ECG Academy

Thesis

European Shipping
in the light of the IMO & EU regulations

Implications of SECAs in 2015 and beyond

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Abbreviations

DG (ENV, CLIMA, MOVE) – EC's Directorates General for Environment, Climate Change, Transport & Mobility
EC – European Commission
ECA – Emissions control area
EMSA – European Maritime Safety Organisation
EP – European Parliament
ESPO – European Sea Ports Organisation
GHG – Greenhouse gas emissions
HFO – Heavy fuel oil
IMO – International Maritime Organisation
MGO – Marine Gas Oil
NO_x - Nitrogen oxide
PM - Particulate matter ozone depleting substances.
SO_x - Sulphur oxide

Glossary

Biofuels could technically substitute oil in all transport modes. The production is limited by the availability of land, food situation and sustainable agriculture

The **International Maritime Organisation** the United Nations' international regulatory body for shipping, ensures that the industry becomes cleaner and safer.
The International Convention for the Prevention of Pollution from Ships (MARPOL, 1973) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It includes six technical Annexes. The Annex VI is entitled: "Prevention of Air Pollution from Ships" (in force since 2005, ratified by 67 Parties).

Liquefied Natural Gas (LNG) a fuel of high energy density and low pollutant emissions.

Natural gas and biomethane can be sourced from fossil natural gas or from biomass and wastes as biomethane, injected into the general gas grid.

Trans European Transport Network* (TEN-T) an EC multi-modal project offering co-funding to connect main transport nodes, thus facilitating the creation of the the single European Transport Area.

1. Introduction

Environment has been given global importance (UNEP) due to its irreversible consequences stretching far beyond the obvious climate change. It attracts armed conflicts for primary resources, disappearance of natural (state) borders, harmful substances and hazardous wastes with adverse impact on human health.

Various international fora promote (in line with their mandate) an environmental awareness. In the case of shipping, an active role is played by: the IMO, the European Institutions (DG Environment, DG Clima, DG MOVE), the EMSA, and other important regional and national (non)state players.

Prior ranking (G20)* and standard benchmarking (GDP) are becoming obsolete because they fail to take into account environmental concerns. Better-off states have more possibilities to promote resource efficiency and lead the green revolution. However, the economic recovery (since 2008) is putting the progress on a standby. Competition is becoming more fearful and liberalisation is stuck in hidden protectionism. The same concerns are echoed by the shipping industry worldwide, particularly with the new IMO requirements as of 2015 onwards.

- Will there be a great gap between the high and low sulphur fuel price?
- Opting for retrofitting with scrubbers or switching to clean fuel?
- Will the infrastructure for alternative fuels be on time for the switch?
- Will refineries adjust?
- Are ports ready to undertake the challenges ahead?

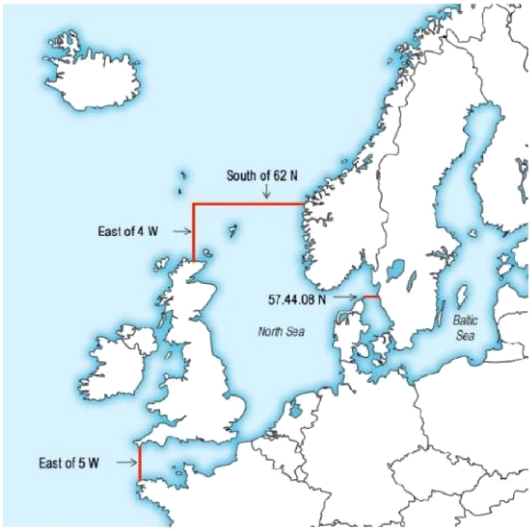
*Communication from the Commission to the Council and The European Parliament “GDP and beyond Measuring progress in a changing world”. http://eur-lex.europa.eu/Notice.do?checktexts=checkbox&val=499855

*The UN international human development indicator (http://hdr.undp.org/en/data/map/)

2. AS-IS Analyses

The UN's IMO, through the Annex VI sets limits on SO_x, NO_x emissions from ship exhausts as well as PM and prohibits emissions of ozone depleting substances. For the Sulphur ECAs, the standards are stricter.

The drawing depicts ECAs limiting SO_x and PM as of October 2010

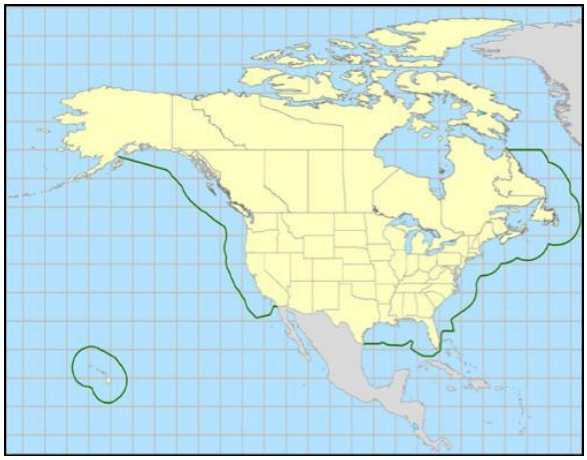


The ECA established are:

Baltic Sea area and North Sea area – SO_x only;

North American area –SO_x, NO_x and PM;

US Caribbean Sea area (as of 1st January 2014) SO_x, NO_x and PM.



The limits for SO_x in fuel oil are subject to modifications over the time:

Outside ECAs	**Inside ECAs**
4.5% prior to 1 January 2012	1.5% prior to 1 July 2010
3.5% on and after 1 January 2012	1.0% on and after 1 July 2010
0.5% on and after 1 January 2020*	0.1% on and after 1 January

**depending on the outcome of a review by MEPC, to be concluded in 2018, as to the availability of the required fuel oil, this date could be deferred to 2025*

2.1. IMO standpoint

Further to the members' states agreement within IMO, ships in and out ECAs must operate on different fuel oils.

The Annex VI mentions a fuel availability and quality clause (Regulation 18). According to it, each subscribing State shall take all reasonable steps to promote the availability of compliant fuel oils, yet it is for ship owners, when ordering bunkers, to at least insert clauses to the effect that the fuel oil supply process is to be in accordance with the requirements of Annex VI.

IMO will grant exceptions or move the deadline date only when the Member states themselves will introduce a reasoned position.

2.2. EU Standpoint

Once adopted at international level, the EU will transpose those provisions as *de minimis* in its *aqui communautaire*. Directive 1999/32/EC amended by Directive 2005/33/EC ("the Sulphur Directive") regulates sulphur emissions from ships by limiting the maximum sulphur content of marine fuel. It declares the Baltic Sea, the North Sea and the English Channel as SECAs, and limited the maximum sulphur content of the fuels used by ships operating in these sea areas to 1.00% by mass until 31st December 2014, and 0.10% by mass as from 1st January 2015.

In 2010, EMSA undertook the analyses of several available at that time studies which could be summarised as follows:

- Whether by shifting to low sulphur fuel or choosing alternative methods, the implementation of the 0.1% target in SECAs as of 2015 indicates additional costs for shipping;
- The range of the cost increase varies according the MGO price. If the extra cost is borne by the buyer, then it will affect the transported volumes, with the fuel intensive segments being most affected;
- There are only certain limited routes and under certain high fuel price scenarios that the modal shift to road could take place. The most endangered

are routes in competition with truck/rail only option; certain shipping routes might lose shares to other shipping routes;

- Routes with a low degree of utilisation will be more affected;

The EU White Paper for Transport has set a GHG reduction goal of at least 40% by 2050 (compared to 2005) for the shipping sector. It also states that shipping will need to further contribute to the reduction of local and global emissions, hence the EC's Proposal for a Directive on the deployment of alternative fuels infrastructure.

Which fuels?

EC is a promoter of technology neutrality and harmonisation. At present, bio-LNG, methanol, hybrid propulsion and H_2 are in testing process. They are all needed to achieve an accessible fuel mix that is suited to the needs of the ship and region in which it operates as well as for accessibility.

However, almost a decade of LNG driven ships experience makes it in EC' eyes a promising short to medium term alternative shipping fuel.

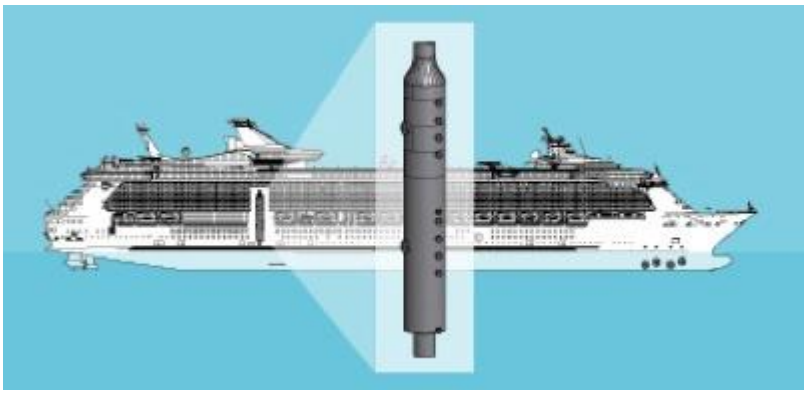
On 11th March 2013 EU Council of Transport Ministers gathered under the aegis of Danish Transport Minister. The EC shared its initiative on "Clean power for transport" aiming to break the oil dependence of transport and reduce GHG from transport by accelerating the market uptake of alternative fuels.

The initiative comprises 3 elements:

- Communication on a European alternative fuels strategy
- Directive focusing on infrastructure and standards, establishing minimum coverage for LNG
- Accompanying document describing an action plan for the development of Liquefied Natural Gas (LNG) in shipping

The Commissioner explained that a full scale deployment of alternative fuels has traditionally been retained by a lack of infrastructure for refuelling. There must be a minimum number of these stations.

To ensure the operability, the Commission is working closely together with the IMO.



An impact assessment on the deployment of alternative fuels infrastructure has been undertaken by the EC. The 83 maritime ports of the TEN-T Core Network are the primary locations for the use of LNG in shipping. Equipping with LNG also the inland waterway and road transport corridors would provide sufficient coverage.

2.3. Member States Standpoint

On 20th December 2012, the French Delegation brought the topic of sulphur to the attention of the EU Council of Transport Ministers. The official note 17790/12, stated that France was explicitly concerned about the Ro-Ro ships operating exclusively in SECAs. France was concerned about the competitiveness of these ships implying the *total shift to road* due to the increasing costs of switching from Heavy Fuel Oil to Marine Diesel Oil. The alternatives (natural gas, exhaust gas cleaning systems) continue to raise technical and safety issues which will be addressed during the Irish Presidency.

Speaking about Alternative Fuels initiative, majority of the Member States agreed that the targets and the deadlines were causing concern, as well as the cost of providing infrastructure. There is support for using a directive as a legal mechanism, yet Member States. The Irish presidency is expected to report on the progress made in June 2013

2.4. Industry Standpoint

Though the stricter binding targets have been known ever since 2008, no massive shift has been registered due to an overall economic downturn. Nonetheless, the time does not stand still and the approaching deadline is giving headaches both to the industry and the legislators.

Pioneers of the shipping industry with an outstanding environmental performance have hard time deciding upon one fits all solutions. Depending on the fleet (age, dimension, purpose) some methods work, others fail, all accompanied by additional costs.

The shipping industry was counting on the co-financing from the EC sustainable transport waterborne toolbox. In January 2013, the European Commission launched the Clean Fuel Strategy proposing “a package of binding targets on Member States for a minimum level of infrastructure for clean fuels (electricity, hydrogen and natural gas), as well as common EU wide standards for equipment needed”.
It TEN-T was the silver bullet. However, after the adoption of the EU budget, Transport has been cut 1/3 of the funds previously aimed for.

3. Alternatives

Some options are available for ship operators who wish to conform to the new SO_x requirements by other means than switching to MGO.

- Use of MGO
- Use of HFO with abatement technology
- Use of LNG

3.1. Marine Gas Oil (MGO)

Conventional marine fuels are divided into residual fuel oil and distillates.
Residual fuel oil (Heavy fuel oil - HFO), is the heaviest marine fuel with respect to viscosity and sulphur content; *Distillate fuels* are in turn divided into two categories: MGO and MDO.
MGO has low SO_x emissions, PM is also reduced. NO_x and GHG remain the same as in the case of HFO. MGO does not require extra volume for storage tanks, and retrofitting of the engine gives only small or no investment costs. However, fuel prices are high and are expected to rise, to some extent due to limited refinery capacity.

3.2. Exhaust Gas Scrubber

A scrubber is an air pollution control devices that can be used to remove some particulates and/or gases from industrial exhaust streams. (SO_x emissions are reduced to almost zero and the PM content is significantly reduced).
Currently there are two main types of scrubbers, both demanding additional maintenance when in harbour:
Dry scrubbers use a dry chemical. Fitting it demands additional stabilising measures, increasing fuel consumption while reducing the carrying cargo capacity. The technology works in any type of water (salt or fresh) and does not require much extra equipment except electricity and some measuring instruments.
Wet scrubbers use salty water or fresh water mixed with caustic soda in a closed loop to clean the exhaust fumes. The caustic soda on board requires special safety equipment and crew training. Salt-water scrubbers discharge it back into the sea yet it also needs to empty the waste (sludge) on a regular basis.

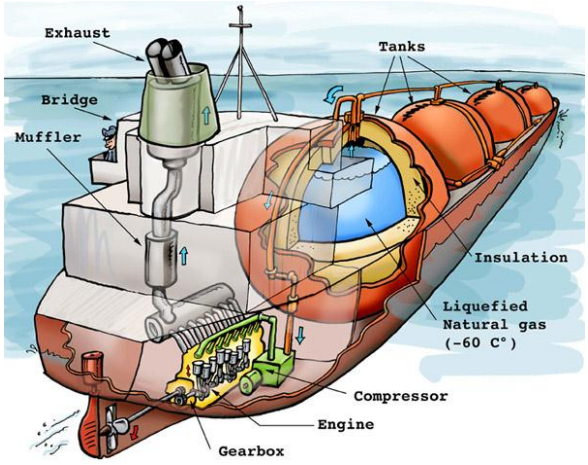
The advantages of the scrubber are the ready HFO infrastructure, and no need to retrofit or replace the engines. While promising, scrubbers reliability is not yet fully proven; manufacturers cannot guarantee 100% that the technology will be fully functional during operations and thus is not commercially mature.
The disadvantages include the required capital investments, IMO certification, CO_2 emissions, space requirements reducing cargo capacity, and the sludge discharge. In July 2011, the IMO issued a resolution with guidelines for reception facilities under the Marpol Annex VI. Yet, this will be another paying service.

Profit margins of the shipping lines make the investments challenging. According to STENA, the time from order to delivery of scrubber technology is, on average, 8 months. The actual fitting of the scrubbers takes 3 weeks during which the ship is not operational. The operators will delay the scrubber investment decision until close to the deadline as it will also leave time for technology improvement. The pace of scrubber installation might increase between 2015 and 2020, at least for the ships that operate in SECAs every day.

The estimation is that out of the 2 200 ships that operate in SECAs daily, 10 % will have installed scrubbers by January 2015. 5 % of the 2 600 ships that operate regularly in SECAs will have installed scrubbers by January 2015. This means that we expect that a total of 220 + 130 ships or 2,5 % of all ships that operate in SECAs daily will achieve compliance with the Directive by installing scrubbers.

Installing scrubbers in combination with either Selective Catalytic Reduction (SCR) or Exhaust Gas Recirculation (EGR) would fulfill the requirements in SECA 2015 and ECA Tier III. An article on IMO Tier III NOx technology states nevertheless that it applies only for vessels built after 1st January 2016. Therefore retrofit of Tier III technology is mainly relevant for vessels constructed after this date.

3.3. LNG



Clean - it reduces nearly completely SO_x which makes it perfectly suitable for (SECAs), emits nearly no PP, about 90% less NO_x and 20-25% less CO_2;
Accessible - global gas reserves are considerably higher than those of oil. Liquefaction of natural gas makes it easy to store and transport ($1m^3$ of LNG corresponds to 600 m^3 of natural gas).

Economically viable - LNG gains support due to its current price (lower than MGO). A feasibility study for an LNG filling station infrastructure and test of recommendations (co-financed by the TEN-T) concluded that payback times would be between 2-4 years; whereas a small scale LNG bunker facility would require an investment of €15m.

Similar trend to use LNG for shipping has been registered in PRC, Japan, South Korea, Singapore and the USA.

3.4. Refiners standpoint

Refiners are also under pressure, as 2015 approaches. The sulphur content of crude oil increases with the age of the oil field. As new oil fields are tricky to discover, the average age of oil fields is growing; hence, the oil extraction becoming more sulphurous. Eliminating SO_x from HFO fuel implies a costly process (higher temperatures, pressures, more stable catalysts); hence the more expensive lower sulphur marine fuels.

The price of low sulphur fuels will be crucial in setting a preference for abatement technology (scrubbers) or the low sulphur fuels. Investing in additional refinery processing might turn out risky if most of the shipping companies would opt for scrubbers.

To conform to the 2015 limits, refineries in SECAs will have to increase the price of diesel to compensate for decreased demand for HFO; low Sulphur fuel outstripping supply capacity.

MGO of 0.5% SO_x content is very similar to the diesel fuel used for road transport. The diesel market is much larger than the MGO-market and the cost to refineries for reducing sulphur content from 0.1% down to (0.005 %) is low.

The lead-time for upgrading a refinery is 3-4 years, excluding the time to obtain the permits. A technology available to refineries to convert the heaviest residual fuels into lighter distillate products and remove SO_x is the Coker. With cokers, refineries could increase diesel, kerosene and gasoline production, the latter is often used as a fuel to run the process. Purvin & Gertz estimate that the investment costs for a coker lie between $0.5- 1bn per refinery. Some state doubt cokers to be a fully commercially

mature technology. Ever since the downturn, refineries have not been operating under full capacity, and profits have fallen; hence, the reluctance to invest.

Dual fuel

LNG can be used in engines being able to run on either liquid fuel oils or gaseous fuel. The idea is to use LNG inside SECA and another fuel outside the SECA and/or let the fuel used outside SECA be determined by the relative fuel prices. Such engines can be either two stroke diesel engines or four stroke engines with the working principle based on the Otto cycle when operating on natural gas and on the Diesel cycle when operation on fuel oils.

3.5. Ports standpoint

The reduction of SO_x and NO_x emission will entail challenges also for ports. If LNG becomes most favoured marine fuel, investments in the infrastructure for distribution of LNG fuel (small scale terminals for bunkering purposes) is inevitable.

In 2009 ESPO in co-operation with EcoPorts Foundation prepared a review collecting the views of 122 ports from 20 European Maritime States on the Environmental Management System. The influence of port size on the environmental priorities is showed below:

	< 1 million tonnes (24 ports)	**1 - 10 million tonnes** (47 ports)	**10 - 25 million tonnes** (23 ports)	**> 25 million tonnes** (28 ports)
1	Garbage/ Port waste	Dredging: operations	Air quality	Air quality
2	Noise	Air quality	Port development (water)	Noise
3	Dredging: disposal	Energy consumption	Noise	Garbage/ Port waste
4	Dredging: operations	Noise	Dust	Dredging: operations
5	Energy Consumption	Dust	Relationship with local community	Port development (land)
6	Dust	Dredging: disposal	Garbage/ Port waste	Relationship with local community
7	Relationship with local community	Garbage/ Port waste	Energy consumption	Dredging: disposal
8	Bunkering	Relationship with local community	Port development (land)	Conservation areas
9	Ship waste	Ship waste	Ship waste	Port development (water)
10	Cargo spillage (handling)	Port development (land)	Dredging: disposal	Climate change

The common priorities for all ports are: noise, port waste, relationship with local community and dredging disposal. Air quality is the most important environmental consideration in large and very large ports. Bunkering and cargo spillage during handling are within the environmental priorities of small ports (<1m tonnes). The largest ports (>25m tonnes) give a high priority to issues such as conservation areas and climate change. Ship waste appears within the environmental priorities of all the ports handling less than 25m tonnes of cargo annually.

Dumping of untreated sewage from ships is illegal for all new ships from 2013, and from 2018 for all ships. The ships should use an approved sewage treatment plant capable of reducing nutrients. The ports in turn, should have adequate port reception facilities.

4. Evaluation

Solution	Advantages	Disadvantages
MGO	low SO_x and PM emissions; does not require extra volume for storage tanks; used in the main engines without posing a major technical or financial challenge.	NO_x and GHG remain the same as in the case of HFO price is higher than HFO and is expected to rise
LNG	reduces CO_2, NO_x emissions availability of world reserves	Incremental infrastructure & administrative framework in ports; Due to the low temperature, LNG has to be stored in cryogenic tanks and needs an additional ignition source; LNG storage tanks require more space than traditional fuel oil tanks; Safety of the fuel. *More on identified hazards and their respective risk indices in the full report on North European LNG Infrastructure Project*

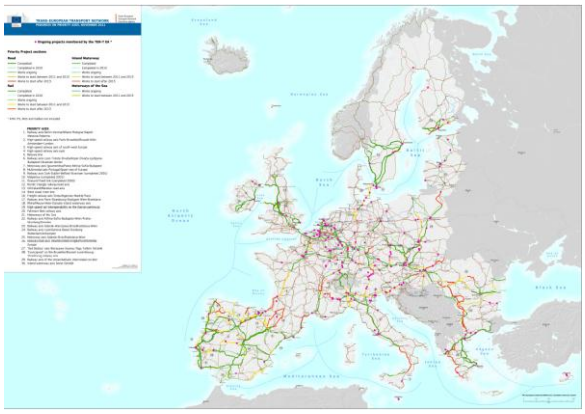
Scrubbers	Use of existing HFO facilities	Pose safety issues Cannot be installed on all ships Some ports refuse to discharge (sludge) Legal frame at EU level According to SWECO impact assessment on the consequences of the SO_x Directive, the following factors should be considered: Scrubber type, planned route; Installation costs including personnel costs; Maintenance and operation costs; Reduced income due to less cargo capacity; Age of vessel at time of installation. Expected price spread between maritime fuels of 3.5 % and 0.1 % sulphur content; Payback time times by 6 - 13 years

5. Conclusion and future scenarios

Member states taking group action in IMO to delay the implementation date.

While this decision will be highly saluted by some companies, it will be rejected by the pioneers of the shipping industry, who since 2009 have been investing and searching alternatives. This minority will prove that transition period was enough to switch to more environmentally friendly fuel or adopt the abatement equipment.

On an international level, any exceptions will be looked at as a competitive advantage.



EC waterborne transport toolbox

This tool is designed to grant a level playing field to the involved stakeholders.

Though still under review, its biggest advantage is that it will allow private investors with visibility. The biggest disadvantage is that this co-finance will be available only on TEN-T routes.

Wait & See strategy

Business as usual, complying to the targets with fines equalling the needed investment until the technology proves itself and achieves the economy of scale.

Modal shift is possible but only on some routes and under certain circumstances.

Shipping industry is currently facing a conundrum. Would the economic situation be more encouraging, the market would have already decided the solutions. As EU is still on its recovery way, the solutions for all involved stakeholders will reveal themselves only closer to 2015.

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LNG picture, courtesy of www.safety4sea.com, magyarnapenergiamuvek.hu,

Refinery picture www.statoil.com

UNEP picture

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Word of honour statement

I declare that I have written the thesis with the title "**European Shipping in the light of the IMO & EU regulations** on my own. Information from other sources or ideas from other persons are marked.

Brussels, March 2013

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