THE IMPACT OF A POSSIBLE EXTENSION AT EU LEVEL OF SECAS TO THE ENTIRE EUROPEAN COASTLINE

NOTE

2012
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Abstract

This briefing note provides an in-depth analysis of the impact of a political decision on Sulphur Emission Control Areas (SECA) in general and their further expansion in all sea areas around the EU coastline. To this end, it includes appropriate background information and research results that will serve to further the parliamentary debate on the opportunity of extending SECAs around the littoral EU regions. Beyond the goal of supporting the evolution of policies, the findings of the current briefing note also include up-to-date information about relevant facts and figures as well as other scientific opinion, based on the findings of the extended survey of this topic.
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<th>Description</th>
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<tbody>
<tr>
<td>BFDN</td>
<td>Bunker Fuel Delivery Note</td>
</tr>
<tr>
<td>CAFE</td>
<td>Clean Air for Europe Programme of the European Commission</td>
</tr>
<tr>
<td>CAPEX</td>
<td>Capital Expenditure</td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>EAP</td>
<td>Environment Action Programme (EAP)</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>ECA</td>
<td>Emission Control Area</td>
</tr>
<tr>
<td>EEDI</td>
<td>Energy Efficiency Design Index</td>
</tr>
<tr>
<td>EEOI</td>
<td>Energy Efficiency Operation Index</td>
</tr>
<tr>
<td>EGCS</td>
<td>Exhaust Gas Cleaning System</td>
</tr>
<tr>
<td>EIAPP</td>
<td>Engine International Air Pollution Prevention</td>
</tr>
<tr>
<td>EIB</td>
<td>European Investment Bank</td>
</tr>
<tr>
<td>EMSA</td>
<td>European Maritime Safety Agency</td>
</tr>
<tr>
<td>EP</td>
<td>European Parliament</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FSI</td>
<td>Flag State Implementation</td>
</tr>
<tr>
<td>GESAMP</td>
<td>Joint Group of Experts for Scientific Aspects of the Marine Environmental Protection</td>
</tr>
<tr>
<td>GHG</td>
<td>Green-House Gases</td>
</tr>
<tr>
<td>HC</td>
<td>Hydrocarbons</td>
</tr>
<tr>
<td>HFO</td>
<td>Heavy Fuel Oil</td>
</tr>
<tr>
<td>HS</td>
<td>High Sulphur</td>
</tr>
<tr>
<td>HSHFO</td>
<td>High Sulphur Heavy Fuel Oil</td>
</tr>
<tr>
<td>IGF</td>
<td>International Code of Safety for Gas-fuelled Ships</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organisation</td>
</tr>
<tr>
<td>JRC</td>
<td>Joint Research Centre</td>
</tr>
<tr>
<td>LIDAR</td>
<td>Laser-based monitoring devise</td>
</tr>
<tr>
<td>LNG</td>
<td>Liquefied Natural Gas</td>
</tr>
<tr>
<td>LS</td>
<td>Low Sulphur</td>
</tr>
<tr>
<td>LSHFO</td>
<td>Low Sulphur Heavy Fuel Oil</td>
</tr>
</tbody>
</table>
MARPOL  International Convention for the Prevention of Maritime Pollution from Ships
MBM  Market Based Measures
MDO  Marine Diesel Oil
MEPC  Marine Environment Protection Committee
MGO  Marine Gas-Oil
MOU  Memorandum of Understanding
NaOH  Caustic Soda
NECA  NOx Emission Control Area
NGO  Non-Governmental Organisation
NOx  Nitrogen oxides
ODS  Ozone-Depleting Substances
OECD  Organization for the Economic Cooperation and Development
OPEX  Operating Expenses
ORB  Oil Record Book
PPP  Public-Private Partnership
PSC  Port State Control
PSCO  Port State Control Officer
R&D  Research and Development
REMPEC  Regional Marine Pollution Emergency Response Centre
SAFEMED  EU-Funded MEDA Regional Project “Euromed Cooperation on Maritime Safety and Prevention of Pollution from Ships - SAFEMED” (MED 2005/109-573)
SCR  Selective Catalytic Reduction
SECA  Sulphur Emission Control Areas
SEEMP  Ship Energy Efficiency Management Plan
SIRC  Seafarers International Research Centre
SOx  Sulphur oxide
SSS  Short Sea Shipping
UN-ECE  United Nations Economic Commission for Europe
UNFCCC  United Nations Framework Convention on Climate Change
VOC  Volatile Organic Compound
WTO  World Trade Organisation
EXECUTIVE SUMMARY

This briefing note is concerned with the strict limits of sulphur in marine fuels, especially in the selected marine protected areas that are particularly sensitive to air pollution, the so-called Sulphur Emission Control Areas (SECA). It also aims to explore the risks associated with the expansion of the current SECAs in the European Union (EU), and considers the introduction of new areas of sulphur emission control, including the possibility of a SECA expansion along the entire coastline of the EU.

Air pollution from ship sources, including Sulphur oxides (SOx), impact on health and the environment. The topic attracts a high political priority, both at European and International levels. It is a complicated topic both scientifically and politically with conflicting stakeholder interests.

Legislative background

The International Maritime Organisation (IMO) is responsible for the prevention of marine pollution from ships, mainly through the MARPOL convention. MARPOL Annex VI addresses the issue of SOx emissions and also introduces the concept of SECAs, e.g. sea areas where strict sulphur limits apply.

- Currently, Annex VI set the limits of 3.5% sulphur content, by mass outside a SECA and 1.0% inside a SECA.
- These limits will be reduced to 0.5% outside a SECA in 2020, (subject to an interim assessment in 2018) and to 0.1% inside a SECA in 2015.

European Union Directive 2005/33/EC aligns in principle with the IMO provisions and regulations on sulphur content of fuel and compliance methods. From the 1st January 2010, Member States are required to take all necessary measures to ensure that ships do not use marine fuels with a sulphur content exceeding 0.1 % by mass, when at berth in a Community port.

Traffic analysis

The decision on whether to extend the SECAs should be taken in the context of changes in traffic volume. The main sea area of concern for this note is the Mediterranean. Traffic and trade are expected to grow and although emission levels per se will be reduced, the increased traffic could lead to a greater pressure on the environment. The extension of SECAs around European waters should be considered as a measure to reduce the environmental burden.

Technical Challenges

The introduction of the sulphur limits in ship fuel has prompted technological research in the areas of abatement and alternative fuels. The following points summarise the main issues:

- Scrubbing technology is available and addresses most of the technical challenges; the cost of installation varies considerably per ship type, age and size.
LNG as a marine fuel is a promising alternative if only a substantial network of bunkering spots is developed along the European coastline.

Further research work is needed in the areas of hybrid scrubbers and in the development of LNG shore side infrastructure.

A stable regulatory framework will enhance the effort of manufacturers towards addressing all technical challenges.

Lessons learned

The Impact of the existing SECAs in the North and Baltic Seas has been studied. The studies indicate that:

- There is currently a culture of compliance, however the level of compliance cannot be estimated.
- There are issues, in terms of policing and enforcement that need addressing. The enforcement of the EU directive could be better if it were encompassed within Paris MoU protocols.
- Regulatory avoidance could be linked to the high price of compliant fuel.
- The benefits of a reduction in SOx emissions outweigh the costs.
- Non-compliant tonnage should be phased out or new technology should be implemented the soonest possible.
- Realistic scenarios should be developed for the proper assessment of the cost of the new regulation and the allocation of costs.

Fuel Issues

Prediction of future prices of marine bunker is a complex issues. However it evident those fuels with low sulphur content are significantly more expensive than currently used high sulphur content fuels. Given Rotterdam as the “base-market port” fuel prices are expected to be higher in other bunkering ports, particularly in Southern Europe.

Issues regarding the availability of LS fuel and its price do not appear to be being addressed.

A substantial financial burden will be imposed on the ship-owners and operators. However, the sharp reduction of the limits increases the societal benefits.

Conclusions and Recommendations

- Shipping traffic is expected to grow and associated SOx emissions will also increase.
- Shipping is the single largest source of acidification in many European states.
- Any reduction in the environmental burden will have wider societal benefits.
- Scrubbing technology is already available.
- The decrease in permissible SOx limits and any extension of European SECAs would be a stimulus to technical research in the area of abatement and alternative fuels.
Technical innovation and the fostering of related business clusters are expected. The declaration of new SECA areas, as per the IMO framework, enables efficient enforcement of the regulations under the existing Port State Control (PSC) regime.

The combination of SECA limits and CAFE requirements intensifies the expected air quality improvement.

Modal shift to more polluting logistics chains or alternatives is possible, yet no quantification is available and it will practically affect some intra-EU trades.

On the basis of the above findings, the policy recommendations are summarized as follows:

- The extension of a SECA around the EU would level the playing field for all stakeholders and enhance the technical compatibility of the SSS-fleet servicing European ports.
- Adjacent third countries should also adopt strict environmental rules; therefore political understanding and cooperation are required.
- The decision of non-extension will maintain technical incompatibilities and competition issues as well as retain the high levels of externalities.
- Further research on the estimation of the impact of sulphur emissions on open sea on global warming is required.
- A thorough assessment of the number and capacity of the required LNG bunkering spots is necessary.
- Financial sources and EU funding is available; focused adjustment to the terms of funding might be required.

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1 The aim of the Clean Air for Europe (CAFE) Programme of the European Commission is to establish a long-term, integrated strategy to tackle air pollution and to protect against its effects on human health and the environment. The European Commission has recently launched a comprehensive review of its air policy building on the 2005 Thematic Strategy on Air Pollution and CAFE initiatives.
The impact of a possible extension at EU level of SECAs to the entire European coastline

1. INTRODUCTION

This briefing note is concerned with the strict limits of sulphur in marine fuels, especially in the selected marine protected areas that are particularly sensitive to air pollution, the so-called Sulphur Emission Control Areas (SECA). It also aims to explore the risks associated with the expansion of the current SECAs in the European Union (EU) and considers the introduction of new areas of sulphur emission Control, including the possibility of a SECA expansion along the entire coastline of the EU.

Maritime transport activities have an impact on the environment. Air emissions from ships such as greenhouse gases (GHG), ozone and aerosol precursors, Nitrogen oxides (NOx), Sulphur oxide (SOx) and Volatile Organic Compound (VOC), all contribute to air pollution. SOx and NOx, which are fuel related, can be converted into acid forms increasing the acidity levels of soil and water, leading to algal blooms in the sea. Some of these pollutants can also become converted into particulate matter that are associated with increased contamination levels and associated health problems. Moreover, shipping emissions contribute notably to the formation of ground level ozone, especially in closed regions, such as the Baltic Sea and the Mediterranean. This has been recognised by the EC CAFE initiative. Finally, ship emissions can contribute to climate change, as particulate black carbon emissions absorb energy from the sunlight and increase the ambient air temperature. This phenomenon is critical in the Arctic areas as it leads to an acceleration of the melting process of snow and ice (Miola, et al. 2010, p.14).

The contribution of air emissions from ships has been recognised and the International Maritime Organization (IMO) has declared the following two SECAs within the EU: Baltic Sea (effective May 2006) and the North Sea & English Channel (effective November 2007). The standard EU limits described in Directive 1999/32/CE are less stringent than the limits in Annex VI of MARPOL. The following section will examine the legislative background and a traffic analysis of some European waters as they pertain to sulphur levels and the establishment of a new European SECAs.

1.1. Legal Framework

1.1.1. Marpol Annex VI

The International Maritime Organization (IMO) is a specialized agency of the United Nations. Its principal responsibility is for the safety and security of shipping and the prevention of marine pollution by ships. In 1973, IMO adopted the International Convention for the Prevention of Pollution from Ships, known universally as MARPOL, which has been amended by the Protocols of 1978 and 1997 and kept updated with relevant amendments. The MARPOL Convention addresses pollution from ships by oil, by noxious liquid substances carried in bulk, harmful substances carried by sea in packaged form, sewage, garbage, and the prevention of air pollution from ships. MARPOL has greatly contributed to a significant decrease in pollution from international shipping and applies to 99% of the world’s merchant tonnage. Annex VI of MARPOL is specifically concerned with the prevention of air pollution by ships (SOx, NOx, ozone-depleting substances (ODS), and Volatile organic compounds (VOC)). In addition to Annex VI, IMO has responsibility for the establishment of Emission Control Areas and the control of Green House Gas (GHG) emissions.
International shipping is regarded as a significant contributor to air pollution. Ships burning marine diesel oil (MDO) and heavy fuel oil (HFO) are reportedly responsible for around 7% of global NOx emissions, around 4% of global sulphur dioxide emissions and 2% of global carbon dioxide emissions (IMO, 2009). The annex of this IMO document provides the full report on the updated 2000 study on greenhouse gas emissions from ships, entitled: Second IMO GHG Study 2009 (Buhag et al., 2009). The issue of emission reduction from ships is high on the political agenda, with stakeholders expressing different arguments concerning the control of ship emissions and methodological issues having been identified.

The concerns expressed against the IMO air pollution regulations mainly come from the maritime industry. They are based on the premise that shipping is the most “energy friendly” mode of transport, when considered in unit terms. Reports, such as that of the International Chamber of Shipping (2011), highlight the comparison of the CO2 emissions between different modes of transport. Miola et al. (2011) also report “the World Shipping Council, representing more that 60% of the global sea borne trade, takes the stand that the adoption of specific maritime emission caps would be inappropriate in the absence of a broader approach to regulation transportation emissions at the national and global level”. Various other sources take the same stance. The position is that shipping, is, in absolute terms, a significant or substantial emitter. However it is ‘greener’, than other forms of transport, in terms of energy consumption and environmental footprint.

Shipping is considered as a substantial emitter of GHGs, particularly CO2 and non-GHGs, such as NOx and SOx, consequently regulatory action has been triggered. The regulatory trigger can be traced back to 1997, when the United Nations Framework Convention on Climate Change (UNFCCC) mandated IMO through the Kyoto Protocol to work towards limiting the GHG emissions from international shipping, and IMO responded with the amendment of the MARPOL Convention that would result to emission reduction strategies (IMO, 1998).

A new Annex VI of the international convention of MARPOL came into force on 19 May 2005 and a revised Annex VI, with significant tighten emissions limits, was adopted in October 2008 which entered into force on 1 July 2010. In July 2009 at its 59\textsuperscript{th} session, the Marine Environment Protection Committee (MEPC) of the IMO agreed to a package of technical and operational measures to reduce GHG emissions from international shipping aimed at improving the energy efficiency for new ships through improved design and propulsion technologies and for new and existing ships, primarily through enhanced operational practices. The package includes the interim guidelines on the method of calculation of the Energy Efficiency Design Index for new ships (EEDI) and its voluntary verification, the guidance for the development of a Ship Energy Efficiency Management Plan (SEEMP) as well as the interim guidelines on the method of calculation of the Energy Efficiency Operational Indicator (EEOI) (IMO, 2009a, b, c, d). These measures are concerned with the energy efficiency of the ship and address the issue of GHG and particularly of CO2. Up until the March 2010 session of MEPC, the package of technical and operational measures was not mandatory. At the MEPC 60, it was agreed that Annex VI was the appropriate regulatory vehicle to make these measures mandatory and at the MEPC 61, in September/October 2010, nine members, parties to the MARPOL Annex VI, requested that EEDI and SEEP to become mandatory. The proposed amendments were adopted at the MEPC 62 in July 2011 and the regulations apply to all ships of 400 gross tonnage and above and are expected to enter into force on 1 January 2013. As per recent data of the IMO, 68 Member States have ratified Annex VI, representing approximately 91.6% of the world tonnage (IMO, 2011). The administrative development of Annex VI reflects the complexity of the air pollution issue as well as the resistance to change. The adoption and enforcement
of MARPOL Annex VI changes the operational pattern of maritime transport, as new rules related to non-GHG, such as SOx and NOx, are directly implemented, while the increase of energy efficiency leads to a direct reduction of CO2, the main GHG pollutant.

With regard to SOx and NOx emissions, Annex VI sets limits on the emissions of nitrogen oxides (NOx) from marine diesel engines, requires ships to avoid using fuel with sulphur content exceeding 4.5% by mass, prohibits deliberate emissions of ozone depleting substances, and prohibits the incineration of certain products on board ships. Furthermore, if a ship is within a SECA, it has to use a fuel with a sulphur content not exceeding 1.5% by mass, or an exhaust gas cleaning system or any other approved apparatus to limit SOx emissions.

From 1 January 2012, the global sulphur cap shall be 3.5% with a further decrease to 0.5% scheduled from 1 January 2020. However, the 2020 decrease is subject to a feasibility review to be completed by the IMO no later than 2018, which shall consider among other issues, the availability of compliant fuel. The sulphur limit in a SECA shall be 1.0% from 1 July 2010 and shall decrease to 0.1% from 1 January 2015.

Regulation 14 of Annex VI is focused on sulphur oxides (SOx). SOx and particulate matter emission controls apply to all fuel oil, as defined in regulation 2.9, combustion equipment and devices on-board and therefore include both main and all auxiliary engines together with items such boilers and inert gas generators. These regulations are divided between those applicable inside Emission Control Areas (ECA) established to limit the emission of SOx and particulate matter and those applicable outside such areas and are primarily achieved by limiting the maximum sulphur content of the fuel oils as loaded, bunkered, and subsequently used on-board. Table 1 illustrates regulations 14.1 and 14.4. The fuel oil sulphur limits (expressed in terms of % m/m – that is by weight) are subject to a series of step changes over the next few years. Figure 1 represents these changes in SOx reductions.

Table 1: MARPOL Annex VI SOx Limits

<table>
<thead>
<tr>
<th>Outside an ECA established to limit SOx and particulate matter emissions</th>
<th>Inside an ECA established to limit SOx and particulate matter emissions</th>
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</thead>
<tbody>
<tr>
<td>4.50% m/m prior to 1 January 2012</td>
<td>1.50% m/m prior to 1 July 2010</td>
</tr>
<tr>
<td>3.50% m/m on and after 1 January 2012</td>
<td>1.00% m/m on and after 1 July 2010</td>
</tr>
<tr>
<td>0.50% m/m on and after 1 January 2020(^2)</td>
<td>0.10% m/m on and after 1 January 2015</td>
</tr>
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\(^2\) Depending on the outcome of a review, to be concluded in 2018, as to the availability of the required fuel oil, this date could be deferred to 1 January 2025.

Source: IMO (2009).
The currently established ECAs are:

- Baltic Sea area – as defined in Annex I of MARPOL (SOx only);
- North Sea area – as defined in Annex V of MARPOL (SOx only);
- North American area (expected to enter into effect 1 August 2012)
- United States Caribbean Sea area (expected to enter into effect 1 January 2014)

At European Union level, certain rules on the sulphur content of marine fuel have been incorporated in the EU Directive 2005/33/EC amending Directive 1999/32/EC relating to a reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC.

Revisions to the regulations for ozone-depleting substances, volatile organic compounds, shipboard incineration, reception facilities and fuel oil quality have been made with regulations on fuel oil availability added. The revised measures are expected to have a significant beneficial impact on the atmospheric environment and on human health, particularly for those people living in port cities and coastal communities.

1.1.2. **Directive 1999/32/EC**


1. SOx emissions contribute significantly to the problem of acidification in the European Union and this has a direct effect on human health and on the environment. Acidification is a trans-border phenomenon requiring Community as well as national or local solutions on the grounds of Articles of the Treaty establishing the European Union, namely those related to the environmental and public health protection;

2. The requirement for more than 30% reduction of SOx, as per the United Nations Economic Commission for Europe (UN-ECE) Convention on Long-Range Trans-boundary Air Pollution;
(3) There is evidence based on studies that the benefits from reducing SOx emissions by reducing the sulphur content of fuels is considerably greater than the estimated cost to the industry.

The directive also refers to the marine fuels and sets the limit of 1% to 3% for heavy fuel oil by mass from 1 January 2003 (article 3, par.2), and 0.1% for gas oil after 2008 (article 4, par.1). However the limits do not apply to marine gas oil used by ships crossing a frontier between a third country and a Member State (article 1, par. 2(a)) and some countries, such as Greece and regions of Spain and Portugal, have derogated from these regulatory limits.

In the reasoning of the Directive, it is also stated that "whereas sulphur emissions from shipping due to the combustion of bunker fuels with a high sulphur content contribute to sulphur dioxide pollution and problems of acidification; whereas the Community will be advocating more effective protection of areas sensitive to SOx emissions and a reduction in the normal limit value for bunker fuel oil (from the present 4,5 %) at the continuing and future negotiations on the MARPOL Convention within the International Maritime Organisation (IMO); whereas the Community initiatives to have the North Sea/Channel declared a special low SOx emission control area should be continued". Which implies the trust vested in the IMO and the strong interest of the Community to deal with the subject.

1.1.3. Directive 2005/33/EC

The Directive 2005/33/EC of 6 July 2005 amends the Directive 1999/32/EC and introduces the basic provisos of MARPOL Annex VI into the European legislation. In the reasoning of the Directives, it is clearly stated that emissions from shipping harm the environment and the human health and that this Directive is considered as the first step in an on-going process to reduce marine emissions.

The application of the Directive impacts on all ship types, regardless their flag. The Directive requires, from the 1 January 2010, that Member States take all necessary measures to ensure that the following ships do not use marine fuels with a sulphur content exceeding 0.1 % by mass:

- Inland waterway vessels, and
- Ships at berth in EU ports, allowing sufficient time for the crew to complete any necessary fuel-changeover operation as soon as possible after arrival at berth, and as late as possible before departure.

The Directive does not allow for any delay in implementation or for any exemptions other than those already included.

The above requirement for ships visiting a Community port has resulted in various operational considerations, which have been addressed and communicated by competent bodies, such as the Baltic and International Maritime Council (BIMCO). The following issues have been raised to highlight ship operational concerns introduced by the Directive:

- Ships that switch off all engines and use shore side electricity while at berth in ports are not subject to the Directive.
- Any fuel-changeover operation to be recorded in ships' logbooks, and Member States might inspect or require the relevant time and data accordingly.
A ship that enters a port and manoeuvres is not obliged to use fuels not exceeding the 0.1% limit.

There is no clear indication of the time or the location for the changeover of fuel; the Directive gives a margin of sufficient time for the crew to complete all necessary operations for all engines and boilers, required to be in operation while at berth, as soon as possible after the safe arrival at berth. The requirement continues to apply while the ship is at berth or at anchor until as late as possible before departure, when changeover procedure should start for leaving the berth.

The Directive does not provide any new definition about the port. It is implied that the port is defined as per the United Nation Convention on the Law of the Seas (UNCLOS). It is however common practice that national authorities delimit the port zones and anchorages.

The Directive aligns, in principle, with the IMO provisions and regulations on the sulphur content and the compliance methods. It also provides for stricter environmental requirements and aims to protect the public health. This it does, as there are no provisions for any exceptions such as passenger ships or ships engaged in regular service, such as in the case of islands.

Further points of interest for this note are:

- The use of liquefied natural gas (LNG) is not addressed in the text of the Directive,
- Member States may allow ships to use an approved emission abatement technology, and
- In principle, any equipment or fuel mixture that respects the limits of the equivalent of burning fuels with 0.1% sulphur content is allowed.

1.2. Traffic Analysis and Development

The sustainability of any regulatory measurement depends on the evolution of the market conditions. The decision on whether to extend SECA s around the European coastline should take into account the growth of traffic volumes. The largest European Sea not declared a SECA is the Mediterranean. The expected increase in traffic growth for the Mediterranean and the attendant increase in air emissions from those ships makes the sea an ideal candidate for SECA status. An exhaustive analysis of the traffic development in the Mediterranean is not available, so a synthesis of results from various sources is presented below. A deliverable of the SAFEMED project is focused on the maritime traffic flows of the Mediterranean. The outcome of the analysis is summarized below (SAFEMED, 2008):

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3 The issue of the definition of a port is thoroughly discussed in the maritime law and numerous arbitration and litigation cases are available.

4 In article 11 of UNCLOS, it is stated: For the purpose of delimiting the territorial sea, the outermost permanent harbour works which form an integral part of the harbour system are regarded as forming part of the coast. Offshore installations and artificial islands shall not be considered as permanent harbour works.

5 It could be the objective of a focused study on this topic.

6 The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) implemented at European Union level and financed MEDA project entitled “Euromed Cooperation On Maritime Safety And Prevention Of Pollution From Ships – SAFEMED”. REMPEC in Malta has been set up on the basis of Protocol on prevention and emergency (2002) to Barcelona Convention.
The Mediterranean Sea is amongst the busiest international waterways and accounts for almost 15% of the global shipping activity by number of calls. More than 13,000 ships have made 252,000 port calls, as per the data of 2006.

Trade in the littoral States accounts for 19% of the world sea borne trade. However this figure does not reflect intra-Mediterranean trade, as it is still underdeveloped. It reflects mainly trade and flows from other regions to the littoral States. Moreover, the traffic flow of containerships and of tankers dominates the trade.

The Mediterranean Sea is a major transit corridor. More than 10,000, mainly large, ships cross the Mediterranean, and their size is at least three times larger than the ships servicing the intra-Med trade. Generally, relatively old and smaller ships trade in the Mediterranean, e.g. mini-7 and handymax bulkers.

Intra-Med vessel activity is increasing steadily and is projected to increase by 18% in the next years, while transit flows are expected to grow by 23%. This increase is coupled with the deployment of larger vessels. Practically all types of freighters will have a larger size in the future. The small intra-Med ships dominate the frequency of calls, while the large volumes of cargo are concentrated to relatively few terminals. The number of routes is high (more than 31,000 in 2006) and this implies that the Mediterranean is a busy sea region in terms of sea-traffic and cargo activity.

Crude oil and LNG trades are very important; their trade account for more than 60% of the total. Crude oil carriers cross the Mediterranean mainly from Suez en route to Gibraltar or from the Black Sea to Mediterranean destinations.

Statistics suggest that 40-45% of the ships trading the Mediterranean fly a Flag of a littoral State, while 80% of the ships are registered under the registry of other Third Countries.

The deployment of older tankers in the East Mediterranean increases the risks for casualties and pollution incidents.

The expected economic growth in the littoral States suggests the expansion of container activity and increase of the handled volumes, implying an increase of the traffic of feeder and mother-containerships; it is expected that Eastern Mediterranean will enjoy higher rates of growth, due to the proximity to the emerging Black Sea and Balkan markets.

Movements of bulk-carriers are also expected to increase, and Adriatic ports will retain their high market shares due to the infrastructure and hinterland connections.

Crude oil trading, new LNG-terminals and pipeline projects are expected to boost the trade and traffic of ships.

These findings are also reflected in the following data concerning of interest container trade. By compiling the most recent data available, it is evident that an annual increase of around 2.08% is reported for the western Mediterranean and 6.05% for the eastern Mediterranean container terminals. As this report is not solely focused on the Mediterranean, it is important to examine the reported growth of the Atlantic ports of the Iberian Peninsula, where the annual increase is close to 5.13% (see Table 2).

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7 Minibulkers are ships carrying dry bulk and break bulk cargoes with a capacity up to 5,000dwt tonnes, while handymax bulker’s range up to 55k dwt tonnes.
8 The data of Table 2 are compiled by the authors on the basis of the data provided by accessing ‘Containerisation International’ website.
Table 2: Number of Containers (TEU) handled in the areas under examination

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
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<tr>
<td>Iberian Peninsula</td>
<td>1,662,255</td>
<td>1,819,707</td>
<td>2,022,839</td>
<td>1,960,974</td>
<td>1,929,607</td>
<td>2,243,929</td>
</tr>
<tr>
<td>West Med</td>
<td>19,794,993</td>
<td>20,993,497</td>
<td>23,129,439</td>
<td>23,452,728</td>
<td>21,410,110</td>
<td>22,397,352</td>
</tr>
<tr>
<td>East Med/Black Sea</td>
<td>14,066,600</td>
<td>16,220,884</td>
<td>19,459,798</td>
<td>20,399,598</td>
<td>18,573,357</td>
<td>20,013,835</td>
</tr>
<tr>
<td>sum</td>
<td>35,523,848</td>
<td>39,034,088</td>
<td>44,612,076</td>
<td>45,813,300</td>
<td>41,913,074</td>
<td>44,655,116</td>
</tr>
<tr>
<td>%</td>
<td>9.02%</td>
<td>8.96%</td>
<td>9.14%</td>
<td>8.99%</td>
<td>9.14%</td>
<td>8.64%</td>
</tr>
<tr>
<td>World Total</td>
<td>393,747,508</td>
<td>435,534,473</td>
<td>488,293,442</td>
<td>509,820,056</td>
<td>458,625,380</td>
<td>516,835,591</td>
</tr>
</tbody>
</table>

Source: Authors’ elaboration on the basis of the Containerisation International Database.

These data reflect also the growing importance of the sea-areas under examination, i.e. the Atlantic coast and the Mediterranean Sea, and partially the financial predicaments of the last years. These markets reflect a percentage around 9% of the world total. The Mediterranean Sea attracts practically the interest of the analysis, in terms of volume and traffic. There is a clear positive correlation of the volumes in the Mediterranean, and the difference, in terms of volume, between eastern and western terminals has continuously declined. Considering also the issue of the number of transit ships, the data from the Suez Canal\(^9\) are clearly reflecting the increase. In the last decade, the number has substantially increased; the economic recession has affected crossings in 2008 and 2009. Taking into account 2010 too, the annual growth rate of the last decade is close to 2.3%.

In conclusion, as traffic and trade grow in the sea areas of interest, the environmental burden in terms of SOx emissions will increase. In order to avoid any escalation of the externalities, it is meaningful to consider severe measures, such as the implementation of the strict limits of the SECA, as per the current MARPOL ruling.

### SUMMARY OF KEY FINDINGS

1) Ship emissions undoubtedly add to air pollution. SOx emissions contribute significantly to the problem of acidification in the EU and this has a direct effect on human health and the environment.

2) MARPOL Annex VI addresses the issue of SOx emissions and introduces also the concept of SECAs, e.g. sea areas where strict sulphur limits apply.
   - Currently, Annex VI sets the limits of 3.5% sulphur content, by mass outside a SECA and 1.0% inside a SECA.
   - These limits will be reduced to 0.5% outside a SECA in 2020, (subject to an interim assessment in 2018) and to 0.1% inside a SECA in 2015

3) Directive 2005/33/EC aligns in principle with the IMO provisions and regulations on sulphur content of fuel and compliance methods. This should be considered as the first step in an ongoing process to reduce marine sulphur emissions.

From 1 January 2010, Member States should take all necessary measures to ensure that ships do not use marine fuels with a sulphur content exceeding 0.1 % by mass, when at berth in a EU port.

4) The adoption and enforcement of regulations on air pollution impact the operational pattern of maritime transport; the new rules related to non-GHG, such as SOx, and to GHG, such as of CO2, that demand an increase of energy, determine the financial outcome and operational life of existing and new tonnage.

5) The main sea area of concern for this note is the Mediterranean. Traffic and trade are expected to grow and although emission levels per se will be reduced, the increased traffic could lead to greater pressure on the environment.
2. **CHALLENGES AND EXPERIENCES**

The following sections outline the technical challenges; summarize some lessons learned from the application of the SECA regulations in the Northern Sea, and highlight issues regarding the pricing of marine fuels in Europe.

The application of the MARPOL Annex VI limits and the European Directives has sparked criticism in the Industry. Principally, the installed propulsion plants\(^{10}\) on-board ships might not meet the new standards without retrofitting, or by using low sulphur bunkers.

### 2.1. Technical Challenges

The introduction of the 0.1% sulphur limit in SECA\(^{s}\) after 2015 and in the EU ports since 2010, prompted an interest for many researchers, stakeholders and technology experts in exploring the issue further. The intention was to highlight potential risks and benefits and to assess the available abatement technologies. Various research teams have derived differing results, which are reported by JRC\(^{11}\) (Miola \textit{et al.}, 2010,). The JRC report focuses on air emissions generally and offers a solid basis for the understanding of the problem of air emissions. At the same time, European Marine Safety Agency (EMSA) conducted a study entitled "The 0.1% sulphur in fuel requirement as from 1 January 2015 in SECA\(^{s}\) - An assessment of available impact studies and alternative means of compliance" (EMSA, 2010). This study aimed at assessing other studies. (Namely three studies from Member States, three from the European Commission, and a further three from industry). This study offers interesting insights into the technical issues and the challenges related to the expansion of the SECA areas along the European coastline. The attention is focussed on exhaust scrubbing and the so-called, Exhaust Gas Cleaning System (EGCS). The three main types of scrubbers and an innovative technology were taken into consideration, namely:

- Seawater scrubber (the ‘open’ type),
- Freshwater / caustic soda scrubber (the ‘closed loop’ type),
- Hybrid scrubber, and
- The CSNOx system, an innovative system that addressed the issue of CO\(_2\), SO\(_x\), and NO\(_x\) simultaneously.

The EMSA study concludes that the existing regulatory framework, of MARPOL and Directive 2005/33/EC is insufficient\(^{12}\), as it does not address issues, such as bunkering on land, port installations, bunkering operations by barges, etc., which are still subject of national rules. A harmonized approach is required and technology manufacturers and providers and the 'market' need more legal certainty in order to develop new technologies. However, it is not really clear from the EMSA report, whether these technologies, if adopted, would not only satisfy IMO regulations, but also European Union Directives and or Regulations.

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\(^{10}\) The regulation includes all combustion equipment and devices onboard and therefore includes both main and all auxiliary engines together with items such boilers and inert gas generators. Therefore the use of the term ‘propulsion plant’ is more appropriate than using the term ‘main engine’ or ‘engines’.

\(^{11}\) The Joint Research Centre (JRC) is a Directorate-General of the European Commission and as scientific and technical arm of the EC falls under the responsibility of the European Commissioner for Research, Innovation and Science.

Technological Options

- **Scrubbing Technology**: scrubbing is a process of neutralizing exhaust gas with a fluid that can absorb SOx. The de-sulphured exhaust gas is released via the ship’s funnel. The resulting waste, known as sludge, is stored on board and is discharged to a shore reception facility. Seawater is widely used for scrubbing exhaust gases. Currently all tankers are required to have inert gas systems and seawater scrubbing is normally installed. While inert gas regulations are mandatory, the reduction of SOx from exhaust gases was not required. Therefore, it is concluded that there are issues in adapting the technology to the new operating requirements. However, this is not a simple matter and many marine engineering problems have emerged. Scrubbing technology solutions can require a dedicated Exhaust Gas Cleaning System EGCS space in the engine room, where space is usually scarce. Additionally they can lead to more complex and therefore more risky operations on board, possibly compromising safety levels. Generally, market reports suggest a reduction level of over 90% of SOx is possible. The same results are discussed in other studies, e.g. in the report of CE Delft, Germanischer Lloyd, MARINTEK and Det Norske Veritas. (2006).

- **Seawater scrubbing** is suitable for newbuildings and retrofit installations. It can be combined with all types of fuel systems, diesel engines and boilers and their relevant configurations. There is no restriction for any engine power range and the results are promising. There are cases where a 99% reduction of SOx and a 50-70% reduction in particulate matter have been reported. The cost of a scrubber is not completely known, yet it seems that monitoring equipment constitutes a large part of the cost. As usual in the shipbuilding sector, it is difficult to estimate the exact cost of a scrubber, as the propulsion plant configuration, vessel design, shipyard and benefits to the owner from their choice from the makers’ list determine the final price and cost. \(^{13}\)

- **Freshwater scrubbing** is based on the addition of caustic soda (NaOH) in the loop as a means to absorb the SOx from the emission gases. Like the seawater scrubbing, freshwater scrubbing can be installed in existing or new ships. There is no power range and propulsion plant configuration limitation. Its main benefit is the effective operation of the system in seas where the alkalinity of the seawater is not sufficient. The results from tests are encouraging as they offer reduction of SOx similar to the use of 0.1% sulphur fuels and other pollutants are also reduced. It appears that the freshwater systems are slightly cheaper to install than seawater ones, given the indicative investment costs tables of the EMSA report. \(^{14}\) (2010).

- **Hybrid systems** combine freshwater and seawater technology. It appears that these systems are more expensive to install, yet they offer versatility and abatement of 98-100% of SOx and close to 80% of particulate matter. These systems are still being tested, but should be commercially available soon.

- **The CSNOX System** is simultaneously targeting and abating three pollutants: SOx, NOx and CO2. It is a promising technology and is based on seawater as an absorbent. The tests are so far very successful, and this solution is reported to offer 99% reduction of SOx, 66% of NOx, and 77% of CO2.

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13 The ‘maker’s list’ is a list of manufacturers, agents and equipment that is discussed and agreed between the yard and the owners before the construction of a new ship. It includes all possible equipment items and for each of them a list of manufacturers and suppliers. The list is very important for both parties as it determines the final cost, quality and reliability of the equipment on board as well as the scheduling and the production plan of the yard. Suppliers included in the list might offer to the owners extra benefits, such as extended guarantees, free technical support and spare parts, etc.

Taking into account these points, some issues should be highlighted and summarized as following:

- Scrubbing is expected to increase fuel consumption by about 1 to 3% and therefore will increase the CO2 emissions\(^{15}\).
- Issues related to the quality of the wash-water from seawater scrubbers\(^{16}\) have been raised. The wash-water quality is an issue, as it is expected to impact the acidification of the oceans.
- Sludge produced by scrubbers represents less than 10% of the “normal” sludge production, thus suggesting an increase of needs for reception facilities.
- Space limitations, design and stability issues related to the installation of an ECGS are reported, especially in small ships, yet they are being addressed by the manufacturers.

The EMSA study (2010) also addresses the issue of alternative fuels and especially Liquefied Natural Gas (LNG). Briefly, LNG is a feasible and cost-effective alternative and the technology for LNG-fuelled ships exists. Although broader environmental and operational benefits are identified, incomplete infrastructure in ports and terminals along the coastline is the main barrier for the wider adoption of this technology and fuel alternative. Moreover, the possibility for co-funding of infrastructure projects through European programmes and the European Investment Bank (EIB) should be further explored (EMSA, 2010).

The environmental performance of LNG can be summarized in the following points:

- Sulphur emissions are eliminated;
- Particulate matter is close to zero;
- CO2 is reduced by 26\(^{17}\);  
- NOx is reduced by 80-90%.

Given the above results, LNG-fuelled ships seem to be a possible answer to the problem of air pollution, especially for non-GHG emissions. However, there are ship- and shore-side technical considerations that should be addressed before considering this as a viable alternative. These considerations are summarised below:

1. Ship-side technical considerations

   a. Bunker tanks: LNG needs new types of storage tanks on-board. In comparison to existing ones, the LNG-tanks are cylindrical and need more space on-board. The LNG is stored under pressure. The LNG tank requirements result in the sacrifice of some cargo space; in the EMSA report (2010) states that 2-4% of the cargo space of containerships should be sacrificed.

   b. Engines: Dual fuelled engines exist and some of the existing engines can easily burn LNG instead of MDO/HFO with an available LNG-kit. Consequently there are not many technical concerns. Nevertheless, for newbuilds an extra cost is expected, depending the size, type and complexity of the propulsion plant.

\(^{15}\) The CO2 emissions are directly linked with the consumption of fuel on-board; as a general rule, it can be assumed that the consumption of 1 ton of HFO results 3.17 tons of CO2.

\(^{16}\) Guidelines reviewed by the Joint Group of Experts for Scientific Aspects of the Marine Environmental Protection (GESAMP) have been developed at IMO.

\(^{17}\) Due to unburned methane the net reduction of greenhouse gases is somewhat lower (approx. 20%).
c. New-built ships and retro-fittings: It is apparent that newbuilds can adopt or accommodate the LNG technology better than existing ships, however, there are some examples of successful conversions.

d. Legal Issues: there is no regulatory framework for LNG-fuelled ships but currently IMO standards are being developed. Some voluntary standards exist in Europe, but a ‘global and universal’ solution is necessary. The international maritime community will probably only consider the LNG as a viable alternative when the new International Code of Safety for Gas-fuelled Ships (IGF Code) is complete and agreed within the IMO bodies. This code will provide guidelines for installations and operations and will become an integral part of the SOLAS Conventions. It is expected that IGF Code will be developed, agreed and adopted by 2014.

(2) Shore-side technical considerations

a. Availability of bunkering stations: Along the European coastline, LNG is not available as a fuel for ships. The LNG infrastructure is primarily servicing land-based networks and not ships. New infrastructure is needed at current import terminals, in order to serve ships.

b. Operational considerations: Bunker barges, ship-to-ship transfer and fixed installations can be used for LNG-fuelled ships, as illustrated by the Norwegian experience. However, further research and development is required. So far the lack of commercial interest has deferred relevant investments.

c. Regulatory Issues: As in the case of IGF Code, a similar administrative pattern is required for the safe storage, bunkering of ships, etc.

The option of using LNG as a marine fuel depends primarily on the availability of shore-based supply network. Apparently, the technology for LNG-fuelled ships is available and mature enough to be widely adopted. Manufacturers offer a ‘kit’, i.e. a component that allows the dual burning of LNG and HFO/MDO fuels. Nevertheless there is not a sufficient number of bunkering terminals along the European coastline and political intervention is necessary in order to shift the attention of the market towards this option. From a financial point of view, the introduction of LNG as fuel for ships seems to be a chicken-and-egg problem. Assuming that this network of bunkering stations existed, then the short sea shipping trade could be considered as a test-bed. These ships would benefit from the new bunkering infrastructure and the EU citizens would get the direct benefit of the ‘clean air’.

In conclusion, it is suggested that LNG is not necessarily the only solution, but it is:

- Promising in theory, as it fully addresses SOx and particulate matter as pollutants, and partially addresses the issue of NOx, yet the issue of GHG is not drastically resolved, which is also a key-issue of air quality regulations. There are currently only few ships fuelled with LNG, and generalisation of any operational results is risky;
- Tested in practice;
- Technical solutions to a large extent are available and industry-led;
- Shore-side needs development (infrastructure and guidelines).
2.2. Experiences from current ECAs

So far the only SECA areas declared are for the North and the Baltic Sea. The experiences from the SECA concept are discussed in a report of Seafarers International Research Centre (SIRC) (Bloor, Baker, Sampson, and Dahlgren 2011). Interestingly, a study on the potential impact of declaring the Baltic Sea a NOx Emission Control Area (NECA) also enhances the argument for the expansion of existing SECAs.

2.2.1. The North Sea and the Baltic SECA

- The SIRC report of December 2011 is the most recent publication concerning international legislation to control pollution. (Bloor, et al., 2011)\(^\text{18}\). The aim of the report was to examine the compliance with the regulations and the governance of the Northern European SECA. This interim report is important as its findings are of direct relevance to this note. The following points of interest have been identified. There is currently a ‘culture of compliance’ with the MARPOL Annex VI requirements in the industry, with the proportion of ship detentions, as a percentage of Paris MoU inspections, falling from 9% in 2001 to just 3% in 2010. But in this highly competitive industry, operator compliance depends crucially on the perception that one’s competitors are also compliant i.e. there is a ‘level playing field’.

- Overall, the available test evidence is insufficient to estimate compliance levels across the ECAs as a whole. Various approaches to control are being taken. Some Administrations, namely the Port State Control (PSC) are examining the oil record book (ORB) and the bunker fuel delivery note (BFDN). A BFDN is a commercial receipt of the quantity and quality of the fuel received on-board and is issued by the bunker agent. The ORB provides information on the time and the procedure of switching from HS to LS fuel. Other Administrations are opting for sampling methods. This implies that the information on the BFDN and the ORB are not prima facie evidence of compliance. The issue reveals the evolution of this marine environment protection regulation, as neither ORB nor BFDNs were originally designed for a statutory function.

- If regulatory avoidance is occurring, it may be linked to the very great cost savings to be made by operating with low-cost, high-sulphur fuel. This is at a time when shipping industry profits and freight rates are low. The imminent arrival of the new North American Emission Control Area (in August 2012) will ensure a continuing, very large, medium term, price differential between compliant and non-compliant fuel. The considerable financial incentives associated with using non-compliant fuel suggest the need for particularly robust enforcement measures.

- Administrations, parties to the Paris-MoU are well prepared and offer the use of the THETIS and EQUASIS databases for the ‘naming and shaming’ of ships that do not comply. However, vessels that are non-compliant, with respect to the EU directive on the burning of 0.1% sulphur fuel in port, do not fall under this scheme as the 0.1% port sulphur cap is not part of the IMO regulation. As a consequence, motivation for compliance is reduced. The PSC system of inspection and enforcement is based solely on the IMO regulations and, in practice, focuses on the Flag State Implementation (FSI) related requirements such as, the protection of the safety, security and environmental interests of the coastal and port States from threats from ships flying other flags.

\(^{18}\) The project will be finished in December 2012.
Not all bunkering operations and MARPOL sampling are processed as required. Additionally, not all ships are equipped with dual service tanks and systems. Ships that do not have dual systems, i.e. one tank for the HS and one for the LS fuels, need to undergo changeover procedures, and residues of sulphur are identified in the samples. Although adequate changeover procedures are published, the final result depends heavily on the operational requirements of the voyage and the skills, competence and/or instructions of the Chief Engineer on board.

The above findings are very interesting, as all other reports are focused on the impact of SECA's. However this one is focused on practical issues, specifically on operations and statutory control. The report also raises questions on the implementation of the sulphur regulations in other sea areas. The report concludes with some recommendations that offer a good basis of discussion for the proposed expansion of the SECA:

- The authors of SIRC report suggest that all EU countries inform the European Commission of all vessels found to be non-compliant in respect of the 0.1% sulphur port fuel regulations. This is with a view to the Commission seeking the inclusion of the non-compliant cases on EQUASIS system. The authors of this note suggest that Administrations should firstly inform EMSA, as the specialized body of such cases.

- They also suggest the electronic recording of BFDN. In the absence of an agreement on electronic recording, it is recommend that an agreement should be sought at IMO on a new format for the Bunker Fuel Delivery Note. Consideration should be given to the following propositions, that:
  - The BFDN should be in English;
  - It should always state the sulphur content;
  - The Registration Number of the bunker supplier be recorded (whether or not delivery is by a sub-contractor); and
  - The material of the BFDN is such that erasures or alterations to the note are visibly obvious.

- An interesting point that is also relevant to the expansion of the existing SECA is the potential danger posed to ships with single service tanks. The authors of the SIRC report suggest that with regard to such ships where the change over to compliant low sulphur fuel is by means of the partial emptying of the service tank, it may be inadvisable, for such ships, to have to queue for bunkering.

- The laser-based monitoring devise (LIDAR) has so far failed the operational tests. However more effort should be given towards the development of this technology. Air surveillance is a common practice for the control of the MARPOL oil discharge limits from ships, and the Administrations have a substantial experience and success with this practice, which could also incorporate other technologies such as LIDAR.

## 2.2.2. The Baltic Sea as a NECA: an interesting extrapolation

The study of Kali, Repka and Karvonen (2010) on Baltic NECA-economic impact is focused on NOx and the economic impact of the NOx related regulation. It does not address SOx issues, however it offers an interesting basis and ‘food for thought’ for the Baltic ECAs. This research study indicates that if the Baltic Sea is not designated as a NECA, then NOx emission from shipping will continue to increase together with the traffic growth. Regulation 13 of MARPOL Annex VI determines progressive reductions in NOx emissions from marine
The impact of a possible extension at EU level of SECAs to the entire European coastline

diesel engines. The "Tier II" emission limit is for engines installed on ships constructed on or after 1 January 2011 and prior to 1 January 2016. The more stringent "Tier III" emission limit is for engines installed on ships constructed on or after 1 January 2016 and operating in ECAs. The control of diesel engine NOx emissions is achieved through the survey and certification requirements leading to the issue of an Engine International Air Pollution Prevention (EIAPP) Certificate and, subsequently by the demonstration of in service compliance in accordance with the requirements of the mandatory regulations 13.8 and 5.3.2 respectively, NOx Technical Code 2008 (resolution MEPC.177 (58)). The introduction of the Tier III reduction scheme would give an 80% reduction in NOx over the Tier I level for new ships. This would be enough to turn the NOx levels into a decrease and halve the NOx emissions of shipping by 2040.

Figure 2: Schematic representation of NOx reduction

![Figure 2: Schematic representation of NOx reduction](Source: IMO, 2009)

Although this study focuses on NOx and not on SOx, there are some notable similarities between the two and the expected results from the application of stringent environmental limits. Both SECA and NECA developments are faced with technical challenges. The improvement of engines and exhaust gas systems and the better quality of fuels are essential to achieve the limits set by regulation. Moreover, the financial impact from the application of these technologies is, in both cases, difficult to estimate and to allocate to a particular stakeholder group. Finally, there is a clear environmental benefit from the application of such strict rules in both areas (SECA and NECA).

The study is based on the raw data collected for the base year 2008 and includes more than 6,000 ships from which the major part only sail for a few days in the Baltic. It is assumed and implied, if a Baltic NECA is established, it will be mainly Tier III ships that are sailing in the Baltic and the numbers of ships that only occasionally visit the Baltic will be

19 MARPOL Annex VI, Regulation 13 determines the limits of specific NOx in gr/kWh as a function of the engine speed (revolutions per minute). The regulation sets also the limits (tiers) of emissions, where Tier III is the one applicable in ECAs and implies a reduction of 80% of NOx emissions from the Tier I engines.
reduced. Therefore two different Capital Expenditure (CAPEX)\textsuperscript{20} scenarios have been created.

The first scenario assumes that in 2016 all new engine power will be fitted with Selective Catalytic Reduction (SCR)\textsuperscript{21}, and the second scenario assumes that the SCR is installed only on the share of engine power that represents 95\% of the NOx emissions of the certain ship type in 2008. With this method it is possible to reduce considerable amounts of SCR CAPEX and make the scenario more realistic. In the first scenario the total additional cost of the Tier III will be 76.6 million Euros in 2020 and 289 million Euros in 2030. While in the second scenario the costs will be 55.6 and 206 million Euros respectively. Figure 3 represent NOx emissions in the Baltic Sea against time and NOx emissions from Tier I, II and III ships against time, respectively.

**Figure 3:** NOx emissions in the Baltic Sea and Figure 3 NOx emissions from Tier I, II and III ships over time

![NOx emissions graph](image)

**Source:** Kali et al. 2010, pp.24-25.

Figure 3 suggests that if no measure is taken then the environmental burden from NOx will be increased, while if the NECA measures apply then in 2040 the expected burden will be half of the one today. Figure 3 demonstrates the contribution of the fleet components to the environmental burden. It can be seen that ‘old’ (non-compliant) tonnage will contribute more to the environmental burden until its final phase out. The expected patterns of the graphs, for a sea-region where stricter environmental rules apply, are akin to the ones above. Consequently, one can draw the following two main results, assuming similitude of the cases:

1. The sooner action is taken the better for the environment (the less the externalities).
2. The sooner the non-compliant tonnage is phased out, or new technology is implemented, the better for the environment.

The most controversial issue for all the stakeholders involved is the cost of abatement and the associated costs to the ship owners. The cost for the ship owners can be split into

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\textsuperscript{20} A company uses Capital Expenditures (CAPEX) in order to acquire or upgrade physical assets such as sea-going vessels and equipment.

\textsuperscript{21} Selective Catalytic Reduction (SCR) is a process of converting NOx, with the aid of a catalyst into diatomic nitrogen (N2) and water. It is possible that Tier III engines will be equipped with SCR technology.
capital expenses (CAPEX), i.e. the financial burden for the acquisition of a ship and operating expenses (OPEX), i.e. the financial burden for operating the ship. Figure 4 illustrates the NOx abatement costs over 30 years assuming a 10% interest (right) or a 5% interest rate (left). Both graphs illustrate the costs for the two previously described scenarios.

**Figure 4: NOx abatement costs over 30 years**

From Figure 4: NOx abatement costs over 30 years it appears that the interest rate can seriously affect the abatement cost. Moreover, it seems that even a small relaxation of the rule, as illustrated by the difference between the two scenarios, could reduce this cost. Assuming once again the similarity of the NOx and SOx cases, the following two conclusions are drawn:

- CAPEX constitute the largest part of the total costs, therefore any regulation should take this point into account;
- Realistic scenarios should be developed for the proper assessment of the cost of the new regulation and the allocation of costs.

### 2.3. Fuel Oil Issues

The estimation of the future price of marine bunkers is a complex issue and is not addressed in either academic works or in the business references that were consulted in this briefing note. The significance of effective forecasting is extremely important, as the costs related to the bunkers might exceed the 50% or even 70% of the total operating costs, especially for fast and large ships, such as the containerships.

The EMSA report (2010) presents specific information on the variation of the future fuel prices. The issue of the ‘absolute’ and of the ‘differential’, i.e. the difference between (High Sulphur Heavy Fuel Oil) HSHFO and (Low Sulphur Heavy Fuel Oil) LSHFO, price is also

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22 The operating expenses (OPEX) cover the needs of shore-administration, crewing, victualling, insurance, maintenance, repair, etc. The OPEX do not include bunkers and port-related expenses, as these are usually considered as ‘voyage costs’.

23 Note the difference between scenario 1 and scenario 2 in the graphs. In scenario 1 all engines comply with the new rules, while in scenario 2 only the engine power that contributes 95% of the burden is taken into account. The second scenario seems more realistic (Kali et al, 2010).

24 Specialized firms and businesses usually offer forecasting and related services.
discussed. Considering the data of the last two years, the difference between the monthly average price for high-sulphur (HS) and low-sulphur (LS) HFO ranges close to 5%. The difference between Heavy Fuel Oil (HFO) and Marine Gas-Oil (MGO) ranges close to 70-80% for the same period. The fluctuations of the monthly averages are not negligible, implying heavy fluctuations of the daily and weekly prices. Figure 5 illustrates monthly HFO and MGO prices in Europe.

**Figure 5: Monthly Bunker prices in Europe**

![Monthly HFO and MGO Prices in Europe](image)

Source: Authors’ compilation, SIN Clarkson Research Services, 2012.

Regarding Figure 5, the differences between the future prices of HFO and MGO can be seen. HFO future prices were higher than the range of USD625-675 per tonne and MGO prices were over USD1000 per tonne. This differential will continue unless market conditions dramatically change.

Another interesting point when discussing the bunker prices is the difference among the main bunkering points; in Figure 5 the key bunkering points in the Mediterranean are taken into account and compared with the ‘base-market’ of Rotterdam. It seems that the future prices in the Mediterranean were close to 5% higher than in Rotterdam.

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25 All data are drawn from the electronic database of Clarcksions, with a cut-off date the end of February 2012.
26 HFO is a pure or nearly pure residual oil with a viscosity of 380cSt used mainly for fuelling ships. MGO is a distillate used onboard ships.
2.4. **Key Findings**

1. A stable regulatory framework will enhance the effort of manufacturers towards addressing all technical challenges.

2. Currently, there is not a technical solution that fits all cases or abates all pollutants:
   a. Scrubbing as a technology can address most of the technical challenges related to SOx.
   b. LNG as a marine fuel is a promising alternative, in terms of abating SOx, if only a substantial network of bunkering spots is developed along the European coastline.

3. The sooner action is taken, the better for the environment (the less the externalities); the benefits outweigh the costs and immediate regulatory action, such as the extension of SECA areas could reduce external costs related to SOx.

4. The sooner the non-compliant tonnage is phased out, or new technology is implemented, the better for the environment.

5. CAPEX constitutes the largest part of the total costs of shipping; therefore any regulation should take this point into account.

6. Realistic scenarios should be developed for the proper assessment of the cost of the new regulation and the allocation of costs.

7. Fuels with low sulphur content are significantly more expensive than the currently used high sulphur ones.

8. Fuel prices are expected to be higher in bunkering ports in all EU regions in comparison to Rotterdam, and especially in the Mediterranean ones.
3. CONCLUSIONS AND RECOMMENDATIONS

The conclusions are focused on the impact of the introduction of further SECAS in the European Union. The second part of this chapter is dedicated to the policy recommendations.

3.1. Conclusions

**SUMMARY OF KEY ARGUMENT FOR THE EXTENSION OF SECAs**

- Trade is expected to grow so the environmental burden will also increase.
- Shipping contributes substantially to SOx emissions that impact on the life of many Europeans.
- The benefits of a reduction in SOx emissions outweigh the costs, according to all sources available.
- Appropriate fuel will be available, though at higher prices, so a substantial financial burden will be imposed on the ship-owners and operators. However, the sharp reduction of the limits increases the societal benefits.
- Scrubbing technology is available; the cost of installation varies considerably per ship type, age and size.
- LNG as a marine fuel is a possible alternative in the future; the main problem is the lack of bunkering infrastructure.
- Technical innovation and the fostering of related business clusters are expected as a result of the technical challenges faced due to the strict SOx limits.
- The declaration of new SECA areas, as per the IMO framework, enables efficient enforcement of the regulations under the existing PSC regime.
- The combination of SECA limits and CAFE requirements intensifies the expected air quality improvement.
- Modal shift to more polluting logistics chains or alternatives is possible, yet no quantification is available and it will practically affect some intra-EU trades.

3.1.1. Estimated rise of SO2 emissions along main shipping routes

Shipping traffic is expected to grow and therefore SOx emissions will also increase (see section 23.2). A conservative growth rate of 3% of traffic would indicate an increase of almost 35% of the traffic in a decade. Clearly a more accurate estimation is necessary, however evidence suggests that figures on traffic growth support the estimates reported in the literature. Some documents submitted to IMO suggest that:

- About 85% of shipping emissions occur within the northern hemisphere (also in Corbett et al., 1999, p.3461) and on a summer's day, ships’ contribution to

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27 The following points are primarily based on the background paper submitted at the 53rd MEPC of IMO, (Friends of Earth, 2005, pp.2-12); Friends of the Earth International was formed in 1971 by four organisations from France, Sweden, England and the US. It's now a federation of 76 groups from around the world.
projected ambient SO\textsubscript{x} levels in the north Atlantic exceeds 60\% and on a winter day can rise to around 90\%.

- Almost 70\% of global ship emissions occur within 400km (~250 miles) of the land and models suggest marine engines contribute 5-30\% of the total sulphur burden and this was close to 3.6m tonnes of SO\textsubscript{x} in Europe in 2000.
- European land-based emissions are gradually being reduced, while those from shipping are expected to continue to increase. Even assuming implementation of MARPOL Annex VI and sulphur emission control areas (SECAs) in the North Sea, Baltic Sea and English Channel, international shipping emissions of SO\textsubscript{2} are expected to increase by more than 42\% by 2020. By 2020, projected international shipping emissions in European sea areas will exceed total land-based emissions in the EU25 countries, as per scientific estimations.
- Shipping is the single largest sources of acidification and eutrophication in many European countries, despite the fact that most emissions are deposited over the oceans.

The reduction of the environmental burden has societal benefits - when considering wider benefits (environment and health) the rules are clearly cost-effective. Other positive environmental benefits are also expected to appear:

- A 25\% reduction in acidification within ECAs;
- Reduction of eutrophication by 3\% in 2015;
- Substantial reduction of 65-85\% of particulate matter in 2020\textsuperscript{28}.

3.1.2. Reduction of 0,1\% sulphur content in the ECAs and rise of fuel costs

The Kalli et al., study (2010) is a study on NO\textsubscript{x} levels in the Baltic Sea, but it also addresses the issue of the higher operations costs for ships, and peripherally the cost of bunker fuel. Bunker prices are expected to rise (see section 24.3), so a substantial financial burden will be imposed on the ship-owners and operators. By extrapolating the results of the NO\textsubscript{x}-focused approach to SO\textsubscript{x}, and given all necessary reservations, it seems that a sharp reduction of the emission limits at the present time could lead to relatively stable cost per abated tonne\textsuperscript{29}.

3.1.3. Feasibility of 0,1\% sulphur regulations in relation to EU technology innovations

None of the available sources challenge the availability of fuel or even the expected higher prices of LS bunkers. Scrubbing technologies seem to offer a technically viable solution as most of them offer a reduction of over 90\% of the SO\textsubscript{x} emissions. The technology is available yet the financial burden for the installation, operation and maintenance seem unclear and their use is heavily dependent on the propulsion plant of each ship. The CSNOX technology seems in many ways promising and potentially available, however the cost of this technical option is still not clear. Reception facilities or other technical solutions should also be considered, as the sludge, or in some cases washing water, from scrubbing should not be discharged, particularly in environmentally sensitive areas, such as the

\textsuperscript{28} Detailed information is provided in the EMSA study (2010, p.12).
\textsuperscript{29} Detailed information is provided in the Kalli et al. (2010, pp. 26-30).
The impact of a possible extension at EU level of SECAs to the entire European coastline

Mediterranean. Nevertheless, this point does not raise too many concerns, as reception facilities and similar issues are currently addressed and the market and Port Administrations are experienced in the port reception facilities.

The LNG-fuelled ships consist of a potentially interesting solution, which is not easy to consider in short-term planning. The key issue is the lack of LNG-bunkering stations in the southern part of Europe, as well as the lack of a regulatory framework (IGF Code, see section 24.1). The view of the authors is that LNG-fuelled ships can be considered in Short Sea Shipping (SSS) trade along the EU coastline and with adjacent regions as viable solution for the future. However, the global operation of LNG-fuelled ships within a global LNG-bunkering Network, as it is currently understood and operated, will take a long time to become established and for operators to become confident about it.

3.1.4. Stimulus for an eco-innovative shipping industry

The authors of the briefing note consider that the introduction of any environmental friendly measure is a drive and trigger for technological improvements and offers chances to the European shipbuilding industry and related business clusters for development and further commercialisation. Two points are highlighted:

1. Existing ships should implement a technical solution in order to achieve the required emissions limit. This can be through the installation of a scrubber or a second on-board fuel storage and transfer system, allowing the burning of LS graded fuel oil.

2. LNG-fuelled ships might be constructed in the future, as LNG technology is mature both ashore and on-board, however, the issue of infrastructure needs to be solved.

3.1.5. Measures to reduce air polluting emissions in existing or new SECAs

Taking into account the points mentioned previously, the use of LS bunkers or the installations of scrubbers are technically the most viable measures. Moreover, the decision for the expansion of the SECAs will enable efficient enforcement through the established Port State Control (PSC) networks and practices. Efficient enforcement, including the use of a 'shame list', will discourage violations. Potentially, initiatives for the development of EGCS abatement technologies that address all pollutants, such as the CSNOX, could be also considered. Technologically advanced EGCS could treat GHG and non-GHG pollutants, contributing to the Clean Air policies and initiatives, and boosting the interests of the European suppliers and R&D centres.

3.1.6. The applications of seawater scrubbing as a lower private cost alternative than that of using ultra-low (0,1%) sulphur

A decision concerning the installation of a scrubber depends on the propulsion plant on board the ship and is closely related to the operational needs of that ship. The cost of the retrofitting scrubbers can vary enormously and no meaningful average costs can be extracted. Therefore the cost comparison between installing a scrubber as opposed to a dual fuel system on board rests on the factors considered above. As prices of LS bunkers are expected to increase, then the decision to install a scrubber seems financially more appropriate. This takes into account that the sludge or the contaminated scrubber wash water does not impose any environmental burden and given that reception facilities or similar regulations will be in place.
3.1.7. **The impacts of ozone levels in the European mainland due to emissions from international shipping**

The EU objective has set the objective to achieve levels of air quality that do not result in unacceptable impacts on, and risks to, humans and the environment; this objective is addressed by launching the Thematic Strategy on Air Pollution and Clean Air For Europe (CAFE), one of the seven Thematic Strategies in the Sixth Environment Action Programme (EAP), "Environment 2010: Our future, Our choice". CAFE focuses on the contribution from ships to the formation of ground-level ozone and particularly the involvement of ship source NOx, Volatile Organic Compounds (VOCs) and to some extent particulate matter. As land-based sources of emission are abated, the shipping sector will have to contribute further reductions in air emissions. The total amount of pollutants emitted from shipping is high, despite its inherent energy efficiency. All forms of maritime traffic around the littoral regions contribute to the problem, however intra-EU trades seem to attract more interest. Primarily this is due to the concentration of maritime traffic in some corridors, such as the Adriatic Sea, the adjacent sea of the main European hub-ports of Rotterdam, Antwerp, and Hamburg, as well as those of Sardinia and Corsica. Most of the ports involved are city-ports therefore the externalities have a high impact. As stated above, the extension of a SECA would have positive impact on the air quality. The extension of a SECA will drastically reduce the emissions from ships, partially meeting the objectives. Further action on NOx and PM remains to be initiated. In conclusion, the total volume of contributing emissions, such as SOx, will be reduced and the air quality will be improved.

The counter argument to the above is that the higher fuel and operating costs of ships may divert some cargo to land based modes. This, in turn, will jeopardise the efforts to shift cargo from land to sea. In the authors’ opinion, this argument is not sufficiently justified. Considering the maritime traffic around Europe and especially in the sea-areas that might become a SECA, then:

1. Ships that cross these seas, but do not call a European port, are affected by the regulation yet they are not involved in any modal shift in Europe.
2. Ships, engaged in a trade between a EU-port and a third country, should comply and a modal shift might be possible, though not probable. These ships are mainly tankers, LNG-ships and containerships (see also section 1.2). Ships carrying energy commodities and products call at specific terminals, and they do not have a viable alternative for a modal shift. Containerships engaged in international trades, are also bound to call at a major hub. In extreme cases, these ships might shift hubs, but a difference on the impact cannot easily be distinguished at a European level.
3. The intra-EU trade might be affected, however, the review of the studies has clearly pinpointed that no modal shift implications are certain\(^{30}\). A shift is unlikely in cases where the demand is captured, e.g. the Adriatic Corridor, with the trade to the islands, such as Sardinia, Corsica, Crete, or, in the situation of feeders (or ships involved in intra-EU SSS trades) calling into the main ports of Rotterdam, Antwerp, Hamburg, etc. In conclusion, modal shift related arguments should be better substantiated, and further investigated.

\(^{30}\) E.g. see EMSA, 2010, p. 18.
3.2. **Policy Recommendations**

### SUMMARY OF POLICY RECOMMENDATIONS

- The extension of a SECA around the EU would level the playing field for all stakeholders and enhance the technical compatibility of the SSS-fleet servicing European ports.
- Adjacent third countries should also adopt strict environmental rules; therefore political understanding and cooperation are required.
- The decision of non-extension will maintain technical incompatibilities and competition issues as well as retain the high levels of externalities.
- Further research on the estimation of the impact of sulphur emissions on open sea on global warming is required.
- A thorough assessment of the number and capacity of the required LNG bunkering spots is necessary.
- Financial sources and EU funding is practically available for the development of infrastructure and of new technologies; financing of incentives is practically not available and this issue needs also further political consideration.

3.2.1. **Allocation of stakeholder costs, risks and benefits**

The establishment of a SECA around the entire EU coast will have a positive environmental impact. The identified risks (threats) will be mitigated either by corrective actions or by being outweighed by the benefits. As the air pollution issue extends beyond the borders of the Member States, European initiatives, such as regulatory action, strategies and programmes, should be implemented. The extension of the SECA around the EU will level the playing field for all stakeholders and enhance the technical compatibility of the SSS-fleet servicing European ports. Moreover it cancels out policies or practices favouring some operators, States, or ports. Such an initiative would amplify the ‘no more favourable treatment’ of Article 5, paragraph 4 of MARPOL Convention. This article dictates that all ships must comply irrespective of the Flag State. The authors also suggest that the extension of SECAs around the EU will make the enforcement of the rules more effective, as PSC can target these requirements when inspecting ships. Eventually the cost of compliance rests with ship owners and operators. Part of the cost might be passed to the charterers or the users of the service. Finally, consumers will probably be affected as well.

The extension of SECAs will also benefit Third Countries into the regions adjacent to the EU. It is important that the EU exercises influence or provides the means for the compliance of third countries with as strict environmental rules as apply within the EU. Otherwise, adjacent Third Countries, especially in the Mediterranean, can enjoy an improvement to their air quality at no cost, and at the same time provide alternatives to operators, who aim to evade the regulations. Such practices might occur in neighbouring EU regions, such as in the Middle East and West Mediterranean. A political understanding with the neighbouring Third Countries will mitigate such risks and increase the positive impact of the new SECA on the environment and to public health.
3.2.2. Distortive effects of non-extension of SECAs

The option of not extending SECAs around the EU will maintain the technical incompatibility of the fleet operating around the EU coastline, will sustain the disruption of enforcement of the current rules and regulations, and justify the arguments of non-level playfield among all stakeholders in the EU. Apart from these administrative and operational issues, such a decision would preserve the current externalities and with the expected increase of trade and traffic they would eventually be increased. It is also feared that the position of the EU in the international fora would be weakened and negative messages regarding climate change issues will be signalled. Moreover, European suppliers would not get the benefit and the chance to improve and commercialise their services and products, implying a loss of competitiveness of various European industrial sectors.

3.2.3. Arguments to maintain the current status quo

The authors are of the opinion that there are few sound arguments to support the maintenance of the current status quo. The key argument is the difficult financial conditions faced in the international shipping markets, the lack of liquidity, and weak trade volumes. Indeed, owners currently contemplate financial predicaments, with low freight rates and high bunker costs. The financial decision to install a scrubber cannot necessarily be justified, especially in times of recession. The financial criteria are predicated on the type and age of the ship, its operating and capital expenses, and the financial structure of the business. Owners will install the scrubbers only if they have to comply with the rules or they are convinced of a cost benefit. High bunker prices, low freight rates have already forced owners to lay up tonnage. A mandatory installation of equipment would only aggravate their financial standing. However, as the benefits are higher than the costs, this policy has a clear positive impact. Ships should comply and there is no argument for including only some ships in the new regulatory framework. Special attention should only be given in cases, where wider policies, such as of economic and social cohesion, are threatened. Ships servicing islands or sensitive geographical regions might be granted a grandfather clause, in order to secure the continuation of the service. Exclusion is not considered as a sound alternative, as the local population will be exposed to higher environmental threats.

3.2.4. The impact of sulphur emissions in open sea on global warming

The issue of global climate change due to the SOx emissions is addressed in academic publications, such as the one of Hansen, Kharecha and von Schuckmann (2011). SOx emissions concentrate and stay close to the ground for year and the transient phenomenon of aerosols is cooling the oceans. Various documents and research work suggest that this phenomenon is still under investigation. Related maps (e.g. see Simons, 2011) imply that the reduction of SOx in the sea-areas around Europe will not drastically impact on the environment. However, this point demands a thorough analysis and further research is required.

31 Since 1986, the objective of economic and social cohesion policy has been to strengthen economic and social cohesion, and to this direction, the Lisbon Treaty and the EU’s high-level strategy (Europe 2020) include also the dimension of territorial cohesion.

32 A grandfather clause is a legal term used to describe a situation in which an old rule continues to apply to some existing situations, while a new rule will apply to all future situations.

33 Information is available in various sources, e.g. in the www.myocean.eu and www.gmes.info supported by the EC.
3.2.5. **Needs assessment for alternative resources in case of SECAs extension**

The option of LNG-fuelled ships is promising, yet it envisages a network of LNG-terminals along the EU coastline enabling bunkering operations. The authors do not consider the lack of regulations as key issue at the moment, as the IGF Code is currently under preparation and eventually will pass all administrative procedures at the IMO in due time. The LNG-fuelled ships could impact the market, as LNG can merely substitute oil-products as fuel; the LNG alternative might influence the investment and operational decisions of owners, either at initial stages of building or at the latter steps of operating a ship. However, it is not certain that a global network of LNG-bunkering stations will be developed. This may only happen if there are enough LNG-fuelled ships trading globally. If, on the other hand, it is decided that such a shore-based network will serve primarily the intra-EU trade, it is possible that potentially there will be a lesser demand for LNG and this could influence the financing of the project. It is not clear from the literature, how many main terminals would be required, how many barges should be deployed and how many ships will be served, therefore the option of developing shore-based LNG bunkering points should thoroughly be analysed.

3.2.6. **Identification of relevant EU funds**

European funding is highly focused on target goals and objectives. If the goal is to develop new technologies, as the case of EGCS discussed above, then financial schemes encouraging investments in ‘green solutions’ should be considered. This kind of schemes should be considered at European level, although market leaders will normally get most of the benefit, yet partners from many EU countries could participate and enhance their level of know-how and mitigate knowledge gaps. EU Programmes, such as SAVE, ALTENER, STEER, COOPENER, and the future HORIZON 2020 could be of assistance. If the goal is to finance the development of infrastructure, e.g. infrastructure of LNG networks and terminals, then these projects fall under the category of European or national interest, and they should get at least primary national funding. The role of the European Investment Bank (EIB) could be catalytic in such projects. Nevertheless, programmes such as the Trans-European Networks could also foster the initial feasibility studies and partially finance the infrastructure.

Alternatively, trading with ‘green’ ships could be promoted by using such tools as Market Based Measures (MBM)\(^\text{34}\) which reward ‘green operators’ by a scheme of incentives. Another approach would be to consider measures related to the taxation, port dues and cargo shifted to sea. The concept of Marco Polo II programme could be of assistance although its current aims and goals do not support projects related to MBM and national or regional political intervention. Under the INTERREG or the ESPON programmes such projects could be financed thorough analysis and study of the potential impact of a SECA in the regions. It should be noted that SSS competition in the Mediterranean regions is not the same as in northern Europe. In the northern regions there is a competition of well-established networks with a lack of such networks in the south. Italy and Spain are faced also with the natural barriers of Alps and Pyrenees that attract the attention of operators and policy-makers.

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\(^{34}\) The discussion on CO2 reduction exposed the issue of the so-called Market-Based Measures (MBM). Miola et al. (2011) reports that in the economic literature four market-based instruments are considered appropriate for climate change policies: emission taxes, emission trading, a hybrid policy (combing a tax with trading), and finally emission crediting that is voluntary.
In conclusion, financing of projects focused on the development of infrastructure, and the development or implementation of new technologies is practically available. However, financing of incentives is not in place, although some potential is available, and this as topic needs further political investigation.
4. REFERENCES


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