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

Final report

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Preface

In October 2008 a revised version of Annex VI of the MARPOL Convention was adopted by the member states of the International Maritime Organization IMO. The Annex includes regulations on the reduction of sulphur oxide emissions from ships divided into specifications for global operation and far stricter limits for Sulphur Emission Control Areas (SECA). Global maritime shipping which presently operates by the limit of 4.5% sulphur contents in fuels is facing a limit of 3.5% as from year 2012, and starting from year 2020 respectively 2025 – depending on the fuel availability – a limit of 0.5% sulphur contents in ship fuels will apply. As regards SECA – which in 2008 covered the North Sea and the Baltic Sea only – a sulphur limit of 0.1% (presently 1.0%) has unexpectedly been agreed to as from year 2015. The IMO member states have failed to conduct a substantiated impact assessment in particular for the SECA regulations before adoption. Availability and affordability of low-sulphur fuels should have been analysed beforehand as well as the risk of a modal shift which in particular arises from Europe’s dense network of transport modes.

The German Federal Government had in principle supported the development of the IMO regulation and at the same time acknowledged the risk of a modal shift to the detriment of Short Sea Shipping in SECA. The Government had also assured to take adequate measures to safeguard that no such transport shift occurs. In March 2008 the Federal Ministry of Transport, Building and Urban Development (BMVBS) and the German Shipowners’ Association (VDR) agreed to enter into a subject-based structured dialogue. The first workshop took place in July 2008 and served as forum for representatives of ferry- and feeder shipping companies in order to demonstrate economic consequences on company-level. A second workshop followed in December 2008. On that occasion BMVBS, VDR and in addition the Association of German Seaport Operators (ZDS) unanimously agreed to jointly commission a study. All available facts were to be impartially reviewed, assessed and evaluated by scientists.

Since a first study which had accordingly been jointly commissioned in August 2009 could not be finalised, both VDR and ZDS then commissioned ISL in June 2010 with the execution of the said expertise. The Federal Ministry of Transport, Building and Urban Development had, as previously agreed upon, been timely informed and continuously been updated on the commissioning, conception and execution of the study at hand. Its valid results offer a sound basis for further dialogue.

German Shipowners’ Association

Association of German Seaport Operators

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1 Summary and findings

The climate debate is the background against which “shipping” – a means of transport which is generally a model of energy efficiency and specific CO_2 emissions – is bearing the brunt of criticism because of the high level of sulphur oxide emissions.

The International Maritime Organisation (IMO), and specifically its Marine Environment Protection Committee (MEPC), elaborated a proposal to reduce sulphur oxide emissions which was adopted in October 2008 and thus authorised by the IMO.

In addition to a general long-term tightening of the specifications for the sulphur content of shipping fuels – involving a limit reduction to 0.5 % by 2020/25 – the limit for sulphur concentrations in shipping fuels was set even lower in so-called “SOx Emission Control Areas” (SECA), which cover areas considered to be worthy of special protection and designated as being at risk. The sulphur concentration in these areas is already limited to 1.0 % but set to reduce dramatically to 0.1 % by 2015. It is highly likely that this figure can only be achieved by the use of petroleum distillates, and no longer by the use of heavy oil – especially when considering that appropriate systems for treating the exhaust gas are not available in the necessary form. The production of distillates is much more complicated, and the demand is much higher, which already makes these fuels more expensive and will therefore tend to drive prices even higher, especially when compared to heavy oil.

The consequence of these factors is that operating ships in SECAs will become disproportionally more expensive, whilst the rise in fuel costs for shipping outside of SECAs (and particularly for land transport) will probably be much lower. The main concern arising from this is a distortion in competition for shipping. In the SECAs, this could give rise to a shift of cargoes currently transported by ship onto land transport, or routes with a much lower proportion of sea miles. This will affect shipping companies as well as ports, who will lose handling volumes and therefore income.

To gain an insight into the volume affected by these shifts in freight transport modes, VDR Verband Deutscher Reeder e.V. and ZDS Zentralverband der deutschen Seehafenbetriebe e.V., engaged ISL Institute of Shipping Economics and Logistics in summer 2010 to analyse the consequences of the reduction in the sulphur content of shipping fuels to 0.1 % in 2015 on shipping in the North Sea and the Baltic Sea. This report summarises the findings of the analysis carried out to investigate this issue.

The first part of the study involved a review of the price levels of the different types of fuel, ranging from heavy oil with a sulphur content of e.g. 3.5 %, to sulphur-reduced heavy oil (1.0 %), and diesel with maximum 0.1 % sulphur. The study then looked at how these prices could develop in future. The analysis considered the current market figures as well as various studies undertaken in other European countries. The results indicated that the price of diesel oil in 2015 could range between 850 and 1,300 US$ per tonne. Compared to heavy oil (also with a sulphur content of 1 %), these forecast prices will mean a disadvantage of around 300 to 560 US$ per tonne fuel.

Comparative calculations were carried out using the figures from the upper and lower limits of the forecast fuel prices to work out how this changes the transport costs (and prices) for shipping and possible alternative routes compared to a situation where no 0.1 % sulphur concentration is stipulated. The following differentiations were incorporated in these calculations:

RoRo shipping: 8 different corridors were calculated with a total of 17 different services and ships. The corridors were defined according to route lengths, hinterlands served, and alternative routes.

Container shipping: Analysis looked at 5 different reference routes from the North Sea into the Baltic. A differentiation was made between feeder shipping and short sea shipping since different parameters are affecting the choice of transport mode here. Different ship sizes were calculated for each route/round trip type.

The sea transport costs in every case were calculated in detail for each round trip, and broken down for each unit (truck/trailer or TEU) using utilisation parameters. With the exception of the fuel costs, all of the assumptions and parameters for the cost calculations were kept constant with and without SECA conditions.

The sea routes were then connected to the relevant hinterland regions on the origin side as well as the destination side, so that the costs for the complete transport chain from “house-to-house” were available for the initial situation, and the cost increases as a consequence of implementing the SECA stipulations. Alternative routes over land or using shorter sea routes were also calculated for both situations. An estimate of the probable amount of shifting onto each of the corridors could then be made based on the resulting changes, and the price advantages and disadvantages of the potential alternatives, using as a basis a modal-split model previously calibrated with real values.

The findings are as follows when considering the results incorporating fuel costs set at the upper limit of the forecast corridor:

There are very tangible shifts in container shipping as well as truck/trailer traffic (RoRo shipping). On the basis of the 2008 figures for the simulated routes and corridors totalling around 1.9 million transported trailers/trucks, and information on the size of the total market, as well as moderate growth assumptions, the basic volume at risk of a shift to road transport in 2015 was estimated to be around 2.7 million units.

Of these 2.7 million trailers, around 600,000 units will shift directly to land routes or to routes with shorter ferry portions.

Tab. 1-1: Trailer transport shift risk for fuel prices at the upper limit of the corridor

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**

* Source: ISL 2010

The estimated shifts primarily affect the routes to Russia and into the Baltic. Parallel land routes are available for these routes which are already a competitive threat to sea shipping because of the cheaper personnel and fuel costs enjoyed by East European hauliers. A particularly high proportion of bunker costs in the total costs for the transport chain also means that the implementation of the new SECA regulations has a particularly strong percentile effect on the costs.

It can be concluded overall that the medium-length to long routes will suffer significantly from the new SECA regulations, and that the proportion of sea transport in the whole transport service will decline ("from Sea to Road"). If there is a shift from a long to a short route, then although there is no change in the number of transported trailers/trucks, and no change in the amounts handled by ports in this case, there is a reduction in the length of the routes taken by each trailer on the shipping leg, and an increase in the truck and road proportion. This means that a shift from longer to shorter routes would also not be desirable in terms of environmental and transport policy. On the routes where the RoRo services have to be terminated because of a shortage of cargo, this service would no longer be available and would therefore shift even more traffic onto the land routes than determined in the calculations. The particularly high losses would make it impossible to continue some services and therefore lead to even more unavoidable shifts in transport volumes.

For the short routes from Germany to Denmark, there is also a risk of shifts to alternative land routes (particularly on the fixed crossings via Jutland/Store Belt) attributable to the only small relative differences in the proportion of fuel costs to the overall costs compared to the medium-long routes to south Sweden (see Tables 4.3 and 4.6). However, it is also likely that these routes will initially at least be able to compensate for some of this by taking shares from the medium-long to long routes. These shifts were therefore not looked at in detail in this study.

However, the now agreed fixed crossing of the Fehmarn-Belt, scheduled to open for business only a few years after the SECA sulphur limits some into force, will probably be much more problematic for these lines. Given that effects can be expected on the parallel ferry routes to south Sweden for instance even under the old sulphur regime, the additional SECA effects are very likely to exacerbate even further the power of these fixed crossings to shift traffic flows – almost certainly also dependent on the price structures.

In terms of container shipping, **short sea-land shipping** is the most strongly affected, with an average forecast shift of 27 %. This is because transport between sea ports and the hinterland in some cases involves a significant detour compared to the land route, and that a larger volume per truck can be transported by direct land transport with trailers. The effect reduces slightly to 25 % in the more distant eastern markets despite the lower HGV costs for traffic heading east.

Tab. 1-2: Risk in the shift of container shipping for fuel prices at the upper limit of the corridor

Market	Traffic 2015* (1,000 TEU)			Shift 2015 in %			Shift 2015 (1,000 TEU)		
	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**

* Source: ISL North European Container Traffic Model, Forecasts based on OSC

Container feeder shipping at around 13 % is slightly less strongly affected by the shift. However, the shift involves a much higher overall number so that around 630 thousand TEU in total will move from the described sea transport corridors onto land transport. The highest relative effect here involves the feeder shipping on the short routes to Denmark. On the other hand, hardly any risk of a shift to road transport is forecast for the longer feeder routes because the cost benefits of shipping are enough to withstand a relatively large rise in the costs of shipping fuel compared to HGV diesel. The cost advantages of container feeder shipping are less on the shorter routes, and demand will therefore react more sensitively to changes in price structures.

The risks of a shift are so high for Poland, as well as Denmark and Sweden, that feeder services can be expected to shut down or at least be replaced by smaller ships. Both of these effects will lead to a further drop in the proportion of sea transport and possibly complete abandonment on certain routes because of the absence of a “critical mass” on which the establishment of scheduled services depends.

Unlike RoRo shipping and short sea shipping, it is also feasible in the case of feeder shipping that part of the shift is moved onto rail. In the direction of Poland in particular, rail plays an important part in the competition for transporting containers from German ports (particularly Hamburg). However, taking into consideration the limited capacities and the restrictions associated with the differences in track gauges, etc, it is likely that most of this shift will be onto road transport.

In addition to a shift (back) of feeder shipping to road and rail because of the planned SECA restrictions, it is also possible for this to give rise to a shift of container hinterland transport from German North Sea ports to the south range ports of Triest, Koper and Rijeka. Austria, Hungary and Slovakia are already in part served by the south range ports. Parts of Bavaria and Baden-Wurttemberg, as well as the Czech Republic, actually lie closer to the south range ports than they do to the German North Sea ports.

Classifying the North Sea as a SECA region makes transport through the North Sea more expensive and boosts the competitive position of the south range ports. It can therefore be expected that the market share of the south range ports will increase in the aforementioned hinterland regions as a result of this measure. It can be assumed in particular that the implementation of the stricter SECA stipulations in the North Sea, and an "improvement" in the position of the Mediterranean, will lead to the establishment of additional Far-East services which terminate directly in the Adriatic and then return again. The ships on such routes could continue to operate with HFO without having to undergo any conversion.

Effects on the ports

It is also true in the case of the ferry and RoRo ports that the calculated shift in volumes in the calculated corridors will also have an effect on the volumes of cargo transhipped at the ports. Based on the total volume of around 1.9 million trailers today, and a shift of around 22 % calculated for the simulated corridors, there is a risk that a total of 604 thousand trailers/trucks could shift in 2015 from the assumed basic volume of 2.7 million trailers, and that these trailers/trucks would be lost by the ports in the first step. In the case of RoRo/ferry shipping, however, the ultra-short routes are an alternative which should be in a position to be able to attract some of the volumes shifting from the long routes. In addition to the pure effect on volumes, one must also expect that the increased use of short routes will change the structure of RoRo shipping in such a way that they lose a share of the trailers which dominate the long routes but gain market share by an increase in the accompanied HGV traffic. This means that the ports overall will lose a significant amount of value-added activity because the accompanied traffic requires a much smaller amount of port services (trailer loading, CLT etc.).

The loss in transhipment volume for German container ports is calculated at around 820 thousand TEU in 2015 if one assumes that the containers fed via Hamburg and Bremerhaven prior to the 0.1 % regulation will continue to arrive on the main ship in Bremerhaven, Hamburg or Wilhelmshaven. Because of the geographical location of the transhipment market looked at in this study, it is probable that the use of German ports will remain stable if the other conditions remain the same, even if there is a shift in cargo transport from ship to land. Because the major lines have to satisfy the SECA stipulations anyway if they want to continue to serve North-western Europe, there is further support for the argument for the longest possible use of the more economical large ships in terms of specific fuel consumption.

More traffic on German roads

It is virtually impossible to quantify the additional traffic levels on German roads in terms of TEU kilometres and truck kilometres, without a detailed network simulation. Assuming plausible alternative routes on German roads and the amount of containers shifted from sea to road, the increase in transport alone on German roads in 2015 will amount to more than 255 million TEU kilometres or 128 million truck kilometres. The estimate for RoRo shipping is around 60 million truck kilometres on German roads.

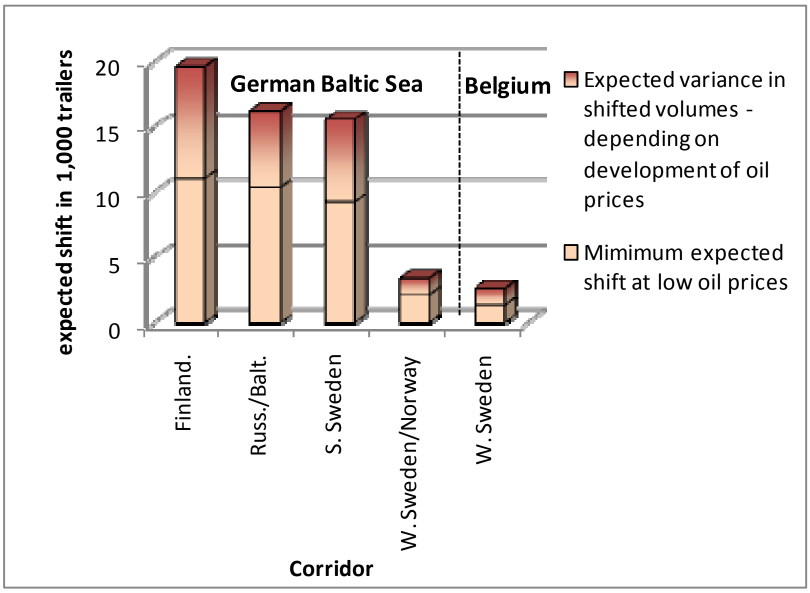
No increase in pure transit journeys is expected because the SECA regulations are not expected to shift any significant volumes to the west ports.

Fuel with a sulphur concentration of 0.5 %

A modification of the SECA limits is at least the subject of discussion because of the less than fully developed technical possibilities available so far, and the economically less attractive case for financial compensation to balance out the disparities between land and sea transport.

The shifts from sea transport to pure land transport are a result of a significant rise in sea transport costs caused by the use of fuel with a 0.1 % sulphur content. A possible alternative could be to use fuel with a sulphur content of 0.5 %. This alone would bring about a considerable reduction in sulphur emissions, but would be only slightly higher in the forecast price corridors compared to the fuel used today with a sulphur content of 1 %.

Fig. 1-1: Forecast shifts in volumes of trailer shipping with the implementation of the 0.5 % limit in 2015



The increase in costs per trailer by using this fuel would only be around 1 – 5 % for the RoRo corridors looked at in this analysis, even for fuel prices at the upper limit of the corridors. This would have hardly any impact on any of the routes and therefore barely disrupt the price structures.

This would therefore only lead to a very minor shift in freight movements from sea shipping to land traffic.

Similar effects are seen for container shipping. Although the increase in costs here would be measurable, it would ultimately not have any major impact on the price structures. Instead of the originally forecast 820 thousand standard container units which would shift from sea transport to land transport, a shift of less than one tenth this volume is prognosed. However, this again has a relatively strong impact on the short routes to Poland and Denmark in particular.

Tab. 1-3: Risk of the shift in container shipping 2015 for fuel prices at the upper limit of the corridor, fuel with 0.5 % sulphur content

	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	2%	3%	2%	21	2	23
Lithuania/Latvia	448	51	499	1%	4%	1%	5	2	7
Russia/Finland/Estonia	2,202	461	2,663	0%	2%	0%	1	11	12
Norway	338	34	371	2%	3%	2%	6	1	7
Sweden	577	64	641	2%	4%	2%	12	2	15
Denmark	340	28	368	4%	4%	4%	12	1	13
Toal	**4,771**	**712**	**5,483**	**1%**	**3%**	**1%**	**57**	**20**	**77**

* Source: ISL North European Container Traffic Model, Forecasts based on OSC

Using fuel with a sulphur content of 0.5 % would therefore be a very good compromise which would lead to hardly any distortion of the market and shift hardly any freight from sea to land even though it would still achieve a significant reduction in sulphur oxide emissions.

2 Introduction

The Institute of Shipping Economics and Logistics (ISL), Bremen, was contracted in June 2010 by VDR Verband Deutscher Reeder together with ZDS Zentralverband der Deutschen Seehafenbetriebe, to elaborate this study and to complete the study by the end of August 2010.

2.1 Introduction

The background is the more stringent stipulations for toxic emissions generated by shipping in selected regions.

The climate debate is the background against which “shipping” – a means of transport which is generally a model of energy efficiency and specific CO_2 emissions – is bearing the brunt of criticism because of the high level of sulphur oxide emissions, because sulphur oxides are environmentally damaging, as well as emitted in much smaller amounts or not at all by other means of transport. The comparatively high emissions of sulphur oxides by shipping is the consequence of its being fuelled by heavy oil with a global average sulphur concentration of 2.7 %.

The International Maritime Organisation (IMO), and specifically its Marine Environment Protection Committee (MEPC), elaborated a proposal to reduce sulphur oxide emissions which was adopted in October 2008 and thus authorised by the IMO. The global aim is therefore to reduce the sulphur content of fuel from today’s level of up to 4.5 % to a maximum of 3.5 % (2012), and further down to a maximum of 0.5 % (2020/25).

The limit for sulphur concentrations in shipping fuels was set even lower in so-called “SOx Emission Control Areas” (SECA), which cover areas considered to be worthy of special protection and designated as being at risk. The sulphur concentration in these areas is already limited to 1.0 % but set to reduce dramatically to 0.1 % by 2015. It is highly likely that this figure can only be achieved by the use of petroleum distillates, and no longer by the use of heavy oil – especially when considering that appropriate systems for treating the exhaust gas are not available in the necessary form. The production of distillates is much more complicated, and the demand is therefore much higher – which already makes these fuels more expensive – and will therefore tend to drive prices up even more

Defining different sulphur limits within and outside of SECAs gives rise to a situation in Europe in the period from 2015 to 2020/25 where the waters to the east of England (North Sea SECA) have a stipulated limit of 0.1 %, while the waters to the west of England (Irish Sea – not a SECA) have a stipulated limit of 3.5 % sulphur in the fuel.

This dramatic rise in fuel costs, which are an important block in overall costs, has an impact on prices and price structures, in particular on routes where shipping is in competition with land-based means of transport unaffected by this price increase. This will lead to a shift in traffic from sea to land – often onto roads – ("sea to road").

2.2 Study goals

The aim of this study is to estimate the expected shift in traffic arising from the implementation of IMO Resolution MEPC 58 to amend MARPOL Annex VI, and to discuss any feasible countermeasures – because one can assume that such shifts from sea traffic to land traffic will take place whatever the other political intentions and measures.

Special consideration is given to transport in the Baltic Sea and the North Sea, and the effects on the shipping companies and ports operating in the region. A brief analysis was also undertaken of the possible distortions to competition in the overlying European competition for container shipping.

2.3 Procedure

Project elaboration involves five main modules whose most important constituents are briefly discussed in the following:

- **Definition and delimitation of the relevant market**: As long as changes in the costs are spread equally amongst all competitors providing a specific service, there will be no competitive distortion. Problems are caused by a (legislated) change in costs if the effects are unequally felt by just some of the service providers. But this also only applies when there is real competition and thus economically sensible alternatives to the services offered by the providers affected by the cost-enhancing measures. The first step is therefore to identify and describe the potentially affected markets. This must take into consideration transport operating within the SECA regions, as well as transport which crosses the boundaries of the SECA or which completely avoids the SECA region because of the more stringent specifications and higher costs.

- **Presentation of the main corridors**: Complete simulation of all transport within or involving the North Sea and the Baltic Sea could not be carried out within the framework of this project. Only a few corridors were therefore defined and described as typical examples. The criteria involved in the selection primarily concerned the length of the sea route, the length of the preceding transport and subsequent transport in the hinterland, and the length of the potential alternative routes. The relative transport volumes currently carried along these corridors is worked out, and the forecast transport volumes in the future are derived from these figures. These estimates are based on data provided by today's active shipping lines as well as export and transit information. This information also provides an indication of which transport routes are already affected today by competition from land transport. Use was made here in particular of the ISL databases at its information centre, and its own surveys on container shipping in Northwest Europe. The corridors/typical routes looked at in this study differentiate between ultra-short, short, medium-long and long routes.

- **Derivation of cost structures and development of scenarios to analyse rising fuel costs on shipping:** Determining the cost structures of certain standard ships (typical ships) in the corridors looked at in this study was essential to estimate the impact of sulphur-reduced fuel on overall costs and the costs per transported unit. Information from the shipping companies operating in these shipping areas was incorporated alongside the information already existing at ISL. The most significant aspect here was quantifying the proportion of fuel costs in the overall costs. Other costs which needed to be taken into consideration were the conversion of ships for complete or partial operation with distillates.

  It is also very important for the analysis to investigate whether the percentile rise in costs is reduced with a rise in the price of crude oil, i.e. whether the rising oil price reduces the significance of the extra costs involved in the production of distillates. This needs to be defined in appropriate scenarios followed by a calculation of the impact on sea transport chains as well as for alternative routes with a higher proportion of road transport. Analysis and discussion in this context is also required to determine the possible availability of distillates in future. This has important consequences for the cost of fuel and trend statements on the possible negative effects on CO_2 emissions of the production and the increased transport of the fuels.

- **Estimating the shifts**: Analysis of the changing differences in costs in the scenarios gives rise to changes in the advantages of sea transport for different parts of the corridor because it must be assumed that the costs will be passed on in the prices. Based on the experience of market players, it can be assumed in the case of road transport that even a small difference in price will immediately shift transport to alternative cheaper routes. Price-sensitive industries with low margins, and low conversion costs, such as the road transport industry, change provider/transport route/mode-of-transport instantly. A shift from sea to land transport here can take place immediately and without any additional investment because the means of transport required for road traffic is already a road-capable truck or trailer. Things are different in the case of container shipping because this is associated with the decision: containerisation yes/no. ISL's experience in model split analysis and elasticity considerations plays an important part in this evaluation.

  Today's division of the market into a Baltic area and a North Sea area developed as a consequence of the price/quality constellations between sea transport and road freight transport. An increase in the costs because of a rise in the price of the types of fuel will lead to a partial shift without compensation. The extent of this shift is discussed and estimated individually for all relevant corridors. A problem in extrapolating the results onto the market as a whole is that in RoRo shipping, certain corridors with short sea distances, and thus affected less by changes in fuel costs affecting sea transport, will profit from the negative effects on corridors with long sea routes. Ultimately, RoRo shipping corridors with short sea journeys in particular will tend to be less strongly affected. This could mean in reality that the number of trucks/trailers with at least a short sea journey portion will decline less strongly than indicated by the aggregation. Nevertheless, the growing proportion of short journeys means that the proportion of shipping in the transport chain overall drops, with an accompanying rise in the proportion of land transport.

- **Discussion of the possible measures to avoid the shifts:** The last part of the report discusses measures that could help prevent a shift from sea to road. Now that the optimisation potential implemented by the shipping companies has been exhausted by their efforts to compensate for the disadvantages to sea transport arising from the scrapping of duty free sales, the opening of fixed crossings, and opening up the border to Poland, consideration is primarily given to measures which could, at least in part, reduce the disadvantages to shipping and thus neutralise the effect on volumes.

2.4 Definitions and assumptions

The discussion of the possible consequences differentiates between three main forms of transport: ferry/RoRo shipping, feeder shipping and short-sea-land/ inner-European sea shipping.

In the case of **ferry and RoRo shipping,** this mainly involves inner-European flows of goods on trucks or trailers. These are characterised by point-to-point transport with high frequency levels. The services generally use relatively fast ships and are often in competition with mainly land-based transport using trucks, even when this also involves short or ultra-short sea routes. The transported cargo primarily involves high quality semi-finished and finished products because these are the only ones able to bear the relatively high transport costs.

The same generally applies to **inner-European sea transport** in containers. This involves the transport of relatively high quality goods in containers from one inner-European location to another. However, this transport is not carried out using dedicated ships – the containers are shipped by scheduled feeder services, a fact which makes differentiation difficult. The main competition here primarily concerns land-based means of transport, in some cases also in combination with ferry/RoRo services. For relatively lightweight high quality goods in particular, inner-European container shipping is disadvantaged here by the drawback that containers are not ideally dimensioned to carry Euro-pallets. This restriction means that a 40-foot container has a considerable volume disadvantage compared to a standard large truck: whilst a 40-foot container can have up to 65 m^3 usable space (for 25 pallets), a normal semitrailer has around 86 m^3, and a large volume truck 120 m^3 (38 pallets). When carrying light cargoes, a truck on a direct route can therefore carry up to 50 % more freight than a container could. Or a truck on a direct route can transport the cargo volume equivalent to up to 3 TEU whereas only 2 TEU could be transported per truck. A volume disadvantage must therefore be taken into consideration here when making cost comparisons.

The constellation for **feeder shipping** is slightly different when containers coming from overseas or going overseas are distributed or collected by smaller container ships (feeders). These loads are also transported in containers in the preceding journey and the subsequent journey.

The volume analysis and the timetables are mostly based on figures for 2008. This is because complete databases are still mostly absent for 2009, and it would also not be correct to use figures for the exceptional circumstances affecting 2009 associated with the tangible consequences of the crisis, soon to be compensated by the short-term and the latest medium-term recovery of the markets.

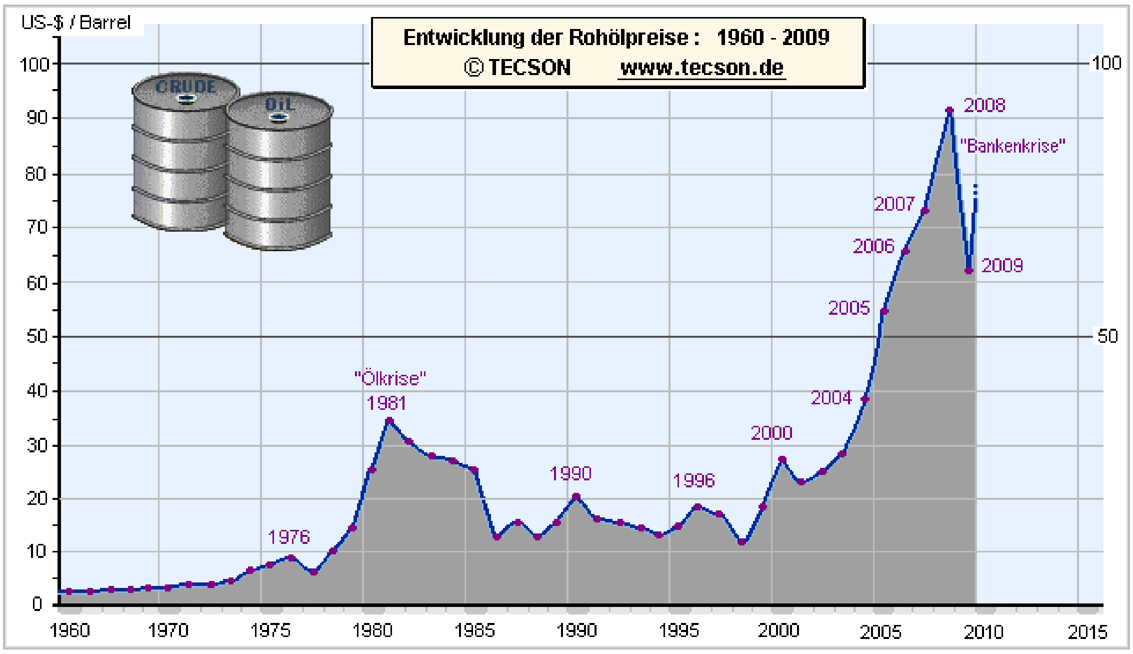
For the sake of simplification, the basis for the calculations of the sea transport costs and the costs of the land-based alternatives in the various corridors, is a general price inflation without energy costs of slightly below 2 %, and therefore within the target corridor pursued by the European Central Bank. This inflation level is used for all costs with the exception of crude oil, bunker oil and petrol prices. The simulations are made in real Euros (reference: 2010), prices for 2015 are therefore discounted by 10 % overall. Because most of the cost components exist on the basis of 2010, and the bills are issued on this basis, the discounting also affects the fuel prices whose figures for 2015 already include the effects of inflation.

3 Crude oil and bunker oil

3.1 Development in crude oil prices

The prices for shipping fuel, the bunker prices, are dependent on the price of crude oil. When a barrel of crude oil cost US $ 3.00 in the 1960s, fuel prices played only a subordinate role in the transport industry. During the oil crises in 1973/74 and 1979/80, i.e. when crude oil prices rose from US $ 3.00 to 9.00, and US $ 10 to 30 respectively, the global economy had to take the problem of fuel costs seriously for the first time. New oil fields in America and the North Sea for instance calmed the markets back down again, and the global economy came to terms with costs ranging between US $ 10 and 20 per barrel right through to the 1990s.

Fig. 3-1: Long-term development in crude oil prices based on annual averages



The oil price strengthened again from 2004 as a result of the China boom, stricter OPEC oil price controls, and speculation. Prices rose accordingly to over US $ 100 per barrel. This meteoric rise did not stop until the onset of the financial and economic crisis. The higher price had a tangible effect on the global economy: with respect to global shipping, these consequences included bunker surcharges, the “slow steaming” of container ships, and the failure of numerous lines and projects involving fast ships.

Fig. 3-2: **Development in crude oil prices since 2008**

Predicting how crude oil prices will change in future is a matter of pure speculation, but it is likely that prices will remain at around the levels seen since 2007 and that a rise exceeding the peak in 2008 is also possible. This forecast is backed up by the following arguments:

- Since reaching its lowest point in the ongoing crisis, the price of crude oil has already risen significantly from around US $ 40 to US $ 80.
- The demand in BRIC countries and other emerging countries is growing.
- Opening up new oil fields is becoming increasingly expensive (because additional production can only come from offshore fields), and also ultimately because oil reserves are finite.

- The recent oil catastrophe in the Gulf of Mexico will make it difficult for the production of oil fields in deep offshore waters to go ahead as planned – resulting in possible delays and higher production costs as a minimum.

It is therefore highly likely that bunker prices will stay at a high level.

3.2 Quality of shipping fuels

Sulphur is a natural constituent of crude oil. Its proportion varies depending on the source of the oil, which means that there are low sulphur and high sulphur crude oil types.

The most frequently used fuel for large diesel ship engines is the heavy bunker oil (heavy fuel oil) which remains behind along with the sulphur when the lighter and cleaner constituents of the crude oil such as petrol, kerosene, diesel etc. have been extracted in petroleum refineries. Shipping became a market for the viscous residues because it is the cheapest form of oil that can be burnt in large diesel engines. Even so, it still needs to be heated up and purified in separators before it can be burnt. Shipping has adapted to these conditions for many years and optimised its engines to cope with this situation.

HFO (heavy fuel oil)

Other names for heavy fuel oil are

- Bunker oil
- Bunker C
- Bunker B
- RFO = residual fuel oil
- IFO = intermediate fuel oil
- MFO = marine fuel oil (trade name)
- HSFO/LSFO (high/low sulphur fuel oil)

Heavy fuel oil is the no longer vaporisable residue from a range of petroleum refinery processes, and contains the heaviest constituents of crude oil. HFO has a high viscosity (300 to 30,000 mm^2/s at 100°C), and has to be mixed with thinners such as kerosene to reach the necessary viscosity for burning. The terms **IFO 380 and IFO 180** refer to the viscosity at 50 °C (pumping temperature). It is heated up to 130 – 140 °C for injection. HFO contains up to 2.5 % non-combustible constituents which are collected in sludge tanks.

	IFO 380	IFO 180
Description	Residual oil max. 380 mm^2/s 2% Distillate	Residual oil max. 180 mm^2/s 12 % Distillate
Density	0,99 kg/L	0,99 kg/L
Flash point	60°C	60°C
Water content	0.5 %	0.5 %
Sulphur	max. 4. 5 %	max. 4. 5 %

MDO (Marine Diesel Oil)

Another name for MDO is Marine Distillate Fuel. MDO is a mixture of different medium distillates such as kerosene, light gas oil or heavy gas oil. There are four qualities in total:

	DMX	**DMA**	**DMB**	DMC
Description	Very light gas oil with good low temperature characteristics almost only for emergency use	Medium gas oil called Marine Gas Oil **(MGO)**	Relatively heavy gas oil called Marine Diesel Oil **(MDO)**	Oil consisting of heavy gas oil, partly blended with residues
Viscosity max.	5.5 mm^2/s	6.0 mm^2/s	11.0 mm^2/sec	14.0 mm^2/sec
Density		max. 0.89 kg/L	max. 0.90 kg/L	max. 0.92 kg/L
Flash point	min. 43°C	min. 60°C	min. 60°C	min. 60°C
Sulphur		max. 1.5 % 0.1 % in EU	max. 2.0 % 1.5 % in EU	max. 4.5 %

This describes the four most important qualities **IFO 380, IFO 180, MDO and MGO**. A feeder operator stated for instance that in 2008 it used in its 35 ships around 2/3 IFO 380 and 1/3 IFO 180 with 1.5 % sulphur contents in each case.

The IMO specifications for SECAs requires the proportion of sulphur by volume in IFO 380 and IFO 180 to be reduced to today's level of 1.5 %. A further reduction to 1 % is to be met by HFO on 1 July 2010 if the HFO is to be used in a SECA.

3.3 IMO and EU stipulations

IMO limited the sulphur content of bunker oil to 4.5 % at the beginning of its efforts to clean up shipping emissions. This measure only had a limited effect because the global average sulphur content in bunker oil was 2.7 % because of the difference in the sulphur contents of crude oil from different sources. Further reductions can be achieved by blending.

The revised stipulations of ANNEX VI to the MARPOL 73/78 convention were adopted in October 2008 and came into force on 1 July 2010. This annex stipulates a reduction in the sulphur content in SOx Emission Control Areas (SECAs) of the Baltic Sea, North Sea and English Channel from 1.5 % to 1 % from July 2010, and down to 0.1 % from 1 January 2015. The maximum sulphur content in other maritime areas is to be reduced from 4.5 % to 3.5 % by 1 January 2012, and down to 0.5 % from the beginning of 2020. The precondition for the latter reduction is that a postponement is possible until the beginning of 2025 if an analysis by an IMO commission of experts in 2018 reveals that not enough fuel with a sulphur content of 0.5 % is available for global shipping in 2020.

Alternatives to reduce the sulphur emissions are allowed with specific mention of scrubbing. However, this technology is not yet fully developed and requires large amounts of space which is not available on every type of ship. There are also doubts that enough verified solutions will be around in five years time. This study therefore assumes that scrubbers will not be a practical alternative because, in addition to the proper functioning of the scrubber in its own right, a solution is also required for the problem of waste disposal.

Shipping has three options available to satisfy the stipulations:

1. Use HSFO alternatively with LSFO or distillates – although this requires a double system of tanks, pipes, etc. (dual fuel operation). This option is valid until 2015.
2. Using distillates (single fuel operation)
3. Using heavy fuel oil combined with flue gas treatment

In addition to the aforementioned regulations, the “EU Sulphur Directive” 2005/33/EC stipulates for all EU ports from 1 January 2010, that all ships docked for more than two hours have to burn fuel with less than 0.1 % sulphur.

Comment: Russia is not a signatory to Annex VI which means that these regulations do not apply to Russian ships and ports.

3.4 Availability of low sulphur bunker oil

The proportion of sulphur in heavy oil depends on the concentration in the crude oil from which it was refined. Sulphur concentrations in sweet crude oils are less than 0.5 %. This means that the sulphur content of heavy oil can be regulated by the choice of crude oil. However, sweet crude oils are not available in adequate quantities, which means that the crude oil must be processed accordingly in a petroleum refinery. The proportion of heavy oil in the products can be reduced further in modern refineries. Crude oil with ~ 0.15 % sulphur usually produces HFO with 0.5 %. This means that high-sulphur crude oils cannot be used to produce HFO with less than 0.5 % sulphur[1]. Crude oils with such low sulphur contents that they can be used to produce HFOs with 0.1 % sulphur are extremely rare. Moreover, such crude oils usually have high paraffin concentrations and are therefore less suitable and are used for refinery purposes.

It is not possible in practise to remove the sulphur from HFO with the methods currently available because the presence of contamination with metals such as vanadium and nickel prevent the use of the same refinery techniques used on lighter fractions – these metals poison the catalysts. Low-sulphur HFO is therefore normally produced from low-sulphur crude oil.

The production of HFO with 0.5 % sulphur is theoretically possible by using the residues from low-sulphur crude oil. However, the vacuum gas oil proportion of the product is already used by the refinery itself and would therefore have to be replaced. In addition, shipping is one of the few markets for the sulphur-rich residual oils from high-sulphur crude oils. This means ultimately that investment to a similar degree is required[2] in refineries to enable either

- sulphur-rich residues to be further treated to produce more HFO with less than 0.5 % sulphur,
- or low-sulphur crude oil is used to produce this HFO and the refineries further treat the undesired sulphur-rich residues again to use them in the refinery.

According to OPEC, the sulphur content in crude oil will rise from today’s 1.2 % to almost 1.4 % by 2020. One can therefore conclude that the difference in price between sweet and sour (sulphur-rich) crude oils will rise. In parallel, the sulphur content in normal HFOs will also either rise or the refineries will have to invest more, which in turn will give rise to more expensive processing.

If the refineries in the regions with bunker stations are not upgraded, the increased demand for low-sulphur fuels would have to be covered by imported oil arriving by tanker. This can give rise to additional energy consumption – varying between regions – combined with high CO_2 emissions and transport costs.

1 SKEMA-study, p.9

2 SKEMA-study after Purvin & Gertz

3.5 Marine engineering aspects

Almost all merchant shipping today is equipped with diesel engines. Steam turbines driven by heavy oil, gas turbines and other types of propulsion play a negligible role – and in the feeder and RoRo shipping in the Baltic, no role at all.

Propulsion using diesel engines is largely configured today in a system involving large diesel engines for the propulsion and smaller diesel generators to generate electricity. Energy needs during the voyages can also be covered by shaft generators, but an auxiliary diesel is usually required at least when the ship is in port so that the main engines can be turned off. According to today's EU legislation, this configuration is used for propulsion and energy generation fuelled by HFO at sea, whilst clean MDO or MGO is used by the ship when it is in port. Previously, many ships were able to use heavy oil for the main engines as well as for the auxiliary diesel engines.

To satisfy the stipulations defined for 2015, it will be necessary in the SECAs for the main engines to also be fuelled by distillates. The technical costs involved are moderate and are estimated in the SKEMA study for instance at €100,000 per ship.

New ships are easy to design to burn distillates alone. Dispensing with two types of oil quality means no dual system of oil tanks and pipes is necessary. Moreover, no more oil pre-heating is required and the number of separators can be reduced. This also means that the volumes of sludge which need to be collected and disposed of are also considerably reduced. However, a shipping company will not build new ships of this type suitable for operation in SECAs, because they cannot be used competitively outside of the SECAs.

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. New injection valves are also needed as a part of the conversion process in this connection.

- Low-sulphur MDO needs special lubricants to improve lubrication and reduce the build-up of deposits. The MDO itself must be treated in this context to enhance its lubrication and antifouling properties. Oil with a higher base number leads to the deposition of calcium ash which can become very hard and accelerate wear and tear. High base numbers must be avoided in oil with less than 1 % sulphur because there is a much higher risk of a sudden significant increase in wear.

- The use of sulphur-rich oils with a low base number can reduce the base number so much that it is incapable of neutralising the acids which are produced, and this can then lead to corrosion. On the other hand, an attempt to counteract the low base number with a higher dose of lubricating oil will lead to excessive lubrication.

- Oil with a low concentration of 0.01 % to 0.2 % sulphur must be used together with lubricating oil with a low base number of 10 to guarantee the necessary alkaline reserves to neutralise sulphur oxides and nitrogen.

The lower sulphur content would make it possible to use catalysts to reduce NO_x levels. This in turn makes it possible to operate at higher combustion temperatures and higher efficiency. Empirical data though indicates that the catalyst raises the CO_2 emissions because of the rise in fuel consumption.

In conclusion, although the sole use of distillates can simplify the equipment needed, the costs for the low-sulphur oil strongly raise the travel costs. Frequently changing from HFO to distillates and the associated matching of fuel and lubricating oils is a highly complex process which requires extreme care. It demands very close co-operation between the ship managers and the bunker suppliers who know their products best, as well as highly trained engine room staff. The failure to satisfy these requirements raises the risk of mechanical shut-downs, mechanical damage, blocked filters, damaged pumps, etc. As a result of the statutory cutting of the sulphur content in California, the number of incidents when ships engines stopped rose to 67 in 2009 compared to the annual average of 23.6 between 2004 and 2008[3]. The stipulations which first came into force on 1 July 2009 are max. 0.5 % sulphur in MDO, and max. 1.5 % sulphur in MGO.[4]

3.6 Development in bunker oil prices

The price for bunker oil is oriented to the markets in Rotterdam, Houston, Fujairah and Singapore, and are quoted in US$/t delivered to a ship. Unlike fuel for land transport, there are only minor differences in price between the ports. Note: crude oil prices are quoted in US $ per barrel, i.e. when oil costs US $ 100 per barrel, a tonne costs around US $ 630.

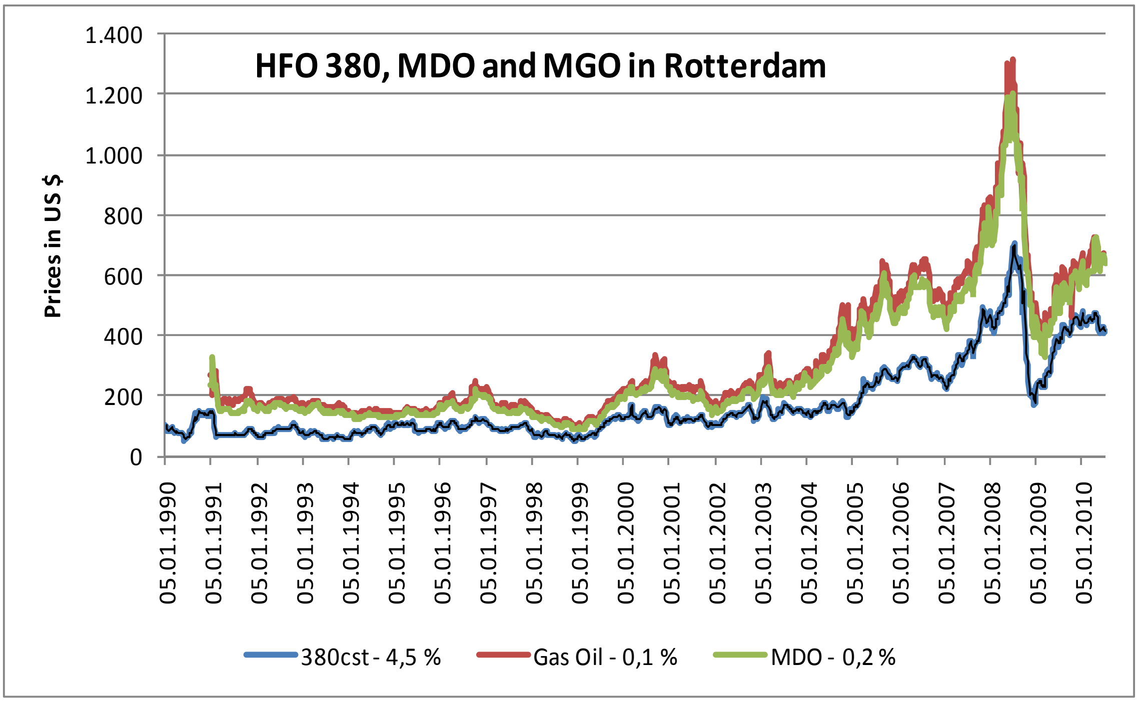
A long-term comparison of the two qualities IFO 380 and MDO not only shows that the prices for both are rising and that the rises and falls are moving in parallel. The most interesting thing in this comparison is the increasing split of the rising trend. Whilst the difference at the beginning of the decade was around US $ 50, it was around US $ 200 to 250 in the middle of the decade. When prices hit their peak in summer 2008, the surcharge for MDO hit US $ 500. The difference declines with decreasing prices. Other comparisons which show the difference in per cent are not very helpful.

The reasons for the difference in prices are not clear. Although the rise in bunker prices naturally reflects the rise in the price of crude oil, it is not possible to demonstrate here whether the tight market was used to raise the surcharge paid for the better qualities, or whether there was actually a shortage of supply of the better qualities.

3 Steffen Kortegaard: “Fuel suppliers have critical role in driving compliancy”, in Marine Log June 2010, p.25

4 www.arb.ca.gov/ports/marinevess/marinevess.htm

Fig. 3-3: Development in bunker prices 1990 to July 2010



Source: ISL 2010 after Clarkson SIN

Examples from various studies

In a study prepared for the **EU Commission**, Purvin & Gertz[5] made the following forecast for the development in the price of shipping fuels.

Tab. 3-1: Shipping fuel prices in Euro/tonne 2009 to 2020

Sulphur content:	**1.5 %**	**1.0 %**	**0.1 %**	**Diff. 1.0->0.1**
2009	167	179	426	247
2010	282	294	492	198
2015	400	412	656	244
2020	425	434	706	272

The figures for 2015 and 2020 cannot be commented on properly here, but those for 2009 and 2010 already proved to be much too low. Moreover, the difference in sulphur

5 Purvin & Gertz: Impacts on the EU Refining Industry & Markets of IMO Specification Changes & Other Measures to Reduce the Sulphur Content of Certain Fuels, 2009

content from 1.5 % to 1.0 % is only valued at Euro 12, with no increase for rising prices.

ECSA:

In its study for ECSA, the University of Antwerp worked out price differences for several oil qualities and made out a large range from 30 % to 250 %. The figures may all be perfectly correct, but they say nothing on their own about the absolute size of the surcharge.

The study also concluded that the difference between normal IFO 380 and LS 380 with a maximum of 1.5 % sulphur is very small, and was only 6 % at the end of 2009 – corresponding to US $ 27. Finally, they forecast a rise in costs of 70 – 90 % for the conversion from 1.5 % to 0.1 %.

The feeder shipping company **Team Lines** concluded that the gap between IFO 380 and MGO between 1995 and 2008 opened from US $ 300 to US $ 590.

TT-Line assumed the following surcharges for low-sulphur oil on 25 June 2008 when the price for IFO 380 (max. 3.5 %) had already reached US $ 635:

Tab. 3-2: Prices in the Antwerp/Hamburg/Copenhagen/Gothenburg range per 25.06.2008

Reducing the sulphur content from	Price surcharge per tonne	Price in US $
3.5 % to 1.5 %	60 US $	695
1.5 % to 1.0 %	50 US $	745
1.0 % to 0.1 %	520 US $	1,155
3.5 % to 0.1 %	**630 US $**	**1,265**

The “**Centre for Maritime Studies**” of the University of Turku assumed in a study produced in 2009 for the Finnish Ministry of Transport (here: Finnish study) that the prices in 2015 would be as follows:

Oil quality :	HFO 1.5 %	Gas oil 0.1 %	Difference
Preis in €/t	271	485	214

The “**Swedish Maritime Administration”** (SMA) based its study[6] on the shift in mode of transport on the following prices which were geared to the figures for October/November 2008 when a price difference of US $ 300 was observed:

[6] Swedish Maritime Administration: Consequences of the IMO’s New Marine Fuel Sulphur Regulations, p. 33

Oil quality	Sulphur content in %	US $ per tonne
MGO	<0.1	662
MGO	<0.2	662
MDO	<0.5	603
LS 180	<1.0	396
LS 380	<1.5	365

A relatively constant difference of US $ 250 to 300 was estimated over a longer period of time.

Current developments

Since 1 July 2010, the time from which HFO with a max sulphur content of 1 % has been stipulated for SECAs, there has been an obligatory increase in the demand for this oil with knock-on effects on the price. “Fox Business” reported that the rise in the surcharge compared to HFO with 3.5 % sulphur was US $ 35 on 1 July compared to US $ 32 one week earlier, and US $ 23 only three weeks previously. There are presumably still supply problems today which have an effect on the price due to the small number of suppliers, and because accidental fires in the refineries in Wilhelmshaven and Lindsey (eastern England) have shut down or restricted production.

“Bunkerworld” reports the following prices in US $ for 500 t in Rotterdam on 16 July 2010:

Quality	IFO 380	IFO 180	MGO	LS 380 1.0 %	LS 180 1.0 %
Price per 16.07.10	428	448	648	466	488
Price per 06.09.10	433	454	657	457	478

The difference between HS and LS in July 2010 was approx. US $ 40 for both IFO 380 and IFO 180. It dropped down to US $ 24 by September. MGO was US $ 200 to 160 more expensive than IFO 180 in July, and US $ 203 to 179 more expensive in September.

Listings for 1.5 % sulphur were suspended at the beginning of July. Prior to this, the prices for LS 180 with 1.5 % dropped from US $ 468 on 28 June to US $ 438 on 2 July.

3.7 Effects on the refineries

The increased demand for low-sulphur oil will have significant consequences for the refineries. These plants are designed for certain proportions of a range of products. If these ratios need to be changed, they have to undertake a large amount of investment to further process specific products.

Diesel fuel is currently in short supply in Europe because it enjoys tax benefits compared to petrol, and therefore more and more vehicles are being supplied with diesel engines. As a result, European petrol is exported to North America and diesel fuel is imported from North America. When the shipping industry requires more low-sulphur oil from 2015, this will only add to this imbalance further and lead to the import of more diesel. This situation would be exacerbated further if the Mediterranean and the coast of the USA were also declared SECAs.

Mixing residual oils with distillates can reduce the sulphur content down to a minimum of 0.5 %.

The alternative is: investment of around Euro 13 billion in the refineries, or Euro 18 billion in total if the Mediterranean is classified as a SECA[7]. The refineries will probably wait until shortly before 2015 before investing in new upgrades because they cannot be certain that there will be a rise in demand in the event that exhaust gas treatment is authorised as an alternative to low-sulphur oil.

Purvin & Gertz (2009) calculated that the more intense refinery production in Europe will lead to an increase in CO_2 emissions because of the higher energy consumption by the refineries – a figure which roughly corresponds to the global emissions by shipping.[8]

Preem AB, the largest Swedish refinery group, assumes[9], that the effort involved to desulphurise HFO down to a level of 0.1 % will require excessively high investments, but that the investment in the more intensive use of residual oil to extract distillates is actually lower and therefore has better prospects. They also point out the higher CO_2 emissions involved in desulphurising HFO. Oil with higher sulphur contents could also be exported to regions where higher sulphur concentrations are still permitted, or used within the country in power stations.

Preem AB estimates that the “Coker” required for the further processing of heavy oil will pay for itself within four to five years, and that refineries will therefore select this method. The alternatives, however, are the possibilities for using gas propulsion systems or to treat the exhaust gas on the ships.

Foster Wheeler, a refinery engineering specialist, assumes that the price for low-sulphur HFO will have to rise to the level of diesel to make production economically attractive.[10]

The process for extracting low-sulphur HFO from refinery residues is highly environmentally relevant – not only because of the CO_2 emissions. The problem is the large amount of energy required in the refinery to further process the residues, i.e. energy is consumed to generate a different energy carrier for a specific application.

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7 “Refineries could face $18bn investment bill”, Lloyd’s List, ~1.6.2010

8 “Refineries could face $18bn investment bill”, Lloyd’s List, ~1.6.2010

9 Swedish Maritime Administration: Consequences of the IMO’s New Marine Fuel Sulphur Regulations, page 21 ff

10 Foster Wheeler, Presentation 2008

3.8 Price forecast

Reliably forecasting the price of low-sulphur fuels is just as difficult as predicting the future price of crude oil.

However, the brief of this study requires assumptions to be made on the future costs of HFO with 3.5 % sulphur, and the price difference to HFO with 1 %, and MGO with 0.1 %. The risks involved in estimating the price require a corridor to be used to cover a range of price developments.

The following table shows the prices for the conventional fuels IFO 380 and IFO 180 with normal sulphur contents; the IFOs with only 1 % sulphur which have to be used in SECAs since the middle of 2010; and gas oil with 0.1 % sulphur that has to be used from 2015. These current prices can be viewed in the internet for instance at “Bunkerworld”.

The central column shows the current price for mid July 2010 (slightly rounded). The “minimal” column shows the figures quoted for a few weeks in the middle of the crisis in winter 2008/09 when demand for transport capacities and therefore bunker consumption slumped to an interim low. These prices show the possible range of downward fluctuation – although a return to these levels over a longer period of time is considered to be very unlikely.

Tab. 3-3: Bunker price development assumptions for the cost calculations in US $

Price:	Minimum	Today	Corridor 2015
IFO 380	200	430	500 - 700
IFO 180	220	450	525 - 740
IFO 380 1.0 %	-	470	540 - 740
IFO 180 1.0 %	-	490	565 - 780
IFO 380 0.5 %	-	495	565 - 785
IFO 180 0.5 %	-	515	595 - 825
MGO 0.1 %	400	650	850 – 1,300

Comment: The price differences valid today are maintained in the corridors (2015) for the better oil qualities with lower sulphur contents. It is assumed, however, that there will by a trend for this difference to increase as demand shifts in future – this is why US $ 20 have been added to the upper limit of the corridor.

The last column “Corridor 2015” shows the range in prices assumed in this study. The lower limit of the corridor 2015 will most likely lie above today’s prices because of the general upward trend in oil and bunker prices. The upper limit is marked by prices as seen at the end of the boom in 2008 and shortly before the financial and economic crisis. They were probably also driven strongly by speculation, but were actually demanded, and the price forecast therefore does not exceed the highest quotes seen in the past.

The price difference between IFO 380 and MGO in 2015 is accordingly between 70 % and 86 %, which corresponds for instance with the ECSA assumptions.

The quality-related surcharge between IFO 380 1.0 % and MGO 0.1 % is therefore US $ 310 to 560 per tonne fuel according to Table 3-3. For a modern RoRo ferry operating on a medium-long route, this would give rise to extra costs of US $ 3.3 to 6.0 million per year.

Fig. 3-4: Operating costs of a German RoPax ferry at different oil prices and using sulphur 0.1% quality in €/p.a.

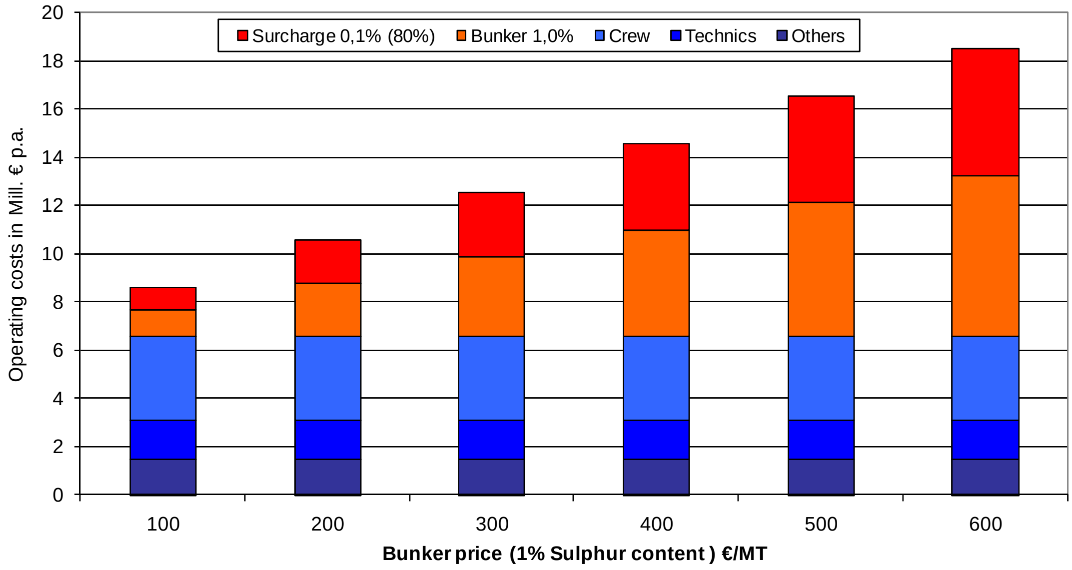


Fig. 3-4 clearly shows the impact of the rise in oil prices on the operating costs of a German RoPax ship. This also shows particularly clearly the rapidly rising proportion of fuel costs in the overall operating costs dependent on the price of bunker oil – which is exacerbated further by the extra costs for MGO 0.1 %. Please note again in this context that the prices for HFO and distillates not only rise in line with an increase in the price of crude oil, but also because the difference between the prices of HFO and distillates increases as the overall price rises. This aspect has already been discussed in Chapter 3.6 Paragraph 2.

4 RoRo-shipping

The Baltic region in Europe in particular is strongly characterised by RoRo shipping. More than 250 ferry and RoRo services operate within or into the Baltic Sea – many of them with capacities for trucks and trailers. These services include a large number of local short-distance services within Denmark, Estonia, Finland, etc., (often only carrying passengers and cars, or at best only suitable for mobile homes and delivery vans. In addition, in the North Sea or from the North Sea in the direction of the Baltic Sea and the Bay of Biscay, there are at least another 20 services with RoRo-capable ships, of which some primarily only transport new vehicles whilst others also have container capacities.

More than 450 ships of various sizes and types are used in total on these almost 280 services/routes. Around 6 million trucks and trailers are estimated to have been transported by these services in 2008 (in addition to passengers, cars and buses).[11] A significant proportion of these services starts or ends in one of the German Baltic ports. The routes and corridors starting from Germany in particular are exposed to considerable competition. On the one hand, there is undoubtedly a certain amount of substitutability between some of the lines, on the other hand, the direct land connections running parallel to these routes, which may also include short or ultra-short sea journeys and fixed crossings, also represent a viable alternative for much of this traffic.

The following first describes the most important corridors for Germany, before presenting the ships used on these routes and their cost structures, and finally analysing the effects of the expected shifts in transport modes.

4.1 Corridors

After modern ferry shipping was established in the Baltic in the 1960s, competition became more and more intense with the operation of increasingly large and better ships. This was followed by a period of consolidation which often ended with only one ferry service on one route. Nevertheless, several important corridors can be defined in the Baltic Sea. And even when lines operating between the same ports have often merged or have forced out the competition, there are hardly any connections which are able to exploit their position by excessive fares because even if there is no direct competitor, there are usually often alternatives – as a shown in the following review:

4.1.1 Germany - Denmark

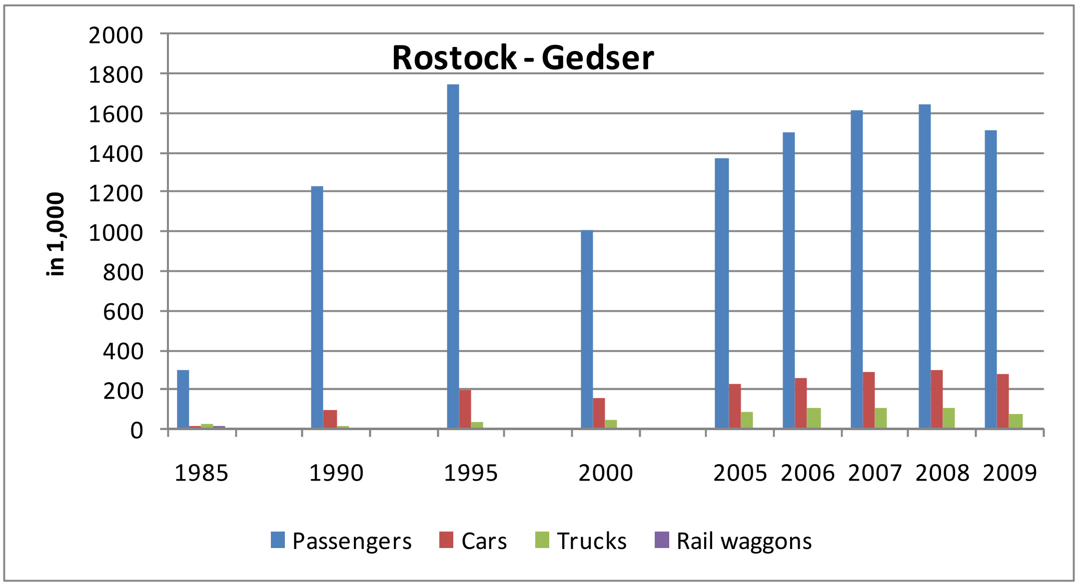
Germany and Denmark are not only joined up by land connections via Schleswig-Holstein: the route via Jutland is also a detour to Denmark’s capital city Copenhagen

[11] These figures were derived from the evaluation of the details of the “ShipPax Market 09”.

and originally required short ferry journeys to cross the Little and Great Belt. The direct route from Berlin to Copenhagen has been via Warnemünde – Gedser since 1903. The connection with West Germany was strengthened after 1945, which led to the development of the only 19 km Puttgarden – Rödby Havn route.

Up until the early 1990s, the "Europa Linien" shipping company operating on the Travemünde-Gedser route was very popular. The German port was relocated to Rostock after German reunification which revived business in competition with the railway ferry. In 1995, Deutsche Bahn relocated its German port from Warnemünde to Rostock and suspended the transport of railway carriages. "Europa Linien" shut down its business later on.

Fig. 4-1: Change in traffic volumes on the Rostock-Gedser line



Source: compiled by ISL from different sources[12]

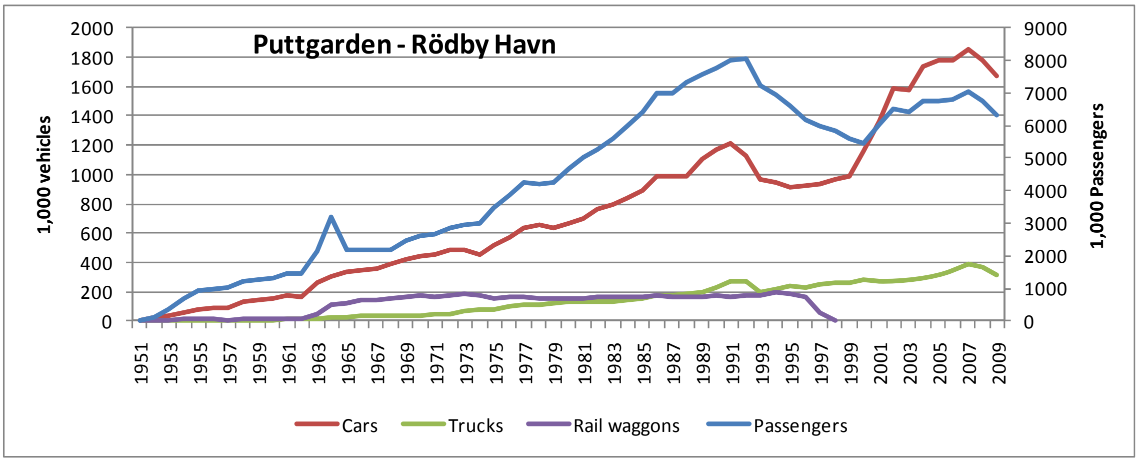
Holiday traffic could only really develop properly after the opening of the inner-German border and was particularly strong in 1990 because of the sudden freedom to travel of the former citizens of the GDR. Truck transport now exceeds 100,000 per year and the capacities will be increased by two new ferries ordered by Scandlines in recent months.

The main line today is the "Vogelfluglinie" Puttgarden – Rödby Havn, which replaced the temporary Großenbrode – Gedser connection in 1963. With up to eight million passengers per year, this is the only line which comes close to matching the main connections such as Store Belt and Öresund – although the latter has already become a fixed connection. The slump in the 1990s is attributable to the shift in traffic to

[12] All of the figures in Chapter 4.1 have been prepared by ISL and are based on the "Market" data collection of "ShipPax" in Sweden on the shipping companies, as well as on "Samferdsel" from "Danmarks Statistik".

Rostock. The fact that the abolition of duty free sales in 1999 did not affect this line even more strongly is attributable to the border shop in Puttgarden and the associated shopping traffic. Holiday traffic has been stagnant for many years and is stimulated on the Vogelfluglinie with 3-hour tickets and similar cheap offers to boost shopping traffic in a way which is hardly possible on the longer ferry routes.

Fig. 4-2: Development in traffic volumes on the Puttgarden-Rödby Havn line



Source: Compiled by ISL from different sources

Road freight traffic has risen continuously despite the changes in passenger traffic, and had already reached almost 400,000 units p.a. before the crisis. Rail freight traffic was relocated to the fixed Belt connection after its opening in 1997 to avoid the complicated shunting of long freight trains.

This German-Danish corridor is of major importance to the ferry business in the western Baltic Sea. However, because the line is one of the shortest, it will not be affected as much by the rise in bunker costs. It could even be one of the winners when traffic shifts from longer to shorter ferry lines. On the other hand, however, these lines are threatened by the land route (Denmark-transit) and fixed crossings.

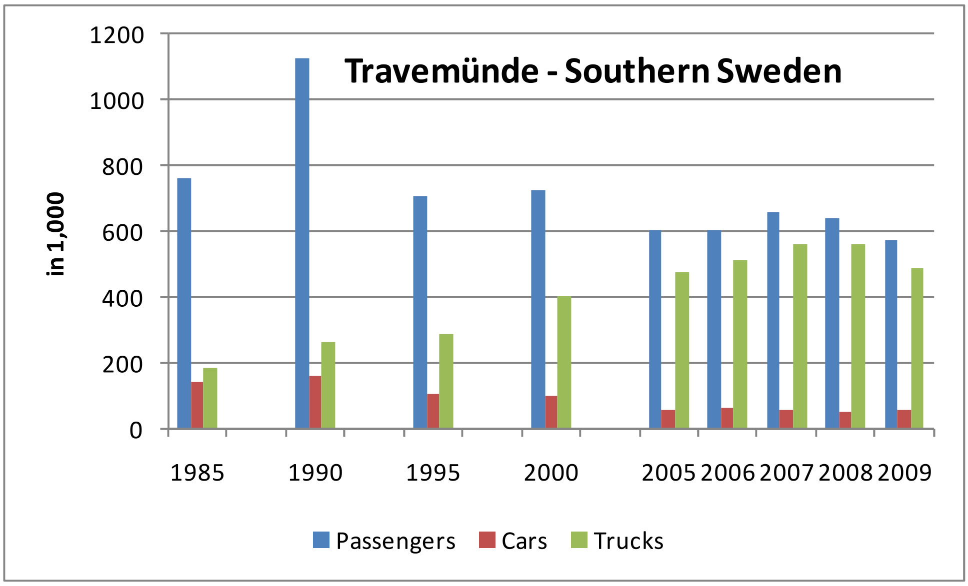
4.1.2 Germany – South Sweden

The Germany – Denmark corridor is an alternative to the route to South Sweden because it is possible to cross very quickly from the Danish island of Seeland (Sjaelland) to Sweden using either the fixed Copenhagen – Malmö connection or the more northern Helsingör – Helsingborg ferry route. The completion of the bridge to Malmö primarily had an impact on passenger traffic but less on freight traffic.

Several direct connections to South Sweden have existed since the 1960s from Lübeck-Travemünde to Trelleborg and to the neighbouring Malmö, and more rarely to Helsingborg. It enables people to rest overnight on board, which with a travel time of around eight hours, provides an ideal break for long distance truck drivers even as the journey continues. Since the 1990s, the routes located in the former GDR were able to reassert their positions. In other words, the shorter distances from Rostock to Trelleborg and Saßnitz to Trelleborg – combined with lower fares – enabled these two routes to regain market shares from Travemünde. The hinterland and the potential of the Saßnitz – Trelleborg line is restricted to the east by the neighbouring Swinemünde – Ystad route.

These two corridors play a key role because South Sweden is not only the bridgehead to the southern part of the country, but also to the whole west coast all the way up to Norway, as well as the east coast, greater Stockholm area and the ferries to Finland.

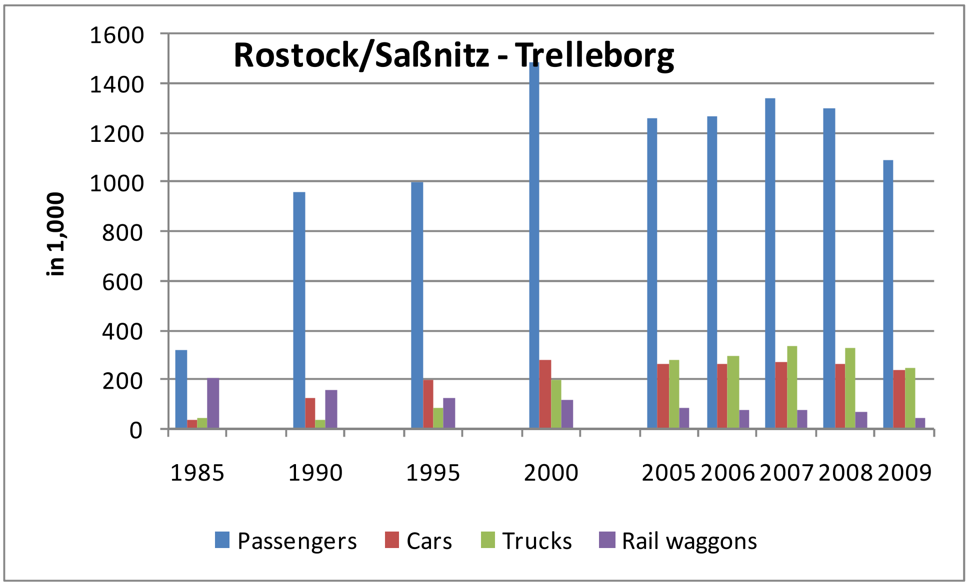
Fig. 4-3: Development in traffic volumes on the Travemünde-South Sweden route



Source: Compiled by ISL from dfferent sources

Passenger traffic on the lines from Travemünde have shown no growth since 1990. The opposite is true for truck traffic which doubled to 564,000 vehicles by 2008. This corresponds to more than 1,500 trucks per day, including weekends. Passenger traffic already shifted to Rostock and Saßnitz in the 1990s with the improvement of the road conditions in Mecklenburg-Vorpommern (Motorway A 20). This is because the seasonal peaks can be coped with more easily thanks to the far more frequent departures from these ports, and the greater capacities. Railway traffic is still subordinate to road traffic, and sunk from around 200,000 freight cars in 1985 to less than 50,000 last year.

Fig. 4-4: Development of traffic volumes on the Rostock/Saßnitz-Trelleborg routes



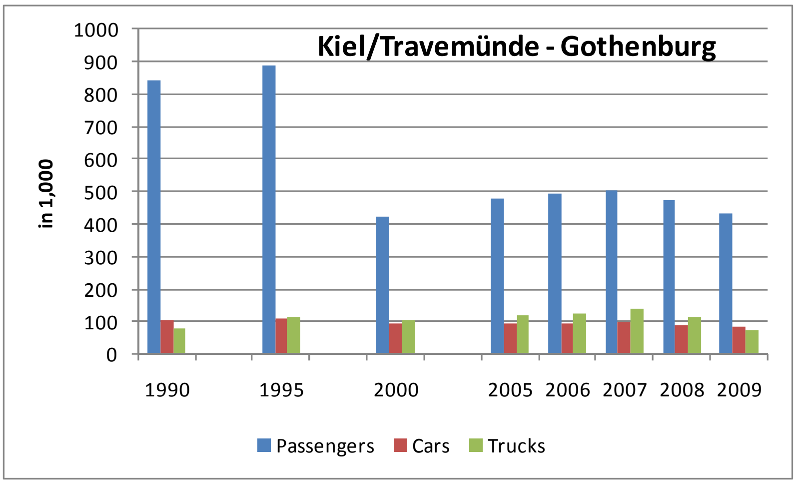
Source: Compiled by ISL from different sources

4.1.3 Germany – West Sweden (Norway)

The direct connection to West Sweden has existed since 1967 in the form of the Kiel – Gothenburg line. With its afternoon departure and morning arrival, it is comfortable for passenger traffic and cuts out a long overland journey for freight traffic. Nevertheless, the German-Danish lines and the route via Jutland with the strongly frequented Fredirikshavn – Gothenburg ferry remain strong competitors.

In Germany, there were two direct routes to Gothenburg for several decades, both operated by Stena Line. The first transported passengers from Kiel, and the second from Travemünde was exclusively used for freight. The last departures from Travemünde took place at the end of August 2010, and the route was merged with the Kiel – Gothenburg line. This change was instigated by the swap of ships in the shipping company's route network to give Kiel RoPax ships with much higher capacities, so that it can also take over the traffic previously shipped via Travemünde. Passenger transport on the relatively long route from Kiel has declined due in part to the abolition of duty free sales, cheaper air fares and the fixed Belt crossing. The dramatic decline in passenger numbers on the Kiel – Gothenburg route is also attributable, however, to the conversion of the ships as a consequence of the scrapping of duty free sales, which reduced Pax capacities and made more room for freight.

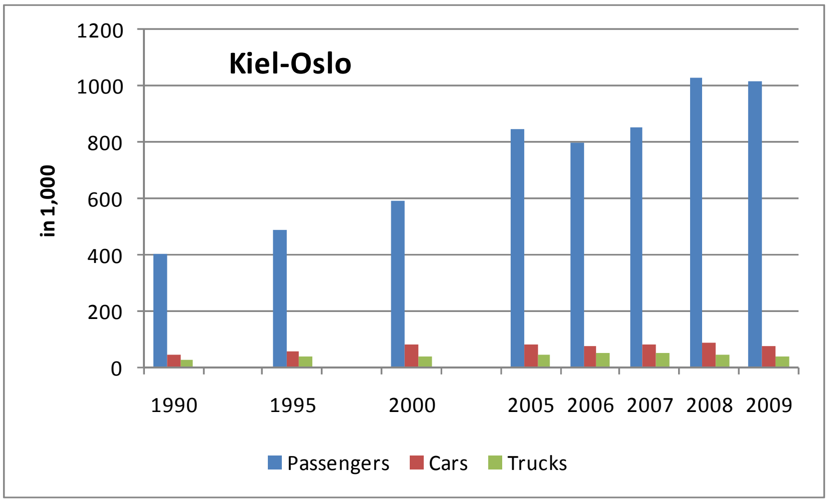
Fig. 4-5: Development in traffic volumes on the Kiel/Travemünde-Gothenburg route



Source: Compiled by ISL from different sources

It is also possible to travel directly to Norway from Kiel. The line has existed for almost 50 years, and is operated by easily the largest ferries in the world – which also boast a cruise liner-type standard. The journey lasts less than 24 hours and is as popular amongst German tourists and short-break holidaymakers as it is with Norwegian shopping tourists. Because Norway is not part of the EU, it can still offer duty free sales. The ferry company charted a different course and promoted the passenger traffic. The passenger numbers in the statistics clearly show the commissioning of two large ships in 2004 and 2007.

Fig. 4-6: Development in traffic volumes on the Kiel-Oslo line



Source: Compiled by ISL from different sources

Freight transport, however, often uses shorter routes: either via Sweden, or via Jutland and the shorter ferries between Northern Denmark and South Norway. Because of the smaller proportion of freight in the overall income from this line, calculating the effects of the higher bunker costs is more difficult than for those lines with subordinate passenger traffic.

Fig. 4-7: Map of the Baltic Sea ports

Source: ISL

4.1.4 Germany - Finland

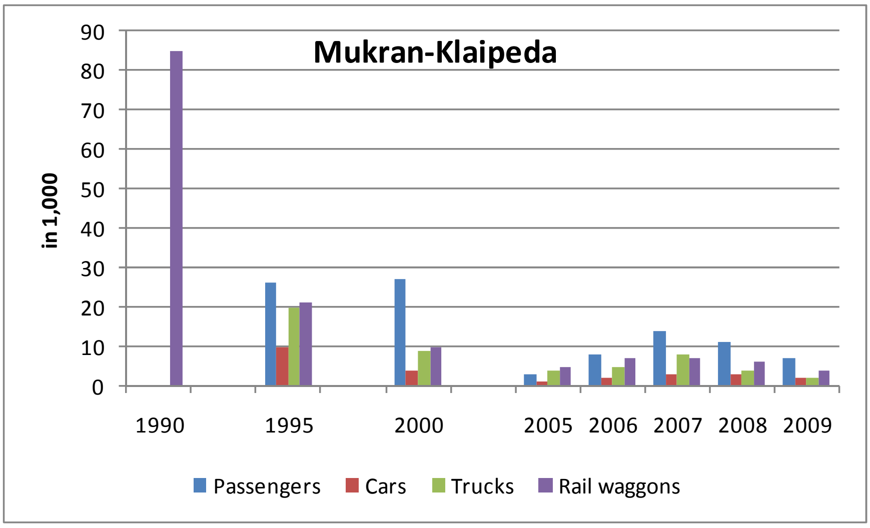
RoPax ships operate on the main routes such as Lübeck – Helsinki. With their capacities of 4,200 m lane metres, and 25 knots speed, they are amongst the most efficient in the world. They can carry up to 500 passengers – which is an advance on the preceding generation of ships, but less than the 1960s when four ferries guaranteed daily departures. From 1977, "Finnlines" attempted to make the journey more attractive by launching its FINNJET gas turbine ferry. With speeds of over 30 Kn, it reached Helsinki in 23 hours, but was too expensive to operate economically. Numerous attempts to make the ship more profitable – including lower speeds with additional diesel engines, or relocating to other ports – failed to produce any convincing results. Because of its length, and good air connections, the route is almost impossible to operate profitably. Regular passenger transport is only feasible in combination with freight traffic. Rostock was also incorporated in this corridor in 1990.

Unlike transit traffic through Sweden, the German-Finland direct shipping traffic has continuously strengthened its position. It is clearly dominated today by freight transport, particularly the transport of forest products from the north. Transporting these products is handled by special RoRo freighters which not only dock in the ferry ports in the south and south-west of Finland, but also call on special terminals further north in the Gulf of Bothnia on the Finnish as well as on the Swedish side. Large fast RoPax ships can only compensate for their higher bunker costs by their higher loading capacities. They will be particularly strongly affected by the increases in bunker prices.

4.1.5 Germany – Russia – Baltic

Even as ferry traffic with Scandinavia and Finland was being developed, the traffic with the Soviet Union (SU) remained very modest. Lithuania, Latvia and Estonia were parts of the SU. The rail ferry route from Rügen to Lithuania which opened in 1986 could have given rise to a significant boost within this political framework, had it not been launched so late.

Fig. 4-8: Development of traffic volumes on the Mukran-Klaipeda line

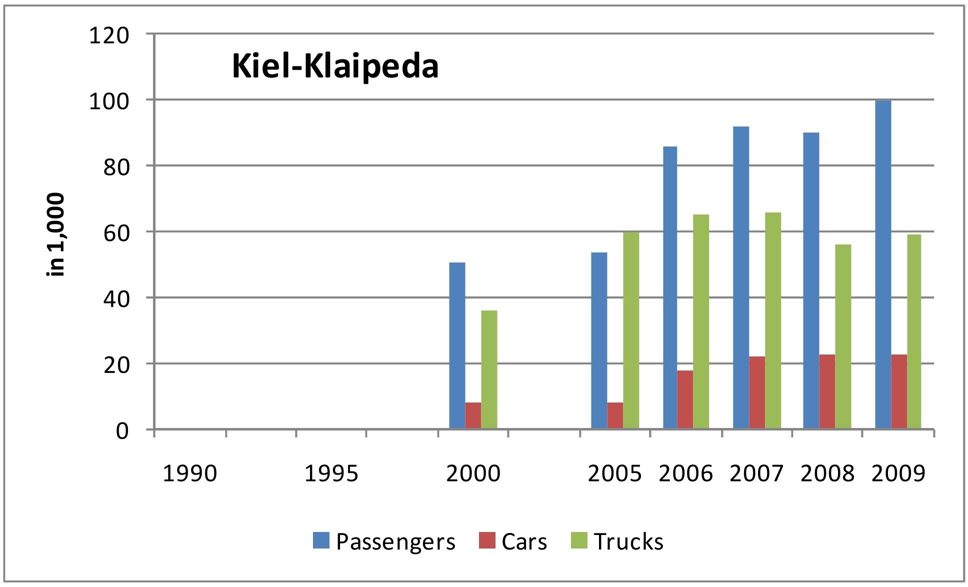


Source: Compiled by ISL from different sources

Today, only one ferry plies the route which was conceived for six units. The former state-owned railway freight traffic has almost completely collapsed; and road traffic has only developed moderately since the conversion of the ferries because the line runs parallel to the coast and is too short for a general shift of transport from land to sea. The more recent alternative via Kiel for traffic with West Germany has more promise.

Numerous new lines were established to Klaipeda, Liepaja, Ventspils, Riga and Tallinn after the Baltic republics regained their independence. The frequent economic ups and downs in these states, as well as the large Russian hinterland, led to the ultimate failure of many of these new lines. In many cases, the ships were also unsuitable because launching the lines did not initially justify the construction of optimal new ships. Only two shipping companies were able to stay in business on this line in the long term thanks to their financial muscle: DFDS from Denmark, and Scandlines. The DFDS line Kiel – Kleipeda is the most successful because it is continuously available.

Fig. 4-9: Development of traffic volumes on the Kiel-Klaipeda line



Source: Compiled by ISL from different sources

4.1.6 Overall development

There is no specific reference in each of the corridors discussed above to the serious impact of the financial and economic crisis on ferry traffic with and within Scandinavia which has continued since autumn 2008. The effects on ferry shipping with Southern and Western Sweden cannot be ignored. However, there are routes and regions which can boast growth despite the crisis, or have at least not suffered so strongly. The best example is the important Helsinki – Tallinn connection where there has been no decline in 2009. The shift of direct sea transport from Finland – Poland / Eastern Germany on to the land route through the Baltic could explain why the negative development in Estonia's GDP did not have a more significant impact on the ferry statistics.

Now that global sea trade has again recovered strongly, and could again be setting new records for container shipping by 2011, it can be assumed that ferry transport in the Baltic Sea will again enjoy an upswing. Encouraging results have again been reported in May 2010 compared to May 2009:

Tab. 4-1: Changes in volumes in May 2010 compared to May 2009

Line	Passengers	Trucks
Kiel - Klaipeda	28 %	36 %
Kiel - Oslo	11 %	6 %
Kiel - Gothenburg	11 %	20 %
Puttgarden – Rödby Havn	2 %	13 %
Rostock/Saßnitz -Trelleborg	-3.5 %	14 %

Source: Compiled by ISL from different sources

The eastern Baltic states from Poland to Lithuania, Latvia and Estonia to Russia, have already participated in the ferry traffic for almost two decades, but the state of their economic development and the small number of vehicles stills allows a lot of room for additional demand in future.

The corridor into the Baltic is particularly sensitive to changes in costs because it is in competition with the land route via Poland. The previous lines can only survive by combining income from passenger and freight transport – both restricted by the low volumes.

4.2 Ships

A range of ships are currently operated on the various routes. The rules of open market competition mean that it is still possible for old and slow ships to be operated successfully in the Baltic Sea alongside ultra-modern large and fast ships. The conditions are changing however in the light of the rising bunker prices. Normally, large ships have lower costs per cargo unit. Nevertheless, the fact that there are large and small ships reflects the transport demand on each of the routes, as well as on the situation in the ports. Faster ships are more attractive, but slower speeds can also support an attractive timetable on shorter routes. Small and slower ships only have a fraction of the bunker consumption of larger and faster ships. When these smaller ships are also old, i.e. only have to carry low capital costs or depreciation costs, they can still operate more cheaply per cargo unit.

Taking all of these possibilities into consideration is beyond the brief of this study, which is why reference ships (type ships) have been selected for each corridor to provide a good representation of the actual fleet operating today. Taking into consideration all the separate ships currently operating also makes no sense because the study looks at a period from 2015 when some of today's older ships will no longer be in service. The ships change almost annually on some of the routes because larger shipping companies optimise their route networks by swapping their ships, and because new operators or ships enter the market. Very good information bases are available for the selected type ships so that the calculated costs are suitable for drawing reliable conclusions.

The following table summarises the corridors with the associated routes and services, as well as the ships calculated to operate on these corridors:

Tab. 4-2: Analysed and calculated corridors

	Corridor	Routes	Route alternatives	Reference ships used to calcualte consumption
1	German Baltic Sea ports - Western Sweden	Kiel-Gothenburg	Travemünde-Southern Sweden; Road route via Belt and Sound; Fredrikshavn-Gothenburg	STENA HOLLANDICA
2	German Baltic Sea ports - Norway	Kiel-Oslo	via Sweden, via Denmark and Skagerrak; via Frederikshavn-Gothenburg	COLOR FANTASY
3	German Baltic Sea ports - Southern Sweden	Travem.-Trelleborg Travem.-Malmö Rostock-Trelleborg Rostock-Trelleborg	Puttgarden-Rödby and Denmark Sassnitz-Trelleborg, Gedser-Rostock and Denmark	ROBIN HOOD; FINNEAGLE
4	German Baltic Sea ports - Finland	Lübeck-Finnland* Lübeck-Hanko Rostock-Helsinki	Road route through Sweden; Stockholm-Turku Road route through Poland using the Tallinn-Hels. ferry-connection	FINNSTAR; TIMCA; URD;
5	German Baltic Sea ports - Russia	Kiel-St.Petersburg Lübeck-Hamina-St.P. Lübeck-Sass.-St.P.	Road route through Germany und Poland	PAULINE RUSS; TRANSLUBECA;
6	German Baltic Sea ports - Baltics	Kiel-Klaipeda Rostock-Ventspils	Road route through Germany und Poland	LISCO GLORIA; URD;
7	Belgium - Western Sweden	Gent-Gothenburg Zeebrügge-Gothenburg	Road route duch Germany und Denmark	TOR MAGNOLIA; SCHIEBORG
		* Rauma/Turku/Hels./Kotka		
	Route alternatives			
8	alternative to routes no. 1, 2, 3	Frederiksh.-Gothenbur Puttgarden-Rödby Helsingör-H'borg Rostock-Gedser Sassnitz-Trelleborg	Road route via Belt and Sound Road route via Belt and Sound via Sound brindge Puttgarden-Rödby Rostock-Trelleborg	STENA JUTLANDICA; DEUTSCHLAND; HAMLET; SASSNITZ

Source: ISL

Almost 1.9 million trailers/trucks were transported in 2008 solely on the routes within the corridors presented here. In addition, in 2008 these routes also transported 24,000 railway wagons, more than 260,000 standard container units (TEU), 21.6 million passengers, as well as 4.4 million cars. The figures for 2009 were down as a result of the crisis but – as also seen in many other shipping markets – traffic volumes have recovered across a broad front in 2010, and it can be assumed that the losses in 2008 will be compensated for in some cases by 2011, and that the growth trend will then continue.

Because detailed cost structures are not available for each of the ships, the current proportion of fuel costs within the overall costs per journey was determined on the basis of the existing technical information and using knowledge on the relationships and structures of shipping costs for each of the corridors. The results of these calculations are shown in the following table:

Tab. 4-3: Proportion of fuel costs of sea transport costs on the Baltic Sea ferry / RoRo shipping corridors

	Price of bunker fuel IFO	Price of bunker fuel MGO	Corridor: German Baltic Sea ports - Western Sweden/Norway	German Baltic Sea ports - Southern Sweden	German Baltic Sea ports - Finland	German Baltic Sea ports - Russia/Baltics	Belgium - Western Sweden	Short routes
Share of fuel costs in total sea transport costs*	$ 450	$ 650	16%	24%	39%	32%	32%	22%

* in 2010 prices

As expected, fuel costs are relatively high on many of the corridors for ferry and RoRo shipping. In addition to the fact that the fuel costs today are around five times higher than they were in the 1990s, another of the reasons is also the relatively high speed. Ship speeds have risen with the size of the ships because the necessary propulsion performance per cargo unit shrinks in parallel. However, speeds of 25 kn and above for conventional ships are well above the average, and may be attributable to timetable optimisation strategies. The proportion of fuel costs here is suppressed by the relatively high capital costs of the expensive ships, and the high personnel cost proportions, which may rise to very high cost ratios on routes carrying a large number of passengers. The longer the route, the higher the tendency for the bunker cost proportion to rise because of the increasing proportion of time at sea and/or relatively lower impact of port costs during a round trip.

A calculation problem with ferry and RoRo shipping is the fact that they often not only load trucks and trailers, but also usually a mixture of freight and passengers, usually also in combination with cars and caravans etc. Different cost structures are also derived particularly because of the different proportions and significance of passengers. For instance, the Colour Fantasy is used on the German – West Sweden/Norway corridor: passenger transport has the highest priority on this route so that the volume of passengers on board is reflected in the personnel cost block – which is of considerable significance – alongside the depreciation and tied-up capital costs because of the design and interior of the ships. At the same time, the proportion of fuel costs is lower accordingly.

If it is hardly feasible to make a valid allocation of the costs – and particularly the fuel costs – to individual cargo units such as trucks, trailers, passengers, cars, caravans, etc., it is also not possible to make any accurate assignment on the basis of fares. A percentage was therefore estimated on the basis of the ratio of passengers to cargo units (trucks, trailers, TEUs), and this percentage is applied to the total round trip costs borne by the cargo. These are high proportions of 85 % to 100 % in most cases. The proportion is lower on some routes as shown in detail in the following table.

However, the shipping companies unanimously agree that the competitive situation and the different demand-motivation will hardly make it possible to pass on the additional costs from the bunker block to the passengers. This means that the cargo (truck, trailer) will have to bear most of these additional costs. This assessment would apply in most cases because the cargo is responsible for most of the costs anyway on most of the calculated routes and corridors. If the passenger transport numbers are also of very minor significance in terms of costs (also because of the lower amount of space required per passenger), it can then be assumed that they also only play a minor role in the earnings. A smaller proportion of the earnings, even with proportional distribution, also means a smaller proportion of the additional costs. Moreover, the operators in general consider passenger volumes to be more elastic with respect to price increases, and that the cargo will therefore have to bear an over proportional share of the additional costs and/or the associated price rises.

This also ignores the fact that the ferry lines only publish an overall figure for “Pax” – in other words, the pax figures also include the truck drivers and co-drivers. The drivers do not have to pay for their passage and therefore reduce the number of paying passengers. Charges are often made for co-drivers but this income cannot be assigned to passengers in this case but rather to the freight earnings. This shifts the assignment of costs further in the direction of the cargo.

The following assumption structure arises for the individual routes in the analysed corridors taking into consideration the significance of the cargo for each route and the elasticity:

Tab. 4-4: Estimated proportion of the total costs (per round trip) assigned to the cargo and/or additional costs arising from an increase in the price of fuel

Corridor	Routes	Ship	est. no. of trailers/FEUs per roundtrip	costs attributable to/borne by trailers/trucks/ FEUs today	share of additional costs to be borne by the cargo
German Baltic Sea ports - Western Sweden	Kiel-Gothenburg	STENA HOLLANDICA	340	40%	60%
German Baltic Sea ports - Norway	Kiel-Oslo	COLOR FANTASY	120	17%	25%
German Baltic Sea ports - Southern Sweden	Travem.-Trelleborg	ROBIN HOOD	160	80%	100%
	Travem.-Malmö	FINNEAGLE	200	95%	100%
	Rostock-Trelleborg	ROBIN HOOD	100	80%	100%
German Baltic Sea ports - Finland	Lübeck-Finnland*	FINNSTAR	320	95%	100%
	Lübeck-Hanko	TIMCA	280	100%	100%
	Rostock-Helsinki	SUPERFAST VII	120	35%	45%
German Baltic Sea ports - Russia	Kiel-St.Petersburg	TRANSLUBECA	190	100%	100%
	Lübeck-Hamina-St.P.	PAULINE RUSS	140	100%	100%
	Lübeck-Sass.-St.P.	TRANSLUBECA	190	100%	100%
German Baltic Sea ports - Baltics	Kiel-Klaipeda	LISCO GLORIA	180	80%	95%
	Rostock-Ventspils	URD	140	80%	100%
Belgium - Western Sweden	Gent-Gothenburg	TOR MAGNOLIA	250	100%	100%
	Zeebrügge-Gothenburg	SCHIEBORG	120	100%	100%

* Rauma/Turku/Hels./Kotka

Route alternatives

alternative to routes no. 1, 2, 3	Frederiksh.-Gothenburg	STENA JUTLANDICA	70	50%	65%
	Puttgarden-Rödby	DEUTSCHLAND	20	30%	40%
	Helsingör-H'borg	HAMLET	10	30%	50%
	Sassnitz-Trelleborg	SASSNITZ	20	30%	40%

The table shows the following: in the “German Baltic ports – Southern Sweden” corridor, the “Robin Hood” is assigned to the “Travemünde-Trelleborg” route as reference ship. In the starting situation, it is assumed that the cargo (described here as a trailer/truck/FEU) will have to bear around 80 % of the costs on the basis of the transport figures. This would also mean that the earnings from the freight business also account for this proportion of the total earnings (or should), and that this cost ratio is also reflected in the relevant fares for the customers.

Because of the higher price elasticity of the passenger flows, a high proportion of cargo, and the already high costs per cargo unit, it is assumed that the cargo in this case would have to bear up to 100 % of the additional costs associated with the SECA stipulations.

4.3 Changes in costs caused by the SECA regulations

The effects of the SECA regulations should be determined for each of the corridors. This involves doing calculations for each section of the segmented transport chains, and subsequently compiling each of these sections. The effects of the SECA regulations are primarily expected to have an impact on the sea routes, but the chains have to be considered individually because of the fluctuating proportion of hinterland and foreland transport which varies according to each source and target region.

4.3.1 Ship-bound route section

The costs for sea transport (apart from the expected increases in the fuel costs) are a constant parameter in the corridors independent of the preceding transport and subsequent transport on the land side of the transport chain. The detailed calculations for all of the services described here (with the associated cost structures) are done for three different cases: For the reference case, every service was calculated with today's cost structures and a general rise in fuel prices up to 2015. The results were summarised as average costs per trailer in each of the corridors.

The rise in fuel costs for the sea leg was then calculated using fuel with a sulphur content of 0.1% from 2015, but was calculated for two different price scenarios in line with the assumptions in Chapter 3. The upper limit here was assumed to be around US $ 720 (IFO) and US $ 1,300 (MGO); in the lowest case, around US $ 515 (IFO) and US $ 850 (MGO) were assumed. These prices already incorporate the general rise in the price of oil as well as inflation in the years to come. The latter fact in particular has to be taken out of the calculation to analyse the effects of the SECA regulations alone so that there is no distortion of the cost structures (otherwise it would have been necessary to forecast the development of all other cost components up to 2015).

These calculations for the different scenarios gave rise to the following cost changes for sea transport:

Tab. 4-5: Total rise in costs for the sea transport leg caused by a reduction in sulphur content in 2015

	Price of bunker fuel IFO	Price of bunker fuel MGO	Corridor: German Baltic Sea ports - Western Sweden/Norway	German Baltic Sea ports - Southern Sweden	German Baltic Sea ports - Finland	German Baltic Sea ports - Russia/Baltics	Belgium - Western Sweden	Short routes
Impact on seaborne transport assuming								
- high fuel prices	$ 709	$ 1,182	**+14%**	**+20%**	**+32%**	**+27%**	**+26%**	**+17%**
- low fuel prices	$ 514	$ 773	**+8%**	**+12%**	**+21%**	**+17%**	**+16%**	**+10%**

* in prices of 2010, excluding port handling

This means that the reduction in the sulphur content of the fuels used to propel the ships gives rise to a considerable increase in the total costs of the round trips in each of the corridors. Assuming that the costs also determine the fares, it means that this amount will have to be borne by the freight rates for trailers/trucks/FEUs. An additional factor is the logically justified opinion of the shipping companies that most of the extra costs will have to be borne by the freight. If one takes into consideration the extra costs on the freight proportion assigned in the preceding table, there will tend to be an even stronger increase for each individual trailer. Overall, there will be an increase in the assigned costs for each individual trailer, and therefore also a probable increase in the freight charges in the middle of each of the corridors, as shown in the following.

Tab. 4-6: Rise in cost per trailer for sea transport resulting from the reduction in sulphur content in 2015

	Price of bunker fuel IFO	Price of bunker fuel MGO	Corridor: German Baltic Sea ports - Western Sweden/Norway	German Baltic Sea ports - Southern Sweden	German Baltic Sea ports - Finland	German Baltic Sea ports - Russia/Baltics	Belgium - Western Sweden	Short routes
Impact on seaborne transport assuming								
- high fuel prices	$ 709	$ 1,182	**+20%**	**+24%**	**+37%**	**+30%**	**+26%**	**+23%**
- low fuel prices	$ 514	$ 773	**+12%**	**+14%**	**+23%**	**+18%**	**+16%**	**+13%**

* in prices of 2010, excluding port handling

The changes in costs in all of the corridors for all trailers is independent of the necessary connecting transport.

4.3.2 Land-based route sections

An appropriate calculation also needs to be carried out for the preceding transport and subsequent transport to and from the sea ports. ISL has information derived from various past projects on the approximate structure of the hinterland – that means the source and destination of the cargo. This usually involves modelled data because the available statistical data only enables information to be acquired for the regional distribution up to German state level.

To estimate the shift in the mode of transport, the analysis of the source-target transport through the Baltic Sea region involved the calculation on the one hand of the segmented transport using RoRo ships, and continuous land transport by truck on the other hand. This involved determining the truck sections of the transport from the source to the departure port and from the unloading port to the destination, in just the same way as the direct route by truck.

In addition, the costs per trucking cost per kilometre were calculated and forecast. Where necessary, this involved making the same assumptions as used for the shipping costs. In general, the prices for 2010 were used and only the fuel costs (diesel) were extrapolated in line with the forecast for the price of MGO.[13] The study also took the cost advantages particularly for Eastern European into consideration as they are able to offer much lower kilometre prices on longer routes than domestic haulage companies because of the relatively high taxes and salaries in Germany. These cheaper alternatives have an effect particularly on the routes heading towards Eastern and North-eastern Europe. The rise in fuel costs and its consequences for the total costs of trucking is not as strong as it is for the sea transport in terms of absolute as well as relative figures. This is due to the fuel costs (per litre) already being relatively high because diesel is already used today. The forecast rise in the market-dependent proportion of the fuel costs is only slightly above the inflation rate, at least for the lower limit of the corridor up to 2015. This means that only a small proportion of the rise remains after discounting to 2010 prices.

Alongside the kilometre-dependent costs, a fixed cost block per trip is also taken into consideration. This mainly encompasses the costs for insurance, repositioning, mobilisation, loading and unloading time etc. This block is mainly kept constant. Only the part involved with vehicle movements (mobilisation, repositioning) is extrapolated with the same figures as the kilometre costs.

For the German hauliers, the following figures were the basis for calculating the truck costs for the preceding transport and subsequent transport journeys to and from the ports, as well as for calculating the continuous direct truck transport. Much lower costs were used for the routes to and from Eastern Europe.

Tab. 4-7: Cost components for calculating truck transport costs from the point of view of German hauliers

	2010	2015 high*	2015 low*
fixed costs per trip	75.00 €	78.72 €	76.93 €
costs per KM	1.20 €	1.32 €	1.23 €
e.g. total costs for a trip of 100 km	195.00 €	211.13 €	200.01 €

* in prices of 2010

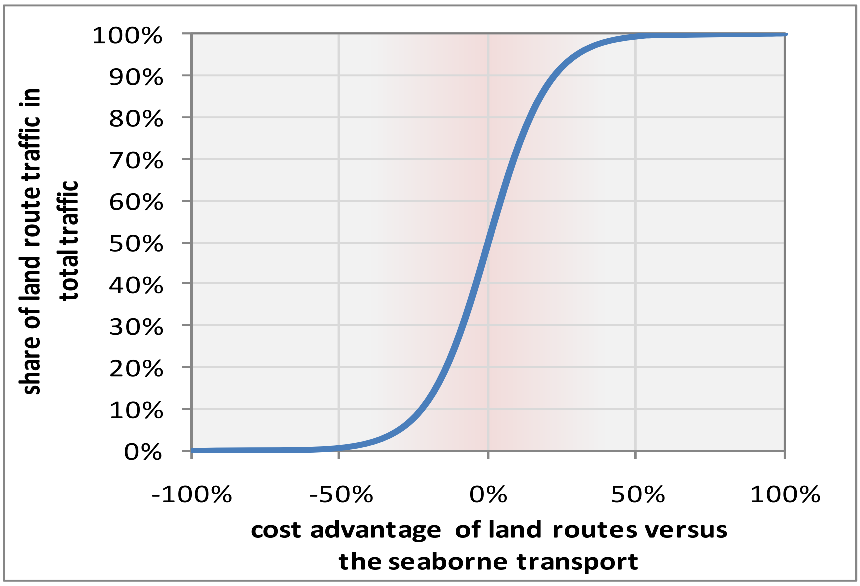
4.3.3 Total chain and shift risk

Compiling all of the calculations as described in the previous two chapters is done for each of the corridors and each of the hinterland relations. Again, the analysis looks at the situation in 2015 without any more stringent SECA regulations – in other words the operation of ships with 1 % HFO, as is already the case since July 2010 – as well as fuel costs for MGO (0.1 % sulphur). In both cases, prices are looked at for both the top limit of the forecast corridor and the bottom limit.

13 Rise in the market-dependent portion of today's diesel price in line with the forecast corridor for the development of the MGO price with subsequent discounting to the levels in 2010. The tax ratio here is kept constant.

The increase in the cost base for sea transport gives rise to shift risks to other modes of transport.[14] These are derived with the help of a Logit model as also used for the modal-split models, which involved taking into consideration the typical preceding transport and subsequent transport for sea transport within the considered corridors on the cost side of the calculation. Information for this purpose was available in the form of our own research findings and external studies on the costs of land transport modes. The parameters for the choice of the sea or land route could be estimated with the help of data on the proportion of short sea and hinterland transport in different hinterland regions (cross-section analysis).

Fig. 4-10: Estimator for the proportion of land transport (or a route with a small sea transport portion)



Source: ISL 2010

In theory, the same proportion should apply to all modes (here: sea transport compared to land transport or a route with only a short sea transport proportion) if there is cost and quality equality between each of the different types of transport. The estimator here shows how a change in the relative cost advantage of a means of transport – using land transport here as an example – impacts on the proportion of the modes of transport amongst one another.

Differentiation is possible here between the separate sections of the plot. The derivative of the curve therefore shows a relatively high increase of 1.5 – 2.5 for approximate cost equality. This means that with approximately corresponding costs, a positive change in the cost benefit of land transport of around X % will lead to an approximate doubling of the shift towards land transport (and vice versa). This

[14] These are cushioned slightly, however, by the simultaneous slight rise in land transport costs also for direct transport means.

behaviour of the hauliers would be expected in the central red-coloured part of the diagram. On the other hand, however, there is a considerable increase in the amount of elasticity at the outer edges of the curve. As soon as land transport has a cost advantage or disadvantage of more than 15 % for instance, the modal-split function only reacts slightly to marginal changes in this cost advantage.

Shift risks can now be derived for each of the corridors on the basis of this modal-split function and the simulations which were carried out. These shift risks are shown in the following table for the scenario with fuel prices in the **upper corridor**. The shift effect estimated on the basis of the calculations is based exclusively on the cost disadvantage to sea transport arising from a reduction in the sulphur content in the fuel because the simultaneous price rises were also included in the calculations for truck diesel.

Around 1.9 million trailers/trucks were transported on the simulated RoRo routes or corridors in 2008. The total volume in 2008 was around 2.5 million units. Assuming that the losses in 2009 will be compensated for in 2011, and that this will then be followed by only moderate growth, the reference volume to which the shift risk will have to be applied in 2015 is estimated at around 2.7 million units.

Tab. 4-8: Shift risk of trailers for fuel prices at the upper limit of the corridor

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**

* Source: ISL 2010

The estimated shifts occur primarily on the routes to Russia and into the Baltic. These routes are in competition with parallel land routes which already compete with sea transport because of the cheaper personnel and fuel costs of the East European hauliers. The particularly higher proportion of bunker costs in the total costs of the transport chain also means that the introduction of the new SECA regulations has a particularly strong percentile effect on the costs.

The routes to Sweden/Norway and Finland are also relatively long, but the alternative routes also involve short ferry journeys (from North Denmark or from Tallinn), which also become more expensive because of the new sulphur regulations. The overall effect on these routes is therefore much smaller than with the Russia routes.

The corridors taken into consideration in the calculations generally consist of several line services. The results for the individual lines will therefore be lower or higher as a consequence for the calculated shifts of e.g. 14 % average for West Sweden/Norway. The shifts will then give rise to such losses in income that there is a direct threat to the existence of the line. If lines closed, some of the transported volumes could change to the other lines, but there would be an even greater shift to land routes than the calculated proportion. The history of transport in the Baltic has numerous examples of lines which opened and were then forced to close again.

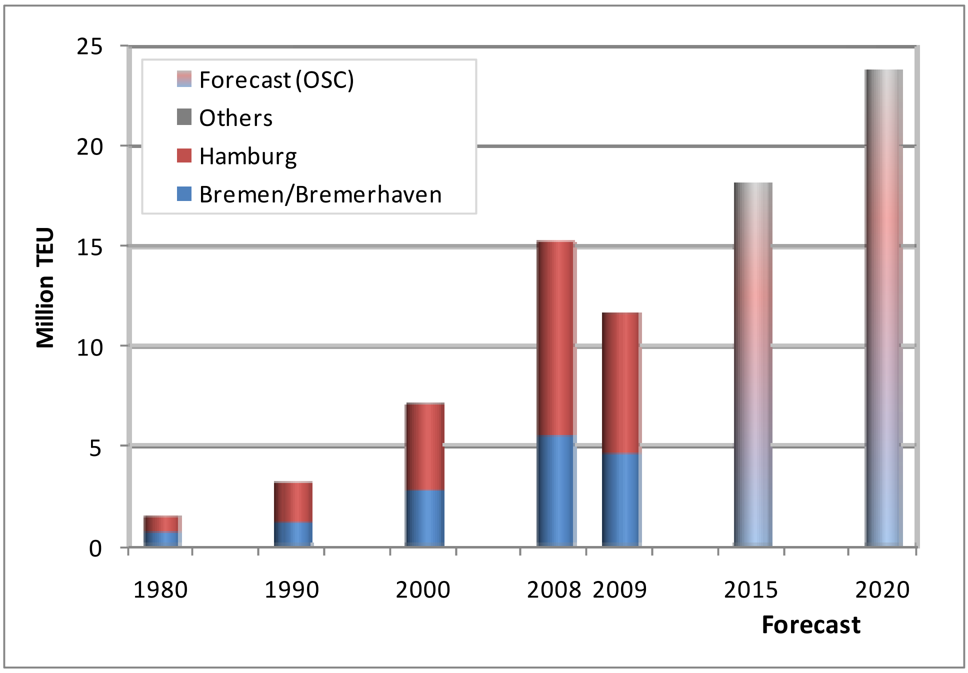
The overall conclusion is that the medium-long to long routes will suffer much more strongly from the new SECA regulations, and the proportion of sea transport in the total transport chain will decline (from sea to road). If transport is shifted from a long to a short sea route, this may mean that the total number of transported trailers/trucks remains unchanged, and that there is no overall change in the volumes handled by the ports in this case. However, there will be a reduction in the sea route taken by each trailer, whilst there would be an associated rise in the truck and road proportion. The shift from the longer to the shorter routes would therefore not be desirable in terms of environmental and transport policy because this also means a shift from sea to road. This service offer would also disappear on routes where RoRo lines have to be shut down because of a shortage of cargo. This in turn would mean that even more traffic would be shifted onto land routes (possibly also with short ferry connections) than determined by the calculations.

5 Container shipping

Container shipping has regularly been the most rapidly growing segment in the shipping market for many years, if one ignores the distortions resulting from the financial crisis. Germany's two largest container terminals at Bremen/Bremerhaven and Hamburg have both profited from this development. Their container handling volumes increased between 1980 and 2008 by on average 8.7 % p.a. to 15.2 million standard container units (TEU). This is almost a tenfold rise compared to 1980.

Both Hamburg and Bremen/Bremerhaven suffered an above average reduction in handling volumes in the crisis year 2009. This was exacerbated by the huge importance the container traffic with Eastern European ports for which the German North Sea ports play a key interface role. The Eastern European economies came more strongly under pressure in 2009 and this gave rise to an over proportional collapse in their container shipping activities. At the same time, the German North Sea ports – and Hamburg in particular – lost market share to the "west ports" (Rotterdam, Antwerp, Zeebrügge): whilst the European market as a whole experienced a decline in handling volumes of around 16 %, the turnover of boxes in the German North Sea ports slumped by 17 % (Bremen/Bremerhaven), and 28 % (Hamburg).

Fig. 5-1: Container handling in German North Sea ports 1980, 1990, 2000, 2008, 2009, forecast 2015, 2020



Source: ISL Port Data Base 2010, Ocean Shipping Consultants 2009 (Base Case)

Even though the very large decline in 2009 means that transhipment volumes corresponding to the previous peaks can not be expected again until 2011/2012, the financial crisis has only interrupted the basic growth in container shipping but not significantly changed it. The analysts at Ocean Shipping Consultants therefore forecast that container transhipment in German North Sea ports will already grow again in 2010, and predict an average annual growth of around 5.9 % between 2009 – 2020.

This growth will be driven by the rise in Asian exports as well as by transhipment for the North and East European economies which is primarily handled via German North Sea ports.

5.1 Short sea and feeder shipping

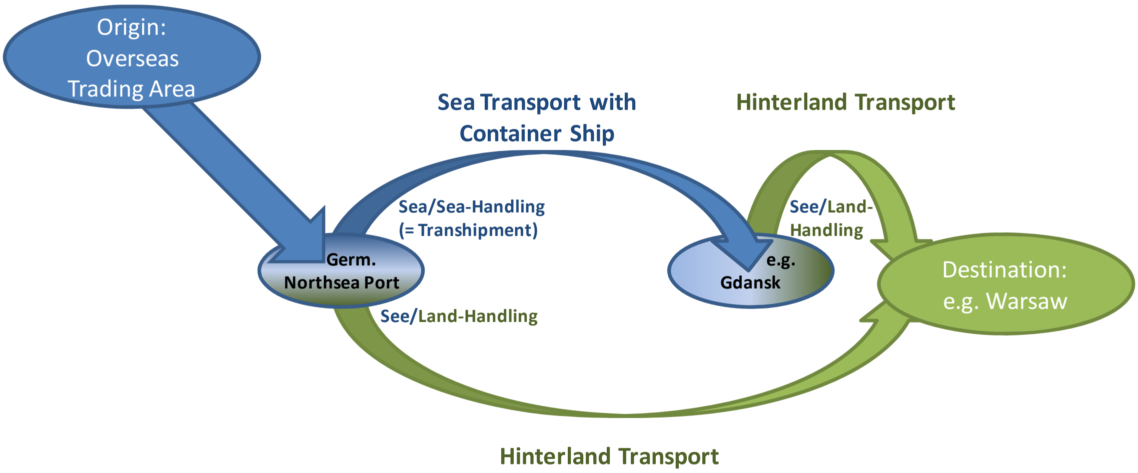
The containers which are loaded in German North Sea ports onto ships heading towards North and East Europe come either

- Direct from the hinterland of the German North Sea ports (**=”Short sea - land-shipping”)**,
- Or from overseas regions and were previously transported to the ports by large line freighters **(= “Feeder” or “Transhipment” shipping)**.

These two types of container shipping methods differ in terms of costs and shift risks because of their intrinsic natures.

Feeder shipping

Fig. 5-2: Possible routes for feeder cargo at German North Sea ports using the hinterland destination Warsaw as an example



Source: ISL

The **feeder cargo** reaching German North Sea ports from overseas locations such as Asia, lies directly available in the terminal and can be transported by regularly operating inner-European liner services to a port (e.g. Danzig) in the proximity of the target region (e.g. Warsaw). Although in the case of German North Sea ports this involves two handling operations, these are usually not twice as expensive as the single handling required for the land transport. In this example, the container is transported by a land-based means of transport to its target region after the time and cost-intensive sea-land handling at the port of Danzig.

The hinterland transport from the German North Sea port would be less time-intensive and incur lower handling costs compared to the feeder transport with subsequent land transport from Danzig. At the same time, it could under certain circumstances reach the target market in the hinterland more directly on some routes, whilst the subsequent land transport in the hinterland of the port (in this case Danzig) could under certain circumstances be associated with smaller detours.

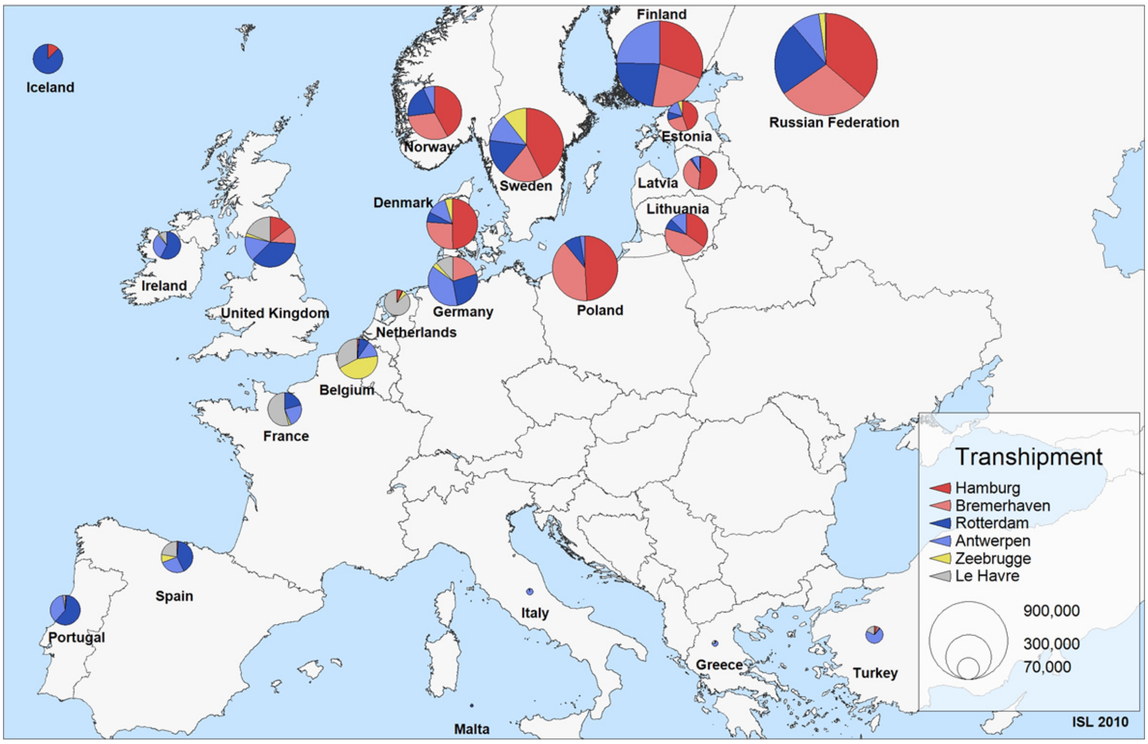
The biggest problem with land transport is the higher average costs per route unit, which in the case of European transhipment markets lying a long distance from the North Sea ports means that overseas containers are practically always transported to these locations by sea transport – in other words as feeder cargo. However, this could be changed by a relative increase in the cost of sea transport.

A regular market analysis by the Institute of Shipping Economics and Logistics carries out comprehensive surveys to weight the total container flows statistically recorded by the harbour authorities and agencies across Europe. The objective of the surveys is to assess the nature of the containers that are being shipped between the major ports of the Hamburg Le Havre range. They can be either short sea-land or feeder. This in turn enables detailed analysis to be carried out on container shipping within Europe.

The following figure shows the feeder shipping for the whole Hamburg-Le Havre range. This reveals the relatively high proportion of containers loaded to or discharged from the relevant countries via German North Sea ports in 2008 (shown in red in the figure). Overall, the German North Sea ports handled of 3.9 million transhipment (=feeder) TEU in 2008. Of this, 3.6 million TEU involved container shipping with North and Eastern Europe.[15] Around a quarter of the volumes handled in Finland involved Russian exports. The same applies to in the Baltic ports, although these involve different proportions. The importance of Russia for inner-European container shipping routes is therefore slightly underrepresented in the map.

[15] The German pie chart is a special case. The map shows the total transhipment volume between the north range ports on the one hand and the corresponding countries within Europe on the other hand. This records the incoming as well as the outgoing activity from the point of view of the ports. In the case of German transhipment, this means that intra-range transhipment is involved. In recent years, ISL have developed a procedure whereby these (already low) volumes are only reported in terms of the transhipment of the port lying further to the west (in this case Bremerhaven). This is done to avoid double counting.

Fig. 5-3: Container feeder shipping in TEU between the ports in the Hamburg – Le Havre range and European countries in 2008

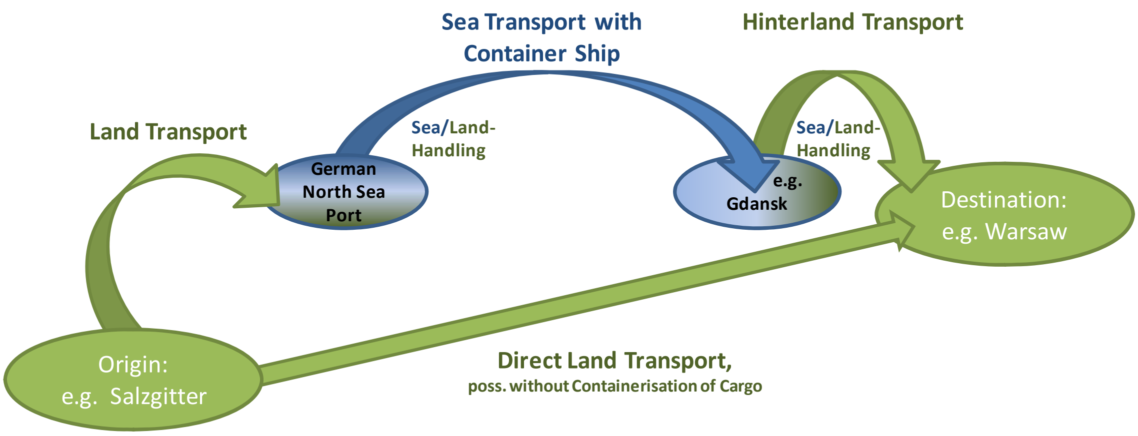


Source: ISL Containerverkehrsmodell Nordrangehäfen 2010

Short sea-land shipping

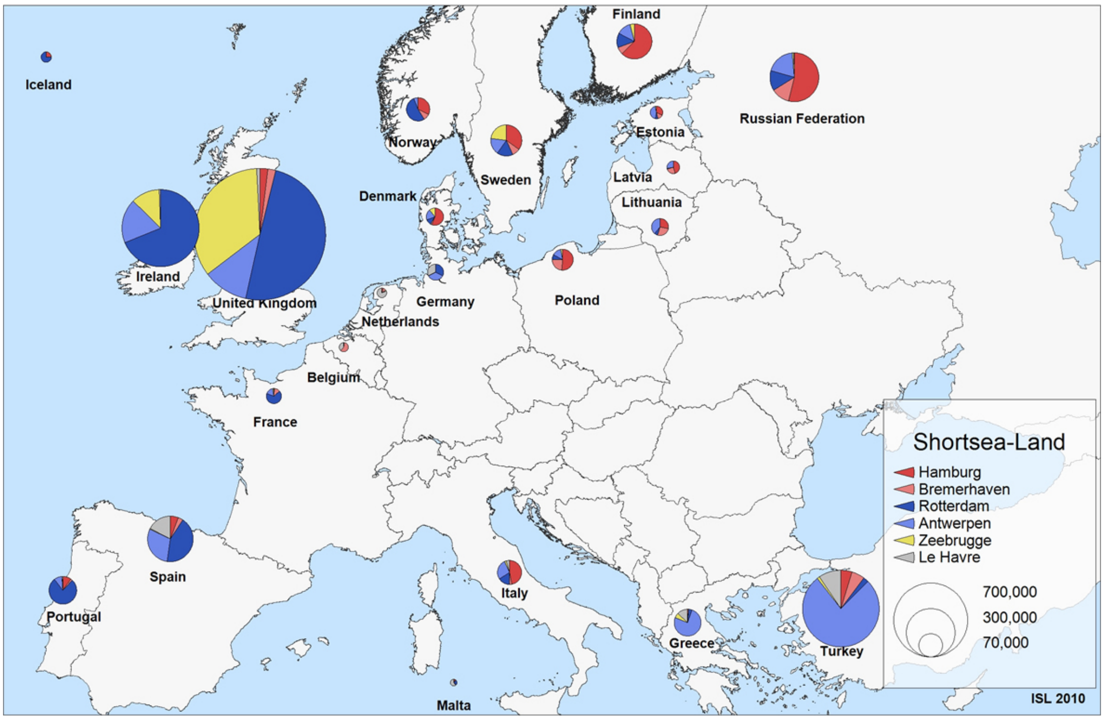
Although there is a great deal of internal trade within Europe, **short sea-land container shipping** only accounts for a small proportion of the handling at German North Sea ports compared to feeder shipping. The following figure highlights the fact that direct land transport here is more competitive compared to container shipping than it is compared to the feeder shipping discussed earlier. In this example, the container has to be transported overland to and from the container terminals, which is sometimes involving detours. As is the case with all modes of transport, this trucking on short routes is relatively more expensive because the fixed transport costs (e.g. delivery times, truck loading and waiting times at the dispatching company) can only be spread over relatively short journeys. Moreover, handling at the ports also involves time and costs which again make direct transport over land more attractive.

Fig. 5-4: Possible routes for short sea-land cargo at German North Sea ports using the hinterland destination of Warsaw as an example



If sea transport in this case were to become more expensive as a result of higher bunker prices, short sea-land shipping would be exposed to greater competitive pressure from direct land transport, especially since on the direct land route, the conventional trailers used within Europe could be employed. Unlike conventional sea containers, the conventional trailers are designed to handle the standardised European pallet size (see above).

Fig. 5-5: Container shortsea-land shipping between the ports of the Hamburg – Le Havre range and European countries in 2008



Source: ISL Containerverkehrsmodell Nordrangehäfen 2010

As part of its continuous market surveying activities, ISL reports that around 750,000 TEU were transported in 2008 between the German North Sea ports and North and Eastern European economies, which originated directly from the hinterland of the ports, (e.g. Salzgitter) or were scheduled for delivery to such locations (= "short sea-land"). The volumes are primarily concentrated in North and Eastern Europe (around 500,000 TEU), whereby high growth has been observed recently in Russian export activities.

5.1.1 Corridors and ship types

The typical timetables of feeder and short sea shipping companies enable the cargo volumes to be assigned to a total of four corridors which involve the use of typical ship sizes and types. The larger ships here can take full advantage of their economies of scale, primarily on the longer routes (e.g. from Hamburg to St. Petersburg), whilst one of the critical factors for the shorter routes is to be able to offer fast round trips with smaller units.

Tab. 5-1: Corridors and ship sizes in the inner-European container shipping business with North and Eastern Europe

Corridor	**Countries**	**Typical Ship Sizes** *nominal capacity/ capacity @ 14t/TEU*	**Cargo Volume 2008** *(from the point ov view of the North Sea ports) Feeder/ Shortsea-Land*	**Growth Potential 2008-2015** *(derived from OSC 2009, handling growth of the countires)*
Baltic Sea - *North East*	Russia, Finland, Estonia	~ 1,400 TEU/ ~ 1,020 TEU	1.65 M TEU/ 0.35 M TEU	~ + 33 %
Baltic Sea- *East*	Latvia, Lithuania	~ 700 TEU/ ~ 435 TEU	0.36 M TEU/ 0.04 M TEU	~ +25 %
Baltic Sea- *South*	Poland	~ 900 TEU/ ~ 600 TEU	0.55 M TEU/ 0.05 M TEU	~ +56 %
Baltic Sea- *West*	Denmark	~ 700 TEU/ ~ 435 TEU	0.29 M TEU/ 0.02 M TEU	~ +19 %
North Sea-/ Baltic Sea	Sweden, Norway	~ 650 TEU/ ~ 335 TEU	0.80 M TEU/ 0.09 M TEU	~ +9 %
Gesamt (Feeder) Gesamt (Shortsea)	**-**	**-**	**3.64 M TEU 0.54 M TEU**	**ca. + 24 %* n.v.**

* Variation may result from changing market shares within the Hamburg-Le Havre range
Source: ISL 2010 based on own analysis of containertraffic in North and Baltic Sea; North European Container Port Markets to 2020, Ocean Shipping Consultants 2009 (Base Case Scenario)

Ocean Shipping Consultants (OSC) has forecast the handling growth for each country in North and Eastern Europe. Weighted for the proportions of each country, the corridors will have the growth potential shown in the table. However, this table can only give an approximate indication because its weighted transhipment growth (2008 – 2015: + 28 %) already lies above the growth assumed by OSC for the transhipment shipping in German North Sea ports (2008 – 2015: 24 %). It is not plausible that the inner-European traffic will grow disproportionally high at the same time. This discrepancy may be attributable to OSC assuming market share shifts within the Hamburg – Le Havre range, or that they have assumed a higher growth in the shipping between the Baltic ports themselves.

5.1.2 Effects of the reduced sulphur content on sea transport costs

ISL carried out simulations based on typical timetables, and internal as well as external expertise, to quantify the effect of reduced sulphur contents on the sea freight rates for inner-European container shipping routes. This simulation took into consideration ship operation costs, voyage costs and capital costs for typical ship sizes and designs for the given round trip times.

The charter markets for the container ship sizes of up to 1,500 TEU relevant to this study have not completely recovered from the crisis. ISL therefore estimated a value which represented a required rate from the point of view of the ship owners.

Overall, the simulations reveal that the bunker costs at 2010 prices have a share of around 30 % of the total sea freight costs on individual routes (excluding port handling).

Tab. 5-2: Proportion of fuel costs on sea transport costs (excluding port handling) between Hamburg and the North Sea and Baltic Sea ports

	Price of bunker fuel		Corridor				
	IFO	MGO	Baltic Sea-Northeast	Balti Sea-East	Baltic Sea-South	Baltic Sea-West	Northsea/Baltic Sea
Share of fuel costs in total sea transport costs*	$ 450	$ 650	29%	32%	29%	27%	33%

* in prices of 2010er, excluding handling costs

As expected, the sea transport costs on the longer routes to the Eastern Baltic Sea ports account for a slightly higher proportion of the costs carried by the service providers. An exception here is the “Baltic Sea West” region where speeds are typically lower leading to a below average consumption.

The cost base for sea freight would increase considerably as a result of the planned reduction in the sulphur content of shipping fuel.

A possible range of prices for IFO and MGO in 2015 was elaborated in Chapter 3. The upper limit here was assumed to be around US $ 720 (IFO) and US $ 1,300 (MGO). In the lowest case, around US $ 515 (IFO) and US $ 850 (MGO) were assumed.

This means that, as a result of the expected rise in oil prices, even the lower limit of the corridor would exceed the prices observed in the market at the time this report was prepared. If the costs are adjusted for this effect and only take into consideration the increase exclusively associated with the use of MGO as fuel, this gives rise to the effects on the costs for sea transport shown in the following table.

Tab. 5-3: Rise in sea transport costs (excluding port handling) caused by the reduction in sulphur content in 2015

	Price of bunker fuel IFO	Price of bunker fuel MGO	Corridor: Baltic Sea-Northeast	Corridor: Balti Sea-East	Corridor: Baltic Sea-South	Corridor: Baltic Sea-West	Corridor: Northsea/Baltic Sea
Impact on seaborne transport assuming							
- high fuel prices	$ 709	$ 1,182	**+22%**	**+25%**	**+21%**	**+28%**	**+24%**
- low fuel prices	$ 514	$ 773	**+14%**	**+16%**	**+13%**	**+18%**	**+15%**

* in prices of 2010, excluding port handling

Overall, the analysis shows that the cost base for sea transport would increase by the order of 21 – 28 % (in the upper corridor) or 14 – 18 % (in the lower corridor).

5.1.3 Shift risks

As already described above, the rise in the cost base for sea transport brings about shift risks to other means of transport. The Logit model described in Chapter 4.3.3 is also used to derive the change in modal split for container shipping. Again, typical preceding land transport and subsequent land transport involved in the sea shipping was taken into consideration on the cost side within the analysed corridors using figures derived from ISL's own study and research results, and partially also from external studies on the costs of land modes of transport.

Here again, the same proportion should apply to all modes (here: sea transport compared to land transport) if there is cost and quality equality between each of the different types of transport. The estimator here shows how a change in the relative cost advantage of a means of transport impacts on the proportion of the modes of transport amongst one another.

Shift risks can now be derived for each of the corridors on the basis of this modal-split function and the simulations which were carried out. These shift risks are shown in the following table for the scenario with fuel prices in the upper corridor. Again, consideration was given to the fact that in a scenario of this kind based on the change in the price of oil, there would also be a simultaneous price rise for truck diesel. The shift effect estimated on the basis of the calculations is therefore based exclusively on the cost disadvantage to sea transport arising from a reduction in the sulphur content in the fuel.

The volumes presented for the 2015 forecast year were determined by extrapolating the actual values for 2008 with the help of a regionally differentiated forecast from Ocean Shipping Consultants.[16]

Tab. 5-4: Shift risk of container shipping for fuel prices at the upper limit of the corridor

	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**

* Source: ISL North European Container Traffic Model, Forecasts based on OSC

The **short sea-land shipping** is the most strongly affected with an average expected shift of 27 %. This is attributable to the fact that transport between the sea port and the hinterland can involve a considerable detour compared to the land route – and that a larger volume per truck can be transported by direct land transport using trailers. Transport with trailers is therefore competitive on shorter and medium distance routes. The effect is slightly lower at around 25 % for the more remote Eastern markets – despite the lower trucking costs for the traffic heading eastwards. This primarily affects the Moscow area and the Russian hinterland where preceding and subsequent land transport accounts for a relatively high proportion. However, the cost advantage of sea transport even after the introduction of the more stringent SECA regulations is still considerable for transport between companies located close to ports (e.g. Hamburg metropolitan region and the greater St. Petersburg area).

The lower percentage shift for Poland despite the shorter distance is due to the fact that sea transport today exclusively involves shipping between the ports and their direct hinterlands – with the associated cost benefits. This also includes special transport activities such as repositioning empty containers, which naturally do not benefit from

[16] Ocean Shipping Consultants 2009, North European Containerport Markets to 2020

the economies of scale of the large volume trucks. This traffic can therefore not be shifted onto land routes so easily.

Consideration is given here to the fact that in the case of container shipping with Denmark this is typically combined with other trade flows (for example Sweden). This means that on the cost accounting side, the operators can provide relatively cheaper rates for transport to Aarhus for instance. Container shipping of this kind even without the reduced sulphur content would be practically unviable without the combination with the higher paying Swedish cargo. The 33 % loss in cargo reported here in the sea transport corridor to Denmark should therefore be considered to be a relatively conservative estimate.

In the case of transport to West Sweden and Norway, consideration must be given to the fact that pure land connections via the Storebelt bridge and Öresund bridge will not be the best alternatives even in the future. Quite the opposite in fact: the short ferry connections from Fredrikshavn to Gothenburg and Oslo, as well as from Hirtshals to Kristiansand will gain in importance. Although the costs here will become more expensive because of the more stringent SECA regulations, this rise in costs is lower related to the whole transport chain than would be the case with longer sea routes.

At around 13 %, **container feeder shipping** is affected to a relatively small extent by the shift. However, the shift involves a much higher base so that around 630,000 TEU will shift from the sea transport corridors described here onto land transport routes. The strongest relative effect here is feeder shipping on the short routes to Denmark. According to the estimates calculated here, up to 34% of the cargo – corresponding to around 120,000 TEU – could be lost to hinterland modes of transport. The second highest loss is expected to be observed in feeder shipping with Poland. Up to 20 % of the market volume could be lost to land transport in the future. This corresponds to a volume of approx. 230,000 TEU.

Because of the higher cargo losses, it can be expected that a smaller number of services will be offered on the short routes and/or that fares will rise because of the deteriorating economies of scale. This will shift even more traffic to the land routes, and push the figures higher than calculated in the simulations.

The reduction in the sulphur content, however, will probably have no practical effect whatsoever on the longer routes originating or ending in Russia. Based on the simulations, ISL estimates that less than 1 % of this cargo will shift. The shift risk for container shipping is therefore primarily seen on the shorter shipping routes where it could have a major impact – with a negative effect on inner-European container shipping in particular.

In the fuel cost scenario based on the lower limit of the range, there would be a slightly lower rise in costs for sea transport as a result of the changes brought about by the SECA regulations (cf. Table 5-3). This means that the price structure of the modes of transport amongst one another will also be affected to a lesser extent.

Tab. 5-5: Shift risk for container shipping as a result of fuel prices at the lower limit of the corridor

Markt	Volumen in Tsd. TEU 2015* Feeder	Shortsea	Gesamt	Verlagerung in % Feeder	Shortsea	Gesamt	Verlagerung in Tsd. TEU Feeder	Shortsea	Gesamt
Poland	865	75	941	17%	16%	17%	144	12	156
Lithuania/Latvia	448	51	499	9%	23%	10%	38	12	50
Russia/Finland/Estonia	2,202	461	2,663	0%	16%	3%	7	72	79
Norway	338	34	371	5%	17%	7%	18	6	24
Sweden	577	64	641	13%	20%	14%	77	13	90
Denmark	340	28	368	21%	21%	21%	71	6	77
Total Baltic Sea	**4,771**	**712**	**5,483**	**7%**	**17%**	**9%**	**356**	**121**	**476**

* Source: ISL North European Container Traffic Model, Forecasts based on OSC

Nevertheless, even in the most "favourable" case, ISL estimates indicate that around 480,000 TEU could shift from sea routes to a land route. Again, the highest relative impact is on short sea shipping with origins or destinations in Denmark, and the shipping to Latvia/Lithuania. Analogous to the calculations for the fuel price scenario at the upper limit of the range, the calculations for the lower limits also reveal that feeder shipping with the more remote easterly lying ports in Russia and Finland will hardly be influenced at all, whilst the short routes can expect relatively strong shifts.

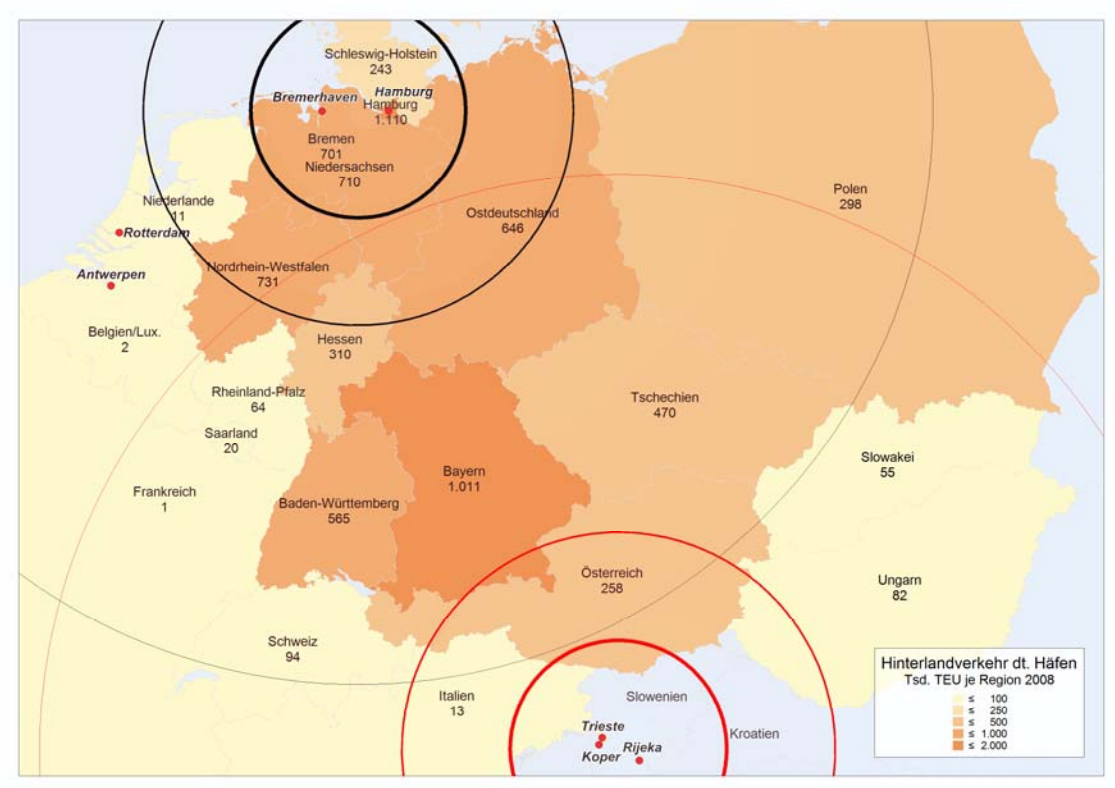
5.2 Competition from south range ports

In addition to the shift (back) of feeder shipping to road or rail because of the planned SECA restrictions, it is also possible for there to be a shift of container hinterland transport away from German North Sea ports to the south range ports of Triest, Koper and Rijeka. Austria, Hungary and Slovakia are already in part supplied by the south range ports. The Czech Republic as well as parts of Bavaria and Baden-Wurttemberg actually lie closer to the south range ports than they do to the German North Sea ports.

In 2008, the total volume transported between the German North Sea ports and the aforementioned hinterland regions was approx. 1.5 to 2.0 million TEU (cf. Fig. 5-6). The north range ports are still, however, dominant in terms of container shipping even though the total travel distance and the subsequent transport into the hinterland for Asian traffic is much longer than it would be via the south range. The disadvantage of the south range ports is that they are currently only served by a few Europe-Far East lines, and largely connected to the Far East container line services via feeder shipping. The geographical location in the north of the Adriatic Sea makes these ports relatively unattractive for direct calls by large container ships, particularly when they need to travel on further in the direction of Northwest Europe. The costs for the additional transhipment handling in the Mediterranean reduce the competitive advantages of these ports considerably, particularly because almost all of the line services travel on further to Northern Europe.

Classification of the North Sea as a SECA region makes journeys through the North Sea more expensive and enhances the competitive position of the south range ports. It is therefore likely that the market share of the south range ports for the hinterland regions discussed above will rise as a result of this measure. One can also expect in particular that implementation of the more stringent SECA regulations in the North Sea and the “improvement in the position” of the Mediterranean, will lead to the launch of additional Far East services which only go direct into the Adriatic Sea and then return. Ships operating such services could run completely on HFO without needing any conversion.

Fig. 5-6: Container hinterland traffic from German North Sea ports to hinterland regions 2008



Source: ISL Containerverkehrsmodell Nordrangehäfen 2010

The port of Genua as well – to which 8,000 TEU class ships already sail to, and which was on the timetables of eight Europe-Far East lines in August 2010 – would also gain competitive advantages over the north range ports as a result of the implementation of the more stringent SECA regulations. This applies particularly to Switzerland and Baden-Wurttemberg which will already have better connections to Genua soon as a result of current expansion measures. In addition to a larger number of direct services to the aforementioned ports, the hub-spoke traffic with transhipment in the Mediterranean will also gain relative cost advantages compared to line services to Northern Europe because these are also not affected by the tighter SECA stipulations.

Ports such as Gioia Tauro or Port Said could be used more intensively, with the organisation from here of medium-sized ships operating feeder shipping into the Adriatic, to Genua or to other Mediterranean regions. This would boost the market share of the south range ports in certain hinterland regions at the expense of shipping for the north range ports. This could increase further the proportion of line services which already turn around in the Mediterranean.

5.3 Competition from the west ports

Compared to the western north range ports (primarily Rotterdam and Antwerp), the German North Sea ports will lose out in the competition as a result of the more stringent SECA regulations because the costs for the Rotterdam-Bremerhaven or Rotterdam-Hamburg route will rise disproportionally strong. This will weaken the competitive edge of the German North Sea ports in all hinterland regions where they are in direct competition with the west ports. This could lead to the loss of market shares particularly in Western and South-western Germany as well as in Switzerland and Austria.

6 The impact of the North Sea and Baltic Sea SECAs on ferry and RoRo shipping services as well as German sea ports

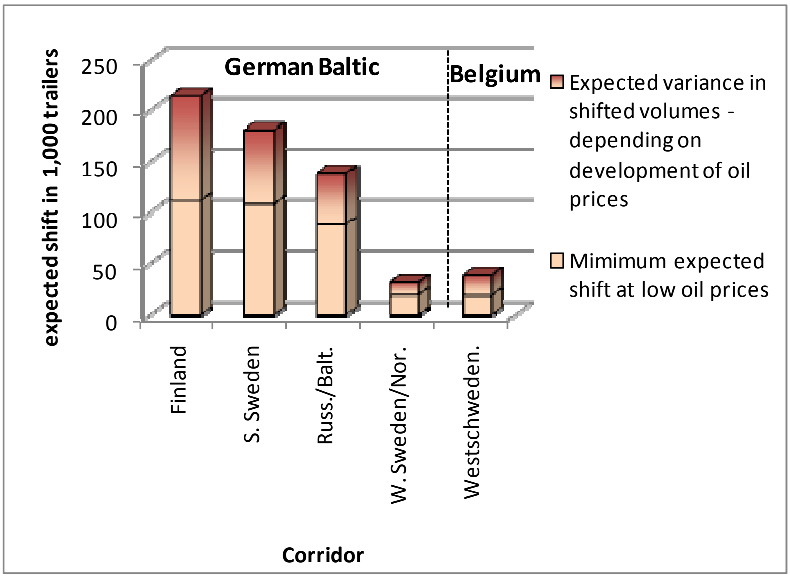
This chapter summarises the consequences of the SECAs. The results of the corridor analyses from the previous chapters will be used here to estimate the overall effect. It should be noted in this context that the corridor analysis carried out in agreement with the client only provides a good indication of the shift risk. Detailed quantification requires the use of an appropriate network model to simulate the whole transport system and to be able to take into consideration in a consolidated manner the substitution effects between the individual corridors.

6.1 Shift effects on shipping

6.1.1 Shifts in RoRo shipping

On the basis of the 2008 figures for the simulated routes and corridors totalling around 1.9 million transported trailers/trucks, and information on the size of the total market, as well as moderate growth assumptions, the basic volume at risk of a shift to road transport in 2015 was estimated to be around 2.7 million units.

Fig. 6-1: Expected shifted volumes (onto land routes or routes with a smaller sea transport portion) in RoRo shipping with the introduction of the 0.1 % limit in 2015

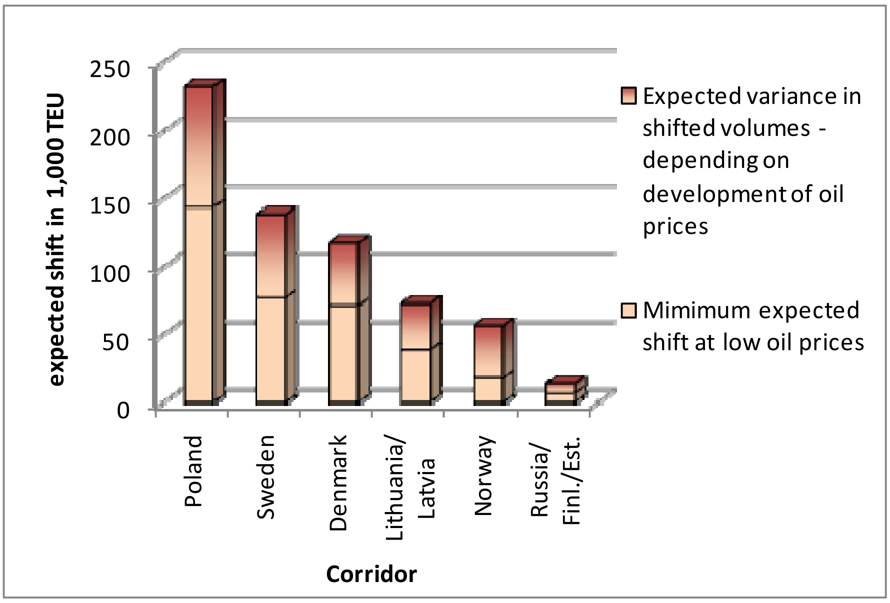


Of these 2.7 million trailers, around 600,000 units will shift directly to land routes or to routes with lower ferry ratios. Because of the current high level of units, the traffic with South Sweden and Finland can expect to suffer the highest absolute losses: around two thirds of the shift will affect these routes. In percentage terms though the strongest effect is on the traffic with Russia and the Baltic states because 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. These particularly painful losses may make the continuation of some services impossible and therefore lead to an additional compulsory shift in volumes.

6.1.2 Shifts affecting feeder shipping

Feeder shipping is the most strongly affected segment of the container shipping sector in absolute terms as a result of the shifts. It can be expected overall that up to 630,000 TEU of feeder containers will shift from sea transport to land transport in 2015. The main routes which lose the most are the routes to Denmark, Sweden and Poland. The next most affected are the routes to the Baltic states, Norway, Russia and Finland. The high absolute figure is, however, based on the high base level compared to short sea shipping discussed below. 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 – despite the lower fuel and personnel costs for traffic heading east.

Fig. 6-2: Expected shift in volumes for feeder shipping with the introduction of the 0.1 % limit in 2015



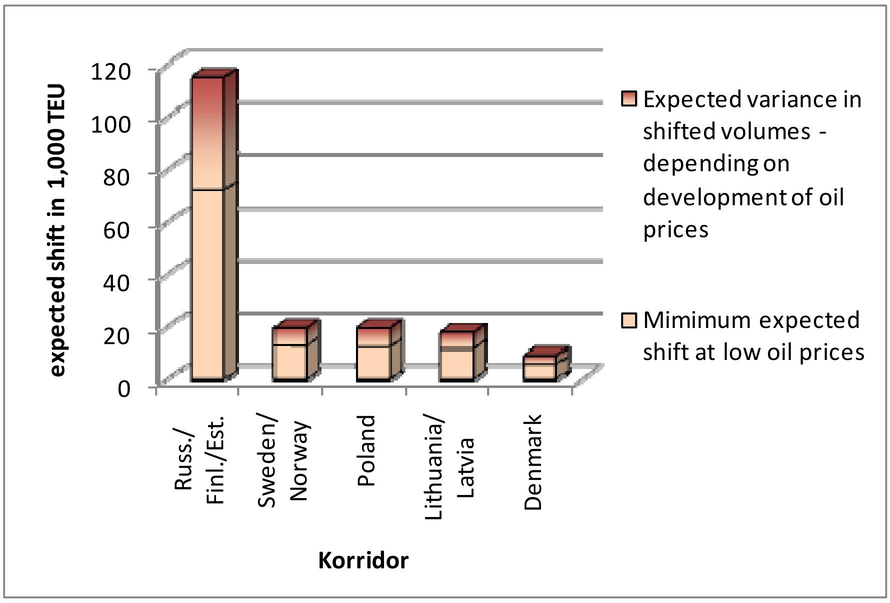
It should also be noted that hardly any risk of a shift is expected on the longer feeder routes because the cost advantages of shipping are adequate here to counteract the relatively high rise in the costs of shipping fuel compared to truck diesel. The cost benefit of feeder shipping is lower on short routes and the demand here will therefore react more sensitively to changes in price structure.

The risks of shift are so high for Poland, as well as Denmark and Sweden, that the closure of feeder services or the use of smaller ships can be expected. Both of these actions would cause a further reduction in the proportion of sea shipping, and possibly eliminate it completely on certain routes because the "critical mass" is no longer adequate to maintain a scheduled service.

6.1.3 Shifts in short sea shipping

At around 190,000 TEU, the container volumes threatened by a shift in short sea shipping are much lower. This is not so much attributable to a lower risk of a shift, but to the smaller base. The proportions threatened by a shift are actually higher in the case of short sea shipping because additional hinterland transport is involved in the total chain than is the case with feeder shipping. These lengthen the overall distance of the segmented transport compared to direct land transport, and simultaneously reduce the proportion of less expensive sea transport across the whole chain. As a result today, the volumes of short sea shipping are less than politically desired. The cost advantage of shipping will reduce with the rise in fuel costs associated with the implementation of the SECA regulations.

Fig. 6-3: Expected shift in volumes in short sea shipping with the implementation of the 0.1 % limit in 2015



The competitive advantage of the sea transport will therefore no longer be sufficient on a number of relations to compensate for the disadvantages associated with the cost-intensive preceding and subsequent trucking services, and the longer distances overall. Higher losses to land transport can therefore be expected in this shipping segment. These shifts run counter to the strategy of the EU and the member states to shift transport from road to sea.

Unlike feeder shipping, the routes to Russia, Finland and Estonia come top here in terms of absolute volumes. This arises from the importance of the larger base volumes. The volumes shifted are lower overall because of the long land routes involved (also when taking into consideration possible alternative routes with lower sea transport proportions).

The high losses for short sea shipping, which come on top of the losses for feeder shipping, increase the pressure on shipping companies to scale down further or even abandon line services.

6.2 Impact on the ports

There are certain differences between the ferry and RoRo ports on the one hand and the container ports on the other hand when considering the effects of the SECA regulations on ports overall.

It is also true in the case of the ferry and RoRo ports that the calculated shift in volumes in the considered corridors will have an effect on the volumes of cargo handled at the ports. Based on the total volume of around 2.7 million trailers in 2015 and a shift of 22 % calculated for the simulated corridors, there is a risk that a total of 604 thousand trailers/trucks could shift, and that these trailers/trucks would be lost by the ports in the first step. In the case of the RoRo/ferry shipping, however, the ultra-short routes are an alternative which should be in a position to be able to attract some of the volumes shifting from the long routes. It is not, however, possible to quantify the size of this proportion within the framework of this study because the costs, even for short services, will also rise as a result of the SECA 2015 regulations and lead to shifts onto the fixed crossings. These alternatives, however, apply mainly to Swedish and Danish shipping, and are irrelevant for the southern and eastern Baltic Sea region. Ultimately, the number of loaded/unloaded trailers and trucks in German Baltic Sea ports may not decline quite so strongly as indicated by the simulations, but this will then be a result of a shift onto ports with ultra-short services. In addition to the pure effect on volumes, one must also expect that the increased use of short routes will change the structure of RoRo shipping in such a way that they lose a share of the trailers which dominate the long routes but gain market share by an increase in the accompanied HGV traffic. This means that the ports overall will lose a significant amount of value-added activity because the accompanied traffic requires a much smaller amount of port services (trailer loading, CLT etc.).

The loss in container handling volumes for German North Sea ports is calculated at around 820 thousand TEU in 2015 if one assumes that the containers fed via Hamburg and Bremerhaven prior to the 0.1 % regulation will continue to arrive on the main ship in Bremerhaven, Hamburg or Wilhelmshaven. Because of the geographical location of the transhipment market looked at in this study, it is probable that the use of German ports will remain stable if the other conditions remain the same, even if there is a shift in cargo transport from ship to land. Because the major lines have to satisfy the SECA stipulations anyway if they want to continue to serve North-western Europe, there is further support for the argument for the longest possible use of the more economical large ships in terms of specific fuel consumption.

This is the reason why there is also considered to be no risk of a shift of substantial volumes of transhipment containers to the west ports as a result of the SECA regulations. It is, however, possible that more line services will be set up in future, for instance involving exports to the USA, which mainly serve the West European hinterland, and which will only dock at a few of the western located ports. In this case, the German North Sea ports would lose growth potential in their hinterlands.

6.3 Rise in traffic on German roads

It is virtually impossible to quantify the additional traffic levels on German roads in terms of TEU kilometres and truck kilometres, without a detailed network simulation. If one assumes a volume shift in the container segment of around 820,000 TEU, and if one also assumes that 2 TEU are frequently but not always transported on one truck, then this alone will give rise to at least 410,000 additional or extended truck journeys. Of these, 315,000 trips are caused by the shifts in the feeder shipping segment, and 95,000 from shifts in the short sea shipping segment.

Feeder shipping going from Hamburg to the Polish border for instance has to travel around 400 km. The distance from Hamburg to the Danish border to use the fixed crossings in the direction of Denmark and Sweden is 160 km. It is 160 km more in each case to Bremerhaven (560 and 320 km respectively). The distance on German soil will tend to be larger for short sea shipping because of the sources and destinations of the traffic are located further back in the hinterland.

If one assumes an average distance of 360 km for the feeder shipping for the sake of simplification, this would give rise to another 227 million TEU kilometres, or 113.4 million truck kilometres. If one also assumes in a conservative estimate that the shifted short sea shipping involves 150 km on average more on German soil if, instead of driving to the ports, they drive to the Polish or Danish borders, this would increase the traffic on the roads by 14.25 million truck kilometres or 28.5 million TEU kilometres.

The argumentation and extrapolations for RoRo shipping will be similar to those for short sea shipping. However, the distances from the Baltic Sea ports to the borders of Poland or Denmark will be much shorter than those involving movements via Hamburg or Bremerhaven as is often the case in container shipping. In the case of RoRo shipping, the truck journey would have gone all the way to the Baltic Sea port anyway so the only aspect which needs to be considered is the detour in the direction of the

Polish or Danish borders. Depending on the hinterland relation in Germany, this is between 0 and 200 km more. With a shift of 604,000 trailers/trucks and an average additional distance of 100 km, this would accordingly give around 60 million extra truck kilometres on German roads.

Because no significant shift is expected to take place to the west ports because of the SECA regulations, no boost in pure transit traffic is expected. The extra traffic on German roads as a result of this estimate is therefore 188 million truck kilometres.

6.4 More expensive global trade – Reduction in international competitiveness

The SECA regulations increase the costs for transport in the analysed corridors independent of whether there is a shift from sea transport to land transport in specific cases. If a shift takes place, then the increase in sea transport costs will not take hold fully because a cheaper alternative would have been found – although this would be more expensive than the previous solution for the analysed transport activity because otherwise it would already have taken this route if it had been cheaper in the first place. The extra costs will come into full effect for the volumes which are not shifted. Because the goods traffic considered here involves the exchange of goods as part of international trade, the rises in the transport costs for the goods will have an impact on the end price of the traded goods in the recipient country, and therefore on the competitiveness of the goods in the export markets.

The simulations carried out as part of this study indicate that, depending on the length of the sea journey in the transport chain, the costs alone from the rise in fuel costs for shipping would be around 40 to 380 € per trailer and between 30 to 63 € per TEU.

The brief of this study did not include analysis of the associated braking effects on trade. The same applies to the overall effect of the higher costs on the economy. However, a Finnish study[17] determined or extrapolated that the negative effect on Finnish industry would lie between € 190 million and almost € 1.2 billion depending on the specific price scenario.

[17] Compare: Centre for Maritime Studies (2009): Sulphur content in ships bunker fuel in 2015 - A study on the impacts of the new IMO regulations and transportation costs; on behalf of Ministry of Transport and Communications. University of Turku 2009

7 Conclusions and recommendations for action

The SECA regulations to cut sulphur dioxide emissions from ships give rise to considerable extra costs for shipping because it can be assumed that the stipulations can only be satisfied, according to the information we have today, by using a very low-sulphur fuel. Because it has not been possible so far to refine heavy fuel oil with a limit of 0.1 % sulphur, the only option is to use distillates – and their costs are considerably higher than those of heavy fuel oil.

Even if one ignores the probable negative effects on trade caused by the rise in transport costs, there will be a significant shift of volumes from sea routes to land routes because of the unequal impact of the extra costs on the different means of transport. Subject to the undoubted limitations of the calculation results attributable to the assumptions and simulations undertaken as part of this study, the cut in the sulphur content of fuel (ultimately requiring the use of MGO with 0.1 %) would cause a shift from sea to land of up to 823,000 TEU in the container shipping segment, and around 604,000 trailers/trucks. Even without additional transit traffic, this means an estimated increase in traffic on German roads in the order of around 300 million truck kilometres, primarily affecting the area around the ports and in North Germany. At the same time, the shipping companies and the ports lose the relevant volume and the associated turnover.

All of these points – the losses in volumes for shipping and port industry service providers; the shift in volumes from sea transport to land transport; and finally, the increase in traffic on the already congested German road network – contradict the strategic aims of industry and politics. A discussion is therefore required on what other options there are to achieve the sulphur reduction objectives of the IMO directives without causing the undesirable effects discussed here.

In principle, this primarily means considering the various technical options available:

Exhaust gas treatment using scrubber technologies

The situation regarding the use of scrubber technologies is contentious in terms of retrofitting as well as its fundamental readiness for the market. The small number of applications is an indicator of its “test stage” status. This means that no conclusions can be reached on the suitability of this technology at the present time. Basically though there are two different treatment methods which have been developed. In the “wet” method, the exhaust gases are mixed with vaporised water to bind the sulphur oxides in the form of sulphuric acids. This form of treatment is subject to a great deal of controversy because the substances which are scrubbed out are frequently dumped overboard without being filtered. The alternative “dry” method uses slaked lime (calcium hydroxide) which turns into gypsum in the desulphurisation process. This method, however, requires setting up a disposal system on board and on land with the associated logistics. It should be noted here that treating the exhaust gas initially with scrubbers (in the case of high-sulphur fuel) followed by SCR catalyst treatment to satisfy the NO_x limits (Tier III) is problematic, and requires the stream of exhaust gas to be heated up again as a minimum. Another alternative here, in addition to the dry desulphurisation method which is still under development, is the use of fuel with a sulphur content of 0.5 % which requires no prior desulphurisation according to the SCR manufacturers. The fuel with a 0.5 % sulphur limit would then be compatible with the SCR catalysts and therefore allow compliance with the NO_x limits.

Measures to reduce fuel consumption

According to today's state-of-the-art, fuel consumption in ships can be reduced to a varying amount by a number of technologies. Slashing fuel consumption further is, however, a precondition for compensating for the costs of higher quality fuels as stipulated from 2015 in the SECA regulations. Realisation of these fuel consumption reduction goals means focusing on the three main groups "resistance", "efficiency", and "operation" as part of an integrated analysis.

The technologies concerned with "resistance" have already been implemented as far as technically and economically feasible in new ships, and therefore in the generally very modern ships operating in the North Sea and the Baltic Sea. Alternative methods such as ACS (Air Cavity Systems) and new antifouling systems (Sharkskin) are still at the development stage and will probably remain in the development pipeline for some considerable time.

In the "efficiency" group, major components such as "propellers", and "engines" (engine size, diesel-electric PODs, WHR (waste heat recovery systems)), have already been implemented as far as possible, and alternative systems such as wind-powered *assistance systems* ("Sky Sails", "Flettner rotors") are either still under development or not yet ready for application. This certainly applies to short-routes according to the information available to date where the saving-effects are only relatively small in the primarily modern and technically highly developed ships operating in short-sea shipping.

In the "operation" group, attention is focussed on the main elements – cruising speed, choice of fuel, and the associated waste gas treatment. A further optimisation of the timetables and speeds in the RoRo/RoPax sector, as well as in the short sea and feeder shipping sector is, however, usually only possible to a very small degree because of the relatively short sea routes and the high and regular departure frequencies demanded by the market. This group therefore does not represent any major potential for cost compensation for the strongly rising costs associated with the more stringent SECA sulphur limits.

Use of LNG as an alternative shipping fuel

From a technical point of view, the necessary marine engineering is basically available and fully developed in principle for the use of LNG. However, more space is required to accommodate the LNG tanks than is currently taken up by bunker oil tanks (up to a factor of 4). For container ships there is an additional problem of the installation of an extra bulkhead to safely separate the tanks, and the associated loss of container spaces. This in turn worsens the ratio of investment costs to income from cargo transport.[18] Another uncertainty is how the price of LNG will develop if there is a rise in demand associated with the SECAs, and whether the difference between the price of LNG and MGO will be sufficiently high. A problem in this context is converting the operating ships: the use of LNG on existing ships would only be possible by installing new LNG engines or dual-fuel engines. This would mean the immediate depreciation of the existing ship engines for all ships which entered service in the last few years, and would also mean that there is too little time left to amortise a new engine installed in old ships with short remaining service lives. The use of LNG is therefore only an alternative in new ships. However, because most of the fleet currently operating is only ten years old, these will not be replaced by new ships until 2015 under normal market conditions.

If one wanted to avoid the negative effects associated with the fuel-cost-related shift in transport, another aspect which could be discussed is neutralising the cost distortions and price distortions arising from the unilateral price rise for shipping fuels (or possible increases in investment).

One alternative would be to increase the costs for land transport accordingly. This is not recommended for several reasons: firstly, this increases transport costs overall and will reduce the competitiveness of German and European companies and restrict international trade. Secondly, such measures only have an effect (higher tax on truck fuel, tolls, etc.) if they are set up across the whole of Europe. Otherwise avoidance strategies would be found with an over proportional negative impact on German hauliers.

The second alternative is to subsidise sea transport. Because this is associated with additional public spending – unlike the higher tax on land transport which gives rise to additional income – this alternative would probably fail first and foremost on the question of the availability of funding. And even if financing existed, the main problem would be how to implement this measure in a targeted way. Subsidising specific means of transport to prevent shifts is impossible for pure reasons of practicability. Subsidising shipping would also mean a great deal of inaccuracy and the waste of public finances. This is because this kind of subsidy would not be restricted solely to the trailers/TEUs which are at risk of a shift in the mode of transport. Ultimately such a subsidy would lead to a cut in average fares and thus also subsidise forms of transport which never needed to be subsidised in the first place.

[18] The same also ultimately applies to the occasionally discussed solution of storing the LNG on deck in special containers near the engine room. This also reduces the amount of cargo space available and would also require as a minimum the setting up of a logistics system to supply a large number of ships with sufficient volumes of containerized LNG.

In addition to the technical options available, and financial compensation for the differences between sea transport and land transport, another aspect worthy of discussion at least is modifying the SECA limits.

Fuel with a 0.5 % sulphur content

The shifts from sea transport to pure land transport, as concluded in Chapter 5, are a result of a significant rise in sea transport costs caused by the use of fuel with a 0.1 % sulphur content. A possible alternative could be to use fuel with a sulphur content of 0.5 %. This alone would bring about a considerable reduction in sulphur emissions, but would be only slightly higher in the forecast price corridors compared to the fuel used today with a sulphur content of 1 %.

The increase in costs per trailer by using this fuel would only be around 1 – 5 % for the RoRo corridors looked at in this analysis, even for fuel prices at the upper limit of the corridors. This would have hardly any impact on any of the routes and therefore hardly disrupt the price structures.

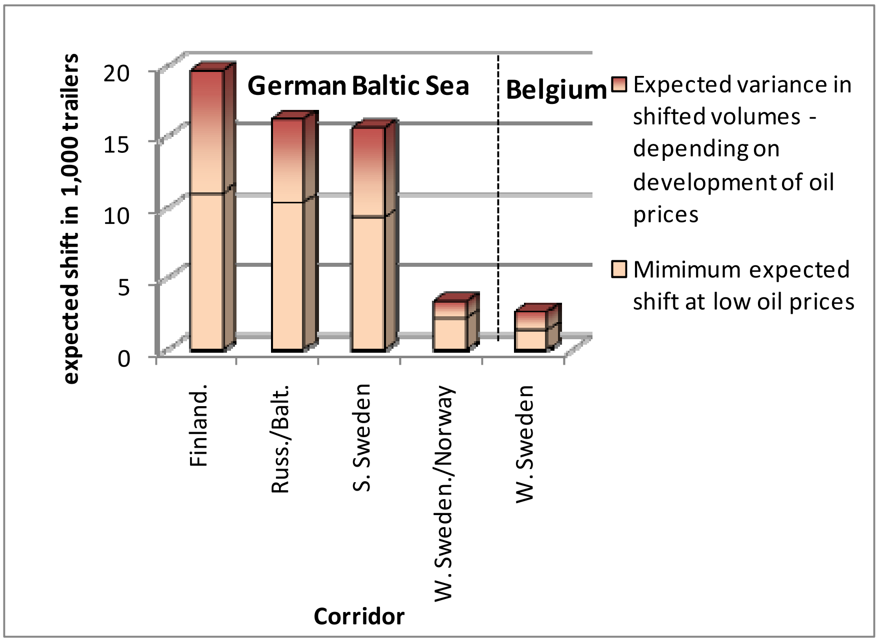
Tab. 7-1: Risk of a shift in trailer transport in 2008 for fuel prices at the upper limit of the corridor, fuel with 0.5 % sulphur content

market	estimated volume in 2015 (1,000 trailers)	expected shift in 2015 in %	expected shift in 2015 (1,000 trailers)
German Baltic Sea Ports ...			
- W. Sweden/Norway	230	1%	3
- S. Sweden	1,220	1%	14
- Finland	790	2%	17
-Russia / Baltics	300	5%	14
Belgium - W. Sweden	160	1%	2
Total	**2,700**	**2%**	**51**

* Quelle: ISL 2010

This would therefore only lead to a very minor shift in freight movements from sea shipping to land traffic.

Fig. 7-1: Expected shift in volumes of trailer transport with the implementation of the 0.5 % limit in 2015



Similar effects are seen for container shipping. Although the increase in costs here would be measurable, it would ultimately not have any major impact on the price structure. Instead of the originally forecast 820 thousand standard container units which would shift from sea transport to land transport, a shift of less than one tenth this volume is expected. However, this again has a relatively strong impact on the short routes in the direction of Denmark in particular.

Tab. 7-2: Risk of a shift in container shipping in 2015 for fuel prices at the upper limit of the corridor, fuel with 0.5 % sulphur content

	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	2%	3%	2%	21	2	23
Lithuania/Latvia	448	51	499	1%	4%	1%	5	2	7
Russia/Finland/Estonia	2,202	461	2,663	0%	2%	0%	1	11	12
Norway	338	34	371	2%	3%	2%	6	1	7
Sweden	577	64	641	2%	4%	2%	12	2	15
Denmark	340	28	368	4%	4%	4%	12	1	13
Toal	**4,771**	**712**	**5,483**	**1%**	**3%**	**1%**	**57**	**20**	**77**

* Source: ISL North European Container Traffic Model, Forecasts based on OSC

Fig. 7-2: Expected shift in volumes of container shipping (feeder) with the implementation of a 0.5 % limit in 2015

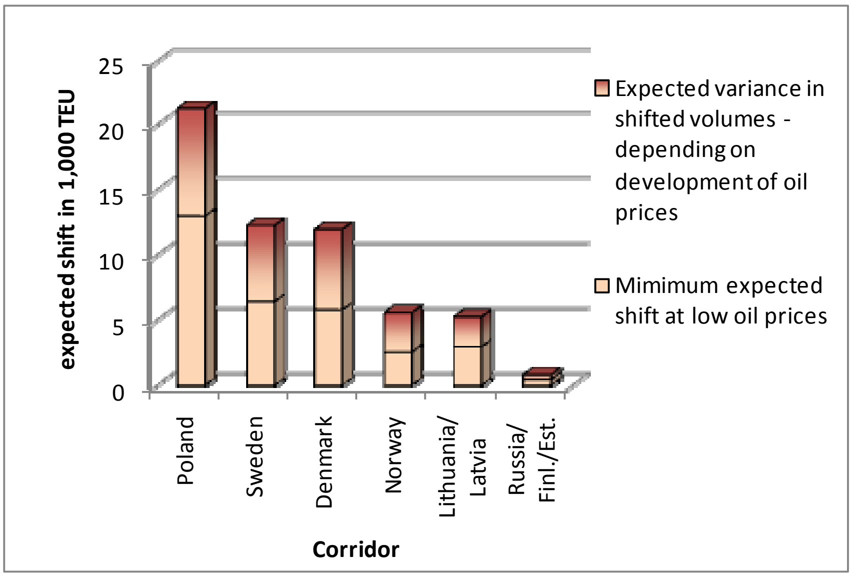
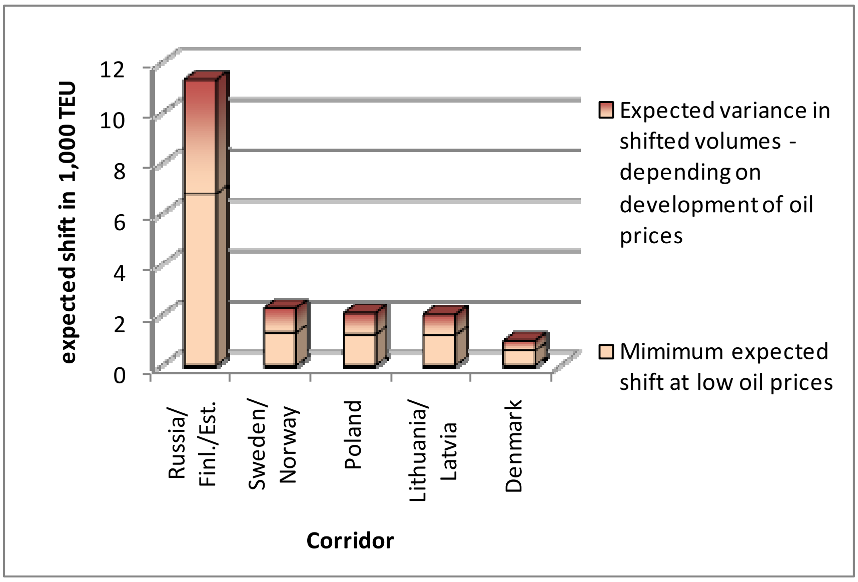


Fig. 7-3: Expected shift in volumes of container shipping (short sea) with implementation of a 0.5 % limit in 2015



Using fuel with a sulphur content of 0.5 % would therefore be a very good compromise which would lead to hardly any distortion of the market and shift hardly any freight from sea to land even though it would still achieve a significant reduction in sulphur oxide emissions. In the sea regions immediately bordering the SECAs, one could still use fuel with an up to seven times higher sulphur content.

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List of abbreviations

BRIC	Brazil, Russia, India, China
BRT (GRT)	Bruttoregistertonne (gross registered tonne) = total enclosed space (1 RT = 2.83 m^3)
BRZ (GT)	Bruttoraumzahl (gross tonnage), replaced GRT after a transition phase since 1994
ECSA	European Community of Shipowners' Assoc.
HFO	Heavy fuel oil
HS	High Sulphur
IMO	International Maritime Organisation
LNG / LPG	Liquefied Natural / Petroleum Gas
LS	Low sulphur
OPEC	Organization of Petroleum Exporting Countries
Pax	Passager
SECA	Sulphur Emission Control Area
SOLAS	IMO-Convention Safety of Life at Sea
tdw	Tons dead weight = load-bearing capacity of ships
TEU	Twenty (foot) Equivalent Unit = standard container unit

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