TransBaltic

Towards an integrated transport system in the Baltic Sea Region

Implications of new regulation regarding sulphur content in ship's fuel on maritime transport sector within Baltic Sea Region

on the basis of the TransBaltic and Baltic Ports Organization's Port Debate:

Implications of the IMO regulations on the future pattern of the cargo flow in the Baltic

held on 15th June 2012 in Helsinki, Finland

July 2012

Photo: Port of Rauma

Project part-financed by the European Union (European Regional Development Fund)

Baltic Sea Region Programme 2007-2013

BPO BALTIC PORTS ORGANIZATION

Report coordinator: **Baltic Ports Organization Secretariat**

Authors:
Monika Rozmarynowska – academic teacher at Gdynia Maritime Academy
Bogdan Ołdakowski, BPO Secretary General

Baltic Ports Organization is made up of forty plus major ports in the nine countries surrounding the Baltic Sea. The main objective of BPO is to improve the competitiveness of maritime transport in the Baltic region by increasing the efficiency of ports, marketing the Baltic region as a strategic logistics centre, improving the infrastructure within the ports and their connections to other modes of transport.

TransBaltic, as one of the few transnational projects so far, has been granted a strategic status by the authorities of the Baltic Sea Region Programme 2007-2013. The overall objective of TransBaltic is to provide regional level incentives for the creation of a comprehensive multimodal transport system in the BSR. This is to be achieved by means of joint transport development measures and jointly implemented business concepts. TransBaltic is led by Region Skåne and lasts from 1 June 2009 to 31 December 2012.

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013

Contents

Project part-financed by the European Union (European Regional Development Fund)

Baltic Sea Region Programme 2007-2013

BPO BALTIC PORTS ORGANIZATION

Introduction

The report has been prepared on the basis of the presentations at the Trans Baltic and Baltic Ports Organisation's seminar – "Implications of the IMO regulations on the future pattern of the cargo flow in the Baltic" held on 15th June 2012 in Helsinki. The important source of information and data were also studies assessing the impact of new IMO regulations regarding sulphur limits in ships' fuel on maritime transport sector in SECA.

In October 2008 the International Maritime Organization (IMO) adopted amendments to Annex VI of the MARPOL Convention which, inter alia, strengthened the requirements on the permitted sulphur limits in ships fuels. Two sets of emission and fuel quality requirements are defined by Annex VI: (1) global requirements, and (2) more stringent requirements applicable to ships in Sulphur Emission Control Areas (SECA). Baltic Sea is included in SECA area, where as of 1st July 2010, the maximum sulphur limit has been reduced to 1.00%, (from 1.50%), while from 1 January 2015, sulphur content in ships' fuel must be below 0.1%.

New regulations caused great concern within countries located within Baltic area. A series of studies have recently been performed by various organizations to assess the implications of the new sulphur standards for the shipping industry and other stakeholders. There is a great concern that new IMO regulation will lead to increase of the sea transport costs. Significant costs' increase for transportation by sea as a consequence of using the more expensive low sulphur fuel (MGO) may reduce competitiveness of sea transport drastically and mean that, in many cases, short sea shipping will not be cost - effective. This may lead, to some extent, to a modal backshift from sea to road and even to change of directions of logistics flows in Europe in order to avoid the SECA. Switching to MGO is not the only one option to meet new regulations. Two other solutions are under development: scrubbers and LNG as a ships' fuel. However development of such solutions will involve simultaneous development of specialized facilities in ports.

Generally, the new environmental regulations are a great challenge not only to shipping industry, but also to ports within Baltic Sea Region. Report outlines the most significant consequences for maritime transport sector within Baltic Sea which have resulted from upcoming rules.

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

1. New regulations concerning sulphur oxide emission from ships

MARPOL Annex VI "Regulations for the Prevention of Air Pollution from Ships"

International regulations regarding pollution from ships are contained in the IMO "International Convention on the Prevention of Pollution from Ships", known as MARPOL 73/78. On 27 September 1997, the MARPOL Convention has been amended by the "1997 Protocol" which includes Annex VI titled "Regulations for the Prevention of Air Pollution from Ships". In particular, Annex VI regulates the matter of emission of such substances as sulphur oxides (SOx), nitrogen oxides (NOx) and particulate matters. Annex VI entered into force on 19th May 2005 and in October 2008 IMO adopted a set of amendments to Annex VI of the MARPOL Convention.

The set of amendments to Annex VI of the MARPOL Convention introduces new standards regarding emission from ships of such substances as sulphur oxides (SOx) and particulate matters and nitrogen oxides (NOx). The most stringent changes regard SOx emission. Reduction of SOx and particulate matter emission are going to be achieved by limiting the maximum sulphur content of the fuel oils used onboard. Two sets of emission and fuel quality requirements are defined by Annex VI: (1) global requirements, and (2) more stringent requirements applicable to ships in Sulphur Emission Control Areas (SECA). On the global level, sulphur cap will be reduced initially to 3.50% (from the current 4.50%), effective from 1st January 2012; then progressively to 0.50 %, effective from 1st January 2020 (or in 2025 at the latest), subject to a feasibility review to be completed no later than 2018. Annex VI introduces much more stringent requirements for ships operated in SECA. As from 1st July 2010, the maximum sulphur limit has been reduced to 1.00%, (from 1.50%), while from 1st January 2015, sulphur content in ships' fuel must be below 0.1 %.

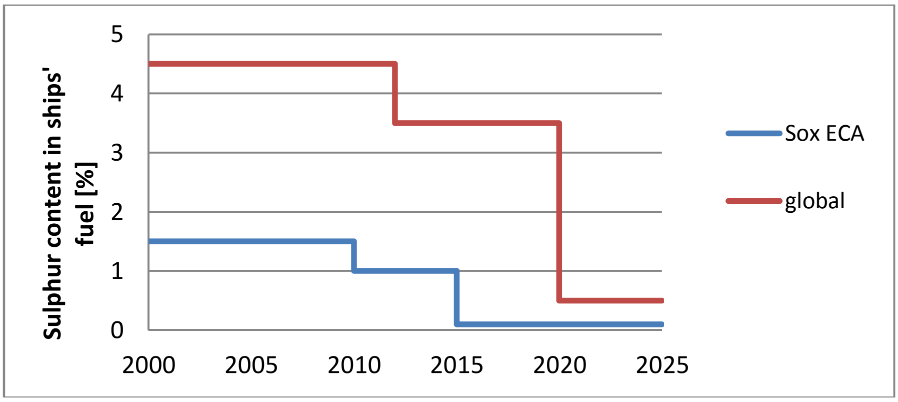

Figure 1. Sulphur Limit in Fuel

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

Table 1. Sulphur Limit in Fuel

Date	Sulphur Limit in Fuel in SECA (%)	Date	Sulphur Limit in Fuel Global (%)
2000	1.5 %	2000	4.5 %
1st July 2010	1.0 %	2012	3.5 %
2015	0.1 %	2020*	0.5 %

* alternative date is 2025, to be decided by a review in 2018
Source: MARPOL *73/78,* Annex VI *Regulations for the* Prevention *of Air Pollution from Ships*

At present four regions are defined as Sulphur Emission Control Area. However, it has to be noted that Emission Control Area can be designated not only for SOx and PM emission but also for NOx emission, or all three types of emissions from ships. At present The ECA established are:

1. Baltic Sea area – as defined in Annex I of MARPOL (SOx only);
2. North Sea area – as defined in Annex V of MARPOL (SOx only);
3. North American area (expected to enter into effect 1st August 2012) – as defined in Appendix VII of Annex VI of MARPOL (SOx, NOx and PM); and
4. United States Caribbean Sea area (expected to enter into effect 1st January 2014) – as defined in Appendix VII of Annex VI of MARPOL (SOx, NOx and PM).

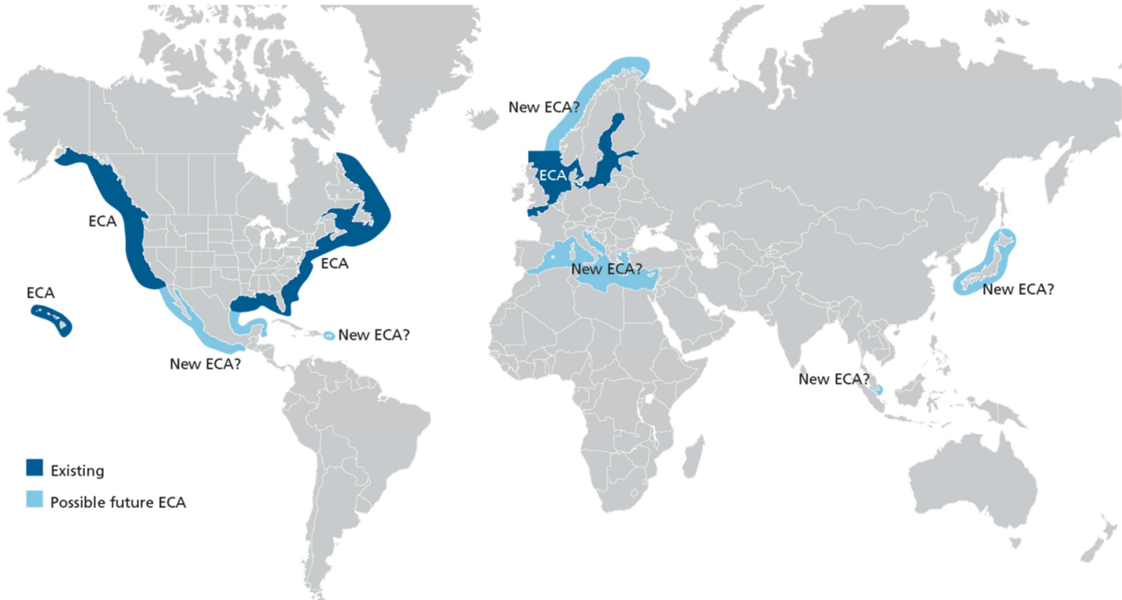

Figure 2. Existing and potential Emission Control Areas
Source: http://blogs.dnv.com/lng/2011/02/lng-for-greener-shipping-in-north-america/

Moreover, other areas are considered to be designated as Emission Control Areas, for example: Mediterranean Sea, waters along the coast of Norway, Japan and Mexico.

Directive 1999/32/EC (as amended by Directive 2005/33/EC)

Directive 1999/32/EC (as amended by Directive 2005/33/EC) regulates the sulphur content of fuels used by maritime transport and incorporates certain international rules into EU law, as agreed under the International Maritime Organisation (IMO). However, due to revision of MARPOL Annex VI in 2008, the Directive is no longer aligned with international (IMO) rules following the revision. The new MARPOL Annex VI rules on sulphur are now significantly different from the 1999/32/EC Directive:

- the Directive allows ships to use fuels with a sulphur content of up to 1.5% when operating in the SECAs, while the new MARPOL Annex VI allows a maximum sulphur content of 1.00% and as of January 2015 a maximum sulphur content of 0.1%;
- the Directive offers a strong operator compliance mechanism, while MARPOL Annex VI has no such enforcement mechanism;
- the Directive allows for a limited range of equivalent emission abatement methods when compared to the revised MARPOL Annex VI.

However, European Union Directive 2005/33/EC, introduces more stringent rules for ships while at berth in European Community ports. As from 1st January 2010, ships at berth in all ports of the European Community shall not use marine fuels with a sulphur content exceeding 0.1% by mass. Due to some technical problems that occurred, ships have been given a transitional period till the end of August 2010 to make the necessary technical changes. However, from 1st September 2010 all ships covered by directive must obey the rules. Additionally, with effect from 1st January 2010, Member States shall ensure that marine gas oils are not placed on the market in their territory if the sulphur content of those marine gas oils exceeds 0.1 % by mass.

In order to ensure coherence with international law as well as to secure proper enforcement of new globally established sulphur standards in the Union, the Commission proposes that

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

the provisions of Directive 1999/32/EC be aligned with the revised Annex VI to MARPOL. In particular:[1]

- Incorporation into the directive of the 2008 amendments to Annex VI to MARPOL concerning the sulphur content of marine fuels.
- Alignment of the directive with the IMO provisions authorising a broad range of equivalent emission abatement technologies. Flanking of these provisions by additional guarantees to ensure that the equivalent abatement technologies do not have unacceptable negative consequences for the environment.
- Introduction of the IMO control procedure for fuels.

The Commission also proposes the following additional measures: introducing a new 0.1% sulphur limit for passenger ships operating outside SECA in 2020 and developing a non-binding guideline for sampling and reporting. If this does not produce the desired effect, binding rules would have to be considered.

2. Solutions to meet new regulation

There are some options available for ship operators operating in Baltic Sea who wish to meet the new sulphur requirements. The first one is switching to marine gas oil (MGO). This option will be probably most popular due to the fact that using marine distillate in the main engines does not pose a major technical challenge. The 0.1% requirement could also be met by using high sulphur fuel together with scrubbers or by using alternative fuel such as LNG. However, these two solutions are rather much more challenging.

Distillates

The following fuels can be used for vessels:[2]
• Residual oil: it is the heaviest fraction of the distillation of crude oil, with high viscosity and high concentration of pollutants (e.g. sulphur).
• IFO 380 (Intermediate Fuel Oil) is a mix of 98% of residual oil and 2% of distillate oil.
• IFO 180 (Intermediate Fuel Oil) is a mix of 88% of residual oil and 12% of distillate oil. Due to the higher content in distillate oil, IFO 180 is more expensive than IFO 380.

[1] *Opinion of the European Economic and Social Committee on the 'Proposal for a Directive of the European Parliament and of the Council amending Directive 1999/32/EC as regards the sulphur content of marine fuels'* COM(2011) 439 final — 2011/0190 (COD) (2012/C 68/13)

[2] *Analysis of the Consequences of Low Sulphur Fuel Requirements*, Report commissioned by European Community Shipowners' Associations (ECSA), January 2010

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

• MDO (Marine Diesel Oil) mainly consists of distillate oil and has a lower sulphur content than the three fuels described above.
• MGO (Marine Gas Oil) is pure distillate oil and has the lowest sulphur content.

Ship engines generally run on heavy fuel oil or intermediate fuel oil (HFO/IFO). Level of sulphur content in heavy fuel oil depends on the sulphur content in the crude oil. Most of the sulphur remains in the heavy fuel oil, so sulphur-rich crude cannot be used to produce heavy fuel oil with low sulphur content. HFO containing less than 0.5% sulphur is obtained from crude oil with sulphur content less than ~0.15%. The level of sulphur content of crude oil needed to production of HFO with 0.1% sulphur content is even lower then that needed to production of 0.5% sulphur fuel. And such crude oils are extremely rare. Moreover, such crude oils are all highly paraffinic, waxy crude oils which would be unsuitable for heavy fuel oil production for marine bunkers due to their high pour points. [3]

At present ships operating in SECA may not use fuel with a sulphur content exceeding 1.0%. It is possible to achieve such sulphur content in fuel in two ways: heavy fuel oil can be made from crude oil, which naturally contains less sulphur or high sulphur and low sulphur fuel can be mixed together to achieve adequate sulphur level. Generally, fuel containing less than 1.0% sulphur, which is used at present in SECA, is high sulphur fuel which has been mixed with a slightly lower sulphur content fuel, to keep the sulphur content under the 1.0% mark.

The new IMO requirements regarding reduction of sulphur content of marine fuels to 0.1% by 2015 means that ships operating in the SECA would have to switch from low sulphur fuel oil (LSFO) with a sulphur content of 1.0% to fuel with a sulphur content of 0.1% by 2015. It will be technically impossible to mix fuel grades to achieve 0.1% sulphur fuel so ships will have to switch to other available fuels. At present, commonly available fuels that have much lower sulphur content than heavy fuel oil are distillates such as marine diesel oil (MDO) or marine gas oil (MGO) with MGO having a maximum content of 0.1% sulphur in Europe. MDO and MGO are also known as light fuel oil. Distillates are commonly used in auxiliary engines to generate electricity. Energy needs during the voyages can also be covered by shaft generators, but distillates are usually required at least when the ship is in port. According to EU legislation, ships may use propulsion and energy generation fuelled by HFO at sea, whilst distillates have to be used by the ship while it is at berth in EU port.

The use of marine distillate in the main engines does not pose a major technical challenge. However, the reduction of the sulphur content and the need of common use of distillates

[3] *Reducing the sulphur content of shipping fuels further to 0.1 % in the North Sea and Baltic Sea in 2015: Consequences for shipping in this shipping area*, ISL, September 2010

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

have raised great concern among shipping sector, which is mainly connected with the fuel costs. Distillates are far more expensive than heavy fuel oils, mainly due to much complicated way it is manufactured. Whilst HFO is the untreated component of crude oil remaining after vacuum distillation, distillate undergoes several refinery processes all of which utilize refinery energy to produce the finished product. Furthermore, as the demand for it increases, it will also presumably go up in price. The use of distillates is also associated with permanent higher costs for lubricants because the sulphur-rich HFO has better lubrication properties which need to be replaced by alternatives.[4]

Scrubbers

Annex VI of MARPOL enables the continued use of high sulphur fuels, however, is such cases additional technological solutions must be implemented to achieve „equivalent" levels of emissions. It means that special installations removing sulphur from ships, called "scrubbers" should be installed on ships.

Scrubbing has been used on shore with success to reduce SOx emissions of industrial plants since the 1930s. Recently, inter alia, such companies as Wärtsilä, Hamworthy and MAN have been working on scrubber technology for ships. So far, first such installation has been developed and underwent successful trials. Some classification societies (including DNV and GL) have already certified some installations.

Four kinds of scrubbers can be used on ships: seawater scrubbing („open scrubber"), the freshwater scrubber („closed-loop scrubber"), a combination of the two (the hybrid technology), and the CSNOx system, which targets not only sulphur oxides but also nitrogen oxides and CO_2.

The seawater scrubbing technology was developed and commercialised by Hamworthy and Wärtsilä. It is based on the natural alkaline characteristic of seawater, it is used to neutralise the acidic exhaust gases. Further to the absorption of the SOx molecules by the seawater, the water is then discharged back into the sea after extracting and storing the relevant sludge from scrubbing. The sludge must be stored on board and then delivered to a shore reception facility. A system based on seawater scrubbing is already available on the market.

[4] *Reducing the sulphur content of shipping fuels further to 0.1 % in the North Sea and Baltic Sea in 2015: Consequences for shipping in this shipping area*, ISL, September 2010

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

The fresh water scrubbing technology was developed and commercialised by Wärtsilä. The principle of the fresh water scrubbing is a variation of the technology which requires the addition of caustic soda (NaOH) to react with and absorb the sulphurous emission gases. Its main benefit is that it opens the possibility to use the scrubbing technology in sea areas where the natural alkalinity of the sea water is not sufficient to react on its own with sulphuric products. Like for the seawater scrubber, the resulting sludge must be stored on board and then deliver to a shore reception facility. Scrubber was testes on board of tanker *Suula* in 2008-2010. After two years of testing Wärtsilä indicated that the freshwater scrubber for marine exhaust gas is ready for commercial application. Installation was certified by two classification societies (DNV and GL).

Figure 3. Scrubber on tanker *Suula*
Source: http://worldmaritimenews.com/archives/20080

The third technology was developed and commercialised by Aalborg and it's based on a combination of the two type of technology described previously. The hybrid approach enables operation in closed loop mode when required, for instance whilst in port and during maneuvering using NaOH as a buffer. When at sea the switch can be made to open loop using only seawater. The technology has been installed on board of the *Tor Ficaria* in July 2009. It is still under extensive tests.

A fourth technology is based on CSNOx system which is being developed by Ecospec. CSNOx, is the first of its kind in the world capable of reducing carbon dioxide (CO2), sulfur dioxide (SO2), and nitrogen oxide (NOx), all in a single system and by a single process. It is based on the use of seawater. So far, the CSNOx system has been tested on a Aframax tanker. This technology is still under extensive tests.

Investment cost of scrubbers is depended on type of scrubber, type of ship and engine power. However, generally it can be estimated that cost will be around 2-4 mln Euro.[5]

LNG as ship's fuel

New regulations on emissions of sulphur oxides (SO_x) within the Baltic Sea and the North Sea have recently increased the interest in and demand for alternative fuels. Liquefied Natural Gas (LNG) as an alternative fuel is currently the most popular option. Using LNG instead of oil considerably lowers the emissions of SO_x and NO_x.

Natural gas is the cleanest form of fossil fuels. Natural gas consists of methane with minor concentrations of heavier hydrocarbons such as ethane and propane. When ships are fuel with LNG, no additional abatement measures are required in order to meet the IMO requirements. The burning process of natural gas is clean. LNG contains virtually no sulphur, hence SO_x emissions from natural gas engines are reduced by close to 100 %. The particle emission is also reduced by close to 100 %. Moreover, burning LNG produces 85% - 90% less NO_x than the conventional fuel, and greenhouse gas emissions are reduced by 15 -20 %.[6]

LNG has been used as marine fuel since 2001. Norway has been the forerunner for LNG – powered ships. The first ship in history that was propelled by LNG was ferry *Glutra*, put into service in 2000 and operated by Fjord1. Currently, over 20 LNG- fuelled ships (other than LNG carriers) are being operated in Norwegian waters. LNG ships that are in use in Norway today are ranging from coast guard boats to supply vessels and ferries.

Many manufactures are offering LNG fuelled engines already. Gas engines which are currently available on the market can be divided in two main categories: dual fuel engines (e.g. Wärtsilä, Man), lean-burn gas engine (e.g. Rolls-Royce, Mitsubishi). These engines have varying characteristics and levels of efficiency. The dual fuel engine runs on both LNG and conventional fuel. It is flexible solution when the availability of LNG fuel is uncertain (e.g. lack of LNG bunkering stations). Whereas, the lean burn mono fuel engine gives a simpler installation on board and is a more suitable solution for ships operating in regions with a developed grid of LNG bunkering stations.

MARINTEK carried out the studies which indicate that additional costs for a gas fuelled ship will be of 10-15% of the total cost of a conventional ship. This additional cost is connected

---

[5] *The 0.1% sulphur in fuel requirement as from 1 January 2015 in SECAs - An assessment of available impact studies and alternative means of compliance*, Technical Report, EMSA, 2010

[6] *Greener Shipping in the Baltic Sea*, DNV, June 2010

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

mainly with large LNG tanks and the fuel piping system. It can be estimated that for a typical ro-ro ship of 5600 DWT, the additional costs will be about 3.2 million Euro.[7]

There are major challenges to the widespread implementation of LNG as a ship's fuel. One of the main challenges is that large space is required onboard for LNG tanks, and this contributes for the loss of cargo space. For example LNG requires about 1.8 times more volume than MDO (marine diesel oil) with equally energy content. If we added the tank insulation the needed volume is about 2.3 times higher.[8] For new - build ships it is quite simple to find space for the larger fuel tanks, while this may be much more difficult or even impossible, to find it on ships which are already in operation. Therefore, there is very little probability that existing ships will be using LNG instead of conventional fuel. It is more likely that LNG as marine fuel will be used by new- build ships.

Moreover, it has to be noted that in order not to lose so much cargo space, the operational range due to the bunker capacity of the vessel must be reduced. Therefore, LNG is a fuel alternative basically for vessels which can be re-fuelled quite often. Hence, this fuel alternative is not suitable for large vessels engaged in deep sea shipping. LNG as ship's fuel is most convenient for short sea shipping and such ships as ro-ro and ferries. That's why more investment in LNG powered ships is expected in this segment.

Until 2013 about 18 ships fuelled by LNG are going to be put into operation in SECA area, these are mainly car and passenger ferries, offshore vessels and also ro-ro ships. The first LNG propelled ro-ro ships were ordered by the Norwegian ship-owner Sea Cargo in Bharati shipyard in India. Two 5,900 DWT vessels are planned to be delivered in 2012. Vessels will be 132.8 metre long and 18 metres wide and will have two LNG tanks with a capacity of 240 m^3 each. Ships will operate on a ten day round trip service covering Baltic, Norwegian and British ports. Another two ro-ro vessels have been ordered by Nor Lines AS, the Norwegian logistics and shipping company based in Stavanger. The ships will be built at Tsuji Heavy Industries (Jiangsu) Shipyard, China. Delivery of the new ships is expected in October 2013 and January 2014. Each of the 5,000 DWT ships will have a capacity equivalent to at least 200 truck loads and will operate along the west coast of Norway.

[7] *Maritime Gas Fuel Logistics. Developing LNG as a clean fuel for ships in the Baltic and North Seas*, MAGALOG, December, 2008, s. 18.

[8] http://www.worldcruise-network.com/features/feature687 (15.11.2010).

Figure 4. Ro-ro ship fuelled by LNG ordered by Sea Cargo

Source: http://www.sea-cargo.no/news09_08.asp

In turn, the first LNG propelled passenger ferry that will be operated in Baltic Sea is being built for Viking Line in the shipyard in Turku. Ship will serve the route connecting Turku, in Finland and Stockholm in Sweden. It is planned that vessel (recently named the M/S Viking Grace) will be delivered to the ship-owner in January 2013. The 57,000 DWT vessel will be 214 meters long, 31.8 meters wide and will have a draught of 6.8 meters, and it will have a capacity to accommodate 2,800 passenger. It will be the largest LNG propelled passenger ferry ever built.

Figure 5. Passenger ferry fuelled by LNG ordered by Viking Line
Source: http://www.lngworldnews.com/abb-wins-deal-for-viking-line-lng-ferry-finland/

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

3. Economic effects of new IMO regulation

It can be expected that in the near future the most widely used solution within Baltic Sea meeting new IMO regulation will be switching to marine gas oil (MGO). This is mainly due to the fact that the alternative solutions are now rather in development stage and at the moment pose some technical challenge. They require additional investments not only on board of the ships but also at the seaports (see chapter 5). Switching to marine distillates seems to be the most suitable option for majority of shipping operators as MGO can be used in the main engines, without posing a major technical challenge.

However, using MGO may contribute to increase of costs and prices of sea transport in Baltic Sea and North Sea as distillates fuels are more expensive than residual fuels. Generally, the price for shipping fuel is dependent on the price of crude oil. The international price of both crude oil and marine fuel is steered by supply and demand, however is shaped in the short term also by expectations about the future. In turn, the expectations are shaped by economic forecast, unrest in different parts of the world, production forecasts from oil-producing countries, stock levels, seasonal variations, and much else.

During the last dozen or so years, the cost of ships' fuel has been characterized by a large fluctuations. However, generally the increasing tendency was observed. The distillate fuels have been always more expensive than residual fuels.

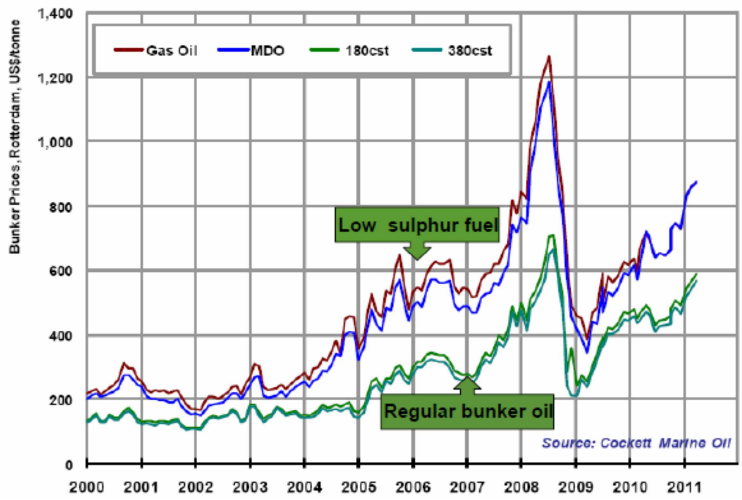

Figure 6. Prices of bunker fuels in 2000-2011

Source : *Industry's perspective on the compliance with the low sulphur requirements*, Bernard Lombard, Bruksela, 2011

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

At the beginning of the past decade price of bunker fuels was rather low so the difference per tonne between residual fuels and distillates was not too high and was about 50-100 USD. As the prices of bunker fuels increased the difference deepened, at first to 200-300 USD and then reached a peak in 2008 (500-600 USD). Afterwards, the difference returned to pre crisis levels (200-300 USD). Generally, during the last several years distillates fuels were from 30% to almost 100% more expensive than Intermediate fuel oil (IFO). Additionally low sulphur fuel oil with sulphur content of 1% (LSFO) that are used in SECA area are usually about 5-15% more expensive than fuel with higher content of sulphur (IFO).

Predicting how bunker fuel prices will change in future is a matter of pure speculation as the price levels are influenced by a series of different factors, e.g.: supply of crude oil, demand, development of alternative fuels, geopolitical developments. During the last few years series of studies have been carried out that tried to assess impact of new regulations on transport costs. Studies present expected price of MGO in 2015 and expected price difference between fuel of 1.5% sulphur content and MGO (0.1%). Table 2 summarises the results of various studies. It has to be noticed that much of these studies were carried out when 1.5% standard was in force. Hence, studies usually assume that ships undertake a complete shift from 1.5% fuel to MGO. That approach may not sufficiently take into account that there is already a requirement to use 1.0% in SECAs and that a maximum of 0.1% sulphur in fuel is already required while at berth in any EU port. The German study was performed after the entry into force of the 1.0% requirement within SECA and has compared the prices of 1.0% sulphur fuel to prices of 0.1% sulphur fuel.

Table 2. Estimated price of MGO in 2015 and estimated price difference between MGO and 1.5% sulphur fuel

Study	Expected price for MGO (0,1 % S) per ton in USD in 2015	Expected differential per ton between 1.5% S and 0.1% S, if indicated
***The COMPetitiveness of EuropeAN Short sea freight Shipping compared with road and rail transport (COMPASS)*, commissioned by EC**	656 EURO, 883 USD	65%
***Analysis of the Consequences of Low Sulphur Fuel Requirements*, ECSA**	Low:500 USD Medium: 750 USD High: 1000 USD	80%
***Reducing the sulphur content of shipping fuels further to 0.1 % in the North Sea and Baltic Sea in 2015: Consequences for shipping in this area* , ISL**	Low: 850 USD High: 1300 USD	70-86% (price difference 1,5% to 0,1% S) 57-75% (price difference 1,0% to 0,1% S)
***Impact Assessment for the revised Annex VI of MARPOL* , ENTEC**	Scenario 1: 545 USD Scenario 2: 727 USD	Scenario 1: 92 and 42% Scenario 2: 119 and 59%
***Sulphur content in ships bunker fuel in 2015, A Study on the impacts of the new IMO regulation on transportation costs* , University of Turku**	470-500 EURO (historic Price used in calculation) (633-673 USD)	73-85% (historic price difference 1,5% to 0,1 % S) The historic price difference

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

		between 1,0 % and 0,1% S has been 51-62%
Task 2 and 3 *Impact Study on the future requirements of Annex VI of the MARPOL Convention on Short Sea Shipping* , commissioned by EC	656 EURO, 883 USD	No comparable values provided.
***Consequences of the IMO"s new marine fuel sulphur regulations* , Swedish Maritime Administration**	Low: 662 USD Medium: 1158 USD High: 1650 USD	No comparable values provided.

Source: *The 0.1% sulphur in fuel requirement as from 1 January 2015 in SECAs - An assessment of available impact studies and alternative means of compliance*, EMSA, December, 2010

The table above suggests that in normal circumstances the price for MGO in 2015 would be somewhere between 600-900 USD. Based on the table, it seems that the shift from 1.5% sulphur fuel to MGO (0.1%) may lead to increase of fuel price by around 65-80%.

Not all ships will be similarly affected by the increased fuel prices. Impact depends on the share of fuel costs out of the overall transport cost for the specific ship type. It can be concluded that such types of ships as container ships, general cargo ships will be particularly affected by an increased fuel price. According to the COMPASS study, fuel represents 47% of the daily costs (including all costs such as fuel, capital investment, interest, manning, gross margin, repairs, maintenance, insurance etc.) for container vessel of 500-700 TEU. The share for a ro-ro ship is estimated at 32%. The Finnish study similarly indicates that the share of fuel costs in total daily operational cost is the highest for container ships (54%). For general cargo vessels it is 38%, for ro-ro around 36% and for ro-pax 30% (figure 7).

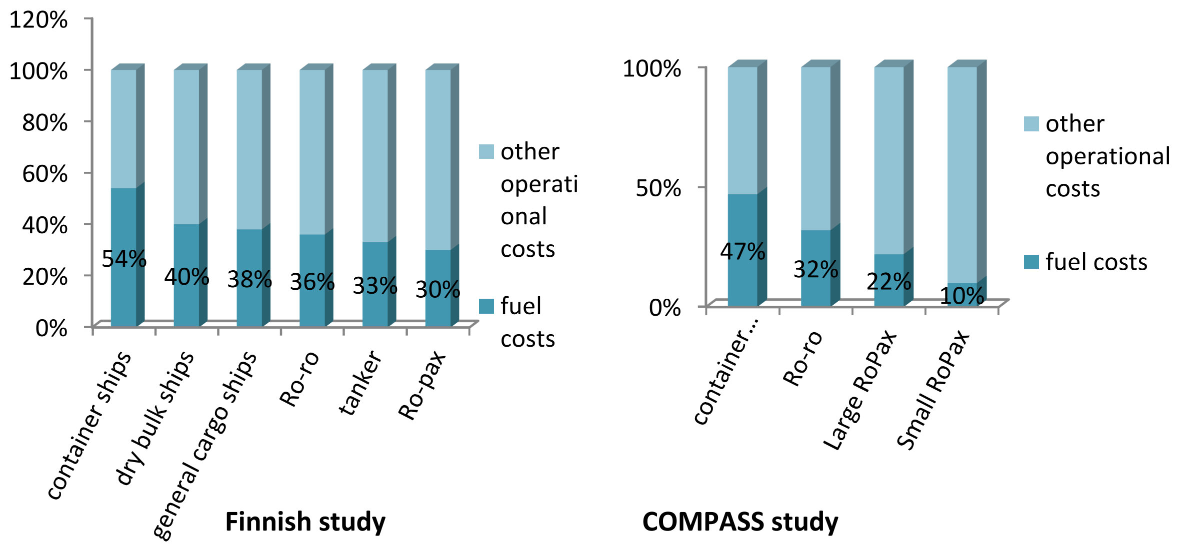

Figure 7. Share of fuel costs in total operational cost for different types of ships

Source: *Sulphur content in ships bunker fuel in 2015. A study on the impacts of the new IMO regulations on transportation costs***,** Ministry of Transport and Communications, Helsinki, 2009; *COMPASS The COMPetitiveness of European Short-sea freight Shipping compared with road and rail transport,* commissioned by European Commission DG Environment, 2010

The bunker costs are an important component in the total freight rate. According to the ECSA study, the share of fuels costs in the freight rate in short sea shipping depend on route length and ships speed but typically reaches 20% to 25%, with peaks up to 50% for fast vessels (when HFO 1.5% cost 556 USD per tonne). A shift to the use of MGO (assuming 1000 USD per tonne) would increase the bunker share to a level of 35%-40% with peaks up to a level of 64% for fast vessels.

Studies performed by ECSA show also some estimates of minimal increase in freight rates[9] per unit as a result of shift from HFO (1.5%) to MGO (0.1%). The calculations have been made for 17 short sea shipping routes in SECA area. Three scenario were presented: Low (HFO 1,5% -278 USD per tonne, MGO- 500 USD per tonne), Base (HFO 1,5% -417 UDS per tonne, MGO - 750 USD per tonne), High (HFO 1,5% -556 USD per tonne, MGO -1000 USD per tonne). For traditional short sea services average freight rate increase is estimated to reach 11.5% for the low scenario and around 20% for the high scenario. For fast short sea services the figures are much higher: on average 26% for the low scenario and 40% for the high scenario. If we take into account routes between ports in the Le Havre-Hamburg range and Baltic ports (excluding fast short sea services) total increase in freight rate per trip in low scenario may very form 7.1% to 12.4% and from 13.0% to 21.5% in high scenario. Freight rate per trip on intra Baltic routes may increase from 8.2% to 18.7% in low scenario and from 15.9% to 30.3% in high scenario (figure 8).

[9] The freight rate is defined here as the total unit price customers pay for using the short sea service (typically per 17 lane meters – equivalent to a truck/trailer combination). The freight rate used in this exercise includes all surcharges (booking fees, fuel surcharges, etc..).

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

			Total increase in freight rate per trip (in %)		
	Sub-market	Distance class	Scenario LOW	Scenario BASE	Scenario HIGH
Route 1	UK/LH-H range <-> Baltic	>750km	7.1%	10.2%	13.0%
Route 2	UK/LH-H range <-> Baltic	>750km	12.4%	17.3%	21.5%
Route 3	UK/LH-H range <-> Baltic	>750km	7.9%	11.4%	14.5%
Route 4	UK <-> LH-H range	400-750km	8.2%	11.7%	14.9%
Route 5	UK/LH-H range <-> Baltic	>750km	7.6%	10.9%	13.9%
Route 6	UK/LH-H range <-> Baltic	400-750km	7.0%	10.1%	12.9%
Route 7	UK/LH-H range <-> Baltic	400-750km	12.4%	17.3%	21.5%
Route 8	UK/LH-H range <-> Baltic	400-750km	8.2%	11.7%	14.8%
Route 9	Intra-Baltic	>750km	8.9%	12.7%	16.0%
Route 10	Intra-Baltic	>750km	18.7%	25.1%	30.3%
Route 11	Intra-Baltic	400-750km	10.7%	15.0%	18.8%
Route 12	Intra-Baltic	400-750km	11.8%	16.5%	20.5%
Route 13	Intra-Baltic	400-750km	12.1%	16.9%	21.0%
Route 14	Intra-Baltic	125-400km	8.9%	12.6%	15.9%
Route 15	Intra-Baltic	125-400km	10.3%	14.6%	18.3%
Route 16	Intra-Baltic	>750km	16.5%	22.4%	27.3%
Route 17	*Intra-Baltic (fast ship 25kn)*	*>750km*	*26.3%*	*34.0%*	*39.6%*
Average			**11.5%**	**15.9%**	**19.7%**
High			**26.3%**	**34.0%**	**39.6%**
Low			**7.0%**	**10.1%**	**12.9%**

Figure 8. Expected minimal increase in freight rates per unit as a result of the use of MGO (0.1%) – short sea vessels with an average commercial speed of 18.5 knots, except route 17 (fast ship)

Source: *Analysis of the Consequences of Low Sulphur Fuel Requirements*, Report commissioned by European Community Shipowners' Associations (ECSA), January 2010

While ECSA studies estimates the increase of freight rates on different short sea shipping routes, studies carried out by University of Turku for Finnish Ministry of Transport and Communications gives examples of by how much transportation freight rates for certain types of cargo will rise (per transported tonne or per TEU). According to the studies the costs for transportation by sea can be expected to rise between 28% and 51% as a consequence of using fuel with sulphur content not exceeding 0.1%. The highest increase of freight rates is expected for containers (44-51%), and the lowest for oil 28-32%, for other cargo the increase is estimated to be around 35-40%. [10]

Some estimation regarding the increase of freight rates due to new IMO 0.1% sulphur requirement were also presented by representative of Finnish Ports Association during the debate held on 15th June in Helsinki. According to Finnish Ports Association the sea freights may increase by 25-40%, per each cargo ton it will be additional 2-10 Euro.

[10] *Sulphur content in ships bunker fuel in 2015. A study on the impacts of the new IMO regulations on transportation costs*, Ministry of Transport and Communications, Helsinki, 2009

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

4. Potential changes in future cargo flow in BSR due to new IMO regulation

Significant increase in costs of transportation by sea as a consequence of using the more expensive fuel may reduce competiveness of sea transport drastically and cause that, in many cases, short sea shipping will not be cost - effective. This may lead, to some extent, to a modal backshift from sea to road and or evan change directions of logistics flows in Europe in order to avoid the SECA.

Several studies tried to assess the potential modal shift due to new IMO regulation. COMPASS study indicates the major corridors where modal shift may occur. These are: Portugal/Spain –southern part of North Sea, West Europe-Baltic States, Germany/Denmark-Sweden, and UK via English Channel to Continental Europe (figure 9). In the ECSA study the similar corridors have been taken into account. These corridors may be regarded as the most sensitive to modal shift from short sea shipping to land transport.

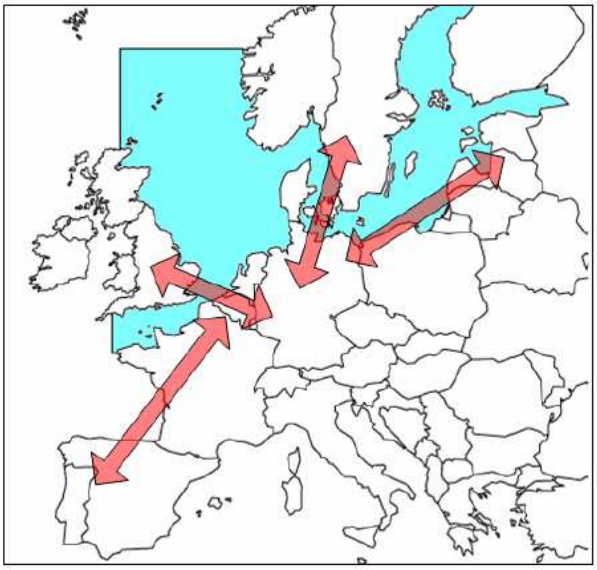

Figure 9. Main corridors where modal shift may occur due to new IMO regulations

Source: *COMPASS The COMPetitiveness of EuropeAn Short-sea freight Shipping compared with road and rail transport,* commissioned by European Commission DG Environment, 2010

COMPASS study includes some estimation of cargo reduction for different types of ships operating in short sea shipping in SECA. The results are divided according to routes' distance. It can be seen from the table 3 that for ro-ro and lo-lo vessels as the route's distance increases the reduction in cargo volumes also increases. This thing is not so obvious for ro-pax vessels, mainly due to the specifics of the routes and small sample for ro-pax vessels routes. For example, in the case of ro-pax small routes, over very short distances (<50km) this services may be affected by relatively large cargo volume reduction. These routes are between Sweden and Denmark, where the Oresund Bridge is alternative to a short sea shipping. For the 50-100 km and 100-300 km distances the ro-pax small routes remains very competitive due to its short port turnaround times and high frequency of service, this enables it to transport a large amount of cargo in a given time period. The distance 100-300 km is represented by route between UK and Belgium. In this case the Eurotunnel could – in theory – be a valid alternative. However, even today rail transport between Belgium and the UK remains very limited.

The ro-pax large vessel routes remains competitive over the distance 0-300km due to the same reason as was mentioned in the case of ro-pax small vessels routes. The cargo losses for the distance range of 500-1000km are small, because this distance is represented only by two port to port routes from Norway to Germany where short sea shipping has been shown to be dominant.

Table 3. Estimated reduction in cargo volumes increases for different ships type and different ranges of operation

Ship Type	Ranges of Operation (km)						
	0-50	**50-100**	**100-300**	**300-500**	**500-1000**	**1000-2000**	**>2000**
Ro-ro (200 trailers and 12 drivers)	x	x	-1.18	-3.47	-3.35	-4.83	-7.58
Ro-pax small (30 trailers and 1000 passengers)	-6.33	-0.24	-1.20	-8.92	x	x	x
Ro-pax large (300 trailers and 1000 passengers)	x	-0.68	-2.74	-4.16	-0.83	-6.50	x
Lo-lo (500 and 700 TEU)	x	x	x	-3.69	-6.06	-6.06	-7.65

Source: *COMPASS The COMPetitiveness of EuropeAn Short-sea freight Shipping compared with road and rail transport,* commissioned by European Commission DG Environment, 2010

Studies carried out by ECSA also presents some expected impact of use of MGO on freight volumes. Short sea operators operating within Baltic Sea and North Sea have been asked how much volumes they expect to lose due to the assumed increases in freight rates. Results depend on route distance and are provided for three different scenarios: Low (MGO- 200 USD per tonne), Base (MGO – 500 USD per tonne) and High (MGO -1000 USD per tonne). For the low scenario the respondents expected that the average volume losses reach 3%. For the base scenario it is 14.5%. The routes covering medium-range distances (400-750km) are

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

likely to be hit the strongest with expected volume losses of 21%. The long-distance routes (>750km) seem to be less affected (1.1%). This might be explained by the limited modal shift potential from short sea to road. For the high scenario it is expected that the average volume losses will reach 40.1%. In this case, the routes covering medium-range distances (400-750km) are likely to be hit the strongest with expected volume losses of 50% and the less affected will be long-distance routes (30%).

Studies commissioned by Swedish Maritime Administration analyse potential changes of transport pattern to and from Sweden. It indicates that a risk from a transfer of cargoes from ship to both truck and train is probable. However, the scale of this phenomenon is different in each of three scenarios considered (depending on ships' fuel costs). The decrease in transportation performance (tonne-km) for shipping ranges from 2% to 10%, depending on scenarios, in favour of rail and road transportation. The transfer is estimated to mainly take place to road in Sweden and to railway outside Sweden. The transfer from routes via the Port of Gothenburg to routes via the Öresund Bridge is the single largest effect. In some cases, it would be more cost effective to go from north of Sweden to Germany or even to southern Europe by lorry. For shipping, the results show that a transfer of freight transport from Sweden's east coast to west coast will take place. Moreover, in many cases, it will also be beneficial to choose the port of Narvik in Norway instead of the ports in northern Sweden. It is also expected, that the transfers from ports in northern Sweden to ports in central and southern Sweden will take place. All of this will contribute to longer transport journeys on land.

Other calculations that show the potential risk of shift to land routes due to IMO sulphur regulations have been carried out by German Institute of Shipping Economics and Logistics. Estimations were made for ro-ro shipping and container shipping. For ro-ro shipping analysis covered 5 routes: form German Baltic Sea ports to Western Sweden / Norway, from German Baltic Sea ports to Southern Sweden, from German Baltic Sea ports to Finland, from German Baltic Sea ports to Russia/ Baltic States and from Belgium to Western Sweden. For container shipping analysis covered 5 different routes from the North Sea into the Baltic Sea (North Sea to Poland, North Sea to Lithuania/Latvia, North Sea to Russia/Finland/ Estonia, North Sea to Sweden, North Sea to Denmark. A differentiation was made between feeder shipping and short sea shipping since different parameters are affecting the choice of transport mode here.

It is estimated that in 2015 about 2.7 million trailers could be transported on selected ro-ro routes. However about 22% (around 600 thou. units) of that volume may be threaten by a shift directly to land routes or to routes with shorter sea leg. Traffic between South Sweden

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

and Finland can expect to suffer the highest absolute losses. It is mainly due to the current high level of units on this route. In percentage terms, the route between German Baltic ports and Russia/Baltic States will suffer the most. The more stringent SECA regulations will make trucks more competitive despite the long routes, and will even give them a clear competitive advantage on some of the routes. The overall conclusion can be that the medium and long routes will suffer much more strongly than short routes, and the proportion of sea transport in the total transport chain will decline (from sea to road).

market	estimated volume in 2015 (1,000 trailers)	expected shift in 2015 in %	expected shift in 2015 (1,000 trailers)
German Baltic Sea ports			
- Western Sweden / Norway	230	14%	31
- Southern Sweden	1,220	15%	181
- Finland	790	27%	215
- Russia / Baltics	300	46%	138
Belgium - Western Sweden	160	24%	38
Gesamt	**2,700**	**22%**	**604**

Figure 10. Shift risk of trailers from sea to road due to IMO regulations
Source: *Reducing the sulphur content of shipping fuels further to 0.1 % in the North Sea and Baltic Sea in 2015: Consequences for shipping in this shipping area*, ISL, September 2010

According to ISL study feeder shipping will be the most strongly affected segment of the container shipping sector in absolute terms. It can be expected that up to 630,000 TEU of containers transported by feeders will shift from sea transport to land transport in 2015. The main routes which lose the most (in absolute terms as well as in percentage terms) are the routes from North Sea ports to Denmark, Sweden and Poland. The risk of a shift is low particularly on the long routes because containers cannot use the scale effects of large trucks during further transport on land routes. This therefore remains relatively expensive compared to sea transport.

	Traffic 2015* (1,000 TEU)			Shift 2015 in %			Shift 2015 (1,000 TEU)		
Market	Feeder	Shortsea	Total	Feeder	Shortsea	Total	Feeder	Shortsea	Total
Poland	865	75	941	27%	26%	27%	233	20	252
Lithuania/Latvia	448	51	499	16%	35%	18%	73	18	91
Russia/Finland/Estonia	2,202	461	2,663	1%	25%	5%	14	115	129
Norway	338	34	371	17%	27%	18%	57	9	66
Sweden	577	64	641	24%	31%	25%	138	20	158
Denmark	340	28	368	34%	33%	34%	117	9	126
Total Baltic Sea	**4,771**	**712**	**5,483**	**13%**	**27%**	**15%**	**632**	**191**	**823**

Figure 11. Shift risk of containers due to IMO regulations
Source: *Reducing the sulphur content of shipping fuels further to 0.1 % in the North Sea and Baltic Sea in 2015: Consequences for shipping in this shipping area*, ISL, September 2010

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

The short sea shipping is the most strongly affected in percentage terms with an average expected shift of 27%. In absolute terms it will be around 190,000 TEU. In the case of short sea shipping more affected in percentage terms will be shorter and medium distance routes. Such long route as North Sea ports –Russia/Finland/Estonia will be the less affected in percentage terms. However due to large volumes generated on this route, it will be most affected in absolute terms.

Some estimates regarding the impact of new IMO sulphur regulations on cargo flows from/to Finland were presented during the port debate held on 15th June in Helsinki, by managing director of port of Helsinki. Sea route from south Finland to south Baltic Sea area (route 1, sea figure 12) is a main route from Finland to the continent, general cargo volume from South of Finland to the continent (Baltic Sea area) is more than 10 million tons per year. General price level for a trailer on this route is about 1,000 – 1,500 EUR. However, due to SECA regulation sea freight on this route may grow even by 30 – 50 %. According to the presentation some cargo flow from Finland – Continent sea route (1) may shift to two main alternative routes: via Rail Baltica (route 2), through Sweden and via Copenhagen - Malmo bridge (route 3). It is believed that about 20 – 30 % of route 1 volumes may be shifted to the optional routes 2 and 3 after 2015 (mailny to route 2).

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

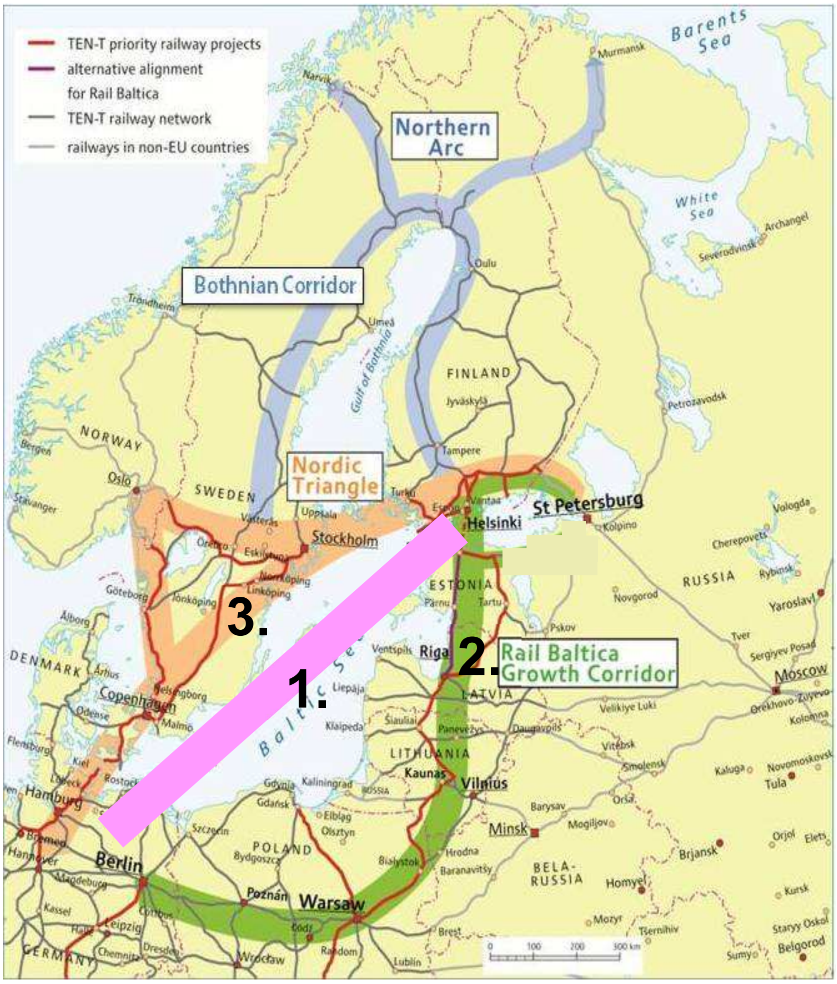

Figure 12. Transport routes from/to Finland

Source: Port of Helsinki Harbours, Kimmo Mäki, Helsinki, 15th June 2012 -presentation

Various studies provide differing conclusions regarding the impact of new IMO regulations on modal shift. This can be explained by the difference in routes selected for their analyses and different assumption of fuel prices. However, studies agree that there are certain risks for shifting from the sea transport to other transport modes. Generally, the higher the price of MGO the greatest risk for shifting. Long and medium routes are more likely to be affected than short routes. However studies underline that some of these routes may lose not necessarily in favour of routes involving only land transport but, what's most probably, in favour of routes involving a shorter sea leg and longer land leg. This change of transportation patterns may pose a potential risk of losing cargo in some Baltic ports in favour of other Baltic seaports.

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

There is also another anxiety in a Baltic port sector, which has not been assessed. After introducing the new IMO regulations competiveness of Baltic ports may be reduced in comparison with ports in other regions of Europe and that logistics flow in Europe will change in favour of European ports not included in the ECA (for example Le Havre or Marseille in France or west coast ports in U.K.). For example, it is possible that cargo flow to and from countries of Central Europe such as Czech, Slovakia, Hungary, Austria and also southern part of Poland will be, to some extent, taken over and handled by the Mediterranean ports. However, it is only a hypothetical scenario, and no one really knows how significant the changes in directions of logistics flow in Europe could be.

5. New regulation and its implications for seaports

New regulations and port marketing strategies

Some Baltic ports see their chances for development in new IMO requirements. It is believed that in many cases long sea routes may lose in favour of routes involving a shorter sea leg and longer land leg. This means that some Baltic ports may lose and some Baltic ports may win. Some ports are involved in projects which aim is to attract cargo by offering cost effective connections. The example is port of Oskarshamn and CARGOTO project.

The objective of the CARGOTO is to establish a coherent freight transport connection Gothenbourg/jönköping/Oskarshamn/Ventspils/Moscow and further East. It will be a regular ferry connection between Ventspils and Oskarshamn based on a stable cargo flow. CARGOTO is working with strategies for transports on road and railway from Nässjö/Jönköping to Oskarshamn and reloading on ferry to Ventspils and even Finland. Nässjö/Jönköping area will connect Malmö, Gothenburg, Oslo and Katrineholm to the CARGOTO corridor and CIS countries (see figure 13). The idea of CARGOTO is to meet future increased volumes between Scandinavia and CIS countries. It is estimated that new route Oskarshamn-Ventspils may attracted up to 20% volumes from routes north of Oskarshamn and 20% volumes from routes south of Oskarshamn.[11]

[11] http://www.cargoto.se

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

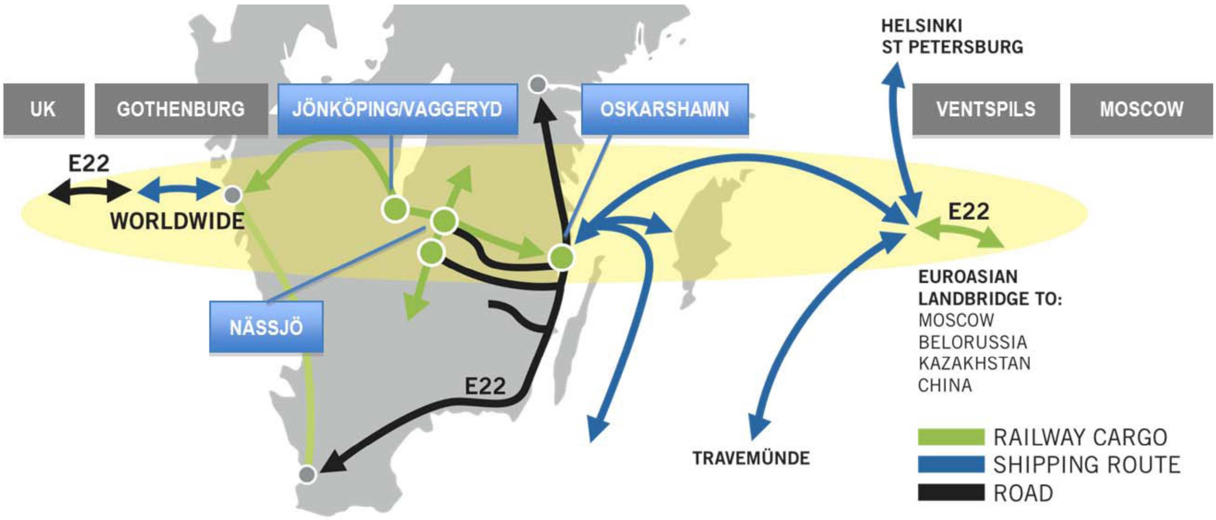

Figure 13. CARGOTO corridor

Source: http://www.cargoto.se

New regulation and its infrastructural implications for seaports

Introduction of new IMO regulation regarding sulphur content in ship's fuel and connecting with that development of such solutions as scrubbers and LNG as a ships' fuel will involve simultaneously development of specialized facilities in ports.

In the case of scrubbers, the waste that are generated during the whole process in scrubber should be handled properly and not be discharged at sea. It means that they must be stored on board and then delivered to a shore reception facility. Regulation 17 of MARPOL Annex VI requires port reception facilities for scrubber residues. However, the infrastructure for scrubber waste disposition is not yet in place and no regulations exist that regulate the port's responsibility to handle such waste. In July 2011, the IMO issued a resolution giving guidelines for reception facilities under MARPOL Annex VI. There exists also need to revise Directive 2000/59/EC of the European Parliament and the Council of 27 November 2000 on port reception facilities for ship generated waste and cargo residues. Pending the revision, Member States should ensure, in accordance with their international obligations, the availability of port reception facilities adequate to meet the needs of ships using exhaust gas cleaning systems.

Other needed investments in SECA seaports are connected with use of LNG as a ships' fuel. Several LNG fuelled vessels that will operate in SECA have been ordered already and will be put into service in one or two years. To offer LNG as a fuel to ships, infrastructure for distribution of LNG fuel must be established. Three basic solutions can be implemented:

1. Tank truck to ship bunkering
2. LNG terminal to ship via pipeline bunkering
3. Ships to ship bunkering

Two first out of this three options are now used in Norway. In the first case, bunkering takes place at berth from tank trucks. Truck capacity varies from 40 to 80 m^3 of LNG, depending on tank design and regulations. This solution makes it possible to bunker the ships in any localization, however, it takes a lot of time. Bunkering process form one 55 m^3 tank truck last about one and a half hour. Which means that bunkering process for typical LNG passenger ferry operated in Norway that has two tank of capacity of 120 m^3 last about 6.5 hour. Due to duration of bunkering, this solution is suitable for small volumes, up to 100-200 m^3, of bunker fuel.

In the second case, bunkering process takes place at berth form port facilities. Bunkering can be carried out at high loading rates and large volumes, which means that bunker times can be kept short. Terminal tanks may vary, from very small (20 m^3) to large (50,000 m^3) depending on requirements, needs, available space etc. Such LNG terminals could be supplied by a small scale LNG shuttle vessel (e.g. 20,000 m^3) from local LNG import terminal which would serve as a hub to such bunker stations. Berth access and distance between source and receiving vessel are essential factors in the success of pipeline to ship solutions. The main limitations of the solution relate to the challenges associated with long liquid LNG pipelines. For longer distances, it is difficult to fuel LNG directly from LNG terminals, from technical, operational and economic perspectives. This implies that storage tanks must be situated in close proximity to the berths where bunkering operations are performed.

The third option is not used yet. At present works are being carried out to create a rules that regulate the ship-to-ship bunkering operations. Bunkering could be performed alongside quays, but it is also possible to bunker at anchor or at sea during running. Typical capacities of LNG bunker vessels may range from approximately 1,000 to 10,000 m^3. Small vessels or barges can also be used in some ports with capacities of less than 1,000 m^3. Ship-to-ship bunkering is expected to be the bunkering method for vessels that have bunker volumes of 100 m^3.

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

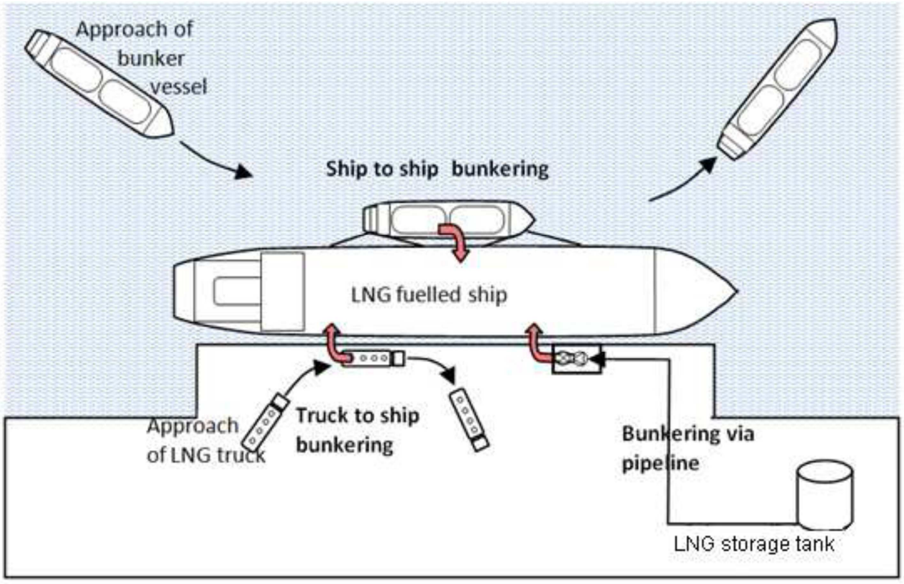

Figure 14. Types of bunkering solutions

Source: *North European LNG infrastructure project. A feasibility study for an LNG filling station infrastructure and test of recommendations*, Danish Martime Autority, May 2012.

Figure 15. Existing and planned production plants and LNG terminals in the SECA

Source: *Gas Infrastructure Europe*, 2011. AF, 2011, Gasnor, Gazprom

The future infrastructural network for distribution LNG fuel is Baltic Sea and North Sea may include all three solutions. In order to select the best solution for an individual port, the following critical parameters should be taken into consideration: the LNG bunkering volumes, physical limitations in port, logistic issues, types of vessels and shipping companies,

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

investment and operating costs, safety, technical and operational regulations, environmental and regulatory issues.

Sufficient number of filling stations needs to exist to provide an adequate network of bunkering terminals and at the same time sufficient demand needs to materialise to ensure the financial viability of individual terminals. Studies carried out by Danish Maritime Authority *A feasibility study for an LNG filling station infrastructure and test of recommendations* shows how network of terminals may develop such that supply can meet demand and vice versa. The number of small scale and medium scale terminals, bunker vessels and tank trucks required to meet the maritime LNG demand in SECA has been estimated. Studies assumed equal proportion of pipeline bunkering and ship-to-ship bunkering. Studies assumes that in 2015 the demand for LNG will reach 1,590,00 tonnes. From logistics point of view the minimum network for distributing LNG fuel in SECA should consist of 7 medium size terminals, 13 small size terminals, 11 bunker vessels of different size (from 1000 m^3 to 10000 m^3) and 5 tank trucks. In 2030 when the demand may reach over 6 mln tonnes the minimum network should consist of 11 medium size terminal, 38 small size, 35 bunker vessels, 8 tank trucks. This is the minimum from logistic point of view. The logistics point of view implies that LNG infrastructure is an optimal way across the different owners, ports operators etc. This is only exemplary network and it must be noticed the overall design of an appropriate supply structure depends on the proportion of bunkering via pipeline versus ship-to-ship bunkering and many other factors.

Year		2015	2020	2030
Maritime demand to be supplied by small and medium terminals, vessels and trucks [tonnes]		1,590,000	3,630,000	6,212,780
Number of terminals	Medium size terminal – Case II	7	9	11
	Small size terminal – Case III	13	23	38
Number of bunker vessels	Bunker Vessel - 1,000 m^3	9	19	28
	Bunker Vessel - 3,000 m^3	1	3	5
	Bunker Vessel - 4,000 m^3		1	1
	Bunker Vessel - 10,000 m^3	1	1	1
Number of trucks	Truck - 50 m^3	5	6	8

Figure 16. Number of small scale and medium scale terminals, bunker vessels and tank truck required to meet potential maritime LNG demand.

Source: *North European LNG infrastructure project. A feasibility study for an LNG filling station infrastructure and test of recommendations*, Danish Martime Autority, May 2012.

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

The choice of location for a LNG bunker station depends both upon where potential users of LNG are and where there are areas available. LNG is considering as an alternative fuel mainly for ships operating in liner service (such as ro - ro ships, ferries and feeder container vessels). Hence, LNG terminals for bunkering purpose should be constructed in locations where there are most dense liner services. In the BSR several LNG bunker stations are considered.

LNG terminal in Nynäshamn (Sweden).

LNG terminal in Nynäshamn owed by AGA Gas AB is a first LNG terminal in Sweden and on the whole Baltic Sea. Terminal was put into operation in May 2011. It is a medium size import facility of a capacity of 300,000 - 400,000 tonnes per year. Tank height is 36.6 meters, diameter 37.5 meters, and the volume 20 000 cubic meters. The harbour for the terminal is able to receive tankers up to 160 m in length, 9 m in depth and with a capacity of 50,000 cubic meters. There are plans to upgrade terminal to make it possible to load LNG on vessels that supply other vessel with LNG fuel.

LNG terminal in Gothenburg (Sweden)

The proposed LNG terminal in Gothenburg will be a small scale terminal established especially for bunkering purpose. According to the planned schedule the terminal will be put into operation by year 2013. The overall project was initiated by Göteborg Energi together with Port of Gothenburg. Gasnor have later joined. In early 2010, Göteborg Energi and Gasnor formed a new company, *LNG GOT*, which will manage the operations of the terminal.[12] The main objective is to construct terminal which will be able to receive LNG and deliver it to bunker boats supplying vessels. Planed terminal's storage capacity is 10,000 m^3.

Terminal LNG w Hirsthals (Denmark)

The Norwegian company Gasnor and the Port of Hirtshals have signed a letter of intent regarding establishment of a small scale LNG terminal at the Port of Hirtshals. The terminal will be owned and operated by Gasnor. The cooperation between Gasnor and the Port of Hirtshals is effected by Fjord Line, which plans to put two newly built cruise ferries fuelled by LNG into service between Norway and Hirtshals in 2012. [13]

[12] http://www.lnggot.com/2010/press-release-2010-06-22/ , http://www.lngworldnews.com/gothenburg-port-moves-forward-with-lng-sweden/

[13] http://www.portofhirtshals.com/default.aspx?m=4&i=125&pi=2&pr=0

Project part-financed by the European Union (European Regional Development Fund)

Baltic Sea Region Programme 2007-2013

BPO BALTIC PORTS ORGANIZATION

LNG terminal in Finland

There are plans to construct LNG bunker stations also in Finland. Gasum indicates several potential localizations for such facility. At first, company plans to construct small LNG terminal in Naantali. Terminal would be used as a bunker station for passenger ferry which is being built for Vinking Line and will be put into operation in 2013 Additionally, Gasum indicate that LNG terminal could be constructed also in other localization: in Tolkkinen, Porvoo, Kotka, Hamina, Hanko.

Summary and conclusions

New IMO regulation regarding sulphur content in ships' fuel caused a great concern within the maritime transport sector in SECA area, particularly in Baltic Sea Region. There are three main options available for ship operators who wish to meet the new revised Annex VI sulphur requirements: switching to MGO, use scrubbers or use LNG as a ships fuel. However, the two last options are now rather in development stage and at the moment pose some technical challenge. They require additional investments not only on board of ship but also in seaports. Hence, it can be expected that in the near future the most widely used solution to meet new IMO regulation will be switching to gas oil (MGO). Switching to marine distillates seems to be the most suitable option for majority of shipping operators as MGO can be used in the main engines, without posing a major technical challenge.

However, distillates fuels are more expensive than residual fuels. Generally, during the last several years distillates fuels (MDO, MGO) were from 30% to almost 100% more expensive than Intermediate fuel oil (IFO). This cause a concern that using MGO instead of fuel with higher sulphur content may contribute to increase costs and prices of sea transport in Baltic Sea, which is included in SECA. In turn, this may lead to modal shift from sea to land transport and change of future pattern of the cargo flow in Baltic.

According to ECSA studies, for traditional short sea services between North European seaport and Baltic seaports as well as intra Baltic services average freight rate increases are estimated to reach 11.5% for the low scenario and around 20% for the high scenario. For fast short sea services the figures are much higher: on average 26% for the low scenario and 40% for the high scenario.

Many studies agree that there are certain risks for shifting from the sea transport to other transport modes due to IMO regulations. The most visible relation is that the higher the price of MGO the greatest risk for shifting. Generally, it can be expected that medium and

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

long sea routes are more likely to be affected than short sea routes. However studies underline that some of these routes may lose not necessarily in favour of routes involving only land transport but, what's most probably, in favour of routes involving a shorter sea leg and longer land leg. Feeder shipping will be the most strongly affected segment of the shipping sector in absolute terms as a result of the shifts.

This potential change of transportation patterns may pose a potential risk of losing cargo in some Baltic ports in favour of other Baltic seaports. There is also anxiety that after introducing the new IMO regulations competiveness of Baltic ports will be reduced in comparison with ports in other regions of Europe and that logistics flow in Europe will change in favour of European ports not included in the ECA (for example Le Havre or Marseille in France or west coast ports in U.K.).

Losing a cargo due to IMO regulation is not only one consequence for Baltic ports. Introduction of new IMO regulation regarding sulphur content in fuel and connecting with that development of such solutions as scrubbers and LNG as a ships' fuel will involve simultaneously development of specialized facilities in ports. In the case of scrubbers, the waste that is generated during the whole process in scrubber should not being discharged at sea. It means ports should be equipped with special reception facility. Another needed investment in SECA seaports are connected with use of LNG as a ships' fuel. To offer LNG as a fuel to ships, infrastructure for distribution of LNG fuel in ports must be established.

Project part-financed by the European Union (European Regional Development Fund)
Baltic Sea Region Programme 2007-2013
BPO BALTIC PORTS ORGANIZATION

P O R T D E B A T E

Implications of the IMO regulations on the future pattern of the cargo flow in the Baltic

15th June 2012
Helsinki, Finland
Venue: Gatehouse, Vousaari Harbour
Organized by BPO and TransBaltic
Supported by Finnish Ports Association & Port of Helsinki

9.00 Introduction

- Bogdan Ołdakowski, Secretary General, BPO
- Wiktor Szydarowski, Project Manager, TransBaltic

Port of Helsinki – recent facts & figures and expected impact of IMO regulations
Kimmo Mäki, Managing Director, Port of Helsinki

Forecasting the future cargo flow in the Baltic
Dr. Tapani Stipa, Project Manager, The Baltic Institute of Finland

Main driving forces for future cargo flow in the BSR
Wiktor Szydarowski, Project Manager, TransBaltic

How the shipping line are adjusting to new rules?
Olof Widen, Managing Director, Finnish Shipowner's Association

10.30 – 11.00 Coffee break

Finnish ports espouse to new situation after 2015
Heikki Nissinen, Vice-Chairman, Finnish Port Association

Review of analysis assessing the impact of SECA rules on transport sector
Monika Rozmarynowska, Assistant, Gdynia Maritime Academy

12.00 Debate with speakers and invited quests

12.45 Lunch

Project part-financed by the European Union (European Regional Development Fund)