ESN – Way Forward SECA report

ESN, the Way Forward
26 November 2013

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1. Summary

In the European SECA (Sulphur Emission Control Area) the highest permitted sulphur content of fuel will fall to 0.1 % from January 1st 2015. Therefore a ship owner must switch to LSMGO (Low Sulphur Marine Gas Oil), LNG, methanol or another fuel with the required sulphur level. Alternatively, the ship can be equipped so that it is capable of reducing the sulphur in the exhaust gas to an equivalent level. The exhaust gases can be abated by installing scrubbers to the ships. ESN, the Way Forward –project has gathered information on impacts of the regulation: status of new technology taken into use (or in planning phase) by ship operators and ports within SECA area, as well as on governmental plans and aid schemes.

The effort to comply with the regulation is enormous. On average about 5 000 ships trade in the SECA. More than 2 000 ships stay in the SECA 100 % of their operating time. As of today, the large majority (85 %) of the fuel consumed is HFO (Heavy Fuel Oil). The fleet of large container and ro-ro ships trading 100 % of their time in SECA counts about 150 ships[1].

According to our survey most of the ship owners plan to switch to LSMGO in 2015. Marine fuels represent a minor share of the overall European diesel market. Therefore it will be possible to meet the additional demand for LSMGO, which is estimated to be 10-12 million tonnes. The long term price difference between LSMGO and HFO is expected to stay at today's level of US$ 300-400/tonne if the current oil price remains stable. At higher oil prices the difference will increase and at lower levels the difference may narrow.

According to our survey to ship owners and manufacturers of abatement technology, there exist approximately sixty scrubber installations and orders in total to both retrofits and newbuildings (November 2013). The knowledge related to real operational circumstances has been fairly scarce but along with the new installations on board the data concerning the effectiveness of scrubbers, which is measured by SOx removal, is increasing.

The LNG supply chain is currently being built. Based on our findings there are LNG bunkering facilities only in few ports at the moment, but a majority of the ports - major hub and satellite ports - have plans to offer these facilities from 2015 onwards. The current challenge regarding LNG is that the price of LNG is not competitive and the distribution is too costly due to the low LNG bunkering volumes.

At today's offered LNG prices, ship owners hesitate to make conversions or order new ships with LNG. There are therefore only few LNG-powered ships outside Norway, where ship owners benefit from investment support from the Norwegian NOx-fund. The world-wide LNG-powered fleet only counts 42 ships with additional 39 ships on order (October 2013). Most ships on order are either Norwegian or intended for trades outside the European SECA.

For newbuildings, LNG is more favourable and increasingly larger share of the new ships will use LNG. Det Norske Veritas expects that the current European LNG-fleet will grow from 66 ships now (including ships on order) to 400 ships in 2020. It is expected that economies of scale will have an effect gradually, and the price of LNG and the logistic costs will decrease making LNG an attractive alternative to HFO towards 2020.

Support for these new incentives is provided currently only by Finland and Norway, as well as by EU programmes (TEN-T).

[1] Ref; 4.1b)

2. Opportunities

In the current situation the following main opportunities exists: Use of MGO, installation of a scrubber and use of LNG. Other alternatives tested are methanol and biofuels. While estimating the best way to adapt to the new regulations, there are certain elements (economical, technical and operational) which the ship owners need to take into account.

Scrubbers

- There has been technical uncertainty on functioning of the scrubbers. However, during ESN project time, the number of orders is increasing. At the moment, there exist in total sixty installations and orders of scrubbers to both retrofits and newbuildings. Still, this is a minor share of the 2 000 vessels sailing on the SECA area.
- Several aspects have to be taken into consideration when the investment decision is made.
  - Technical suitability
  - Economic suitability; the price difference between MGO and HFO is a crucial factor. The price difference between MGO and HFO is currently US$ 300 per tonne.
  - Fuel consumption in SECA; have to be large enough
  - Operational area - time which the ship is trading in SECA
  - Expected remaining lifetime of a ship
- Payback time for a scrubber installation has been estimated to be at minimum only one to two years for ships trading 100 % of the time in SECA. The time spent in SECA and the price difference between different fuels affect the payback time significantly.
- The fuel cost for ships using LSMGO will increase significantly; a scrubber could be considered as a viable alternative, especially for ships having large fuel consumption and operating most of the time in SECA.
- A two-tier market will develop and the chartering market will very soon have different rate levels for ships with and without scrubber.
- According to case study for a 800-1000 TEU container vessel, scrubber investment is feasible for ship owners when
  - a ship is built after 2000;
  - it trades 100 % of the time in SECA;
  - ship engines are higher than 5-8 MW. The bigger the engine is, the more profitable the scrubber investment will be.

LNG

- In the future, topics related to energy are represents a major challenge for Europe. One important target is to create a common market for LNG in Europe.
- Uncertainty related to the LNG market and its price and price development is hindering the deployment of LNG. Diminishing this uncertainty is essential in order to increase the use of LNG.
- Import, storage, distribution and end use of LNG requires major investments that cause hesitation among potential LNG users.
- Since the use of LNG as a marine fuel is fairly minor in the near future, the land-based use of the industry and the traffic, have a relevant importance when extending the use of LNG.

- LNG is an interesting alternative for ships staying 100 % of the time in SECA and trading frequently on ports offering LNG bunkering facilities, if the LNG is priced more favorably than today.
- According to estimations of SPC Norway, LNG can be considered when LNG-contracts are offered at LNG prices less than 10 % higher than the HFO price.
- Longer supply contracts could diminish the uncertainty related the LNG prices and investment decisions.
- The European LNG bunkering market is expected to grow to 2 million tons before 2020. Economic aid to for example small ships calling LNG terminals could be considered in order to make possible bunkering LNG at reasonable cost at the terminal.

Other alternatives

- Methanol is an interesting option as a ship fuel. Stena Line is piloting the use of methanol and the results may be interesting for other ship owners, too.
- Biofuels have also been tested. Second and third generation biofuels do not compete with food production.

Supply of MGO

- Supplier of bunkers to ships in North-Europe need to be prepared for an increase in demand for MGO from the current level of 7 million tonnes per year to 17-20 million from the start of 2015.

Support to new technology

- The support from the governments and the EU is of fundamental importance and should continue. Incentives are important for ship owners when they start using environmental technologies and for investments in infrastructure.

Monitoring of enforcement of new regulation

- Monitoring of compliance with the new regulation and enforcement is vital to offer a level-playing field for ship owners and operators, in particular for those who comply with the new regulation.

3. Introduction

This SECA –report has been produced as the main deliverable of the Environment work package of the project ESN - the Way Forward. From 1 January 2015, all ships in the SECA (Sulphur emissions Control Area), which includes the English Channel, North Sea and Baltic Sea, must use fuel with a sulphur content of less than 0.1%. Alternatively, the vessels must have cleaning system (scrubbers), which reduces the sulphur content of the exhaust gases accordingly. Ship owners can also choose LNG or alternative fuels such as methanol or biofuel.

The aim of the report was to provide a clear assessment of the current situation and a set of recommendations to the current problem posed by the compliance with the 0,1% sulphur content in marine fuels by 2015.

This report gives an overview of the current status of preparedness for 2015. It presents the main alternatives available and status of their use among ship owners and ports as well as plans for future. Information has been collected from publicly available sources, reports, seminars, interviews and via own surveys. Available sources of funding for new environmental-related practices and technologies are also presented.

Major part of this information has been published during the project time at shortsea.info/environment and distributed for the recipients of the environmental newsletters. We have sent altogether 17 environmental newsletters.

We thank the EU Commission for the funding this joint initiative of the ESN, which made this report possible.

a) Rates and factors

In this report we have used the following rates and factors, unless otherwise stated:

- € 1 = $ 1,38
- 1 MWh = 3,4 mmBtu

The energy content of the various fuels may vary. We have used the following energy content for the alternative fuels in our comparisons:

- 1 tonne of HFO = 11,3 MWh
- 1 tonne of MGO = 11,8 MWh
- 1 tonne of LNG = 13,7 MWh

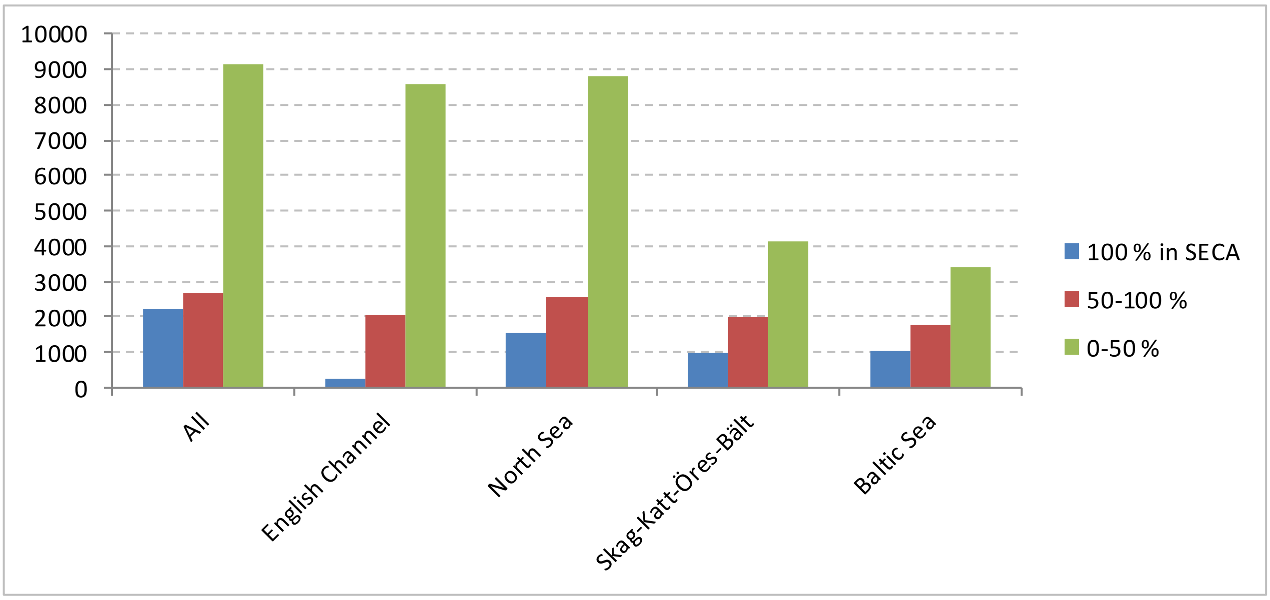
4. SECA Traffic, Bunkering and Volume Impact

4.1 Fuel consumption and fuels used

a) Ships in SECA

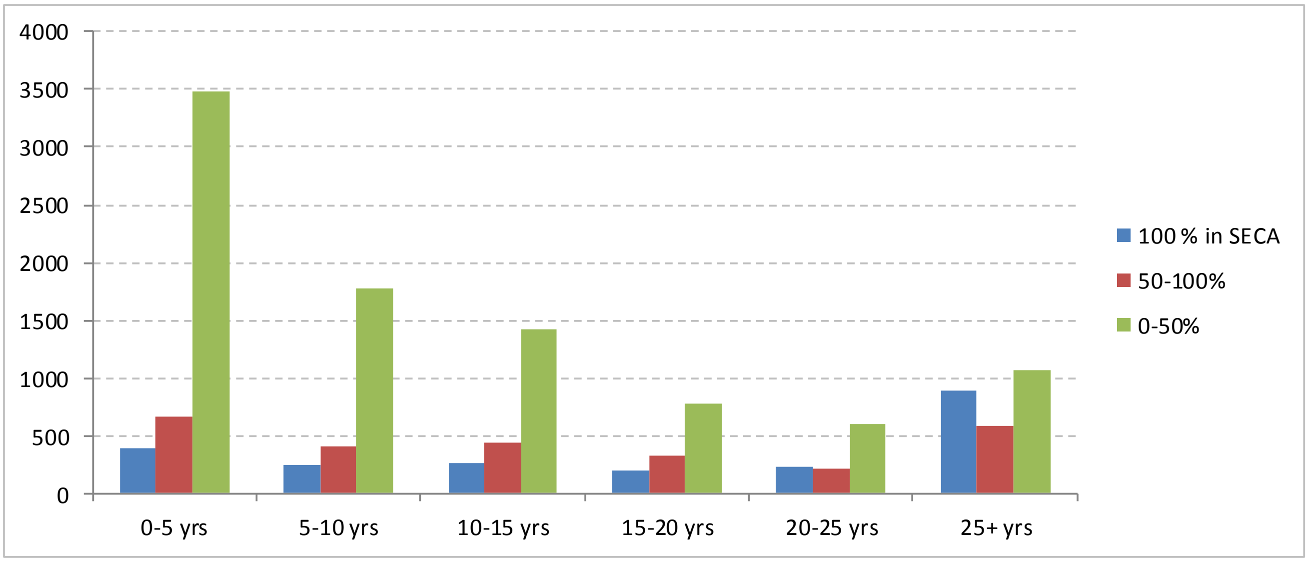
There are about 5 000 vessels[2] in the SECA at any time, on average. About 14 000 vessels visit the area in a year. 2 200 ships spend all of their time in the area and 2 700 more than 50 % of their time. 71 % of the ships belong to European operators. In the Baltic Sea and the area leading into it, the share of ships that stay 100 % of their time in the SECA is high.

Figure 1. Number of ships in the SECA by area and time spent in SECA



Source of data: AIS study in DMA - North European LNG Infrastructure Project

Figure 2. Number of ships in SECA by age of ship and time spent in SECA



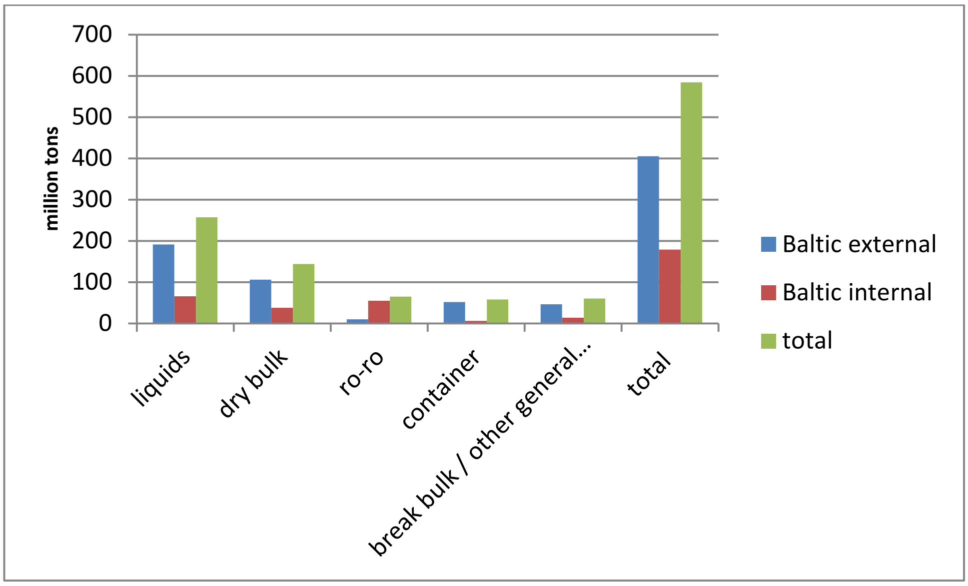
Source of data: AIS study in DMA - North European LNG Infrastructure Project

[2] Ref: Danish Maritime Authority (May 2012). North European LNG Infrastructure Project http://is.gd/yi8id0

It is more profitable to convert younger ships and ships that stay a large share of their time in SECA. According to the same report, the number ships that are less than 10 year old and that stay 100 % of the time in SECA is 652.

As presented in the figure below, a specific characteristic of Baltic Sea area is that 85% of ro-ro is Baltic internal maritime transport. Of container transport ca. 90 % is Baltic external transport.

Figure 3. Structure of Baltic Maritime Transport according to the type of cargo (2010)

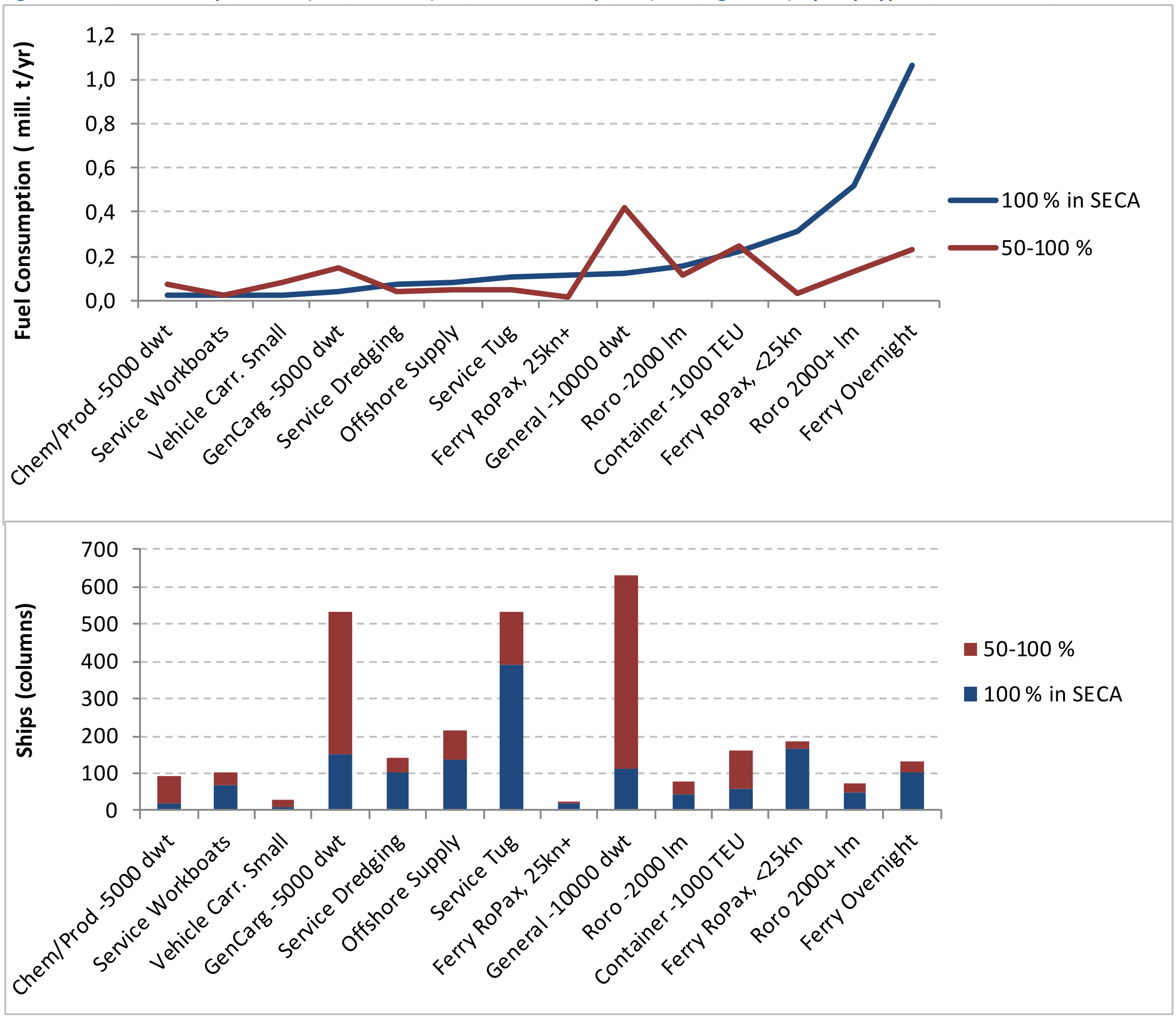


Source: Breitzmann et al.2013.

b) Most relevant ships for conversion

The next figure shows the ship types that are most affected by the new regulation and that stay a large share of their time in SECA. The segments that consume most fuel are ferry, ropax, ro-ro and container ships. The ship types that risk losing cargo to trucks are ro-ro and container vessels. There are about 150 ships of these types that trade 100 % of the time in SECA. These ships should be prioritized to avoid back-shift of cargo. Roughly half of them are less than 10 years old. At an average cost of € 4 million per conversion it would cost about € 300 million to convert the ships that are less than 10 years old. To offer government support for such conversion would be a small investment to avoid back-shift of some of the 1,5-2 million of trailer-loads they carry every year. Finland and Norway are already offering such support.

Figure 4. Number of ship in SECA (bars-left axis) and fuel consumption (lines-right axis) by ship type and time in SECA



Source of data: AIS study in DMA - North European LNG Infrastructure Project

c) Fuel consumed in SECA

The fuel consumption of the ships in SECA was estimated in the European LNG Infrastructure Project [3]. The estimated total is about 12 million tonnes (mt) per year. Of this 3.3 mt was consumed in the Baltic Sea, 1.5 mt in Skagerrak and Kattegat, 5.0 mt in the North Sea and 2.3 mt in the English Channel.

According to Ship Traffic Emissions Assessment Model (STEAM)[4] of the Finnish Meteorological Institute, the total fuel consumption of the vessel traffic in the SECA was approximately 17 million tons in 2011.

d) Share of ships on HFO

It have been estimated[5] that the share of low sulphur fuel (marine gas oil or marine diesel oil) is approximately 15% of fuel used. With the consumption of 17 million tons of fuel it means approximately 2.5 million tons of low sulphur fuel.

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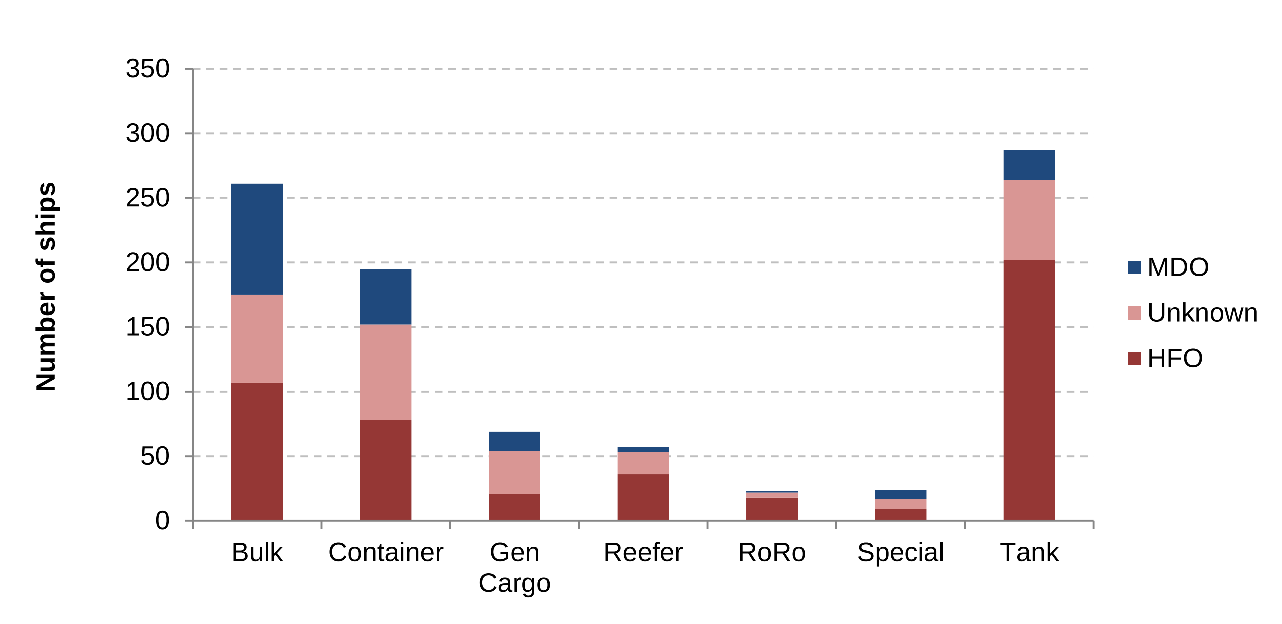
[3] Danish Maritime Authority (May 2012). North European LNG Infrastructure Project - http://is.gd/yi8id0

[4] Jalkanen et al. 2012. Extension of an assessment model of ship traffic exhaust emissions for particulate matter and carbon monoxide

Figure 5. Norwegian shortsea fleet by fuel type



Source: SPC Norway based on data from www.ship-info.com

The above chart shows that 50 % of the ships in the Norwegian short sea fleet of about 1 000 ships use HFO. 18 % of them use MGO. For the remaining ships the fuel type is unknown from our data source. Assuming the same ratio for HFO/MGO for the unknown, the share of ships that use HFO is about 70 %. Within Norway 80 % of the fuel sold is MGO[6], reflecting that the share of MGO in coastal transport is higher. We can therefore conclude that there will be no problem supplying sufficient MGO in Norway. Similar conclusions may apply for other countries than Norway, since coastal transport is often made by small ship using MGO. Also, since HFO is cheaper in the central European hub ports, we must assume that ships that are larger and consume more fuel, purchase their fuel in the central European hub ports.

4.2 Impact of SECA

Stricter environmental regulation makes short sea shipping more environmentally friendly. The challenge is that new environmental requirements only affect water transport. Sea transport loses market share and CO_2 emissions from transport will increase.

The SECA regulation will substantially increase the cost of maritime transport and it will be more expensive for cargo owners to use sea transport. This will lead to a back-shift of cargo from sea to road.

Since IMO's decision in 2008 on the amendment to MARPOL Annex VI sulphur content in maritime fuel to be used in SECAs, several studies have been made on the impact of the stricter regulations. Maritime transport is important in whole SECA. In 2011, total cargo volume is the North Sea[7] was about 1 828 million tons[8]. In 2012, total cargo handling in Baltic Sea ports amounted to 839 million tons[9]. In terms of volume, sea transport is the decisive transport mode for Sweden and Finland and the most important for Denmark

[5] Ref: Kalli J. 2012
[6] Ref Næringslivets NOx-fond (June, 2013). Et bedre fungerende LNG-Marked. http://is.gd/HOZQ9J
[7] Including all of UK, but only North Sea bassin of Germany and Sweden
[8] Source: Eurostat table - http://is.gd/rmHzfV
[9] Source: Baltic Port List 2013.

and Russia[10]. Stricter regulations will increase the costs of maritime transport which has influence on the industries in the region.

The SECA regulation has different impacts on the countries in the area because of different geographical locations. Geography influences mainly West-East routes in Europe, and there is strong competition with road transport. The rising costs may increase transport on road, which already has a major share in transportation of high-value exports, 62 %, from West to East. [11]

Finland is affected most by stricter regulations on sulphur content in fuel, as over 80 % of trade is transported by sea. Maritime transport is nearly always used in west-bound transport. Finland's industry is fully dependent on efficiently operating maritime transport in all shipping segments. It is expected that price increase of fuel and freight costs will be transferred directly into the prices of products and raw materials which might cause that production will be transferred to lower cost countries.

a) Impact studies made until 2010

EMSA produced a report that contains an overview of the available studies until 2010. The reports had been ordered by the member states in the SECA area and by ECSA, the European Community Ship Owner Association. The European Commission commissioned three studies. In addition, ship owner associations of Belgium, Finland, Germany, Holland, Sweden and UK; endorsed by the wider membership of ECSA and ICS, commissioned in 2010 an assessment on the existing studies.

The conclusion of EMSA's report[12] notes that the studies are based on different perspectives and different parameters, but central to all of them is the price for low sulphur fuel. General conclusions based on the studies available in 2010 are:

- The ship owner will have increased costs due to the new regulations, either in form of increased operational cost due to higher fuel costs or investment cost in new technology.
- The increased costs will be paid by the ship owners or by the transport buyers, which is the more probable option according to the report. If the costs will be paid by transport buyers, it is expected that the volumes of transport goods in the short sea shipping segment are affected.
- The Finnish study estimated that the costs will most probably be channeled to sea freights and the transport buyer.
- On the other hand, the Swedish study notes that the price is difficult to be channeled to sea freights, because industries in the SECA compete with industries in the areas which do not have these kinds of requirements. ECSA's study says this is difficult due to competition from road.
- There are certain risks for modal-back-shift, within certain limited routes and under certain (high-end) fuel price scenarios. This risk is probable on the routes where a competition from truck or rail exists.
- However, not all medium- long shipping routes traffic is expected to be lost to rail or road transport, but to other SSS routes involving a shorter sea leg.

[10] Breitzman 2013. BSR InnoShip.
[11] Breitzman et al. 2013. BSR InnoShip.
[12] European Maritime Safety Agency Technical Report 1.2010.

- The studies point out that the benefits for the society (health and environmental benefits) are higher than the costs in implementing the new requirements.

b) Impact studies between 2010 - 2013

The estimates on the increase of freight costs usually vary between 30-50 %. For example, in a study of PENTA project[13] it is estimated that on longer voyages, such as between Finland and Europe, the sulphur directive will increase the costs of sea freight up to 30% or 40%. The impact of the price increase is assessed to result in the increased use of roads in the Baltic States and Sweden to avoid expensive shipping as road transportation from Finland to Europe is currently only 20% more expensive compared to the sea transportation. From the point of view of the shipping companies, the sulphur directive increases operating costs and the longest routes will suffer the most.

Also the recent report of UK Chamber of Shipping[14] assesses there will a modal shift: sea routes will become shorter because of price increase. The report states that increased prices on longer sea routes will result in haulage operators switching from longer sea routes to shorter sea routes which require longer road journeys. This will result in a reduced viability of some ferry routes. In the North Sea Western Channel, the loss of viability of routes and port operations has the potential to displace thousands of jobs. The modal shift is expected to increase congestion on the roads and to create local environmental problems.

The Finnish Ministry of Transport and Communications commissioned in 2012 an update[15] on the impacts of the new IMO regulation on transportation costs. The price increase for vessel traffic concerning Finland was estimated to be 371 million euro annually. The costs for vessels under a Finnish flag are € 64 million. The report also estimated the economic potential of scrubber investment for vessels under a Finnish flag.

A report prepared by Sweco[16] in October 2012 outlined the following consequences:

- 2% of all ships (300 ships) with daily operations (of 14.000 totally) in SECAs start using alternative fuels (primarily LNG, but also methanol).
- 2.5% of all ships (350 ships) will install scrubbers.
- Sudden demand of 20 million tonnes of LSMGO in 2015.
- In 2015, there will be a temporary shift in the market shares of the three modes of freight transport. By 2020 the shares are expected to be back at the starting mix.
- an increased demand for rail freight transport from Central Europe to Sweden is expected, resulting in a reduced ability for haulers to give discounts for transport in the opposite direction.
- The price spread of LSMGO/HFO will be over $ 350 per ton in 2015.
- Ro-ro, containers in SSS sector, also low valued goods like pulp logs, wood chips, peat moss, will be the most seriously affected.

The report also estimates that costs faced by road diesel users will increase.

[13] Lappalainen A. Scenario-Based Traffic Forecasts for Routes between the Penta Ports in 2020 A 65 (2013).
[14] UK Chamber of Shipping Impact on Jobs and the Economy of Meeting the Requirements of MARPOL Annex VI. AMEC Environment & Infrastructure UK Limited. March 2013.
[15] Kalli J. 2012
[16] Swedish Maritime Administration (2009), Consequences of the IMO's new marine fuel sulphur regulations.

BSR Innoship[17] estimates that the additional cost of sea transport is about € 3 billion per year. The calculation is based on a SECA fuel consumption of 15.7 mt/year, an assumed current share of HFO of 85 %, and a price difference of US$ 294/ton between LSMGO and HFO.

c) Regulation on nitrogen oxides

The IMO accepted new stricter regulations for nitrogen oxide emissions in 2008 for new as well as some of the old diesel engines. This emission standard, Tier III, requires a designation of a sea area as an Emission Control Area. HELCOM Annual Meeting 2012 decided to propose to establish a Nitrogen Emission Control Area (NECA) also in the Baltic Sea area. Hence the follow-up measures have not yet been decided. The status of Nitrogen Emission Control Area is included in the HELCOM Baltic Sea Action Plan.[18] In 2010, the North Sea countries decided to initiate a process that entails studies of environmental and economic implications of an emission control area (ECA) for NOx in the North Sea, including the English Chanel, in the following referred to as NECA. Both at the Baltic Sea area and in the North Sea area assessments on environmental and economic consequences have been carried out, but not in the same extent as regarding the sulphur regulation.

The report assigned by the North Sea Consultation Group[19] assesses that the introduction of an SECA and an NECA in 2015 will increase the cost of sea-based transport by 8 %-16 %. For the entire sea-based travel route (including road haulage), the cost increase is 5%-13%. However, they estimate that less than 1 % of the cost increases is related to NECA. The report also says that a North Sea emission control area being SECA and/or NECA only will give rise to minor modal shifts.

d) Case study - Cost increase for Rotterdam-Oslofjord

The short sea segment with most direct competition with trucks is container and ro-ro. None of the earlier mentioned studies have focused on this segment in particular. We have therefore made our own case study of this.

We have done this calculation for a typical sea transport from Rotterdam to the Oslofjord by a 40-foot container. In our case study, the fuel price for HFO was $ 610/ton (28 February - 2013), while for LSMGO the price was $ 930/ton. This represents a price difference of € 257/ton.

A typical ship carrying 800 TEU (or 400 FEU - 40 feet containers) burns about 1.4 tons / hour. The round-trip consumption Rotterdam, Oslo and return via Kristiansand represents 93 tons of oil. The additional cost for the roundtrip corresponds to about € 24 000. Assuming a load rate of the ship at 75%, this amounts to EUR 80/FEU per round trip. This represents an increase of 8-10% of the cost of transport from port-gate to port-gate, i.e. including terminal handling in port at both ends. For the door-door price the cost increase will be even smaller.

For smaller ships the extra cost per 40-foot container are slightly higher. Shipping companies we have spoken with say the extra cost is in the order of € 80-110/container. The smaller vessels operate in segments where rates are somewhat higher. The % estimate is therefore still quite accurate.

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[17] http://www.baltic.org/bsr_innoship
[18] Transport and the Environment 2013
[19] The impact on short sea shipping and the risk of modal shift from the establishment of an NOx emission control area. North Sea Consultation Group. 2013.

For ro-ro ships the price increase is a higher on the same distance, since they consume more fuel per cargo unit. The SECA regulation will therefore make container vessels more competitive relative to ro-ro vessels.

We can therefore conclude that the sulphur emission rules in 2015 will lead to an increase in transport costs to Norway and loss of market share for sea transport. The expected cost increase will be 8-10 % to the Oslofjord (port-gate to port-gate). For door-to-door the cost increase will be lower in %.

Based on a price sensitivity of 0.5 % for a price increase of 1 %, and accounting for uncertainties, the expected backshift of cargo due to higher transport prices is 3-7 % for transport to Norway. The back-shift will be limited for feeder cargo, which constitute 50-70 % of the cargo to Norway.

Sea transport is more competitive on longer distances where the margin relative to truck is higher. This would indicate that longer distances will have less back-shift.

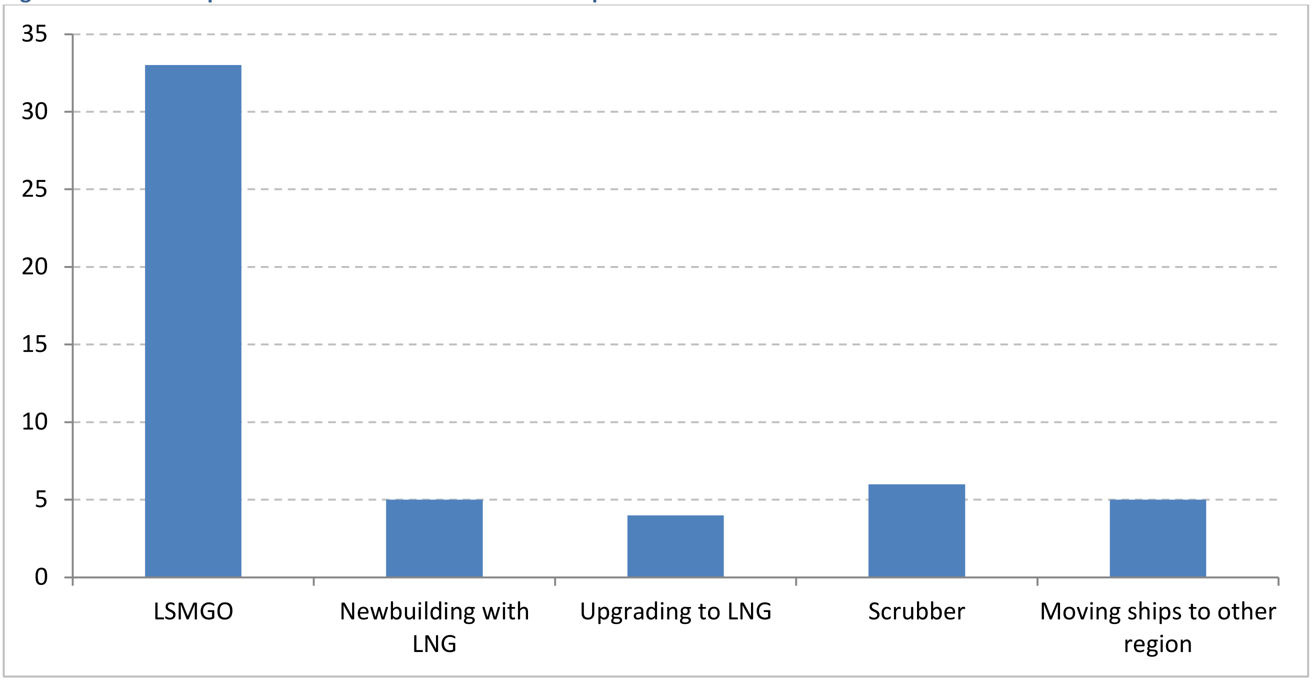
5. Ship Owners - Benchmarking of Alternatives

5.1 Preparation by Ship Owners

a) ESN survey - Most ship owners prefer LSMGO

In the first half of 2013 we made a survey of the plans to meet the SECA requirements. 33 ship owners responded, of which the majority were based in Norway and Finland.

Figure 6. Plans of ship owners on how to meet the SECA requirements



Source: ESN survey of ship owner plans

The most viable solution seems to be marine diesel with low sulphur content (LSMGO = Low Sulphur Marine Gas Oil). In our survey, 70 % of the shipping companies say that they are considering only going for this option. The remaining owners say that they are also considering scrubber for their second hand ships and LNG for newbuildings. A few owners are planning to sell or move their ships to other areas. Based on the comments from the ship operators we can conclude that scrubbers are preferred for ships with at an age of 0-10 years. LNG is preferred for newbuildings, if the ships have a regular trade pattern and spend all their time in SECA.

We can therefore conclude that from 2015 the preferred choice is LSMGO. The demand for LSMGO will therefore increase significantly.

b) BSR Innoship survey

According to the responses from the BSR Innoship survey (2013)[20] there will be a high demand for MGO as of 2015 due to limited time to retrofit the existing vessels to comply with regulation of 0.1% sulphur in fuel. The general opinion among the shipping companies was that there will be no difficulties with availability, but the price of the low sulphur fuel will be high. The geographical aspect was also seen as a possible obstacle; MGO will be available in main bunker ports, but might be scarce in smaller ports. If the vessel is

[20] http://eu.baltic.net/Project_Database.5308.html?contentid=64&contentaction=single

operating both in ECAs and in other sea areas it will probably switch the fuel and use high sulphur fuel where it is permitted and MGO where it is imposed.

c) Motivation and preferences of ship owners

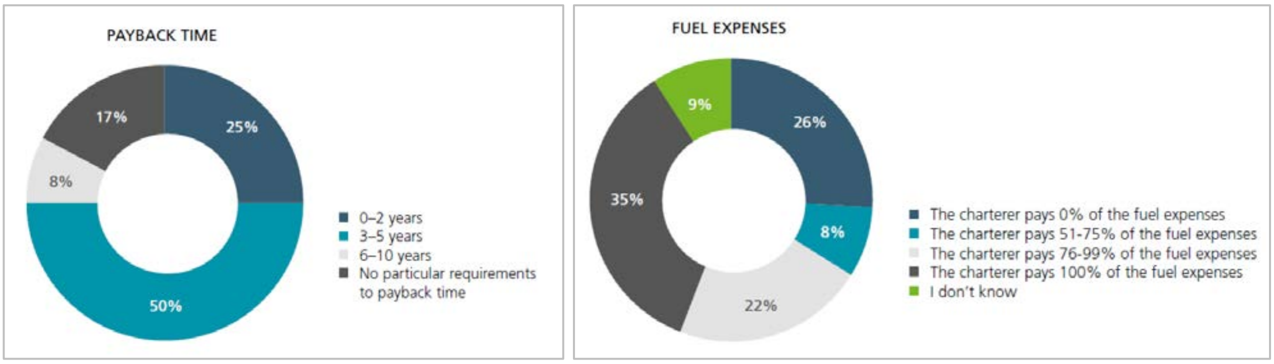
Det Norske Veritas has made a survey on the motivation and preferences of ship owners. The main environmental motivation of ship owner is, by order of priority:

1. Comply with rules and regulation
2. Become more fuel efficient and save cost
3. Maintaining trade flexibility
4. Branding, innovation, first-mover perception

The main barriers to making environmental investments are, by order of importance:

1. High cost of investment
2. High cost of operation
3. Technical maturity/reliability/experience
4. Lack of competitive incentives
5. Safety of ship and crew
6. Complexity of installation and integration
7. Crew know-how for operation
8. Acceptance of class

Figure 7. Ship owner investment preferences and payment of fuel expenses



Source: Det Norske Veritas

The above chart shows that most (50 %) of the ship owner require a payback time of 3-5 years and 25 % require 0-2 years. In most of the cases the charterer pays for the fuel expenses, giving the ship owner less incentive to make investments to reduce the fuel cost.

Based on this survey, we can conclude that there are major inhibitors to investments in scrubbers or LNG-fuelling.

d) Ship owner best practice

Some ship owners are more active than others in making fuel-related investments.

In 2007, Maersk set the target of reducing emissions 25 % by 2020. This goal was reached in January 2013.[21] New targets were set[22]. The new ambition is to reduce emissions by 40 % from 2007 to 2020.

Nor Lines[23] has contracted two multipurpose ships that are fuelled by LNG. These ships were winners of "Next Generation Shipping Award" on Nor Shipping in 2011.

Both DFDS and Color Line has decided to invest in scrubber. In the latest months (autumn 2013), more owners are making enquiries for scrubbers.

Stena Line is in the process of evaluating methanol as fuel for ships[24].

5.2 Use of LSMGO

We have seen that most of the ship operators are opting for LSMGO, at least in the short term perspective and for ships older than ten years. This alternative requires a minimal investment, but has high operation expenses.

Upon regulations coming in force the refinery plants will produce and supply fuels containing 0.1 % at higher prices. The refining of crude oil is a heavy process which consumes a lot of energy and leaves the worst part of oil to be placed somewhere. Earlier the shipping sector has been the graveyard for the crude oil, but the current and forthcoming situation with stricter regulations does no longer allow it. Due to the rising environmental awareness it is expectable that in the future other emissions from maritime transport will be regulated as well.

a) Price relation HFO/LSMGO

In the below chart the spread refers to the right axis. We see that the spread currently is US$ 250-400 per tonne. The key question is how this price relation will develop.

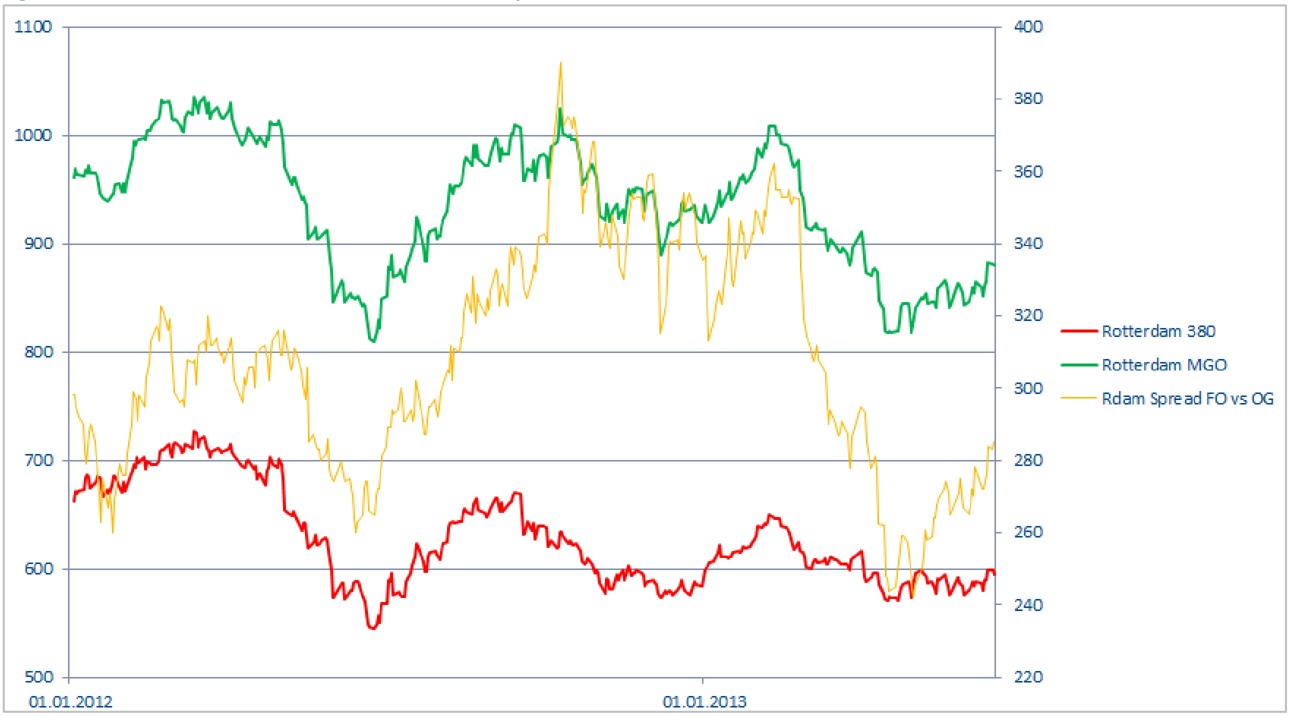
[21] http://www.maerskpress.com/Latest%20News/maersk-line-reaches-2020-co2-target/s/28c43229-765c-4375-8e86-bcf1a43e4d34

[22] http://www.maersklineroute2.com/

[23] http://www.norlines.no

[24] http://www.shiptonorway.no/SitePages/NewsDetail.aspx?nid=120&t=We+prefer+methanol%2c+thank+you!

Figure 8. HFO 380 versus MGO in Rotterdam in US$ per tonne

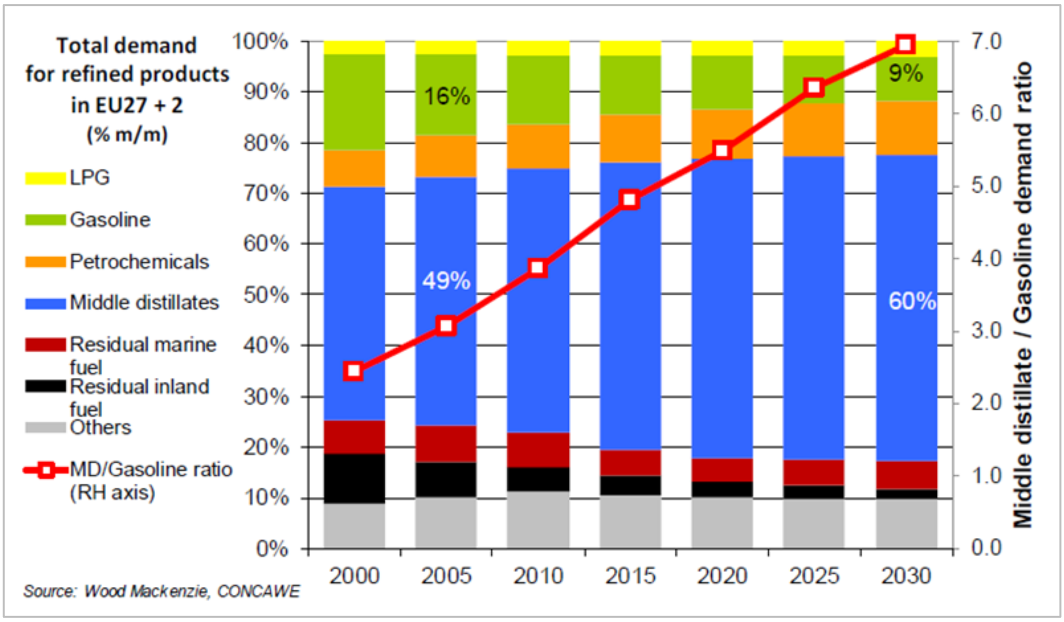


Source: Wilhelmsen Marine Fuels

b) Future supply and demand of diesel

Europe is short on diesel and a net importer. 30-40 million tonnes out of demand of 250 million is imported. The diesel deficit in Europe is expected to grow to 100 million tonnes in 2020. Diesel is the most important oil product by demand in Europe, and is showing the strongest growth globally. Refineries are struggling to make profits and imports to Europe will increase as percentage of total sales.

Figure 9. The relative demand for middle distillates



Source: Wilhelmsen Marine Fuels

80% of the European middle distillate production is diesel fuel with sulphur content below 0.05%. The extra distillate demand generated by the 2015 changeover from fuel oil to distillates within the SECAs is insignificant to the total market balance for distillates in the Atlantic basin. However, as Europe is already short on distillates, the changeover will increase the tightness in distillate markets and lead to further price increases. As North America is currently a net exporter of distillates the situation here is expected to be less tight. Furthermore it is estimated that North American refiners can increase their yield (% of output) of distillates by 4-5% percentage points without major investments.

c) Sufficient supply of MGO

The current EU bunkering market represents about 57 million tonnes, of which MGO is 7 million tonnes per year. This represents a small share of the diesel demand in Europe. The changeover from HFO to MGO is limited relative to the overall market (2.4 % according to number in following figure). It will therefore be possible to supply the extra maritime fuel.

Figure 10. 2015 change over to MGO compared to total demand in European and American SECAs

2015 changeover	MT	Barrels	Bpd
North European ECA	22 000 000	139 700 000	382 740
North American ECA	15 000 000	95 250 000	260 959
Total volume change			**643 699**

Source: EPA, Purvin & Gertz

Total demand in Europe and North America in Million b/d	2000	2009	2015
Additional ECA demand for middle distillates*			0,6
Middle distillates	13,5	14,0	14,8
Light distillates	14,4	14,1	15,0
Fuel oil	3,5	2,3	1,8
Others	8,1	7,8	8,3
Total	**25,9**	**24,3**	**25,1**

* Assuming 100% changeover from Fuel oil to MGO in ECA's

Source: BP Statistical review of energy 2010, WPMF research 2010

Source: Wilhemsen Marine Fuels

One barrel per day (bpd) is equivalent to 55 tonnes per year. According to the preceding figure the increase demand in Europe equals 21 million tonnes, which is a high estimate compared to others estimates we have shown earlier.

d) Extra supply from Russia

Russian refineries have the potential to boost diesel output. 20 refineries are planning upgrades. This could boost diesel output by 12 million tons. Most of the refineries are located in the European part of Russia and would naturally send their exports westwards.

e) Fuel availability in the Mediterranean Sea

Several South-European refineries have boosted diesel output and may supply some of the short fall in Northwest-Europe. Currently the availability is good. No problems are expected in 2015. The area has high production of 10 ppm gasoil (automotive diesel), which can be used for as marine fuel as well. Several refineries have upgraded in the last years, increasing distillate output. Saudi-Arabia is establishing export refineries along the Red Sea. These will be important suppliers of distillates to the South-Europe.

f) Fuel availability in Nordic countries

MGO is readily available along the Norwegian coast, both 0.1% and 0.05% sulphur. Statoil is main supplier, sourcing from the Mongstad refinery. Mongstad and Slagen can produce around 6-7 million tonnes of diesel per year, consumption for the domestic car market is 3.5 million tonnes. This leaves around 3 million tonnes for the marine market. The marine market is estimated at around 1.4 million tonnes per year. Both Denmark and Sweden are net exporters of distillates currently and will have sufficient diesel for the increase marine demand. The Finnish fuel suppliers have predicted that there should be no difficulties with the availability of fuel with sulphur content less than 0.1% in the year 2015.

g) Future HFO-MGO spread

Spread depends on several factors:

- Absolute oil price level
- Profits for distillates
- Fuel oil availability
- Economic growth

According to Wilhelmsen Marine Fuels, the drop in demand for HFO due to changeover to MGO is small relative to the overall market for HFO. In an environment with stable and rising oil price, the current spread of US$ 350-400/tonne will be stable in the long term with a slight increase. Dropping economic grown and lower oil prices will lead to lower spread. High growth and growing oil prices will lead to a higher spread.

h) Cost of retrofitting from HFO to MGO

The estimated cost of engine conversion to MGO is € 130 000[25]. In addition € 49/kW for SCR to comply with the NOx requirements (typically US$ 360 000 for an 800-1000 TEU container vessel).

5.3 Use of LNG

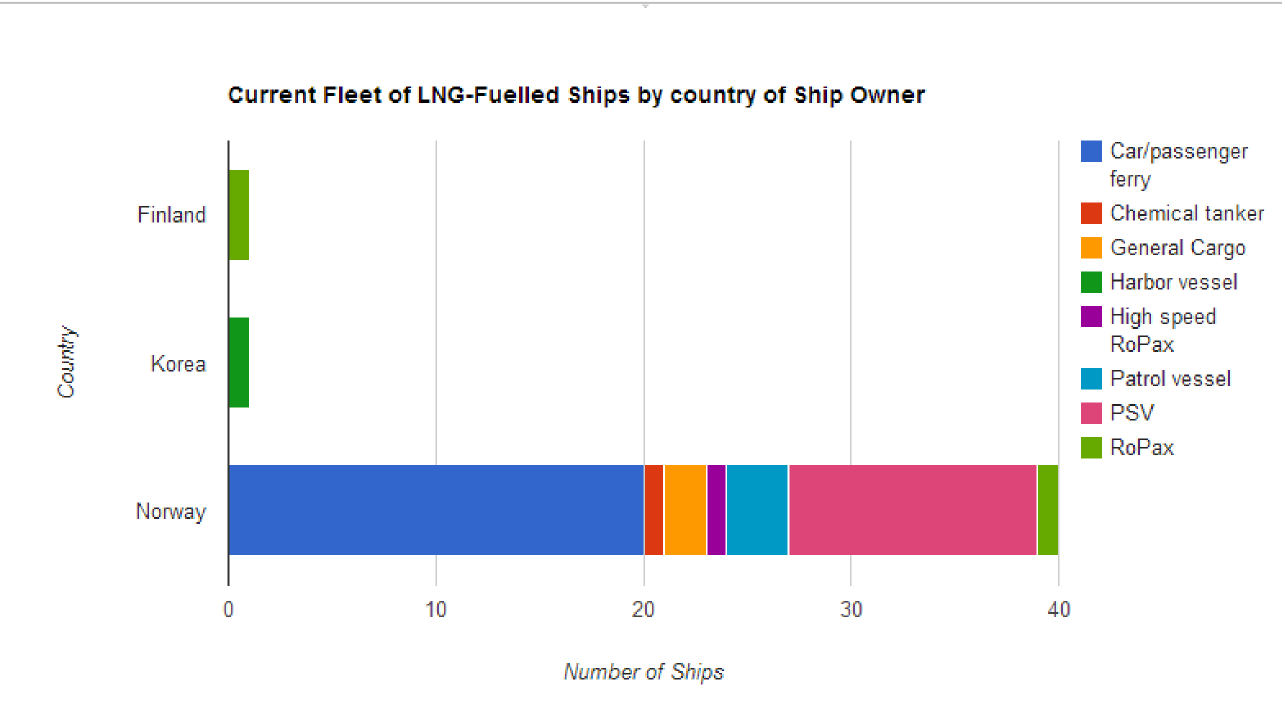
In the Commission Staff Working Document (European Commission 2013) it is stated that LNG (Liquefied Natural Gas) is the most promising alternative shipping fuel in the short term, at least for short sea transport. The sulphur emissions and particulate matters can be reduced almost entirely and nitrogen oxides by 90% and CO_2 by 20-25% with LNG. In addition to environmental advantages, LNG is considered to have a potential to decouple bunker prices from the price of oil which is expected to increase in future. At the same time there are many challenges related to LNG before it can be regarded as a real alternative. The main obstacle at the moment is missing bunkering network which withhold shipping companies' investment and conversion plans. Unharmonized bunkering rules and facilities weaken the willingness to invest on LNG.

a) LNG-powered fleet

The uptake of LNG is very slow. Only 42 existing vessels (October 2013) use LNG as a fuel. They are mainly Norwegian and there are few cargo vessels.

[25] Ref: Danish Maritime Authority (May 2012). North European LNG Infrastructure Project - http://is.gd/yi8id0

Figure 11. World fleet of LNG Fuelled ships

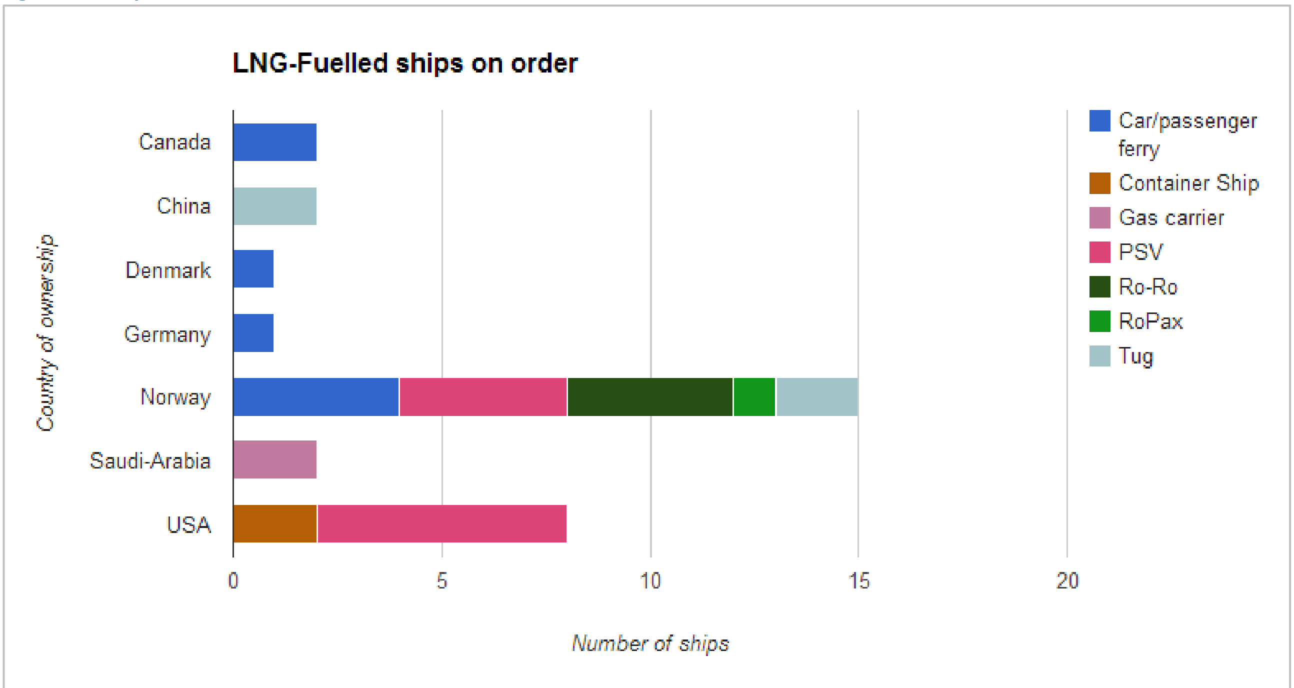


Source of data: Det Norske Veritas

b) Development of LNG-fleet

There are (October 2013) 39 ships LNG-fuelled ships on order. Most are bound for Norway.

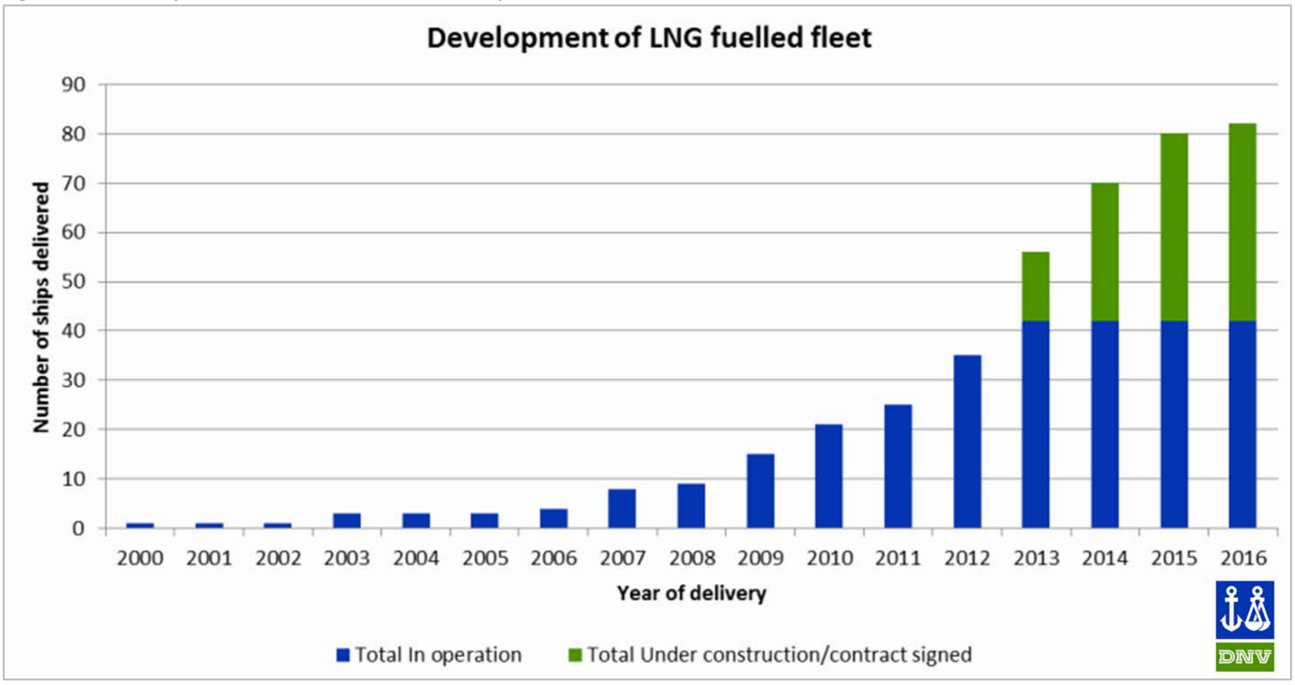
Figure 12. Ships on order with LNG fuel



Source of data: Det Norske Veritas

Based on the current order book, the fleet of LNG-fuelled will be 80 in 2015, of which 66 will trade in Europe. This compares to 5 000 ships in SECA on average (ref 4.1a). LNG will therefore not solve the problem from 2015.

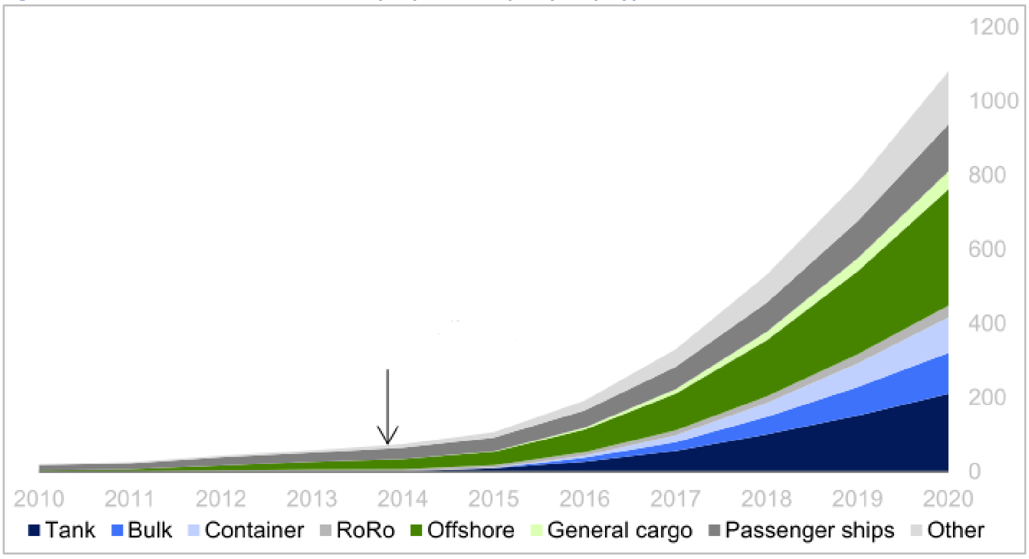
Figure 13. Development of LNG fuelled fleet of ships



Source: Det Norske Veritas

Det Norske Veritas estimates [26] there will be 1000 new LNG-capable ships by 2020. This represents 10-15% of the expected newbuildings in the period from now. The estimate includes ships with either pure LNG or dual-fuel engines. Larger ships will have higher LNG share since they benefit more from LNG. In 2018-2020, about 30% of the newbuildings will have LNG engines. Det Norske Veritas estimates that about 400 of the ships will trade in North-Europe.

Figure 14. Forecasted number of LNG-propelled ships by ship type towards 2020



Source: Det Norske Veritas

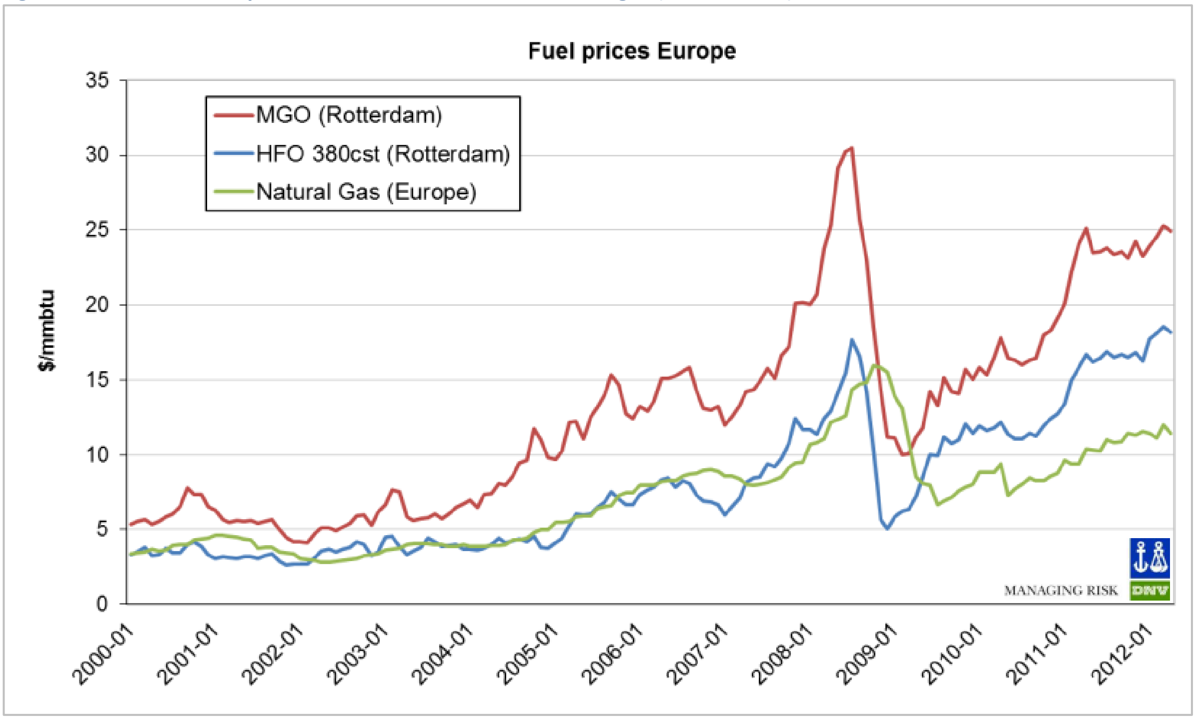
c) Price of LNG and price relation LSMGO/LNG

The future price of delivered LNG is the most important criteria for choice of solution from 2015. The following figure shows that until 2009 the price of natural gas has been close to the price of HFO. The shale

[26] Source: Det Norske Veritas – Presentation made by Martin Crawford-Brunt at Nor Shipping - 2013

gas revolution has changed this, making LNG a more favourable fuel for the future. In Europe the price of gas is now higher than in USA, but the price relation to MGO is still very favourable. The below figure shows that the price is natural gas to the pipelines is roughly 50 % of the price of MGO and 65 % of the price of HFO per energy unit.

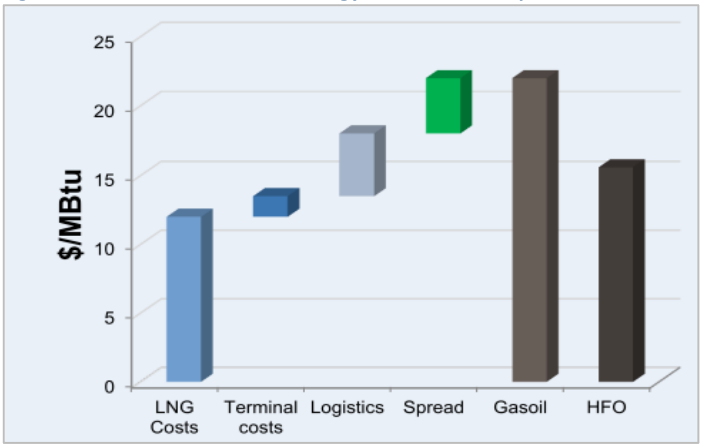
Figure 15. Historical fuel prices for maritime fuels and natural gas (US$/mmBtu)



Source: Det Norske Veritas

The problem is that the cost of distributing LNG is very high as shown in the following chart, where the cost of the terminal and the logistics from the LNG terminal is estimated to US$ 5-6/MBtu.

Figure 16 Price of alternative energy sources in Europe

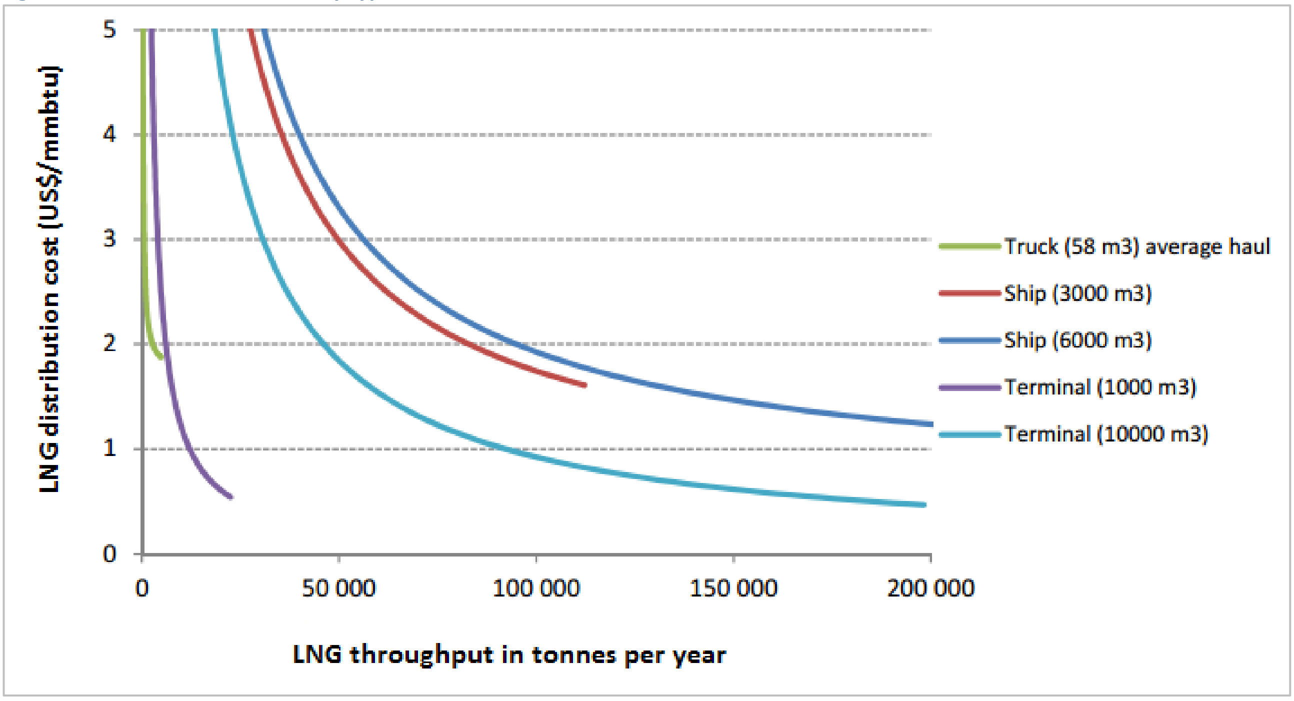


Source: ELENGY[27]

The distribution cost depends on the distance from the LNG import terminal in Northwest-Europe, the method of distribution and the LNG volumes. This is illustrated in the following chart.

[27] www.elengy.com

Figure 17. LNG distribution cost by type of distribution and volume



Source: Det Norske Veritas

The average distribution cost of LNG[28] in Norway in 2011 was US$ 128/tonne (US$ 2.5/mMBtu). This is expected to fall to US$ 88/tonne in 2016. A practical minimum seems to be US$ 80/tonne.

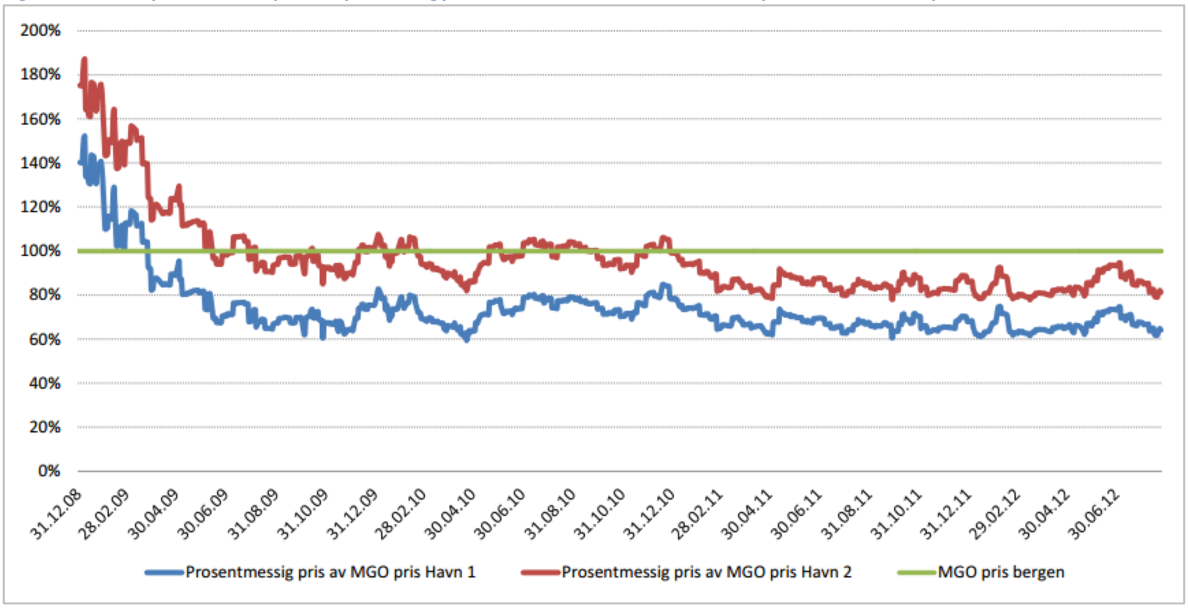
A typical LNG contract in Norway 2013 is:

- TTF[29] – price in € per mmBtu + % margin
- €/MWh differentiated by the harbour
- Local fees for transportation by LNG truck at about $ 0.18/tonne-km

The following chart shows the LNG price relation with MGO for different ports in Norway. Since 2009 the saving has been in the 10-40 % saving range.

[28] Ref: Næringslivets NOx-fond (June, 2013). Et bedre fungerende LNG-Marked.
http://is.gd/HOZQ9J
[29] The Dutch Title Transfer Facility – A benchmark for the natural gas price in the Netherlands

Figure 18. LNG price development per energy unit relative to MGO in Norway - Two different ports[30]

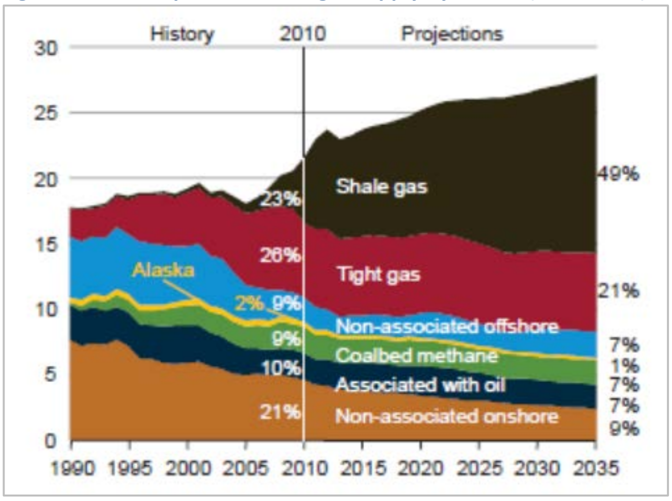


Source: The Norwegian NOx Fund, simulation of LNG Contracts – March 2013

d) Expected price development of LNG

This production of shale gas in the USA is expected to continue as shown in the following figure. This, in addition to potential shale gas development in Europe and China, will keep the price of gas relative MGO at today's price levels or lower. The higher the price of oil is the higher the saving will be.

Figure 19. Development of USA gas supply by source (1990-2035)



Source: US Energy Information Administration, Annual Energy Outlook 2012

The increased fleet of LNG-powered ships equate to a demand of 4-7 million tonnes of LNG per year by 2020[31], which corresponds to 0.2-0.3% of the global LNG production (2012). The demand for LNG to ships will therefore have no impact on the LNG prices.

[30] http://www.ndptl.org/c/document_library/get_file?folderId=19620&name=DLFE-1547.pdf
[31] Source: Den Norske Veritas

Also ARA[32]-range the price of LNG will be based on the TTF, same as in Norway currently. The pricing formula will be:

- TTF – price in € per mmBtu + % margin
- Bunker delivery cost by LNG bunker vessel

The TTF natural gas price is currently (October 2013) at $ 11-12/mmBtu. The margin and the bunker vessel cost will depend on the sales volumes in the region. As they approach 100 000 tonnes of LNG per year in the region, the cost will be in the US$ 1-3/mmBtu range (*see Figure 16. LNG distribution cost by type of distribution and volume*). Including margins and logistics we may expect a price level of US$ 14-16/mmBTU in the ARA-range. The prices in the Bremerhafen-Hamburg range will be similar. The price in the Skagen area and in the Baltic Sea might be higher due to higher distance to the Dutch/German gas market area. This may change if the Russian supplier decide to supply LNG.

In the following chart the future price relation is predicted for the port of Rotterdam. In a price scenario with slowly growing oil prices the LNG price will still remain stable at about US$ 15/MBtu (= US$ 50/MWh = € 35/MWh) delivered to the bunkering vessel. In this scenario the expected LNG price is 50 % of MGO and 65 % of HFO. A further US$ 1-3/mmBtu must be added for delivery by bunker vessel to the ship.

Figure 20. Expected fuel spread in Rotterdam for MGO, HFO and LNG

Source: Joachim Grieg & Co at LNG Fuelled Ships Conference in Bergen 2012

e) Cost of fitting ships for LNG-fuel

The main cost related to the use of LNG is the cost of the fuel tank. The following figure illustrates how two LNG containers can be fitted to a container vessel without loss of cargo capacity.

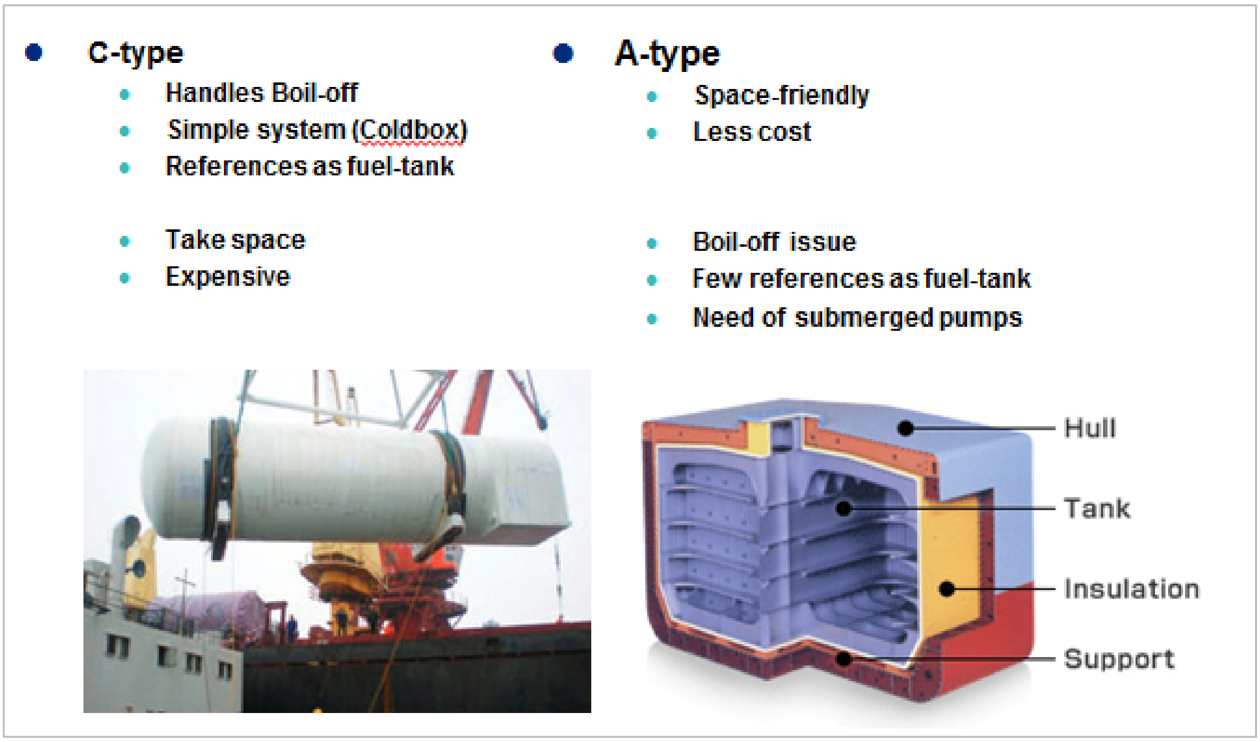
[32] Antwerpen, Rotterdam, Amsterdam

Figure 21 Fitting LNG tanks to an existing container vessel

Source: Rolls Royce

This cost varies with the size and type of the tank. The next illustration illustrates the two main types and the advantages and disadvantages. For retrofits, the C-type is the main alternative, while A-type may be considered for newbuildings.

Figure 22 Types of LNG fuel tanks



Source: Rolls Royce

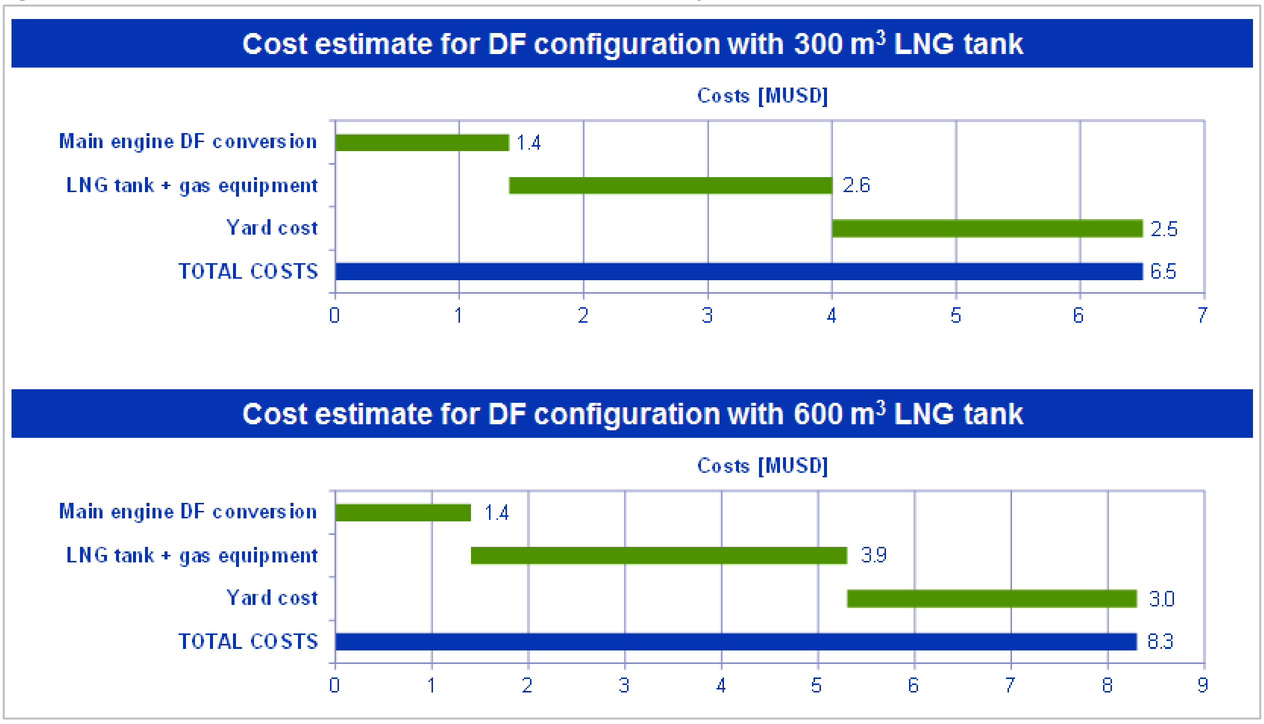
Rolls Royce has given us the following cost elements for refitting a container vessel of 800 TEU to LNG with a new engine:

- Fuel-tanks C-type: 2 * 250 cbm. € 2 mill
- New engine - 5 MW € 1.5-2 mill
- New gearbox incl. PTI and HSG € 0.7-1.2 mill

- Design work € 0.3-0.5 mill
- Yard work € 1.3-2.5 mill
- Total € 6-8 mill

The total cost depends much on the fuel tank. From Det Norske Veritas we have received similar numbers, based on conversion of a dual fuel engine. The cost saving in this case is considerable. From the figure below we see that the conversion cost is US$ 8,3 million (€ 6 million).

Figure 23. Conversion cost for 800 TEU container vessel with installed power of 8 000 kW



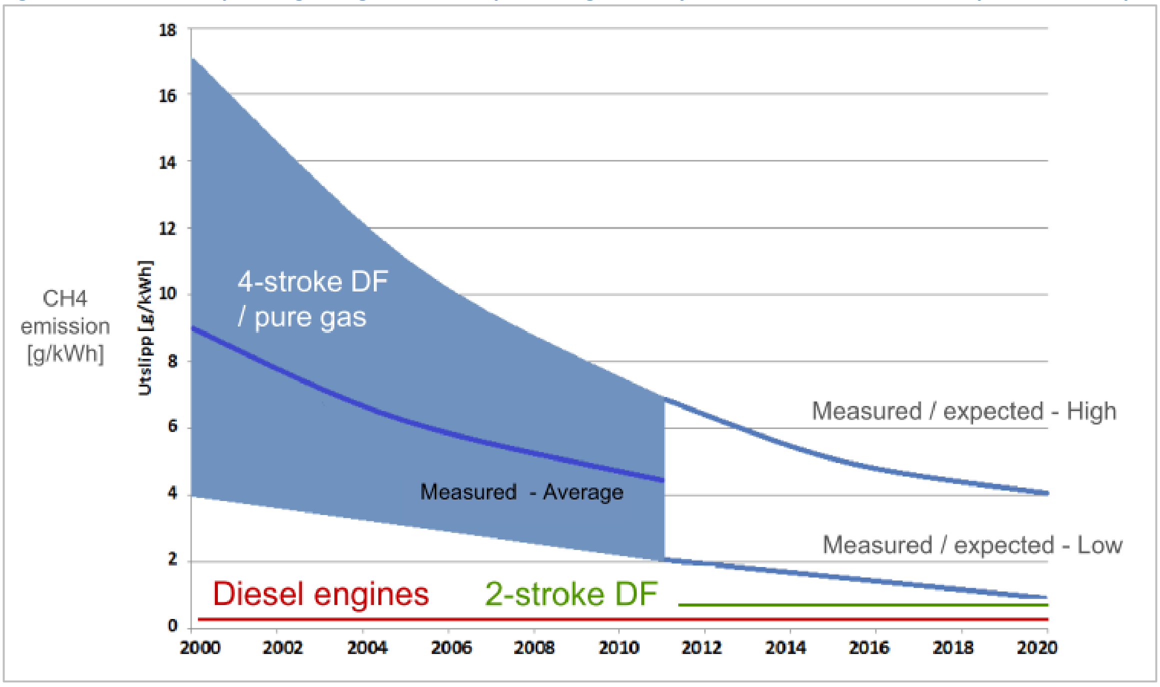
Source: Det Norske Veritas

For a newbuilding, the extra cost related to LNG is lower than the refitting cost. Based on the figures from Rolls Royce we estimate the cost to € 4-6 million. This makes LNG more attractive for newbuildings.

f) Methane slip

Methane slip (methane emission from LNG-powered engine) has been a problem to be considered. Singe fuel engines handle this better and new engines get increasingly better. For newly delivered engines, Rolls Royce estimate that the CO_2 emission is 28 % lower for LNG compared to HFO. If the methane slip is included the CO_2 equivalent emission of greenhouse gas is still 22 % below HFO. The following figure shows the expected development of methane slip the coming years, as the technology improves.

Figure 24. Methane slip from gas engines have improved significantly and further technical development is anticipated



Source: Det Norske Veritas

g) Case story – Bit Viking

Figure 25. Bit Viking after conversion - LNG tanks on deck

Source: Statoil

Bit Viking is a tanker that has been converted to LNG-fuel. Key facts:

- Owner: Tarbit Shipping – Charterer: Statoil
- Transport of oil products on the Norwegian coast
- Main engine conversion to dual fuel
- Transport of oil products on the Norwegian coast
- NOx-reduction: 479 tons/yr
- Cost of measure: € 7,2 million (€ 631/kW)
- NOx Fund support: € 6,1 million (80%)
- Engines post retrofit: 2 x Wärtsilä 6L50DF

- Installed power 2 x 5700 kW
- 2 x 500m3 LNG tanks
- Retrofit conducted October 2011
- No operational challenges post retrofit

h) Case story – Cargo ship Høydal

Høydal is the first cargo vessel to be delivered for LNG fuel. Key facts:

- Owner NKS Shipping[33]
- Newbuilding - Cargo ship "Høydal"
- Cargo: Feed stock for fish farms
- Operation from Summer 2012
- 90 tons NOx reduction
- LNG cargo tanks of 90 cubic meters
- Additional cost of LNG propulsion: € 3,6 million (€ 2 181/ kW installed)
- Installed power 1650 kW
- NOx Fund support: € 2,8 million (80%)
- Rolls-Royce Gas Engine C25:33L6PG

Figure 26. Cargo vessel Høydal with LNG power

i) Case story – Fjord Lines

Fjord Lines have to new RoPax that has been delivered with single LNG-fuel engines. Key facts:

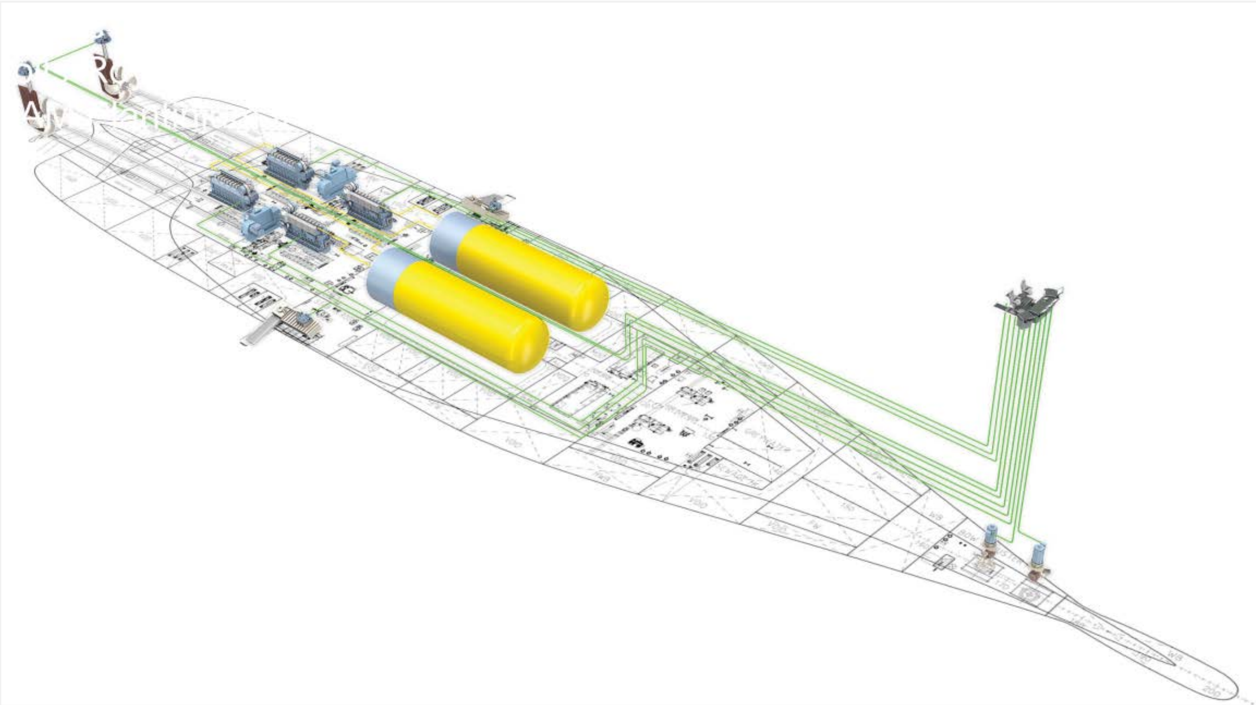
- Two car/cargo ferries
- Total installed power per ship: 21 600 kW
- 4 x Rolls-Royce B35:40V12PG engines
- 2 x 300 m3 LNG tank inkl. TCS with max. Pressure of 8 bars (30 days)
- Investment per ship of € 14 mill. (€ 600/kW installed)
- NOx fund € 11 mill. support per ship
- In service

[33] www.nkshipping.no

Main conclusions made by Fjord Lines from their first operation:

- Marine Gas engines represents well proven technology
- LNG is available – increased demand will ensure even better distribution network
- Dual fuel engines are the choice when enough LNG cannot be carried to complete the voyage
- Where the application allows single fuel marine gas engines:
- More efficient engines
- Less expensive in terms of operating and life cycle cost
- Lower emissions and methane slip
- Less complex engine supporting systems
- Green profile for the ship owner – marketing tool
- Lower lube consumption
- Less or no sludge
- No oil spill during bunker operation
- Better working environment for engine crew

Figure 27. LNG lay-out for Fjord Line ships



Source: Fjord Line

5.4 Installation of Scrubbers

a) Scrubber installations in "history"

While exhaust gas cleaning (EGC) systems have been for a long time in widespread use on land, such as in incineration plants and power plants, and also in inert gas systems on tankers, the use of EGC systems onboard vessels is relatively new. The first seawater scrubber system prototype was presumably installed onboard in 1991 on passenger ferry M/S Kronprins Harald. A more comprehensive experiment was conducted in 1998 when the Canadian icebreaker Louis S. St.-Laurent was equipped with a seawater scrubber. At the same time another Canadian vessel, a freight and passenger ferry Leif Ericson, was equipped with the Eco-Silencer® scrubber prototype in order to investigate specially wash-water quality.

More recent pilot tests have been made between 2005-2008 on board of three vessels, the Zaandam, the Price of Kent and the Suula. The two first mentioned were equipped with a Hamworthy's seawater scrubber and the last mentioned with Wärtsilä's freshwater scrubber. All the tests proved the scrubbers' viability and functionality in marine applications. From then onwards, there have been only a handful of scrubber installations but at the moment the acceleration in the field of the scrubber market is obvious, especially installations among the newbuildings have been increasing. According to this study, the manufacturers of the emission abatement devices situated in Europe have so far supplied to both retrofits and newbuildings some sixty scrubber installations in total. [34]

b) Scrubber types and installation

The scrubber is a technological means to treat exhaust gases with sea water, chemically treated fresh water or dry substances in order to remove sulphur from exhaust gases. Besides the sulphur removal, the scrubber system's other benefit is reduced particulate matter emissions, compared with the marine diesel oil (MDO) alternative. There exist significant amount of data concerning laboratory tests of scrubbers but due to limited amount of scrubber installations so far, the knowledge related to real operational circumstances is fairly scarce. However, along with the new installations on board the data concerning the effectiveness of scrubbers, which is measured by SOx removal, is increasing. The scrubbers available at the moment can be divided to two groups: dry scrubbers and wet scrubbers which can be further divided to open loop, closed loop and hybrid scrubbers. [35]

- **Dry scrubber** does not use any liquids in process but exhaust gases are cleaned with hydrated lime-treated granulates. There is no discharge to the sea from the system. As a result of the process a non-toxic gypsum, which is used to manufacture wallboard, is generated. An advantage of a dry scrubber is its lower energy consumption compared to a water scrubber.
- **Open loop**, **i.e. sea water scrubber** utilizes untreated sea water, which alkalinity has to be enough in order to neutralize the sulphur from exhaust gases. The effectiveness of an open loop system is strongly dependent on the alkalinity of the sea water. If the alkalinity of water is too low, the system is unable to comply with the regulations applied for SOx emissions. The residuals from the system are removed from the wash-water and discharged to tank onboard and further to suitable reception facilities ashore. After the treatment the cleaned water is returned to the sea. The negative characteristic of an open loop system is its greater energy consumption compared to a close loop system, but then there is no need for chemical additives like caustic soda in a close loop system.
- **Close loop, i.e. fresh water scrubber** is not dependent on the type of the water the vessel is operating in, because the exhaust gases are neutralized with a caustic soda which is added to fresh water in a close system. Circulating water is processed after the scrubber and dosed with caustic soda in order to restore the alkalinity of wash-water. The amount of the water which is needed in a close loop process is about half of the flow in an open loop system. Similar to an open loop system the residue is stored on board to a tank to be later disposed ashore.
- **Hybrid scrubber** gives the possibility to use either closed loop or open loop technology. Hybrid scrubbers are used as an open loop system when the vessel is operating in the open sea and as a closed loop system when operating in SECA. Among the different types of scrubbers a hybrid scrubber is becoming increasingly common because of its flexibility.

[34] United States Environmental Protection Agency (2011.) Exhaust Gas Scrubber Washwater Effluent.
[35] http://www.eagle.org/eagleExternalPortalWEB/ShowProperty/BEA%20Repository/References/Capability%20Brochures/ExhaustScrubbers

- Besides the above mentioned scrubber types, there exist Ecospec's CSNOxTM system, which is the world's first commercially viable 3-in-1 emission abatement system. The system removes not only sulphur dioxide (SO2) and nitrogen oxides (NOx), but also carbon dioxide (CO_2) in a single system. Even more notable is CSNOxTM's quality of wash water, which does not acidify the ocean, nor discharge any secondary pollutants or harmful substances into the sea. Such results are achieved without any chemicals being introduced. Instead, Ecospec's patented Ultra Low Frequency (ULF) wave electrolysis treatment is utilized in the system.

At the moment the systems are fairly tailor-made products, but in the future there will probably be more standardized systems. Due to different characteristics of scrubber systems the suitability of an installation has to be considered on a vessel-specific basis. For example for the vessel operating only in brackish water where the alkalinity of the water is low, there is no reason to install an open loop system because it is impossible to clean the exhaust gases with the sea water. Also energy consumption should be taken into consideration. The use of a scrubber increases the energy consumption which is calculated to raise fuel consumption by 3 % in case of seawater scrubber and by 1 % in case of freshwater scrubber[36].

According to Innoship –project[37] the obstacles to install scrubbers are mainly related to technical issues, especially concerning retrofit installations; the lack of free space is one of the most problematic issues to be solved. In that sense the installation of a scrubber to a newbuilding is remarkably easier, although fast solutions cannot be achieved because the renewal of the fleet is a slow process. Also the quality of wash-water has proved to be a problem that needs to be solved. Test concerning for example Containerships VII indicates that the sulphur removal itself is functioning well, but there are difficulties with the wash-water quality because of its turbidity. Besides turbidity there are other criteria, such as the pH value, Polycyclic Aromatic Hydrocarbons (PAH) concentration and amount of nitrates for washwater that cannot be exceeded[38]. Besides the technical issues, the economic aspects cannot be ignored. At the moment the impact of recession is affecting the shipping companies which are cautious to invest in a technology which is considered expensive and incomplete, although the general payback times are estimated to be fairly short.

c) Factors affecting the feasibility of installation

In spite of the fact that scrubber provides a possibility to operate on cheaper high sulphur fuels, there are many issues, such as equipment itself, installation and operational costs, that have to be taken into consideration when the investment is planned (Figure 27). Along with scrubber installation the amount of peripheral equipment increases significantly. Equipment for wash-water, pumps and pipe systems need own space like the monitoring systems that have to be fitted in a control room. The space needed for the equipment itself plus all peripheral devices is fairly extensive while it is impossible to raise size of the vessel which challenges the planning and installation of a scrubber on board. Due to the space needed for the system, the installation is easier to accomplish in larger vessels.

Besides the scrubber and related devices, the estimated remaining lifetime of a vessel affects significantly to the feasibility of a scrubber installation on board. According to many European shipping companies which were contacted during Innoship project[39], a feasible remaining lifetime of a vessel is about ten years,

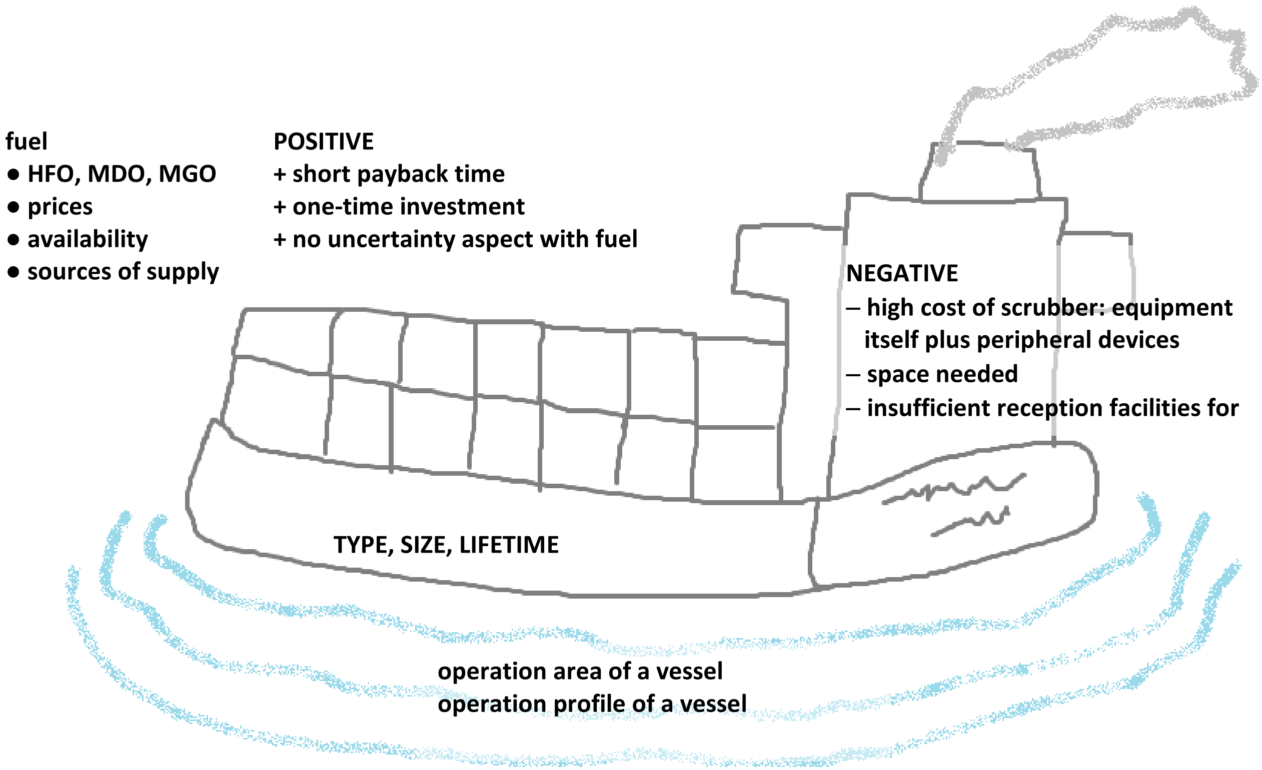
[36,31] http://www.eagle.org/eagleExternalPortalWEB/ShowProperty/BEA%20Repository/References/Capability%20Brochures/ExhaustScrubbers
[37] http://cleanshippingcurrents.eu/ojs/index.php/CSCurr/article/view/33

[32] http://cleanshippingcurrents.eu/ojs/index.php/CSCurr/article/view/33

but different factors, such as vessel type, trade lines and the technology used, affect significantly cost-effectiveness of the investment. Besides, the price difference between HFO and MGO is affecting the most. If the price aspect is not taken into consideration a total investment cost of a scrubber consists of multifold issues such as:

- The system itself plus all peripheral equipment.
- Operating/maintenance costs; electrical power and consumables such as caustic soda.
- Required modifications of the vessel (retrofit).
- Docking period during the installation -> lost income (retrofit).
- Start-up –process, tests, repair work etc.
- Education of personnel.

Figure 28 Advantages, disadvantages and other aspects affecting scrubber installation on board



The operation area and operation profile of a vessel affect the feasibility of a scrubber. The more transportation inside ECAs, such as the Baltic Sea, the more cost-effective it is to install on board a scrubber which enables the use of cheaper heavy fuel oil. The payback time of installation is strongly dependent on the time the vessel operates in ECAs. Also the type of vessel is affecting through the fuel consumption. For example fast vessels navigating on ice have a huge fuel consumption, which makes this type of vessels more suitable for scrubber installations. In this type of vessels, in a shorter term, it might be more cost-effective to use low sulphur fuel which price will probably increase from 2015 onwards.

d) Estimated scrubber prices and payback times of installations

Due to fairly new and still narrow market for scrubbers, there are not many examples of the realized supply agreements so far and in general, the purchase prices are kept confidential. There are of course exemptions; for example DFDS informed in June 2013 that they are investing circa € 13.5 million (100 million Danish crowns) in order to install scrubbers for their three ro-ro vessels. In addition, because the systems are often tailor-made products and because the installations are strongly dependent on vessel the total costs are difficult to define. It is impossible to make an inclusive comparison of the total costs of the scrubber installation because there are multifold aspects, such as the equipment itself, all peripheral devices, and installation costs etc., which affect the final cost. Besides, for example the operational costs and the personnel education have to be taken into consideration when the cost-effectiveness is calculated. Although there do not exist precise figures, the manufacturers of engines, shipping companies, authorities and specialists have all expressed their estimations regarding the scrubber costs which are presented below.

Some examples of prices of scrubbers:

- € 3-6 million *(Ministry of Transport and Communications in Finland)*
- € 1,8-4,5 million *(Reynolds 2011)* [40]
- € 1-2 million for a small vessel and up to € 5 million for larger vessels *(Wärtsilä)*
- Seawater scrubber: equipment € 900 000 plus installation € 300 000 *(Hamworthy, before it was a part of Wärtsilä)*
- € 2-3 million, the scrubber system which can handle both seawater and freshwater *(Alfa Laval)*

There are also available figures related to the savings in fuel prices and payback time of scrubber installations on the basis of price difference between HFO and MGO. Some examples of estimations are presented below.

- If the price difference between HFO and MGO is about $ 300 per ton, payback times are limited to one to three years if the operation takes place in ECA 100 %. Even when operating only 60 % of the time in ECAs the payback time is typically below five years. *(Alfa Laval)*
- If the price difference between HFO and MGO is about $ 300 per ton, and 100% of operations take place inside an emission control area (ECA), the payback time on the investment would be about a year. (Clean Marine)
- At its best the payback time would be between one and two years. *(Wärtsilä)*

One example regarding the scrubber installation is from Finland where it is possible to get financial support to retrofit existing vessel with emission abatement technology, i.e. subvention for scrubbers to improve the level of environmental performance of vessels already in use. In June 2013 the Ministry of Transport and Communications in Finland had received applications from nine shipping companies for 34 vessels. The budget of the aid scheme is € 30 million and the total maximum of aid is 50 per cent of the costs. At the beginning of September 2013, the Finnish Ministry of Transport and Communications granted state aid of €19 million to six shipping companies and their 22 vessels for retrofit investment aiming at environmental protection.

e) Current and forthcoming scrubber orders

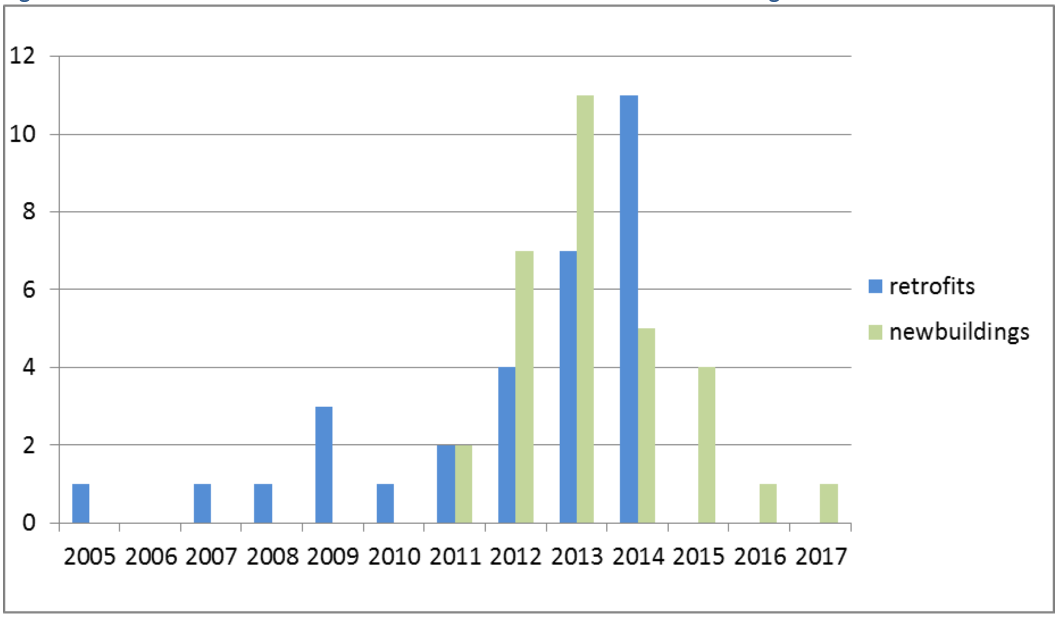
Gathering the data of scrubbers during the Way Forward -project was organized, like gathering all the other information during the project, by forms which was sent to relevant stakeholders and which were also available in Shortsea webpage http://www.shortsea.info/forms.html. The result concerning information of

[40] http://www.marad.dot.gov/documents/Exhaust_Gas_Cleaning_Systems_Guide.PDF

scrubber installations to retrofits and to new buildings was not very effective, so the information was collected from Internet pages. Efforts were concentrated to the manufacturers which dominant activities are situated in Europe. There are exceptions to the vessels' operation area surveyed in this project; for instance the figures include eight bulk carriers which will operate in Great Lakes. The information which was collected from Internet was further sent to eight manufacturers of scrubbers in order to correct and complete the information. All but one of the manufacturers are members of Exhaust Gas Cleaning System Association (EGCSA). Half of the companies verified the collected data concerning their scrubber installations. Two who did not respond have their market area outside the Europe which might partly explain their unwillingness to comment. Besides, some of the information is kept confidential due to the on-going negotiation processes between shipping companies, manufacturers, shipyards etc.

Since many years only few orders have realized, but at the moment there exist clear sights of acceleration in the scrubber market. The most of the current installation of retrofits and newbuildings are placed for this year (2013), but in general, new orders are expected to be placed just before 2015. According the BSR Innoship survey[41], the readiness to deliver scrubbers is high among the manufacturers of the engines and emission abatement devices. The most essential challenge related to the deliveries of the devices is the probable accumulation of orders to a certain moment which will be a bottleneck that affects significantly the delivery times. There is not available any public statistics of the orders of the scrubbers, but an estimation of a specialist of the issue is that current amount of orders is from 100 to 200 scrubbers worldwide. The information gathered among the European manufacturers during this project showed that in November 2013 there are same amount of retrofits and newbuildings, both 31, either already installed or ordered (Figure 28) . There is a clear growth during 2013 and 2014 in both newbuildings and retrofits. The exact information concerning the installations of scrubber newbuildings and retrofits can be found from the tables 2 and 3.

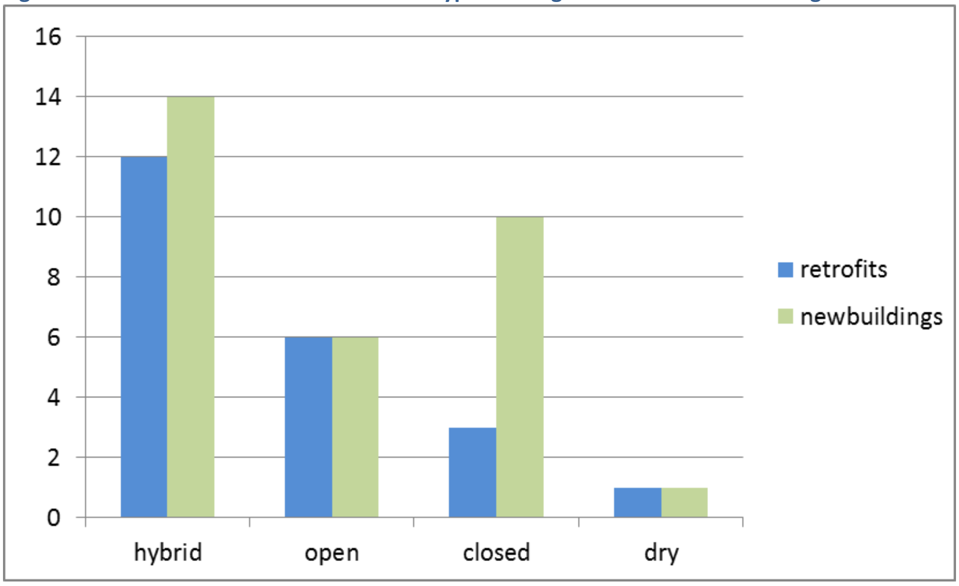
Figure 29. The number of scrubber installations in retrofits and in newbuildings



[41] http://cleanshippingcurrents.eu/ojs/index.php/CSCurr/article/view/32

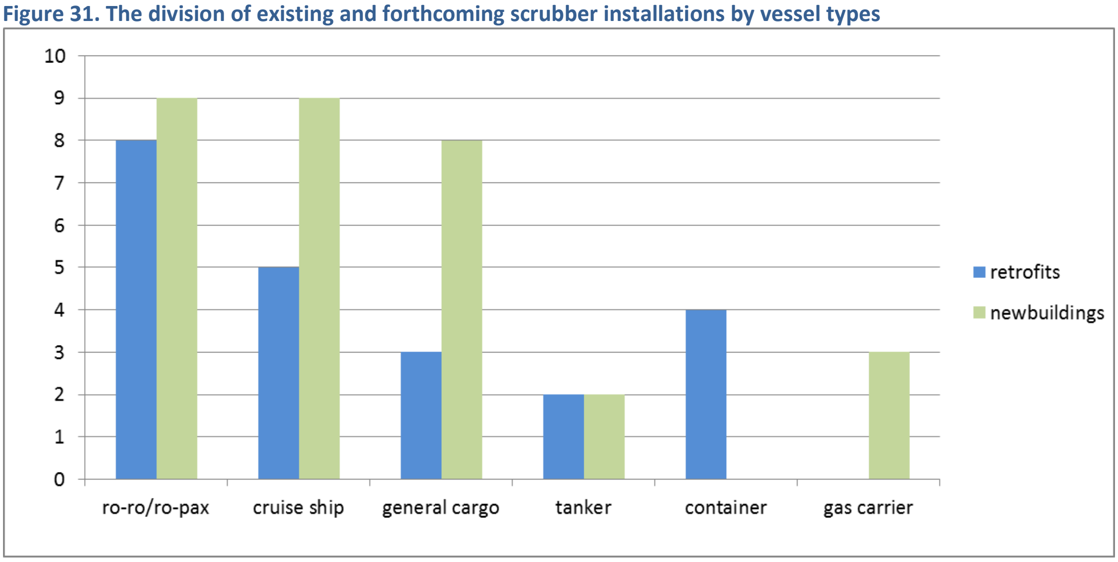
The most common scrubber system type of this sample is a hybrid scrubber, almost half of the installations, among both retrofits and newbuildings (Fig.X). Although it is more complicated and thus expensive, it is not necessary to know the alkalinity of the operation water beforehand. The open loop system is equal common in retrofits and in newbuildings, but closed loop systems prevail in newbuildings. Two dry scrubbers has been installed so far, and negotiation concerning of third is on-going. Currently, Couple Systems is the only dry scrubber supplier.

Figure 30.The shares of different scrubbers types among retrofits and newbuildings.



According to the findings of this study, the current and forthcoming scrubber installations are divided between different types of vessels as shown in figure 30. The most common vessel type for scrubber installation is ro-ro/ro-pax vessels, but newbuildings of cruise ships and general cargo are almost as common.

Figure 31. The division of existing and forthcoming scrubber installations by vessel types



Source: SPC Finland

The age of a vessel to be retrofitted differs significantly among the vessels; the range is from two to fifteen years when all retrofitted vessel types of this study are taken into consideration. However, more important than age when a scrubber is installed is to estimate the remaining lifetime of a vessel. According to

European Commission DG TREN's study of an average lifetime of different vessel types are as follows: ro-ro vessels 27.1 years, container 25.4 years and cruise ship 27.7 years (non-cargo vessel) which means that estimated remaining lifetimes after the installations for the vessels of this sample are 17.5, 19.4 and 20.7 respectively. According to data collected within Way Forward –project, the average of remaining lifetime of a vessel differs significantly from Innoship (2013) survey[42]. Approximately 80% of respondents of that survey estimated that the feasible remaining life time of a vessel is maximum ten years. In other words, the remaining lifetimes of realized installations were twice as high that were the general estimations concerning feasibility among European shipping companies.

Table 1. Average range and average lifetimes of retrofitted vessels.

vessel type	age range when scrubber installed	average lifetime	average lifetime left after installation
ro-ro/ro-pax	3 to 15	27.1	17.5
container	5 to 10	25.4	19.4
cruise ship	2 to 13	27.7	20.7

[42] http://cleanshippingcurrents.eu/ojs/index.php/CSCurr/article/view/33

Table 2 Scrubber installations, realized or planned, in newbuildings (November 2013)

NEWBUILDINGS						
ship	**shipping company**	**vessel type**	**engine size**	**supplier**	**system type**	**installation year**
Unnamed (Great Lake Vessels)	Algoma	8 bulk carriers		Wärtsilä	closed loop	2012-2013
Mein Schiff 3	TUI Cruises	cruise ship		Wärtsilä	hybrid	2013
Mein Schiff 4	TUI Cruises	cruise ship		Wärtsilä	hybrid	2013
HHI Hull 2516	Solvang	gas carrier	19MW	Wärtsilä	open loop	2012-2013
HHI Hull 2517	Solvang	gas carrier	19MW	Wärtsilä	open loop	2012-2013
Jolly Diamante/Perla/Cristallo/Quartzo	Ignazio Messina&C.S.p.A.	4 ro-ro		Wärtsilä	open loop	2011-2012
Unnamed	Ignazio Messina&C.S.p.A.	4 ro-ro		Wärtsilä	hybrid	2013-2014
confidential	*confidential*	*2 cruise ships*		*Wärtsilä*	*hybrid*	*2013-2014*
confidential	*confidential*	*cruise ship*		*Wärtsilä*	*hybrid*	*2014*
Unnamed	Viking Ocean cruises	cruise ship		Alfa Laval	close loop	2015
Unnamed	Viking Ocean cruises	cruise ship		Alfa Laval	close loop	2016
Oceanex Connaigra	Oceanex	multi-purpose ferry	20,2MW	Couple Systems	dry	2013
Unnamed	AET	shuttle tanker		Clean Marine	hybrid	2014
Unnamed	AET	shuttle tanker		Clean Marine	hybrid	2015
Unnamed	Dorian LPG	gas carrier (VLGC)		Clean Marine	hybrid	2015
Breakaway 3*	Norwegian Cruise Line	cruise ship	76,8 MW	Green Tech Marine	hybrid	2015
Breakaway 4*	Norwegian Cruise Line	cruise ship	76,8 MW	Green Tech Marine	hybrid (GTM-R15)	2017
*not verified		**TOTAL 31**				

Table 3. Scrubber installations, realized or planned, in retrofits (November 2013)

RETROFITS								
ship	**shipping company**	**vessel type**	**engine size**	**supplier**	**system type**	**inst year**	**build year**	**age when inst**
Plyca	Spliethoff	ro-ro	28 MW	Alfa Laval	hybrid	2012	2009	3
Ficaria Seaways	DFDS	ro-ro	21 MW	Alfa Laval	hybrid	2009	2006	3
Magnolia Seaways	DFDS	ro-ro	21MW	Alfa Laval	hybrid	2013	2003	10
Petunia Seaways	DFDS	ro-ro	21 MW	Alfa Laval	hybrid	2013	2004	9
Selandia Seaways	DFDS	ro-ro	21,6 MW	Alfa Laval	hybrid	2013	1998	15
not known yet	DFDS	in total 8				2014		
confidential				*Alfa Laval*	*hybrid*	*2014*		
Maersk Tukang	A.P. Moller-Maersk	container	3,5 MW	BELCO	hybrid	2013	2008	5
Norma	CMA CGM	container	2,5 MW	BELCO	open loop	2013		*on hold*
Pride of Kent	P&O European Ferries Ltd.	cruise ship	4x1,2 MW (AE)	Wärtsilä	open loop	2005	1992	13
Zaandam	Carnival Corporation	cruise ship	9 MW (ME)	Wärtsilä	open loop	2007	2000	7
Suula	Neste Shipping	tanker	680 kW (AE)	Wärtsilä	closed loop	2008	2005	3
Containerships VII	Containerships	container		Wärtsilä	closed loop	2011	2002	9
APL England	APL	container	8 MW	Wärtsilä	open loop	2011	2001	10
Tarago	Wilh. Wilhelmsen ASA	ro-ro	25 MW	Wärtsilä	hybrid	2012	2000	12
SuperSpeed II	Color Line	ro-pax	38 MW	Wärtsilä	open loop	2014	2008	6
Robin Hood	TT-Line	ro-pax	18 MW	Wärtsilä	hybrid	2014	1995	19
Timbus	Södra Shipping	cargo vessel	3,6 MW	Couple Systems	dry	2009	1999	10
Laura	Langh Ship	cargo vessel	5,8 MW	Lang Ship	closed loop	2013	1996	17
Balder	Klaveness	bulk carrier		Clean Marine	hybrid	2012	2002	10
Pride of America*	Norwegian Cruise Line	cruise ship	32 MW	Green Tech Marine	hybrid	2013	2005	8
Liberty of the Seas*	Royal Caribbean	cruise ship	2-12,4 MW	Green Tech Marine	hybrid	2012	2007	5
Independence of the Seas*	Royal Caribbean	cruise ship		Ecospec	open loop	2010	2008	2
White Sea*		tanker		Ecospec	CSNOx	2009	1991	18
* not verified		**TOTAL 31**						

5.5 Repayment time and preferred choices of owners

a) Repayment time for LNG investment

We have looked at the repayment time concerning the investment of refitting a typical 800-1000 TEU container ship. Three scenarios are show in the following table. The investment levels the operational performance has been given to us by the suppliers of scrubber and LNG solutions.

Table 4. Repayment time for retrofit with scrubber or LNG for an 800-1000 TEU container ship

	HFO+Scrubber	LNG	LSMGO
Fuel consumption (tonnes/year)	10 000	8 100	9 400
Investment € '000	3 000	6 000	100
Extra operation cost € '000/yr	370		
Fuel price $/tonne	585		910
Fuel price €/tonne	424	617	659
Fuel price €/MWh	38	45	56
Fuel price $/mmBtu		18	
Fuel price relative to LSMGO	68 %	81 %	100 %
Fuel cost € '000/year	4 240	5 000	6 200
Fuel cost saving vs LSMGO € '000/year	1 960	1 200	-
Annual cost saving vs vs LSMGO € '000/year	1 590	1 200	-
Repayment time of extra investement vs LSMGO at 8 % yield	2,0	6,5	
Fuel price for same yield for HFO & LNG at market price abov	$ 719/t	€ 27/MWh	

Source: SPC Norway and SPC Finland

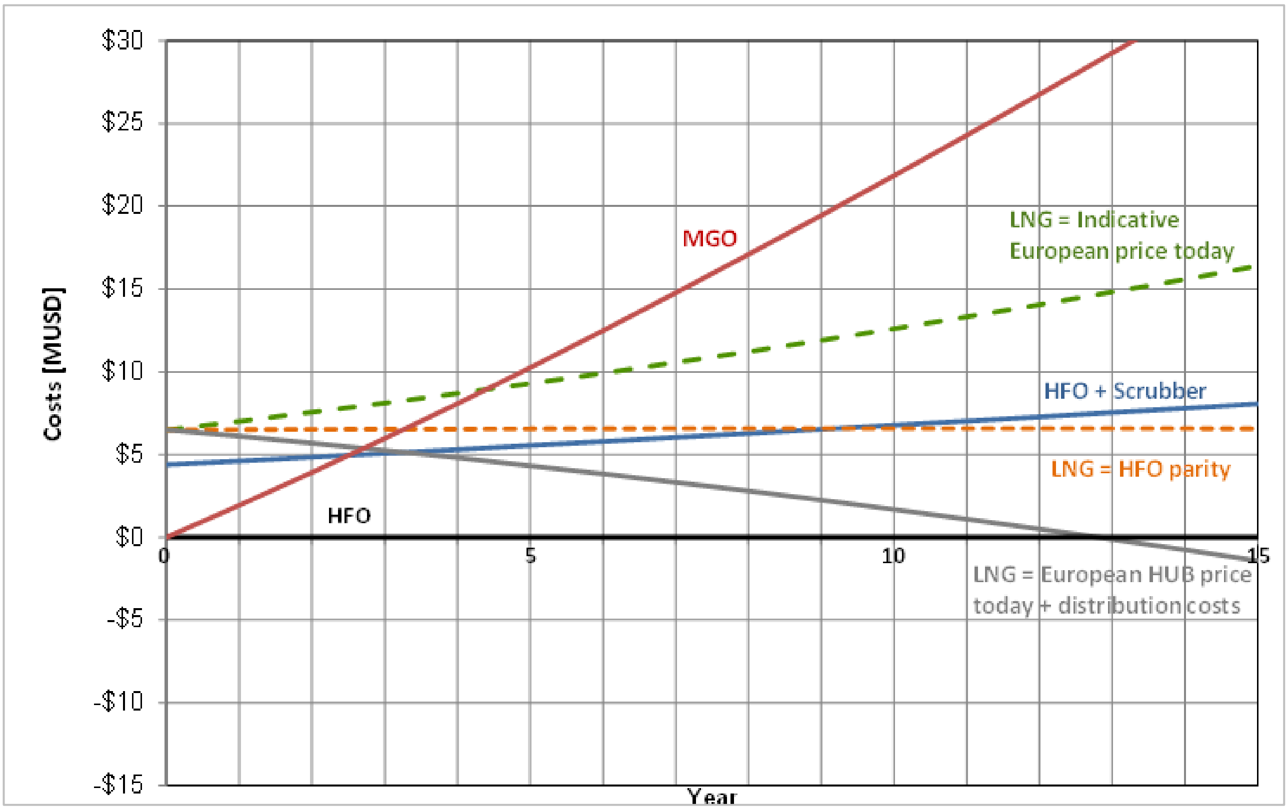
The fuel prices are based on spot prices in Rotterdam (October 2013) and the expected cost of delivering the LNG by LNG-bunker vessel. For the scrubber we have assumed an extra fuel consumption of 2 % and a chemical cost of US$ 40/tonne of fuel.

We clearly see that at the given price level, installation of scrubber would be the best alternative. The repayment time for LNG is too long. The price of LNG would have to be considerably lower or the price of HFO considerable higher to make LNG interesting.

The following figure shows the repayment time for the alternative investments in an 800-1000 TEU container vessel. In this scenario, developed by Det Norske Veritas, the break even for fuel switch from HFO to MGO is between 2 and three years. LNG is only attractive if it can be purchased at European hub price plus distribution cost. This is not yet possible. The assumed price levels for the figure are:

Fuel	USD/ton	USD/mmbtu	EUR/MWh
HFO	600	15,6	39,4
MGO	950	23,5	59,2
LNG = Indicative European price today	827	17,7	45
LNG = HFO	731	15,6	39,4
LNG = European HUB price today + distribution costs	653	14	35,5

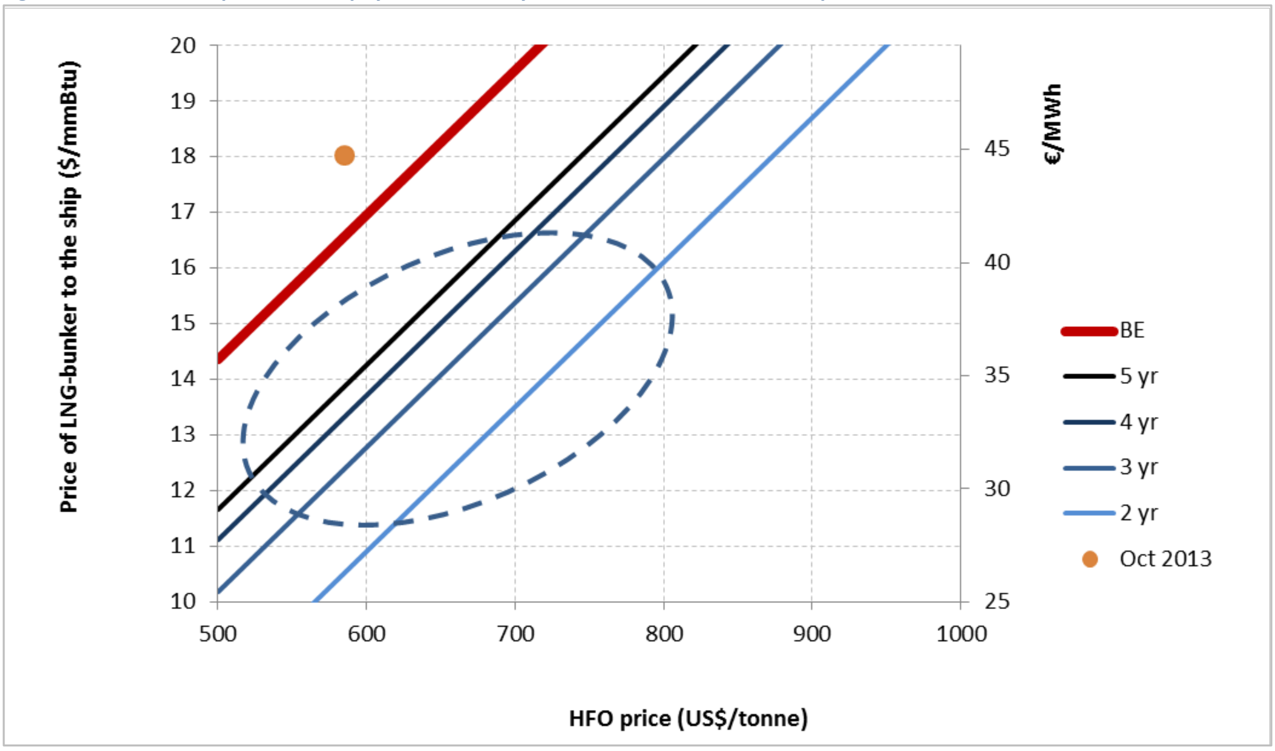
Figure 32. Cumulative cost difference compared to baseline (mUS$)



Source: Det Norske Veritas

The next figure illustrates at which price levels LNG is of interest relative to HFO with scrubber. The dot illustrates the current price relation. The red line illustrates when the annual saving of the two alternatives is equal. The blue lines illustrates the repayment time for the extra investment related to LNG. The 5 year line indicates when the extra investment in LNG offers a 5 year repayment time.

Figure 33. Break even prices and repayment time in years for LNG investment compared to HFO + scrubber investment



Source: SPC Norway and SPC Finland

The price of HFO must clearly increase to the US$ 600-800 range and the price of LNG delivered to the ship must fall below € 40/MWh to make LNG an attractive investment relative to scrubber. The energy content of LNG is roughly 21 % higher than HFO. The extra fuel consumption adds another 2 % to the disadvantage of HFO. However, the disadvantage of LNG is the higher investment. At today's price levels this represents a reduction of 13 %. Our conclusion is therefore that LNG should be considered if the LNG price per tonne is less than 10 % higher than the price per tonne of HFO.

For a newbuilding, LNG is more favourable. The extra cost is relatively lower for LNG. The long term LNG price is expected to become lower and the price of oil is expected to grow. The next table shows the same calculation as Table 2, but with different investment levels and different input prices. In this scenario we have set the price equal. In this case LNG is the preferred fuel.

Table 5. Repayment time for newbuilding with scrubber or LNG for a 800-1000 TEU container ship

	HFO+Scrubber	LNG
Fuel consumption (tonnes/year)	10 000	8 100
Investment € '000	2 500	4 500
Extra operation cost € '000/yr	390	
Fuel price €/tonne (2020)	500	500
Fuel price €/MWh	45	35
Fuel and extra operatino cost € '000/year	5 000	4 100
Annual cost saving LNG vs LSMGO € '000/year		900
Repayment time of extra investement vs HFO at 8 % yield		2,5

Source: SPC Norway and SPC Finland

5.6 Methanol

Stena Rederi in Sweden has found an alternative way of meeting the requirements for reduced sulphur emissions in 2015. Stena goes for methanol. They have done a thorough analysis of this and Per Stefenson presented their plans at SPC Norway's mini-conference in Oslo in June 2013 ("Sulphur Directive in 2015 and Norwegian short-sea shipping").

Stena's vessels are mostly in regular service in the English Channel, the North Sea and the Baltic Sea. They therefore have a hard time coping with the new rules.

a) Methanol for ships

Methanol in almost the same molecular structure and properties as natural gas (methane / LNG = Liquefied Natural Gas). Methanol is already used as fuel, but in limited areas, such as car racing and model planes, mainly because of its high octane rating.

Methanol can also be used as fuel for ships through modification of existing engines and fuel systems.

b) Higher production costs - Cheaper distribution

The advantage of methanol is substantially cheaper distribution compared to LNG. Both fuels are produced from natural gas. Production of methanol is more expensive than LNG, US$ 250/tonne against US$ 160/tonne (USA). Transport to Gothenburg is much cheaper for methanol. Stena estimates logistics costs from the U.S. to Sweden to US$ 500/tonne for LNG and US$ 370/tonne for methanol. Thus, the delivered cost of methanol in Gothenburg is US$ 800/tonne for methanol and US$ 840/tonne for LNG.

Methanol is currently about 22% cheaper than LSMGO per energy unit. The price of methanol is US$ 352/tonne. To compare with MGO per energy unit the methanol price must be multiplied by 2.05. This gives a cost methanol of US$ 721/tonne per MGO equivalent. In contrast, marine diesel is priced at US$ 925/tonne (June 2013). The cost of methanol is in fact only 12% higher than heavy oil, per energy unit.

c) Environmental-friendly

Per Stefenson, Stena Line, says that methanol has equally good environmental properties as LNG / natural gas. CO_2 emissions are at par with LNG. The net greenhouse gas emission is better for methanol due to the methane slip from LNG. The reduction of SOx, NOx and particulates is similar to LNG. Methanol is also bio-degradable.

d) Biofuel

Methanol can be produced from wood and is therefore a bio-fuel. This can be a big advantage in the future, if the production process can be more efficient and if the used wood is considered carbon neutral. Methanol can also be produced with renewable energy, CO2 and water. This process absorbs CO2 from the air.

e) High availability

World methanol production is relatively large with an annual world supply of 55 million tons. Methanol is used mostly in industrial production. Norway is the largest producer in Europe. The flash point of methanol is low and it is easy to transport the commodity.

f) Low retrofitting costs

The cost of retrofitting to methanol is low compared to LNG. Existing engines and fuel tanks can still be used. The expected conversion cost is EUR 300/kW installed power. This is in line with scrubber installation.

Reconstruction of the main engine includes reshaping of the cylinder head, new fuel injectors, new fuel pump solutions and new pipes for high pressure fuel injection. Furthermore, the fuel tanks need different coating and the automation system needs to be upgraded.

g) Testing

Use of methanol is being tested on MS Stena Scan Rail. Using a process called Obata™ reforms methanol to a mixture of three components: DME (dimethyl ether), methanol and water. Since the fuel now contains DME, the methanol mixture can now be used as fuel in a traditional diesel engine.

h) Rebuilding program

The next step is to re-build the Gøteborg/Kiel-ferry to test full-scale methanol. This will happen in 2014. Afterwards, 59 vessels will gradually be converted until 2018.

i) Swedish pilot project

The BSAP Fund[43] is a fund managed by the Nordic Investment Bank[44] (NIB) and the Nordic Environment Finance Corporation (NEFCO[45]). The BSAP Fund has financed usage of methanol based fuel together with SSPA Sweden[46]. Partners are ScandinNAOS, Stena Rederi, Haldor-Topsøe, Wärtsilä, Lloyds, and Methanex. The key findings of this project are:

- It is faster and less expensive to use methanol instead of LNG
- The conversion costs is lower
- The demand for methanol exceeds the current supply
- It takes some 5 years to construct a methanol plant
- No SOx emissions from ethanol
- The NOx emissions are below IMO's requirements
- Dual use of diesel and methanol is feasible

[43] www.nib.int/loans/loan_products/trust_funds/bsap_fund
[44] www.nib.int/
[45] www.nefco.org/
[46] www.sspa.se

5.7 Alternative fuels

a) Overview of alternative fuels

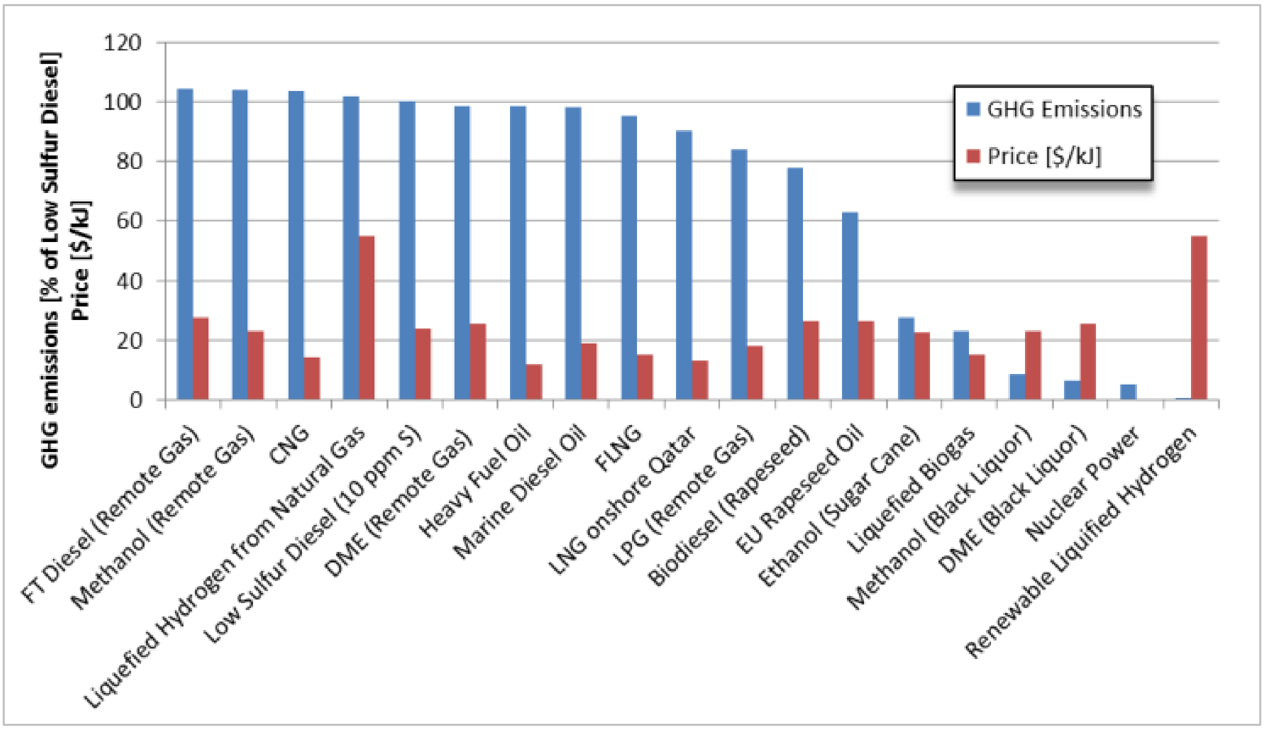
Here is an overview[47] of world consumption of all alternative fuels for shipping

Table 6. Alternative fuels for shipping – All numbers in Tonnes Oil Equivalent

• Oil based	4 028
of which for shipping	300
• Natural Gas	2 858
of which LNG	250-300
• LPG	275
• Methanol	23
• Ethanol	58
• DME	3-5
• Fischer-Tropsch	15
• Biodiesel	18-20
• Biogas	Very low
• Hydrogen	Very low

In following figure the tank-to-propeller emissions is assumed to be equal to CO_2 absorbed by the plant during its lifetime for the biofuels.

Figure 34. Well-to-propeller CO_2 emissions and relative prices



Source: Det Norske Veritas

[47] Source: Det Norske Veritas

b) LPG

LPG is in use since 1912 and is a mixture of Propane & Butane. Annual production is 270 Mt/year, and increasing. The safety issues are similar to LNG. The main uses are domestic, chemicals, agriculture.

In contrast to LNG, LPG is already a well-established fuel that enjoys a mature, global supply network with less-costly terminals and comparatively minor safety issues. As such, older LPG carriers could function as bunkering stations since all have on-board re-liquefaction plants installed, which are less demanding and less expensive to run than LNG systems. Furthermore, ship to ship loading of LPG is not considered complicated.

c) Biofuels

Biofuels can provide 10 – 70 % lower CO_2 emissions. Currently ethanol is not cost competitive as a marine fuel. Bio diesel can be used in blends. In Europe the spare capacity is about 11 Mt/year. There are strict regulations on sustainability in the EU. Biofuels have been applied by US Navy (algae-based fuels), Maersk Line (30t Rapeseed oil, 30t algae-based), and Meriaura Ltd (industry side streams). Maersk is involved in fuel development research program.

Bio diesel is currently 10-20% more expensive than distillate fuels.

Currently the most important types of biofuel are bioethanol, biomethanol and higher bioalcohols, biodiesel, pure vegetable oils, hydrotreated vegetable oils, dimethyl ether and organic compounds. In the European Commissions' (2013) Clean Power for Transport: A European alternative fuels strategy[48] it is stated that in the future there is no single fuel solution but a comprehensive mix of alternative fuels.

Biofuels[49] can reduce greenhouse gas emissions from transportation and dependency on oil. Biofuels have many advantages: they are biodegradable, they contain no sulphur and small particulate emissions are very low. Biofuels are well suited for different modes of transport, due to their availability is good at the global level. Hence, availability is occasionally uneven. Biofuels are mainly used in road transport. In shipping, biofuels have mostly been used on a small scale. Ships need of a lot of the fuel in one go, so constant availability is a more significant factor. The energy content of biofuels is less than in traditional fuels.

When evaluating the use of biofuels and their emissions, the raw materials of biofuels should be taken into account, as well as the entire production and supply chain. Biofuels are divided into first, second and third generation by their properties. Biofuels are produced from very many kinds of biomasses and through various methods.

The most commonly used biofuels are first generation biofuels: biodiesel from oil-rich plants and bio-based raw materials, as well as bioethanol, which is made from sugar and starchy plants. The problem is that their production competes with food production. Second-generation biofuels are more advanced versions of biodiesel and bioethanol, and the raw materials come from wood-based cellulose and waste. The emissions are reduced and quality is improved. Third-generation biofuels are under development, and their raw materials are completely new, such as algae.

[48] http://cor.europa.eu/en/activities/stakeholders/Documents/com2013-17.pdf
[49] Transport and the Environment 2013

Maersk has tested the use of biofuels and manufacturing, for example from algae. In 2012 Oy Gaiamare Ab's new vessel m/v Meri was finished. The vessel uses biodiesel as its fuel. The fuel is produced from fish as a by-product.

6. Port plans for SECA 2015 - Infrastructure

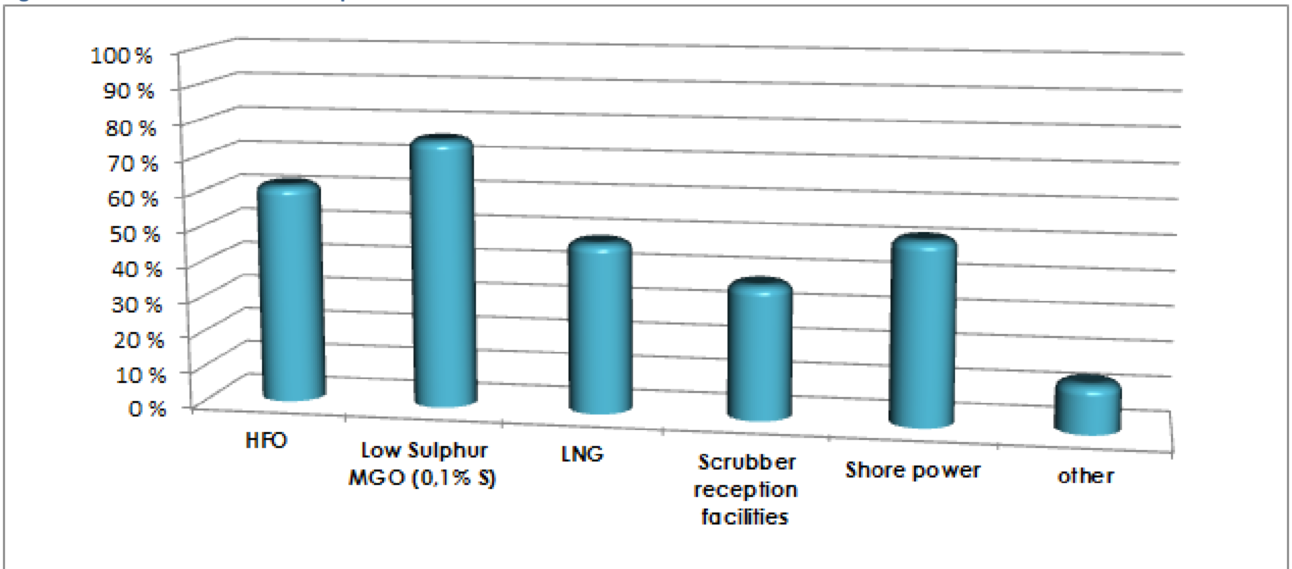
6.1 Results of the survey for the ports on their plans for 2015

ESN, the Way Forward –project surveyed the plans of major ports in the SECA area for the year 2015, when the stricter sulphur regulations will be enforced. The ports were asked to report on plans and prospects for supply of fuels that comply with SECA regulation, and about bunkering and fuel facilities that are planned to be available in 2015. Also preparedness of the ports concerning the waste reception and shore power facilities in the future was examined. The survey was carried out in February – March 2013.

Regarding bunkering and fuel facilities, the shares of the planned services in the ports which responded to the survey are presented below in percentages. As can be seen from the figure below, the use of MGO seems to be the most realistic means to comply with the stricter regulation. The option "other" includes for example the use of alternative fuels.

Other options mentioned were for example alternative fuels and MGO (marine gas oil) delivered by trucks.

Figure 35. Planned services in the ports



Source: ESN – European Shortsea Network

Most respondents reported on various plans for 2015 and beyond. The plans mentioned were mostly related to LNG infrastructure and bunkering of LNG. LNG infrastructure for shipping lines, including LNG tanks in ports, requires co-operation with private companies and public institutions. Also approval by the authorities is required. Supply options / bunkering of LNG are considered by the ports, mainly consisting of bunker trucks or ship/barge to bunker LNG.

In the first phase LNG-bunkering is considered to be arranged by trucks and barges and later by building tanks and/or terminals. Bunkering with barge requires still national regulation, which is not yet published e.g. in France. In order to reduce final cost the availability for other customers than shipping lines is also considered. In general, further (prefeasibility) studies are carried out concerning LNG. In many cases it is expressed that the financial support programmes are needed to realize the LNG-infrastructure.

Some ports report that they have scrubber reception facilities already available, but some are uncertain about receiving scrubber sludge. It may be accepted within waste disposal scheme, but for example the characteristics of sludge are still uncertain. One Finnish port reports that scrubber water is not possible to discharge directly to the city sewage system, because of high concentrate of sulphate. Scrubber reception facilities may be provided by specialised companies or by the port authorities themselves.

Table 7 Port plans for SECA 2015

LNG BUNKERING FACILITIES	WASTE RECEPTION FACILITIES	SHORE POWER FACILITIES	CHALLENGES AND OTHER REMARKS
EXISTING - LNG terminal (in action 25 years), f = 1 - LNG deliveries by trucks, f = 2 - LNG bunkering by barges, f = 2 **PLANNED** - LNG bunkering facilities in general (in 2015, in 2018), f = 9 - LNG terminal / storage tanks (in 2016), f = 5 - use of LNG bunker vessels, f = 3 - use of LNG trucks (in 2015), f = 3 - development and construction of an LNG bunkering vessel, f = 1 **REMARKS** - the role of the port is to provide safe operational environment for LNG bunkering in the port - national regulation concerning bunkering from barges is not published yet - need for space, which is rare on ferry terminal	**EXISTING** - all ship generated waste, f = 2 - scrubber waste, f = 2 **PLANNED** - scrubber waste (in 2018), f = 4 **REMARKS** - scrubber waste water is not possible to discharge directly to the city sewage system, because of high concentrate of sulphate - scrubber waste facilities will be provided and operated by private companies - characteristics of scrubber waste is still uncertain - if demanded by shipping companies	**EXISTING** - shore power (for seagoing container vessels, for inland vessels, low voltage, high voltage), f = 4 **PLANNED** - shore power (in 2013, 2015, in 2016, only for submarines), f = 9 **REMARKS** - cannot be forced legally because air emissions are within limits	- opening the use of LNG for multiple users to reduce the final cost - having a knowledge about the future market - financial aspects, such as support programmes and EU-funding - lack of appropriate rules - communication with the public, a port is often a seaside resort

n=29 (amount of respondents), f=frequency, i.e. the amount of expressed and planned facilities

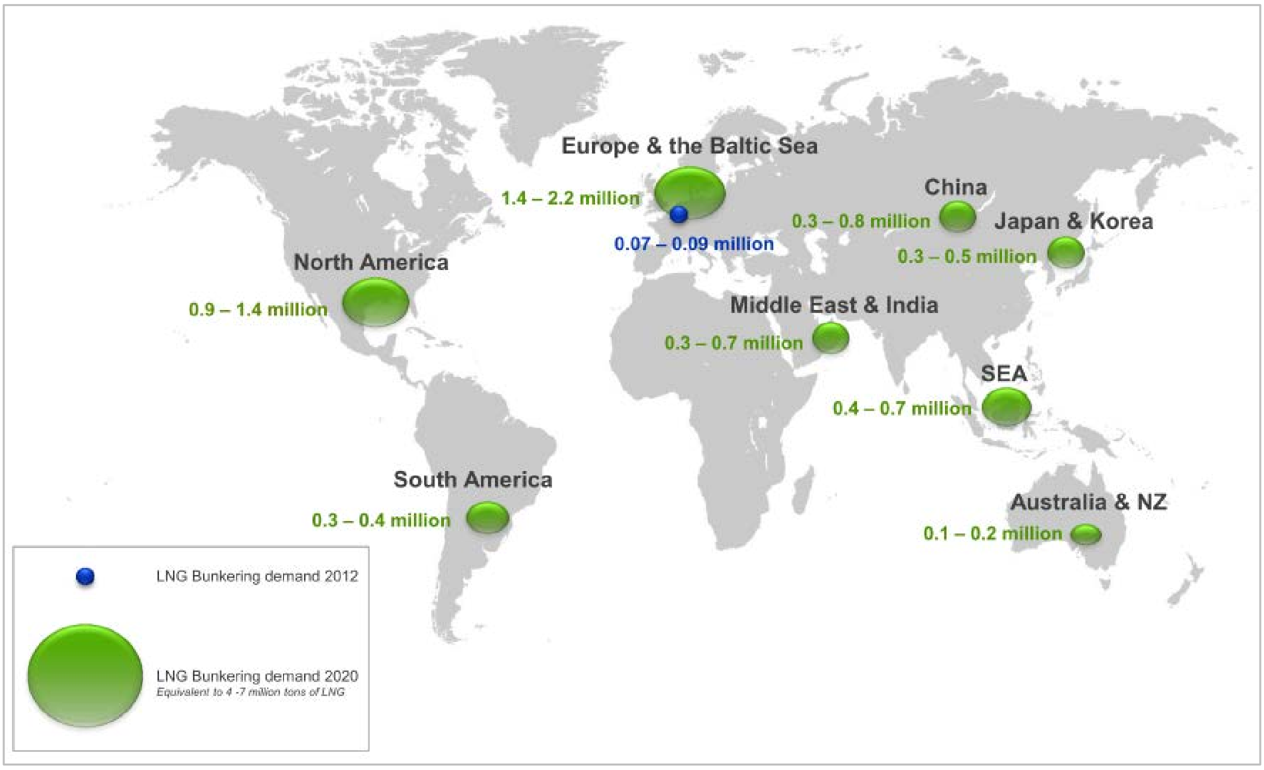
As the shipping companies have not decided on their reaction towards the upcoming constraints regarding sulphur and nitrogen oxides the demand side for reception facilities / bunker qualities is still very uncertain.

6.2 LNG distribution

a) Bunkering demand

The current market for LNG bunker is about 90 000 tonnes. It is expected to grow to 1,4-2,2 million as shown in the chart below.

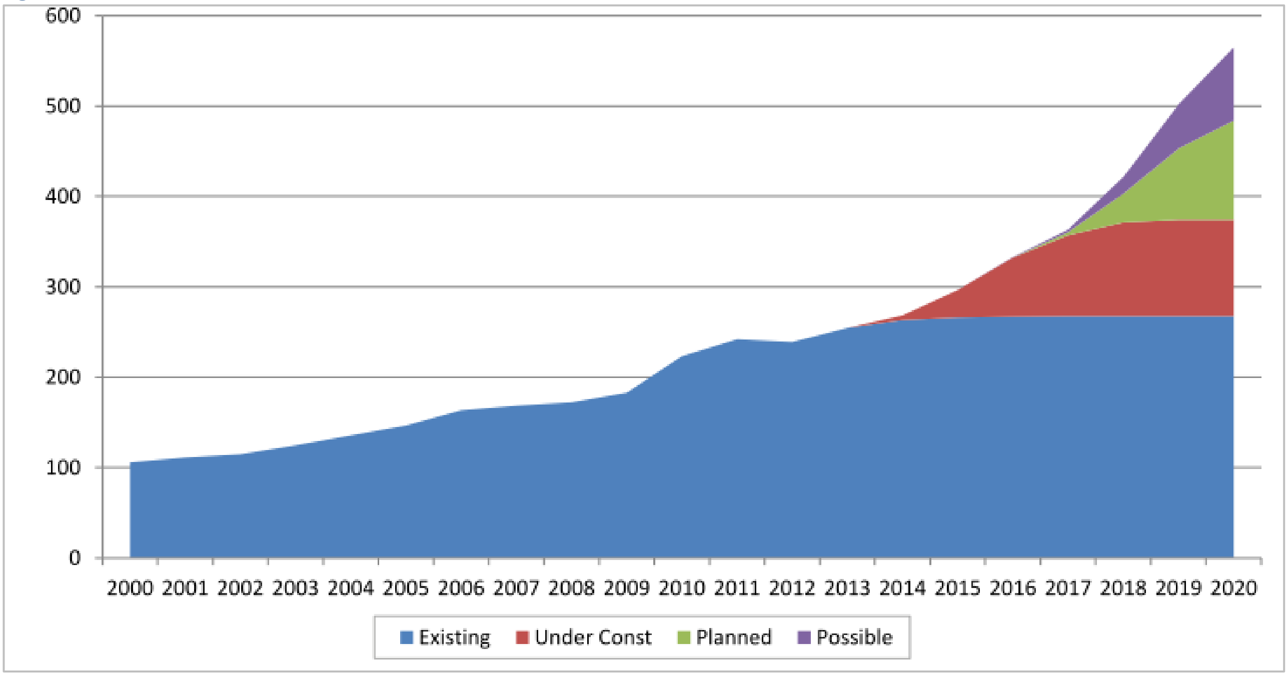
Figure 36. Global LNG Bunker demand estimate by 2020



Source: Det Norske Veritas estimate June 2013

This is small compared to the global market for LNG as shown in the following figure. The extra demand for LNG for bunkering will therefore have no effect on the LNG market or its prices.

Figure 37. Global LNG Production 2000 – 2020 in million tonnes



Source: Fearnleys

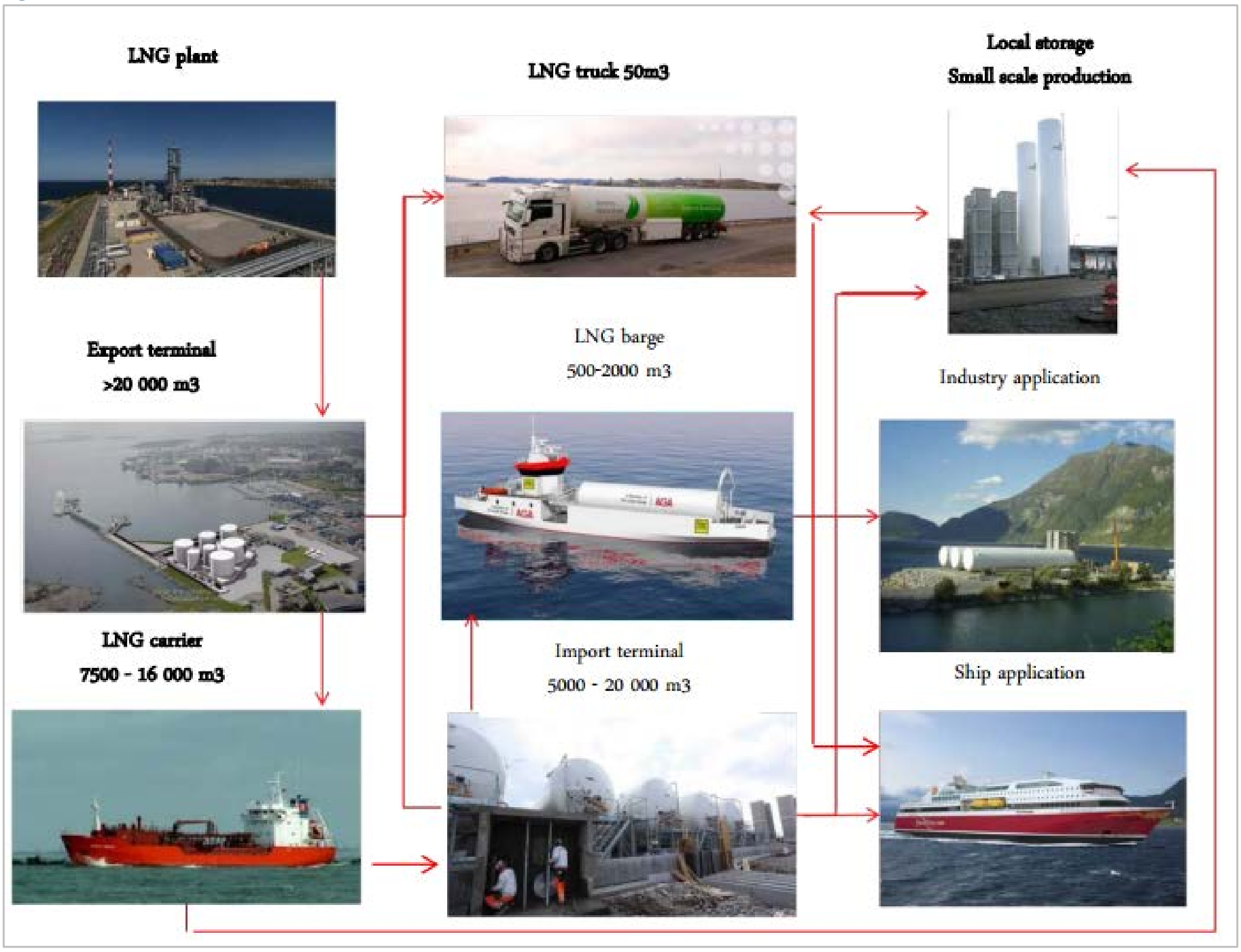
b) Distribution of LNG

An LNG distribution net must be built out meet this new demand for LNG bunkers. We have seen earlier (*Ref. Figure 16. LNG distribution cost by type of distribution and volume*) that there is a great economy of shale in LNG distribution. This will lead to lower LNG prices as the volumes grow. The prices will also be lower closer to the sourcing points.

The alternative ways of distributing LNG is show in the following figure. The main alternatives are:

- The LNG entry point is large European LNG terminal or a European LNG-plant.
- From the entry point it can be distributed locally to ships through pipe lines, LNG barges/bunker vessels or by LNG truck or container.
- From the entry point it can be transported to smaller terminals by LNG Feeder vessels, or in LNG containers on container ships or by LNG trucks.
- Bunker can be delivered to the ship through direct pipeline from a terminal, from a battery of LNG containers, from a LNG bunker barge or directly from a LNG truck or container.

Figure 38. LNG distribution



Source: Norwegian NOx fund[50]

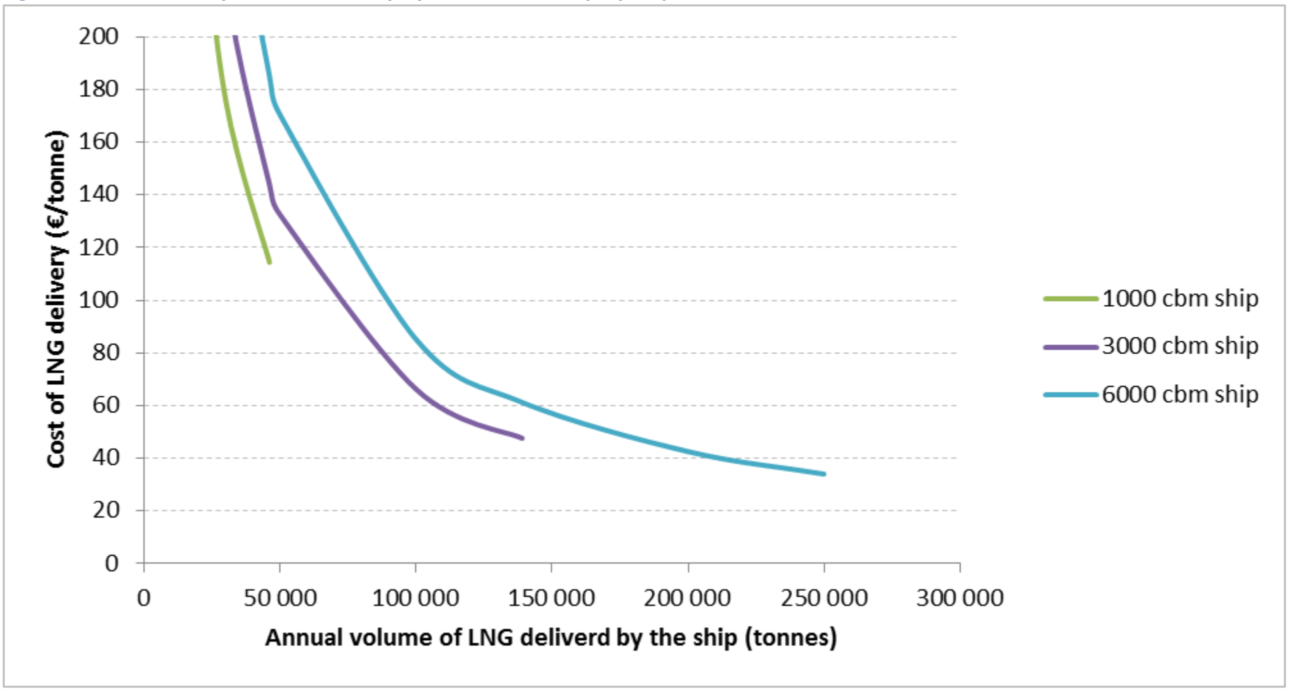
c) Large scale delivery in European hub ports

In a port with an existing LNG terminal or for ports close by, the best alternative is bunker ships or barges. A ship is more flexible and can serve more ports. The cost of a new LNG-ship of 6 000 cbm is about € 30 million. The annual cost is about € 9 million. The capacity of such a ship is up to 250 000 tonnes per year. 6-10 ships are required to handle the bunkering needs in and close to major LNG terminals.

In the following figure we have calculated the distribution cost for alternative sizes of bunker ships. The distribution cost will be in the range of € 40-130/tonne (€ 3-10/MWh), depending on utilization and annual volume of the ship.

[50] http://www.ndptl.org/c/document_library/get_file?folderId=19620&name=DLFE-1547.pdf

Figure 39. LNG delivery cost for delivery by LNG-bunker ship by ship size



Source: SPC Norway based on input prices and operation cost for LNG Carriers

d) Delivery outside the European hub ports

Delivery via a LNG-terminal is recommended if there is an industrial need in the area. In this case the ships can bunker at the terminal or receive bunker from a local bunker vessel or LNG truck or container. Examples of this are the new LNG terminals in Fredrikstad, Norway and Nynäshamn and Lysekil in Sweden.

The cost of the terminal is also illustrated in figure 15. The terminal adds another US$ 1-2/mmBtu (€3-5/Mwh = € 40-70/tonne) to the cost.

e) Early-bird solutions and distribution by container

In an early stage, when the volumes are low, the following solutions can be used:

- Ship-to-ship using LNG feeder ships and eventually LNG bunker ships. LNG suppliers Skangass and GasNor offer this.
- LNG can be supplied directly to the ship from tank containers. This solution can be designed for unmanned storage and distribution solution on terminal. LNG can be supplied from quay-side or from a barge with LNG-container. If required, and as volume picks up, a bunker terminal can be established nearby.

A main challenge is that LNG volumes are unpredictable. Flexible volume solutions are:

- As LNG volume increases, several tank containers can be connected to a manifold to supply LNG directly to the ship
- Pumping solutions can be designed for future increase in filling flows

One challenge is that there are limited LNG carriers available. Potential alternative logistics solutions are:

- LNG can be supplied with LNG tank containers approved for road, rail and sea transport
- Tank containers can be controlled and monitored remotely.

The economics of the bunkering terminal may not allow for a large operational organization. The operation cost can be minimized by:

- Start out with LNG tank containers
- The bunkering terminal can be designed for unmanned operations. The terminal can be supplied with a remote monitoring system.
- The safety system of the terminal can be designed to go to shut-down in case problem.

Figure 40. LNG containers for distribution and storage of LNG by ship and truck

Image: Liquiline

45 ft. LNG containers can carry 55 m3 cargo and represent a cost efficient transport alternative by ship or truck in an early stage.

f) Transport of LNG

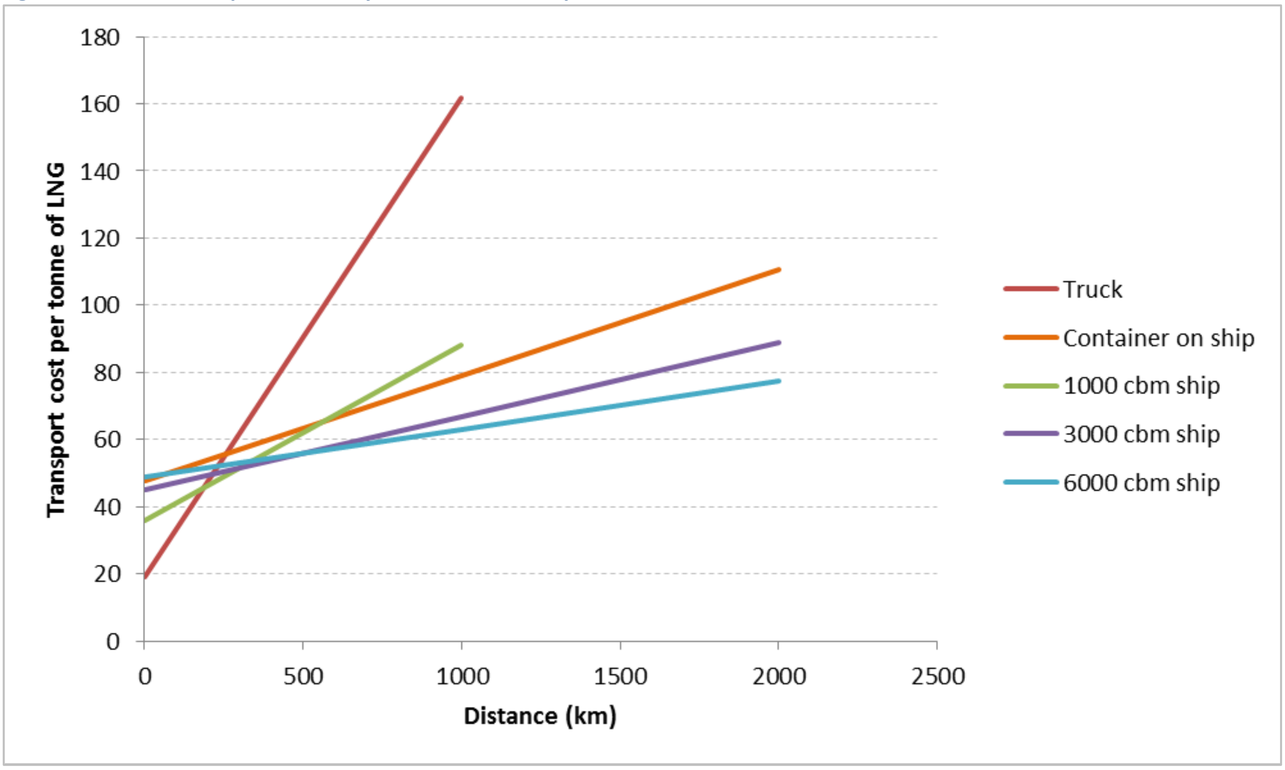
The cost of bringing LNG to the terminal varies with the distances. The following chart illustrates this.

The cost of an LNG container of 45 ft is about € 200 000. The day rate is about € 125. The LNG cargo capacity is about 21 tonnes. The container can be distributed by truck or by shortsea shipping on a container vessel. The transport cost by road would be about € 3 per km, including the LNG-container and the empty return. This gives a transport cost of about € 0.15/tonne-km.

For distribution of LNG-container by container ship the initial cost is higher. At a distance of more than 300 km it seems more profitable to use a container ship rather than trucks between locations where short sea shipping is offered.

If the volume is sufficiently high, it is more profitable to use a LNG carrier. The cost of this is illustrated in the next figure at various ship sizes.

Figure 41. Cost of transport of LNG by distance and transport form



Source: SPC Norway – based on input from many sources

g) LNG distribution cost

Based on the earlier discussions we can conclude that the LNG distribution cost will vary from € 40-200/tonne depending on the distance from the LNG source terminal and the need for an extra terminal to store the volumes on the bunkering terminal. This is often required for large ships requiring fast loading of high volumes of LNG bunker.

h) LNG feeder and bunker vessels

Ship-to-ship is an important part of LNG distribution. Operational bunkering process and technical solutions need to be developed case-by-case. There has been several ship-to-ship bunkering assessments, for example GOT LNG, BunGas, North European infrastructure project and the North America bunkering advisory council. This includes concept studies for LNG bunker barges and bunkering vessels.

The first bunker barge we know of is a rebuilt ferry that is used for bunkering of a ro-pax ferry in Stockholm.

Figure 42. The first dedicated LNG bunkering barge in the world used by AGA in Stockholm

Image from Marine Traffic

There are already some LNG feeder and bunker vessels available. The following table lists ships available in Europe. Further ships are needed to cover the expected maritime LNG demand in Europe in 2020.

Table 8. LNG Feeder and Bunker vessels in Europe

Ship name	Owner	Operator	Type	Built	Cubic
Pioneer Knutsen	Knutsen OAS	Gasnor	LNG	2004	1100
Coral Methane	Anthony Veder	Gasnor	Multi	2008	7500
Coral Energy	Anthony Veder	Skangass	LNG	2012	15600
Seagas		AGA	LNG	^2013	187
Coral Athelia	Anthony Veder	Skangass	Multi	2013	6500

^ Converted ferry

Figure 43. LNG Feeder vessel with a tank capacity of 15 600 cbm

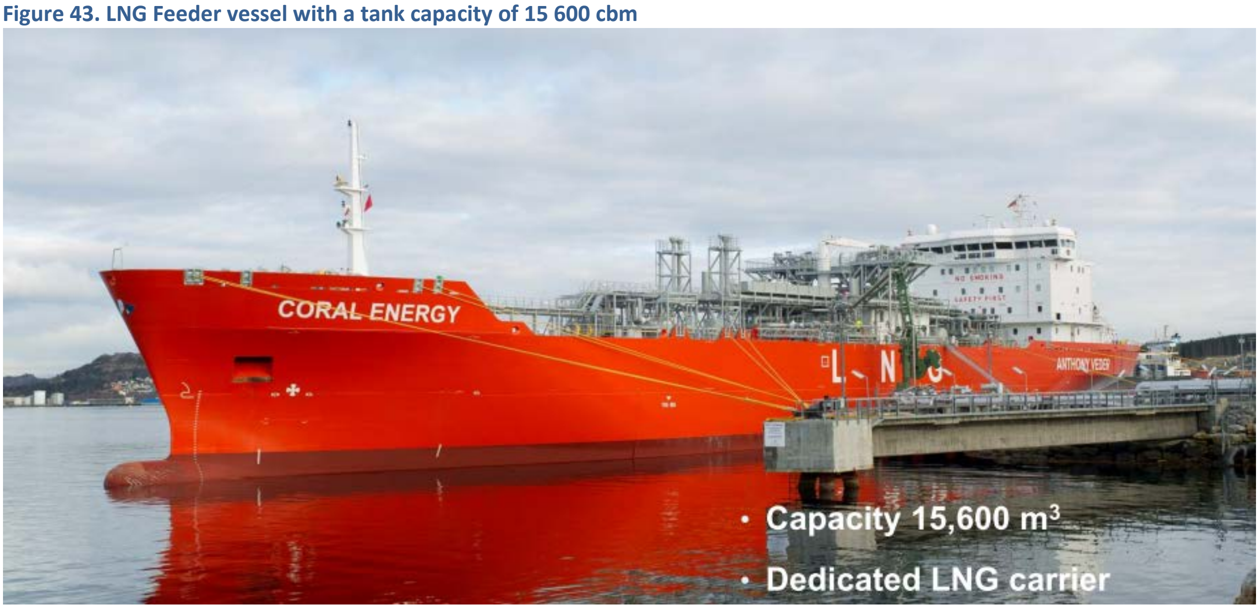


Figure 44.Transhipment of LNG to smaller distribution vessel

6.3 LNG infrastructure - existing and planned

a) Terminal alternatives

The following figure illustrates some of the small-scale terminal solutions. LNG containers or dedicated tankers can be used.

Figure 45. Examples of terminal solutions for small-scale LNG distribution

Source: Liquiline[51]

[51] www.liquiline.com

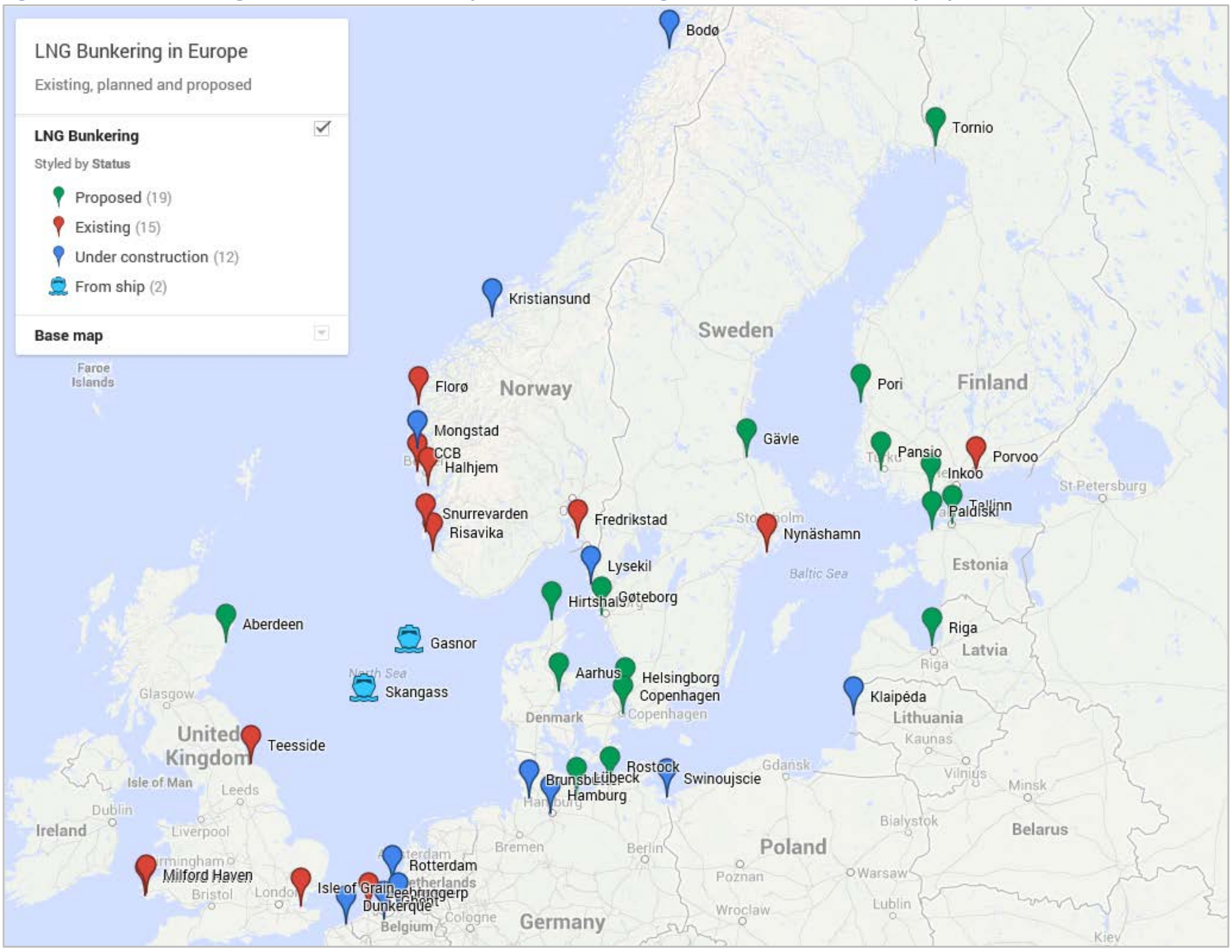
b) LNG terminals and bunkering

We have made a survey of all the existing, planned and proposed LNG terminal and bunkering facilities in Norht-Europe. This is illustrated in the following figure. We have also made an interactive map[52] where more details can be found.

From the map we see that there are already existing bunkering facilities in Norway and on the east-coast of Sweden. It also seems clear that from 2015 there will be LNG available in the main hub ports in the Zeebrucke to Amsterdam range and the Bremerhafen to Hamburg range. A large number of facilities are being constructed or are proposed and construction will start shortly.

Also, both Gasnor and Skangass will offer ship-to-ship delivery of LNG in the North Sea to Skagen range.

Figure 46. LNG Bunkering facilities in North-European SECA – Existing, under construction and proposed

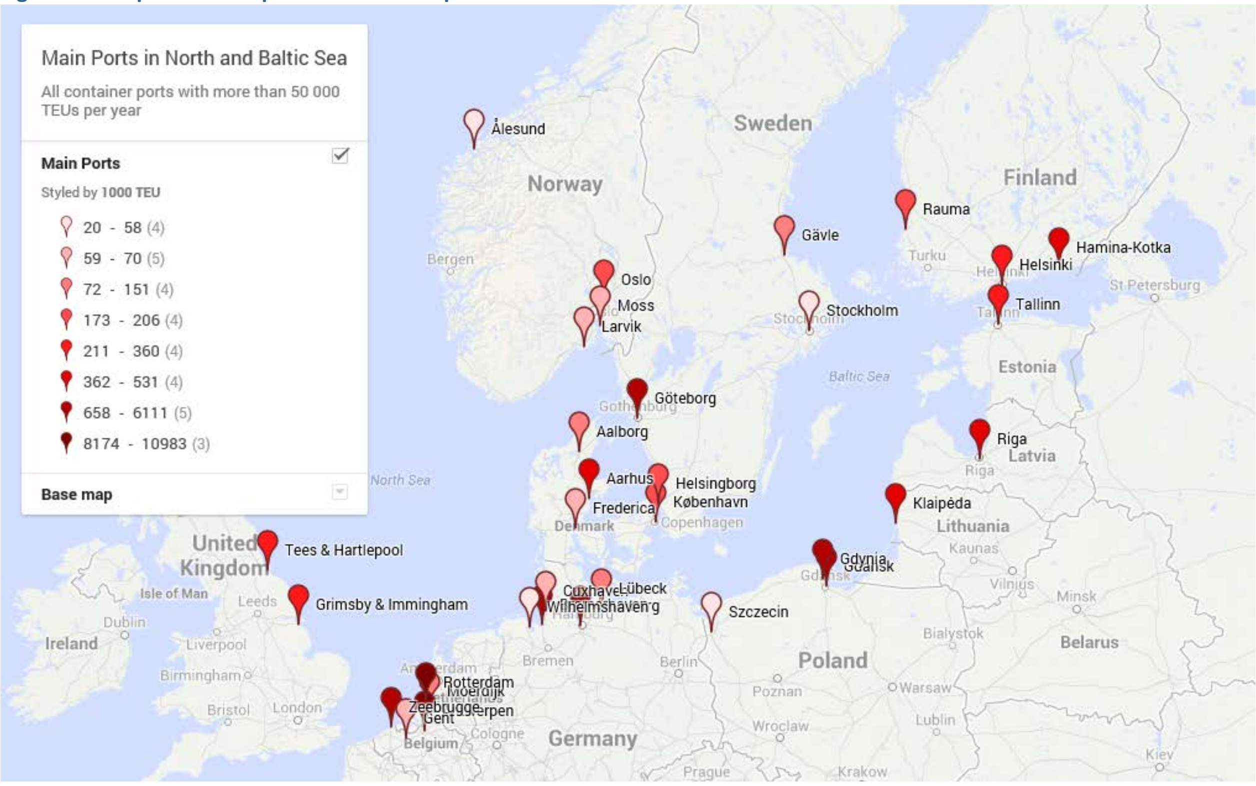


Source: Det Norske Veritas and SPCs in each country

The following map[53] shows the most important short sea port in terms of cargo volume. It seems clear that we can expect that the coverage of LNG bunkering will be good from 2015 and increasing good towards 2020 in almost all major ports.

[52] Interactive LNG bunkering map: http://is.gd/TwKAlf
[53] Interactive map of main ports in North Sea and Baltic Sea: http://is.gd/lFs4mb

Figure 47. Map of most important container ports in the North Sea and Baltic Sea



Source: ESN interactive map of ports in the North and Baltic Sea Area

Here are some examples of the developments:

- **Rotterdam**: At Gate terminal. Partners Vopak and Gasunie. EU support (Motorways of the Seas) of € 34 mill. Cooperation and distribution to Gothenburg. The Gate terminal will have storage facilities, ship jetty and truck loading facilities. A range of LNG suppliers will be allowed to use the facilities. The competition will ensure competitive services and pricing.
- **Klaipedia**[54]: State-owned terminal operator Klaipedos Nafta. Loan from European Investment Bank. Lease a floating LNG terminal from Norway's Hoegh LNG for a decade.
- **Finland**: In Finland there is one liquefaction plant in Porvoo (Gasum), but no LNG bunkering facilities for public use. The liquefactions plant receives its natural gas from Russia through the gas pipe, and it is transported by road to Vaasa where Wärtsilä uses it for instance for testing the engines. One terminal will be placed either in Porvoo or Inkoo depending on the decision from European Commission whether Finland (Inkoo) or Estonia (Paldiski) will get the support to build a LNG-terminal. Gasum is planning both of these two terminals. In some sense Pansio and Pori are also alternative places. Gasum have plans to both and AGA to only Pori. At the moment it is believed that Tornio will most probably get its terminal.

[54] http://www.bloomberg.com/news/2013-09-25/lithuania-makes-lng-terminal-priority-in-battle-for-cheaper-gas.html

Figure 48. Rotterdam Gate terminal will provide LNG bunkering

6.4 LNG bunker suppliers

a) Existing suppliers

Existing suppliers of LNG as fuel for ships are:

- **GasNor**[55]: Owned 100 % by Shell. LNG-production in West-Norway. Offering ship-to-ship bunkering. Offering truck delivery. Two LNG feeder ships on charter. Partner in Brunsbüttel development.
- **Skangass**[56] is based in Stavanger, Norway. LNG-production plant in the port of Risavika. Two LNG carriers on charter (Oct 2013), Coral Energy and Coral Athelia. Offers ship-to-ship LNG bunkering in the North Sea-Skagerak range and from terminals in Risvika, Fredrikstad and Lysekil

[55] www.gasnor.no
[56] www.skangass.com

6.5 Availability of onshore power in ports

The sulphur content of fuel in EU ports is already today restricted to 0.1 % for vessels staying over two hours in the port. Some ports provide onshore power supply for vessels. Electricity generated onshore replaces energy from the vessels' diesel auxiliary engine. The use of onshore electricity improves air quality in ports. It reduces not only sulphur but other emissions into air. In addition, it also reduces ship-generated noise in ports which are often situated in sites that are densely populated. [57]

Within the SECA area, onshore power is offered by the following ports:

- In Finland, the Port of Helsinki offers since 2012 onshore power to passenger ships in two quays, Katajanokka and Pakkahuone.
- In Sweden, the Port of Gothenburg[58] offers onshore power since 2000. At present, the following quays are equipped to provide OPS:
    - Quay 24, Masthugget, Stena Line: OPS for a high-speed passenger ferry 50 Hz
    - Quays 28-32, Masthugget, Stena Line: OPS for ro/pax vessels, 50 Hz
    - Quays 46-49 Majnabbe, Stena Line: OPS for ro/pax vessels, 50 and 60 Hz
    - Quay 700, ro/ro terminal: OPS for ro/ro vessels, 50 Hz
    - Quay 712, ro/ro terminal: OPS for ro/ro vessels, 50 Hz

  All new and renovated quays will be equipped to provide onshore power supply.

In Belgium, the Port of Antwerp offers shore power[59] for barges in the port area in a number of locations: on the northern side of the Willem dock, the southern part of the Kattendijk dock and the Wacht dock for barges at the Noordkasteel bridges. There are 230 Volt and 400 Volt connections. Shore power is also being supplied in Zeebrugge since 2000. In addition, in 2014 ships will be able to make use of shore power in Ghent. This is a joint initiative of the Ghent Port Authority and DFDS Seaways and it is a first for the port of Ghent. It will spare the environment as far as emissions and noise hindrance are concerned.

In the Netherlands, the first shore-based power connection for sea-going vessels[60] was opened in 2012 in the Port of Rotterdam at the Stena Line terminal. For inland vessels, there are several connections.

More information on onshore power is available on a dedicated website by the working group on Onshore Power Supply (OPS)[61] established by the World Ports Climate Initiative (WPCI).

[57] Transport and the Environment 2013
[58] http://www.portofgothenburg.com/About-the-port/Sustainable-port/Onshore-power-supply-for-vessels-at-berth/
[59] http://www.portofantwerp.com/en/my-poa/services/shore-power
[60] http://www.portofrotterdam.com/en/News/pressreleases-news/Pages/1st-dutch-shore-based-power-connection-ocean-shipping.aspx
[61] http://www.ops.wpci.nl/

7. Support facilities

7.1 Market-based instruments to encourage environmental innovations

Economic instruments are one of the means to encourage environmental innovation in the field of transport. Examples of the economic instruments are environmentally related taxes and charges, environmentally motivated subsidies, tradable permits, and deposit refund systems. Besides, there exists voluntary policy approaches such as environmental agreements, negotiated with industry, and public programs in which firms can volunteer to participate. Information on these instruments is available at a joint database of the OECD and the EEA (European Environment Agency)[62].

7.2 Plans and developments in SECA countries

Each SPC in the SECA area was asked to provide information on the most topical SECA-related issues from its country. Information was gathered on state aid, other national support provided, investments on LNG or other alternative fuels, discussion on the rising costs, and new innovations etc. information was provided by the SPCs of Belgium, Bulgaria, Finland and France. The country reports are included as Annex VI.

Alternative fuels and technologies are extensively discussed in Finland. Different kinds of methods and tools for adaptation on stricter sulphur regulation have been proposed. A working group coordinated by the Ministry of Employment considered a range of alternative measures and their impacts.

Alternative tools proposed include

- support to new innovations and environmental investments
- promotion of the use of LNG and biofuels
- increasing the maximum permissible weights and dimensions masses of the road transport vehicles
- renewal of fairway due system in Finland

The Finnish Ministry of Transport and Communications published a report on alternative fuels used in transportation. The report examines the various forms of energy usage and access. The report provides a separate LNG Action Plan for the period 2013-17.[63] There is an Environmental Aid Scheme for Finnish Vessels, which is described in more detail in Chapter 7.2.

In Belgium, in particular the development of LNG, but also of shore power is high on the agenda. The role of the Flemish Administration/Government is mainly to create the legal framework to make it possible to use LNG for maritime purposes. The Flemish Administration supports LNG pilot projects, for bunkering as well as for infrastructure, for instance by offering assistance for writing files for European subsidies. The Flemish Government made a study on the possibilities of offering LNG as fuel for the shipping sector in the Flemish Ports.

In France, a provisional inter-ministry & industry group has been created. This group is under the responsibility of CGEDD (*Conseil Général de l'Environnement et du Développement Durable* - General Council for Environment and Sustainable Development) for "public side" and SPC France for "industry side". This group has been tasked to make recommendations to French Ministry of Transport regarding the

[62] http://www.eea.europa.eu/themes/policy/economic-instruments
[63] http://www.lvm.fi/publication/4156469/future-transport-power-sourcesexecutive-summary

development of LNG as a fuel for shipping in France. The group has investigated, through open dialogue and good cooperation, the current situation in the fields of regulation, finances as well as technical and operational topics. The various European policies have also been studied along the process. The group has been confirmed and extended for two years (until 2015) by the French Ministry of transport in order to maintain the global coordination capacity as well as cross-sector understanding and harmonization of on-going work. In addition, AFG (*Association Française du Gaz* - French Association for Gas) has started a specific working group between LNG providers and French regulation authorities. Pilot projects are under consideration in France.

Outside the current European SECA, **Bulgaria** is exploring the options and increasing awareness on the up-coming more strict emissions control regulations. These measures include:

- Exploring carefully all the options for compliance /"pros." & "cons" of the different methods;
- Ensure better use of the EU & National transport funding instruments;
- Identify possible incentives applicable at local, national and regional level /i.e. green port dues and tariffs for green ships;
- continue the active dialogue with all the maritime industry stakeholders at national and international level – to exchange information, expertise and good practices;
- continue the dialogue with major international partners and co-ordination with IMO & EMSA on maritime sustainability related topics.

7.3 State Aid

a) Norwegian NOx fund

The NOX fund[64] in Norway was established by fifteen business organisations. Reducing NOX emissions is the primary objective of the environmental agreement signed between these organisations and the Ministry of the Environment. The Environmental Agreement on NOx 2011 – 2017 is extension of the agreement for the period 2008 – 2010. It is directed for shipping between Norwegian ports.

Payments that are assigned to the fund replace the governmental NOX tax for participating enterprises. In maritime transport, the NOX tax concerns vessels of all nationalities, with the exemption of vessels in international traffic or vessels which operate directly between Norway and foreign ports. The participant enterprises can apply for financial support for measures aiming at decreasing NOX emissions. Foreign owned enterprises must join the Agreement through a Norwegian representative. Support is granted both for investment costs and operating costs with respect to the measures designed to reduce NOX emissions. Annual amount offered by the fund is NOK 600 million (about € 80 million per year).

Support may be granted for:

- Newbuildings and retrofitting gas propulsion and LNG infrastructure
- New and promising NOx reducing measures
- SCR systems with the use of urea on ships and SCR and SNCR systems in the incineration industry
- Battery-powered propulsion of car and passenger ferries

[64] http://www.nho.no/nox/english

- Gas in land based industry
- Engine modification and replacement
- EGR and water based treatment
- Other NOx reducing measures (for instance energy efficiency)

The NOx Fund has granted support to 49 ships converted to LNG or new LNG vessels (August 2013).

b) State Aid in Finland - Environmental Aid Scheme for Finnish Vessels

In 2011, the European Commission approved the Finnish aid scheme for vessels that aim at environmental protection. Under the Government Decree on investment aid improving the level of environmental protection of ships, the Finnish Ministry of Transport and Communications supports innovations of Finnish shipping companies for their vessel investments improving the level of environmental protection. The projects receiving aid involve major environmental innovations. In 2010, in total € 30 million was granted for two new building investments improving the level of environmental protection. The Viking Line passenger ferry Grace uses liquefied natural gas (LNG) as its fuel, and the new Gaiamare freight vessel uses liquid bio-oil. The Gaiamare vessel will also be equipped with an oil recovery system to respond to possible accidents.[65]

In March 2013, the Finnish Government issued an amendment to the Decree.[66] The amendment entered into force on 1 April 2013 and the application period for investment aid has been carried. With the amendment, the scope of aid is extended so that it may also be granted to ships which are already in use. The environmental standards of shipping have changed and shipping companies will in the coming years be subjected to new requirements concerning the reduction of sulphur content of fuel, in particular.

Following entry into force of the amendment, aid can be targeted at retrofitting vessels with emission abatement technologies, particularly sulphur scrubbers. Investment aid may be granted to technical solutions which enable implementation of alternative fuels or reducing emissions from fuels.

In the 2013 Budget, a total of € 30 million has been reserved for environmental aid to be granted for vessel investments.[67] This budget authority is targeted at costs which arise from retrofitting existing ships with systems improving the level of environmental protection. Within the aid scheme approved by the EU, state aid to sulphur scrubber retrofitting operations may be up to 50 per cent of the costs included in the project.

Six shipping companies and their 22 vessels benefited from the aid. An additional call for proposals was opened in November, concerning the 11 million euro still available. Investment aid can be used for exhaust gas cleaning systems, such as sulphur scrubbers.

[65] http://www.lvm.fi/web/en/topical/pressreleases/-/view/1281174
[66] http://www.lvm.fi/web/en/pressreleases/-/view/4142610
[67] http://www.lvm.fi/web/en/topical/pressreleases/-/view/4144518

c) Investment Support for LNG terminals in Finland

The Finnish Ministry of Employment and the Economy has opened an investment support programme for LNG terminals in Finland. [68] Adopting LNG will require the construction of a national LNG terminal network in Finland, and a similar network in the Baltic Region, as well as a regulatory framework for the purchase and use of LNG-fuelled vessels. A so-called bunkering infrastructure is required for refuelling with LNG. In addition, LNG carriers are needed in order to transport LNG to terminals.

LNG terminals enable the transportation of natural gas to areas outside the natural gas network. This diversifies and helps to secure the energy supply. It also reduces emissions, particularly in industry in which other fossil fuels are used as a power source. LNG terminals also provide a way of boosting competition on the energy markets and give energy buyers more choice.

In autumn 2008, the European Commission launched the BEMIP (Baltic Energy Market Interconnection Plan). The goals of the BEMIP include connecting the Baltic countries' and Finland's natural gas network to the European network, as well as the construction of an LNG terminal – serving the neighbouring Baltic countries and Finland – on the coast of the Gulf of Finland. The Projects of Common Interest list (PCI list) includes the regional projects through which this is to be achieved. Projects accepted onto the PCI list are eligible for support by the European Commission. Finland aims to secure such support for large-scale, regional LNG terminals.

Support programme

The aim is to provide € 123 million in support for investments in the construction of a national LNG terminal network in 2013 and 2014. Investment support is intended for terminals used in the import or cargo handling of natural gas, as well as in the discharge, storage and supply of such gas. It is also intended for the design and construction of the related equipment.

Investment support for LNG terminals will be granted according to the Act on Discretionary Government Transfers (688/2001) and the Government Decree on General Terms of Granting Investment Support for LNG terminals (707/2013). The investment support can be sought from the Ministry of Employment and the Economy, when the decree is in force on 15 October 2013. Investment support must be sought before purchasing fixed assets or beginning any construction, refitting or renovation work to be financed from the support. Furthermore, the initiation of any such work will be looked upon as a final and binding investment decision.

Investment support can be granted to a company if:

1) LNG can be supplied from the LNG terminal as fuel for marine and other traffic;

2) Within the limits of the LNG terminal's capacity, the company sells rights of use to the terminal against reasonable compensation and makes public the related general terms of sale and prices;

3) State subsidies have an incentivising effect on investment in the terminal;

[68] http://www.tem.fi/en/energy/investment_support_for_lng_terminals

4) Investment in the terminal cost-efficiently promotes security of natural gas supply and greater choice for fuel purchasers, as well as competition on the natural gas markets and otherwise on the fuel markets; and

5) Investment in the terminal has the effect of reducing the overall burden on the environment;

6) The company provides at least 25 % of the financing for the project, through monies unconnected with public financial support.

As a discretionary form of support, the maximum level of support for LNG terminal investment is restricted by the authority granted under the state budget. This means that it will not necessarily be possible to grant investment support for every project that fulfils the requirements.

The granting and payment of LNG terminal investment support also depends on the approval of such support by the European Commission, as being compatible with the common market. However, support can be granted on a conditional basis prior to the Commission's approval.

7.4 Sources of EU financing

The European Commission published on June 28 2013 the first progress report on the implementation of the Commission Staff Working Paper "Pollutant emission reduction from maritime transport and the Sustainable Waterborne Transport Toolbox”. The aim was to promote compliance with, and minimise the possible negative impacts of, new environmental standards in maritime transport. The toolbox measures are in particular aimed at dealing with the implementation of the 2008 International Maritime Organization (IMO) rules on the maximum level of sulphur for fuels and their subsequent introduction into EU legislation.

The Progress report[69] covers the period from September 2011 to January 2013, with description of current status and next steps for action. It contains the short term measures: EU funding through TEN-T and Marco Polo II programmes, European Investment Bank (EIB) and national funding. Medium and longer term measures include coordination with stakeholders and member states: the creation of the European Sustainable Shipping Forum (ESSF). Regulatory measures are aimed at use of marine LNG as ship fuel, scrubbing technology and shore side electricity. The report also describes development of infrastructure as well as research, technological development and innovation.

a) Trans-European Transport Network TEN-T

Trans-European Transport Network, TEN-T[70] aims for a more sustainable EU transport system. The network covers all transport modes, Motorways of the Sea and intelligent transport. Connections between various modes of transport as well as ports, airports and railway-road terminals and the connecting routes between them will be improved. The infrastructure will be multimodal. TEN-T Calls for Proposals (Multi-Annual and Annual) have provided support for environmental projects in the field of transport.

The proposal for new guidelines for the TEN-T network was presented in 2011. The European Parliament, Council and European Commission reached an agreement on the proposal in May 2013. The agreement must be formally approved by the European Parliament Plenary and Council, which will take place in the end of 2013.

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[69] http://ec.europa.eu/commission_2010-2014/kallas/headlines/news/2013/06/doc/com%282013%29475_en.pdf
[70] http://ec.europa.eu/transport/themes/infrastructure/index_en.htm

The network will consist of a core network and a comprehensive network. In addition, there will be nine multimodal corridors across Europe, which consist of sustainable modes of transport, rail and inland waterway transport. Environmentally friendlier transport consists of the promotion of cleaner transport modes, high-speed broadband connections, and facilitating the use of renewable energy, in line with the Europe 2020 Strategy.

The priorities of TEN-T financing will contain investments in environmental technologies. Funding of the network will be realized within Connecting Europe Facility (CEF), which will fund for transport, telecommunications and energy infrastructure in 2014-2020. Most of the funding will be dedicated to cross-border projects, bridging missing links, avoiding bottlenecks and enhancing rail interoperability. CEF is primarily targeted to financing the corridors and the core network infrastructure. Comprehensive network of routes which are linked into the core network at regional and national level will largely be financed by Member States, with some EU transport and regional funding possibilities, including with new innovative financing instruments. Financing of innovation will be implemented by relevant parts of the new research and innovation programme (Horizon 2020).[71]

b) Marco Polo II Programme

The Marco Polo II programme[72] runs until the end of 2013 with an annual grant budget of about € 60 million. The European Commission has informed that Marco Polo II programme will be discontinued in the current form beyond 2013. During EUs next financing period 2014 – 2020, support for innovative and sustainable freight transport services has been included in the Commission's proposal for a revised Trans-European Transport Network guidelines (COM(2011) 650/2).

The last call for the proposals was published on 26 March 2013 and it was open until 23 August 2013. Marco Polo co-funds direct modal-shift or traffic avoidance projects and projects providing supporting services which enable freight to switch from road to other modes efficiently and profitably.

One of the political priorities for the Marco Polo programme in 2013 in the field of Short Sea Shipping and Motorways of the Sea (MoS) projects was reducing polluting emissions of maritime transport (low sulphur fuels, LNG powered vessels, energy efficiency measures, etc.). For these projects the support rate is raised from 2 € per 500tkm to 3 €.

The five Marco Polo action types are

1) Modal Shift
2) Catalyst
3) Motorways of the Sea
4) Traffic Avoidance
5) Common Learning

The decision to give funding to a project is based on the basic principles, with variations for each funding area:

- the amount of freight shifted from road to greener modes (or the amount of road transport avoided)

[71] http://ec.europa.eu/research/horizon2020/index_en.cfm
[72] http://ec.europa.eu/transport/marcopolo/about/index_en.htm

- a fixed rate of subsidy
- a maximum duration
- a ceiling on the costs covered

For projects selected in the call for proposals, funding will be calculated to be the lowest of:

Modal Shift, Catalyst, Motorways of the Sea and Traffic Avoidance actions:

- Modal shift: 2 or 3 Euro / 500 tkm
- Maximum 35% of total eligible costs
- Deficit of the action

Common Learning actions:

- Maximum 50% of total eligible costs
- Deficit of the action

7.5 Loans, other grants

a) European Investment Bank (EIB)

The priorities of the European Investment Bank (EIB)[73] are

- Small and medium sized enterprises & mid-caps
- Regional development
- Environmental sustainability: including both climate action and investment in the urban and natural environment
- Innovation: promoting skills and innovation at every level
- Trans-European Networks: linking Europe's infrastructure, principally in transport
- Energy: building competitive and secure supply

b) Nordic Investment Bank (NIB)

The lending activities of NIB[74] are directed towards energy and environment; infrastructure, transportation and telecom; industries; financial institutions and SMEs.

Environmental loans of NIB are provided through special lending facilities such as: Baltic Sea Environment Financing Facility (BASE), Climate Change, Energy Efficiency and Renewable Energy Facility (CLEERE) and Environmental Lending Facility.

c) Nordic Environment Finance Corporation (NEFCO)

NEFCO[75] is an international financial institution established by the five Nordic countries. NEFCO finances investments and projects primarily in Russia, Ukraine, Estonia, Latvia, Lithuania, Moldova and Belarus, in order to generate positive environmental effects of interest to the Nordic region.

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[73] http://www.eib.org/index.htm
[74] http://www.nib.int/

For example, the BSAP Fund is a fund managed by NEFCO and the Nordic Investment Bank (NIB). The fund provides grants for technical assistance to projects that support the implementation of the HELCOM Baltic Sea Action Plan (BSAP). The aim of the BSAP is to help restore the ecological status of the Baltic Sea.

[75] http://www.nefco.org/

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Horizon 2020
http://ec.europa.eu/research/horizon2020/index_en.cfm

Trans-European transport network (TEN-T)
http://ec.europa.eu/transport/themes/infrastructure/index_en.htm

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Gasnor
www.gasnor.no

Liquiline
www.liquiline.com

Maersk Line Route2
http://www.maerskline route2.com/

Nordic Environment Finance Corporation
www.nefco.org/

The Nox Fund
http://www.nho.no/

Nordic Investment Bank
www.nib.int/
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Skangass
www.skangass.com

SSPA
www.sspa.se

Appendix I. Exhaust Gas Cleaning System Association Members

A number of manufacturers have established an association, the Exhaust Gas Cleaning Systems Association (EGCSA), to create a sustainable operating environment for the companies who are interested in reducing marine exhaust gas emissions. The members of EGCSA are Alfa Laval, Clean Marine, DuPont BELCO Clean Air Technologies, Green Tech Marine, MAN Diesel, Marine Exhaust Solutions, Saacke GmbH and Wärtsilä. All members produce wet scrubbers, except for Couple Systems, which produces only dry scrubbers. Most of the companies are proving exhaust abatement systems to a large variety of industry, while some are concentrated only on marine solutions. The EGCSA members are not the only companies offering EGC system solutions to the marine sector, but at least at the Baltic Sea Region they are most well-known.

Among the manufacturers there are differences between the types of systems they are offering. Most of the manufacturers are providing wet scrubbers available in a hybrid version which enables operating by both open and close loop modes. Also there are differences related to amount of scrubbers needed on board; some companies provides small scrubbers for each engine to be installed separately whereas other use large multi-inlet scrubbers serving simultaneously several engines. With some systems the replacement of a silencer is possible. The systems are suitable for both newbuildings and retrofitting of existing vessels. Installations to retrofits are mostly realized during a scheduled dry dock, but there are some examples of installations during continuous service.

Alfa Laval's product is PureSOx which is available as a seawater, a freshwater or a hybrid version. With pureSOx system it is possible to combine several main and auxiliary engines into one scrubber which reduces the initial investment.

Clean Marine offers an integrated multi streaming system which means that all exhaust sources on board, including boilers, are served by one common EGC unit. Scrubber design is based on the The Advanced Vortex Chamber (AVC) which is suitable for both open and closed loop mode.

Ecospec' CSNOx™ is 3-in-1 emission abatement system that removes sulphur dioxide and nitrogen oxides but also carbon dioxide (CO_2) in one process, in a single system. Emission abatement is achieved at a net carbon reduction.

DuPont BELCO Clean Air Technologies product is BELCO® Marine Gas Scrubbing System which includes close and open loop and hybrid scrubber design. The system is suitable to reduce air emissions from ship engines, boilers and heaters.

Green Tech Marine is dedicated totally developing of marine srcubbers. GTM R15 is a hybrid scrubber operating in both open loop and close loop modes, and replacing the silencer, which is suitable for cruise ships. GTM uses one smaller scrubber for each engine instead of a large multi- inlet scrubber serving several engines.

Marine Exhaust Solutions' The MES EcoSilencer® utilizes advances in sea water scrubbing, thus operating in an open loop mode. The silencer of a vessel can be replaced with a system which reduces space needed for installation.

SAACKE GmbH acts among industrial and maritime firing technology and complete plant firing systems. Saacke offers reliable, environmentally friendly and energy-efficient combustion plants for sea-going vessels, offshore plants and LNG tankers.

Wärtsilä Hamworthy has recently combined their scrubber and marine engineering expertise to provide an open loop, a closed loop and a hybrid system. Company's portfolio includes both an integrated scrubber system for several main and auxiliary engines and oil-fired boilers and a main stream scrubber designed to be installed in the individual main engine.

MAN Diesel does not offer scrubbers independently, but they have developed a scrubber as an integrated part of their Tier III EGR system for nitrogen emission control.

Appendix II. LNG fuelled ships

This list was last updated in October 2013:

Year	Type	Owner	Country	Class
2000	Car/passenger ferry	Fjord1	Norway	DNV
2003	PSV	Simon Møkster	Norway	DNV
2003	PSV	Eidesvik DNV	Norway	DNV
2006	Car/passenger ferry	Fjord1	Norway	DNV
2007	Car/passenger ferry	Fjord1	Norway	DNV
2007	Car/passenger ferry	Fjord1	Norway	DNV
2007	Car/passenger ferry	Fjord1	Norway	DNV
2007	Car/passenger ferry	Fjord1	Norway	DNV
2008	PSV	Eidesvik Shipping	Norway	DNV
2009	Car/passenger ferry	Tide Sjø	Norway	DNV
2009	Car/passenger ferry	Tide Sjø	Norway	DNV
2009	Car/passenger ferry	Tide Sjø	Norway	DNV
2009	Car/passenger ferry	Fjord1	Norway	DNV
2009	Patrol vessel	Remøy Management	Norway	DNV
2009	PSV	Eidesvik Shipping	Norway	DNV
2010	Car/passenger ferry	Fjord1	Norway	DNV
2010	Car/passenger ferry	Fjord1	Norway	DNV
2010	Car/passenger ferry	Fjord1	Norway	DNV
2010	Car/passenger ferry	Fosen Namsos Sjø	Norway	DNV
2010	Patrol vessel	Remøy Management	Norway	DNV
2010	Patrol vessel	Remøy Management	Norway	DNV
2011	Car/passenger ferry	Fjord1	Norway	DNV
2011	Chemical tanker	Tarbit Shipping	Norway	GL
2011	PSV	DOF DNV	Norway	DNV
2011	PSV	Solstad Rederi	Norway	DNV
2012	Car/passenger ferry	Fjord1	Norway	DNV
2012	Car/passenger ferry	Torghatten Nord	Norway	DNV
2012	Car/passenger ferry	Torghatten Nord	Norway	DNV
2012	Car/passenger ferry	Torghatten Nord	Norway	DNV
2012	General Cargo	Nordnorsk Shipping	Norway	DNV
2012	PSV	Eidesvik DNV	Norway	DNV
2012	PSV	Olympic Shipping	Norway	DNV
2012	PSV	Island Offshore	Norway	DNV
2012	PSV	Eidesvik Shipping	Norway	DNV
2012	PSV	Island Offshore	Norway	DNV
2013	Car/passenger ferry	Torghatten Nord	Norway	DNV
2013	General Cargo	Eidsvaag	Norway	DNV
2013	Harbor vessel	Incheon Port Authority	Korea	KR
2013	High speed RoPax	Buquebus	Norway	DNV
2013	PSV	REM	Norway	DNV
2013	RoPax	Viking Line	Finland	LR
2013	RoPax	Fjordline	Norway	DNV

Appendix III. LNG-Powered ships on order

This list was last updated in October 2013:

Year	Type of vessel	Owner	Country	Class	Conversion
2013	Ro-Ro	Sea-Cargo	Norway	DNV	
2013	Ro-Ro	Sea-Cargo	Norway	DNV	
2013	RoPax	Fjordline	Norway	DNV	
2013	Car/passenger ferry	Norled	Norway	DNV	
2013	Car/passenger ferry	Norled	Norway	DNV	
2013	Ro-Ro	Norlines	Norway	DNV	
2013	Ro-Ro	Norlines	Norway	DNV	
2013	Tug	Buksér & Berging	Norway	DNV	
2013	Patrol vessel	Finish Border Guard	Finland	GL	
2013	Car/passenger ferry	Society of Quebec ferries	Canada	LR	
2013	Tug	CNOOC	China	CCS	
2013	Tug	CNOOC	China	CCS	
2014	Car/passenger ferry	Society of Quebec ferries	Canada	LR	
2014	Tug	Buksér & Berging	Norway	DNV	
2014	PSV	Harvey Gulf Int. Marine	USA	ABS	
2014	PSV	Harvey Gulf Int. Marine	USA	ABS	
2014	PSV	Harvey Gulf Int. Marine	USA	ABS	
2014	PSV	Harvey Gulf Int. Marine	USA	ABS	
2014	Gas carrier	SABIC	Saudi-Arabia	BV	
2014	Gas carrier	SABIC	Saudi-Arabia	BV	
2014	Product tanker	Product tanker Bergen Tankers	Norway	LR	TRUE
2014	General	Cargo Egil Ulvan Rederi	Norway	DNV	
2014	General	Cargo Egil Ulvan Rederi	Norway	DNV	
2014	PSV	Remøy Shipping	Norway	DNV	
2014	Car/passenger ferry	Aktien-Gesellschaft EMS	Germany	GL	TRUE
2014	Car/passenger ferry	Samsoe Municipality	Denmark	DNV	
2015	PSV	Siem Offshore	Norway	DNV	
2015	PSV	Siem Offshore	Norway	?	
2015	PSV	Simon Møkster Shipping	Norway	DNV	
2015	PSV	Harvey Gulf Int. Marine	USA	ABS	
2015	PSV	Harvey Gulf Int. Marine	USA	ABS	
2015	LEG carrier	Evergas	Denmark	BV	
2015	LEG carrier	Evergas	Denmark	BV	
2015	LEG carrier	Evergas	Denmark	BV	
2015	Container Ship	TOTE Shipholdings	USA	ABS	
2016	Container Ship	TOTE Shipholdings	USA	ABS	
2016	Car/passenger ferry	Boreal Transport	Norway	?	
2016	Car/passenger ferry	Boreal Transport	Norway	?	

Appendix IV. World fleet of small LNG carriers

Name	Built	Deadweight	Tank capacity	Status
TELLIER	1974	21301	40000	In service
AMAN BINTULU	1993	11001	18928	In service
SURYA AKI	1996	11612	19474	In service
AMAN SENDAI	1997	10957	18928	In service
AMAN HAKATA	1998	10951	18800	In service
SURYA SATSUMA	2000	12493	23096	In service
SHINJU MARU NO.1	2003	1781	2513	In service
PIONEER KNUTSEN	2004	817	1100	In service
NORTH PIONEER	2005	1938	2500	In service
SUN ARROWS	2007	11142	19100	In service
SHINJU MARU NO.2	2008	1781	2513	In service
KAKUREI MARU	2008	1801	2512	In service
CORAL METHANE	2009	6150	7500	In service
NORGAS INNOVATION	2010	10630	10000	In service
NORGAR CREATION	2010	10429	10000	In service
NORGAS INVENTION	2011	10441	10000	In service
NORGAS UNIKUM	2011	12210	12000	In service
NORGAS CONCEPTION	2011	10500	10000	In service
BAHRAIN VISION	2011	12600	12000	In service
CORAL ENERGY	2013	8000	15600	In Service
CORAL ATHELIA	2013		6500	In service
DINGHENG JIANGSU NB	2012	12600	12000	Under construction
DINGHENG JIANGSU NB	2012	12600	12000	Ordered

Appendix V. Country reports

a) BULGARIA
Status of preparation for the year 2015 / SECA

Regarding: The IMO's MARPOL Convention
The Convention with all Annexes (I-VI) has been ratified by the Republic of Bulgaria.
Convention ratified on 26 July 1984 is in force since 12 March 1985; Annex VI- Prevention of Air Pollution from Ships, ratified on 13 Oct. 2004 is in force since 19 May 2005. In line with art.5 of the Bulgarian Constitution, the international treaties, which have been ratified in accordance with the constitutional procedures, become part of the legislation of the State.
MARPOL is part of our national legislation and is directly applicable.

Regarding: The EU "SULPHUR" Directives
Directive 1999/32/EC, as amended by Directive 2009/30/EC, have been generally introduced into Bulgarian law by a regulation on the liquid fuels, the terms and manner of their control/effective from 01.10.2003, approved by Decree of the Council of Ministers № 156/15.07.2003, SG. 66 of 25 July 2003 and last amend. SG. 103 of 28 December 2012.Directive 2012/33/EC is not yet transposed. Ministry of Environment and Water is the lead ministry for the transposition of Directive 2012/33/EC –The regulations will be ready till June 2014. Art.4 f discussed with stakeholders.

On 21 November 2012 - the European Parliament and the Council adopted Dir.2012/33/EC that promotes the use of alternative technologies to ensure compliance with emissions reduction regulations / e.g. on-board exhaust gas cleaning systems, LNG, bio fuels, shore-side electricity/. The Directive has been supplemented by European alternative fuels strategy and a proposal for a Directive on the deployment of alternative fuels infrastructure. Bulgaria support the stated purposes in the both Communications.

Bulgaria: implementation of IMO's & EU's SOx-emissions control regulations - horizon 2015:
Re: Option 1 – use of low sulphur content marine fuels: Todays most commonly practiced method.
n.b.Lukoil Neftochim Burgas prepares production of LsMgo till end of 2014.Capacity is 1.5 mil t/annum.
Re: Option 2 – Alternative fuels: Possible method is the use of liquefied natural gas (LNG), biofuels and methanol in combination with di-methyl-ether (DME). However an obstacle to its wider implementation is the lack of infrastructure in ports - appropriate facilities for bunkering of LNG, and the lack of legal regulation on this issue. In the Ministry of Transport has established a Working group N9 that prepared the Bulgarian position. On May 14, in Ministry of Transport was held the first meeting to discuss the proposal for a Directive. Major adjustments are needed in the Bulgarian legislation.(over 15).

Proposals have been made for tax/fiscal stimulus to 2020. The discussions with stakeholders continues.
n.b.New biodiesel plant and LNG terminal under construction in Ruse company Bulmarket (end of 2014).
n.b.. During the Environmental event "ECA Impact on Shipping" 27-28 August, SPC Bulgaria establish Short Sea ECA Club specialists - ship owners, ship operators, ship builders - where will be discussed ECA impact on shipping, ECA technical retrofit/solution, possible funding sources-investment aid, loans.

Re: Option 3 – Emissions abatement technologies
The main disadvantages of this option are the relatively high prices of scrubbers, as well as the lack of adequate PRF to collect scrubber's sludge and other operational waste from their exploitation**.**

Bulgaria - Ideas for next steps:
Stress awareness on the up-coming more strict emissions control regulations;
Explore carefully all the options for compliance /"pros." & "cons" of the different methods/;
Ensure better use of the EU & National transport funding instruments;
- Identify possible incentives applicable at local, national and regional level /i.e. green port dues and tariffs for green ships/;
- Continue the active dialogue with all the maritime industry stakeholders at national and international level – to exchange information, expertise and good practices;
- Continue the dialogue with major international partners and co-ordination with IMO & EMSA on maritime sustainability related topics;

b) Belgium

The European Directive on Sulphur (2015) is since some time a "hot" topic on the level of the Flemish Administration and in the ports: especially the development of LNG but also of shore power is high on the agenda.

The role of the Flemish Administration/Government is mainly to create the legal framework to make it possible to use LNG for maritime purposes. This includes very regular contacts with Environmental Administrations and the Federal Administration (receiving for instance European Legislation which has to be 'transferred' into Flemish one). This requires constant follow up of European and international developments concerning LNG (IMO, EMSA). The Flemish Administration supports LNG pilot projects, for bunkering as well as for infrastructure, for instance by offering assistance for writing files for European subsidies.

The Flemish Government has made a study on the possibilities of offering LNG as fuel for the shipping sector in the Flemish Ports.

The port of Antwerp is developing procedures for the bunkering of LNG in the port(s).

The port of Ghent is developing a shore power project, which should be operational in 2014.

Also in Zeebrugge a shore power project is developed. In Antwerp a similar project is already in use on certain quays.

The port of Ghent received an environmentally-friendly ship with cylinders acting like sails and saving fuel.

Fluxys, the LNG plant in Zeebrugge, constructs a second jetty to meet demand and development / extension of the LNG hub.

c) Finland

Background

In the Baltic Sea, the North Sea and the English Channel SECA area, Finland is affected most by IMO's stricter regulations on sulphur content in fuel. Maritime transport has a key role in Finland's import and export as over 80 % of trade is transported by sea. Maritime transport is nearly always used in west-bound transport. Finland's industry is fully dependent on efficiently operating maritime transport in all shipping segments. Liner shipping services require a high frequency even in winter, supported by ice-breaking assistance. Thus impact of IMO's decision is discussed extensively in Finland, and shippers, ship owners, ports and other parties keep that on the agenda.

Impacts of sulphur regulation

There are different scenarios on transport costs, which base on the expected prices for fuel in 2015. All studies compiled in Finland and in other SECA area countries result that there will be a drastic increase of transport costs. It is also expected that price increase of fuel and freight costs will be transferred directly into the prices of products and raw materials. The Finnish industry is concerned on the possibility that production may be transferred to lower cost countries.

Due to Finland's geographical situation, there cannot be a complete modal shift from sea to road or rail. However, the sea leg may shorten and the routings may change in the future. Longer sea routes on the Baltic Sea will suffer most on the sulphur directive. It is expected that vessel traffic between Finland and Germany will diminish, and it will be replaced by road transport via Sweden and on the Via Baltica. Concerning year 2015 which is near, there may be capacity limits in Sweden and the infrastructure of Via Baltica is still insufficient.[76]

National policies and new solutions

Different kinds of methods and tools for adaptation have been proposed in Finland. A working group coordinated by the Ministry of Employment considered a range of alternative measures and their impacts.

Alternative tools include

- support to new innovations and environmental investments
- promotion of the use of LNG and biofuels
- increasing the maximum permissible weights and dimensions masses of the road transport vehicles
- renewal of fairway due system in Finland

The Finnish Ministry of Transport and Communications granted support under the Finnish aid scheme for vessels that aim at environmental protection, first in 2010 for two vessels: Viking Line's new passenger ferry which uses LNG as its fuel, and the new Gaiamare freight vessel which uses liquid bio oil. In 2013, the scope of Government Decree on investment aid was extended so that it may also be granted to vessels which are already in use. With this amendment, aid could be targeted also at retrofitting vessels with emission abatement technologies, in particular sulphur scrubbers. Support was granted for six ship owners for investments in total in 22 vessels.

[76] Lappalainen A. (2013)

The Finnish Ministry of Transport and Communications published in 2013 a report on alternative propulsion systems for the transport of the future. The group's vision is that passenger car traffic, rail transport and shipping will be almost entirely independent of oil in 2050. In shipping, the use of sustainable alternative fuels would contribute to the reduction of greenhouse gas emissions by 40-50 per cent. The report includes an LNG Action Plan for the period of 2013 - 2017.[77]

Current plans on LNG terminals, LNG tankers and distribution infrastructure include several ongoing projects, including Tornio ManGa LNG, Gasum's Finngulf LNG, Oy FennoGas Ab's and AGA's projects. In the case an LNG terminal will be built in a port it will support development of the port and its surroundings in many ways. Current plans related to the EU framework for LNG as an alternative fuel for shipping suggest that all TEN-T core ports have to provide LNG refueling facilities since 2020[78]. In Finland there will be four TEN-T core ports; Turku, Naantali, Helsinki and HaminaKotka.

In Finland, the maximum permissible weights and dimensions of heavy goods vehicles and vehicle combinations were raised as of 1 October 2013, under a government decree. The maximum permitted height of a vehicle will increase from 4.2 meters to 4.4 meters and the mass from 60 tons to 76 tons. The aim is to improve the logistic competitiveness and equalize the cost differences between Central Europe and Finland where the costs are higher due to long distances.

In addition, the fairway dues system has been reviewed by a working group of the Finnish Ministry of Transport and Communications. Small adjustments to the current system would be sufficient to correct the single defects, whereas larger-scale structural changes would require more extensive measures. Preparations for a comprehensive reform of the system are also a part of the Ministry's work on Maritime Transport Strategy, which will be completed by the end of 2013.

[77] Future transport power sources. Executive summary. Publications of the Ministry of Transport and Communications 24/2013
[78] European Commission 2013. Commission staff working document. Action towards a comprehensive EU framework on LNG for shipping.