DEPARTMENT OF INTERNATIONAL AND EUROPEAN ECONOMIC STUDIES

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

New Challenges and Opportunities for Sustainable Ports: The Deep Demonstration in Maritime Hubs project

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Working Paper Series

20-26

May 2020

Chapter 11

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Abstract

Environmental challenges related to ports are twofold, namely the effects of maritime transport on the environment (e.g. pollution, CO2 emissions) and conversely the environmental impact on maritime transport e.g. Climatic Variability and Change. This chapter[6] presents an overview of main challenges faced today, to engage port proactively take the responsibility of providing reward schemes or green certificates to complied ships, and to identify key indicators in measuring GHG emissions. European Union has put into force a number of Directives and Regulations aiming to incentivise port and shipping companies to commit to comply with environmental standards. The IMO 2020 regulation, bringing the sulphur cap in fuel oil for ships down from 3.50 per cent to 0.50 per cent, is expected to bring significant benefits for human health and the environment, while the European Green Deal, the most ambitious action plan of European Union, aims at increasing the EU's greenhouse gas emission reductions target for 2030 to at least 50% compared with 1990 levels, creating the most ambitious package of measures, accompanied by an initial roadmap of key policies in cutting-edge research and innovation, in green technologies and sustainable solutions. Among them, Deep Demonstrations by EIT Climate-KIC using systems innovation approach aim at the decarbonisation of the European ports and the sustainable transformation of their key elements.

Key words: Sustainable ports, European Green Deal, Maritime transport, ports regulation, Deep Demonstration, Environmental policy

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[6] This work has received funding from the European Union's European Institute of Innovation and Technology under grant agreement N° 201166.

11.1 Introduction

Sea ports are major hubs of economic activity which may also involve severe environmental pollution in coastal urban areas. The port industry along with the shipping industry constitutes a key node in the international supply chain taking into consideration that over 80% of volume (70% of value) of world's merchandise trade is carried by sea (port to port). Due to increasing global trade, transport of goods through ports has been steadily increasing and will likely continue to increase in the future. United Nations Conference on Trade and Development is projecting an annual average growth rate of 3,4 per cent for the Maritime Trade the period 2019-2024 (UNCTAD 2019).

Ports and Shipping are intrinsically linked – as such, efforts to reduce maritime emissions need to extend beyond seagoing ships alone. IMO's MARPOL Annex VI (2010) regulations on air pollution and energy efficiency are aimed at ships; however, it is clear that in order for port emissions to be reduced, emissions from all port-related emission sources need to be addressed.

Environmental challenges relating to ports are twofold, namely the effects of maritime transport on the environment (e.g. pollution, CO2 emissions) and conversely the environmental impact on maritime transport (e.g. Climatic Variability and Change, (CV&C)) (Asariotis, Benamara & Mohos-Naray, 2017). In this regard, it is important to address the global challenges effectively, in the light of the Paris Agreement and the 2030 UN Sustainable Development Agenda. Reducing the sources of GH emissions and of marine pollution emanating from the port industry is of growing importance and source of anxiety for port authorities, policy makers, port users and the local communities (Acciaro, Ghiara & Cusano, 2014).

11.2 Ports needs towards environmental sustainability

This analysis focuses only on the environmental dimension of port sustainability although the port sustainability literature engages in the social and the economic aspect as well (Özispa & Arabelen, 2018). As environmental concerns over managing seaports are gaining utmost importance, evaluating the greenness of the port draws a serious academic and research attention. A set of indicators, both qualitative as well as quantitative, visualizing the environmental sustainability perspective has been identified under several scientific studies (Puig, Wooldridge & Darbra, 2014). Indicators which formulate the port's environmental sustainability constitute inter alia, waste management and handling, ballast water and water conservation and quality, air quality and reduction of emissions, noise control, energy efficiency and transition to cleaner energy.

As the shipping industry and international trade increase, ports are improving maritime infrastructure and enhancing port facilities with smarter, more intelligent designs with the help of technology. By going digital, connectivity and automation may reduce environmental footprints of the port industry along with intelligent transport systems, which have a significant potential to reduce CO2 emissions. Environmental reporting is also becoming increasingly important for ports in the face of growing environmental concerns and stakeholder pressure from market players, public bodies and social interest groups.

Evaluating air pollution impacts of ports requires consideration of numerous sources, including marine vessels, trucks, locomotives, and off-road equipment used for moving cargo. The air quality impacts of ports are significant, with particularly large emissions of diesel exhaust, particulate matter, and nitrogen oxides. Approaches to mitigation encompass a range of possibilities from currently available, low-cost

approaches, to more significant investments for cleaner air, such as restrictions on truck idling and the use of low-sulfur diesel fuel; the latter includes shore-side power for docked ships, and alternative fuels (Bailey & Solomon, 2004).

The IMO (2020) regulation, bringing the sulphur cap in fuel oil for ships down from 3.50 per cent to 0.50 per cent, is expected to bring significant benefits for human health and the environment. Enforcement, compliance with and monitoring of the new sulphur limit is the responsibility of States parties, both in their capacity as Flag States or Port States, to the International Convention for the Prevention of Pollution from Ships (MARPOL 1973), as modified by the Protocol of 1978 (MARPOL 73/78), Annex VI. Ships found to be in non-compliance can be detained by Port State control, and/or sanctions may be imposed for violations. Furthermore, the additional amendment to MARPOL 73/78 which enters into force on 1 March 2020, prohibits not only the use, but also the carriage of non-compliant fuel oil for combustion purposes for propulsion or operation on board a ship, unless it is fitted with a scrubber, which is an exhaust-gas cleaning system.

A variety of further measures are suggested towards the reduction of port emissions such as: introducing differentiated port dues, providing onshore power supply/ 'cold ironing', switching to low-sulphur fuels at berth and establishing speed limits in ports. In addition, the improvement of the exchange of information between ports and ships so that ships are able to sail at optimal speed (virtual arrival) is of great importance. Another potential measure is giving preferential treatment to harbour crafts with engines that meet stringent emissions standards while on the other hand, strengthening port State control inspection regimes for visiting ships, relating to compliance with MARPOL, Annex VI. Finally the designation of additional emission-control areas, leading to stricter environmental emission standards enforced at certain ports (ships going through them should use fuel with a sulphur content lower than 0.10 per cent (below the 0.5 per cent limit applicable on 1 January 2020) could make a significant difference (UNCTAD, 2019).

11.3 Systems Innovations Approach to Engage Stakeholders in Co-designing and Implementing

Accordingly, ports are increasingly expected to align their performance with sustainability expectations, namely, to deliver optimum economic and social gains while causing minimum environmental damage. As international trade and cargo volumes continue to grow, ports around the globe are looking to new technologies to help manage resources in a more sustainable and cost-effective manner through digitalization.

In view of the differences among ports and the changing nature of the environmental challenges that ports face, the establishment of an environmental management system is considered of utmost importance. A systematic approach to environmental management system enables the continuous identification of an individual port’s priorities while it introduces a functional organisational structure that sets respective targets, implements measures, monitors impact, evaluates, reviews and takes corrective actions when and where necessary. In this way ports can achieve and demonstrate continuous environmental improvement towards sustainability.

When it comes to the systems innovation, envisioning the desired future and learning from that becomes necessary. Visioning and backcasting are two pillars of the approach and should be done under a participatory approach. Since stakeholders have radically different world views and different frames for understanding the problem, you should incorporate their perspectives, even if they are wildly different to your own. Because of the different stakeholders’ perspectives, they all have their own priorities and

agendas. Involving them in the backcasting process will allow you to draw more than one plan from the same process. In complex and wicked problems, as sustainability is, the problem definition might come to focus after adopting a future vision. In such cases, the vision is the seed for the challenge and not a consequence of it. Visioning should be a participatory tool in which a large diversity of stakeholders ensures a richer and broader vision.

The adoption of new technologies in conjunction to the system innovation approach could prevent reaching the point of an environmental crisis in the port. This could be achieved through systematic and formal training of special scientists regarding the alternatives towards environmental sustainability, working closely with the practitioners to familiarize themselves with new technologies of controlling emissions considering localities and idiosyncrasies, explore onshore power supply (e.g. cold ironing) and consider it as an asset to be managed, better design of pricing policies based on meeting International environmental standards and exploit the opportunities renewable energy and energy communities as a primer source of port's energy.

Therefore, inviting all the interested parties to co-design and implement a commonly accepted solution adds value to the initiative as all of them work towards achieving the same goal. Such being the case a mix of social and economic policy solutions is needed. All in all, the ecosystem services approach helps in the direction of supporting the agreed solution without.

11.4 Deep Demonstrations for Zero-Net Emissions

Ports are places where multiple systems collide (shipping, energy, waste, tourism and other transport). Ports can either be emissions hotspots or hubs able to drive enormous change. In a phased way, EIT Climate-KIC[7] works with a small cohort of high-ambition port authorities in Valencia (Spain) and Piraeus (Greece) and Cyprus Ministry of Shipping to demonstrate how ambitious maritime hubs can be catalysts for reversing the fast-growing emissions from international shipping and trade using Systems Innovation approach.

Deep Demonstrations funded by EIT Climate-KIC start with a demand-led approach, working with organisations willing to take on the responsibility of acting as 'problem owners' – in Greece Piraeus Port Authority - committed to zero-net emissions, resilient futures (EIT Climate-KIC, 2020). Deep demonstrations (Figure 1) progress in tightly designed, iterative phases - steps of rolling out systems innovation-as-a-service, aiming at the identification of the key actors to be involved, current status, vision, innovation needs, sustainable financial planning and ultimately at the alignment of all actors able to drive systems transition to a low-carbon emissions future. Deep Demonstration is a circular approach in innovation implementation with final goal the holistic change of the port to Sustainability.

Deep Demonstration methodology is composed of four phases (Intent, Frame, Portfolio and Intelligence). Intent phase aims at analysing the current status of the port and identify key stakeholders creating a consortium of key players able to drive the highly needed change and co-create a vision. This phase intends to develop a frame of reference for approaching innovation deliberately and systemically

[7] EIT Climate-KIC is a European knowledge and innovation community, working towards a prosperous, inclusive, climate-resilient society founded on a circular, zero-carbon economy. The EIT Climate-KIC is part of the European Institute of Innovation and Technology (EIT) and the EIT Community. The EIT is a body of the European Union and a global innovation leader, delivering world class solutions to societal problems. In particular, we aim to catalyze the rapid innovation needed across sectors by convening the brightest minds to tackle challenges, empowering leaders through capacity building, and seed funding the most promising climate-positive businesses.

through a portfolio approach and sense-making in order to manage uncertainty and generate options and intelligence from innovation experience. The Frame phase identifies and addresses ports' needs, cause and effect relationships and opportunities aiming at inviting innovation and research to meet these needs. The focus of the next phase, the Portfolio phase is to raise awareness on the major challenges of the port and encourage diversity to ensure a spread of learning and connectivity and to enable the identification of multiplier effects and integrated solutions. The Intelligence phase is the ultimate objective of the Deep Demonstrations process. Intelligence is the outcome of sense-making and analytics drawing on innovation experience and learning from multiple different experiments deploying diverse leverage points.

The combination of all these phases in a circular manner can support challenge owners change mindset and action plan through understanding the interdependences among different actors and the common vision they can develop, which is beneficial delivering optimum economic, social and environmental gains.

Figure 1 - Deep Demonstration methodology (source: EIT Climate-KIC (2020))

11.5 Ports role in reducing the global carbon footprint

Environmental sustainability in the port sector mainly relates to environmental performance and management. Environmental considerations may be different for each port, depending on the specific location and the characteristics of the port area. Seaport environmental management progressed over the last decades from a 'point focused' seafront-based exercise to an integrated seaport area management concept. There is potential for further integration as seaports proactively act as facilitators of procedures and of communication between the different parties involved in the logistic chain. The concept of ports as facilitators refers to the contribution that ports can make in assisting the whole port community (including partners in the logistic chain) to deliver compliance with legislation, prevention of pollution, reduction and mitigation of environmental impacts, sustainable development and evidence of

satisfactory performance. This resulted in the development of the port practice to include the sustainability performance, as part of the annual corporate social responsibility and financial report.

Greenhouse gas emissions from shipping currently represent around 2.6% of total global emissions and without reduction measures, this share could more than triple by 2050. The International Maritime Organization (IMO) has set a target of reducing shipping CO2 emissions from the shipping sector by 'at least' 50% by 2050 compared to 2008 levels. To achieve this, stringent measures now need to be put into place.

According to the analysis report published by the International Transport Forum (ITF) in 2018, ports play a significant role in reducing the global carbon footprint of maritime shipping and consequently portside measures can significantly add to the environmental performance of shipping and the decarbonisation of maritime transport. Currently 28 of the 100 world's largest ports (in terms of total cargo volume handled) offer incentives for environmentally friendly ships: Some US ports offer fee reductions for ships reducing speed when approaching the port. The Panama Canal Authority provides priority slot allocation to greener ships. Spain includes environmental incentives in the tender and license criteria for the towage services provided in ports. Shanghai has an emission-trading scheme that includes ports and domestic shipping. However, green incentives typically apply to the 5% of the ships calling at a port with an incentive scheme. Only five ports use CO2 emissions as a substantial criterion for incentives. The report expands on port-based incentives for low-emission ships. It links port-based incentives to actual greenhouse gas emissions, moving to a more harmonised application of green port fees.

Notwithstanding the dearth of data, it is clear that the impact of port-based incentives on global shipping emissions is marginal. Currently only few ports use indices in which GHG emissions provide a substantial part of the index criteria. Yet, ports clearly play a hugely important role in helping the shipping sector to manage the transition to clean shipping. Port-based incentives for GHG emission mitigation could provide an important supporting role. The first lesson learned is therefore that ports are stakeholders in this context, and that they are taking actions - to both incentivize cleaner ships and to increase the efficiency of their operations, which can also have an effect on shipping emissions. Furthermore, the existing port-based measures establish that market interventions are needed to reward clean performance. The fact that financial incentives have been chosen implies there is support for flexible measures to drive behavioural change. However, more emphasis is needed on monitoring, reporting and verification of the impacts of these measures. More could also be done to enshrine the 'polluter pays' principle. Higher rates of differentiation between vessels based on their environmental performance could drive more and faster change. It is possible within the policies to differentiate fees according to type of vessel enabling the economic activities that can afford to pay to take more of the responsibility for acting.

A project on the Environmental Impacts of International Shipping and the role of ports, that took place under the aegis of OECD, showed that while it is difficult to identify 'best practices' for all the environmental impacts that port activities generate, the introduction of shore-side electricity supply ('cold ironing') is identified as a specific measure that would have the advantage of reducing several negative impacts simultaneously, such as SO2, NOx and particulates emissions, noise and, possibly, CO2 emissions. In states where electricity generation is covered by a 'cap-and-trade' system for CO2 emissions (e.g. in some EU states), the latter would be the case, regardless of how the electricity used to supply the ships is produced, as long as the 'cap' of the trading system remains unchanged. However, an important obstacle to a broader use of shore-side electricity is that electricity systems vary between

states, both in terms of voltage, frequency and pricing. And it is not enough to make shore-side electricity available, unless ships are obliged to use it, they have few incentives to do so.

11.5.1 Environmental Ship Index (ESI)

On 12 May 2017 the International Association of Ports and Harbours decided to set up a World Ports Sustainability Program (WPSP) guided by the 17 UN SDGs in order to enhance and coordinate future sustainability efforts of ports worldwide and foster international cooperation with partners in the supply chain. The WPSP aims to demonstrate global leadership of ports in contributing to the Sustainable Development Goals of the United Nations. The cooperation between port professionals, academic researchers and specialist organisations has proven to be a potent mix in terms of delivering a functional framework of cost-effective solutions developed to implement policies and produce continuous improvement of the port environment.

The WPSP builds on the World Ports Climate Initiative that IAPH started in 2008 and extends it to other areas of sustainable development. Building on the output of the World Ports Climate Initiative, port community actors can collaborate in refining and developing tools to facilitate reduction of CO2 emissions from shipping, port and landside operations. In addition, they can take initiatives to enable energy transition, improve air quality and stimulate circular economy. The American Association of Port Authorities (AAPA), the European Sea Ports Organisation (ESPO), the International Association of Cities and Ports (AIVP) and the World Association for Waterborne Transport Infrastructure (PIANC) signed up as strategic partners of the World Ports Sustainability Program.

One of the projects within WPSP is the Environmental Ship Index (ESI). The Environmental Ship Index (ESI) identifies seagoing ships that perform better in reducing air emissions than required by the current emission standards of the International Maritime Organization. The ESI evaluates the amount of nitrogen oxide (NOx) and sulphur oxide (SOx) that is emitted by a ship; it includes a reporting scheme on the greenhouse gas emission of the ship. The ESI is a perfect indicator of the environmental performance of ocean-going vessels and will assist in identifying cleaner ships in a general way. The index is intended to be used by ports to reward ships when they participate in the ESI in order to promote clean ships but can also be used by shippers and ship owners as their own promotional instrument. It should be noted that while the ESI database will provide a total score, the rewards can either be based on that total or on each of its constituent parts separately; for that purpose, those parts are appearing in the ship details. ESI is completely voluntary and WPSP hopes that the global port community will assume its role in improving the maritime and port environment taking into account the priorities of ports with regard to the environmental performance of ships that ports wish to promote.

11.5.2 Port Emissions Toolkits

Toolkits to tackle ship and port emissions have been developed under the GEF-UNDP-IMO Global Maritime Energy Efficiency Partnerships (GloMEEP) project in collaboration with its partners, the Institute of Marine Engineering, Science and Technology (IMarEST) and the International Association of Ports and Harbors (IAPH).

The Port Emissions Toolkit includes two guides addressing the impact of air emissions from ports on the local and global environment which are as follows:

Guide No.1: Assessment of port emissions: The guide serves as a resource guide for ports intending to develop or improve their air pollutant and/or GHG emissions assessments. It incorporates the latest

emission inventory methods and approaches. It recognizes that ships do not operate independently from shore-based entities in the maritime transportation system, and that port emission considerations must extend beyond the ships themselves to include all port-related emission sources including: seagoing vessels, domestic vessels, cargo handling equipment, heavy-duty vehicles, locomotives, and electrical grid.

Guide No.2: 'Development of port emissions reduction strategies' serves as a resource guide for ports intending to develop an emissions reduction strategy (ERS) for port-related emission sources. It describes the approaches and methods that can be used by ports to develop, evaluate, implement, and track voluntary emission control measures that go beyond regulatory requirements.

By utilizing these guides, national strategies can be developed which address emissions from the maritime sector as a whole – protecting public health and the environment while contributing to the fight against climate change.

11.6 EU policies on Sustainable Ports

The EU has already in place an extensive and comprehensive regulatory environmental framework with which the European Ports' Environmental Policies must be aligned, indicatively: the 'Birds Directive' (Directive 2009/147/EC on the conservation of wild birds), the Natura 2000 ecological network including all Special Protection Areas (Habitats Directive 92/43/EEC), Directive (EU) 2016/802 relating to a reduction in the sulphur content of certain liquid fuels, Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, Directive (EU) 2004/35 (2006) establishing a framework for the protection of soil, Directive (EU) 2019/883 on port reception facilities for the delivery of waste from ships, Directive (EU) 2014/94 on Alternative Fuels Infrastructure (the AFID), Directive 2003/96/EC on the taxation of energy products and electricity, Regulation (EC) No 1013/2006 on shipments of waste, Directive 2008/98/EC on Waste, Directive 2008/50/EC on ambient air quality and cleaner air for Europe, Regulation (EC) No 1221/2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS). The Trans-European Transport Network (TEN-T) policy based on Regulation (EU) No 1315/2013 aiming at sustainability through: development of all transport modes in a manner consistent with ensuring transport that is sustainable and economically efficient in the long term; its contribution to the objectives of low greenhouse gas emissions, low-carbon and clean transport, fuel security, reduction of external costs and environmental protection; promotion of low-carbon transport with the aim of achieving by 2050 a significant reduction in CO2 emissions, in line with the relevant Union CO2 reduction targets.

Furthermore, new stricter environmental protection measures are on the way with the introduction of the European Green Deal (European Commission, 2019). On the 11th of December 2019, the European Green Deal was communicated by the EU Commission, boosting a new strategy on implementing the United Nation's 2030 Agenda and the sustainable development goals, thereby increasing the EU's greenhouse gas emission reductions target for 2030 to at least 50% and towards 55% compared with 1990 levels. Becoming the world's first climate-neutral continent by 2050 is the most ambitious package of measures, accompanied with an initial roadmap of key policies ranging from ambitiously cutting emissions to investing in cutting-edge research and innovation, in green technologies and sustainable solutions. The Green Deal seeks a 90% reduction in the transport emissions by 2050, while it boosts the supply of sustainable alternative transport fuels - biofuels and hydrogen – which will be promoted in aviation, shipping and road transport. In addition, the European Green Deal purports to extend emissions trading to the maritime sector as well.

The overarching objective of the European Green Deal, aiming to reach net-zero greenhouse gas emissions by 2050, signifies an update of the EU's climate ambition for 2030, with a 50-55% cut in greenhouse gas emissions to replace the current 40% objective. To deliver these additional greenhouse gas emissions reductions, all relevant climate-related policies will be reviewed and potentially revised. To address these interlinked challenges, a zero-pollution action plan for air, water and soil will also be adopted. The 55% figure will be subject to a cost-benefit analysis of every EU law and regulation in order to align them with the new climate goals. Further decarbonizing the energy system is critical to reach climate objectives in 2030 and 2050. The production and use of energy across economic sectors account for more than 75% of the EU's greenhouse gas emissions. Energy efficiency must be prioritized. A power sector must be developed that is based largely on renewable sources, complemented by the rapid phasing out of coal and decarbonizing gas. At the same time, the EU's energy supply needs to be secure and affordable for consumers and businesses. The Renewable Energy Directive and the Energy Efficiency Directive as well as the Emissions Trading Directive will be revised accordingly. Most importantly the circular economy, including new waste and recycling laws is erected as ' utmost priority' of the European Green Deal in the EU's effort to achieve net-zero carbon emissions by 2050.

Greening 'the port' means more than greening the transport side. All industry players in the port should have their agendas, goals and plans and the port managing body must support the industries in the port in their pathways to a more sustainable future. This requires support for large investments in the provision of clean energy, connectivity of energy infrastructure networks and green grids, as well as support for innovative technological projects in and between ports. In addition, ports can also attract new investments in clean energy and technology and become centres of excellence and innovation, instead of being just energy 'takers'. Thanks to the presence of industry and the proximity to large urban agglomeration they also constitute an ideal location to develop circular economy projects.

11.7 The European Sea Ports Organisation (ESPO)

11.7.1 The Green Guide

Published back in 2012 by ESPO, the 'Green Guide' towards excellence in port environmental management and sustainability' defines the sector's vision on environmental governance and establishes a structured approach that European ports subscribe to while tackling their environmental liabilities. European ports commit to work towards continuously improving their environmental performance through focused action under five principles; Exemplify, Enable, Encourage, Engage and Enforce. Overall, the ESPO Green Guide favors a bottom-up approach, in which port authorities are proactively taking responsibility and living up to the expectations of the community. It encourages ports to be responsible for their own initiatives, to benchmark their performance, and to deliver science-based evidence of achievements. The ESPO Green Guide specifically addresses five major environmental issues, namely; air quality, energy and climate, noise, waste management and water quality. The guide is the outcome of the common work of port environmental professionals around Europe under the umbrella of the sustainability committee of ESPO and is accompanied by a best practice database that promotes existing port projects. It defines a common vision of the port sector on environmental sustainability, promotes the efforts of European port authorities in the field of environmental management and demonstrates evidence of the progress achieved by the sector over time. The guide provides guidance to ports in establishing and developing further their environmental management programmes, highlights the main environmental challenges that ports face and demonstrates response options, developing a common approach towards responsible action, while respecting the diversity of ports, their competences and their abilities.

The European Sea Ports Organisation (ESPO) welcomed Europe's objective set out in the European Green Deal to become the world's first net zero emission area by 2050 and to reduce emissions by 50% towards 55% compared with 1990 levels by 2030. On the 19th of February 2020, ESPO published its Position Paper on the European Green Deal objectives in ports. ESPO recognizes the importance of LNG as a transition fuel and considers Onshore Power Supply (OPS) as an important pillar of the future energy landscape. Investments in those technologies should be further encouraged. LNG's role as a transition fuel should be recognised. LNG has been one of the compliant fuels for shipping to meet the 0.1% Sulphur cap in SECA areas (since 2015) and the overall 0.5% sulphur cap (effective as of 1 January 2020). Current LNG infrastructure may also be used for bio-LNG.

However, ESPO considers that there is still uncertainty, as to which clean fuels will be most suitable for each segment of shipping. ESPO therefore argues that any new legislation should retain the current flexibility for any clean fuels or technologies which provide equivalent solutions. New legislation should allow the uptake of a variety of clean fuels, rather than prescribing specific fuels for shipping.

A technology neutral approach is an absolute prerequisite to support innovation in different promising technologies. For ESPO, a goal-based approach with emission reduction standards accompanied by port roadmaps is the best way to ensure that Europe's greening objectives are achieved. An EU standard for the reduction of emissions at berths should initially address berths close to urban areas and should target specific segments of shipping such as cruise ships and ferries. The standard should be subsequently expanded to all segments of shipping taking into account progress on the development of clean technologies. Any technologies available to achieve the gradual emission reduction standards should be accelerated and encouraged. These technologies include shore-side electricity, hybrid solutions, hydrogen, ammonia or synthetic fuels. A goal-based approach would give clear guidance to the shipping sector on the objectives to be reached while providing necessary flexibility for shipping, energy suppliers and ports on the choice of technologies allowing them to choose the most effective solutions. While ESPO is supportive of a policy framework that encourages investments in OPS and takes away the barriers for using OPS, it must be assessed case-by-case against other green solutions and must be seen in the context of the rapidly evolving zero-emission propulsion technologies (including hydrogen and ammonia).

The EU legislative proposals should increase the pressure on the IMO to roll out meaningful measures by 2023. ESPO believes that any European proposals such as an Emission Trading Scheme (ETS), a levy or an innovation fund must be thoroughly examined in view of safeguarding the competitiveness of the EU port sector. In essence, a substantial part of the revenues from any market-based mechanism introduced must be used for port infrastructure investments and for supporting the use of clean fuel infrastructure. Environmentally differentiated port fees (incentive schemes) could be further adapted to the current challenges and encouraged. While streamlining between ports should be encouraged, the introduction, modalities of application and the level of potential environmental charges must remain a decision for each port managing body, taking into account the local situation and local environmental concerns and in accordance with the port's own roadmap.

11.7.2 EcoPorts Initiative and EcoPortsinSights Environmental Report

EcoPorts constitutes the main environmental initiative of the European port sector initiated in 1997 that has been fully integrated into the European Sea Ports Organisation (ESPO) since 2011. The founding principle of EcoPorts is to create a level playing field on environment through cooperation and sharing of knowledge between ports. EcoPorts provides two well-established tools to its members: the Self

Diagnosis Method (SDM) and the Port Environmental Review System (PERS, certificate assessed by Lloyds register). The SDM procedure takes place in three steps as follows:

- SDM checklist: The SDM is a well-established and widely adopted, time and cost efficient methodology for identifying environmental risk and establishing priorities for action and compliance. Aggregated and anonymised data provided by EcoPorts members are used to build and update the sector's benchmark of performance in environmental management. The SDM is a concise checklist against which port managers can self-assess the environmental management programme of the port in relation to the performance of both the sector and international standards. The SDM checklist addresses the fields of environmental policy - placing the focus on activities, aspects, objectives and targets-, management organisation and personnel, environmental training, communication, operational management, emergency planning, monitoring, auditing and review. Individual port responses are treated confidentially.
- SDM Comparison: comparison of the port's SDM score with the European average.
- SDM Review: receive expert's advice and personalised recommendations.

Developed by ports themselves, the Port Environmental Review System (PERS) has firmly established its reputation as the only port sector specific environmental management standard. The Port Environmental Review System (PERS) does not only incorporate the main general requirements of recognised environmental management standards (e.g. ISO 14001), but also takes into account the specificities of ports. PERS builds upon the policy recommendations of ESPO while its implementation is independently reviewed by Lloyd's Register. Both of the aforementioned tools fit ports of different sizes and at different stages in the development of their environmental priorities.

The following ESPO (2019) Environmental Report – EcoPortsinSights provides the latest trends of European sea ports concerning environmental issues. The data presented were obtained from 94 ESPO-member EU/EEA ports, which completed the online EcoPorts' Self-Diagnosis Method (SDM). A set of environmental indicators were selected from the SDM to assess the environmental performance of EU ports. The SDM tool is also part of the EcoPorts pathway towards achievement of the port sector's own environmental standards, the Eco Ports' PERS.

11.7.2.1 Environmental management indicators

Table 1 presents the results of a set of selected environmental management indicators that are included in the EcoPorts' Self Diagnosis Method (SDM) providing information about the management efforts that influence the environmental performance of a port and it includes the percentage of positive responses to these indicators for the year 2019 as well as for 2013, 2016, 2017 and 2018 in order to analyse the variations over time.

Over the last years, the existence of an inventory of relevant environmental legislation has been the indicator with the higher percentage of positive responses demonstrating the awareness of ports about the requirement to comply with legislation. The indicator on the existence of an Environmental Policy (95%) follows in the second position, evincing ports' environmental commitment.

The definition of objectives and targets as well as the existence of an inventory of Significant Environmental Aspects (SEA) are elements that are present in most of the ports (around 90%). These two indicators are the required first steps to start the implementation of any Environmental Management

System (EMS). Related to this, the indicator on the existence of a certified Environmental Management System, i.e. ISO 14001, EcoPorts' PERS or EMAS has increased by 17% since 2013. Consequently, ports are not only willing to implement an Environmental Management System but also commit to comply with the standards in order to be certified.

Table 1 – Percentage of positive responses to the environmental management indicators (source: ESPO (2019))

	Indicators	2013	2016	2017	2018	2019	CHANGE 2013–2019
A	Existence of a Certified Environmental Management System –EMS (ISO, EMAS, PERS)	54	70	70	73	71	+17%
B	Existence of an Environmental Policy	90	92	97	96	95	+5%
C	Environmental Policy makes reference to ESPO's guideline documents	38	34	35	36	38	–
D	Existence of an inventory of relevant environmental legislation	90	90	93	97	96	+6%
E	Existence of an inventory of Significant Environmental Aspects (SEA)	84	89	93	93	89	+5%
F	Definition of objectives and targets for environmental improvement	84	89	93	93	90	+6%
G	Existence of an environmental training programme for port employees	66	55	68	58	53	-13%
H	Existence of an environmental monitoring programme	79	82	89	89	82	+3%
I	Environmental responsibilities of key personnel are documented	71	85	86	86	85	+14%
J	Publicly available environmental report	62	66	68	68	65	+3%

Table 2 below demonstrates the number of ports that are certified with an internationally recognised environmental standard (Environmental Management System-EMS). Out of the 71% of ports with a certified EMS, more than half have opted for ISO 14001 (53.7%) and almost one third of them for EcoPorts' PERS (26.9% - Table 15), making ISO and PERS the most popular standards in the port sector. Additionally, there are ports certified with more than one standard such as ports with ISO and EcoPorts' PERS (10.4%), followed by ports with all three certificates (4.5%) and ports certified with ISO and EMAS (3%). Another 1.5% of the ports is only certified with EMAS. Since 2013, the number of ports that are certified with EMS has significantly increased, manifesting the willingness of the sector to contribute to greening the supply chain.

Importantly PERS, which is the EcoPorts' environmental standard and the only port sector-specific environmental standard available, is well recognised and preferred by the sector. EcoPorts' PERS is currently listed in a source of Good International Industry Practices (GIIP) in the World Bank Group Environmental, Health and Safety Guidelines for Ports, Harbors and Terminals and is recognised by several other port organisations and associations including the American Association of Port Authorities (AAPA), the Taiwan International Port Corporation (TIPC), the Port Management Association of West and Central Africa (PMAWCA) and the Arab Sea Ports Federation (ASPF).

Table 2 - Breakdown of the EMS Certificates (source: ESPO (2019))

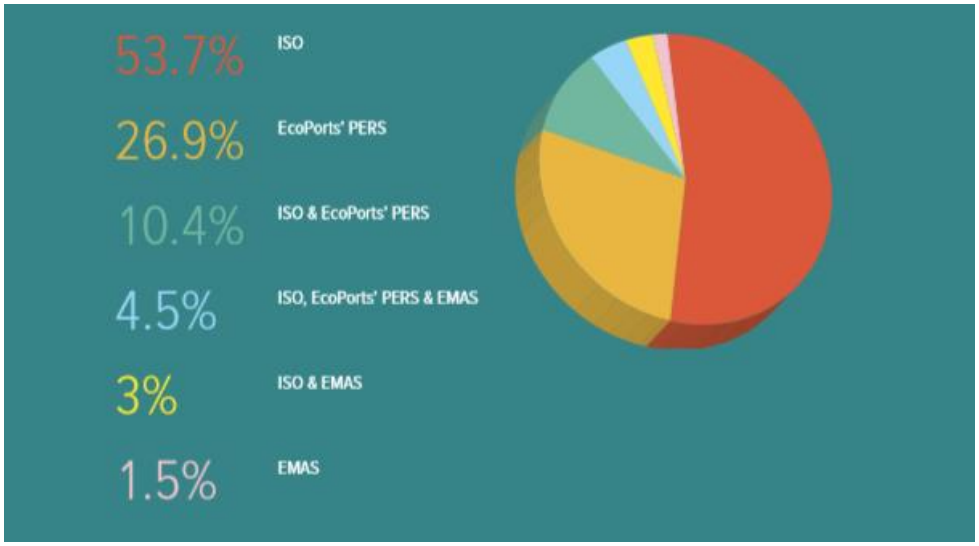


Table 3 presents the percentages of positive responses listed in descending order, based on the results obtained in 2019, with regard to a set of indicators related to the Environmental Monitoring Programs of European ports. These results provide information on the percentage of ports that monitor selected environmental issues

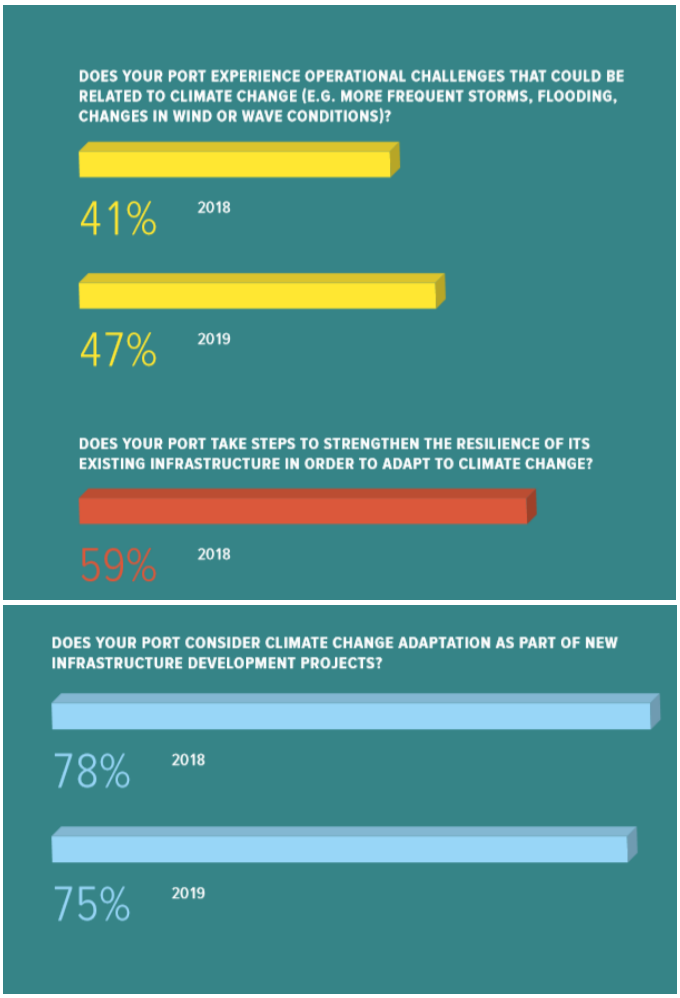
Table 3 - Percentage of positive responses to environmental monitoring indicators (source: ESPO (2019))

Indicators	2013	2016	2017	2018	2019	CHANGE 2013–2019
Waste	67	79	88	84	79	+12
Energy consumption	65	73	80	80	76	+11
Water quality	56	70	75	76	71	+15
Water consumption	58	62	71	72	68	+10
Air quality	52	65	69	67	62	+10
Noise	52	57	64	68	57	+5
Sediment quality	56	63	65	58	54	-2
Carbon Footprint	48	47	49	47	49	+1
Marine ecosystems	35	36	44	40	40	+5
Terrestrial habitats	38	30	37	38	37	-1
Soil quality	42	44	48	38	32	-10

Since 2016, the three environmental issues regularly monitored by ports have remained the same. Following this trend, in 2019 waste was the most monitored indicator (79%), followed by energy consumption (76%) and water quality (71%). Water quality has increased the most over the last six years (+15%). Energy consumption, air quality and water consumption are monitoring issues that have increased by around 10% since 2013. However, comparing the results with those of 2018, a reduction trend can be observed. Monitoring of soil quality has relatively decreased since 2017, though such monitoring is often associated with specific port development projects, Carbon footprint monitoring has slightly increased since 2018.

Three new indicators related to climate change have been recently included in the report. The results are shown in Table 4. From 2018 to 2019 there has been an increase in the number of ports reporting operational challenges due to climate change from 41 to 47%. The same trend is observed with the percentage of ports that are taking steps to strengthen the resilience of their existing infrastructure to adapt themselves to climate change (62%). Finally, most of the ports are taking climate change into consideration for the development of their future infrastructure projects (75%). This is clear evidence that climate change and making infrastructure climate-proof is becoming a high priority. The latter are requirements of EcoPorts' PERS, ISO 14001 and EMAS.

Table 4 - Percentage of positive responses to indicators related to climate change (source: ESPO (2019))



Moreover, the 2019 EcoPorts Report presents the current issues faced by the port sector as top 10 environmental priorities of the European ports' managing bodies in 2019. These data are important as they identify the high priority environmental issues in which port managing bodies are engaged and sets the framework for guidance and initiatives to be taken by ESPO.

The total set of Top 10 environmental priorities has been the same during 2017, 2018 and 2019. However, their relative positions have varied, with climate change rising from position ten to position three for instance. Air quality and energy consumption have occupied the first and second position since 2013 and 2016 respectively. These two environmental issues are of high relevance for European ports.

Air quality has been the first priority due to new legislation introduced over time. At the same time, air quality has increasingly been a priority for citizens of port cities and urban areas in general. Air quality

has become a key determinant of public acceptance of port and since more than 90% of European ports are urban ports, port managing bodies have this concern high on their agendas. In addition, EU regulations aiming to address air pollution include the implementation of the Sulphur Directive, the new National Emission Ceiling Directive, the introduction of the global 0.5% sulphur cap on marine fuels in 2020 and the IMO NOx Tier III requirements for vessels built from 1-1-2021 onwards operating in the North and the Baltic Seas (NECAs). Energy consumption has come second and has also remained in the same position. Improvement of efficiency, reduction of energy costs and the carbon footprint and climate change explain this stable position.

Climate change appeared in the Top 10 list for the first time in 2017 in the last position and it has risen up to the third position in 2019. This increasing trend shows that complying with climate regulations, reducing carbon emissions and making infrastructure climate-proof are high priorities for European ports. In particular, many ports host industrial clusters in the port area and aim to organise their transition to a low carbon economy and become carbon neutral. Ship waste follows in sixth position and garbage/port waste in the seventh position. The implementation of the new EU Directive on Port Reception Facilities for ship waste will be among the priorities of ports for the next few years. This priority is also related to waste being the most monitored indicator for more than five years (see Table 5 above). Moreover, it evinces ports' readiness to contribute to addressing marine litter which is a great concern for local communities and civil society. Port development (land related) and water quality have decreased in priority whilst dredging operations has remained in the same position. Dredging operations along with port development (land related) have been in the Top 10 rankings since 1996.

11.7.2.2. Green Services to Shipping

This section presents the share of EU ports that provide green services to shipping. It comprises three categories of indicators on the efforts made by the port managing bodies in order to contribute to greener shipping. These are the provision of onshore power supply (OPS), the provision of liquefied natural gas (LNG) bunkering facilities and environmentally differentiated port fees aiming to reward front-runners in the market and ships going beyond regulatory standards.

The EcoPorts SDM was updated in 2016 to enable the monitoring of the status and evolution of the green services that ports may choose to provide to their stakeholders. The results are benchmarked and presented in tables 5,6 and 7 and cover the period from 2016 until 2019. It should also be noted that the sample of the ports providing data for these three indicators was much smaller in the first year (2016) when the indicators were first introduced.

As shown in Table 5, more than half of the ports use OPS at their berths. In absolute figures, the ports offering OPS have increased from 32 (2016) to 50 ports (2019). Low voltage OPS, with some exceptions, mainly relate to inland and domestic vessels as well as auxiliary vessels (e.g. tugs and/or other port authority vessels). In principle, the high voltage OPS figure is more relevant for commercial seagoing vessels. The availability of high voltage OPS has increased by 10% since 2016. In 96% of the OPS equipped ports, electricity is provided through fixed installations and in 16% of them through mobile installations. It should be noted that some ports opt for both fixed and mobile installations. Interestingly, 29% of the ports seem to be planning to provide OPS in the next couple of years.

These results offer encouraging perspectives for the particular measure. However, the price differential between electricity and marine fuel and increased investment costs are the most significant barriers for the uptake of OPS. A recent evaluation paper of the European Commission on the Energy Taxation

Directive (ETD) identified the problematic situation on OPS and recognised that 'the ETD does not provide for EU-wide preferential tax treatment of shore-side electricity and as a result, shore-side electricity is disadvantaged compared to onboard generation'.

Currently, electricity produced from the combustion of marine fuel on board of ships is tax exempt. However, when ships at berth connect with the shoreside electricity system, they are obliged to pay the energy tax applied to electricity. A limited number of EU Member States such as Sweden, Germany, Denmark and Spain have applied for and have been provided a temporary permit by the EU to apply a reduced rate of taxation to shore-side electricity for ships. This tax exemption has a time limit though and is obtained through a long administrative process at EU level. Taking into consideration these challenges, the Energy Taxation Directive should be reviewed to provide a permanent EU-wide tax exemption for OPS in order to be on equal terms with electricity generated on-board of the vessel which enjoys a tax exemption.

ESPO surveyed ports that currently provide OPS and found that levies applied to the electricity price is another significant barrier. Interestingly, in some cases the price differential remains high even after a tax exemption is provided by the EU, due to other national levies applied to the electricity price.In addition, technical challenges such as the frequency difference and additional investments for connection with the grid often prevent the uptake of OPS. In principle, ocean-going ships are 60Hz equipped and ports need to invest in frequency and high voltage converters to address the frequency difference between the electricity from the grid (50Hz) and the ship's equipment (60 Hz). Electricity shortage at city or regional level may be an additional barrier.

However, it has to be noted that investments in shore-side electricity remain high-risk investments since there is no guarantee or requirements whatsoever for the use of the available installations once provided. EU funding or co-funding of these investments by the users could contribute to sharing this risk. Policy measures on the port side such as the mandate for OPS under the Alternative Fuels Infrastructure Directive should be accompanied by corresponding measures for the port users.

Table 5 - Onshore power supply (OPS) (source: ESPO (2019))

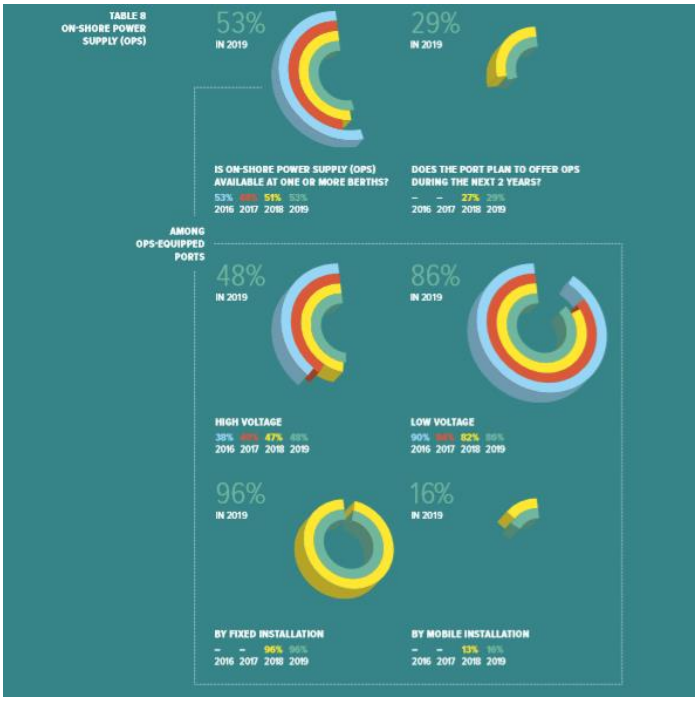
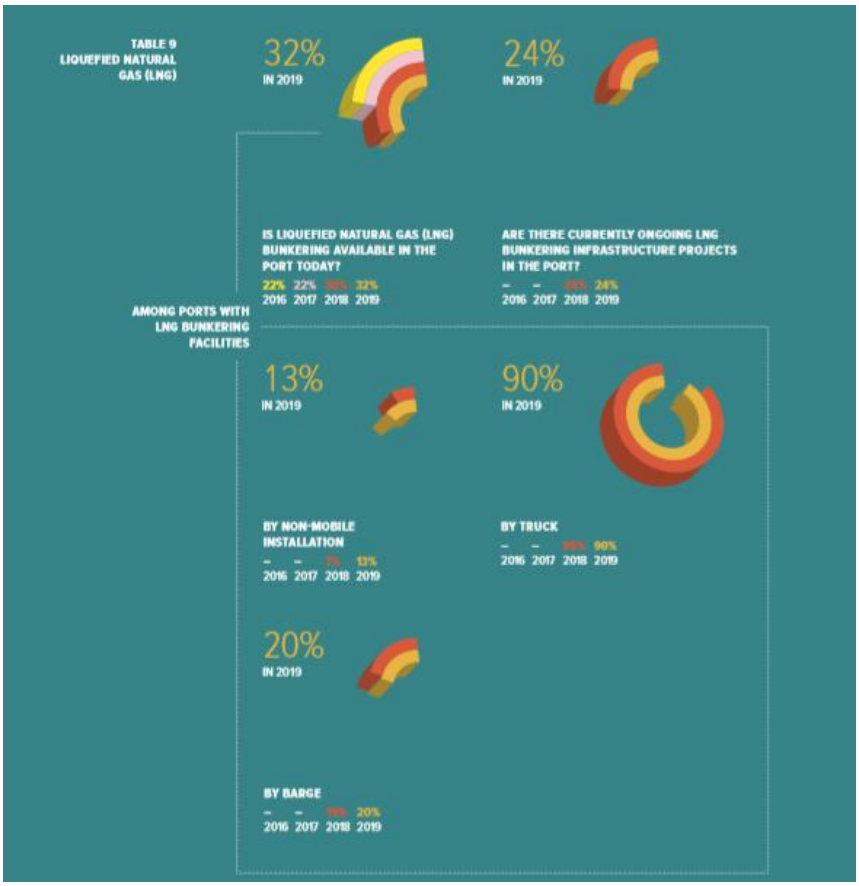


Table 6 shows that the availability of LNG bunkering in the port sector continues to increase. This is a positive sign for the implementation of the Alternative Fuels Infrastructure Directive with regard to the provision by TEN-T core network ports of LNG bunkering facilities by 2025. Currently, one third of the ports offer this service to ships. This represents an increase of 10% since 2016. Interestingly, LNG is mainly provided by trucks (90%) and by barges (20%). Only 13% of the ports that provide LNG bunkering facilities have opted for non-mobile installation. It should be noted that some ports opt for more than one type of bunkering facilities while 24% of the ports mentioned the existence of ongoing projects to install LNG bunkering. This indicator was only added in 2018, hence there is no data for the previous years.

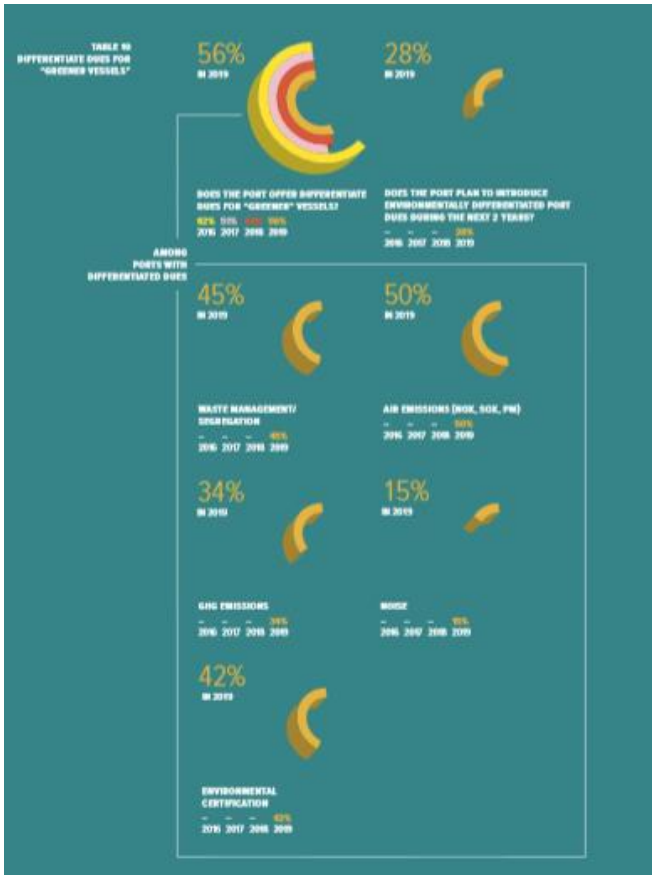
Table 6 - Liquefied Natural Gas (LNG) (source: ESPO (2019))



As indicated in Table 10, environmentally differentiated port fees for ships that go beyond regulatory standards are set up in 56% of the ports. ESPO has been promoting this type of initiatives in its Green Guide (2012). However, it should be noted that, in principle, port fees make up a small part of the total port costs for ships and even smaller part of the total cost of a ship's journey. Thus, they do not aim to change investment decisions of shipowners but rather to reward and enhance the market reputation of the front-runners contributing to the greening of the supply chain as a whole.

Evidently, half of the ports that provide green discounts aim to encourage the reduction of air emissions, 45% of them to encourage better waste management and another 34% to encourage the reduction of GHG emissions. Environmental certification of ships is rewarded by 42% of them. Furthermore, 28% of them are planning to introduce environmentally differentiated port dues over the next years.

Table 7 - Differentiated Fees for "Greener Vessels" (source: ESPO (2019))



11.8 Conclusions

European Union has put into force a number of Directives and Regulations aiming to incentivise port and shipping companies to commit to comply with environmental standards. The European Green Deal, the most ambitious action plan of European Union, aims at increasing the EU's greenhouse gas emission reductions target for 2030 to at least 50% compared with 1990 levels, creating the most ambitious package of measures, accompanied with an initial roadmap of key policies in cutting-edge research and innovation, in green technologies and sustainable solutions. Most of the EU ports are actively working to protect the environment with the aim of achieving sustainable development. There has been a positive evolution of most of the environmental indicators since 2013. In principle, EU ports continue to improve their environmental performance and to maintain or even further enhance the declared policies of compliance, environmental protection and sustainable development. While it is difficult to identify and implement at once 'best practices' for all the environmental impacts that port activities generate, positive steps towards sustainable development and management are increasingly taking place.

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