated Maritime Policy and supports the achievement of the EU Biodiversity Strategy goals for the marine environment. The aim of the MSFD is to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. GES is achieved when 1) ecosystems are fully functioning and resilient to human-induced environmental change; 2) biodiversity is protected and its decline caused by human activities is prevented; and 3) human activities that introduce substances and energy (including noise) into the marine environment do not cause pollution effects. GES is determined through eleven general descriptors, listed in Figure 2.

Member States are required to develop marine strategy for their respective marine region, which must include a detailed initial assessment of the state of the environment, a definition of GES at a regional level and clear environmental and monitoring programmes. In addition to creating a strategy, Member States must draw up programmes of cost-effective measures, each of which must have an impact assessment and detailed cost-benefit analysis.

[8] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

Figure 2: List of Descriptors to Achieve Good Environmental Status of the MSFD

1. Biodiversity is maintained
2. Non-indigenous species do not adversely alter the ecosystem
3. The population of commercial fish species is healthy
4. Elements of food webs ensure long-term abundance and reproduction
5. Eutrophication is minimised
6. The sea floor integrity ensures functioning of the ecosystem
7. Permanent alteration of hydrographical conditions does not adversely affect the ecosystem
8. Concentrations of contaminants give no effects
9. Contaminants in seafood are below safe levels
10. Marine litter does not cause harm
11. Introduction of energy (including underwater noise) does not adversely affect the ecosystem

The EU Water Framework Directive (WFD)[9] commits Member States to achieve good qualitative and quantitative status of all EU water bodies, including marine waters up to one nautical mile from shore. It establishes a framework to protect inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater; ensuring all aquatic ecosystems, wetlands and terrestrial ecosystems (with regard to their water needs) meet good status by 2015. The aim of the WFD is long-term sustainable water management that is based on high-level protection of aquatic environments.

The WFD requires Member States to establish river basin districts and management plans for each district. These plans are composed of four distinct elements: characterisation and assessment of impacts on river basin districts; environmental monitoring; the setting of environmental objectives; and the design and implementation of the programme of measures needed to achieve them. These river basin management plans are part of a cyclical process, where they are prepared, implemented and reviewed every six years. The measures developed within the WFD can also be applied by Member States to help reach targets under the MSFD. In this regard, existing measures developed under the scope of the WFD do not require further analysis to be implemented under the MSFD.

In 2011, the EC attempted to address the challenge of biodiversity loss in the EU, which had around one in four species threatened with extinction and 88% of fish stocks overfished or significantly depleted. As such, the EC adopted the ambitious 2020 Biodiversity Strategy, which aims to halt the loss of biodiversity and ecosystem services in the EU by 2020. Comprised of six main targets and 20 actions to reach this goal, the 2020 Biodiversity Strategy strives for (EU, 2011):

- Full implementation of EU nature legislation to protect biodiversity
- Better protection for ecosystems, and more use of green infrastructure
- More sustainable agriculture and forestry
- Better management of fish stocks
- Tighter controls on invasive alien species
- A bigger EU contribution to averting global biodiversity loss

[9] http://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF

At a regional level, HELCOM's Baltic Sea Action Plan (BSAP)[10] aims to restore the Baltic marine environment to good ecological status by 2021. The Plan, adopted by all Baltic coastal states and the EU in 2007, provides a necessary stepping stone to ensure wider and more effective actions to address the continuing deterioration of the marine environment caused by human activities. The BSAP has four aims: 1) safeguard the Baltic Sea's natural ecosystems while sustainably using its goods and services; 2) improve prosperity and quality of life in the entire region; 3) set specific ecological objectives with measurable targets in line with the ecosystem approach; and 4) implement the plan through national programmes and regional actions. The Plan's goals are to see the Baltic Sea unaffected by eutrophication, life undisturbed by hazardous substances, its biodiversity in favourable status, and its maritime activities conducted in an environmentally friendly way. The specific objectives of the BSAP are listed in Table 2.

Table 2: Objectives of the Baltic Sea Action Plan

Eutrophication	Biodiversity
∴ Concentrations of nutrients close to natural levels ∴ Clear water ∴ Natural level of algal blooms ∴ Natural distribution and occurrence of plants and animals ∴ Natural oxygen levels	∴ Natural marine and coastal landscapes ∴ Thriving and balanced communities of plants and animals ∴ Viable populations of species
Hazardous Substances	**Maritime Activities**
∴ Concentrations of hazardous substances close to natural levels ∴ All fish are safe to eat ∴ Healthy wildlife ∴ Radioactivity at the pre-Chernobyl level	∴ Enforcement of international regulations – no illegal discharges ∴ Safe maritime traffic without accidental pollution ∴ Efficient emergency and response capabilities ∴ Minimum sewage pollution from ships ∴ No introductions of alien species from ships ∴ Minimum air pollution from ships ∴ Zero discharges from offshore platforms ∴ Minimum threats from offshore installations

3.1.2 Sulphur oxides, nitrous oxides and particles

MARPOL Annex VI includes emissions of SO_X and NO_X from ships. The limits are differentiated by general regulations and more ambitious maximum values for ECAs. MARPOL Annex VI amendments from 2015 state, from 1 January 2020, the limit of sulphur content of any fuel oil used on board ships will be reduced from current 3.5% to 0.5%. By 1 January 2015, the sulphur limits for ECAs are reduced to 0.1% (IMO, 2008). The limits in the two European Sulphur ECAs will be relevant for about 50% of the 10,000 ships currently engaged in shipping between EU countries (EC, 2013b). Since 2006, the Baltic Sea area is one of these ECAs for SO_X. The mitigation of emissions can be implemented via a fuel change or by exhaust gas cleaning (scrubbers) (DNV, 2012).

In view of the 1997 adopted Annex VI of MARPOL and the Kyoto Protocol, the EU adopted in 2002 "A European Union strategy to reduce atmospheric emissions from seagoing ships". The strategy had two parts: a Communication of the EC (COM (2002) 595) (EC, 2002) and the Directive on the Sulphur

[10] http://helcom.fi/baltic-sea-action-plan

Content of Marine Fuels (2005/33/EU, updated in 2012, 2012/33/EU) (European Parliament and the Council, 2012a).

The Communication had the objective to coordinate actions between the different Member States to reduce the shipping emissions of SO_X, NO_X, PM, VOC, CO_2 and ozone depleting substances. It proposed to amend different directives concerning these emissions. Following this process, in 2005, the Directive on the Sulphur Content of Marine Fuels was adopted. With the Sulphur Directive 2012/33/EU a further update was implemented. An overview on the latest SO_X limits can be seen in Table 3.

Table 3: MARPOL Annex VI and EU SO_X Limits

Outside an ECA, established to limit SO_X and PM emissions (IMO)	Inside an ECA, established to limit SO_X and PM emissions (IMO)	Passenger ships operating on regular services according to EU Sulphur Directive	Ships in EU ports according to EU Sulphur Directive (to be at berth for more than two hours)
4.50% m/m prior to 1 January 2012	1.50% m/m prior to July 2010	1.50% m/m (in ECA 1.00% m/m) prior to 1 January 2020	0.10% m/m after December 2012
3.50% m/m on and after 1 January 2012	1.00% m/m on and after 1 July 2010	1.50% m/m (in ECA 1.00% m/m) prior to 1 January 2020	0.10% m/m after December 2012
0.50% m/m on and after 1 January 2020	0.10% m/m on and after January 2015	0.50% m/m on and after 1 January 2020	0.10% m/m after December 2012

Source: Author's illustration based on IMO (2015b) and European Parliament and the Council (2012a)

With $NO_{X,}$ another air pollutant emitted from marine diesel engines is covered in Annex VI. There is "Tier II" approach for engines on ships which are constructed in 2011 or later and "Tier III" approach for ships constructed in 2016 and later and are operating in the ECAs in North America and the U.S. Caribbean Seas. For ships constructed before 2021, a minimum threshold of 500 gross tonnage is included.

3.1.3 Greenhouse gas emissions

One major type of air emissions from shipping are GHG emissions. In 2011, the IMO established the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP) (IMO, 2011a). The EEDI is developed for each ship and should be reduced compared to the reference line until end of 2019 up to 10%, until end of 2024 up to 20% and from 2025 onwards up to 30%. The concrete objectives are depending on the ship type and the size of the ship – smaller ships have reduced objectives whereas larger ships should reach the maximum reduction (IMO, 2011a). The aim of the EEDI is to push the development of energy efficient ship designs. The SEEEMPs have the objective to initiate energy efficient operational practices. For each ship a ship specific SEEMP should be developed (IMO, 2011a). The measures included in the SEEMP are not mandatory for implementation (EEA, 2013).

To date, neither the international nor European levels have adopted GHG reduction targets or mandatory instruments, e.g. market based measures. Discussions in the IMO did not lead to any agreement. The EU and its Member States would prefer a global approach. The EU has an objective on the EU's CO_2 emissions from maritime transport, which excludes international shipping (EC, 2015b). In 2011, the EC adopted a White Paper: Roadmap to a Single European Transport Area (COM (2011) 144), which formulated as a key goal to reduce EU's shipping CO_2 emissions by at least 40% by 2050 compared to 2005 levels (EC, 2011a). The goal should be reached by technology improvements and better fuels and operations. In June 2013, the EC set out a strategy for: integrating maritime emissions into the EU's policy for reducing its domestic GHG emissions (EC, 2013b). The strategy includes three steps: 1) monitoring, reporting and verification (MRV) of CO_2 emissions from large ships using EU ports; 2) GHG reduction targets for the maritime transport sector; and 3) further measures, including market based measures, in the medium to long term.

The regulation on MRV of CO_2 emissions from maritime transport was approved in April 2015 (European Parliament and the Council, 2015) as a first step to reducing shipping emissions in the absence of an international agreement to tackle the sector's climate impact. The directive creates a framework to collect data of all large ships (irrespective of where the ships are registered, over 5,000 gross tonnes) calling at EU ports. From 2018 onwards companies have to monitor and report the verified amount of CO_2 emissions. An overview of shipping policies regarding $C0_2$ emissions is provided in Table 4.

Table 4: Overview of Shipping Policies Regarding CO_2 Emissions

Policy	Objective
Global level: IMO	
MARPOL: Inclusion of regulations on energy efficiency for ships in MARPOL Annex VI	Establishment of instruments: Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP)
European level	
White Paper: Roadmap to a Single European Transport Area (COM(2011) 144)	Key goal to reduce EU's shipping CO_2 emissions by at least 40% by 2050 compared to 2005 levels; Optimising of the multimodal logistic chains and the greater use of more energy-efficient modes
Integrating maritime transport emissions in the EU's GHG reduction policies (COM(2013) 479)	Reduction of maritime GHG emissions
Regulation on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport (2015/757/EU)	Framework to collect CO_2 emissions data of all large ships calling at EU ports
Clean Power for Transport: A European alternative fuels strategy (COM(2013) 17)	Increase use of alternative fuels in different transport modes
Actions towards a comprehensive EU framework on LNG for shipping (SWD(2013) 4)	Outlines future planning to achieve an EU framework for LNG as an alternative shipping fuel
Directive on the deployment of alternative fuels infrastructure (2014/94/EU)	Development of national policy frameworks for market development of alternative fuels and their infrastructure; Establishment of infrastructure for alternative fuels (e.g. LNG and shore side electricity at ports)
Strategic goals and recommendations for the EU's maritime transport policy until 2018 (COM(2009) 8)	'the long-term objective of 'zero-waste, zero-emission'

Source: Authors

One of the most relevant options for reducing air emissions by shipping are alternative fuels. At the European level, the EC initiated a process on alternative marine fuels. "The Clean Power for Transport: A European alternative fuels strategy" published by the EC in 2013 states that Liquefied Natural Gas (LNG) and biofuels (liquid) are suitable for maritime transport (EC, 2013c). Liquefied Petroleum Gas (LPG) is also an option for short-sea-shipping which made up 58% of total EU-28 maritime transport of goods in 2013 (Eurostat, 2015). However, at the moment, the main potential for maritime transport is seen in a change to LNG. LNG as the most environmental friendly fossil fuel, reduces sulphur emissions to almost 0% and emits nearly no PM[11], about 90% less NO_X and 20-25% less CO_2 (EC, 2013d)[12]. LNG is an attractive option for vessels to meet the limits for sulphur content in marine fuels (described in the chapter above). The EC has initiated work towards an "Action Plan on a comprehensive EU framework on LNG for shipping", involving in particular the European Maritime Safety Agency and representatives from industry (EC, 2013d). A 2015 study summarises that shipowners are interested in LNG as a shipping fuel to comply with the requirements on SO_X, but a critical issue is the further deployment of LNG as a fuel and the high price of LNG. For many shipping companies, LNG is not profitable, due to higher equipment costs which are not balanced by fuel savings or operating expenses (EC, 2015c). Main problems at the moment are the missing LNG bunkering facilities at ports and the not harmonised bunkering procedures in the individual ports (e.g. also mentioned in EC (2015) as a major barrier).

Therefore, the EU adopted in 2014 the Directive on the deployment of alternative fuels infrastructure (2014/94/EU; European Parliament and the Council, 2014). It requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure. Concerning shipping, it requires especially that LNG bunker facilities at maritime ports are established (all ports of the Trans-European Transport Network [TEN-T] core network) by end of 2025. Additionally, electricity should be delivered shore-side at ports of the TEN-T core network and other ports by end of 2025. Furthermore the EC published in 2009 strategic goals and recommendations for the EU's maritime transport policy until 2018 (COM(2009) 8 final; EC, 2009). It outlines that the EC, Member States and shipping industry should work towards 'the long-term objective of 'zero-waste, zero-emission', by:

- Reducing GHG emissions from international shipping
- Actively working with the IMO
- Ensuring that Member States achieve GES, as required by the MSFD
- Strengthening EU legislation regarding port reception facilities
- Following up on proposals from the EC on an EU strategy for better ship dismantling
- Overseeing the smooth implementation of the amendments to MARPOL Annex VI to reduce SO_X and NO_X emissions from ships.
- Promoting alternative fuel solutions in ports such as the use of shore-side electricity
- Re-launching the EC's Quality Shipping Campaign
- Promoting a European Environmental Managements System for Maritime Transport

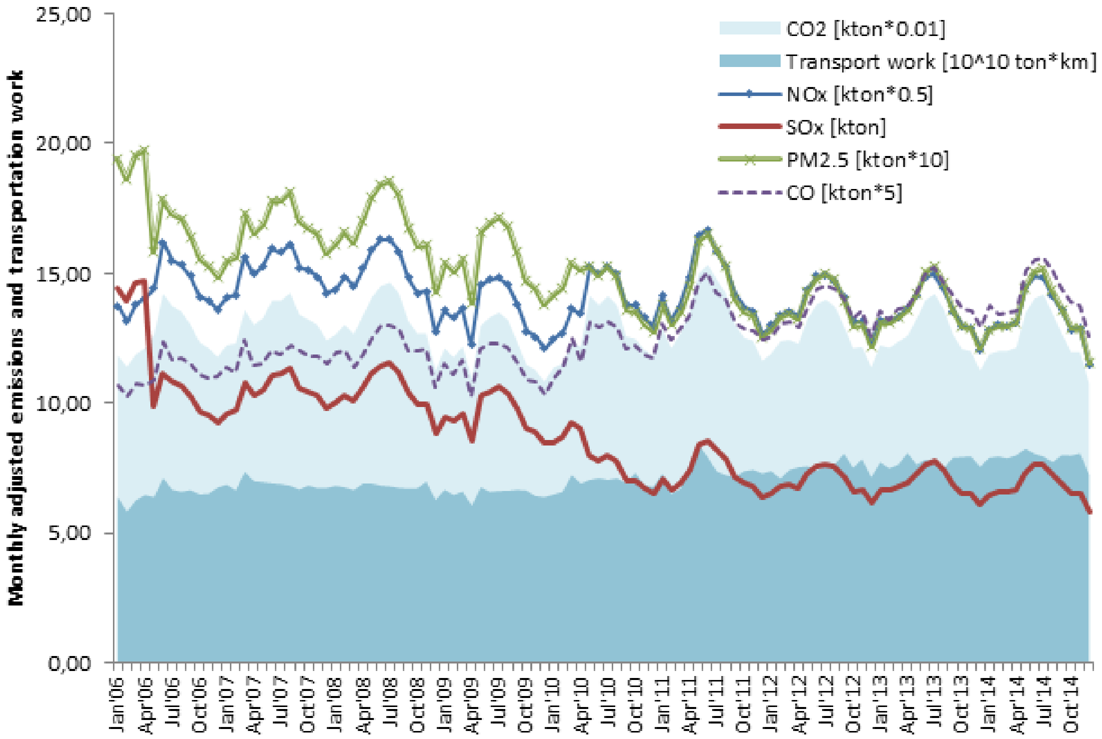
[11] It should be noted that most LNG engines will be dual-fuel engines using about 5% Marine Gas Oil (MGO). Thus there will still be emissions of PM and SOx and some higher NO_X due to the MGO-use. At low loads, engines may run on only MGO.
[12] It should be noted, that while the CO2 is likely to go down through the use of LNG, there is a risk of the potential increase in methane (CH4) emissions. This is due to methane leaking or 'slip' which is a serious problem.

The already mentioned White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system (COM(2011) 144; EC, 2011a) contains, in addition to the already described overall 40% CO_2 emissions reduction objective from maritime bunker fuels, further goals for maritime shipping by optimising the use of multimodal logistic chains and the greater use of more energy-efficient modes. It proposes that 30% of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050, that a fully functional and EU-wide multimodal TEN-T 'core network' should be established by 2030, with a high quality and capacity network by 2050 and a corresponding set of information services. And by 2050, it should be ensured that all core seaports are sufficiently connected to the rail freight and, where possible, inland waterway system. A second main focus in maritime transport is the increasing efficiency of transport and of infrastructure use with information systems and market-based incentives. The deployment of equivalent land and waterborne transport management systems (ERTMS, ITS, SSN and LRIT, RIS) and the European Global Navigation Satellite System (Galileo) should be improved. By 2020, the framework for a European multimodal transport information, management and payment system should be established. It should be moved towards the full application of "user pays" and "polluter pays" principles and private sector engagement to eliminate distortions, including harmful subsidies, generate revenues and ensure financing for future transport investments. In regard to maritime transport, the 2011 White Paper also states, "For maritime transport, a 'Blue Belt' in the seas around Europe shall simplify the formalities for ships travelling between EU ports, and a suitable framework must be established to take care of European tasks for inland waterway transport. Market access to ports needs to be further improved."

The tax on road fuel was originally established as a financial instrument with the objective to raise revenue. In the last years, the focus is more moving to the need to reduce emissions and to decrease dependency of imported oil. Therefore, the taxes are more used to reach a steering effect on CO_2 emissions. The Energy Tax Directive sets the minimum levels of tax that Member States must apply. The marine fuels (and also aviation) have always been fallen under full exemptions from the fuel tax under the Energy Tax Directive (Council of the European Union, 2003).

The following figure (Figure 3) includes the CO_2, NO_X, SO_X and PM emissions from 2006 to 2014. The figure shows a significantly decrease in SO_X and PM emissions during this time. CO_2 emissions did not change much. Overall transport work across the Baltic Sea was quite steady with a small growth during the period 2010-2014.

Figure 3: Emissions from Shipping in the Baltic Sea, 2006-2014



Source: Johansson and Jalkanen, 2015.

3.1.4 Waste

Two IMO MARPOL Annexes focus on discharges of waste water and waste. Vessels are one of the main sea-based sources of marine litter. Discharging waste at sea is a cheap and convenient solution for vessels and used to be common practice promoted also by the lack of discharging facilities at ports. Dumping waste at sea has been gradually prohibited since 1988 under MARPOL. MARPOL Annex IV has the objective to regulate pollution of sewage from ships (entered into force in 2003) and Annex V deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of (entered into force in 1988, updated 2013) (IMO, 2006, 2011a). Yet illegal discharge continued at sea in light of limited control and enforcement of the ban. Ports charging direct fees in relation to volumes and types of waste furthermore disincentivised vessels to bring their waste to port.

Consequently, coastal states in the Baltic Sea agreed introduction of a 100% indirect fee system applicable to all vessels independent from the amount of waste discharged. The so called “No Special Fee” (NSF) system in the Baltic was established in the late 1990s following the adoption of guidelines for NSF systems under the HELCOM Convention. According to the guidelines costs of reception, handling and final disposal of ship-generated wastes should be levied on the ship irrespective of the actual amounts of waste delivered to port. The fee should be included in the harbour fee or otherwise be charged to the ship (HELCOM Recommendation (28E/10) (HELCOM, 2007).

Box 1: Example of No Special Fee system in Sweden

> As an example, Sweden introduced a 100% indirect fee-based system relying on the Gross Tonnage (GT), type or size of a vessel. Unlike some other Baltic countries, ports in Sweden do not limit the waste volume included in the fee. Types of waste included are garbage, waste oil, sludge and sewage (Paulin 2012, Ikonen 2012).

The NSF is in compliance with the EU Directive on port reception facilities for ship-generated waste and cargo residues (PRF Directive) that entered into force in 2002 (59/2000/EC) (European Parliament and the Council, 2000). The PRF Directive requires ships to deliver all ship-generated waste to port unless storage capacity has not been met yet. Member States are required to ensure their ports provide adequate reception facilities and establish waste reception and handling plans. Costs for the port reception facilities, treatment and disposal of waste are to be covered through a fee to be collected from ships (following the polluter pays principle) (European Parliament and the Council 2000). But this cost recovery system shall provide no incentive to ships to discharge their waste at sea requiring all ships calling at a port to contribute 'significantly' to these costs irrespectively of actual use the facilities.

Because the issue of marine littering has received increased political attention in recent years, in 2015, HELCOM adopted the Regional Action Plan on Marine litter, which among others includes three actions on shipping related waste. The first activity is development of best practice on the disposal of old pleasure boats until 2018. The second is to develop best practice for the inspections for MARPOL Annex V, including harmonised management of data until 2017. The third action is the further implementation and harmonisation of the NSF system in ports at the Baltic Sea which evaluates the implementation of HELCOM Recommendation (28E-10) beginning in 2016 (HELCOM, 2015).

3.1.5 Non-indigenous species

The 2004 International Convention for Control and Management of Ships' Ballast Water and Sediments (BWMC) of the IMO aims to act as the global instrument to regulate the management, treatment, and release of ballast water. It is a result of increasing concern regarding the introduction of non-indigenous species via shipping vectors. The BWMC specifically takes into account Article 196(1) of the UN Convention of the Law of the Sea, which stipulates that "States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control, or the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto."

It also notes the objectives of the 1992 Convention on Biological Diversity (CBD) and that the transfer and introduction of harmful aquatic organisms and pathogens via ballast water threatens the conservation and sustainable use of biological diversity. In addition, decision IV/5 of the 1998 Fourth Conference of the Parties (COP4) to the CBD, which concerns the conservation and sustainable use of marine and coastal ecosystems, as well as decision VI/23 of the 2002 COP6 to the CBD, concerning non-indigenous and alien species that threaten ecosystems and habitats of species, including guiding principles on invasive species, are also taken into account.

The convention includes a fixed time plan for ballast water treatment systems in ships. The required standards are depending on the construction date of the ship and the ship size. For each ship a Ballast Water Management Plan should be developed and a Ballast Water Record Book carried. All parties should also ensure that sediment reception facilities are available at all ports and terminals where cleaning and repair of ballast tanks occur (IMO, 2004).

Table 5: Requirement for on Board Ballast Water Treatment According to BWMC Specified by Ship's Construction Year and Ballast Water Capacity

Category	Construction Year	Ballast Water Capacity (m^3)	2012	2013	2014	2015	2016
1	Before 2009	>1,500 and <5,000	D-1 or D-2		D-2		
2	Before 2009	<1,500 or >5,000	D-1 or D-2				D-2
3	In or after 2009	<5,000	D-2				
4	In or after 2009 but before 2012	≥5,000	D-1 or D-2				D-2
5	In or after 2012	≥5,000	D-2				

Source: HELCOM, 2014

Table 5 above can be seen that for some ships only D-1 or D-2 regulation has to be fulfilled in the first years:

> D-1 regulation states that ships performing ballast water exchange shall do this with an efficiency of at least 95 percent volumetric exchange of ballast water. Furthermore, the regulation includes certain minimum distance from the nearest land (200 nautical miles) and water depth (at least 200 metres) to conduct a Ballast Water exchange.
>
> D-2 regulation defines a Ballast Water Performance Standard which limits the number of viable organisms to cubic metre (defined by size). The D-2 standard can only be fulfilled if the ballast water is treated on board. Different types of technologies are available: chemical disinfection (including biocides and chemicals), physical disinfection and mechanical separation. According to the IMO 68 different technologies for on board treatment are available. Most existing systems are two stage-treatments with a physical solids-liquid separation and a biocidal disinfection (HELCOM 2014).

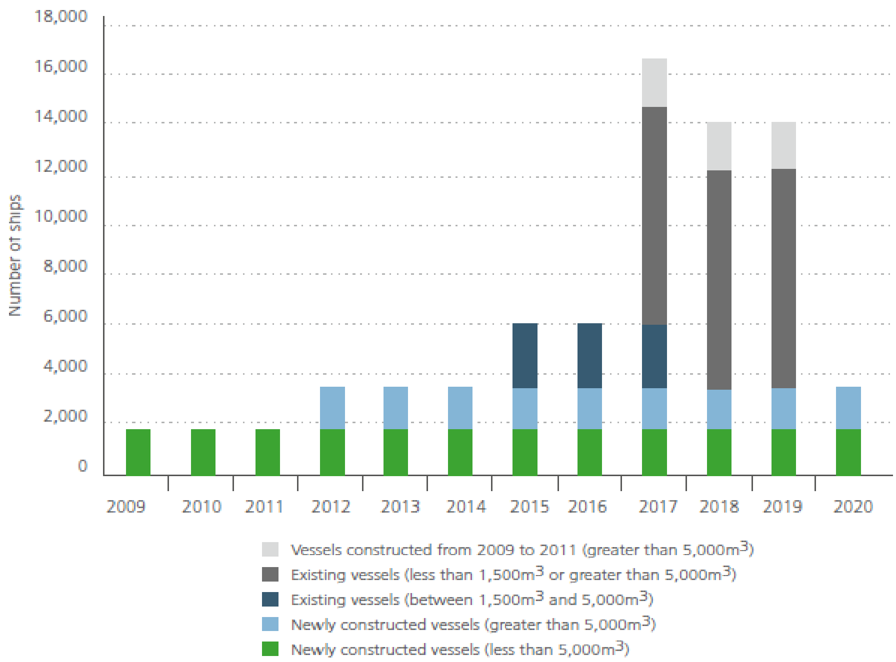
In 2014, HELCOM has published a Guide to Alien Species and Ballast Water Management in the Baltic Sea, which states that the possible distances from the coast for a ballast water exchange in the Baltic Sea are not sufficient with the requirements of the BWMC, therefore the ballast water exchange (if entering or leaving the Baltic Sea) has to be performed outside the Baltic Sea in certain distance to North-West Europe (HELCOM, 2014).

The convention did not enter into force, but it is close to its ratification threshold of 30 States, representing 35% of world merchant shipping tonnage (IMO 2004). Because the delay in ratification has consequences on the adopted time schedule where 2016 already all ships should have an onboard ballast water treatment system, the IMO has adopted an amendment that if ships are constructed before the entry into force of BWMC they only have to comply with the regulation until their first renewal survey following the date of entry into force of the Convention. HELCOM (2014) estimated the effects of the time shift if the BWMC would have entered into force beginning of 2015.

The results show an expected peak of installation of treatment systems for a five-year period, from 2017 to 2021.

However, the US implements a scheme for ships in US waters, which would anyway lead to an implementation of ballast water treatment systems in a significant number of ships (DNV 2012). Indeed, King et al. (2012) estimated that over 60,000 ships in the world fleet would need to be retrofitted with one or more cleansing units, potentially amounting to 1.3 million EUR each, see Figure 4.

Figure 4: Estimated Number of Vessels Required to Install Ballast Water Treatment Systems



Source: DNV 2012 based on IMO MEPC 61/2/17

3.1.6 Anti-fouling systems

In 2001, the IMO adopted a Convention on the control of harmful anti-fouling systems on ships (AFS Convention). The Convention defines "anti-fouling systems" as "a coating, paint, surface treatment, surface or device that is used on a ship to control or prevent attachment of unwanted organisms". The main issue is the harmful environmental effects of organotin compounds used as anti-fouling systems on ships. The AFS Convention entered into force in 2008 and prohibits the use of harmful organotin compounds in anti-fouling paints used on ships and installs a mechanism to avoid the future use of other harmful substances (IMO, 2015c). The European Union approved in 2003 a regulation on organotin compounds in anti-fouling systems, as implementation of the AFS Convention and especially for the interim period before the AFS Convention entered into force (European Parliament and the Council, 2003).

Today, biocidal products including anti-fouling systems are regulated in EU through the Biocidal Product Regulation (BPR, Regulation (EU) 528/2012) which entered into force on 1 September 2013. The aim of the BPR is to increase safety for human and animal health as well as to minimize adverse effects on the environment (European Parliament and the Council, 2012b).

Before a product can be put out on the market, the paint company must show that the risk for the environment due to leaching of biocides is acceptable. In this Environmental Risk Assessment (ERA) predicted environmental concentrations (PECs) and predicted no effect concentrations (PNECs) needs to be calculated. A PEC/PNEC ratio of >1 indicates an unacceptable risk to the environmental compartment under consideration.

To understand the environmental fate of an antifouling product, information on degradation, adsorption, solubility and bioaccumulation is needed. This information is used when calculating the PECs of the active substances of the product. In EU, the MAMPEC (Marine Antifoulant Model to Predict Environmental Concentrations) model is used to derive PEC values in standardized scenarios representing an EU harbour and an EU marina. However, these scenarios are not representable for the Baltic Sea, both in respect to abiotic environmental factors (e.g. salinity and tidal water) but also in the number and size of boats and ships in harbours and marinas. Due to this discrepancy, the Swedish Chemicals Agency (KemI) has developed own scenarios for the Baltic Sea and for the Swedish West coast (Ambrosson, 2008). Also, KemI uses more protective PNECs (Predicted No Effect Concentrations) for the Baltic Sea compared to the PNECs used in EU for marine environments. For these reasons, the biocidal leaching rate in paints approved for the Baltic Sea region is allowed to be higher in Finland, Germany and Denmark compared to Sweden. For example, paints holding almost 35% copper oxide (CuO) is allowed to be used on leisure boats in Finland while Sweden (KemI) accepts 8.5% CuO. There is an EU ban on paints with tributyltin. TBT-paints were restricted in 1989 for application on leisure boats (<25 m) (Directive 89/677/EEC).

3.1.7 Specific policies for recreational crafts

In addition to policies affecting shipping and fishing vessels, specific policies for recreational crafts are also used.

On 18 January 2016 Directive 94/25/EC will be repealed and no longer applicable. The new Directive: 2013/53/EU on recreational craft and personal watercraft was adopted in 2013 and will enter into force in 2016 (European Parliament and the Council, 2013). It contains further developed limits for different emissions, e.g. air and noise emissions.

It includes exhaust air emission limits for NO_X, hydrocarbons and PM depending on different engine types. Noise emission levels are defined and the maximum sound pressure level is varying between 67 and 75 dB depending on the engine.

The watercrafts should be constructed so that they prevent accidental discharge of water pollutants overboard, such as oil or fuel. On board toilets should be connected to a holding tank system or water treatment system.

3.1.8 Voluntary initiatives

Additionally to the above mentioned policies and regulations, voluntary initiatives have been initiated. Especially, the Clean Shipping Index and the Environmental Ship Index are noticed internationally.

Clean Shipping Index (CSI) is an initiative by leading international cargo owners to evaluate the environmental performance of ships and shipowners. The CSI enables a comparison of environmental performance based on air emission of CO_2, NO_X, SO_X and PM. Furthermore, the index integrates use of chemicals and how carriers deal with their waste on board and water discharges, such as sewage and ballast water. The general CO_2 emissions policy (e.g. companywide CO_2 emission target) and recycling policy of the shipowner is also included in the assessment. Around 30 large cargo owners form the clean shipping network. Shipowners enter data on from one or more ships in their fleet in the database. The database calculates a score from the entered data and weights assigned to the data based on the potential environmental damage related to them. The assessment can deliver a result for each vessel and per cargo carrier. The common method for the assessment is a key to the comparability of the environmental performance (CSI, 2015a, 2015b).

The Environmental Ship Index (ESI) is an initiative to improve the environmental performance of sea going vessels. It was initiated by the World Ports Climate Initiative. It enables ports and other interested parties to stimulate ships to improve their environmental performance and rewards ships that participate in the ESI in order to promote clean ships. It evaluates the environmental performance of ships regarding air pollutants (mainly based on NO_X and SO_X emissions) in a score. The index value can be improved if the ship is prepared for on shore power supply and if two of the Energy Efficiency Operational Indicator data sets are reported. The administration of ESI is carried out by the ESI bureau of International Association of Ports and Harbours. The ESI Score ranges from 0 to 100 with 0 for a ship that meets the environmental regulations in force and 100 for a ship that emits no SO_X and no NO_X and reports or monitors its energy efficiency. At the moment, the best performing ships have scores that reach around 60 points. Only LNG carriers reach around 80 points (ESI, 2015).

3.2 National and regional legislation

Additional to international regulation, national and regional policies are adopted in the different EU Member States. At first international regulations, especially from the EU, are transposed into national legislation. Beside these, further relevant policies such as fairway dues or special instruments for leisure boats or ports are adopted. The following chapter summarises policies in selected Baltic Sea countries.

The review, based on those covered within the SHEBA consortium, showed that national and regional governments are taking diverse actions to reach environmental goals. Obtaining information on these initiatives is a highly challenging exercise and the varied results per Member State show this.

3.2.1 Germany

In Germany port charges are mainly focusing on size and type of ships. Increasingly ports also integrate environment-related components especially regarding air emissions in the charges – mainly ships with lower air emissions get a discount on the port charges. The analyses covered the largest German ports at the Baltic Sea (Lübeck, Rostock, Kiel, Sassnitz-Mukran, Flensburg, Wismar, Stralsund, Wolgast). From these ports, Rostock only has discounted port charges if the used marine diesel has low sulphur content or onshore electricity is used during the stay in the port or the ship has many points in the ESI-certificate (Rostock Port, 2014).

Antifouling paints for leisure boats are also regulated via EU BPR regulation (see chapter 3.1.6). The substances have to be approved by a two-step admission procedure. The first step includes a risk assessment by one European Member State based on provided material by the producer or import-er. Regarding environment, the concentration of water emissions is checked according to ecological effect threshold. Two antifouling substances are already approved in the first step. These are Zineb and DCOIT (Dichloroctylisothiazolinon). The second step assesses the product. This step is taken forward by the individual member states and includes the product's environmental assessment and the regional situation of water bodies. Due to the lack of measured data of water emissions in leisure boat harbours in Germany the risk assessment is based on models. For the modelling of the concentration of antifouling substances in German leisure boat harbours number of leisure boats per harbour would be an important indicator. Unfortunately, a registration of leisure boats in harbours is only necessary in some German regions such as the Bodensee-region. But especially for the very large lake area in the North-East of Germany no data on the number of boats in the leisure boat harbours is available which complicates the risk assessments significantly. According to assessments done by the German Federal Environmental Agency (UBA) a relief of water bodies according to antifouling substances is appropriate. UBA also discusses if in inland water bodies antifouling substances with biocides should be banned at all or at least in especially sensitive areas. (UBA 2014)

3.2.2 Sweden

Different national taxes and fees for shipping in Sweden are established. The fairway dues are paid based on the gross tonnage of the ship and the amount of goods loaded and off-loaded in Swedish ports. The amount related to gross tonnage of the ship has an environmental component – it will be reduced if the NO_X emissions are less than 6 g/kWh and further reductions in six steps in fee are available down to 0.5 g/kWh, at which level the fee is annulled (Sjöfartsverket, 2014).

In June, 2011, Sweden was authorised to give tax breaks to boats that use onshore electricity while berthed in ports, as onshore electricity reduces noise and is less air polluting than electricity produced on board. The measure will apply for a three-year period and was endorsed by all Member States. The tax cuts target vessels with significant onboard electricity generation and is to vessels of at least 400 tonnes as well as to supplies of shore-side electricity of at least 380 volts (EC, 2011b).

The NSF system for waste disposal in Sweden consists of a 100% indirect fee based on categories like the Gross Tonnage (GT), type or size of a vessel as specified in the waste handling plan. Unlike some other Baltic countries, ports in Sweden do not limit the waste volume included in the fee. Types of waste included are garbage, waste oil, sludge and sewage. A direct fee (i.e. charged to individual vessels in relation to amounts and type of waste it wants to discharge and related handling costs) is applied only to liquid cargo residues and special wastes and discharge requests for non-ship generated waste. Collection and payment is handled by the Port Authority based on the costs from the waste operator (Paulin 2012, Ikonen 2012).

On regional and local level in Sweden, many port administrations chose to have an environmental differentiation of their port due. The basis for the differentiation can of course vary between ports, since each port decides the level of due that should be paid for a ship call. Previously many ports used differentiation based on emissions of SO_2 and NO_X emissions, following the model for Swedish fairway dues. After the Sulphur ECA 2015 limit for sulphur in fuel, a differentiation based on sulphur makes little sense and other models for differentiation have been tested.

A brief overview of environmental port due differentiation schemes in the ten largest cargo ports and the five largest passenger ports were made. The results are presented in Table 6 and Table 7 respectively. Three large ports, Port of Gothenburg, Port of Stockholm and Port of Ystad, offer rebates based on more than one environmental performance parameter. Port of Helsingborg and Port of Trelleborg offers a reduced fee based on emissions of NO_X. The Port of Trelleborg offers a 20% rebate to ships that fulfil requirements for the environmental performance in the fairway due system. Port of Gävle, Ports of Halland, Husum/ Örnsköldsvik have no standardised fees. Two ports are not an industrial port (Preemraff Brofjorden, Luleå Port (LKAB)) and the Malmö port doesn't offer a rebate.

Table 6: Environmental Differentiation (if any) of Port Dues in the Ten Largest Goods Ports in Sweden

Port of Gothenburg	The port of Gothenburg uses two different environmental indexes, ESI and CSI to differentiate the dues. Vessels that are rated according ESI and has 30 points or more receives a 10 percent discount on GT based port dues. The same discounts are valid for vessels that reach up to the green class according to CSI. LNG driven vessels can receive a discount of 20 percent.
Port of Helsingborg	Reductions on port fees are given based on NO_X emissions; the seven step model used for the fairway dues is used.
Trelleborg port	The Port of Trelleborg offers a 20% rebate to ships that fulfil requirements for the environmental performance in the fairway due system.

Table 7: Environmental Differentiation (if any) of Port Dues in the Five Largest Passenger Ports in Sweden

1. Port of Stockholm	The model in the Port of Stockholm also favours LNG driven ships. A reduced fee by 5 cents per GT is offered to ships operating with LNG as fuel. Port of Stockholm also uses the seven step NO_X emission model for rebate. Further, up to 1 million SEK (107,000 EUR) are offered as support to ships with frequent visits to the port that are retrofitted in order to receive on shore electricity at berth.
2. Port of Helsingborg	Reductions on port fees are given based on NO_X emissions; the seven step model used for the fairway dues is used.
3. Port of Ystad	The Port of Ystad offers a 20% rebate to ships that fulfil requirements for the environmental performance in the fairway due system. A 40% rebate can be applied for if a ship connects to shore side electricity at berth, or if it is driven by LNG.
4. Port of Gothenburg	The port of Gothenburg uses two different environmental indexes, ESI and CSI to differentiate the dues. Vessels that are rated according ESI and has 30 points or more receives a 10 percent discount on GT based port dues. The same discounts are valid for vessels that reach up to the green class according to CSI. ESI and CSI are described below under 'Procurement initiatives'. LNG driven vessels can receive a discount of 20%.
5. Port of Visby	n/a, only 2 domestic ships in traffic to the port

Other local policy instruments that can influence environmental performance of ships originate in local target emission levels. One example is the climate strategy for Gothenburg published in 2014 setting goals on GHG emission levels for different sectors in the city. The port was appointed main responsible party to reduce emissions of GHGs from ships in traffic to the port by 20% to 2030 from 2010 absolute levels.

Further, many Swedish ports are obliged by municipal authorities to investigate costs and benefits from on shore power connections for ships at berth. Environmental and health benefits are expected from reduced emissions to air and noise reduction.

For leisure boats, the Swedish Chemicals Agency (KemI) (2015) tests the antifouling paints available on the market; as implemented in all EU countries according to the EU BPR Regulation (see chapter 3.1.6) companies must show that the risk for the environment due to leaching of biocides is acceptable. No biocide leaching antifouling paints for boats are allowed in fresh sea environments including the Bothnian bay and the Bothnian Sea north of Örskär. The regulations for the Swedish East coast are more stringent than for the West coast. In general the active ingredients in the antifouling paints are cupper based compounds, and the concentrations of the active ingredients are lower in paints approved for use on the East coast than in those approved for the West coast.

Since the first of April 2015, discharge of toilet water from leisure boats is prohibited in Swedish territorial waters. This applies to seas, lakes and other inland waterways. Only ships with distinguished cultural values may be exempted from the regulation (Transportstyrelsen, 2015).

Replacing the petrol/oil fuel traditionally used in boat engines with alkylate fuel can improve environmental performance significantly. Alkylate fuel is a fuel free from benzene and other aromatic compounds. One example of a policy instrument has been found to favour the use of alkylate fuel by a subsidy. The regional municipality in Östergötland and Jönköping subsidised alkylate by 1 SEK (0.107 EUR) per litre. This price model was tested in 2009. Normally the price for alkylate fuel is significantly higher than for petrol.

3.2.3 Poland

Polish legislation follows EU regulations and international conventions. The crucial document focusing on the development and environmental policy is the *"Maritime Policy of the Republic of Poland until 2020".* The document defines nine fundamental directions of maritime policy development and the assumptions concerning their objectives, activities and expected results. The document states that the priorities of maritime development until 2020 are the development of seaports, competitive maritime transport and the improvement of safety and environmental protection of Polish shipping. The policy document was elaborated due to the requirement of the EC, according to which the member states elaborate national integrated maritime policies in close cooperation with the interested entities. The essence of the integrated maritime policy is departure from sectoral approach to maritime issues, in favour of more effective and holistic approach, at the same time distinguishing three instruments of the policy's implementation: development of maritime research, integration of the systems of maritime supervision and works on maritime spatial planning.

The issues of environmental protection and maritime safety plus waste management are regulated at national level by acts and regulations applying and implementing international law regulations, e.g. the maritime environmental protection issues are present in two important documents which were obligatory in terms of MSFD's implementation: *Preliminary assessment of the environmental status of the Polish zone marine waters of the Baltic Sea*[13] and *Programme of marine waters monitoring.*[14]

[13] Report for the European Commission, Chief Inspectorate of Environmental Protection 2014.
[14] Report for the European Commission, Chief Inspectorate of Environmental Protection 2014.

Acts from 2007 and 2002 regulate issues of waste management / port reception facilities and duties of ports, maritime administration and regions in this matter. They also show rules of creation of port fees pricelist. *Act from 26 April 2006 on crisis management (Dz. U. 2007 nr 89 poz. 590)* structures rules of crisis management in case of oil-spills and marine accidents. Additionally, all three Maritime Offices in Poland (Gdynia, Szczecin, Slupsk) do have detailed procedures in case of environmental threats. Coastal regions have contingency plans in case of maritime accidents plus crisis management/emergency units their development strategy.

3.2.4 Finland

The Finnish Environmental Protection Law for Shipping published in 2009,[15] implements the rules and regulations from IMO, HELCOM and the EU for merchant shipping and leisure boats. This includes e.g. waste water releases (IMO, MARPOL IV), antifouling substances (IMO, AFS), air emissions (IMO, MARPOL VI).

All ships must pay fairway dues if they come to Finnish harbours. Exceptions to this are vessels, which assist in contracted ice breaking services or the vessel is smaller than 300 tonnes (net). The amount of dues is determined from vessel net tonnage per unit cost. Environmental-related components are not included.

In 2004, the Law of oil spill protection fund[16] was adopted with which an extra-governmental fund was initiated. Its purpose is to cover the costs of oil spill combating measures. Fee of 1.5 EUR/tonne must be paid for every ton of oil exported or imported through Finland. The fee will be doubled if oil tanker does not have a double hull. The entity who receives the oil in Finland will have to pay the ÖSR fee. If Finland is not the final destination of oil cargo, the sender of cargo will have to pay the fee.

3.2.5 Denmark

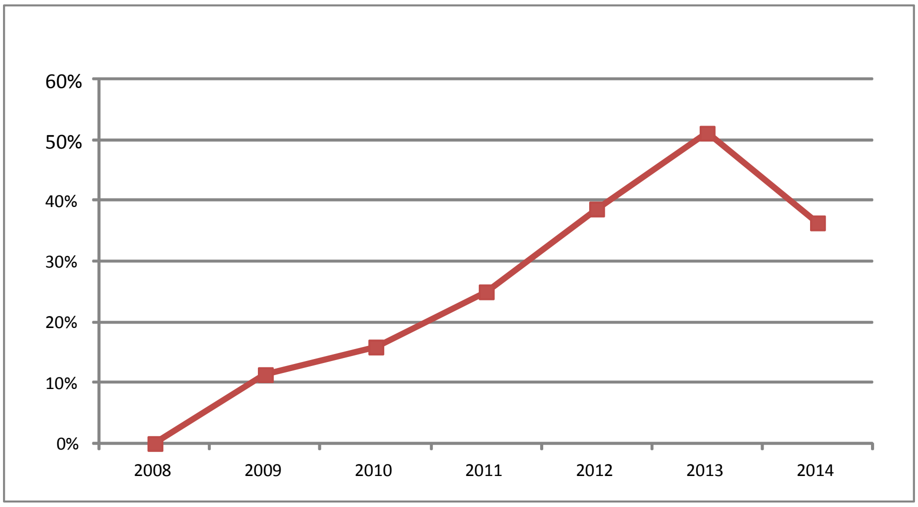
Denmark implements the European directives in the national legislation. Since 1959 Denmark is IMO member and ratified the conventions of the prevention of marine pollution; as well as many of the conventions dealing with liability and compensation, especially in relation to damage caused by pollution. Although notably not the Hong Kong Convention, which is focusing on recycling of ships, HNS PROT 2010 (Liability and compensation connected to hazardous substances), both are not yet in force. Furthermore the SUA convention from 2005 which regulates the Suppression of unlawful acts against safety on fixed platforms and went already into force) (IMO homepage 23rd October 2015).

The Danish shipowners as well as the Danish maritime authorities and the Danish Environmental Protection Agency have a common interest in the development of shipping technology and shipping operation that lowers the environmental impact on nature in a cost effective way, but also safeguards a level playing field when it comes to competition in the maritime transport industry. The Danish shipowners and the Danish official authorities therefore work for international environmental regulations primarily through EU and IMO. Also in response to efforts of Danish actors, the IMO adopted the regulations on SO_X and NO_X emissions (Miljøstyrelsen, 2008). Furthermore, the Danish shipowners already voluntarily monitor, report and verify their CO_2 emissions from ships. As can be

[15] Merenkulun ympäristönsuojelulaki 1672/2009 (Environmental protection law for shipping, http://www.finlex.fi/fi/laki/alkup/2009/20091672)
[16] Laki öljysuojarahastosta (ÖSR) 30.12.2004/1406 (Law of oil spill protection fund, https://www.finlex.fi/fi/laki/ajantasa/2004/20041406)

seen from the following figure, the shipowners have been successful in reducing their CO_2 emissions relative to deadweight[17] . The Danish initiative was probably contributing to the formulation and adoption of an MRV-regulation on CO_2 emissions for maritime transport in the EU (see above chapter).

Figure 5: Danish Shipowners' Relative CO_2 Reductions per Deadweight in Relation to 2008 (%)



Source: Danish Shipowners' Association (2015)

Different initiatives and instruments are implemented to take up the market potential of environmental friendly shipping. Plans with clear objectives and specified goals have been developed in the strategic network of the Blue Denmark. In 2012, the White paper (Danmark i arbejde, Vækstplan for Det blå Danmark) was approved. It acknowledges the green transition faced by the international shipping industry and counter to a perception of increased costs, as a consequence of increased focus on green and clean technology. The Blue Denmark focus on the growth potential of the development of environmental and energy efficient solutions in the broad maritime industrial complex (Erhvervs- og Vækstministeriet, 2012). Furthermore, the Danish Maritime cluster is expected to utilise the commercial opportunities of expected environmental regulation in the shipping industry. The goals of this initiative are reaching from documentation of environmental performance, building of more energy-efficient ships and ships in light materials to LNG as an alternative fuel for maritime transport.

Two partnerships between the Danish Shipowners' Association and Danish authorities were established in 2008/2009. The partnership for ballast water was established in 2009 as a co-operation between the Nature Agency, Danish Maritime Authority and Danish Shipowners' Association and focuses on the implementation of the Ballast Water Convention, also supported by funds from the Action Plan for Promoting Eco-efficient Technology (Danish Ministry of Environment and Food, 2015a). As second, Cleaner Shipping was established in 2008 and is a partnership between the Danish Environmental Protection Agency and The Danish Shipowners' Association, which aims to reduce air pollution by shipping in Denmark and worldwide. The partnership was formed following a tightening of standards on NO_X, SO_X and PM for Danish and international shipping by the IMO. Both

[17] Deadweight tonne (dwt) is a measure of how much mass a ship is carrying or can safely carry. It does not include the weight of the ship.

partners wish to promote awareness for the new IMO regulations and put attention on the reduction of air emissions, ensure the visibility of the measures and promote innovative frameworks for technological solutions. The Clean Technology partnership is supported via the subsidy from the Danish Eco-Innovation Program (Danish Ministry of Environment and Food, 2015b).

To neutralise any incentives for not following the rules for disposing of waste from ships in Danish ports – the costs are included in the normal harbour fees for call upon Danish harbours.

3.2.6 Estonia

The Estonian environmental related national regulation on shipping and ports includes the Maritime Safety Act, the Ports Act and the Ambient Air Protection Act. The Maritime Safety Act implements the IMO conventions, e.g. on Antifouling (Riigi Teatajy, 2015a). The Ports Act provides the requirements for the provision of port services and water traffic safety and for port authorities and port operators' security requirements and environmental protection requirements. The Act includes the reception and transfer of ship-generated waste. The fees on reception on ship-generated waste and cargo restudies can be included in the port dues or a separately determined waste fee. The fee can be reduced if that the ship procedures reduce the quantities of waste due to its environmental management (including taken care of water and air emissions), design, equipment or operation. (Riigi Teatajy, 2015b) The Ambient Air Protection Act includes for shipping the yearly reporting of fluorinated GHGs (Riigi Teatajy, 2015c).

3.3 Summary

For different water, air and noise emissions of shipping different regulations and policies are in place. Actions are taken on different levels. For the air emissions: SO_X, and NO_X policies and limits are established at global level by IMO. SO_X-limits seem ambitious and could lead to a change in shipping technologies and use of alternative fuels. The NO_X emissions policies are less elaborated and it is expected that consequences for shipping in the Baltic Sea will be limited, unless Baltic Sea would be registered as NO_X ECA. Potential indicators for the development of future scenarios can be found in the Annex 2.1 Policy Indicators.

The responsibility for measures on GHG emissions and especially CO_2 emissions is transferred to the IMO by the Kyoto Protocol. Unfortunately, in the last decade no clear CO_2 emissions reduction limit or suitable policy instrument was adopted at the global level due to different reasons especially the balancing of reductions in developing and developed countries. However, IMO adopted in 2013 the EEPI and SEEMP, but which are very soft instruments, e.g. the implementation of the measures included in the SEEMP is not enforced. Driven by this ambiguity on global level, the European Union - in general in favour of a global approach – started to implement first actions according to their climate change agenda. Therefore, CO_2 emission limits for shipping in the EU are agreed with 40% reduction by 2050 (on basis of 2005). A first step for a stronger climate policy is the framework for collection of CO_2 emissions data for large ships calling at EU ports. Further policies are focusing on the deployment of alternative fuels and their bunker facilities at harbours, with a clear target for establishment of infrastructure for alternative fuels at large European ports. Nevertheless, also because of the missing activities and difficult discussions at global level, European Union did not implement ambitious policy instruments for CO_2 emissions, e.g. integration into the European Emission Trading or energy taxes.

Waste and antifouling regulation is in place on a global level. It is now more a question of enforcement. Especially, the NSF system adopted by HELCOM was implemented quite differently in the countries. A good example can be seen in Sweden, where the fee is fully independent from the waste volume. Also in Denmark the costs for waste are included in the harbour costs, to avoid any incentive for waste disposal in the sea.

National legislation, in general, is at first mainly implementing inter- and supranational policies, e.g. waste water or antifouling substances policies of IMO. Additional, the policies and fee structure of ports are an important environmental related aspect. Different ambitions can be seen in different countries. In Sweden, for example, port fees in three of the ten largest good ports include environmental components. From the five largest passenger ports four are using environmental components. Compared to this in Germany, only one of the eight largest ports is using an environmental discount for its fees.

To give environmental related discounts a good assessed Environmental Ship Index (ESI) and the Clean Shipping Index (CSI) is used in different ports. Furthermore, rebates account for ships which are using LNG as fuel or have facilities for using onshore electricity. Other ports are using NO_X emissions directly.

Additional activities also on a voluntary basis can be seen in some countries, e.g. Danish authorities and Danish Shipowners' Association have built up to partnerships for the implementation of IMO Conventions (BWMC, MARPOL Annex VI). Furthermore, market potential and deployment potential for innovative environmental friendly technologies for ships are seen and the processes are supported by the Danish authorities and the shipowners.

A further driver of environmental regulation and policy instruments for shipping are regional and local climate strategies or action plans in coastal regions which are initiated by the regional or local authorities to reduce GHG emissions. But these coastal regions' climate strategies were not the focus of the research done here.

4 Socioeconomic drivers of shipping, fishing vessels, and recreational boats

This section reviews and describes key socioeconomic drivers of the shipping and leisure boat industry as well as taking into account fishing vessels. Drivers in this chapter are understood as the social and economic processes which are the result of human activities and give an indication of pressures on the environment. In this regard, it is important to understand socioeconomic drivers in an effort to characterise the present and future transport needs due to economic (e.g. trade) and societal developments (e.g. population growth) as well as resource use (e.g. energy demand). Moreover, sector specific drivers focusing on demand and supply side are provided and discussed for commercial shipping, fishing vessels and leisure boats. Indicators, needed to asses trends and characterise potential future changes, are suggested for each sector. In an effort to provide a snapshot of socioeconomic drivers, current statistics are provided. However, this assessment showed that the availability of statistics regarding some aspects of economic activities is not available.

4.1 General socioeconomic drivers

4.1.1 Economic growth

Global Gross Domestic Product (GDP) is a key indicator for purchasing power and labour costs and therefore an important measure for global trade. GDP purchasing power parity can be used to show per-capita welfare and when comparing living conditions or use of resources across countries. In other words, as GDP grows globally, or in national economies, both industry and consumers will have a greater purchasing power. Due to a globalised market, raw materials and commodities will be transported by sea to reach consumers and industries to convert raw materials. Figure 6 below shows that world GDP purchasing power parity has been steadily increasing between 1999 and 2013, with some times of levelling off around 2006 and 2008. Trends for Baltic Sea region[18] countries show a similar trend (see Figure 7).

Figure 6: World GDP (purchasing power parity) growth (1999-2013) billion Euros

Source: CIA World Factbook

According to July 2015 estimates global growth of GDP is projected at 3.3% in 2015. This is somewhat lower than in 2014, and includes a slight increase in advanced economies and a slowdown in emerging markets and developing economies. In 2016, about 3.8% growth is expected (IMF, 2015). In the short- and near-term, economic forecasts suggest there may be slower economic growth due to risks such as increased financial market volatility, disruptive price shifts, and lower commodity prices and low-income developing economies (IMF, 2015).

[18] Denmark, Germany, Estonia, Finland, Latvia, Lithuania, Poland, Russia and Sweden

Figure 7: Baltic Sea Region GDP (purchasing power parity) growth (1999-2013) billion Euros

Source: CIA World Factbook

Global forecasts of purchasing power estimate that it could grow by up to three times within the next 20 years. The countries with the largest growth in per capita GDP will be China, Vietnam, India and Indonesia. Purchasing power in developing Asia will rise eight times between 2010 and 2030. Growth in the global economy (GDP) will cause significant impacts on the seaborne trade, and some estimates suggest that it could more than double (Global Marine Trends, 2013).

4.1.2 Societal drivers

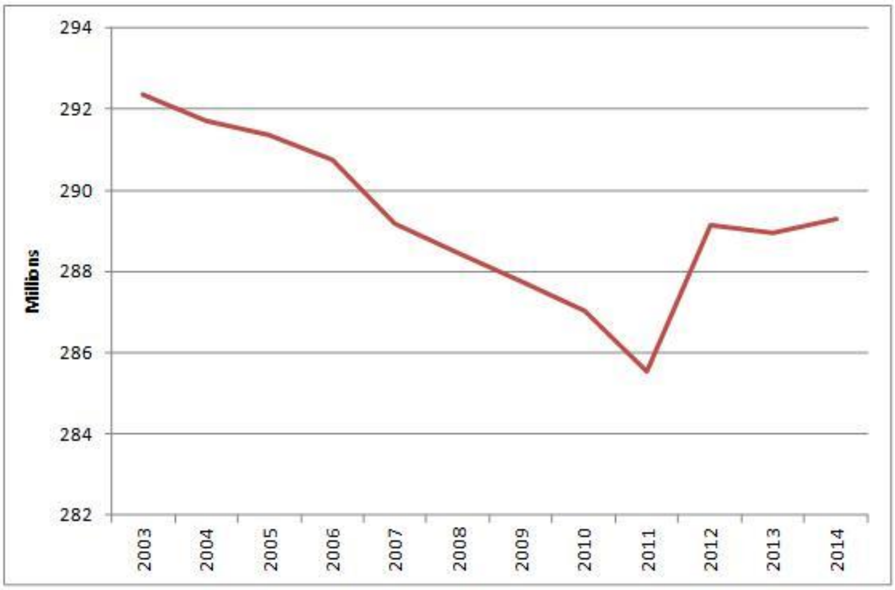
Societal drivers such as population, population density, rate of urbanisation, and age of society will affect the work force and labour costs and therefore also trade dynamics and commercial shipping activity. For example, total population presents an overall measure of the potential impact of the country or region. Figure 8 below shows world population which has had steady growth between 2000 and 2014, with some declines in 2008.

Figure 8: World Population Growth (2000 – 2014)

Source: CIA World Factbook

Statistics for the Baltic Region[19] show a much different trend. Here, population numbers show a decrease between 2003 and 2011, before beginning to increase.

Figure 9: Baltic Sea Region Population Growth (2003 – 2014)



Source: CIA World Factbook

Global population was around 7.2 billion in 2104 and it is expected to reach 8 billion by 2030 (Global Marine Trends, 2013). According to the UN, the global population is expected to reach more than 9.6 billion by 2050 (UNDESA, 2013). The majority of this growth, about 96%, is expected to come from developing countries. Most important are India, which will surpass China with the largest

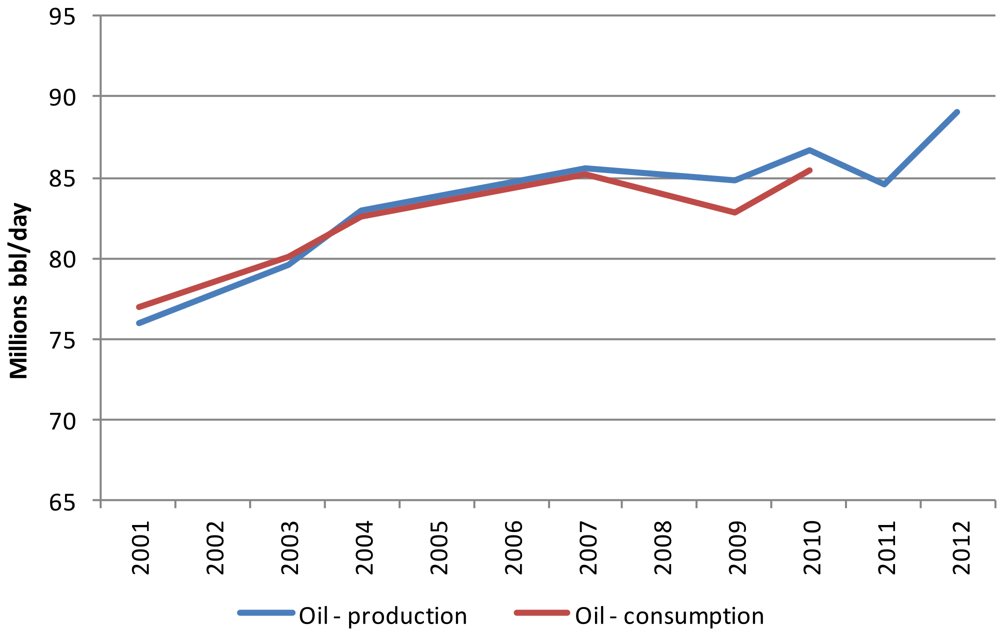
[19] Denmark, Germany, Estonia, Finland, Latvia, Lithuania, Poland, Russia and Sweden

population and labour force in the world. Aging countries are more likely to experience a decline in economic growth. Increased migration will spread to emerging powers (Global Marine Trends, 2013).

4.1.3 Resource use

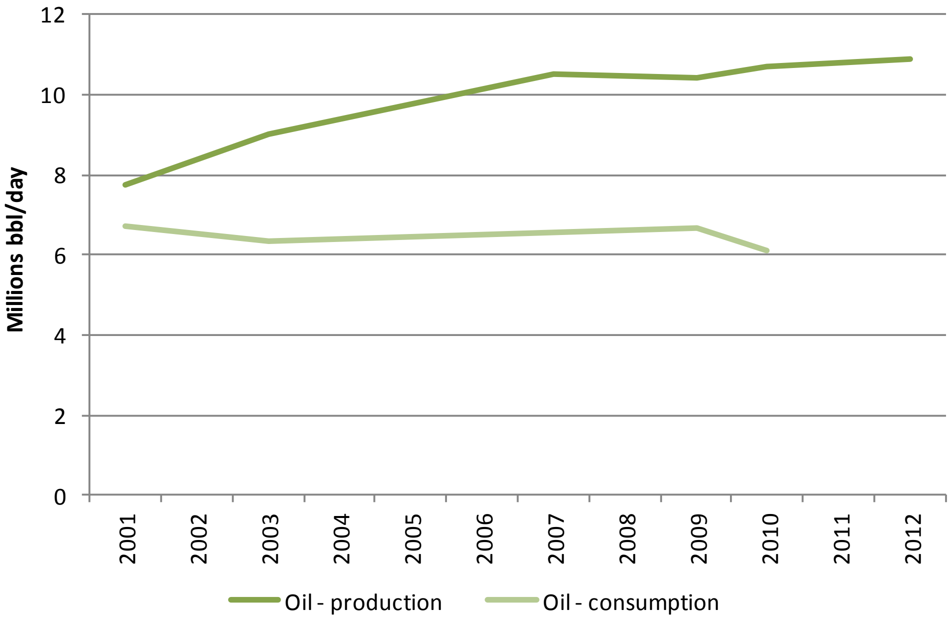
Similar to economic and societal drivers, resource demand will also greatly influence prosperity, both globally as well as in the Baltic Sea region. Indicators of resource use include consumption of oil, natural gas, coal, and steel. In this section, only oil is reviewed as a key resource, while indicators for other resources are described. Globally, oil consumption rose between 2001 and 2010 with slight declines in 2008 (see Figure 10). While in the Baltic Sea region, oil consumption remained stagnant before slightly declining in 2008, due to the financial crisis, and production rose (see Figure 10). Although data is not available, it is expected that oil consumption continued to increase after the crisis.

Figure 10: World Oil Production and Consumption



Source: CIA World Factbook

Figure 11: Baltic Sea Region Oil Production and Consumption



Source: CIA World Factbook

Globally, there is an expected 40% higher energy demand in 2030. In particular, it is expected that China will become the world's largest oil consumer. The US will remain the largest natural gas consumer, while China's natural gas consumption will go through the largest growth. China and India will be the world's biggest coal consumers. China will consume around 60% of the world's coal. It is expected that China's steel consumption will slow, while India will experience the greatest growth. Yet China will remain the largest steel consumer (Global Marine Trends, 2013).

4.2 Socioeconomic drivers on commercial shipping

Commercial shipping as like other industries is driven by supply and demand, for both raw materials as well as commodities, which is influenced by the global drivers above. As of 1 January 2014, there are 1.6 million deadweight tonnes (dwt) in the world fleet, 575.031 million dwt of which are controlled by the EU, equating to roughly 13,136 ships.[20] Countries surrounding the Baltic Sea, including Russia, control 7033 ships (203.757 million dwt), representing 13% and 35% of the world fleet and EU fleet with respect to dwt capacity, and 53% of ships in the EU (EC, 2015a). As of 2012, employment in the Baltic "sea transport" sector is estimated at 69,000 jobs, with an average turnover of 60,023 million EUR (EC, 2015a).

The market creates the mechanism for supply and demand interaction and the equilibrium market will be formed at the balance of supply and demand. Stopford (2009) provide a conceptual framework to describe the drivers of maritime economics and shipping markets. This includes five major drivers of demand for shipping: 1) economic growth, 2) commodities traded by sea, 3) average haul and tone miles, 4) random shocks, and 5) transport costs. Similarly, five major drivers of shipping supply are 1) the commercial vessel fleet, 2) fleet productivity, 3) balance of shipbuilding, scrapping and losses, 4) freight revenue and profit for ship operators, and 5) regulation and technology. The drivers of demand and supply and demand interact together creating market equilibrium in the short, medium and long term.

[20] Ships of 1,000 gross tonnage and over

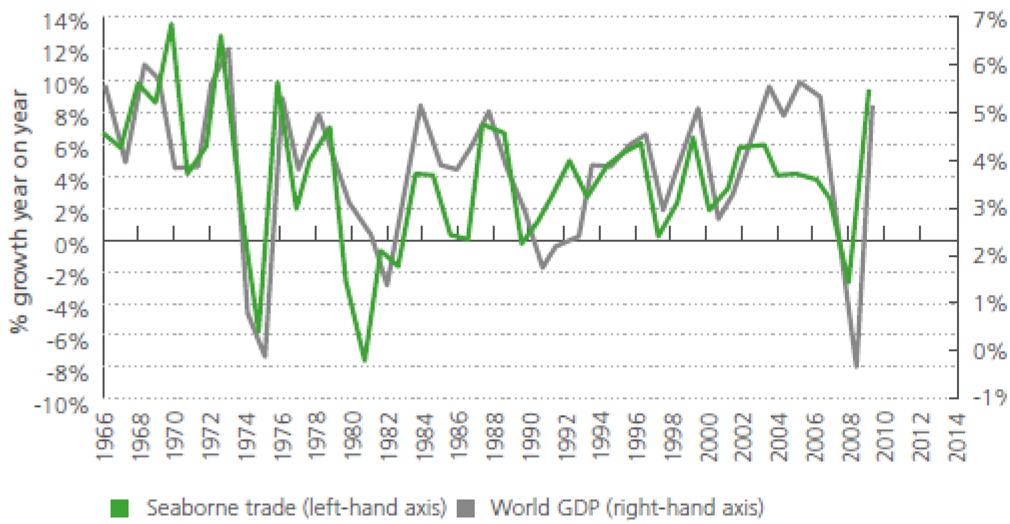
4.2.1 Socioeconomic drivers of commercial shipping demand

Economic drivers

Economic growth generates most of the demand for sea transport, through either the import of raw materials for manufacturing or the trade in manufactured products. The business and trade cycles are two aspects of the global economy which effect shipping demand. The fluctuation in economic growth rates creates the cyclical pattern of demand for commercial shipping in the short term. In this regard, there is a close relationship between GDP and growth rate of sea trade (Stopford, 2009; DNV, 2012; UNCTAD, 2014), see

Figure 12. Big past declines in growth are associated with economic shocks, for example the 1973 oil crisis that lead to an economic crisis in 1974-75 show significant drops in seaborne trade.

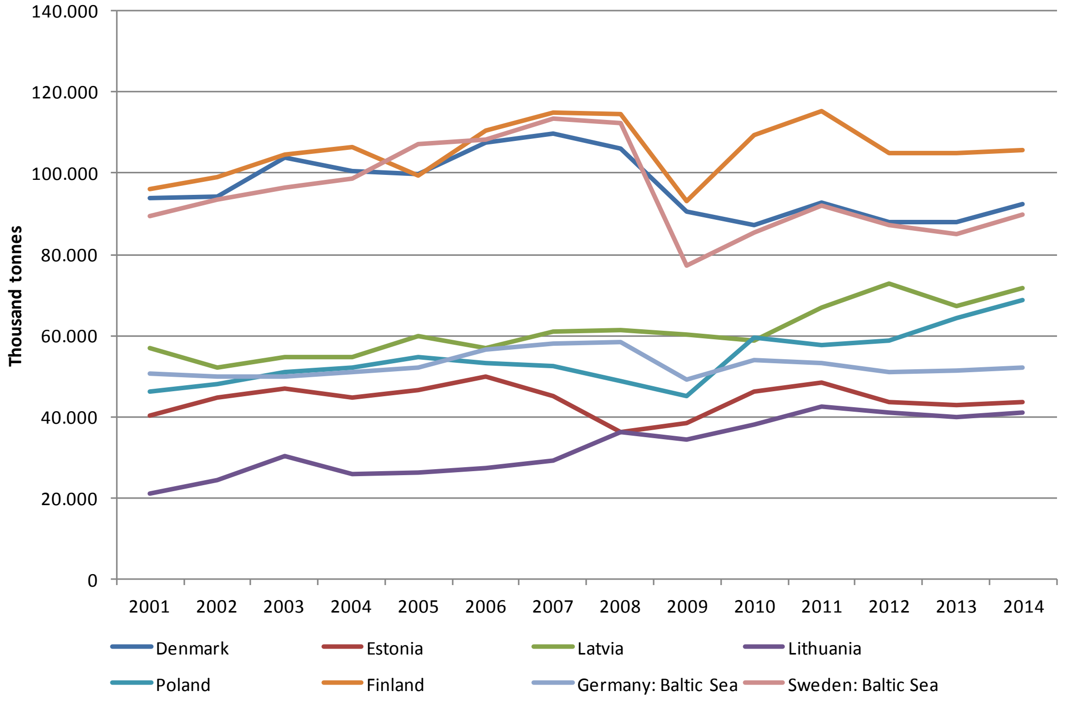
Figure 12: The Relationship between GDP Growth and Seaborne Trade Growth



Source: DNV, 2012 citing Clarkson Research Services Ltd.

The 2013 annual growth was lower than that observed during any of the previous 10 years and the trend in early 2014 suggests an even lower growth rate for the current year. The slowdown reflects the turn of the largest historical shipbuilding cycle that had peaked in 2012. Growth in containerised trade picked up speed in 2013 and expanded by 4.6% reflecting, in particular, improved import demand in Europe and the United States (DNV, 2012). Within the Baltic Sea region, the national commercial shipping fleets followed a similar pattern between 2001 and 2014. All countries showed a slight decline in goods handled in 2008 due to the economic crisis, while this was most intensely recognised in Finland, Denmark, and Sweden, which were also the countries showing the highest numbers of goods transported (see Figure 13).

Figure 13: Maritime Transport Goods in Baltic Sea Countries between 2001 and 2014 (gross weight)



Source: Eurostat [mar_go_aa]

There have been relatively large variations in the growth of the world fleet and seaborne trade since 1995 (DNV, 2012). The performance of world seaborne trade in 2013 was shaped by various trends, including a more balanced growth in demand (trade), a continued persistent oversupply in the world fleet across the various market segments, relatively high bunker price levels, as well as a wider use of slow steaming, especially in the container-ship sector. Volumes expanded at the slower rate of 3.8%, taking the total to nearly 9.6 billion tonnes.

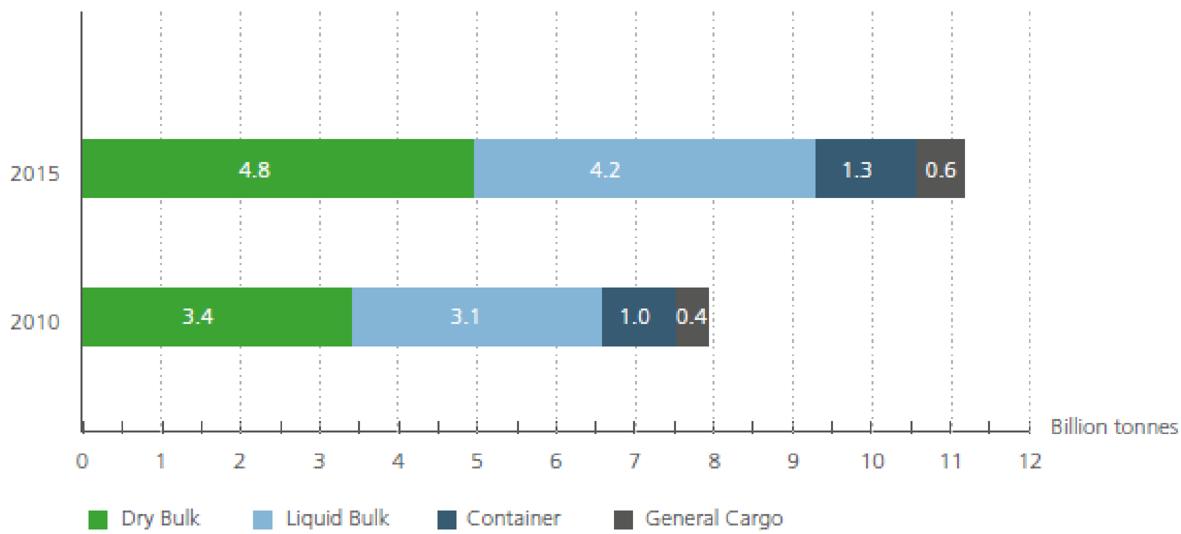
In this regard, the economic cycles rise from the combination of external and internal factors. The external factors include events like wars, conflicts or changes in commodity price (e.g. crude oil). The internal factors refer to the dynamic structure of the economy itself. The common internal factors causing fluctuations in the business cycles include: the interplay between consumption and investment (multiplier and accelerator), the delay between economic decision and their implementation (time-lags), booms and bursts cycles driven by short-term stock-building by industry in anticipation of future shortages or price raise, and mass psychology (i.e. periods of optimism or pessimism in investor behaviour) (Stopford, 2009). The long-term relationship between seaborne trade and world economy is the result of major economic changes of direction (i.e. sector trend) which may accompany the emergence of a new major economic area (e.g. Japan, South Korea, China) or a structural change such as the emergence of new technologies (DNV, 2012; Stopford, 2009; Michel and Noble, 2008). For example, the development of new technologies from steam, to electricity to information technology has significantly changed sea transport making ships faster and more efficient (DNV, 2012; Michel and Noble, 2008). The industrial economies of Europe and Japan in the 1960s had a major impact on sea trade, producing a period of rapid growth in the period and then followed by an equally sudden stagnation in the 1970s. A similar pattern was occurred in the 1990s for South Korea and other Asian countries and now for China (Stopford, 2009; DNV, 2012). These changes in trade are driven by the change in demand for the bulk commodities. As the industrial economies mature, it becomes less resource-intensive, and trade demand switches from the heavy raw materials such as iron ore, bauxite or durable products as motor car to service such as medical care and recreation, resulting in less transport intensive requirements for imported raw materials (Stopford, 2009).

Commodities traded by sea

Commodities traded by sea are influenced by factors such as seasonality and specific characteristics of the industry which in turn affect the short- and long-term demand of commercial shipping. Many agricultural commodities as well as crude oil are typically subject to seasonal fluctuations causing short-term volatility in the sea transport demand. For example, the seasonal variation of agricultural commodities such as grain, seafood and sugar is caused by harvesting during the year. The oil business cycle reflects the seasonal fluctuation in energy consumption in the industrial economies.

The economic characteristics of the industries drive the long-term trend of sea transport demand (Stopford, 2009; Rodrigue, 2010). The international trade follows changes in the international division of labour and the change in relative prices of raw material and energy. Change in demand for industrial inputs (e.g. for raw materials and energy), change in supply sources of these inputs, processing of industrial raw materials before shipping, and shipper's transport policy are the factors which change the transport demand (Rodrigue, 2010). For example, during the 1960s the growth in demand of crude oil due to the decrease in the relative price of oil made Japan and Western Europe switch from coal to oil as their primary energy source. Imported oil replaced the domestic coal and pushed the sea trade elasticities very high. Changes in the primary industries from exporting unprocessed raw materials to processing their raw materials (e.g. refining bauxite to alumina) before shipment have also affected the demand of cargo shipped by sea and type of ships required (Stopford, 2009). Figure 14 below shows the change from 2010 to 2015 in global seaborne trade by commodity type.

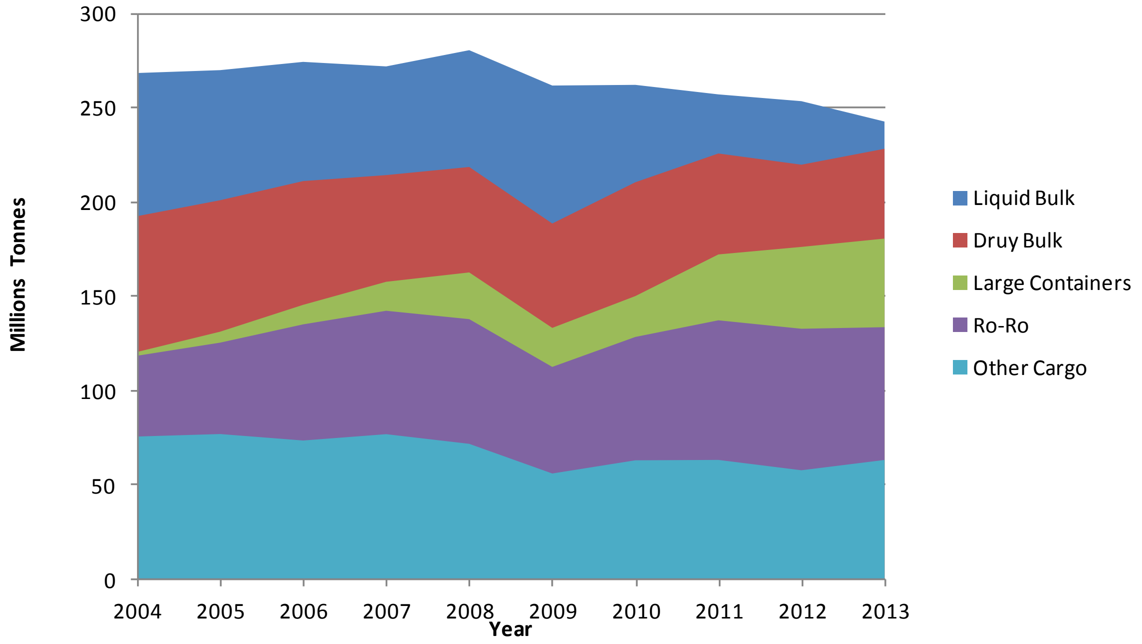
Figure 14: Global Seaborne Trade by Commodity Type



Source: DNV, 2012 citing IHS Global Insight and SAI data as of February 2012, 2015 includes forecasts

Commodities traded by sea in the Baltic Sea region show that the main type carried is liquid bulk, followed by dry bulk, large containers, Ro-Ros, and other cargo types, see Figure 15. This reflects a slight difference to global commodities, where dry bulk is main cargo type.

Figure 15: Trends of Commodity Types Handled in the Baltic Sea Region (2004 – 2013)



Source: Eurostat, 2015 [mar_mg_am_cwhc]

Tonne miles

Transport demand is determined by the distance between destinations (Limao and Venables, 2001). The effect of the distance is generally referred to as the 'average haul' of the trade. The 'tonne mile' is usually used to measure transport demand. 'Tonne mile' is defined by the tonnage of cargo shipped, multiplied by average distance over which it is transported (Stopford, 2009). The changing of the average haul is driven by the closure or openness of the sea transport routes and by the balance between the long-haul and the short-haul suppliers.

Random shocks

Weather changes, wars and conflicts, new resources and commodity price changes are all candidates for the random shocks, which upset the stability of the economic system, and in turn impact commercial shipping markets (Rodrigue, 2010; Stopford, 2008). The US economic depression in the 1930s, the US financial crisis in the 1990s, the Asian crisis of 1997, the Korean War and the Gulf War and the economic crisis of 2008 are prominent examples of random shocks. These shocks impacted transport demand at both global and regional scales.

Transport costs

Transport costs have a direct impact on commercial shipping. In the early 1980s transport cost accounted for 20% of the cost of dry bulk cargo delivered to countries within EEC Community (Rodrigue, 2010; UNCTAD, 2014). Over the last century, improved efficiency, increased ship size and more efficient organisation of shipping activities (i.e. logistics) have brought a steady reduction in transport costs and higher quality service (García-Menéndez et al., 2004). A recent study by Novy (2013) showed that trade costs between US and major partners were reduced by 40% from 1970 to 2000. Freight rates are usually indicators of transportation costs that may be measured and included in demand transport models (Turnquist, 2006; Limao and Venables, 2001; García-Menéndez et al., 2004).

4.2.2 Socioeconomic drivers of commercial shipping supply

The second group of drivers of shipping activities is from the supply of shipping services. The supply of shipping services is controlled by four groups of decision makers: shipowners, shippers/chatterers, the bankers, and various regulatory authorities who make rules for safety and environmental protection.

The commercial vessel fleet

Over the last decades, the commercial vessel fleet has grown significantly (DNV, 2012; Stopford, 2009). This includes container ships, oil tankers, bulk carriers and others. These different types of ships do not operate in separate and self-contained markets; there is a high degree of substitution between ship types (Stopford, 2009). The sizes of ships are also varied. In general the large vessels of 40,000 deadweight tonnage (dwt) and above are particularly economical on the long hauls (Cullinane and Khanna, 1999). During the last three decades, there has been a rapid increase in ship size, especially in the bulk sector of the fleet (Stopford, 2009). The supply of shipping services is determined by the time-lag from commissioning to delivery of a new ship (often several years). This prohibits the market from responding promptly to any sudden upsurge in demand. Likewise the supply is decreased when ships are taken out of operation. On average, the economic life of a ship is about 25 years (Stopford, 2009).

Fleet productivity

The productivity of fleets is affected by their flexibility to address short-term change in trade patterns. The productivity of a fleet of ships is measured in ton miles per deadweight and it depends on four main factors: speed, port time, deadweight utilisation and loaded days at sea (Stopford, 2009, Cullinane et al., 2005; Ducruet et al., 2014).

Speed is measured in knots and is the number of nautical miles per hours a ship travels. This determines the time a vessel takes on a voyage and impacts the overall capacity of the fleet. The actual speed is determined by design speed and age of the fleet (Stopford, 2009). At present, overcapacity of fleets has led to slow steaming (i.e. going at a reduced speed) to save fuel costs and utilise the tonnage.

Port time is determined by the physical performance of the ship and organisation of the port. The port performance and efficiency is the key factors driving the port time (Ducruet et al., 2014). For example, the introduction of containerisation in late 19th century drastically reduced port time for liners (Stopford, 2009).

Deadweight utilisation refers to the cargo capacity lost. This is because bunkers or stores are needed to stabilise ships and prevent a full load from being carried. The vessel time is divided between loaded days at sea and ‘unproductive’ days (i.e. in ballast, port, or off hire). Reductions in unproductive time allows for an increase in loaded days at sea. Vessels designed for cargo flexibility can improve their loaded time at sea because they are able to switch cargoes for backhauls (Brønmo, Christiansen and Nygreen, 2007).

Shipbuilding, scrapping and losses

The rate of growth of the merchant fleets depends on the balance between deliveries of new ships and removal of ships from the fleet in the form of ships scraped or lost at sea. Shipbuilding is a long cycle-business and the time-lag between ordering and delivering a ship is between 1 to 4 years, depending on the number of orders held by the shipbuilders (Stopford, 2009). The orders are normally placed on the estimation of future demand. But the estimation is often not accurate and in addition to time-lag between order and delivery often results in market imbalance-and consequently volatile freight rates as the demand does not meet the supply. Tankers and bulk production have dominated in shipbuilding industry over the last decades (DNV, 2012). Normally, the proportion of ships scrapped and lost at sea is smaller than the proportion of delivery of new ships, except in case of war. The scrapping depends on the balance of a number of factors such as age, technical obsolescence, scrap prices, current earnings and expectation of the future market (Bijwaard and Knapp, 2009; Stopford, 2009).

Freight revenue or profit of shipping performance

Freight revenue is an incentive for commercial fleets to shift capacity in the short term, and find ways of reducing their costs and improving their services in the long term. In the shipping industry, there are two main pricing regimes liner and bulk (Stopford, 2009). Liner shipping provides transport for small quantities of cargo for many customers and is essentially a retail shipping business. Bulk shipping is a wholesale operation, selling transport for shiploads of cargo to a small number of industrial customers. Liner and bulk shipping have different business strategies and economic structure (Lun et al., 2010). In the short run, supply responds to prices as ships adjust their operation speed (e.g. slow steaming) and move to and from lay-up, while liner operators adjust their services. In the long run, freight rates contribute to investment decisions which also result in scrapping and building new ships (Stopford, 2009).

Box 2: The Baltic Dry Index

The Baltic Dry Index (BDI) is commonly used as an economic indicator of transportation costs for raw materials and goods shipped by sea. It is the only independent source of quality freight market data and information (Baltic Exchange). It measures shipment rates for chartering giant ships that transport dry bulk cargoes, consisting of raw commodities such as oil, iron ore, coal, grain, copper and other primary materials (Lin et al., 2013; Baltic Exchange). Published daily, BDI rates are calculated as the weighted average of the Baltic Exchange's shipping costs for the four largest dry-vessel types: Baltic's Capesize, Panamax, Supramax and Handysize indices (Bakshi et al., 2011; Baltic Exchange).

Since its inception, the BDI has grown to become the foremost indicators for shipping costs as well as an indicator for the volume of worldwide manufacturing and trade activity (Lin et al., 2013). This is based on the idea that the supply of ships in the shipping industry is relatively in-flexible and generally predictable; thus, changes in shipping costs can be seen as largely due to changes in worldwide demand for raw materials (Bakshi et al., 2011).

Environmental regulations and updating technologies

Shipping industry currently operates under a complex set of international and national regulations regarding to environmental protection and climate change (see Section 3.1) (DNV, 2012; Rodrigue, 2010). These regulations will force shipowners to develop and improve technologies to respond to regulations and can impact SO_X emissions, NO_X emission, ballast water cleaning, noise and energy efficiency. Upcoming regulations and market pressure will impact on ship technologies and fuel type selection that is toward to lower pollution, higher fuel efficiency and green energy (DNV, 2012). The list of available technologies for these requirements is long and filled with difficult decision to make (see DNV, 2012 for the review on technologies). The expected growing scarcity and high price of oil which has guided the decision in the near past will favour the use of alternative fuels. At present (2015) the oil prices are very low and overcapacity in the shipping market may slow down the innovation in green technology for ships (Michel and Noble, 2008; DNV, 2012).

4.3 Socioeconomic drivers on fishing vessels

The seafood system seeks to ensure accessibility and availability to fish and shellfish products. The seafood industry is a global business more than any other animal protein industry, connecting all continents through its trade flows. The EU is the biggest seafood market in the world and the main global importer of seafood covering its domestic consumption mostly through imports: it currently produces 44% of its needs (EUMOFA, 2014). The demand is met by local fishing activities and imports. While fishing is a global industry, the focus here is on vessels active within the Baltic Sea region or operating from a national fleet.

4.3.1 Socioeconomic drivers of fishing demand

Economic drivers

Ultimately, it is the demand for fish and shell fish products that is mainly driving the sector and thus vessel activity. The demand for fish and the seafood market are shaped by a number of factors including consumer preferences for fish and seafood products, influenced by cultural and traditional factors, trends, price, consumers concerns about health, safety and sustainability, as well as policies and food security (World Bank, 2013). Because the seafood is global the Baltic Sea region will depend on both imports and exports to meet consumer demand. At the same time the Baltic Sea fishing fleet's production (i.e. landings) will be exported outside of the region, both to EU Member States as well as internationally. Per capita consumption of fish is predicted to decline until 2030 (World Bank, 2013). However, taking population growth into account, the overall demand for fish will increase significantly by 30% during that time (World Bank, 2013). The demand for fish is likely to shift downwards competing livestock products - particularly poultry and pork - become significantly cheaper (FAO, 1998).

Random shocks

Similar to commercial shipping vessels, random shocks will also potentially have significant effects on the sector. These could be global (e.g. wars, conflicts) as well as regional (e.g. natural disasters) or local (e.g. weather, price shifts).

4.3.2 Socioeconomic drivers of fishing supply

Fishing fleet and capacity

The fishing fleet and its productivity provide an estimation of fishing activities. This gives an indication of the intensity of vessels fishing on the Baltic Sea or coming from Baltic countries. The number of active fishing vessels along with days spent at sea, vessel power, vessel tonnage and numbers employed provide an indication of the fishing vessel capacity are all indicators in the fishing vessel capacity, see Table 8 (STECF, 2015).

Table 8: Overview of Baltic Sea Fishing Fleet

Country	No. of Vessels	Days at sea in region (days)	Vessel power (KW)	Vessels tonnage (tonne)	Estimated employed (FTE)
Germany	897	71,799	34,896	5,809	880
Denmark	619	36,142	49,881	12,168	406
Estonia	1,336	3,315	29,631	5,951	2,046
Finland	1,733	138,458	104,330	12,251	1,817
Lithuania	91	8,452	9,251	3,967	405
Latvia	267	19,364	20,673	7,681	680
Poland	752	70,515	64,203	15,584	2,213
Sweden	561	39,343	76,623	14,117	840
Total	**6,256**	**387,388**	**389,488**	**77,528**	**9,287**

Source: STECF, 2015

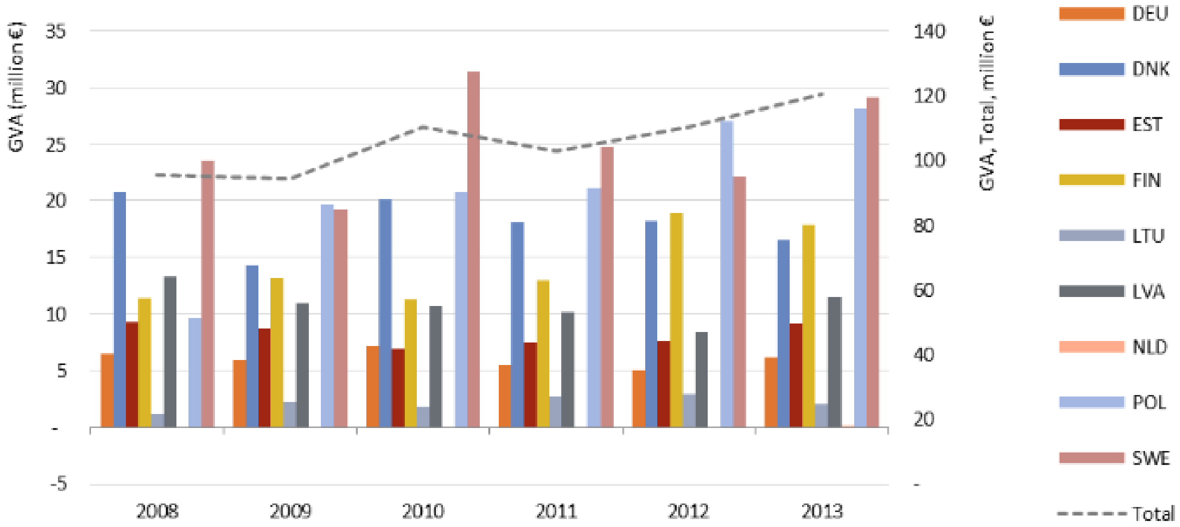
Profitability of the sector

Revenue of the fishing sector is the income earned from landings and other sources generated by the sector. This indicates the profitability of the sector and its overall economic performance. Unprofitable fisherman will likely discontinue fishing activities or seek methods (i.e. reducing costs) to maintain profitability. Gross Value Added (GVA)[21] provides an indication of the economic performance of the sector (STECF, 2015).

The revenue (income from landings and other income) generated by the Baltic Sea fleet in 2013 was estimated at 267.5 million EUR, 74% of which was split between four Member States – Sweden (59.7 million EUR), Poland (56.6 million EUR), Finland (43 million EUR) and Denmark (39.4 million EUR). Revenue increased 3% compared to 2012, largely driven by increased revenue in the Swedish and Estonian fleets (STECF, 2013). GVA produced by the Baltic Sea fleet in 2013 was estimated at 120.6 million EUR. After accounting for operating costs, the fleet made 39.7 million EUR in gross profit (STECF, 2015), see Figure 16.

[21] According to Eurostat, Gross value added (GVA) at market prices is output at market prices minus intermediate consumption at purchaser prices.

Figure 16: GVA Produced by the Baltic Sea Fleet between 2008 and 2013



Source: STECF, 2015

Environmental regulations and updating technologies

EU fisheries activities are subject to a variety of different policies, regulations and strategies with the Common Fisheries Policy (CFP) being the central element for the regulation of European fisheries across the globe and the coordination of aquaculture and marketing of seafood in Europe (Regulation (EU) No 1380/2013 on the Common Fisheries Policy). The CFP has four main pillars: stock conservation and fisheries management, international relations, market and trade policy and policy funding. Its main objective is to ensure fisheries and aquaculture is sustainable and contributes to food security. Managing fish stocks toward exploitation levels at Maximum Sustainable Yield (MSY) by 2020 and gradually establishing a discard ban for all regulated fisheries by 2019 correspond to the objective of ensuring resource efficiency under the green economy. The primary method policy makers use to reach MSY is by setting Total Allowable Catch (TACs). Total allowable catches (TACs) or fishing opportunities, are catch limits (expressed in tonnes or numbers) that are set for most commercial fish stocks. TACs are set annually for most stocks (every two years for deep-sea stocks) by the Council of fisheries ministers. Other policies related to human health, environmental protection (i.e. the MSFD), social protection and aid will also impact the fisheries sector.

4.4 Socioeconomic drivers on leisure boats

Leisure boats, also known as pleasure craft or recreational boats have a maximum length of up to 24 meters, and are meant to be used for recreational or leisure activities only. Thus they are usually not involved in or utilised for any type of business or moneymaking venture. However, they may be rented to tourists or used by tour operators. European residents[22] own an estimated 6 million recreational boats.[23] Recreational boats are predominantly sold in four Member States, Germany, France, Italy and the United Kingdom, accounting for 63% of industry revenues. Yet per capita boat ownership is almost ten times higher in Scandinavian countries than in Europe, and these countries account for over 14% of industry revenues (EC, 2006). Some 3.5 million leisure boats in the Baltic Sea use the coastal areas for recreational boating (CHANGE, 2015). Seaports and recreational boating generate 284,000 and 253,000 jobs respectively (EC, 2006).

[22] Including Norway, Switzerland, Croatia, Romania, Bulgaria and Turkey.
[23] Excluding kayaks, sailboards and other small boats (those under 2.5 m or lightweight inflatables)

4.4.1 Socioeconomic drivers of leisure boat demand

Economic drivers

The primary factors driving the leisure boat industry are expected to be linked to GDP (see above); this impacts volumes of both inbound and domestic tourists (i.e. a raise in disposable incomes), increasing high net worth and urban populations. Economic drivers will influence the recreational boating industry in terms of number of boats sold, but also types of boats sold (e.g. motor boats, sail boats, super yachts), as well as use. Scandinavian countries which typically have a higher GDP per capita compared to countries located along the southern Baltic Sea generally show greater recreational boat ownership see Table 9.

Table 9: National Recreational Boat Ownership for Some Baltic Sea Countries

Country	Population	Recreational boats per 1000 inhabitants	Total fleet	Sailboats	Inboard motor boats	Outboard motor boats and other rigid boats	Inflatable boats >2.5 m and >20 kg
Finland	5,300,000	143	734,100	19,000	93,000	620,000	2,100
Germany	82,438,000	5	441,530	120,475	88,932	232,123	n.a.
Poland	37,000,000	2	68,000	64,000	n.a.	n.a.	n.a.
Sweden	9,182,927	83	778,100	97,100	90,800	552,200	38,000

Source: Plan Bleu, 2011 citing ICOMA 2011

Tourism

Tourism will be impacted by economic drivers such as GDP and purchasing power. Number of tourists to coastal areas, both long stay and short stay (e.g. one day) are expected to impact recreational boat use in an area, both through renting units (for multiple night or single day use) as well as by joining boat tours operated by local businesses.

Coastal tourism in the EU has increased over the last 25 years and most significantly since 1998. This is due to more vacation time and increased consumer spending power as well as improved communication such as internet booking and changes in transportation options such as the rapid expansion of low-cost European airlines. Tourists visiting coastal areas will create additional demand for recreational boats, as rentals as well as users of tourist operators. The Baltic Sea countries estimate that total tourism (i.e. all forms of tourism) in the region has an annual turnover of 90 billion EUR, and that the number of employees in the sector (excluding Russia) is 156,200 (HELCOM, 2010b citing the EC, 2008). It is difficult to identify statistics in regard to tourism related to the Baltic Sea. However, an overview of the countries shows that the capacity to receive tourists and nights spent by residents and non-residents in Baltic Sea countries, Germany followed by Poland show the highest numbers, see Table 10.

Table 10: Tourist Capacity in Baltic Countries in 2013

Member State	Number of establishments (units)	Number of bed places (thousands)	Nights spent by residents and non-residents (millions)
Germany	51,954	3,481.60	354.90
Denmark	1,102	417.60	28.50
Estonia	1,320	55.50	5.70
Finland	1,443	254.10	20.20
Lithuania	1,837	69.30	6.10
Latvia	628	38.40	3.80
Poland	9,775	679.40	63
Sweden	4,261	805	49.70
Total	**72,320**	**5,800.90**	**531.90**

Source: Eurostat, 2015, tour_cap_nat, and tour_occ_ninat

Operational costs

Operational costs will impact the use of recreational boats. Fuel costs, maintenance costs, and marina charges are expected to influence boat owners in regard to distance travelled and single day vs multi-day boat trips. High operating costs (e.g. through raises in fuel prices) are expected to cause some boat owners to limit or stop the use of their boats. High costs would also lead decreased tour boat operators.

Random shocks

Random shocks will also affect the industry and include economic shocks as adverse weather conditions such as floods, drought, unreasonably hot or cold weather. Random shocks at the local level, especially weather, are expected to have significant impact on recreational boat use.

4.4.2 Socioeconomic drivers of leisure boat supply

The boatbuilding industry

The boatbuilding industry is responding to market demand made up of boatbuilders, engine manufacturers, equipment manufacturers, trade and service providers and consists of approximately 32,000 companies, directly employing over 280,000 people. The rate of growth both depends on the balance between deliveries of new leisure boats and removal of old boats.

Prior to the financial crisis, the European boating industry achieved an annual average growth rate of 6% and a turnover of over 23 billion EUR (today its turnover is approximately 20 billion EUR) (European Boating Industry, 2015). Within the Baltic, there is some available information on the boatbuilding industry. Finland showed a decrease of 3.5% in sales in 2013 while the situation shifted and increased in 2014. The Swedish market thrives with decent sales volumes as well as service and maintenance industries in 2014. The East Baltic States have a small but successful industry, where 80% of the manufactured vessels are exported and 20% are sold to domestic boat buyers (BOATSHOP24, 2015).

Marinas and harbours

The availability of marinas and harbours will affect the availability of storage for recreational boat owners. Where some boat owners will have private facilities to store boats, either in a private marina or dry docks, the primary storage for boats will be in marinas and harbours operating as businesses.

Environmental regulations and updating technologies

Leisure boats are subject to a number of EU legislation (see above) regulating their impact on marine ecosystems. Regulations will act as a driver for the activity and lead to updates in approaches as well as technologies to meet policy objectives. Biofouling (i.e. the attachment of microorganisms, plants and animals on submerged surfaces) is a key issue affecting the leisure boating sector. It can be very difficult to remove, and the boat owners often use paints containing biocides such as copper to combat biofouling. However, these paints can also have significant adverse effects on the marine environment, in particular in semi-enclosed marinas/harbours where the water exchange capacity is low (CHANGE, 2015). Other prevention techniques are also being developed. These include paints and mechanical methods such as boat washers, manual washing, ultra sound, boat hull protectors and boat lifting and washing. Paints without biocides use alternative physical properties for fouling release which is free from biocides. These are usually silicon based paints which form a smooth non-stick surface on the hull where fouling organisms have problems to attach (CHANGE, 2015).

4.5 Summary

The main global socioeconomic drivers affecting commercial shipping, the fishing sector, and the leisure boat industry will stem from economic growth, societal dynamics, and resource use. At the same time, global trends are not always in line with regional trends, showing that the Baltic Sea region must considered in terms of its own characteristics and specific socioeconomic drivers. Some key considerations for developing future scenarios have been provided above, while a number of potential indicators are provided in the Annex 2.2 Economic Indicators.

Shipping is an enormously complex and volatile industry which is cyclical in nature. Shipping activity is impacted by the interaction of numerous drivers, both from the demand and supply. It is also greatly influenced by different stakeholders (e.g. ship-owners, cargo shippers, shipping investors, ship builders, and bankers). These variables ripple through the global, regional and national scales. Socioeconomic drivers on the commercial shipping industry have been presented describe full picture of the sector. However, many of these drivers are highly difficult or impossible to be measure (e.g. random shocks). Therefore, forecasting the future of shipping activities is highly challenging (DNV, 2012). Nevertheless the main drivers regarding the demand and supply of commercial shipping as described above should be considered when developing future scenarios for the sector.

The fishing sector, both globally and in the Baltic Sea region is greatly influenced by consumer demand. Fishing fleets then seek to meet this demand by supplying fish and seafood to the market while maintaining profitability. Many of these drivers are highly difficult or impossible to measure (e.g. random shocks).

The recreational boat industry is highly influenced by consumer spending power and the tourism industry. Economic growth (i.e. GDP) is expected to lead to both greater sales as well as use of recreational boats (e.g. by tourists). At the same time, factors such as availability of marinas or limiting operational costs may also affect the future of the sector.

5 Random Shocks Potentially Affecting Shipping

Random shocks or ‘other’ events are disruptive events that might influence the ‘normal’ flow of drivers. They can bring the system out of balance and can happen on different scales. Thus events such as for example, a war, sever pollution accidents, severe weather events could be examples of random shocks, including loss of lives, ecosystem degradation an bearing high costs. Other possible examples could include geopolitical changes, change of political power, dictators coming into power, depletion of a natural resource. This would bring a shift to the previous state of play and a new baseline would be established.

Many possible events could cause such a disruption. Nicholas et al. (2013)[24] determine potential changes which were adopted more to the Baltic Sea area:

- Global economic collapse in China (economic event)
- Major pollution accident in the Baltic Sea (environmental event)
- Renewable fuels are ready for use as drive technology for vehicles at low price and on a large scale. (technological event)
- War leads to shut down of Panama Canal (geopolitical event)
- The opening of the North-West passage for shipping

Within a global economic collapse in China, the product production and GDP per year worldwide would decrease tremendously due to the globalised markets and strong trade relationships with China. The demand for goods transportation would decrease tremendously. As example, during economic recessions in 2009-2010, the world economy was in its weakest state since the Great Depression of the 1930s (DNV 2012). The current reduced level of world economic growth after the economic recessions in 2009-2010 also coincides with overcapacity in the global fleet, and the shipping market is experiencing tough conditions (DNV 2012). Most likely, only the large shipping companies would survive the years after the economic crisis. The fleet capacity would need to be reduced, less new ships would be built in the following decade and higher scrapping rates would be reached (as seen in the 1980s, DNV 2012). Fishing vessels would be effected less, but demand would for their products would probably also drop. The recreational crafts would decrease according to the lower salary level and purchasing power in most countries worldwide and the less available financial budget for leisure and tourism activities.

A major pollution accident in the Baltic Sea (e.g. a large scale oil spill, could lead to an increased awareness on environmental issues in the Baltic Sea with consequences on environmental regulation). For example, this may lead to increased interest to protect the marine environment and a shift to cleaner technologies as drive technology. A well-known example is the Exxon Valdez oil spill, which resulted in stronger oil pollution legislation and safety measures in construction of ships in the US (DNV 2012). The legislation would affect all vessels which are active in the Baltic Sea (including fishing vessels and recreational crafts). The increased environmental awareness could also lead to an improvement by climate related economic instruments, e.g. establishment of emissions trading, tax or other instruments which would lead to a renewal of the fleet and significant investment costs for shipping companies.

[24] Nicholas Brown, Patrick Carnie and Atilla Incecik, 2013. Global Marine Trends 2030.

A major technological change regarding renewable technologies as car drive technology would lead to a drop in oil demand with the consequence in lower demand of tanker capacity. The poor oil-tanker market could lead to bankruptcies, distress sales of tonnage and higher scrapping rate for tanker, especially for companies which are very specialised in oil transportation. Offshore oil logistics will not be needed and furthermore rebuilt. New navigation possibilities could occur which might lead to a shorter travel time with less emissions. Furthermore, competitive renewable technologies could be also available for the shipping sector which could lead to stricter environmental regulations. Furthermore, new market potential could be seen, e.g. shipping of biofuels or serving of offshore renewable power infrastructure (DNV 2012). Fishing vessels and recreational crafts are not affected on the demand side, but the construction could be shifted regarding the use of renewable fuels. Stricter environmental regulations could be also adopted for these vessel types.

In the scenario of a war leading to shut down of Panama Canal, more merchant ships would be built due to the extended travel time. As an example, the closing of the Suez Canal has led to a period of heavy investment in shipping during the 1970s (DNV 2012). The prices for ship construction and also good transportation would increase until the fleet has been extended. Fishing vessels and recreational crafts are not affected.

Stakeholders (see Chapter 2) questioned about future shocks that could affect shipping and vessel traffic suggested that the opening of the Northwest Passage (a collection of potential sea routes through the Arctic) due to melting ice combined with new technologies (i.e. ice breakers) could cause significant changes to the industry. This would affect the pattern of transport to China (e.g. shorter routes) and potentially the need for adaptation (e.g. bigger ships) as well as traffic to and from harbours on the Baltic Sea.

It can be seen that different random shocks can have heavy positive and negative effects on the shipping industry. The above section aims to describe a few events these potential events, while these could include any number of various events which is impossible to explore in detail.

6 Outlook

This assessment seeks to assess drivers on the shipping industry, including fishing vessels and recreational boats, both globally and in the Baltic Sea region. In an effort to do so, major policies regulating in the respective sectors were reviewed and discussed. Socioeconomic drivers of change were also identified and reviewed; these include global drivers (i.e. world economy) and specific sectoral drivers. This section aims to provide an outlook on the potential future of these sectors, globally and in the Baltic Sea Region.

Different environmental issues will become important for shipping after 2020. Legislations which are already adopted and with consequences in the upcoming years are regulations on ballast water management, SO_X, NO_X and also Monitoring and Reporting of CO_2 emissions.

It is expected that the adopted SO_X limits in Europe will reduce the SO_X emissions of shipping heavily, e.g. 87% of reduction for the 2015 sulphur limit is estimated by Johansson et al. (2013) counting in the low-sulphur distillate fuels. The SO_X regulation is leading to technical measures such as a fuel change and the use of scrubbers in ships.

The regulation on NO_X emissions are expected to have a lower influence on the Baltic Sea area, due to the fact that the ambitious tier III limits are only applied to the nitrogen ECAs. At the moment only two nitrogen ECAs are registered: North American ECA or the United States Caribbean Sea ECA. The situation would only change if the Baltic Sea would be registered at nitrogen ECA. There were already initiatives to establish a Baltic Sea nitrogen ECA but they were postponed due to the IMO amendments on Annex VI, accepted at MEPC 66 in April 2014.

The Ballast Water Management Convention is close to fulfilling its entry into force criteria (of 30 states and the combined merchant fleets of which constitute not less than 35% of the GT of world merchant shipping). As of 30 June 2015, 44 States are parties, representing 32.8% the world's merchant fleet GT. So the Convention would soon enter into force, 12 months after the criteria are reached. Ballast water treatment systems could be mandatory for ships in the near future.

The European Union stepped forwarded regarding climate impacts with the monitoring, reporting and verification (MRV) of CO_2 emissions from large ships using EU ports. The MRV will be in place from 2018 and is expected to lead to a reduction CO_2 emissions by up to 2% compared with a 'business as usual' situation (EC, 2013e). Unless further instruments for a cut of CO_2 emissions are applied the effect will be limited.

Furthermore, IMO is planning to prepare a data collection system for fuel consumption. There are also discussions and proposals from IMO members to establish an emissions reporting for international shipping (UNCTAD, 2015). IMO has not yet decided if the data collection system should be mandatory or voluntary. But it should include ships of 5,000 gross tons or above on international voyages. They should collect data on the total annual fuel consumption by fuel type. Further discussions were hold and will be taken place on procedures how to extend the data collection on data other than fuel consumption to reach a CO_2 emissions reporting. And especially the confidentiality of data reported requires further consideration (UNCTAD, 2015).

Climate change could initiate further regulatory activities regarding the reduction of GHG emissions after 2020. Therefore, the demand for cost-effectively clean shipping technologies would increase. In 2025, the EEDI will enter its last phase with an objective of 30% emission reduction. Depending on technical possibilities (new designs) a phase 4 could be adopted (DNV, 2012).

Market based measures to reduce GHG emissions are discussed within the IMO since some years. The negotiations are slowed down by several reasons, which major one is the conflict between developing and developed countries about the implementability of such an instrument. If IMO is not progressing, the EU could take action in this regard (EC 2015a). Furthermore, shipping could be obligated to pay 5-6 billion USD/year into the UN Framework Convention on Climate Change (UNFCCC) Green Climate Fund. From 2020, the fund has the objective to support developing countries for adapting to climate change and mitigate GHG emissions. This development could lead to an IMO market based measure, but is probably depending on the climate agreement in 2015 in Paris (DNV 2012).

IMO discussions on market-based measures for the reduction of GHG emissions are shifted after the UN Climate Change conference in Paris in December 2015. In general, GHG emissions from international shipping are excluded from the Kyoto-protocol and their obligations and left as an IMO responsibility. But initiatives to establish market-based measures to reduce CO_2 emissions has met with fierce resistance by the industry and developing states(Laursen, 2015; UNCTAD, 2015) Nevertheless, in preparation for the Paris Climate Conference a carbon tax, a fuel levy and annual action plans and progress reports to the UNFCCC are proposed by different organisations. The instruments were criticised by IMO and were removed from the latest draft of the Paris agreement (Roach, 2015). However, the pressure on IMO to develop further actions, eventually market-based measures, regarding GHG emissions is increasing.

Further relevant issues from a regulatory perspective seem to be black carbon, hull bio-fouling and underwater noise. Black carbon emissions have already entered the IMO agenda. Black carbon is a PM and forms during the incomplete combustion of fuels, such as fossil fuels and biofuel. Scientists are still not totally sure, but it seems that black carbon emissions could be a major driver for global warming and global climate change. A study on marine black carbon emissions indicate that 8% - 13% of all diesel emissions in 2010 are produced by maritime transport and suggested the amount will be maintained and might even increase until 2030 (ICCT, 2015). The IMO approved at the MEPC meeting in May 2015 a definition of black carbon for international shipping. The MEPC stated that at that moment it is not possible to develop control measures to reduce the impact on the Arctic of emissions of black carbon from international shipping. But there might be further initiatives in the upcoming years (UNCTAD, 2015).

As the same as ballast water, hull biofouling is noticed as transporting alien species. Biofouling is the accumulation of various aquatic organisms on ships' hulls. The IMO took already action and published a voluntary guideline to manage biofouling (resolution MEPC.207(62); IMO, 2011b). Over the last decades, the problem of invasive species carried by ships has increased based on expanded trade and traffic volume. While, the IMO AFS Convention addresses anti-fouling systems on ships. Their focus is on the negative impacts of anti-fouling systems and not the prevention of invasive species transfer by hull fouling. The biofouling guidelines contain recommended management measures, such as biofouling management plan and a biofouling record book, as well as antifouling technical measures, e.g. a coating system for exposed surfaces or biofouling resistant material for piping or other unpainted components (IMO, 2011b). It could be expected if this guideline would be transformed into regulations over the next 10–15 years, with its involved cost implications (DNV, 2012).

A further potentially upcoming regulatory issues, is underwater noise. It is raising increased attention regarding its potential effect in ocean-dwelling mammals. Scientific results are unclear at the moment, but initiatives may lead to international regulation. Although now addressed under the MSFD, noise control actions to measure ships engines is challenging and potentially expensive (DNV, 2012).

On the following page you can find a summary table (Table 11 of important already adopted regulation, their objectives and resulting future obligations).

	2013	2015	2016	2018	2019	2020	2024	2025	2030	2050
SO_x emissions		0.1% ECA sulphur limit		IMO low sulphur availability review		0.5% global sulphur limit (delay until 2025?)		Latest date for 0.5% global sulphur limit		
NO_x emissions			NO_x tier III for new buildings and operating in NECAs							
CO_2 Emissions	Entry into force of EEDI and SEEMP				EEDI reduced by 10%	MRV of CO_2 emissions (in EU)	EEDI reduced by 20%	EEDI reduced by 30%		40% reduction to 2005 level (EU shipping)
Ballast Water			BWMC entry into force?					BW treatment on all ships?		
LNG/ shore side electricity infrastructure at ports								LNG bunker facilities and shore side electricity established at all ports of the TEN-T core network		
Modal shift and network (Roadmap to a Single European Transport Area)									30% of road freight over 300 km shift to rail or water-borne transport Fully functional EU-wide multimodal TEN-T 'core network'	More than 50% of road freight over 300 km shift to rail or water-borne transport High quality and capacity network
Recreational crafts (2013/53/EU)			Emission limits for NO_x, Hydrocarbons, PM, noise emissions for recreational crafts							

Table 11: Summary of Future Environmental Related Obligations for Shipping in the Baltic Sea

In the long-term, the global economy is expected to continue to grow while populations increase. It is thus foreseen that in future decades so will the demand for commercial shipping, and recreational boats. The future of global fishing will continue to see demand, while the complex challenges of managing fish stocks means there will be significant regional variances. The market dynamics (e.g. supply and demand) of the sectors within the region will lead to short- and mid-term shifts in growth patterns.

Global drivers such as the world economy, societal changes and resource use will continue to have a great impact over future decades on demand for commercial shipping, fishing vessels, and recreational boats. Nevertheless, the market dynamics (e.g. supply and demand) of the specific sectors, including regional variances into account, will lead to short- and mid-term shifts in growth patterns.

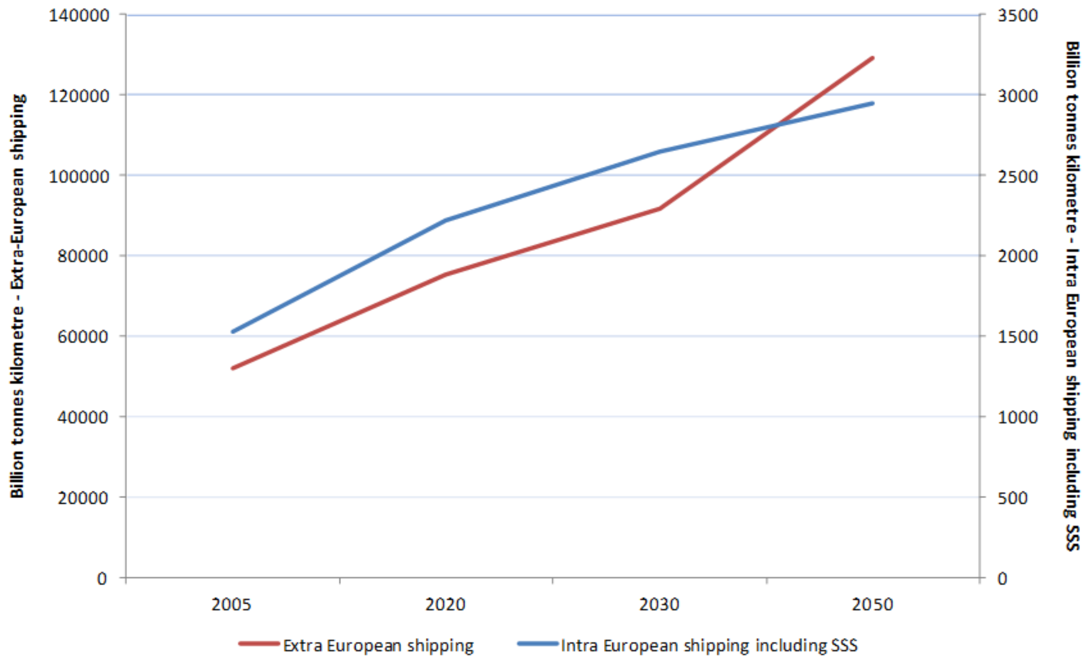
The global shipping industry is showing severe signs of struggle at present due to overcapacity and oversupply of ships. Regional analysis shows that shipping in the Baltic Sea region will follow global shipping trends, and also experience downward trends in the short- and midterm. Nevertheless, long-term forecasts to 2050 for the international as well as intra-EU shipping predict continued growth.

Trade patterns and regional variables will affect the short and mid-term trends in commercial shipping and in particular related to the commodities traded. High growth economies will create demand for bulk and tank shipping as well as containerised goods (DNV, 2012). Population changes such as increased urbanisation in coastal areas will lead to growth in demand for regional transport of goods. Regional economic growth and population dynamics (e.g. aging) are also expected to lead to changes in global trade patterns. At the same time, slowed economic growth or sudden increases in costs (e.g. fuel) can have significant effects on the industry. However, as demonstrated by the economic crisis in 2008, the commercial shipping sector is able to recover within a few years.

At present the global demand on the shipping sector is slow, and the industry is showing signs of struggle and many industry experts are predicting continued challenges for the sector. This is mainly due to slowdowns in world trade as global economic powers deal with sluggish national markets (i.e. China, Russia, Japan, and Brazil) (Richter, 2015). At the same time, the supply side of the industry has not slowed in time. Estimates suggest that an additional 1.6 million twenty-foot equivalent unit (TEU) of new capacity is being added to the container shipping fleet this year, and not enough ships are being scrapped, leading to a growth rate of 7.7%. In 2016, an additional 1.3 million TEU of capacity is going to be added (Richter, 2015). This had led to a decrease in freight rates. But as oil prices have also fell recently, most shipping companies are able to keep afloat (Richter, 2015).

Nevertheless, forecasts to 2050 suggest that EU maritime transport, including Short Sea Shipping, will grow at high rates (TransVisions, 2009). Projections suggest growth rates to be about 100% for intra-EU shipping and 150% for extra EU shipping for 2050 compared to 2005 levels. Growth is explained by technological, economic and globalisation trends, as well as weak decoupling of economic and transport activity. Improved ship technology is expected to increase ships' efficiency, while at the same time other modes of transport are likely to become more congested (i.e. road and rail). This may be especially true in the case of Short Sea Shipping. In economic terms, the impact of transportation costs is becoming less important because the unit value of goods transported is increasing (i.e. the ratio value-to-weight of goods transport is growing). Finally, globalisation trends (i.e. the increase of goods imported and exported) and the transport of goods over long distances significantly rely on maritime transport (Sessa and Enei, 2010).

Figure 17: EU 27 Maritime Transport Growth (2005-2020-2030-2050, billion tonne kilometre)

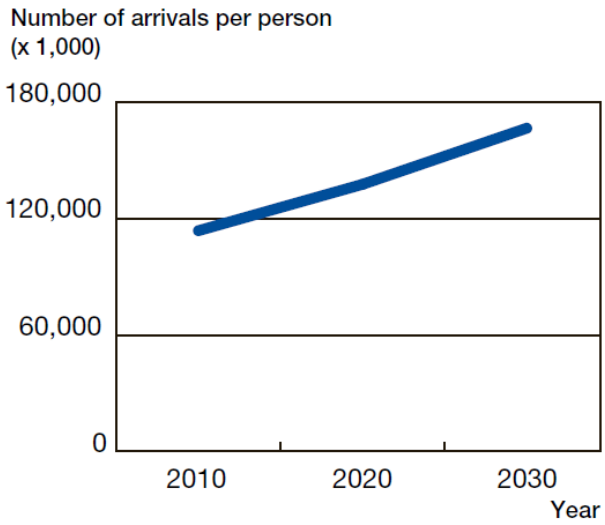


Source: MRAG, Poseidon and IFM, 2009

The fishing sector is a complex industry within the global food system, making it difficult to assess. It competes with other food sectors such as livestock and poultry. Moreover, global fish stocks have been declining for decades as policy makers seek to regulate them. Baltic Sea fishing fleets seek to meet demand both for regional sales, as well as export within the EU and externally while maintaining profitability and reducing costs. Over recent years, the number of commercial fishermen in the region have shrunk due to overcapacity in the sector and poorly managed fish stocks which led to overfishing (WWF, 2010). Along these lines, EU forecasts suggest that the number of fishing vessels in the Baltic Sea will decrease (MRAG, Poseidon and IFM, 2009) to balance the capacity to the resource availability.

Recreational boating is expected to grow in line with economic growth, increased incomes, as well as growing numbers of tourists. Within the EU, recreational boating is expanding at an annual growth rate of 5–6%. Tourism in the Baltic Sea region shows signs of stable growth along with economic development, see Figure 18 . Growth in tourism between 2000 and 2010 was around 21% in the region. If the same growth were expected until 2030, tourist arrivals will reach around 160 million (WWF, 2010). There is also a growing retirement age population in the region. This group has a large income and remains in good health compared to previous generations. Moreover, current trends show that seniors in the region are beginning to retire earlier than other generations (WWF, 2010).

Figure 18: Expected Growth in Number of Tourist Arrivals in Hotels and Similar Establishments in the Baltic Sea Countries



Source: WWF, 2010

The outlook of shipping, fishing vessels and recreational boats both globally and in the Baltic Sea region is difficult to define. A number of factors including environmental policies and socioeconomic drivers intermingle in a complex web causing changes to and shifts in the current scenario affecting future outcomes. To add to this complexity, random shocks to the current situation have the potential to unexpectedly disrupt established trends and significant affects to the scenario. Many environmental regulations have been set in place address environmental issues (SO_X, NO_X) which cause industry to adapt as it seeks to adhere to these regulations. At same time, other environmental regulations to exist environmental pressures such as for ballast water exist without a clear indication of the future and how it will affect the industry. For some environmental pressures (e.g. underwater noise) it is recognised that this pressure affects the marine environment (also within the MSFD) yet there is no clear picture as to how policies or industry will address this issue. Socioeconomic drivers range from global trends (e.g. economy) to regional (e.g. flows in tourists) and sector specific aspects (e.g. market variables). Such drivers are closely coupled with the performance of industries. Forecasts of future trends suggest that the global and EU shipping industry will continue to grow to 2050, however the current situation of the industry shows that major economic challenges must first be overcome before the sector will continue to grow. Fishing in the Baltic has reached a state of stagnation and is expected to decrease in the future, while recreational boating is projected to grow in the region.

7 Key messages

Based on the compiled information for environmental related policies for shipping in the Baltic Sea and relevant socioeconomic drivers following key messages can be summarised:

- The ambition level for reduction of different air emissions is varying: SO_X emissions limits are ambitious and will lead to a significant reduction, NO_X emissions limit will only lead to relevant reductions, if the Baltic Sea will be registered as NECA.
- The design of policy instruments and ambitions on reduction of GHG emissions on global level is postponed after Paris Climate Change Conference (in December 2015). In absence of international agreement, the European Union moves slowly forward and indicated some reduction targets for European shipping (excluding international shipping) and a framework for monitoring and reporting of CO_2 emissions. But especially during the preparation of the Paris Climate Change Conference the pressure on the IMO and the international shipping sector increased to take action on measures with significant results, also market-based measures are discussed. The way forward will also depend on the results of the Paris Climate Change Conference.
- Further regulation such as the IMO Ballast Water Treatment Convention will lead to technological changes for the whole shipping fleet in the next years.
- Waste regulations are in place but the national and regional implementation by policy instruments could be supported, e.g. with the discussion of best practice examples.
- Further discussions are starting on the issues of black carbon, hull bio-fouling and underwater noise.
- Shipping is an enormously complex and volatile industry which is cyclical in nature. Shipping activity is impacted by the interaction of numerous global drivers, as well as market drivers (demand and supply).
- Future expectations of economic growth suggest that the industry shipping will grow both globally as well as in the Baltic Sea region. However, differences of past trends between global and regional drivers are recognised.
- The current economic situation of the global shipping industry (i.e. overcapacity combined with oversupply) means that the industry will go through a challenging period and some companies may exit the market before growth continues.
- Recreational boats are influenced by global drivers as well as regional specifics of supply and demand.
- The Baltic Sea fishing fleet is expected to decrease in the future as some fishermen exit the industry due to insufficient economic incentives and regulations to manage fish stocks reduce activity.
- Recreational boating will continue to grow in the Baltic Sea region as economic growth in the region leads to increased purchasing power, but also as more tourists travel to the area and more people retire at a younger age and with more expendable money.
- Random shocks to the system have the potential cause major shifts to current trends. These include geopolitical events, weather events, major economic shocks, and major pollution events.

References

Adland, R. and Strandenes, S.P., 2007. A Discrete-time Stochastic Partial Equilibrium Model of the Spot Freight Market. *Journal of Transport Economics and Policy* 41 (2), pp. 189-218.

Ambrosson, J. (2008) MAMPEC-scenarier för Sveriges östkust och västkust. Konsultrapport till KemI 2008-10-08, 48 sid.

Bakshi, G., Panayotov, G. and Skoulakis, G., 2011. The Baltic Dry Index as a Predictor of Global Stock Returns, Commodity Returns, and Global Economic Activity. In AFA 2012 Chicago Meetings Paper. Accessed online 13 November 2015: http://www.researchgate.net/profile/Georgios_Skoulakis/publication/228553908_The_Baltic_Dry_Index_as_a_Predictor_of_Global_Stock_Returns_Commodity_Returns_and_Global_Economic_Activity/links/09e4150dc8683242f4000000.pdf

Baltic Exchange. http://www.balticexchange.com/about-us/faqs/

Bijwaard, G.E. and Knapp, S., 2009. Analysis of Ship Life Cycles—The Impact of Economic Cycles and Ship Inspections. *Marine Policy* 33 (2), pp. 350-369.

BOATSHOP24, 2015. European market Report in the Boating Industry. BOATSHOP24, Marine Industry News article published online 29 July 2015. Accessed online 13 November 2015: http://www.boatshop24.com/en/news/european-market-report-in-the-boating-industry/318#ADlMogSbsthaOJHE.97

Boersma, K.F., Vinken, G.C.M. and Jean Tournadre, J., 2015. Ships Going Slow in Reducing Their NO_X Emissions: Changes in 2005–2012 Ship Exhaust Inferred from Satellite Measurements Over Europe. *Environmental Research Letters* 10 (074007). Accessed online 13 November 2015: http://iopscience.iop.org/article/10.1088/1748-9326/10/7/074007/pdf

Brønmo, G., Christiansen, M. and Nygreen, B., 2007. Ship Routing and Scheduling with Flexible Cargo Sizes. *Journal of the Operational Research Society* 58 (9), pp. 1167-1177.

CHANGE, 2015. Biocide-based Paints. Accessed online 13 November 2015: http://changeantifouling.com/antifouling-techniques/biocide-based-paints/

CIA World Factbook. Accessed online 13 November 2015: http://www.indexmundi.com/g/g.aspx?v=65&c=xx&l=en

Council of the European Union, 2003. Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity. In: Official Journal of the European Union, 31.10.2003, L283/51. Accessed online 13 November 2015: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:283:0051:0070:EN:PDF

CSI, 2015a. About. Clean Shipping Index. Accessed online 9 November 2015: http://www.cleanshippingindex.com/about/

CSI, 2015b. Guidance Document. Version 5.2. August 2015. Clean Shipping Index. Gothenburg, Sweden. Accessed online 13 November 2015: http://www.cleanshippingindex.com/wp-content/uploads/2015/10/Guidance-doc-CLEAN-SHIPPING-INDEX-5.2.pdf

Cullinane, K. and Khanna, M., 1999. Economies of Scale in Large Container Ships. *Journal of Transport Economics and Policy* 33 (2), pp. 185-208. Accessed online 13 November 2015: http://www.bath.ac.uk/e-journals/jtep/pdf/Volume_33_Part_2_185-207.pdf

Cullinane, K. and Toy, N., 2000. Identifying Influential Attributes in Freight Route/Mode Choice Decisions: A Content Analysis. *Transportation Research Part E: Logistics and Transportation Review* 36 (1), pp. 41-53.

Cullinane, K., Song, D.W. and Wang, T., 2005. The Application of Mathematical Programming Approaches to Estimating Container Port Production Efficiency. *Journal of Productivity Analysis* 24 (1), pp. 73-92.

Danish Ministry of Environment and Food, 2015a. Partnership for Ballast Water. Accessed online 10 November 2015: http://eng.ecoinnovation.dk/the-danish-eco-innovation-program/publicprivate-partnerships/present-partnerships/ballast-water/

Danish Ministry of Environment and Food, 2015b. Cleaner Shipping. Accessed online 10 November 2015: http://eng.ecoinnovation.dk/the-danish-eco-innovation-program/publicprivate-partnerships/present-partnerships/shipping/

Danish Shipowners' Association, 2015. Danish Shipping Statistics May 2015. Article published online 28 May 2015. Accessed online 13 November 2015: https://www.shipowners.dk/en/presse/nyheder/skibsfarten-i-tal-maj-2015/

DNV, 2012. Shipping 2020. Det Norske Veritas (DNV) report. Accessed online 13 November 2015: http://www.dnv.nl/binaries/shipping%202020%20-%20final%20report_tcm141-530559.pdf

Douglas-Westwood Limited, 2005. Marine Industries Global Market Analysis. Marine Foresight Series No. 1. Marine Institute. Accessed online 13 November 2015: http://oar.marine.ie/bitstream/10793/559/1/Foresight%20Series%201%20Marine%20Industries%20Global%20Market%20Analysis.pdf

Ducruet, C., Itoh, H. and Merk, O., 2014. Time Efficiency at World Container Ports. In *International Transport Forum Discussion Papers* (No. 2014-08). Accessed online 13 November 2015: http://www.internationaltransportforum.org/jtrc/DiscussionPapers/DP201408.pdf

EC, 2002. Communication from the Commission to the European Parliament and the Council, of 20 November 2002, "A European Union strategy to reduce atmospheric emissions from seagoing ships" COM (2002) 595 final, Volume I. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=URISERV:l28131&from=EN

EC, 2005. Communication from the Commission to the Council and the European Parliament: Thematic Strategy on air pollution. COM(2005) 446 final.

EC, 2006. An Exhaustive Analysis of Employment Trends in all Sectors Related to Sea or Using Sea Resources-Summary Report. Final Report to the European Commission, DG Fisheries and Maritime Affairs C3135/ September 2006. Accessed online 13 November 2015: http://ec.europa.eu/maritimeaffairs/documentation/studies/documents/summary_report_en.pdf

EC, 2009. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions of 21 January 2009, "Strategic goals and recommendations for the EU's maritime transport policy until 2018." COM(2009) 8 Final. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0008&from=EN

EC, 2011a. White Paper: Roadmap to a Single European Transport Area- Towards a Competitive and Resource Efficient Transport System. COM (2011) 144 Final. Accessed online 13 November

2015: http://ec.europa.eu/transport/themes/strategies/doc/2011_white_paper/white_paper_com%282011%29_144_en.pdf

EC, 2011b. Council Implementing Decision of 20 June 2011 authorising Sweden to apply a reduced rate of electricity directly provided to vessels at berth in a port ('shore-side electricity') in accordance with Article 19 of Directive 2003/96/EC. Accessed online 13 November 2015: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:170:0036:0037:EN:PDF

EC, 2013a. Communication from the Commission to the Council of May 2013 concerning a consultation on fishing opportunities for 2014. COM(2013) 319 Final. Accessed 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0319&from=EN

EC, 2013b. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Integrating maritime transport emissions in the EU's greenhouse gas reduction policies. COM(2013) 479 Final. Accessed online 13 November 2015: http://ec.europa.eu/clima/policies/transport/shipping/docs/com_2013_479_en.pdf

EC, 2013c. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Clean Power for Transport: A European alternative fuels strategy. SWD(2013) 17 Final. Accessed online 13 November 2015: http://cor.europa.eu/en/activities/stakeholders/Documents/com2013-17.pdf

EC, 2013d. Commission Staff Working Document: Actions towards a comprehensive EU framework on LNG for shipping. SWD(2013) 4 Final. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013SC0004&from=EN

EC, 2013e. Commission Staff Working Document. Executive Summary of the Impact Assessment. Accompanying the document: Proposal for a Regulation of the European Parliament and of the Council on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport and amending Regulation (EU) N° 525/2013, SWD(2013) 236 final. Accessed online 13 November 2015: http://eur-lex.europa.eu/resource.html?uri=cellar:ec447f45-ee12-11e2-a22e-01aa75ed71a1.0013.05/DOC_1&format=PDF

EC, 2015a. EU Transport in Figures: Statistical Pocketbook 2015. Accessed online 13 November 2015: http://ec.europa.eu/transport/facts-fundings/statistics/doc/2015/pocketbook2015.pdf

EC, 2015b. Reducing Emissions from the Shipping Sector. EC Climate Action. Last update 20 October 2015. Accessed 10 November 2015: http://ec.europa.eu/clima/policies/transport/shipping/index_en.htm

EC, 2015c. European Commissions' Study on LNG as a Shipping Fuel Shows Industry's Support. EC Mobility and Transport Maritime News article published 3 March 2015. Last update 23 June 2015. Accessed online 12 November 2015: http://ec.europa.eu/transport/modes/maritime/news/2015-03-03-lng_en.htm

EEA, 2013. The Impact of International Shipping on European Air Quality and Climate Forcing. EEA Technical Report, No 4/2013. European Environment Agency. Copenhagen, Denmark.

Accessed online 13 November 2015: http://www.eea.europa.eu/publications/the-impact-of-international-shipping

EEA, 2015. State of Europe's Seas. EEA Report 2/2015. European Environment Agency. Copenhagen, Denmark. Accessed online 13 November 2015: http://www.eea.europa.eu/publications/state-of-europes-seas

Erhvervs- og Vækstministeriet, 2012. Danmark i arbejde. Vækstplan for Det Blå Danmark. December 2012, Rederingen. Accessed online 13 November 2015: http://www.soefartsstyrelsen.dk/Documents/Publikationer/V%C3%A6kstplanDetBlaaDanmark.pdf

ESI, 2015. Environmental Ship Index (ESI). Accessed online 9 November 2015: http://www.environmentalshipindex.org/Public/FAQ

EU, 2011. The EU Biodiversity Strategy to 2020. Luxembourg: Publications Office of the European Union. Accessed online 13 November 2015: http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/2020%20Biod%20brochure%20final%20lowres.pdf

EUMOFA, 2014. The EU Fish Market – 2014 Edition. European Market Observatory for Fisheries and Aquaculture Products (EUMOFA). Accessed online 13 November 2015: https://www.eumofa.eu/documents/10157/7a04438d-9c52-4191-99ca-cfad38985718

European Boating Industry, 2015. Facts and Figures. Accessed online 13 November 2015: http://www.europeanboatingindustry.eu/index.php?option=com_content&view=article&id=4&Itemid=119

European Parliament and the Council, 1989. Directive 89/677/EEC of 21 December 1989 amending for the eighth time Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the member states relating to restrictions on the marketing and use of certain dangerous substances and preparations. Accessed online 23 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31989L0677R(01)&from=EN

European Parliament and the Council, 2000. 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. 2000/59/EC. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=URISERV:l24199&from=EN

European Parliament and the Council, 2003. Regulation (EC) No 782/2003 of the European Parliament and of the Council of 14 April 2003 on the prohibition of organotin compounds on ships. EC 782/2003, In: Official Journal of the European Union, 9.5.2003, L115/1. Accessed online 13 November 2015: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:115:0001:0011:EN:PDF

European Parliament and the Council, 2008. Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe of 21 May 2008. In: Official Journal of the European Union, L 152, 11.6.2008, p. 1–44.

European Parliament and the Council, 2012a. Directive 2012/33/EU of the European Parliament and of the Council of 21 November 2012 amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0033&from=EN

European Parliament and the Council, 2012b. Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products. Accessed online 22 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0528&from=EN

European Parliament and the Council, 2013. Directive 2013/53/EU of the European Parliament and of the Council of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0053&from=EN

European Parliament and the Council, 2014. Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0094&from=EN

European Parliament and the Council, 2015. Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC. In: Official Journal of the European Union. 19.5.2015, L 123/55. Accessed online 13 November 2015: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0757&from=EN

Eurostat, 2010. Maritime transport of goods – 1st quarter 2010. Data in focus 52/2010. Accessed online 13 November 2015: http://ec.europa.eu/eurostat/documents/4168041/5947589/KS-QA-10-052-EN.PDF/9611a957-ce11-4f86-9e2b-35eef4195399

Eurostat, 2015. Maritime transport statistics - short sea shipping of goods. Updated April 2015. Accessed online 9 November 2015: http://ec.europa.eu/eurostat/statistics-explained/index.php/Maritime_transport_statistics_-_short_sea_shipping_of_goods

FAO, 1998. Part 4- Outlook: Expected Trends in Supply and Demand. In *The State of World Fisheries and Aquaculture*. Accessed online 13 November 2015: http://www.fao.org/docrep/w9900e/w9900e05.htm

García-Menéndez, L., Martínez-Zarzoso, I. and De Miguel, D.P., 2004. Determinants of Mode Choice Between Road and Shipping for Freight Transport: Evidence for Four Spanish Exporting Sectors. *Journal of Transport Economics and Policy* 38 (3), pp. 447-466.

Global Marine Trends, 2013. Global Marine Trends 2030. Accessed online 13 November 2015: http://www.futurenautics.com/wp-content/uploads/2013/10/GlobalMarineTrends2030Report.pdf

Hawdon, D., 1978. Tanker Freight Rates in the Short and Long Run. *Applied Economics* 10 (3), pp. 203-218.

HELCOM, 2007. Application of the No-Special-Fee System to ship-generated Wastes and Marine Litter caught in Fishing Nets in the Baltic Sea Area. HELCOM Recommendation 28E/10.

HELCOM, 2010a. Maritime Activities in the Baltic Sea: An Integrated Thematic Assessment on Maritime Activities and Response to Pollution at Sea in the Baltic Sea Region. Baltic Sea Environmental Proceedings No. 123. Accessed online 13 November 2015: http://helcom.fi/Lists/Publications/BSEP123.pdf

HELCOM, 2010b. Ecosystem Health of the Baltic Sea 2003-2007: HELCOM Initial Holistic Assessment. Baltic Sea Environmental Proceedings No. 122. Accessed online 10 November 2015: http://www.helcom.fi/Lists/Publications/BSEP122.pdf

HELCOM, 2013. Review of the Fifth Baltic Sea Pollution Load Compilation for the 2013 HELCOM Ministerial Meeting. Accessed online 13 November 2015: http://helcom.fi/Lists/Publications/BSEP141.pdf

HELCOM, 2014. HELCOM Guide to Alien Species and Ballast Water Management in the Baltic Sea. Adopted by the Joint HELCOM/OSPAR Task Group on Ballast Water Management Convention Exemptions on 12-13 May 2014. Accessed online 13 November 2015: http://helcom.fi/Lists/Publications/HELCOM%20Guide%20to%20Alien%20Species%20and%20Ballast%20Water%20Management%20in%20the%20Baltic%20Sea.pdf

HELCOM, 2015. HELCOM Recommendations 36/1, Regional Action Plan on Marine Litter (RAP ML). Adopted on 4 March 2015. Accessed online 13 November 2015: http://www.helcom.fi/Recommendations/Rec%2036-1.pdf

ICCT, 2015. Needs and Opportunities to Reduce Black Carbon Emissions from Maritime Shipping. ICCT, Working Paper 2015-2. International Council on Clean Transportation. Published online 23 March 2015. Accessed online 12 November 2015: http://theicct.org/sites/default/files/publications/ICCT_black-carbon-maritime-shipping_20150324.pdf

Ikonen, M., 2012. HELCOM No-special-fee system. Presentation Mirja Ikonen - Special Adviser, Finnish Transport Safety Agency, USBSR Joint workshop on no-special-fee system to ship-generated wastes in the Baltic Sea area, Copenhagen Malmö Port. 5 November 2012.

IMF, 2015. World Economic Outlook 2015 Update – Slower Growth in Emerging Markets, a Gradual Pickup in Advanced Economies. International Monetary Fund. Published online 9 July 2015. Accessed online 13 November 2015: http://www.imf.org/external/pubs/ft/weo/2015/update/02/pdf/0715.pdf

IMO, 2004. International Convention for the Control and Management of Ships' Ballast Water and Sediments. BWM/CONF/36, 16 February 2004. Accessed online 13 November 2015: http://www.bsh.de/de/Meeresdaten/Umweltschutz/Ballastwasser/Konvention_en.pdf

IMO, 2006. Recommendation on Standards for the Rate of Discharge of Untreated Sewage from Ships. Resolution MEPC.157(55). Annex 14. Adopted on 13 October 2006. Accessed online 13 November 2015: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/Sewage/Documents/Resolution%20MEPC.157-55.pdf

IMO, 2008. Report of the Marine Environment Protection Committee on its Fifty-eighth Session. MEPC 58/23. Annexes 13 and 14. Accessed online 13 November 2015: http://www3.epa.gov/nonroad/marine/ci/mepc58-23-annexes13-14.pdf

IMO, 2011a. International Convention for the Prevention of Pollution from Ships (MARPOL)-Inclusion of Regulations on Energy Efficiency for Ships in MARPOL Annex VI. Resolution MEPC.203(62). Annex 19. Adopted on 15 July 2011. Accessed online 13 November 2015: http://www.imo.org/en/MediaCentre/HotTopics/GHG/Documents/eedi%20amendments%20RESOLUTION%20MEPC203%2062.pdf

IMO, 2011b. International Convention for the Prevention of Pollution from Ships (MARPOL)- 2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species. Resolution MEPC.207(62). Annex 26. Adopted on 15 July 2011. Accessed online 13 November 2015: http://www.imo.org/en/OurWork/Environment/Biofouling/Documents/RESOLUTION%20MEPC.207%5B62%5D.pdf

IMO, 2015a. International Convention for the Prevention of Pollution from Ships (MARPOL). Accessed online 10 November 2015: http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-%28MARPOL%29.aspx

IMO, 2015b. Sulphur oxides (SO_X) – Regulation 14. Accessed online 10 November 2015: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-%28SOx%29-%E2%80%93-Regulation-14.aspx

IMO, 2015c. Anti-fouling systems. Accessed online 10 November 2015: http://www.imo.org/en/OurWork/Environment/Anti-foulingSystems/Pages/Default.aspx

Johansson, L. and Jalkanen, J.P., 2015. Baltic Sea Environment Fact Sheet 2015. Published 20 October 2015.

Johansson, L., Jalkanen, J.P., Kalli, J. and Kukkonen, J., 2013. The Evolution of Shipping Emissions and the Costs of Regulation Changes in the Northern EU Area. *Atmospheric Chemistry and Physics* 13, pp. 11375–11389. Accessed online 13 November 2015: http://www.atmos-chem-phys.net/13/11375/2013/acp-13-11375-2013.pdf

Kemikalieinspektionen, 2015. Båtbottenfärger – om du måste måla. Accessed online 13 November 2015: http://www.kemi.se/hitta-direkt/bekampningsmedel/biocidprodukter/regler-for-nagra-vanliga-typer-av-biocidprodukter/batbottenfarger--om-du-maste-mala

King, D.M., Hagan, P.T., Riggio, M. and Wright, D.A., 2012. Preview of Global Ballast Water Treatment Markets. *Journal of Marine Engineering & Technology* 11 (1), pp. 3-15. Accessed online 13 November 2015: http://www.tandfonline.com/doi/pdf/10.1080/20464177.2012.11020256

Laursen, W., 2015. CO_2 Data Collection Decision Making Delayed. Op-Ed in the Maritime Executive, published online 18 May 2015. Accessed online 12 November 2015: http://maritime-executive.com/editorials/co2-data-collection-decision-making-delayed

Limao, N. And Venables, A. J., 2001. Infrastructure, Geographical Disadvantage, Transport Costs, and Trade. *The World Bank Economic Review* 15 (3), pp. 451-479. Accessed online 13 November 2015: http://elibrary.worldbank.org/doi/abs/10.1093/wber/15.3.451?journalCode=wber

Lin, F. and Sim, N.C., 2013. Trade, Income and the Baltic Dry Index. *European Economic Review* 59, pp. 1-18. Accessed online 13 November 2015: http://www.sciencedirect.com/science/article/pii/S0014292112001596

Lun, Y.H.V., Lai, K.H. And Cheng, T.C.E., 2010. Chapter 5: Business Strategy in Shipping. In *Shipping and Logistics Management*. Springer, London, pp. 61-75.

Michel, K. and Noble, P., 2008. Technological Advances in Maritime Transportation. *The Bridge* 38 (2), pp. 33-40. Accessed online 13 November 2015: https://www.nae.edu/File.aspx?id=7420

Miljøstyrelsen, 2008. Clean Air for All - Action on Air Pollution. Annex II: The Strategic Plan on Air Pollution. Copenhagen, Denmark. Accessed online 13 November 2015: http://eng.mst.dk/media/mst/69143/Luftstrategi%202008_ENG.pdf

Moore, S.E., Reever, R.R., Southall, B.L., Ragen, T.J., Suydam, R.S. and Clark, C.W., 2012. A New Framework for Assessing the Effects of Anthropogenic Sound on Marine Mammals in a Rapidly Changing Arctic. *BioScience* 62 (3), pp. 289-295. Accessed online 13 November 2015: http://bioscience.oxfordjournals.org/content/62/3/289.full.pdf+html

MRAG, Poseidon and IFM, 2009. Economic and Social Impacts of the Proposed Scenarios for a Multi-annual Management Plan for Baltic Pelagic Fisheries. Final Report to the European Commission Fish/2006/09. Accessed online 13 November 2015: http://ec.europa.eu/fisheries/documentation/studies/baltic-pelagic-fisheries_en.pdf

Novy, D., 2013. Gravity Redux: Measuring International Trade Costs with Panel Data. *Economic Inquiry* 51 (1), pp. 101-121.

Paulin, S.,2012. Use of NSF in Swedish ports. Presentation Stina Paulin, Swedish Transport Agency, EUSBSR Joint workshop on no-special-fee system to ship-generated wastes in the Baltic Sea area, Copenhagen Malmö Port. 5 November 2012.

Plan Bleu, 2011. Cruises and Recreational Boating in the Mediterranean. Accessed online 13 November 2015: http://planbleu.org/sites/default/files/publications/2-1-en_croisiereplaisance.pdf

Research and Markets, 2015. Global Leisure Boat Market Report: 2015 Edition. Accessed online 13 November 2015: http://www.researchandmarkets.com/research/vz9ggz/global_leisure

Richter, W., 2015. "Global Shipping Veers into Capital Destruction." Wolf Street article, published online 9 October 2015. Accessed online 13 November 2015: http://wolfstreet.com/2015/10/09/capital-destruction-low-demand-overcapacity-sink-global-shipping-industry/

Riigi Teatajy, 2015a. Maritime Safety Act. Accessed online 10 November 2015: https://www.riigiteataja.ee/en/eli/518062015003/consolide

Riigi Teatajy, 2015b. Ports Act. Accessed online 10 November 2015: https://www.riigiteataja.ee/en/eli/ee/Riigikogu/act/513042015010/consolide

Riigi Teatajy, 2015c. Ambient Air Protection Act. Accessed online 10 November 2015: https://www.riigiteataja.ee/en/eli/ee/Riigikogu/act/517062015007/consolide

Roach, S., 2015. "OECD body backs Paris shipping CO_2 action." ENDSEurope article, published online 14 October 2015. Accessed online 12 November 2015: http://www.endseurope.com/article/43647/oecd-body-backs-paris-shipping-co2-action

Rodrigue, J. P., 2010. Maritime Transportation: Drivers for the Shipping and Port Industries. International Transport Forum. Accessed online 13 November 2015: http://www.internationaltransportforum.org/Proceedings/Genoa2010/Rodrigue.pdf

Rostock Port, 2014. Bestimmungen und Entgelte 2015- für die Benutzung des dem öffentlichen Verkehr zugänglichen Hafens der Hafen-Entwicklungsgesellschaft Rostock mbH und des Passagierkais in Warnemünde/Neuer Strom. Accessed online 13 November 2015: http://www.rostock-port.de/fileadmin/user_upload/pdf/entgelte/2015_01_01_Hafenentgelte2015Deu.pdfSjöfartsverket (Swedish Maritime Administration), 2014. Sjöfartsverkets föreskrifter om farledsavgift, Sjöfartsverkets författningssamling, SJÖFS 2014:8. Accessed online 13 November 2015: http://www.sjofartsverket.se/upload/SJOFS/2014-8.pdf

Sessa, C. and Enei, R., 2010. Annex 4: Freight Trends and Forecasts. In EU Transport GHG: Routes to 2050?—EU Transport Demand: Trends and Drivers. Accessed online 13 November 2015: http://www.eutransportghg2050.eu/cms/assets/EU-Transport-GHG-2050-Task3-Paper-EU-Transport-Trends-and-Drivers-22-12-09-FINAL.pdfStamper, D.M. and Montgomery,M.T, 2008. Biological Treatment and Toxicity of Low Concentrations of Oily Wastewater (bilgewater). *Canadian Journal of Microbiology* 54 (8), pp. 687–93.

STECF, 2013. The 2013 Annual Economic Report on the EU Fishing Fleet (STECF- 13-15). Scientific, Technical and Economic Committee for Fisheries. JRC Scientific and Policy Reports. Accessed online 13 November 2015: https://stecf.jrc.ec.europa.eu/documents/43805/581354/2013-09_STECF+13-15+-+AER+EU+Fleet+2013_JRC84745.pdf

STECF, 2015. The 2015 Annual Economic Report on the EU Fishing Fleet (STECF- 15-07). Scientific, Technical and Economic Committee for Fisheries. JRC Scientific and Policy Reports. Accessed online 13 November 2015: https://stecf.jrc.ec.europa.eu/documents/43805/1034590/2015-07_STECF+15-07+-+AER+2015_JRC97371.pdf

Stopford, M., 2009. Maritime Economics, 3rd edition. Routledge, London.

Transportstyrelsen, 2015. Föreskrifter om ändring i Transportstyrelsens föreskrifter och allmänna råd (TSFS 2010:96) om åtgärder mot förorening från fartyg, Transportstyrelsens författningssamling, TSFS2015:10

TRANSvisions, 2009. *Study on Transport Scenarios with a 20 and 40 Year Horizon*, Service contract A2/78 2007 for the DG TREN, Copenhagen, Denmark.

Turnquist, M. A., 2006. Characteristics of Effective Freight Models. *Freight Demand Modeling*, pp. 11-16. Accessed online 13 November 2015: http://onlinepubs.trb.org/onlinepubs/conf/CP40.pdf#page=23

UBA, 2014. Wie viel Antifouling vertragen unsere Gewässer? Umwelt-Risiken durch Sportboote in Deutschland. Hintergrund, Oktober 2014, Dessau-Roßlau.

UNDESA, 2013. World Population Prospects: The 2012 Revision, Highlights and Advance Tables. United Nations, Department of Economic and Social Affairs (UNDESA), Population Division. Working Paper No. ESA/P/WP.228. Accessed online 13 November 2015: http://esa.un.org/unpd/wpp/Publications/Files/WPP2012_HIGHLIGHTS.pdf

UNCTAD, 2014. Review of Maritime Transport 2014. United Nations Conference on Trade and Development (UNCTAD), 2014. Accessed online 13 November 2015: http://unctad.org/en/PublicationsLibrary/rmt2014_en.pdf

UNCTAD, 2015. Review of Maritime Transport 2015. United Nations Conference on trade and development (UNCTAD), 2015. Accessed online 12 November 2015: http://unctad.org/en/PublicationsLibrary/rmt2015_en.pdf

UNECE, 1979. 1979 Convention on Long Range Transport of Air Pollution. http://www.unece.org/fileadmin/DAM/env/lrtap/full%20text/1979.CLRTAP.e.pdf, Accessed online 27 November 2015.

World Bank, 2013. Fish to 2030: Prospects for Fisheries and Aquaculture. World Bank Report Number 83177-GLB. Accessed online 13 November 2015: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/01/31/000461832_20140131135525/Rendered/PDF/831770WP0P11260ES003000Fish0to02030.pdf

WWF, 2010. Future Trends in the Baltic Sea- WWF Baltic Ecoregion Programme- Technical Report, World Wide Fund for Nature. Accessed online 13 November 2015: http://wwf.panda.org/about_our_earth/all_publications/?194764/Future-trends-in-the-Baltic-Sea

Yang, W.C., Chou, L.S., Jepson, P. D., Brownell, R.L., Cowan, D., Chang, P.H., Chiou, H.I., Yao, C.J., Yamada, T.K., Chiu, J.T., King, S.S., Wang, B.J. and Fernández, A., 2008. Unusual Cetacean Mortality Event in Taiwan, Possibly Linked to Naval Activities? *Veterinary Record* 162, pp. 184-186. Accessed online 13 November 2015: http://www.researchgate.net/profile/Paul_Jepson3/publication/230737175_Anusual_cetacean_mortality_event_in_Taiwan_caused_by_naval_activities/links/02e7e515af807838e5000000.pdf

Annex

1.1 Questions Posed to Stakeholders at Workshop

The Current Policy Mix

- How successful (i.e. ensuring some level of marine environment protection) have existing shipping policies been designed, implemented and enforced to date (e.g. MARPOL)?
- Which barriers and success factors do you see in the current policy framework?
- What indirect effects does the current policy framework lead to (e.g. increased operational costs, or creation of new environmental concerns)?
- Do you think is realistic to meet the GHG reduction target of 40-50% by 2050 in the shipping sector as defined in the EU White Paper on transport?

The Future of Shipping Policy (focus on international and EU policy)

- Do you expect to have more or less stringent environmental regulations in the future? In regard to which environmental concerns (e.g. underwater noise, carbon emissions, water emissions, invasive species, hull bio-fouling)?
- Do you have a preference for future policy measures for shipping? Traditional command and control (regulation) vs economic policy instruments?
- Which instruments fit well together? Which do not fit so well together, might cause issues/challenges? Which policy measures or types/mixes of measures do you consider most cost-effective for the shipping industry?

Shipping in the Baltic

- What policy developments for shipping do you expect to take place in the Baltic Region in the future (i.e. 2030, 2040)?
- What suggestions on the current shipping political framework do you suggest for the future in the Baltic? e.g. better investments in reception/fuelling stations in ports, increased coordination between governing bodies, reduction on administrative procedures/ increased synergies between legislative requirements, any gaps in coverage, better coordination among Member States, implementation of MSP for the region, the establishment of an inter-organisational regulating body.
- How will the Baltic, as a Particularly Sensitive Sea Area, handle a potential increase in shipping?
    - How might this influence other environmental factors?
    - How might this affect interaction with other sectors in the Baltic?
- Do you consider the shipping sector in the Baltic to be an innovator or laggard in regard to the use of new technologies to comply with environmental standards?
- Do you consider policies/instruments from other regions to be valuable for the Baltic Sea?

1.2 Template Sent to Country Experts

1. What policies/policy instruments referring to environmental impacts (air pollution, water pollution, noise, waste) from shipping, leisure boats, and ports exist in the country? These can be:
   - General legislation – national/regional? Such as regulations/laws/bans/etc.
   - Economic instruments e.g. port tariffs/taxes/trading schemes/etc.
2. Does any non-regulation such as industry initiatives or voluntary measures exist, e.g. similar to Environmental Ship Index?
3. Are these initiatives considered successful/unsuccessful in regard to their design/implementation/monitoring? What challenges and barriers do these policies face?
4. Are there any future plans or innovative approaches on policy instruments/regulatory initiatives/etc. in discussion?

2.1 Policy Indicators

Policy	Explanation	Indicators	Data source
MARPOL Annex VI, Sulphur Directive	SO_X, NO_X and PM are major environmental air emissions of shipping and are especially harming coastal regions.	• SO_X emissions of shipping in the Baltic Sea • NO_X of shipping in the Baltic Sea • PM emissions of shipping in the Baltic Sea • Percentage/ number of ships with scrubbers • LNG indicators could be added	HELCOM Baltic Sea Environment Fact Sheets
EEDI, SEEMP established by IMO	The EEDI should lead to energy efficient ship design.	• Distribution of EEDI • percentage/number of ships with SEEMP	
White Paper: Roadmap to a Single European Transport area (COM (2011) 144)	The White Paper includes a CO_2 emissions objective for EU shipping (excluding international shipping).	• CO_2 emissions of shipping in the Baltic Sea • LNG-indicators could be added? •	HELCOM Baltic Sea Environment Fact Sheets
The Clean Power for Transport: A European alternative fuels strategy (COM/2013/017), Action Plan on a comprehensive EU framework on LNG for shipping (SWD(2013) 4 final)	LNG as an alternative fuel for shipping, shows potential to reduce different air emissions, e.g. SO_X, NO_X, CO, CO_2, PM.	• Percentage of alternative fuels used (especially LNG) • number of ships fuelled with alternative fuels (LNG)	
Directive on the deployment of alternative fuels infrastructure (2014/94/EU)		• percentage/number of ports with LNG-bunkering facilities • percentage/number of ports electricity shore-side	
Ballast water convention	Ballast water is a major source for invasive species.	• number of ships with installed ballast water treatment system	
Directive on recreational craft and personal watercraft (2013/53/EU)	Regulating air emissions (NO_X, Hydrocarbons, PM) and noise	• NO_X of recreational crafts in the Baltic Sea • PM emissions of recreational crafts in the Baltic Sea	

	emissions regarding recreational crafts	• Hydrocarbon emissions of recreational crafts in the Baltic Sea • Average of maximum sound pressure level of recreational crafts in the Baltic	
Non-regulatory initiatives (CSI, ESI)		• Number of ships assessed via CSI • Number of ships assessed by ESI • Number of shipowners assessing CSI • Number of shipowners assessing ESI	
National/ regional/ local legislation on ports, other fees		• Percentage/Number of ports with environmental related fees (e.g. discount for low SO_x, NO_x, CO_2 emissions) • Fairway dues with environmental related components	

2.2 Economic Indicators

Global socioeconomic drivers			
Socioeconomic drivers	**Explanation**	**Indicators**	**Data source(s)**
Economic drivers	GDP is a key indicator for purchasing power and labour costs and therefore an important measure for global trade.	• GDP growth (and growth rate) • GNI purchasing power propensity • GDP per capita	http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG http://data.worldbank.org/indicator/NY.GNP.MKTP.PP.CD/countries http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries
Societal drivers	Societal drivers will affect labour costs and the work force and therefore impact trade dynamics.	• Population growth • Rate of urbanisation • Age of population • Rate of population change	http://data.worldbank.org/indicator/SP.POP.GROW http://data.worldbank.org/indicator/SP.URB.GROW http://data.worldbank.org/indicator/SP.POP.1564.TO.ZS

Resource use Use of resources	Will have an influence on a region or nations industry and therefore on trade dynamics.	• Oil production and consumption • Natural gas production and consumption • Coal production and consumption • Steel production and consumption	Eurostat (nrg 100a),(nrg_102a), (nrg 103a)
Socioeconomic drivers of shipping demand			
Socioeconomic drivers	**Explanation**	**Indicators**	**Data source(s)**
Economic drivers	The world economy generates most of the demand for sea transport. Higher economic growth rates bring higher demand for sea transport. Economy structure and economic changes of direction are major drivers for long-term seaborne transport demand.	• GDP growth (and growth rate) • GNI purchasing power propensity • GDP per capita	http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG http://data.worldbank.org/indicator/NY.GNP.MKTP.PP.CD/countries http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries
Commodities traded by sea	The seasonality of traded commodities affect transportation demand in short-term. Economic characteristics of the industry drive the long-term effect on the demand.	• Seasonality of traded commodities (short term) • Change in demand, change in supply sources, relocation of the processing of the industrial raw materials and shipper's transport policy (long term)	Eurostat (DS-022469), (sbs_na_ind_r2)
Tonne miles	Tone mile is defined as the tonnage of cargo shipped multiplied by the average distance over which it is transported.	• Tone mile = tonnage of cargo shipped X average distance shipped	https://www.dnvgl.com/maritime/index.html
Random shocks	Random shocks refer to the sudden change of weather, social and political (e.g. war, conflict), and economical events (e.g. commodity price).	• n.a.	n.a.
Transport costs	The cost of the shipping	• Freight rate	http://www.bloomberg.com

	operation (usually cost per nautical mile).	• Baltic Dry Index	/quote/BDIY:IND
Socioeconomic drivers of shipping supply			
Socioeconomic drivers	**Explanation**	**Indicators**	**Data source(s)**
Commercial vessel fleet	Commercial vessel fleets include major groups: bulk carrier, tankers, containership, cargo and combination. The supply of shipping services is determined by the time of building ship, delivery, economic life of a ship, scrapping time and losses.	• Current number of vessel of each group, classified by different size and function • Forecasts for commercial vessel fleet (future ship fleet is estimated by using number of orders, time of building, delivery, life of a ship, scraping and losses)	https://www.ihs.com/products/maritime-world-fleet-statistics.html http://www.emsa.europa.eu/implementation-tasks/equasis-a-statistics/item/472.html https://www.dnvgl.com/services/recycling-and-hazmat--3413
Fleet productivity	Fleet productivity reflects the efficiency of organization of shipping industry, including port activities and physical performance of the ship.	• Productivity is measured by: ○ Speed of the ship, i.e. knot equals nautical miles per hours; ○ Port time: average time that ship stay in the port for loading and unloading commodity ○ Deadweight utilisation ○ Flexibility ○ Frequency	https://www.ihs.com/products/maritime-world-fleet-statistics.html http://www.emsa.europa.eu/implementation-tasks/equasis-a-statistics/item/472.html https://www.dnvgl.com/services/recycling-and-hazmat-management--3413
Shipbuilding, scrapping and losses	The growth of merchant fleet subjects to the balance of delivery of new ship and deletion from the fleet the ship scrapped or lost.	• Time of building ship • Cost of building ship (investment) • Time lag between order and delivery • Proportion and chance of scrapping or losing ship	http://www.statista.com/markets/407/topic/937/shipbuilding/ https://www.ihs.com/products/maritime-world-shipbuilding-statistics.html
Freight revenue or profit of	Freight revenue or profit of	• Freight revenue or profit (GVA, turnover)	https://www.ihs.com/produ

shipping performance	shipowners depends on the freight rate and are incentive for ship-owners to adjust its supply.	• Cost of input variables: fuel price, labour • Capital costs	cts/maritime-world-fleet-statistics.html http://www.emsa.europa.eu/implementation-tasks/equasis-a-statistics/item/472.html https://www.dnvgl.com/services/recycling-and-hazmat-management--3413
Regulation and technology	The environmental regulations and market pressure will force shipowners to adapt new technologies toward environmental friendly and efficient alternatives.	• Operating cost and fuel price can be used to project the upcoming technologies • New regulations and entry into force of existing legislation (see above)	https://www.ihs.com/products/maritime-world-fleet-statistics.html http://www.emsa.europa.eu/implementation-tasks/equasis-a-statistics/item/472.html https://www.dnvgl.com/services/recycling-and-hazmat-management--3413
Socioeconomic drivers of fishing demand			
Socioeconomic drivers	**Explanation**	**Indicators**	**Data source(s)**
Economic drivers	The seafood market creates demand for fish and seafood. Fishing activities are will meet global demand.	• GDP growth (and growth rate) • GNI purchasing power propensity • GDP per capita • Fish production (landings weight and landings value)	STECF, 2015 http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG http://data.worldbank.org/indicator/NY.GNP.MKTP.PP.CD/countries http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries Eurostat (sbs_na_ind_r2), (fish_ld07)
Random shocks	Random shocks refer to the	• n.a.	n.a.

	sudden change of weather, social and political (e.g. war, conflict), and economical events (e.g. commodity price).		
Socioeconomic drivers of fishing supply			
Socioeconomic drivers	**Explanation**	**Indicators**	**Data source(s)**
Fishing fleet and capacity	The fishing fleet indicates the capacity of the vessels operating from Baltic Sea countries.	• Estimated number of vessels • Days at sea • Vessel power • Vessel tonnage • Numbers employed	STECF, 2015 Eurostat (fish_ld07), (fish_fleet)
Profitability of the sector	Profitability indicates the sectors economic performance.	• GVA • Gross profit	STECF, 2015 Eurostat (fish_ld07),
Environmental regulations and updating technologies	Fish stocks are managed by the CFP, which places limits on fish through quotas.	• TACs	STECF, 2015
Socioeconomic drivers of recreational boating demand			
Socioeconomic drivers	**Explanation**	**Indicators**	**Data source(s)**
Economic drivers	GDP and purchasing power propensity will directly impact consumer spending on recreational boats as well tourism	• GDP growth (and growth rate) • GNI purchasing power propensity • GDP per capita	http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG http://data.worldbank.org/indicator/NY.GNP.MKTP.PP.CD/countries http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries
Tourism	Tourists in coastal areas create demand for recreational boats in addition to boat owners.	• Tourism intensity in coastal areas	Eurostat (tour_occ_arn2), (tour_occ_ninatc)
Random shocks	Random shocks refer to the sudden change of weather, social and political (e.g. war, conflict),	• n.a.	n.a.

	and economical events (e.g. commodity price).		
Socioeconomic drivers of recreational boating supply			
Socioeconomic drivers	**Explanation**	**Indicators**	**Data source(s)**
Boat building industry	The boat building industry is responding to consumer demand and numbers of boats produced indicate sectoral trends.	• Number (and type) of recreational boats sold	http://www.icomia.com/
Marinas and harbours	Marinas and harbours along coasts cater to recreational boaters, providing them with long-term storage facilities as well as amenities for short-term stays.	• Number of marinas and harbours • Distance (km) between marinas and harbours	www.marinas.com http://shop.ihs.com/buy/en/ihs/maritime/ports-guide
Environmental regulations and updating technologies	Environmental regulations are driving the uptake of new technologies.	• See above	http://shop.ihs.com/buy/en/ihs/maritime/ports-guide