Greening of Ports: Sailing the green Course?

Sergi Sauri*, Christa Sys** and Thierry Vanelslander***

Maritime shipping and ports are important contributors to air emissions. Legislation is available at various policy levels, but more solutions are needed that are in a further stage of development, taking into account also the economics of the various involved actors.

Introduction

European ports are key gateways for the European economy and global trade. Next to this, they also accommodate passenger transport as well as cruise and tourism activities. Furthermore, ports are home to industrial activities and play a key role as energy hubs with energy commodities representing a substantial part of traffic volumes.

Notwithstanding the critical role that ports play, the environmental sustainability of port activities is a growing concern for port stakeholders, policy makers and local communities. Shipping and port activities affect the natural environment and have a negative impact on human health and marine ecosystems. Harmful effects of port activities include air emissions, noise and water pollution, congestion and waste generation, among others. Environmental issues arise from vessel and cargo handling operations, hinterland transport modes, port development and industrial activities in ports. A substantial part of the externalities of port operations results from shipping.

This contribution gives an overview of the current situation with respect to emission problems in shipping and ports, as well as a state of policy-making on the matter.

Air emissions from shipping

Emissions from ships represent the primary source of air pollution in the majority of ports (Eyring et al., 2009, Mueller et al., 2011, and Wang et al., 2020, for instance). Furthermore, port emission inventories show that most of these emissions occur at berth and while manoeuvring. Accompanied by considerable fuel consumption, marine transport produced 1.056 million tons of CO_2 in 2018, representing 2.89% of the global CO_2 emissions (IMO, 2020). In addition to this greenhouse gas (GHG), maritime fleets also emit a considerable amount of other pollutant emissions such as NOx and SOx: according to Deng (2021), between 2014 and 2018, annually:

- NOx emissions increased from 19 million tons to 20.9 million tons
- SOx emissions increased from 10.2 million tons to 11.3 million tons.

Moreover, most shipping emissions (CH4, CO, CO_2 and NOx) are expected to grow fourfold up to 2050.

The regulation of shipping emissions is insufficient, slow and complex due to the fact that maritime transport is, by nature, an international activity. Companies in the sector demand maximum uniformity and stability in rules and regulations in order to ensure a level playing field for the industry and to allow for planning and scheduling of their investments over time. For that reason, emissions from international shipping are regulated at the international level by the International Maritime Organisation (IMO) under the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). The regulations for the Prevention of Air Pollution from Ships (Annex VI) seek to minimise airborne emissions and their contribution to local and global air pollution, as well as other environmental problems.

MARPOL Annex VI lays out global progressive reduction standards for emissions of SOx, NOx and particulate matter (PM) and defines emission control areas (ECAs) to help further reduce emissions of those air pollutants in designated sea areas. At the moment, only the MARPOL provisions on SOx emissions are covered by EU law. Directive (EU) 2016/802, known as the 'Sulphur Directive', regulates SOx emissions from ships. This Directive integrates the sulphur emission standards defined in the MARPOL Annex VI, which set stricter sulphur limits for marine fuel in SECAs (0,10%) and sea areas outside SECAs (3,50%), since 2015. The latter limit is further strengthened since 2020 through a global

* Dr. Sergi Sauri, Director of Center for Innovation in Transport-CENIT at UPC-CIMNE, sergi.sauri@upc.edu
** Prof. Christa Sys, University of Antwerp – Department of Transport and Regional Economics, christa.sys@uantwerpen.be
*** Prof. Thierry Vanelslander, University of Antwerp – Department of Transport and Regional Economics, thierry.vanelslander@uantwerpen.be

0,5% sulphur cap on marine fuels. On 1 January 2020, the Sulphur Directive also introduced a 0,1% maximum sulphur requirement for fuels used by ships at berth in EU ports and a 1,50% for passenger ships operating on regular services to or from any EU port in sea areas outside the SECAs. The sulphur limit for vessels at berth in EU ports has been the critical element in reducing SOx emissions, to the extent that these emissions are no longer a priority for action in EU ports. Furthermore, the last report on implementation and compliance with the sulphur standards for marine fuels set out in Directive (EU) 2016/802 (European Commission, 2018) reports a significant reduction of sulphur dioxide concentrations in regions bordering the SOx-ECA.

However, emissions of PM and NOx from international ships are not regulated by the EU. The IMO designated the North and the Baltic seas as 'Nitrogen Oxides Emission Control Areas' (NOx-ECAs) in July 2017. This implies that an engine installed on a ship constructed after 1 January 2021 that operates in the Baltic Sea or the North Sea has to comply with the 'Tier III' engine requirements laid out in MARPOL Annex VI. Since this regulation only addresses new ships built after 2021 and only those ships operating in a NOx-ECA, it is not expected that there will be any significant short- or medium-term improvement in NOx emissions in the EU.

So far, only one Member State has put forward a measure to address NOx emissions from (domestic) shipping. In 2008, Norway created a NOx Fund as an instrument to reduce NOx emissions from shipping (and a number of other sectors) and as an alternative to the existing NOx tax. Companies joining the NOx fund pay a fee to the organisation, instead of the fiscal NOx state tax, in order to incentivise participation. In return, affiliated companies can apply for and get NOx funding for NOx reduction measures, and the industry commits to certain obligations in the form of emission ceilings. Recently, shipping companies have claimed that the taxation of CO_2 has undermined efforts towards NOx reductions. In January 2018, Norway removed the exemption from the national CO_2 tax of liquefied natural gas (LNG) as fuel on ships and increased the tax on NOx to €500 per tonne of CO_2. This has caused LNG to be more expensive with a knock-on effect on the NOx fund investments for LNG fuelled ships, whose business has been affected. This is a clear example of how energy taxation can influence investments in the greening of maritime transport.

Since IMO regulations do not specifically consider ship emissions in ports, regulations at the regional level (EU Sulphur Directive, California CARB) and industry (voluntary) initiatives have taken over the role of addressing shipping emissions in ports and particularly at berth. It should be noted that these two regulatory attempts have two very different approaches. The EU Sulphur Directive imposes an emissions limit at berth while not imposing any technical solution to reduce them. Meanwhile, the California regulation has favoured the connection of vessels to grid-based shore power and only, in some cases, allows other (approved) alternative emission reduction measures.

The Marine Environment Protection Committee (MEPC, 2011), a committee of the IMO, did make amendments to the MARPOL 73/78. From 1 January 2013, the Energy-Efficient Design Index (EEDI) and the Ship Energy Efficient Management Plan (SEEMP) became mandatory for all vessels over 400 gross tonnes. These systems attempt to further enhance the reduction of greenhouse gas emissions.

The EEDI is a benchmark on the energy efficiency set to reduce exhaust gas on newly-built vessels. It is a non-prescriptive measure that helps the industry decide which technologies should be installed on a specific ship design. When the emission of CO_2 is above this benchmark, the design of the vessel has to be changed.

The SEEMP is an operational measure that helps the shipping company improve the energy efficiency of its operations in existing vessels. The SEEMP shows how energy savings can be made in four steps: planning, implementation, monitoring and self-evaluation.

MEPC (2011) also discusses other possibilities of reducing greenhouse gas emissions, such as market-based mechanisms. These mechanisms put a price on greenhouse gas emissions, consequently giving economic incentives to the industry to invest in vessels and technologies with low emissions. The generated revenue can be used to limit climate change (IMO, 2011). These mechanisms could include:

- A levy on vessels that do not meet the EEDI standard;
- A levy on all greenhouse gas emissions coming from all types of vessels;

- A global emission trading system;
- A penalty on trade and development;
- A rebate mechanism for a market-based instrument for international shipping.

(IMO, 2010).

These are two new measures: the technical requirement to reduce carbon intensity, based on a new Energy Efficiency Existing Ship Index (EEXI), and the operational carbon intensity reduction requirements, based on a new operational carbon intensity indicator (CII). In a recent publication, Rutherford et al. (2020) concluded that the EEXI would only marginally reduce CO_2 from the 2030 fleet, but it would be more impactful if evaluated at higher engine loads.

With regards to GHG emissions from shipping, following the Paris Climate Agreement in 2015 in which shipping was not included, and under the pressure of the EU, the IMO adopted an initial Green House Gas (GHG) Strategy in April 2018. This GHG-Strategy sets out two objectives taking 2008 as a baseline year.

- The first target aims to reduce the average carbon intensity (CO_2 per tonne-mile) by at least 40% by 2030 while aiming for 70% by 2050.
- The second target aims to reduce total GHG emissions from shipping by at least 50% by 2050 and hopes for the phasing out of such emissions as soon as possible within this century.

The strategy and its targets will be reviewed in 2023, based on information gathered from its Data Collection System and from a fourth IMO GHG study undertaken in 2019.

The EU also laid out general decarbonisation goals with a target reduction of GHG emissions of 80% below 1990 levels by 2050 and milestones of 40% cuts by 2030 and 60% by 2040. Since all sectors are expected to contribute, the EU has put forward the following measures:

- The EU 'MRV' regulation
- The EU ETS Directive: The Emission Trading Scheme (ETS)

It can be expected that if a shipowner is forced to take measures to fulfil new criteria, they will opt for the solutions that are the least costly. There are three reasons why it could be argued that investing in new technologies, to reduce the EEXI could be problematic due to too much uncertainty:

- The effectiveness of the new technology is unknown or not yet proven;
- The actual fuel consumption of a ship is related to the total propulsion system, including external effects. Therefore, the technologies' effectiveness depends not only on the total propulsion system but also on external effects;
- The high volatility in the bunker fuel price and the unknown development of the bunker price make investments in new technologies more risky.

Solutions for shipping and the role of ports

Driven by the EU Directive 2014/94/EU on the deployment of alternative fuels infrastructure, EU ports are making substantial investment efforts to develop Liquefied Natural Gas (LNG) bunkering facilities. In addition, several EU ports (a.o. Gothenburg, Hamburg, Bremen, Rotterdam and Barcelona) promote the use of LNG through important rebates in the port dues charged to ships.

The carbon intensity of fuels needs to be assessed from well to tank in accordance with standards based on life cycle assessment. This will enable biofuels and synthetic fuels to be accounted for as carbon-neutral while preventing the use of zero-carbon fuels made by carbon-intensive processes (e.g., hydrogen produced from natural gas) (DNV, 2020). Key aspects to study are the potential to re-use LNG infrastructure for biogas and requirements for the supply of other well-to-propeller zero-carbon fuels.

One of the measures adopted by ports to reduce local air emissions from ships in ports is the provision of Onshore Power Supply (OPS) technologies, also called Cold Ironing or Alternative power supply. Vessels equipped with OPS can turn off their auxiliary engines and replace power generated onboard the ship with electricity generated onshore. The European Alternative Fuels Infrastructure Directive sets out that OPS shall be installed as a priority in ports of the TEN-T Core Network, and in other ports, by the end of 2025 unless there is no demand costs are disproportionate to the benefits, including environmental benefits.

However, electricity produced from the combustion of marine fuel on board ships is tax-exempt. But, when ships at berth are plugging into the shore-side electricity system, they have to pay taxes applied to electricity. OPS electricity can be tax-exempted for a limited period as laid down in Article 19 of Directive 2003/96 (Energy Taxation Directive). Since 2011, Sweden, Germany and Denmark have been provided with a permit to temporarily apply a reduced rate of taxation to shore-side electricity for ships. Recently, other countries, such as Spain, have joined the exemption. However, the reduction is often insufficient. The EU port sector is therefore calling for a permanent EU-wide tax exemption for the use of shore-side electricity under the Energy Taxation Directive.

Likewise, the EC should explore the impact of marine battery technology in ships (vessels' lithium batteries / battery-powered / electrified vessels) on OPS solutions. In hybrid vessels, batteries are charged at sea using the vessel's main engines and used while at berth to reduce emissions in the port. For more extended port stays, batteries may be charged using shore-side power. To date, only a small number of battery-powered vessels are in operation, but several initiatives are underway to push those figures higher.

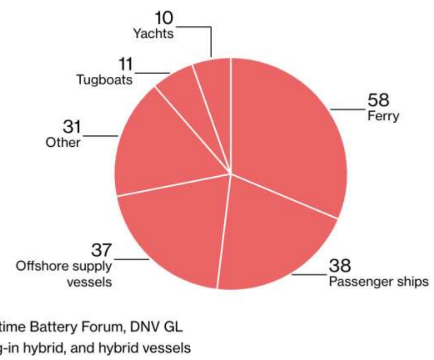

Figure 3. Battery-powered vessels either in operation or under construction around the world (2018)

OECD/ITF (2018) analysed the existing port incentives schemes as drivers of change in the greening of maritime transport with the following conclusions:

- Port incentives should have a more mandatory character and be harmonised to some extent in terms of green ships definitions to allow shipping companies to benefit from them;
- A more robust application of the polluter pays principle is needed, in line with the principles of EU environmental law;
- Efforts should be made to improve the measurement and assessment of the impact of port incentive schemes on shipping emissions.

Greening port operations

While a lot of attention usually goes to ships in the greening debate on maritime supply chains, ports' operations should also be considered when talking about port greening (Vanelslander and Sys, 2020). Growing port activities themselves come with an environmental burden that needs to be mitigated through a more sustainable and efficient operational model.

The World Ports Sustainability Program (WPSP) of the International Association of Ports and Harbours (IAPH) is an international initiative of eleven leading ports (Antwerp, Barcelona, Gothenburg, Hamburg, Le Havre, Long Beach, Los Angeles, New York & New Jersey, Rotterdam, Vancouver and Yokohama) that are working on plans to reduce CO_2 emissions from shipping and ports and improve air quality. Examples of initiatives taken by ports listed under the initiative involve:

- upgrade existing environmental sensors set with new sensors;
- develop a Port Environmental Performance IT platform that will receive real-time data from the sensor networks and existing operating systems in each port (i.e., PCS);
- decrease port traffic congestion and reduce CO_2 emissions from trucks;
- optimise vessel calls before and after port closure due to bad meteorological conditions;
- predict air quality and noise levels and generate notifications to government institutions when certain emission levels will be exceeded;

- predict how ship-to-shore crane productivity will be affected by waves, currents and wind and sending warnings 48 hours in advance to vessels calling;
- inform shippers about the real emissions generated by their shipments in door-to-door transport chains.

Conclusions

Several adverse environmental effects, as well as strategies and policies to tackle them, have been pointed out in the previous sections. Following the 2019 Green Deal Strategy of the European Commission, it is important to have an overview of strategies and practices pursuing economic growth paired with green objectives and to aid in knowledge sharing and identification of the tools in pursuing similar objectives by other ports and authorities and adjusting them to their specificities.

While there are regulatory recommendations at the global level, implementations at the EU country level are uneven and still slow. The multitude of stakeholders involved in reducing emissions from ships and the maritime sector's international scale make common or similar regulation at the European level difficult. Short-term challenges should focus on extending technological advances in fuels and port energy supply facilities to the maritime and port sector, respectively.

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