Clean Fuels – Setting the Future Course for International Shipping

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The shipping industry faces increasing pressures – both from within its own ranks and from policymakers – to become a clean form of transport. Alongside industry initiatives focusing primarily on passenger and ferry transport, new regulations are also impacting the transition to a more environmentally friendly shipping industry. In the recent past, the Intern ational Maritime Organization (IMO) has enacted a variety of regulations and requirements for maritime commerce and companies involved in such business. The regulations span from the total (energy) efficiency of ships and ballast water management, to waste management and emission restrictions. As a consecuence shipping companies and charterers find themselves facing a host of serious economic, financial, and technical challenges.

Maritime commerce: Shipping conducted for the purpose of merchant activity

Emission Restrictions:

Regionally limited shipping regulations

The first regionally limited shipping regulations that applied to both new and existing vessels entered into effect in the 2000s. Later these were expanded to so called Emission Control Areas (ECAs) and Sulphur Emission Control Areas (SO_X ECA or SECA). They introduce stricter limits for pollutant emissions from shipping within some international waters.

There are two sets of emission and requirements to fuel quality defined by the International Maritime Organization (IMO) by MARPOL Annex VI[1]: (1) global requirements, and (2) more stringent requirements applicable to ships in Emission Controlled Areas. These can be designated for SO_X and PM and/or NO_X, or all three types of emissions from ships.

Europe

The European SECA (designated for SO_X) was introduced in 2015, and is comprising the North Sea south of 62° N and east of 4° W, the English Channel east of 5° W, and the entire Baltic Sea. Within this area, the sulphur content of the fuel used or the emitted exhaustgas produced must not exceed 0.1 %. This compares to the 1.0 % previously allowed. To give an

[1] „International Convention on the Prevention of Pollution from ships" known as MARPOL 73/78 (Annex VI – SO_X and NO_X limits and further)

indication of the effects of this SECA, around one third of all vessels operating around the world pass through this at least once a year[2].

In addition to this SECA, an European Union's directive[3] limits the sulphur content of fuels used to power vessels in all ports of European Union to 0.1 %. The directive is older than the SECA and came into effect 1 January 2010. The directive still applies to ports and coastal areas that are not comprised by the SECA, for example European ports in the Mediterranean and on the Atlantic coast.

North America

In North America, an ECA was established in 2012/2014 to limit emissions of sulphur (di)oxide, nitrogen oxide, and particles along the US and Canadian coastline (including the Great Lakes). Further restrictions for every vessel, keel laid after 1 January 2016, that wish to enter North American waters must comply to Tier III are in place. This means a limitation of NOx emissions to between 3.4 and 2.0 g/kWh, depending on the type of vessel and its service speed.

Summary: Existing Emission Control Areas include:

- All European harbours (SO_X, 2010)
- SECA - North Sea, Baltic and parts of Engish Channel (new SO_X limits, 1st Jan 2015)
    - Before: Baltic (SO_X, adopted: 1997 / entered into force: 2005)
    - Before: North Sea (SO_X, 2005/2006)
- North American ECA, including most of US and Canadian coast (NO_X & SO_X, 2010/2012).
- US Caribbean ECA, including Puerto Rico and the US Virgin Islands (NO_X & SO_X, 2011/2014).

More emission control areas expected

IMO is expected to declare considerably more emission control areas in the near future. Specific research is carried out to this in the following areas: Central America, the Mediterranean, the northern coast of Norway and the Barents Sea, the Strait of Malacca, the coast of China, the territorial waters of Japan and Australia, and the Arctic and Antarctic.

The IMO is also currently investigating the feasibility of monitoring and limiting CO2 emissions and enacting wider-reaching efficiency requirements – issues that are set to become relevant to the shipping industry in the medium term.[4]

Open seas / Worldwide:

From 2020, it is expected that sulphur limits will be reduced also outside the SECA and ECAs, from the 3.5 % limit currently applicable to 0.5 %. May be postponed to 2025.

Alternative fuels and LNG

[2] CPL Competence in Ports and Logistics. Wenzel, Heine & Kollegen (2015): "LNG Marktentwicklungs- und Nachfragepotenzialanalyse für die Schifffahrt sowie weitere LNG affine Verkehrsträger in Bremerhaven und Bremen" (*LNG market development and demand potential analysis for shipping and other LNG-based forms of transport in Bremerhaven and Bremen*), p. 3

[3] Directive 2005/33/EC, applies to vessels at berth for at least two hours

[4] Gas Carrier Update No. 1 2016

As a consequence of these new emission control areas, alternative fuels are expected to gain significance. Liquefied natural gas (LNG) is considered by many as the best alternative fuel since it is well placed to help reduce environment and health-damaging emissions from shipping, particularly in coastal areas and port cities. Vessels running on LNG emit up to 25 % less carbon dioxide and 90 % less nitrogen oxide than vessels running on conventional fuels. In addition, sulphur and particle emissions fall to almost zero.

A vessel can run on gas both using gas-only engines and dual- and tri-fuel engines. A gas-only engine may have advantages over multi-fuel engines since there is nearly no methane slip from the combustion process. However, using the latest research and developments, methane slip can also be largely eliminated in dual and tri-fuel engines.Test engines are already being operated on a trial basis. Overall, natural gas's total ecobalance is superior to that of fuel oils when measured using the tank-to-propeller (TTP) metric and particularly when using the well-to-wheel (WTW) metric.[5]

With the latest technology, LNG already enables engine manufacturers to meet all applicable legal requirements (SECA requirements, ECA requirements, Tier III requirements) and planned emission regulations (CO_2-Cut measures and limits on NOx and particles)[6] on the seas without additional exhaust treatment.

The world's current LNG-powered fleet

There are 186 LNG-powered vessels in operation around the world or in production, not including LNG tankers.[7] Of these 186 vessels, 74 seagoing vessels and 6 inland vessels are already in operation, while 88 seagoing and 18 inland vessels are yet to be delivered. Additionally a rising number of newbuilds are ordered "LNG-ready". A significant portion of this LNG-powered fleet operates in the North Sea and Baltic Sea, with Norway playing a leading role. However, if we look to Germany's situation, the first German LNG-powered ships are now also operating: the MS "Ostfriesland", the MS "Helgoland", and the Bremenport's hopper barge "greenports". In several ports, such as the Port of Hamburg, cruise ships can now be fuelled directly with LNG or supplied with electricity using a hybrid LNG power barge while at berth.

Industry still hesitant

However, the uptake of alternative fuels for the shipping industry has been relatively hesitant. Heavy fuel oil and diesel products continue to dominate the maritime market - mainly because of their low price. To still comply with the required emission limits, the majority of shipping companies and charters use one of the three following methods.

- *Low-sulphur marine diesel (LSMGO, MGX etc.):* Converting to low-sulphur marine diesel requires relatively little technical modification, and it is often older vessels and vessels that rarely enter the SECAs that convert to run it.

[5] www.forschungsinformationssystem.de/servlet/is/332825/
[6] DNVGL – Future Limits Baltic & DNVGL, "In Focus – LNG as Ship Fuel" No. 1 2015
[7] LNG World Shipping, May/June 2016

- *Scrubbers:* Fitting a vessel with a scrubber so that it can continue to run on heavy fuel oil requires greater investment. Neverthless, with the low costs of heavy fuel oil, the investment amortizes in the middle term. Scrubbers remove most sulphur compounds originating in the fuel, and the pollutants filtered out are disposed off on land (for closed-loop scrubbers and dry scrubbers) or at sea (for open-loop scrubbers). However, there is no generally accepted practice for disposing the pollutants collected, meaning that they still pose a hazard to the environment. The open-loop method has already been banned in some territorial areas, for example, in German and Belgian waters, and other countries are in the process of deciding.

- *"Black distillates":* Running on a special heavy fuel oil with ultra low sulphur content (<0,1%) also requires relatively little technical modification of a vessel, just as for low sulfur marine diesel. However it still involves significant demand in handling and complex fuel changeover procedures. Using this relatively new fuel reduces sulphur emissions, but not other emissions that are harmful to both environment and public health. Furthermore there are no longtime experiences existing.

With this in mind and measuring both current market share and the likelihood of their uptake in the international long-distance maritime commerce sector, the most promising alternatives are currently estimated to be (1) LNG, (2) methanol, (3) LEG (ethane), (4) liquid gases (propane, butane), and (5) electricity.

For LNG to prevail as the environmentally-friendly shipping fuel, there are still a host of technical, legal, and organizational prerequisites that must be met or refined. However, the biggest steps have already been taken when compared to the aforementioned other alternative fuels.

This is the case for regulatory considerations surrounding shipbuilding; the implementation of approval, permitting, and organizational procedures for LNG facilities; and the performance of various bunkering procedures.

The first internationally applicable regulation for the construction of vessels that use natural gas as their fuel entered into effect in January 2016. This is the IMO's IGF Code. The new code represents an improvement in planning security for the potential construction of new ships.

Case: the European SECAs

As our article has shown so far, LNG has great potenital in order for the maritime sector to meet the restrictions and regulations set upon them. Many of the necessary prepositions are in place. Let's take a closer look at the current situation of LNG use within the European SECA:

Public discourse especially in Germany unfavourably concentrates on the following paradoxical situation: On one hand, most investors and shipping companies do not favour LNG ships because of a lack of bunkering infrastructure both in Germany and elsewhere in Europe. On the other, industry players such as the oil majors, bunkering service providers and port operators will not invest in LNG terminals until demand firms up – the so called "chicken and egg" dilemma. In other countries, however, a series of bold forerunner

initiatives have advanced the industry far beyond that point: For example, cooperation between suppliers and their customers in the ARA region (Amsterdam, Rotterdam and Antwerpen), Scandinavia, and Lithuania has led to the launch of a number of larger-scale infrastructure and LNG shipping projects.

Within the European SECA there seems to be lacking a standardized process. It is currently up to each individual port (harbour master and local authority) and other stakeholder representatives (customer, supplier, and security and safety agencies such as police and fire service) to make their own decisions on LNG projects, and in particular to determine how to arrive at the decisions they make.

The European Sustainable Shipping Forum (ESSF), an expert group of the European Commission, is now working to establish all required processes and standards at European level. However, each member state will still need to implement uniform processes and standards at national level – an effort that will require authorities and ports to work together and learn from each other to dismantle the current web of one-off solutions and establish a national, if not international, basis upon which to organize and handle approvals for the industry.

Bunkering from trucks

However, within this current situation, many ports in Germany and around Europe already offer the facility to bunker LNG ships from trucks. One example is Rostock, Germany, where a study on the feasibility of LNG bunkering was undertaken and completed in 2016. It was prepared in conjunction with representatives of a classification society, a new bunkering company, the port authority, the port operator, and all local stakeholders. Consideration was paid to all port operations at Rostock and a basis for the port authority´s decision-making in favour of bunkering LNG at Rostock port was established successfully. After proving its expertise in the area, an interested bunkering service provider was then able to apply for an LNG- bunkering- permit. Following additional consultations on the organizational procedure at the port and the technical arrangements between the supplier and the customer as outlined in the basis for decision-making, GAZPROM Germania GmbH was able to obtain a LNG- bunkering- permit and bunker the first ship at Germany's largest Baltic Sea port in February 2016. "The bunkering operation showed that the vision of using LNG as a bunker fuel has already become a reality", says Timo Vehrs, Director of Business Development at GAZPROM Germania GmbH. Pilot projects like this contribute to optimizing the bunkering process and enable widespread availability of smaller bunker quantities as first steps.

The way forward for Europe

While LNG is available and different providers are able to be supplied to (potential) customers using mobile supply units, there are still some challenges to overcome. One major challenge is to remove prejudices and safety concerns concerning LNG and establish good practices and trust. One suitable approach might be to host practical demonstrations of the LNG bunkering process for shipping companies, authorities, and other stakeholders. That way, it would be possible to show that as experience increases and management and other staff are trained, the risk of handling LNG is no higher than handling other fuels.

There is also need for more advocacy work at political level. The competent authorities should define uniform permitting and approval standards for LNG bunkering, taking consideration of specific local requirements. For example, it is now possible to perform bunkering in parallel to loading and unloading at a small number of ports such as Stavanger, Norway; Rostock, Germany; and Stockholm, Sweden. However, in the majority of ports located in the European SECA where LNG bunkering is possible, bunkering may be performed only without other simultaneous operation. The safety areas that must be established – which differ significantly depending on the country in question, and sometimes even depending on the port in question – are a second example.

Moreover, controls and sanctions of ships that do not adhere to the sulphur emission limits inside the SECAs and the persons responsible for those ships are managed differently in each country; often, there is little verification and only minor penalties are imposed. A stricter approach could motivate ship operators and charterers to purify their exhaust gases or switch to alternative fuels that are cleaner than heavy fuel oil. That would, among other things, create a secure investment climate for investment in both the ships themselves and the infrastructure required to fuel them. Some Harbours push green shipping, like Antwerp (BE) and Gothenborg (SW) where LNG powered ships receive discounts on harbour fees.

The German Shipowner's Association (VDR) calls for state support for equipping vessels with LNG engines to shield owners from the additional investment required, which can be up to 30 % higher than for conventional propulsion systems. In Sweden, for example, operators that continue to sail with heavy fuel oil are required to pay into a fund, while those that use alternative fuels receive financial subsidies.

"Without a broad programme in support of constructing new LNG ships and converting existing ships to run on LNG, the barriers to market will remain high", says Ralf Nagel, Chief Executive Officer of the German Shipowner's Association (VDR). "Not a single LNG ship has entered service to date in Europe without state subsidies. As a leading maritime location, Germany should be at the forefront." Ships that can run on both conventional fuels and LNG (dual-fuel engines) are up to 25 % more expensive due to their special engines, special piping, and tanks.[8]

In summary, the six following aspects would drive uptake of LNG bunkering at European ports:

1. **Security of LNG supply**
2. **Positive investment and tax climate**
3. **Clear, established, generally applicable, and practical rules and regulations**
4. **Safe, reliable logistics**
5. **Information, education, and training**
6. **Public acceptance**

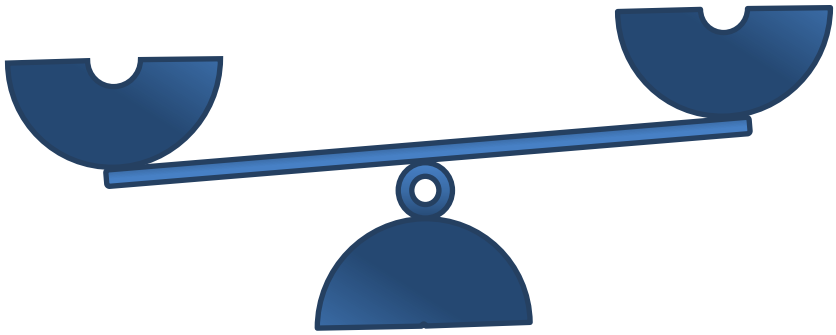
All that remains for the market, and in particular for those bold first movers, is to accept the requirements imposed on the transport sector and in particular maritime commerce and associated industries and to establish a competitive marketplace.

[8] Quote by Ralf Nagel, Chief Executive Officer of the German Shipowner's Association (VDR), Hamburg, 27 August 2015

When it comes to natural gas as a shipping fuel, the shipping industry is going through a process of finding the balance between the challenges presented and the potential to be realized. In the interest of its reputation and its compliance, greater weighting towards harnessing that potential is clearly desirable.

- Security of supply
- System diversity
- Lack of regulation, but also
- Over-regulation
- Capex
- Short-notice availability
- Tax issues
- Local SECA restrictions
- Gap between oil price and gas price
- Financing options

- Business model
- Compliance with SECA requirements & future limits
- First-mover advantage
- Utilization of commercial niches
- Brand-building
- Fuel flexibility
- Technology leadership



Source: Based on infographic by Richard Neighbour (April 2016)