Athens University of Economics and Business
School of Economic Sciences
Department of International and European Economic Studies
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Sustainable Ports

Nikolaos Papakonstantinou

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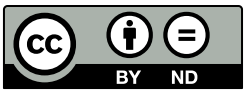

Examining Committee

Professor Phoebe Koundouri, Supervisor
Professor Georgios Economides
Professor Thomas Moutos

Abstract

The present dissertation explores the concept of port sustainability, technical solutions to improve the environmental footprint of ports and European Union policies towards the reduction of greenhouse gas emissions of the maritime sector. First, the dimensions and the respective targets that compose the concept of port sustainability are presented. Next, the implementation of the United Nations Sustainable Development Goals to ports according to the World Ports Sustainability Program is exhibited. Then, the seaside and hinterland aspects of port sustainability are examined. Afterwards, the applications of smart grids, circular economy, Systems Innovation Approach and Global Maritime Energy Efficiency Partnerships toolkits to ports are highlighted. Furthermore, key findings of the latest European Sea Ports Organisation Environmental Report are underlined. Moreover, European Union policies on sustainability and relative funding programmes are presented. Additionally, the European Union Emissions Trading System (EU ETS) is analysed, according to the latest report from the European Commission on the functioning of the European carbon market. Last, the possible effects of the inclusion of shipping in the EU ETS are explored.

Περίληψη

Η παρούσα εργασία διερευνά την έννοια της βιωσιμότητας των λιμανιών, τεχνικές λύσεις για τη βελτίωση του περιβαλλοντικού αποτυπώματος των λιμανιών και πολιτικές της Ευρωπαϊκής Ένωσης για τη μείωση των εκπομπών αερίων του θερμοκηπίου από τον ναυτιλιακό κλάδο. Αρχικά, παρουσιάζονται οι διαστάσεις και οι αντίστοιχοι στόχοι που αποτελούν την έννοια της βιωσιμότητας των λιμανιών. Έπειτα, εκτίθεται η εφαρμογή στα λιμάνια των Στόχων για τη Βιώσιμη Ανάπτυξη των Ηνωμένων Εθνών, σύμφωνα με το Παγκόσμιο Πρόγραμμα για τη Βιωσιμότητα των Λιμανιών. Μετά, εξετάζονται οι πλευρές της βιωσιμότητας των λιμανιών που σχετίζονται με τις θαλάσσιες και χερσαίες διαδρομές. Στη συνέχεια, τονίζονται οι εφαρμογές στα λιμάνια των έξυπνων δικτύων, της κυκλικής οικονομίας, της Συστημικής Προσέγγισης για την Καινοτομία και των εργαλείων της Παγκόσμιας Συνεργασίας για την Ενεργειακή Αποδοτικότητα στη Ναυτιλία. Επιπλέον, υπογραμμίζονται σημαντικά ευρήματα της τελευταίας περιβαλλοντικής έκθεσης του Ευρωπαϊκού Οργανισμού Λιμανιών. Επίσης, παρουσιάζονται πολιτικές της Ευρωπαϊκής Ένωσης για τη βιωσιμότητα και σχετικά χρηματοδοτικά προγράμματα. Επιπρόσθετα, αναλύεται το Σύστημα Εμπορίου Εκπομπών της Ευρωπαϊκής Ένωσης, σύμφωνα με την τελευταία έκθεση της Ευρωπαϊκής Επιτροπής για τη λειτουργία του. Τέλος, διερευνώνται οι πιθανές συνέπειες της ένταξης της ναυτιλίας σε αυτό.

Contents

1. Introduction

Sea ports and the shipping industry are crucial elements of the international supply chain, as over 80% of volume and 70% of value of world merchandise trade is carried by sea. United Nations Conference on Trade and Development projects an annual average growth rate of 3,4% for the maritime trade in the period 2019-2024 (UNCTAD, 2019).

Reducing the sources of greenhouse gas (GHG) emissions and of marine pollution emanating from ports is of growing importance and source of anxiety for port authorities, policy makers, port users and the local communities. It is important to address the global challenges regarding climate change effectively, in the light of the Paris Agreement and the 2030 UN Sustainable Development Agenda (Alexandropoulou et al., 2020).

Due to the increasing importance of the environmental performance of seaports, various indicators of port environmental sustainability have been included in scientific studies. These indicators cover issues such as 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 (Alexandropoulou et al., 2020).

Ports are enhancing their facilities using new smarter technologies. Digitalization, connectivity, automation and intelligent transport systems may reduce environmental footprints of the port industry. “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” (Alexandropoulou et al., 2020).

According to Alexandropoulou et al. (2020), there are numerous sources of air pollution in ports, such as marine vessels, trucks, locomotives, and off-road equipment used for moving cargo. Ports have significant negative impact on air quality, as they are responsible for large emissions of diesel exhaust, particulate matter, and nitrogen oxides. Mitigation measures include restrictions on truck idling, 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 important. Another potential measure is giving preferential treatment to harbour crafts with engines that meet stringent emissions standards while on the other hand, strengthening port 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 could make a significant difference (UNCTAD, 2019).

2. The dimensions of port sustainability

The concept of port sustainability comprises the following four dimensions with the respective targets, as these targets are illustrated by Molina Serrano et al. (2018):

1. the economic dimension, including "returns on investment, efficiency of the use of the port area, and provision of facilities for companies to maximize their performance" (Sislian et al., 2016)
    - increase turnover
    - increase concessional revenues
    - reduce debt risk
    - optimize and make profitable investments in port assets
2. the social dimension, including "direct contribution to employment in port companies and activities connecting to the port (indirect employment, the interaction and relationship between port and city, the contribution to knowledge development and education, and the liveability of the area surrounding the port)" (Sislian et al., 2016)
    - develop and modernize management systems of human resources
    - create a motivated and committed team
    - achieve sustained and active support from the surrounding community
3. the environmental dimension, including "noise pollution, air quality, dredging operations, and dredging disposal" (Sislian et al., 2016)
    - respect environment
    - minimize environmental impact of port activity
    - minimize environmental accidents
    - improve environmental management in port area
4. the institutional dimension, "understood as the definition of transparent and independent forms of governance with objective criteria, so that the institutions themselves formulate policies to ensure the development of the other three dimensions" (Laxe et al., 2017)
    - promote legal changes to modernize port development
    - reorganize market incorporating competition
    - develop port community to increase efficiency
    - institutionalize city-port relationship
    - expand operational management of port to the logistics chain

3. Sustainable Development Goals and ports

According to Verhoeven et al. (2020), the World Ports Sustainability Program (WPSP) was launched in 2018 to contribute to the sustainable development of world ports in line with the United Nations Sustainability Agenda and its seventeen Sustainable Development Goals (SDGs). The International Association of Ports and Harbors (IAPH) is leading the Program in partnership with some of the world's major port industry-related organizations. Considering the different roles, responsibilities and competences of ports and port community actors, the World Ports Sustainability Program considers the seventeen Sustainable Development Goals as a single and indivisible orientation for the sustainable development of ports. WPSP implements the UN SDGs along five themes with the respective focus areas:

1. Resilient infrastructure
    - IT-assisted optimization of port operations
    - IT-assisted optimization of the supply chain
    - Adaptation of infrastructure and ecosystems management for responding to climate change effects
    - Port planning and development to accommodate market demands and stakeholders' interests
2. Climate and energy
    - Initiatives to reduce GHG emissions from ships
    - Increasing the efficiency of port operations
    - Clean and renewable energy production, demonstration and implementation projects
    - Ecosystems management for carbon capture and adaptation to climate change
    - Circular economy
3. Community outreach and port city dialogue
    - Initiatives addressing environmental externalities
    - Initiatives addressing societal needs and demands
    - Protection of ecosystems and biodiversity and ecological recovery projects
    - Sustainable port management, planning and development
4. Safety and security
    - Health and safety emergency preparedness and response
    - Port area security
    - Cybersecurity
5. Governance and ethics
    - Corporate Social Responsibility initiatives
    - Sustainability policy, planning and reporting
    - Fostering innovation
    - Gender equality initiatives

4. The seaside and hinterland aspects

4.1. The seaside aspect

Different variables of port sustainability need to be included in the carrier network optimization. Network design, called Ocean's Carrier Network Problem (OCNP), "is the problem of choosing ports and combining them to create the infrastructure of shipping operation". The OCNP can be viewed as a transportation system for general cargo where each route "provides transportation links between ports and the ports allow for transshipment in between routes". Its target is to optimize the design of the networks to minimize cost, while satisfying service requirements and operational constraints. It may be designed to consider not only economic costs, but also environmental costs, reducing energy consumption and emissions (Sislian et al., 2016). Sislian et al. (2016) support that integrating port sustainability indicators, such as noise pollution, air quality, dredging operations and dredging disposal, in the carrier network optimization problem is crucial for ports.

4.2. The hinterland aspect

The hinterland transport aspect of the port activities contributes to a range of externalities, especially emissions and congestion. Reducing hinterland transport emissions is partly responsibility of ports. The three types of emissions over which ports have influence are emissions from the port activities, indirect emissions from generation of electricity used in the port activities, and emissions from transport to/from the port (including vessels and hinterland transport). The goals set by ports to improve the environmental performance of their hinterland transport are reduction of air pollution (all kinds, but as many of the strategies aim to reduce emissions from road vehicles whose engines already produce lower NO_x, SO_x and PM than maritime vessels, the reductions are likely to be mostly related to CO_2), reduction of noise from trucks, train locomotives and inland vessels, reduction of traffic flows on connecting infrastructure, transferring traffic from a congested mode (road) to a less congested mode (rail or inland waterway) and promoting the cooperation between two or more transport modes (e.g. information sharing, planning services) (Gonzalez Aregall et al., 2018).

Gonzalez Aregall et al. (2018) group the measures applied by ports into the following ten types, which are categorized by type of enforcement mechanism:

1. Supporting investment
    - Dedicated infrastructure: construction of specific facilities or connections
    - Improve knowledge: educational programmes for professionals
    - Technology: electronic devices and technology platforms
2. Market access control
    - Certification: granting of authorization or license from being recognised as environmentally friendly according to a specific framework
    - Concession contract: modal split obligation for the port terminal operator
    - Intermodal service development: taking an active role in developing and/or operating an intermodal service
3. Environmental standard regulation
    - Engine standards: incentive programmes related to sources of power or engine performance/emission standards

- Regulatory instrument: implementation of different regulations regarding certain emission levels/limits

4. Pricing
    - Port dues and subsidy funds: subsidies to promote sustainability
5. Monitoring and measuring
    - Monitoring programme: inventory and emissions control

As the above ten types of measures show, “there are many issues to deal with in order to achieve the goals, such as designing and investing in infrastructure, dealing with many stakeholders, applying regulations, taxes and subsidies, certification programmes and technology projects” (Gonzalez Aregall et al., 2018).

5. Electrical energy management and smart grids in ports

According to Yigit and Acarkan (2018), shore-side power (SSP) application is a solution to ensure interaction among ship, port, and smart grid (SG). The required electricity can be provided to ships by the grid system thanks to shore-side power connection. Using shore-side power instead of auxiliary engines (AEs) reduces consumption of marine fuel, cost of energy, exhaust emissions, noises, and vibrations from ships. Smart grid features, such as energy management, two-way energy flow and two-way information transfer, can offer significant benefits for ship and port interactions. Ships will become more active participants when they are at the ports using appliance, such as smart devices, smart meters, and management systems. The ships produce electrical energy from renewable energy sources (RES) and store excess energy with energy storage systems (ESS). They connect to the smart grid through power connection interfaces (smart meters and shore connection box). Energy management systems perform the control of operations, optimize the power flows, collect the data from energy sources and grid, and provide the situational awareness. Ships connect to port-side energy management system to collect data from all the other elements of the smart grid. Ship-side management system gathers information, such as power generation, storage and consumption capacities of the ship, voltage and frequency characteristics of ship and port, unit electricity prices and emission factors from available energy sources, and marine fuel types by using sensors, smart devices, smart meters and data servers. Port-side management system collects data, such as power demand, voltage level and frequency characteristic from ship-side through a smart meter, and it defines the energy plan of the ship. Also, it checks the grid state, unit electricity prices and emission factors of grid thanks to the smart grid components. Then, defined algorithm in the ship energy management (SEM) system processes all the data collected from both sides. Thus, ship crew will choose the best energy source to meet the electrical energy need of a ship.

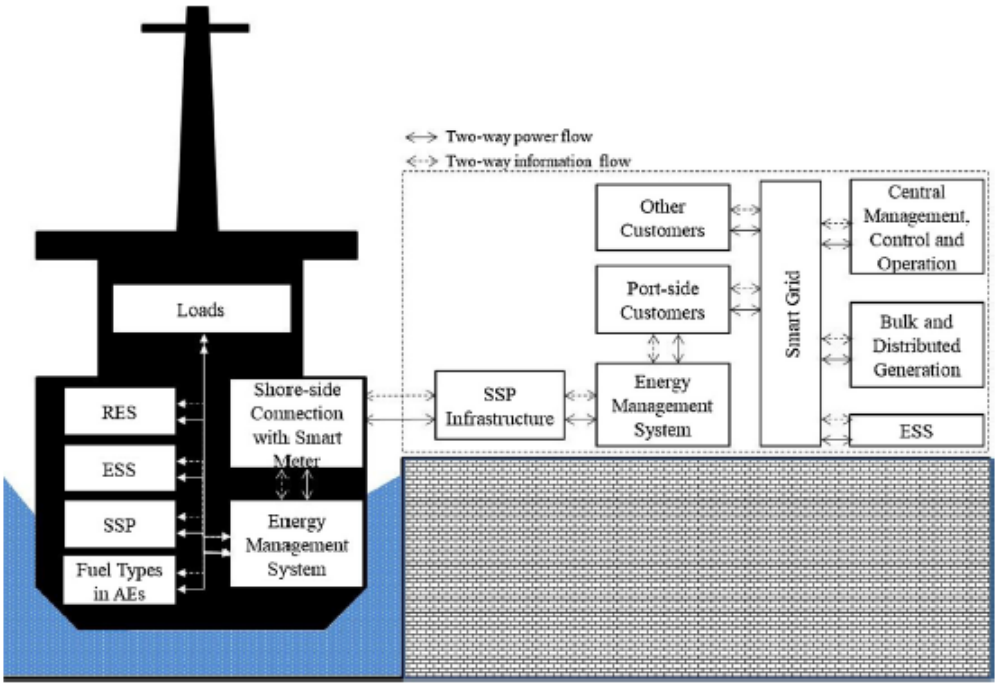

Figure 1: Future ship and port designs in the smart grid (Yigit & Acarkan, 2018)

6. Port sustainability and circular economy

In circular economy, waste is used as a resource in other parts of the value chain, closing material loops, through reduction, reuse and recycling. This requires reformation of production processes and consumption activities. These include changes in technology to cleaner production, better reuse and recycling of waste, prices that reflect full costs, social and organisational changes and economic and legal tools to promote circular economy. Switching to a circular economy approach needs the involvement of many different stakeholders (Carpenter et al., 2018).

According to Carpenter et al. (2018), some examples of moving towards circular economy are efficiency: reducing the use of energy and materials in production and use phases, substitution: reducing the use of materials that are hazardous or difficult to recycle in products and production processes, reducing: incentivising and supporting waste reduction and high-quality separation by consumers, industrial symbiosis: facilitating the clustering of activities to prevent by-products from becoming wastes, new business models: encouraging wider and better consumer choice through renting, lending or sharing services.

Carpenter et al. (2018) list the following challenges faced when moving towards circular economy: knowing the contribution of a particular economic activity to the environment, equipping the labour force with the relevant skills, raising awareness and increasing capacity in companies, modifying current linear economic systems, developing and investing in new business models, changing behaviour of consumers, changing relationships between consumer and producer liability regimes, pricing goods and services to reflect full costs, setting up policies that promote circular economy.

Circular economy in ports focusses on minimising the use of inputs and the elimination of waste and pollution, maximising the value created at each stage, managing flows of bio-based resources and recovery of flows of non-renewable resources in a closed loop, establishing mutually beneficial relationships between companies within each circular chain (Carpenter et al., 2018).

Circular economy within ports requires an “approach which combines economic, logistic and industrial activities with the cultural heritage of the port and the creativity of its wider community, resulting in a dynamic, complex and sustainable system” (Carpenter et al., 2018).

7. Systems Innovations Approach and Deep Demonstrations for zero-net emissions

7.1. Systems Innovations Approach

Ports need environmental management systems, in order to cope with the environmental challenges they face. "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" (Alexandropoulou et al., 2020).

The two pillars of systems innovation approach are visioning and backcasting. The various stakeholders have their own perspectives, views and priorities. A broad vision of the desired future is the beginning of a participatory backcasting process. Ports can achieve improvements towards sustainability through the application of new technologies and the implementation of systems innovation approach. Necessary measures are training of scientists on the alternatives towards environmental sustainability and familiarizing the practitioners with new technologies of controlling emissions, taking into consideration localities. "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" (Alexandropoulou et al., 2020).

7.2. Deep Demonstrations

EIT Climate-KIC (part of the European Institute of Innovation and Technology) works with authorities in Valencia (Spain) and Piraeus (Greece) and Cyprus Ministry of Shipping to demonstrate how 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 committed to zero-net emissions. Deep Demonstrations aim at the identification of the key actors to be involved, current status, vision, innovation needs, sustainable financial planning and the alignment of all actors able to drive systems transition to a low-carbon emissions future (Alexandropoulou et al., 2020).

Deep Demonstration methodology is composed of the following four phases (Alexandropoulou et al., 2020):
1. 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 through a portfolio approach and sense-making in order to manage uncertainty and generate options and intelligence from innovation experience.
2. Frame phase: identifies and addresses ports' needs, cause and effect relationships and opportunities aiming at inviting innovation and research to meet these needs.
3. Portfolio phase: raises awareness on the major challenges of the port and encourages diversity to ensure a spread of learning and connectivity and to enable the identification of multiplier effects and integrated solutions.

4. 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.

8. Port emissions toolkits

Toolkits to tackle ship and port emissions have been developed under the Global Environment Facility (GEF) – United Nations Development Program (UNDP) – International Maritime Organization (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) (Alexandropoulou et al., 2020).

The Port Emissions Toolkit includes the following two guides addressing the impact of air emissions from ports on the local and global environment (Alexandropoulou et al., 2020):
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.
2. Development of port emissions reduction strategies: the guide 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.

Based on these guides, strategies can be developed which reduce emissions from the maritime sector, protecting public health and the environment (Alexandropoulou et al., 2020).

9. The European Sea Ports Organisation Environmental Report

EcoPorts is an environmental initiative of the European Sea Ports Organisation (ESPO). Ecoports promotes cooperation and sharing of knowledge between ports. Ecoports provides two tools to its members: the Self-Diagnosis Method (SDM) and the Port Environmental Review System (PERS) (Alexandropoulou et al., 2020).

The Self-Diagnosis Method (SDM) includes the following three steps (Alexandropoulou et al., 2020):

- Checklist: port managers self-assess the environmental management programme of their ports. The checklist addresses the fields of environmental policy, management organisation and personnel, environmental training, communication, operational management, emergency planning, monitoring, auditing and review.
- Comparison: comparison of the score of each port with the European average.
- Review: advice and recommendations.

The Port Environmental Review System (PERS) incorporates the main general requirements of environmental management standards and the specificities of ports. The PERS is based on the policy recommendations of the European Sea Ports Organisation (ESPO) and its implementation is independently reviewed by Lloyd's Register (Alexandropoulou et al., 2020).

Next, selected data from the 2019 European Sea Ports Organisation (ESPO) Environmental Report is presented. The below presented data was obtained from 94 ESPO member EU/EEA ports' responses to the EcoPorts Self-Diagnosis Method (SDM) (Darbra et al., 2019).

9.1. Environmental indicators

The following table presents the percentage of positive responses to indicators that provide information about the management efforts that influence the environmental performance of ports.

Table 1: Percentage of positive responses to the environmental management indicators (Darbra et al., 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%

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 follows in the second position, showing port 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. These two indicators are the required first steps to start the implementation of any Environmental Management System (EMS). The indicator on the existence of a certified EMS has increased (Darbra et al., 2019).

The figure below shows 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 26.9% of them for EcoPorts' PERS, making ISO and PERS the most popular standards in the 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 Eco-Management and Audit Scheme (EMAS) (3%). Another 1.5% of the ports is only certified with EMAS (Darbra et al., 2019).

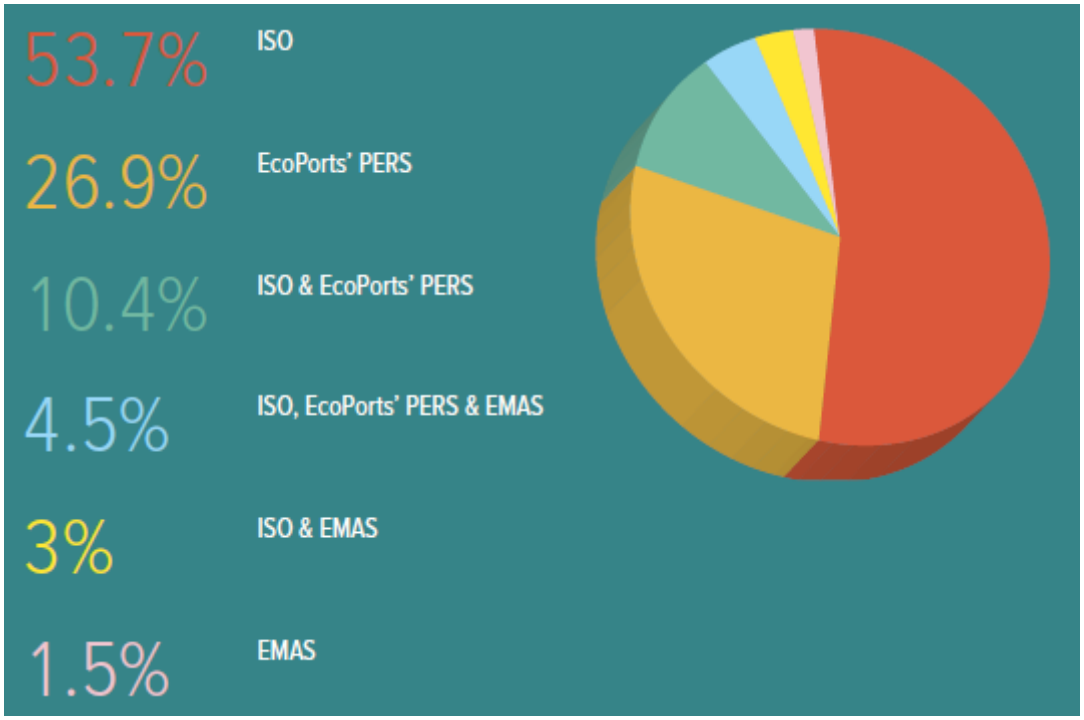

Figure 2: Breakdown of the EMS Certificates (Darbra et al., 2019)

Although most of the indicators have improved their percentage of positive responses, the performance of some indicators has decreased. This is shown in the following figure, where the Environmental Management Index (EMI) is presented. EMI is a formula that measures the whole environmental performance of the port by compiling the ten environmental indicators. A varying weighting is applied depending on the significance of these key environmental components. EMI is calculated by multiplying the weighting of each indicator to the percentage of positive responses (Darbra et al., 2019):

$$EMI = A \cdot 1.5 + B \cdot 1.25 + C \cdot 0.75 + D \cdot 1 + E \cdot 1 + F \cdot 1 + G \cdot 0.75 + H \cdot 1 + I \cdot 1 + J \cdot 0.75$$

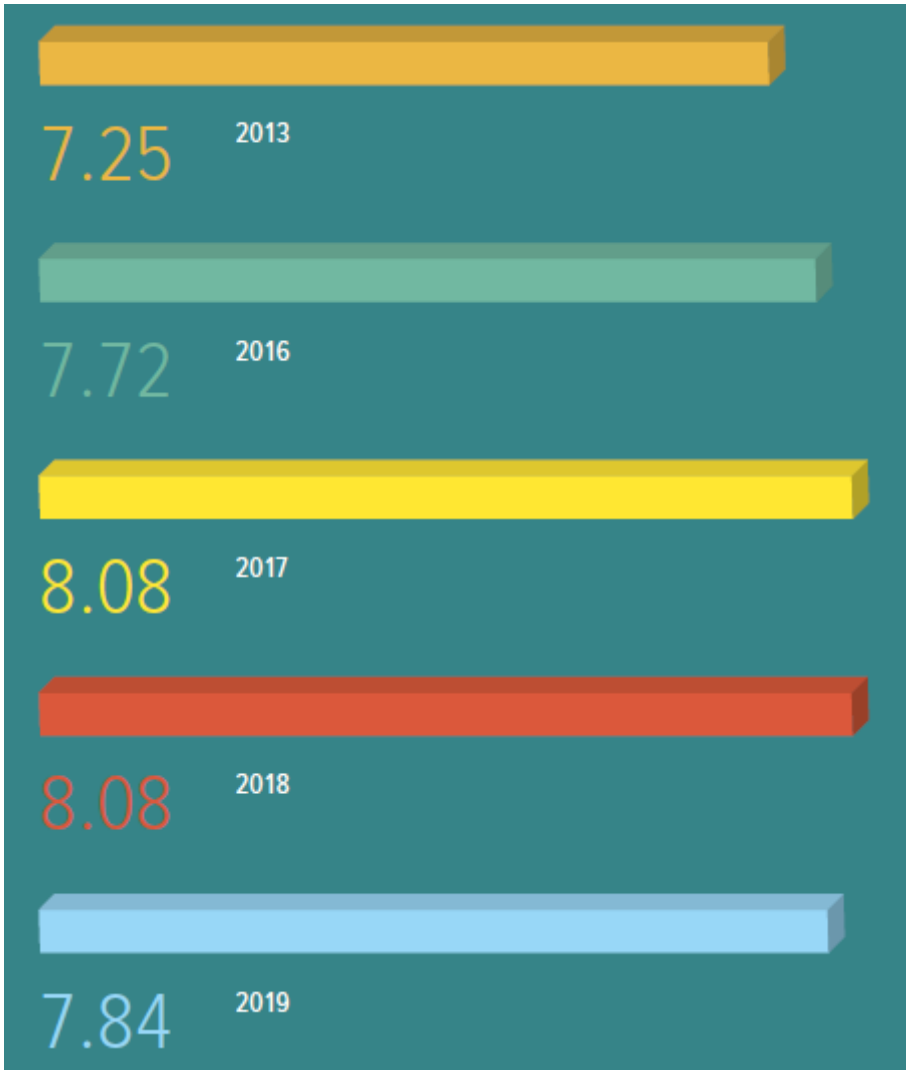

Figure 3: Evolution of the EMI (Darbra et al., 2019)

The value of EMI has increased year on year until 2018 and in 2019 has slightly decreased. The main reason for this decrease is the reduction of ports having an environmental monitoring program, an inventory of SEAs and an environmental training program for port employees (Darbra et al., 2019).

The table below presents the percentage of ports that monitor selected environmental issues.

Table 2: Percentage of positive responses to environmental monitoring indicators (Darbra et al., 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. Waste has been the most monitored indicator, followed by energy consumption and water quality. Water quality has increased the most since 2013. Comparing 2019 results with those of 2018, a reduction trend can be observed. On the contrary, carbon footprint monitoring has slightly increased since 2018 (Darbra et al., 2019).

9.2. Green services to shipping

As shown in the following figures, more than half of the ports provide onshore power supply (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. 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 (Darbra et al., 2019).

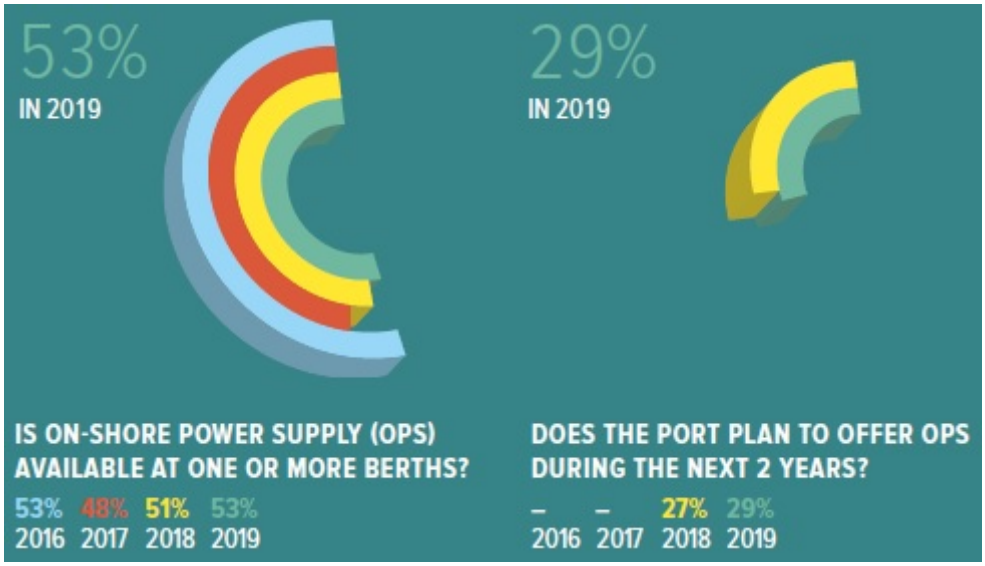

Figure 4: Onshore power supply (OPS) (Darbra et al., 2019)

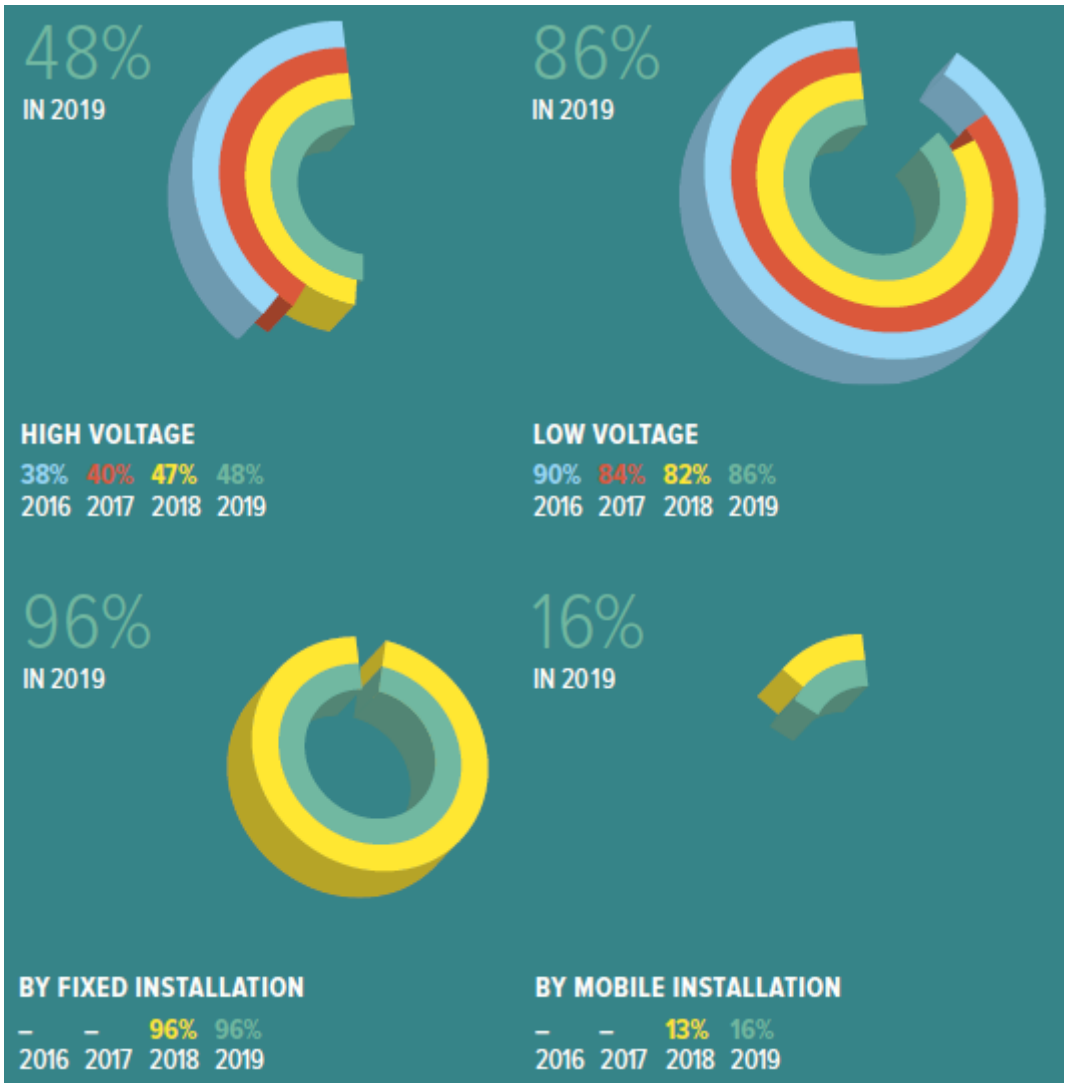

Figure 5: Among OPS-equipped ports (Darbra et al., 2019)

Darbra et al. (2019) support that 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 have 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 is time-limited though and Member States first have to go through a long administrative process at EU level in order to obtain it. Levies applied to the electricity price is another significant barrier. 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 (Darbra et al., 2019).

According to Darbra et al. (2019), aiming to address these challenges, the Energy Taxation Directive should be reviewed to provide a permanent EU-wide tax exemption for OPS. That would take away the disadvantage compared to electricity generated on-board of the vessel which enjoys a tax exemption. In addition, 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.

The figures below show that the availability of LNG bunkering in the port 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. One third of the ports offer this service to ships. This represents an increase of 10% since 2016. 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. 24% of the ports mentioned the existence of ongoing projects to install LNG bunkering (Darbra et al., 2019).

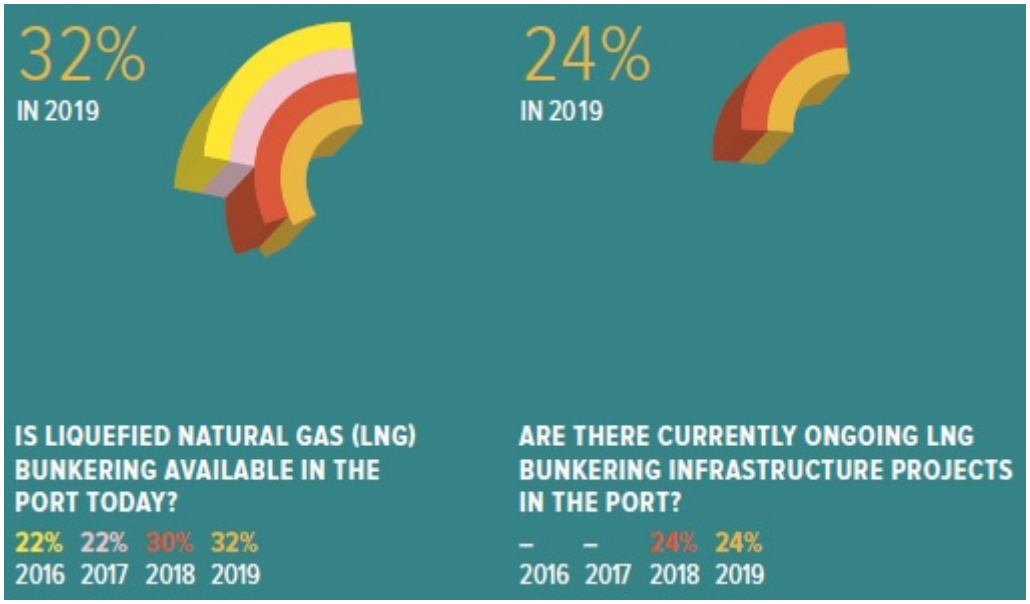

Figure 6: Liquefied Natural Gas (LNG) (Darbra et al., 2019)

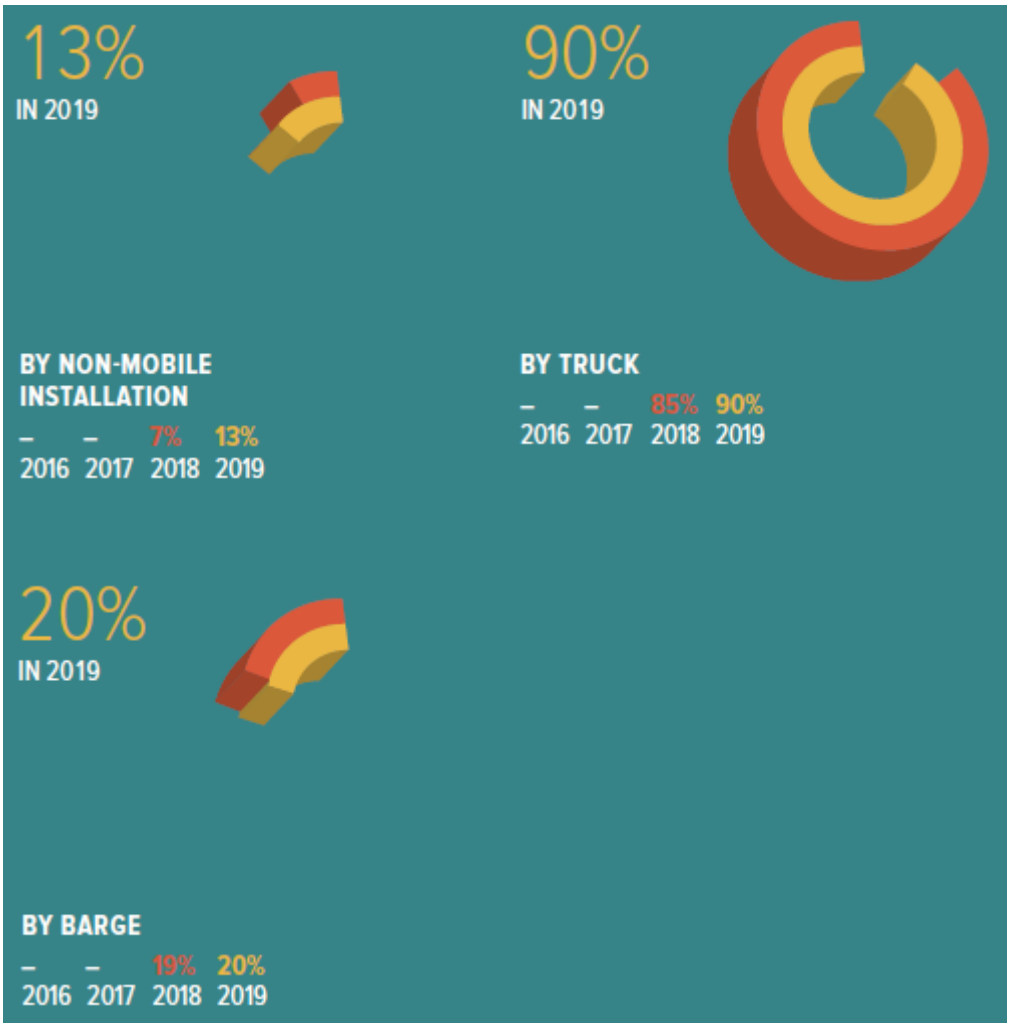

Figure 7: Among ports with LNG bunkering facilities (Darbra et al., 2019)

As shown in the following figures, environmentally differentiated port fees for ships that go beyond regulatory standards are set up in 56% of the ports. 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. 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 two years (Darbra et al., 2019).

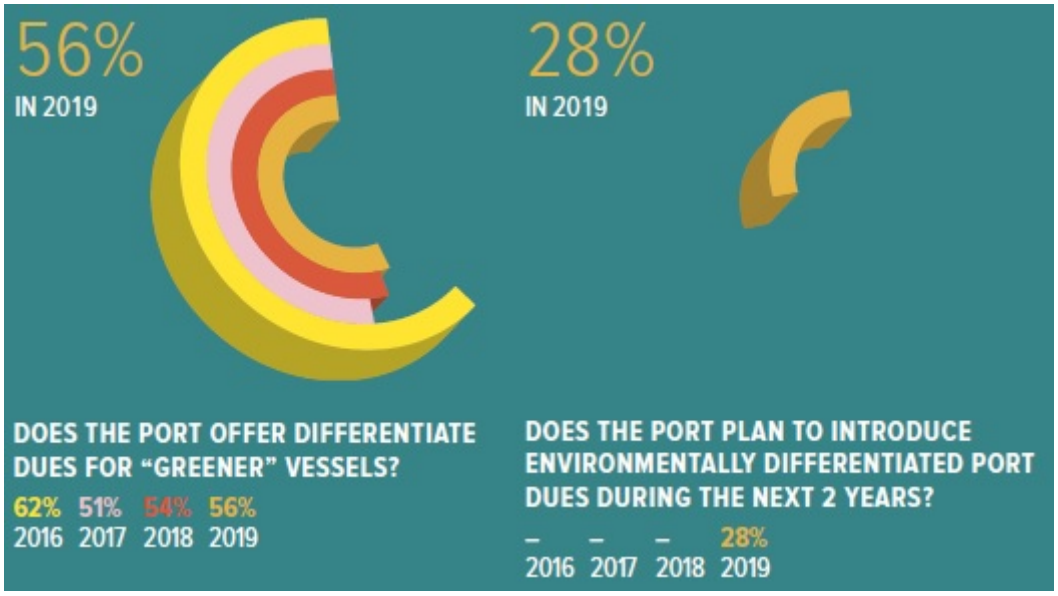

Figure 8: Environmentally differentiated port fees (Darbra et al., 2019)

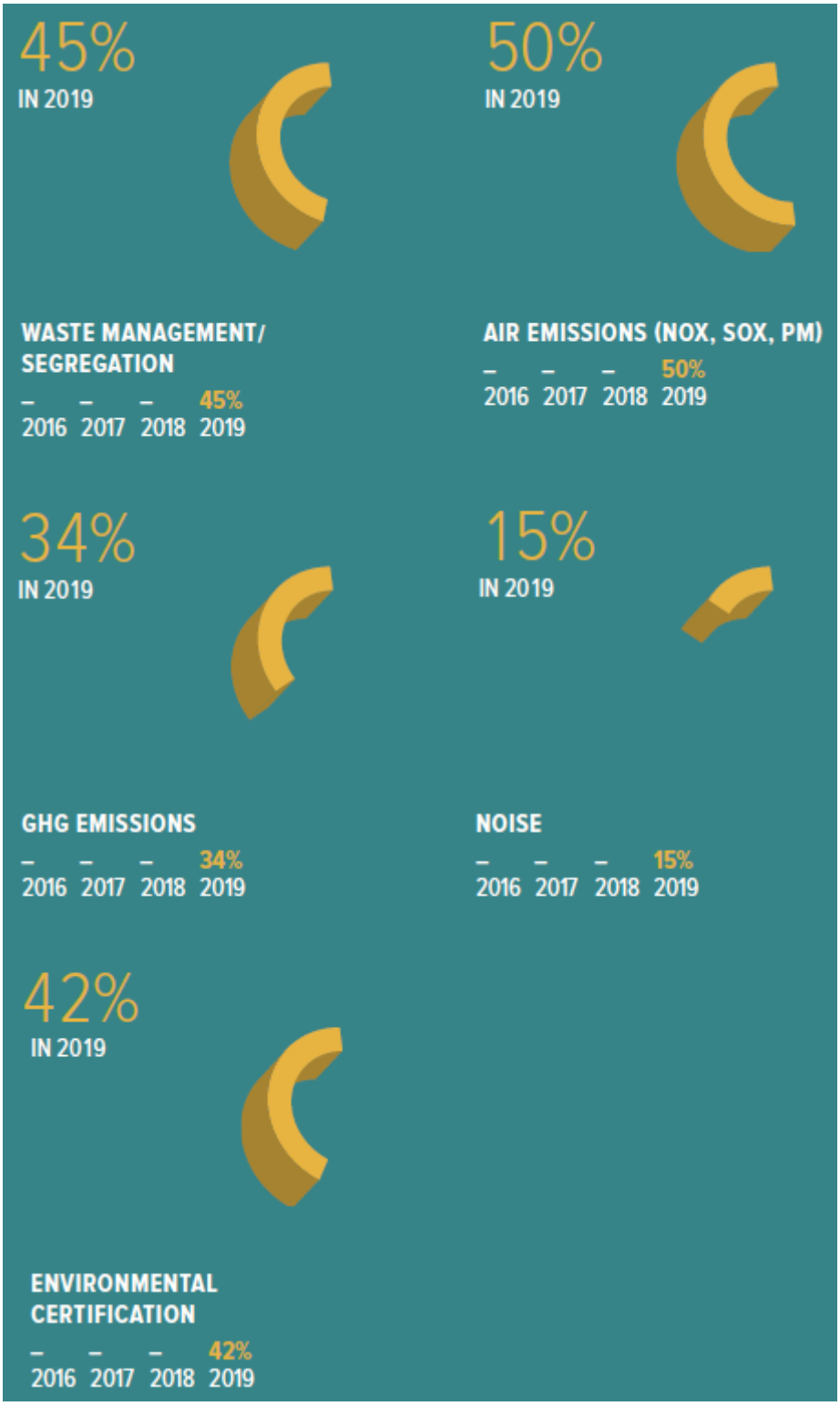

Figure 9: Among ports with environmentally differentiated fees (Darbra et al., 2019)

10. European Union policies on sustainability and sustainable ports

The European Union has in place an extensive and comprehensive regulatory environmental framework with which the European ports' environmental policies must be aligned, indicatively: the 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), the Directive (EU) 2016/802 relating to a reduction in the sulphur content of certain liquid fuels, the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, the Directive (EU) 2004/35 (2006) establishing a framework for the protection of soil, the Directive (EU) 2019/883 on port reception facilities for the delivery of waste from ships, the Directive (EU) 2014/94 on Alternative Fuels Infrastructure (the AFID), the Directive 2003/96/EC on the taxation of energy products and electricity, the Regulation (EC) 1013/2006 on shipments of waste, the Directive 2008/98/EC on Waste, the Directive 2008/50/EC on ambient air quality and cleaner air for Europe, the Regulation (EC) 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 the Regulation (EU) 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, contributing 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 CO_2 emissions, in line with the relevant European Union CO_2 reduction targets (Alexandropoulou et al., 2020).

Furthermore, new stricter environmental protection measures are to be implemented with the introduction of the European Green Deal (European Commission, 2019). On 11 December 2019, the European Green Deal was communicated by the European Commission, boosting a new strategy on implementing the United Nation's 2030 Agenda and the sustainable development goals, thereby increasing the European Union'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, which will be promoted in aviation, shipping and road transport (Alexandropoulou et al., 2020).

According to Alexandropoulou et al. (2020), the aim of the European Green Deal to reach net-zero greenhouse gas emissions by 2050, signifies an update of the European Union's climate ambition for 2030, with a 50%-55% cut in greenhouse gas emissions to replace the 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 European Union regulation in order to be aligned 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 European Union'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 European Union'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. The circular economy, including new waste and recycling laws, is an utmost priority of the European Green Deal in the European Union's effort to achieve net-zero carbon emissions by 2050.

On 16 September 2020 the European Parliament adopted its position on the European Commission's proposal to revise the European Union system for monitoring, reporting and verifying CO_2 emissions from maritime transport (EU MRV Regulation). The Parliament agrees that reporting obligations by the EU and the International Maritime Organisation (IMO) should be aligned, as proposed by the Commission and asks the Commission to examine the overall environmental integrity of the measures decided by the IMO, including the targets under the Paris Agreement. The Parliament wants maritime transport to be more ambitious and believes ships of 5.000 gross tonnage and above should be included in the EU Emissions Trading System (ETS). The Parliament claims that market-based emissions reduction policies are not enough and requests that shipping companies reduce their annual average CO_2 emissions per transport unit for all their ships by at least 40% by 2030. The Parliament calls for an Ocean Fund for the period from 2022 to 2030, financed by revenues from auctioning allowances under the ETS, to make ships more energy-efficient and to support investment in innovative technologies and infrastructure, such as alternative fuel and green ports. 20% of the revenues under the Fund should be used to contribute to protecting, restoring and efficiently managing marine ecosystems impacted by global warming (European Parliament, 2020a).

On 7 October 2020 the European Parliament adopted its negotiating mandate on the EU climate law. The new law aims to transform political promises that the EU will become climate neutral by 2050 into a binding obligation and to give European citizens and businesses the legal certainty and predictability they need to plan for the transformation. The Parliament insists that both the EU and all member states individually must become climate-neutral by 2050 and that thereafter the EU shall achieve negative emissions and calls for sufficient financing to achieve this. According to the Parliament, the Commission must propose by 31 May 2023 a trajectory at EU level on how to reach carbon neutrality by 2050. It must take into account the total remaining EU greenhouse gas (GHG) emissions until 2050 to limit the increase in temperature in accordance with the Paris Agreement. The Parliament also wants to establish an EU Climate Change Council (ECCC) as an independent scientific body to assess whether policy is consistent and to monitor progress. The EU's current emissions reductions target for 2030 is 40% compared to 1990. The Commission recently proposed to increase this target to at least 55% in the amended proposal for an EU climate law. The Parliament calls for a reduction of 60% in 2030, adding that national targets shall be increased in a cost-efficient and fair way. The Parliament also wants an interim target for 2040 to be proposed by the Commission following an impact assessment, to ensure the EU is on track to reach its 2050 target. The parliament states that the EU and member states must also phase out all direct and indirect fossil fuel subsidies by 31 December 2025 at the latest and underlines the need to continue efforts to combat energy poverty (European Parliament, 2020b).

The European Council at its meeting on 15 and 16 October 2020 stated that the EU needs to increase its ambition for the coming decade and update its climate and energy policy framework, in order to meet the objective of a climate-neutral EU by 2050 in line with the objectives of the Paris Agreement. According to the conclusions of the meeting, the European Council considers that the updated target should be delivered collectively by the EU in the most cost-effective manner possible. All member states will participate in this effort, taking into account national circumstances and considerations of fairness and solidarity. All relevant EU legislation and policies need to contribute to the new 2030 target and to the fulfilment of the climate neutrality objective, while respecting a level playing field and preventing carbon leakage (European Council, 2020b). The European Council at its meeting on 10 and 11 December 2020 stated that it endorses a binding EU target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990 (European Council, 2020c).

10.1. European Semester

The European Semester is a tool for greater economic and fiscal policy coordination within the EU, which produces recommendations for member states. Based on a six-month cycle, the European Semester covers three blocks of economic policy coordination, including structural reforms, fiscal policies and the prevention of excessive macroeconomic imbalances. The European Commission has committed to integrate the Sustainable Development Goals into the European Semester, as part of the Green Deal. The Semester currently tracks 21 green growth performance indicators, which are presented in the table below. The focus of the process has ignored other key policy objectives. For example, issues like good air quality and the protection of biodiversity and ecosystems and their services, are not covered in the European Semester process. Recommendations for structural reforms to member states largely fail to take into account environmental risks and opportunities (Charveriat & Bodin, 2020).

Table 3: Green growth performance indicators in the European Semester's standard country tables (Charveriat & Bodin, 2020)

Macroeconomic	**Sectoral**	**Security of energy supply**
Resource intensity	Sectoral Industry energy intensity	Energy import dependency
Energy balance of trade	Share of energy-intensive industries in the economy %	Aggregated supplier concentration index HHI
Weighting of energy in HICP	Real unit energy cost for manufacturing industry excl. refining % of value added	Diversification of energy mix HHI
Energy intensity	Electricity prices for medium sized industrial users	
Difference between energy price change and inflation	Gas prices for medium-sized industrial users	
Real unit of energy cost	Public R&D for energy	
Ratio of environmental taxes to labour taxes ratio	Public R&D for environmental protection	

Environmental taxes	Municipal waste recycling rate	
	Share of GHG emissions covered by ETS	
	Transport energy intensity	

Charveriat & Bodin (2020) list the following eight dimensions of a sustainable economy and propose indicators to be developed for each dimension:

1. Size of the green economy
    - Green Gross Fixed Capital Formation/GDP
    - Private investment, jobs and gross value added related to low-carbon and circular economy sectors
2. Long-term sustainability of the economy
    - Indicators for Good Environmental Status of Marine Waters
    - Absolute decoupling indicators
    - Additional indicators measuring also the human, social and financial/physical capitals
3. Sustainable public finance
    - Indicators of climate and biodiversity mainstreaming of public budgets at MS level based on an improved EU methodology for the MFF
4. Green incentives, taxes and subsidies
    - Green public procurement as share of total public procurement
5. Green Research, Development and Innovation
6. Sustainable Industry
    - Material footprint per capita
    - Greenhouse gas emissions of the digital sector
    - Greenhouse gas emissions of the chemical sector
    - Level of take-up in corporate sustainability schemes
7. Climate change risk
    - Climate adaptation and Disaster Risk Reduction (DRR) expenditures as a share of GDP
    - Public funding for just transition
    - Indicators for integrating climate-related risks into financial stability monitoring and microsupervision
8. Negative spill-over effects of Europe's economic and industrial policies on third countries' decarbonisation pathways

According to Charveriat & Bodin (2020), currently the European Union has at least 64 quantitative policy targets that are relevant to climate and the environment. It also has 12 quantitative policy targets related to other dimensions of sustainability. Amongst environmental targets, at least 16 are translated into member state-level targets. The process of the Semester should be used to assess progress towards the achievement of targets by each member state and to adjust recommendations according to the distance to target and to back-casting methodologies. Greater Policy Coherence for Sustainable Development (PCSD) should be one of the objectives of the integration of the Sustainable Development Goals in the Semester. There should be complementarity and synergies between indicators within the Semester, whose main audience objectives would be policy-makers in charge of macroeconomic, financial and industrial policies within member states, and the wider set of

environmental indicators of the 8th Environment Action Programme (EAP), whose audience would include a wider set of stakeholders in member states. Likewise, there should be complementarity between indicators within the Semester and indicator sets within major flagship policies. More adequate EU funding for structural reform in member states will partly depend on financial resources allocated under the Just Transition Mechanism and the mainstreaming within the multiannual financial framework (MFF) for 2021-2027. But it will also be important to ensure the full alignment of programming exercises with each member state. These should be based on an assessment of needs from member states based on the distance to targets. Where the European Semester could be useful is in shedding light during the implementation period of the MFF on how a member state is using funding available to support structural reform. To deliver the Green Deal, it would also be essential to foster climate and biodiversity mainstreaming in member state budgets. Relevant indicators should feature in the environmental sustainability scoreboard of the Semester. Moreover, the Semester should assess progress in the greening of economic instruments, such as taxation, subsidies and public procurement at the member state level and make relevant recommendations to support relevant structural reform in these crucial areas. Finally, the Semester should support greater compliance by analysing records of relevant infringement procedures by each member state, so that the incentives to comply are fully aligned.

10.2. Next Generation EU

According to the conclusions of the special meeting of the European Council held on 17-21 July 2020 (European Council, 2020a), the exceptional nature of the economic and social situation due to the COVID-19 crisis requires exceptional measures to support the recovery and resilience of the economies of the member states. The plan for European recovery will need massive public and private investment at European level to set the Union firmly on the path to a sustainable and resilient recovery, creating jobs and repairing the immediate damage caused by the COVID-19 pandemic whilst supporting the Union's green and digital priorities. The Multiannual Financial Framework (MFF), reinforced by Next Generation EU (NGEU), will be the main European tool. For NGEU the Commission shall be empowered in the Own Resources Decision to borrow funds on the capital markets on behalf of the Union up to the amount of EUR 750 billion in 2018 prices. The Union shall use the funds borrowed on the capital markets for the sole purpose of addressing the consequences of the COVID-19 crisis. The funds borrowed may be used for loans up to an amount of EUR 360 billion in 2018 prices and for expenditure up to an amount of EUR 390 billion in 2018 prices. Member states shall prepare national recovery and resilience plans setting out the reform and investment agenda of the member state concerned for the years 2021-2023. The amounts under NGEU for individual programmes are shown in the following table:

Table 4: The amounts under NGEU for individual programmes (European Council, 2020a)	
Recovery and Resilience Facility (RRF)	EUR 672.5 billion
ReactEU	EUR 47.5 billion
Horizon Europe	EUR 5 billion
InvestEU	EUR 5.6 billion
Rural Development	EUR 7.5 billion

Just Transition Fund (JTF)	EUR 10 billion
RescEU	EUR 1.9 billion
Total	**EUR 750 billion**

10.3. Multiannual Financial Framework 2021-2027

In the Multiannual Financial Framework (MFF) 2021-2027 the overall amount for commitments is EUR 1,074.3 billion. The financial allocation for RescEU will be EUR 1.1 billion. Health will be increased to EUR 1.7 billion to respond to COVID-19. A new own resource based on non-recycled plastic waste will be introduced and apply as of 1 January 2021. As a basis for additional own resources, the Commission will put forward in the first semester of 2021 proposals on a carbon border adjustment mechanism and on a digital levy, with a view to their introduction at the latest by 1 January 2023. In the same spirit, the Commission will put forward a proposal on a revised ETS scheme, possibly extending it to aviation and maritime. Finally, the Union will, in the course of the next MFF, work towards the introduction of other own resources, which may include a Financial Transaction Tax. The proceeds of the new own resources introduced after 2021 will be used for early repayment of NGEU borrowing (European Council, 2020a).

Reflecting the importance of tackling climate change in line with the Union's commitments to implement the Paris Agreement and the United Nations Sustainable Development Goals, programmes and instruments should contribute to mainstream climate actions and to the achievement of an overall target of at least 30% of the total amount of Union budget and NGEU expenditures supporting climate objectives. EU expenditure should be consistent with Paris Agreement objectives and the “do no harm” principle of the European Green Deal. An effective methodology for monitoring climate-spending and its performance, including reporting and relevant measures in case of insufficient progress, should ensure that the next MFF as a whole contributes to the implementation of the Paris Agreement. The Commission shall report annually on climate expenditure. In order to address the social and economic consequences of the objective of reaching climate neutrality by 2050 and the Union's new 2030 climate target, a Just Transition Mechanism, including a Just Transition Fund, will be created. The allocation for the Just Transition Fund for the period 2021-2027 is EUR 7,500 million (European Council, 2020a).

Funding in the Heading 3: Natural Resources and Environment of the budget focuses on delivering added value through a modernised, sustainable agricultural, maritime and fisheries policy as well as by advancing climate action and promoting environmental and biodiversity protection. The mainstreaming of climate across the budget and enhanced integration of environmental objectives gives this Heading a key role in reaching the ambitious target of at least 30% of EU expenditure contributing to climate objectives. Commitment appropriations for this Heading will not exceed EUR 356,374 million of which EUR 258,594 million will be allocated to market related expenditure and direct payments (European Council, 2020a).

Financing under this Heading will also support the European Maritime and Fisheries Fund, targeting funding to the Common Fisheries Policy (CFP), the Union's maritime policy and the Union's international commitments in the field of ocean governance, notably in the context of the 2030 Agenda for Sustainable Development. It will therefore support sustainable fisheries

and aquaculture and the conservation of marine biological resources, as well as the local communities dependent on it. The Heading will further finance the programme for the environment and climate action, LIFE, which will provide additional support to conservation of biodiversity, including Natura 2000, and the transformation of the Union into a clean, circular, energy efficient, low carbon and climate resilient society (European Council, 2020a).

11. The European Union Emissions Trading System

According to the latest report from the European Commission on the functioning of the European carbon market (European Commission, 2020), the EU Emissions Trading System (EU ETS) has been the cornerstone of the EU's strategy for reducing greenhouse gas (GHG) emissions from industry and electricity and heat production since 2005. Implementing legislation on the new carbon leakage list and free allocation rules has been adopted, and the legal framework for the Union Registry system has been revised to accommodate the required adjustments for phase 4. Moreover, the rules for the operationalisation of the Innovation Fund (the ETS's main instrument for the funding of low-carbon innovative technologies and breakthrough innovation in phase 4) have been established. At the same time, the Auctioning Regulation has been revised to enable the auctioning of the first 50 million allowances for the Innovation Fund in 2020. A second revision to create the institutional framework for the auctioning of allowances for the Innovation and the Modernisation Funds in phase 4 was adopted by the Commission in August 2019. The monitoring, reporting, verification and accreditation (MRVA) framework of the EU ETS has been updated to improve and clarify existing rules based on the implementation experience from phase 3. In 2018, the generated total revenues from auctioning were EUR 14 billion, more than two times higher than the revenues generated in 2017, due to the higher price of emission allowances. Based on data submitted by member states, over the course of 2018, close to 70% of these revenues were spent (or were planned for spending) on specified climate and energy related purposes.

The EU ETS operates in the 31 countries of the European Economic Area (EEA). It limits emissions from nearly 11,000 power plants and manufacturing installations as well as over 500 aircraft operators flying between EEA's airports. It covers around 39% of the EU's GHG emissions. In phase 3 (2013-2020), the sectors with stationary installations regulated by the EU ETS are energy intensive industries, including power stations and other combustion plants with >20MW thermal rated input (except hazardous or municipal waste installations), oil refineries, coke ovens, iron and steel, cement clinker, glass, lime, bricks, ceramics, pulp, paper and board, aluminium, petrochemicals, ammonia, nitric, adipic, glyoxal and glyoxylic acid production, CO_2 capture, transport in pipelines and geological storage of CO_2. The aviation scope of the EU ETS was limited to flights within the EEA in the period 2013-2016, pending the adoption of a global approach by the International Civil Aviation Organization (ICAO). To support the development of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), in 2017 the limitation to intra-EEA flights was prolonged until 2023 (European Commission, 2020).

The EU ETS covers carbon dioxide (CO_2) emissions, but also nitrous oxide (N_2O) emissions from all nitric, adipic, glyoxylic acid and glyoxal production, and perfluorocarbons (PFC) emissions from aluminium production. Even though participation in the EU ETS is mandatory, in some sectors only installations above a certain size are included. Moreover, participating countries can exclude small installations (emitting less than 25,000 tonnes of CO_2e) from the system if alternative and equivalent measures are in place. In phase 4 very small emitters (with reported emissions of less than 2,500 tonnes of CO_2e in the last three years) can be excluded from the EU ETS subject to the existence of simplified monitoring arrangements to assess the quantity of their emissions. Participating countries may also add more sectors and GHGs to the EU ETS (European Commission, 2020).

Category C installations emit more than 500,000 tonnes CO_2e per year, category B installations emit between 500,000 and 50,000 tonnes CO_2e per year, and category A installations emit less than 50,000 tonnes CO_2e per year. Installations with low emissions are a sub-set within category A installations, which emit less than 25,000 tonnes CO_2e per year. Within the installation categories based on annual emissions, the data for 2018 shows that, as in previous years, 72% of installations are category A, 21% are category B and 7% are category C. 6,113 installations were reported as installations with low emissions (57% of the total) (European Commission, 2020).

11.1. Supply: allowances put in circulation

The cap is the absolute quantity of GHGs, which may be emitted by covered entities to ensure the emission reduction target is met and that it corresponds to the number of allowances put in circulation over a trading period. In phase 3 a common EU-wide cap applies, replacing the previous system of national caps. The 2013 cap for emissions from stationary installations was set at 2,084,301,856 allowances. This cap decreases each year by a linear reduction factor of 1.74% of the average total quantity of allowances issued annually in 2008-2012, thus ensuring that the number of allowances that can be used by stationary installations will be 21% lower in 2020 than in 2005 (European Commission, 2020).

A significant amount of allowances is allocated for free according to the following principles (European Commission, 2020):

- Electricity production does not receive free allowances.
- Free allowances to manufacturing industry are distributed according to EU-wide harmonised rules.
- Free allocation is based on performance benchmarks to strengthen the incentives for GHG emission reductions and innovation and reward the most efficient installations.
- An EU-wide New Entrants' Reserve (NER) for new industrial installations and installations significantly increasing capacity has been established, equivalent to 5% of the total amount of allowances for phase 3.

Free allocation is provided to industrial installations to address the risk of carbon leakage (a situation where companies transfer production to third countries with laxer constraints on GHG emissions, which may lead to an increase in their total emissions). The sectors and sub-sectors deemed to be exposed to a significant risk of carbon leakage are placed on a carbon leakage list. Free allocation will continue after 2020, based on updated benchmark values derived with reference to the performance of the 10% most efficient installations in the EU. The level of carbon leakage exposure of sectors has been assessed on the basis of a combined indicator multiplying the sector’s intensity of trade with third countries by the sector’s emission intensity. Based on this assessment, in February 2019 the Commission adopted the carbon leakage list for the next trading period, which will be valid for the entirety of phase 4 (European Commission, 2020).

The initial New Entrants Reserve, after deducting 300 million allowances for the NER300 programme, held 480.2 million allowances. Until June 2019, 167.9 million allowances have been reserved for 937 installations for the entirety of phase 3. The remaining NER amounts to 312.3 million allowances. It is expected that a significant number of these allowances will remain unallocated. These will be placed at the end of phase 3 in the Market Stability Reserve

(MSR), out of which 200 million will be used to establish a NER for phase 4 (European Commission, 2020).

In the course of phase 3, about 43% of the total quantity of available allowances will be allocated for free, while the share of allowances to be auctioned by member states amounts to some 57%. Until end June 2019, free allocation has been reduced by around 457 million allowances due to installations that have closed or reduced their production or production capacity compared to the one initially used to calculate phase 3 allocation (European Commission, 2020).

To reflect progress in technology and innovation, the benchmark values will be updated twice in phase 4, on the basis of real data. The installations applying for free allocation for the first allocation period (2021-2025) had to submit the required data by 30 May 2019 to the competent authorities. This data will be used by the Commission to calculate each installation's allocation and for updating the benchmark values for 2021-2025. The delegated act on revising the free allocation rules for 2021-2030 was adopted in December 2018, while work on updating the benchmark values for 2021-2025 has started. In phase 4, allocations to individual installations will be adjusted in a timely manner to reflect significant increases and decreases in operation. To prevent manipulation and abuse of the allocation adjustment system and to avoid any undue administrative burden, the Commission will adopt an implementing act to define further arrangements for the adjustments (European Commission, 2020).

The NER300 is a large-scale funding programme for innovative low-carbon energy demonstration projects. It is aimed at demonstrating environmentally safe carbon capture and storage (CCS) and innovative renewable energy (RES) technologies on a commercial scale within the EU. The NER 300 was funded from the monetisation of 300 million emission allowances from the NER. The funds were awarded to projects selected through two rounds of calls for proposals in December 2012 and July 2014. As a result of the two calls for proposals of the NER 300, 38 RES projects and 1 CCS project were awarded in total in 20 EU member states, amounting to EUR 2.1 billion (European Commission, 2020).

The Innovation Fund is one of the two low-carbon mechanisms created by the revised EU ETS Directive for phase 4. It will support, on a competitive basis, first-time market development and commercial scale demonstration of innovative technologies and breakthrough innovation in sectors covered by the EU ETS, including innovative renewables, energy intensive industries, carbon capture and utilisation (CCU), and energy storage. It will be funded by the auctioning of at least 450 million allowances and any undisbursed budget from the NER 300 Programme. The value of 450 million allowances available for the fund will depend on the carbon price. With an average price of EUR 25 per allowance, resources for the fund would amount to EUR 11.3 billion (European Commission, 2020).

In addition to free allocation to cover direct carbon costs, EU member states may grant state aid to compensate some electro-intensive industries for indirect carbon costs, i.e. costs resulting from increased electricity prices due to electricity generators passing on the costs of purchasing allowances to consumers. To ensure harmonized application of indirect carbon cost compensation across member states and minimize competition distortions in the internal market, the Commission has adopted the EU ETS State Aid Guidelines. The Guidelines

determine, inter alia, eligible sectors and maximum amounts for compensation of indirect carbon costs. The revised ETS Directive allows member states to continue providing indirect carbon cost compensation in phase 4, and complements it with enhanced transparency and reporting provisions. In 2018 indirect cost compensation was paid out by 11 member states. The total indirect cost compensation paid out by the 11 member states in 2018 amounted to about EUR 462 million which represents close to 11% of the auction revenue of these member states. The member states in which compensation schemes are in place together account for some 70% of EU GDP. The largest recipients of compensation were the chemical sector, the non-ferrous metals sector, and the iron and steel sector (European Commission, 2020).

Table 5: Indirect carbon cost compensation paid out by Member States in 2018 (European Commission, 2020)

Member State	Duration of the scheme	Compensation disbursed in 2018 for indirect costs incurred in 2017 (in million euros)	Number of beneficiaries (installations)	Auction revenue 2017 (excluding aviation allowances, in million euros)	Percentage of auction revenues spent on indirect cost compensation
UK	2013 - 2020	22,36	60	1607	3,7%
DE	2013 - 2020	202	891	1141,7	17,6%
BE (FL)	2013 - 2020	31,7	106	143,5	27,3%
BE (WL)	2017 - 2020	7,5	30		
NL	2013 - 2020	36,9	96	189	19,5%
EL	2013 - 2020	16,8	50	196,6	8,5%
LT	2014 - 2020	0,24	1	31,4	0,8%
SK	2014 - 2020	10	7	87	11,4%
FR	2015 - 2020	98,7	296	309,8	31,8%
FI	2016 - 2020	26,7	58	94,6	28,2%
ES	2013 - 2015	6	151	488,8	1,2%
LU	2018-2020	3,4	2	6,8	50%

According to the latest report from the European Commission on the functioning of the European carbon market (European Commission, 2020), in phase 3, auctioning is the default mode for allocating allowances. Primary auctions are governed by the Auctioning Regulation which specifies the timing, administration and other aspects of how auctions should take place to ensure an open, transparent, harmonised and non-discriminatory process. In 2018, the European Energy Exchange (EEX), auctioning on behalf of its 27 member states, auctioned 89% of the total auctioned amount, while InterContinental Exchange Futures Europe (ICE) auctioned 11% of the total amount on behalf of the UK. In accordance with the safeguard measures adopted to protect the environmental integrity of the EU ETS in cases where EU law ceases to apply to a member state withdrawing from the EU, allowances issued by the United Kingdom for 2018 were accepted for surrender, but no allowances have been auctioned in 2019 on behalf of the United Kingdom. An overview of the auction clearing prices from 2013 to 30 June 2019 is provided in the figure below:

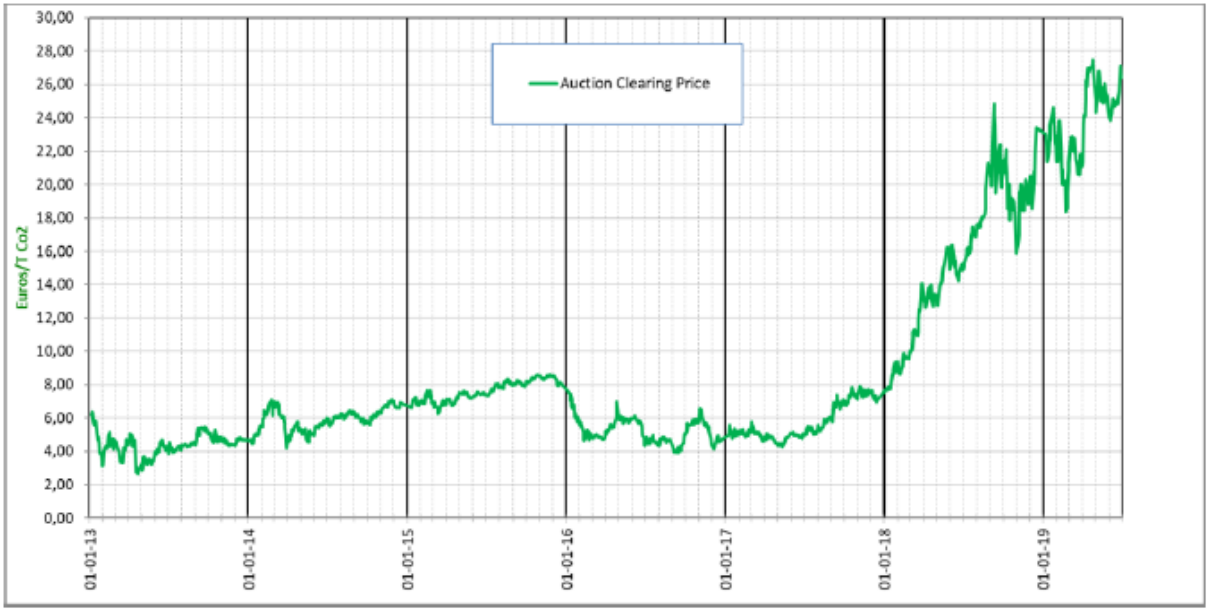

Figure 10: Clearing price for general allowances auctions from 2013 to 30 June 2019 (European Commission, 2020)

The total revenues generated by member states from the auctions between 2012 and 30 June 2019 exceeded EUR 42 billion. In 2018 alone, the generated total revenues were EUR 14 billion. The EU ETS Directive provides that at least 50% of auction revenues, including all revenues generated from allowances distributed for the purposes of solidarity and growth, should be used by member states for climate and energy related purposes. According to the information submitted to the Commission by member states, member states spent or planned to spend close to 70% of these revenues for specified climate and energy related purposes in 2018. In the period 2013-2018, about 80% of auction revenues were spent for such purposes (European Commission, 2020).

Article 10c of the EU ETS Directive provides a derogation from the general rule of auctioning to support investments in the modernisation of the electricity sector in certain lower income EU member states. Eight out of ten eligible member states make use of this derogation in phase 3 and allocate to electricity generators a number of allowances for free provided corresponding investments are carried out. The free allowances under Article 10c are deducted from the quantity that the respective member state would otherwise auction. Depending on the national rules for the implementation of the derogation, electricity generators can receive free allowances of an equivalent value to the investments they carry out from their National Investment Plans, or to payments made into a national fund through which such investments are financed. As the free allocation of allowances to electricity generators under Article 10c of the ETS Directive would in principle involve state aid, the national schemes for the implementation of the Article 10c derogation have been cleared under state aid rules and are subject to the requirements of the State Aid Guidelines. Transitional free allocation under Article 10c will continue to be available in phase 4 but with enhanced transparency provisions and with the option for eligible member states to use all or part of their Article 10c allocation to support investments within the framework of the Modernisation Fund. Based on information submitted to the Commission by member states, the use of Article 10c derogation will be very limited in the next trading period (European Commission, 2020).

Participants in the EU ETS can still use international credits from the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI) towards fulfilling part of their EU ETS obligations until 2020, subject to qualitative and quantitative restrictions. These credits are financial instruments that represent a tonne of CO_2 removed or reduced from the atmosphere as a result of an emissions reduction project. In phase 3, credits are no longer surrendered directly, but instead may be exchanged for allowances at any time during the calendar year (European Commission, 2020).

11.2. Demand: allowances taken out of circulation

In 2018, emissions from installations participating in the EU ETS are estimated to have decreased by 4.1% compared to 2017 based on the information recorded in the Union Registry. As demonstrated in the following table, the decrease in emissions was mainly driven by electricity and heat production, whereas emissions from industry decreased only very slightly (European Commission, 2020).

Table 6: Verified emissions (in million tonnes CO2 equivalents) (European Commission, 2020)

Year	2011	2012	2013	2014	2015	2016	2017	2018
Verified total emissions	1904	1867	1908	1814	1803	1750	1755	1682
Change to year x-1	-1,8%	-2%	2.2%	-4,9%	-0,6%	-2,9%	0,2%	-4,1%
Verified emissions from electricity and heat production	1190	1184	1125	1037	1032	992	985	913
Change to year x-1		-0,5%	-5,0%	-7,8%	-0,5%	-3,8%	-0,7%	-7,3%
Verified emissions from industrial installations	715	683	783	777	771	758	769	769
Change to year x-1		-4,5%	14,7%	-0,9%	-0,7%	-1,7%	1,4%	-0,1%
Real GDPgrowth rate EU28	1,8%	-0,4%	0,3%	1,8%	2,3%	2,0%	2,5%	2,0%

The number of allowances cancelled on a voluntary basis amounts to 36,559 allowances in 2018. In total, voluntary cancellations of 345,893 allowances have been recorded until end June 2019 (European Commission, 2020).

11.3. Balancing supply and demand

At the start of phase 3 in 2013, the EU ETS was characterised by a large structural imbalance between the supply and demand of allowances, equalling 2.1 billion allowances. The surplus has been decreasing over the course of the current trading period, remaining stable in 2014 and falling significantly to 1.78 billion allowances in 2015, 1.69 billion allowances in 2016, and 1.65 billion allowances in 2017. In 2018, the surplus remained at 1.65 billion allowances. To address the structural imbalance between the supply and demand of allowances, a Market Stability Reserve (MSR) was created in 2015 to render the auction supply of emission allowances more flexible. The MSR began operating at the start of 2019. A key notion for the functioning of the MSR is the total number of allowances in circulation (TNAC). Allowances will be added to the reserve, if the TNAC is above a predefined upper threshold (833 million allowances) and will be released from the reserve, if the number is below a predefined lower threshold (below 400 million allowances). Thus, the MSR absorbs or releases allowances, if the TNAC indicator is outside of a predefined range. Back-loaded allowances from the period 2014-2016, as well as unallocated allowances (allowances not allocated pursuant to Article 10a(7) of the EU ETS Directive) will also be put in the reserve. The revised EU ETS Directive makes two notable changes to the functioning of the MSR. First, the percentage of the TNAC to be placed in the reserve from 2019 to 2023 is doubled from 12% to 24%. This substantially increases the pace of reducing the surplus. Second, from 2023, allowances held in the MSR exceeding the previous year's auction volume will no longer be valid (European Commission, 2020).

The figure below shows the composition of cumulative supply and demand in 2018:

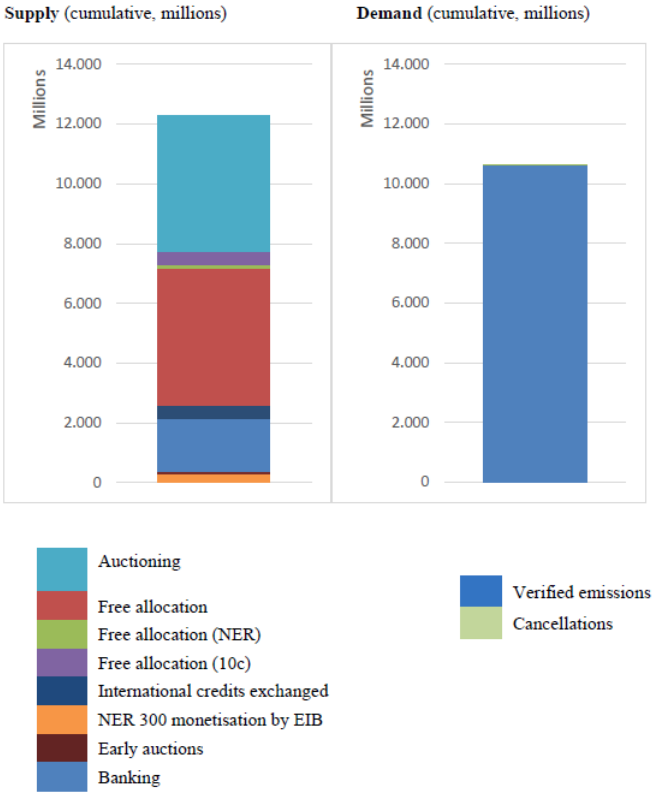

Figure 11: Composition of cumulative supply and demand in 2018 (European Commission, 2020)

12. The inclusion of shipping in the EU ETS

12.1. The environmental aspect

Hermeling et al. (2015) construct a model to examine if a regional scheme, such as the EU ETS, is successful in reducing global emissions and if the definition of its scope, in the sense of the share of emissions considered from a regulated entity, affect its environmental effectiveness. According to their model, a regional ETS regulating all maritime emissions on voyages to and from the EU on global emissions is effective in reducing emissions. Global emissions from water transport reduce compared to business as usual. The emission change for inland transport is positive but small. Emissions from air transport do not change much as a result of regulating shipping emissions. So while there is some carbon leakage to other transport modes in consequence of the EU scheme capping a part of shipping emissions, the overall emission reduction is positive. Hermeling et al. (2015) underline three main reasons for such a limited shift of transport emissions. First, of all transport modes, water transport is the cheapest option for transporting most commodities and apparently even the introduction of a regional emission regulation does not impede this comparative advantage. Second, leakage to inland transport is limited to the cases where there is a land link between regions. Third, European air transport is also included in the EU ETS and thus a corresponding shift would also incur additional emission costs.

According to Hermeling et al. (2015), from an aggregated perspective, for a given stringency (equal reduction targets), the scope of the scheme has no direct effect on the amount of avoided emissions. This becomes clear when recalling two things. First, although the total amount of regulated emission may vary for different scopes, for a specific requested absolute emission reduction, the cap implied by a certain reduction target will be scaled accordingly. Thus, if the regulation covers a bigger amount of emissions but the same absolute emission reductions are demanded, the corresponding reduction target can be set less strict and the overall cap will be bigger. Second, for ships, almost all CO_2 abatement technologies involve high fix costs or are non-variable in their use. This implies that in total, abatement options are applied homogeneously during the complete voyage of a ship and are not applied only when a ship enters regulated waters. As a consequence, emission intensities can be assumed to be constant along the whole route. Eventually, it is the stringency of the system that determines how many emissions are reduced and the costs of the regulation. The mere scaling of the regulated emissions, that is what share of emissions is included, has no effect to this regard.

12.2. The economic aspect

According to Hermeling et al. (2015), in a technical support paper commissioned by the European Commission in 2009 various policy options to reduce CO_2 emissions from maritime transport are discussed, concluding that an ETS or a tax for maritime emissions should be the instrument of choice when targeting a reduction of CO_2 emissions of maritime transport. Reports of the French Ministry of Transport in 2012 and Franc & Sutto (2014) examine a cap-and-trade scheme in the maritime sector focusing on the effects of shipping lines and ports. They suggest that an ETS restricted to Europe will lead to distortions and thus argue in favour of a global scheme. They point in particular to the risk of an undesired modal shift for inter-european transport services. Koesler et al. (2012) evaluate the effects of an ETS for maritime emissions on the organisation and operations of shipping companies. According to them, it is

unlikely that a maritime ETS will add significant overhead costs to shipping operations, because most of the required monitoring and reporting processes and similar trading activities are already in place due to business reasons or other regulations.

Thanks to their effectiveness in establishing financial incentives for emission abatement in the form of an emission price and the cost-efficiency that comes along with it, market based mechanisms are generally acknowledged by economists to be a superior approach to deal with the externalities of CO_2 emissions. Cost-efficiency in the EU ETS is only granted among entities regulated by the EU ETS and not relative to entities outside the EU ETS. But while usually this problem relates to the question which entities are incorporated, in a regional system covering mobile entities such as ships, cost-efficiency may not always be granted even among regulated entities and may not be achieved for certain designs of the scope of the system. The stringency of a scheme is generally seen as the parameter determining the costs of the regulation. The mere scaling of the emissions should have no effect. This however neglects that the neutrality of the scope holds only if the scaling of the emissions is homogenous across entities. In the context of regulating transport emissions this may however not be the case. Transport services with European involvement feature a highly varying share of regulated emissions with respect to different definitions of the scope. In such a case, emission costs of entities are not distributed solely on the basis of their share of emissions. A scheme regulating only a share of total emission along a route comes along with distortions which may have a disproportional negative effect to routes featuring a relatively high share of regulated emissions (Hermeling et al., 2015).

12.3. The legal aspect

As cited by Hermeling et al. (2015), König and Morgenstern (2009) have focused on whether a regional EU trading scheme for maritime transport would comply with international law and give a negative answer, while Lassen (2010) has reached the opposite conclusion. Kermlis (2010) deals with different design options for the implementation of a trading scheme from a legal perspective. Ringbom (2011) addresses various international law questions linked to a potential future EU emission trading scheme for shipping. According to him, international law does not necessarily prevent the establishment of a trading scheme that covers emissions that have occurred beyond the territorial waters of the member states or even in other states' maritime zones but places a number of important limitations on its design.

Bäuerle et al. (2010) investigate a possible integration of maritime transport into the EU ETS and study the issue taking a legal and an economic perspective. They analyse three options: considering a ship's historic emissions over a certain period as a baseline, regulating the emissions of a ship during its last voyage and an approach regulating not the ship's emissions but rather the maritime transport emissions related to the carried cargo. With regard to a potential environmental benefit, they argue that regulating historic emissions is more effective than the other two options. The legal analysis takes the position that in principle the inclusion of maritime emissions in the EU ETS does not infringe international law even if it covers emissions arising from vessels outside the territorial seas of EU member states. They conclude that regulating maritime emissions by including shipping transport into the EU ETS is environmentally effective, possible from a legal point of view and it will not entail significant negative effects (Hermeling et al., 2015).

After an extensive legal analysis, Hermeling et al. (2015) conclude that international law does not hinder the EU to implement an EU maritime ETS that encompasses emissions produced within the territorial seas of EU member states. Likewise, an EU maritime ETS designed to capture territorial as well as extraterritorial emissions of EU vessels does not raise deep concerns as to its compatibility with international law. A comprehensive EU maritime ETS model, however, that includes emissions of non-EU vessels irrespective of their local production would have relevant extraterritorial effects incompatible with the flag-state principle (Article 92 United Nations Convention on the Law of the Sea – UNCLOS). Furthermore, it would disregard the prohibition to all states to subject any part of the high seas to its sovereignty (Article 89 UNCLOS) as well as the national sovereignty over the territorial sea (Article 2 UNCLOS). In consequence of this lack of international legislative jurisdiction world trade law is infringed. In contrast, the International Maritime Organization (IMO) would not be hindered to act against global warming.

13. Conclusion

Sea ports and the shipping industry are crucial elements of the international supply chain, as over 80% of volume and 70% of value of world merchandise trade is carried by sea. Reducing the sources of greenhouse gas (GHG) emissions and of marine pollution emanating from ports is of growing importance and source of anxiety for port authorities, policy makers, port users and the local communities. Ports are enhancing their facilities using new smarter technologies. Digitalization, connectivity, automation and intelligent transport systems may reduce environmental footprints of the port industry. The concept of port sustainability comprises four dimensions: economic, social, environmental and institutional. WPSP implements the UN SDGs along five themes: resilient infrastructure, climate and energy, community outreach and port city dialogue, safety and security, governance and ethics.

Shipping networks may be designed to consider not only economic costs, but also environmental costs, reducing energy consumption and emissions. The hinterland transport aspect of the port activities contributes to a range of externalities, especially emissions and congestion. Reducing hinterland transport emissions is partly responsibility of ports. Shore-side power (SSP) application is a solution to ensure interaction among ship, port, and smart grid (SG). The required electricity can be provided to ships by the grid system thanks to shore-side power connection. Using shore-side power instead of auxiliary engines (AEs) reduces consumption of marine fuel, cost of energy, exhaust emissions, noises, and vibrations from ships. Circular economy in ports focusses on minimising the use of inputs and the elimination of waste and pollution, maximising the value created at each stage, managing flows of bio-based resources and recovery of flows of non-renewable resources in a closed loop, establishing mutually beneficial relationships between companies within each circular chain. Ports can achieve improvements towards sustainability through the application of new technologies and the implementation of systems innovation approach. EcoPorts, an environmental initiative of the European Sea Ports Organisation (ESPO), promotes cooperation and sharing of knowledge between ports. Ecoports provides two tools to its members: the Self-Diagnosis Method (SDM) and the Port Environmental Review System (PERS).

The European Union has in place an extensive and comprehensive regulatory environmental framework with which the European ports' environmental policies must be aligned. Furthermore, new stricter environmental protection measures are to be implemented with the introduction of the European Green Deal. On 11 December 2019, the European Green Deal was communicated by the European Commission, boosting a new strategy on implementing the United Nation's 2030 Agenda and the sustainable development goals, thereby increasing the European Union's greenhouse gas emission reductions target for 2030 to at least 50% and towards 55% compared with 1990 levels. The Green Deal seeks a 90% reduction in the transport emissions by 2050, while it boosts the supply of sustainable alternative transport fuels, which will be promoted in aviation, shipping and road transport. On 16 September 2020 the European Parliament adopted its position on the European Commission's proposal to revise the European Union system for monitoring, reporting and verifying CO_2 emissions from maritime transport. The Parliament wants maritime transport to be more ambitious and believes ships of 5.000 gross tonnage and above should be included in the EU Emissions Trading System (ETS). The Parliament claims that market-based emissions reduction policies are not enough and requests that shipping companies reduce their annual average CO_2

emissions per transport unit for all their ships by at least 40% by 2030. On 7 October 2020 the European Parliament adopted its negotiating mandate on the EU climate law. The new law aims to transform political promises that the EU will become climate neutral by 2050 into a binding obligation and to give European citizens and businesses the legal certainty and predictability they need to plan for the transformation. The Parliament insists that both the EU and all member states individually must become climate-neutral by 2050 and that thereafter the EU shall achieve negative emissions and calls for sufficient financing to achieve this. The Commission recently proposed to increase this target to at least 55% in the amended proposal for an EU climate law. The Parliament calls for a reduction of 60% in 2030, adding that national targets shall be increased in a cost-efficient and fair way. The European Council at its meeting on 10 and 11 December 2020 stated that it endorses a binding EU target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990.

The EU Emissions Trading System (EU ETS) has been the cornerstone of the EU's strategy for reducing greenhouse gas (GHG) emissions from industry and electricity and heat production since 2005. The EU ETS operates in the 31 countries of the European Economic Area (EEA). It limits emissions from nearly 11,000 power plants and manufacturing installations as well as over 500 aircraft operators flying between EEA's airports. It covers around 39% of the EU's GHG emissions. A regional ETS regulating all maritime emissions on voyages to and from the EU on global emissions is effective in reducing emissions. Cost-efficiency in the EU ETS is only granted among entities regulated by the EU ETS and not relative to entities outside the EU ETS. But while usually this problem relates to the question which entities are incorporated, in a regional system covering mobile entities such as ships, cost-efficiency may not always be granted even among regulated entities and may not be achieved for certain designs of the scope of the system. Transport services with European involvement feature a highly varying share of regulated emissions with respect to different definitions of the scope. In such a case, emission costs of entities are not distributed solely on the basis of their share of emissions. A scheme regulating only a share of total emission along a route comes along with distortions which may have a disproportional negative effect to routes featuring a relatively high share of regulated emissions. Literature analysing whether the inclusion of shipping in the EU ETS is compatible with international law offers contradictory results.

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15. Appendix

The following is a list of applications of the seventeen Sustainable Development Goals in ports according to Verhoeven et al. (2020):

1. No poverty
    - ■ Setting a good minimum wage for the port employees and encouraging similar practices in the port community
    - ■ Taking responsibility for the application of ethical standards throughout the supply chain
    - ■ Including sustainability requirements in procurement
    - ■ Supporting local communities in need through social projects targeting sustainable growth
    - ■ Supporting local social institutions
2. Zero hunger
    - ■ Supporting local projects targeting the provision of food to families/communities in need
    - ■ Encouraging the transfer of food surpluses out of the warehouses in the port to charities, food banks and community organizations
    - ■ Supporting the trade/storage of Fairtrade and other ethically-produced agricultural products in cooperation with NGOs and community organizations
    - ■ Sourcing Fairtrade food products for own catering
3. Good health and well-being
    - ■ Improving health and safety awareness of employees and local communities through training and transparent communication on health and safety risks
    - ■ Minimizing environmental externalities of port operations and greening of the port and urban areas
    - ■ Initiatives on sustainable/safe mobility and projects targeting congestion
    - ■ Enhancing port safety and security and minimizing risks
    - ■ Awareness raising and actions against the use of addictive substances
    - ■ Protecting habitats and biodiversity in and around the port area
4. Quality education
    - ■ Competence and talent policy for port employees
    - ■ Enhance life-long learning for the port employees
    - ■ Cooperating with local schools, universities and research centres in educational programs, internships and port visits
    - ■ Offering training to port professionals through dedicated institutions
    - ■ Creating synergies with universities in port research and development projects
5. Gender equality
    - ■ Gender-neutral hiring and remuneration policies
    - ■ Promoting women to leadership roles; training and hiring more women for port operational positions
    - ■ Levelling the male/female ratio of port employees for operational and managerial positions
    - ■ Taking measures that make the port working environment more attractive to women
6. Clean water and sanitation
    - ■ Providing drinking water and clean sanitation facilities for port employees and visitors
    - ■ Minimizing/optimizing water consumption in the port area

- Harvesting rainwater for port use
- Protecting water-related ecosystems in and around the port area
- Projects protecting freshwater resources

7. Affordable and clean energy
   - Locally producing and/or sourcing renewable energy
   - Supporting research and development on clean energy technology
   - Producing and/or recovering energy from industrial waste streams
   - Investing in energy-efficient port equipment
   - Encouraging clean energy initiatives from third parties through appropriate instruments
   - Providing Onshore Power Supply from renewable sources
   - Providing cleaner (marine) fuels in a safe and efficient manner
   - Optimizing port operations and processes
8. Decent work and economic growth
   - Achieving economic growth through diversification, innovation and technological modernization
   - Generating economic growth in an environmentally sustainable manner
   - Ensuring that economic growth positively impacts local communities economically and socially
   - Promoting employment, including opportunities for disadvantaged groups and young people
   - Striving for a healthy and safe working environment for all: specific actions related to safety and ergonomics, and creating a good work/life balance
   - Generating a sustainable model for cruise tourism
   - Taking responsibility for applying ethical standards throughout the end-to-end supply chain
9. Industry, innovation and infrastructure
   - Devising sustainable port development policies supported by relevant key performance indicators
   - Digitally optimizing infrastructure and port operations/processes/services
   - Piloting, testing and implementing innovative IT and digital technologies in the port for public and private use
   - Foreseeing the adaptation of port infrastructure to withstand climate change
   - Adapting port infrastructure and processes to meet market demands
   - Sustainable port development projects
   - Investing in infrastructure for all transport modes to enable a balanced modal split
   - Minimizing environmental impact of the port activities
10. Reduced inequalities
    - Achieving equality within the port
    - Port community initiatives being all-inclusive irrespective of socio-economic background
    - Social background-neutral hiring and remuneration policies
    - Taking responsibility for the application of ethical standards throughout the supply chain
    - Financial support to local communities in need and social projects targeting sustainable growth of neighbouring communities
    - Ethical investment and banking
11. Sustainable cities and communities

- Improving sustainable mobility and reducing congestion for both employees and goods
- Restoring ecosystems and making the port accessible and attractive for people in neighbouring urban areas
- Minimizing environmental externalities of port operations
- Disaster recovery planning
- Community engagement programs and initiatives
- Supporting local communities in need through social projects targeting decent living and working opportunities that generate sustainable growth of neighbouring communities
- Supporting local social institutions

12. Responsible consumption and production
    - Sustainably managing natural resources, chemicals and waste
    - Implementing responsible procurement and sustainable investments in port area management and development as well as the end-to-end supply chain
    - Encouraging circular economy and industrial reuse and mutually beneficial use of resources in the port community
    - Optimizing port operations/processes/services
    - Reducing food wastage and food loss in the production/supply chain
13. Climate action
    - Improving energy efficiency of port operations, processes and services
    - Enabling the reduction of carbon and greenhouse gas emissions within the port area
    - Adapting port infrastructure and port-related operations to Climate Change
    - Providing services to reduce greenhouse gas emissions at sea and on the waterways, as well as the hinterland part of the supply chain
    - Producing and/or sourcing renewable energy
    - Encouraging third parties to take clean energy initiatives, by providing incentives and integrating clauses in lease and concession agreements
14. Life below water
    - Taking measures to prevent waste from ending up in the oceans
    - Promoting sustainable fishing activities
    - Supporting research regarding sustainable use of maritime resources
    - Reducing the emission of CO_2, SO_2, NO_x, NH_3 from port-related activities to avoid acidification of the oceans
    - Minimizing water pollution through adequate wastewater treatment facilities
    - Protecting coastal and estuarine ecosystems
    - Minimizing disturbing factors such as underwater noise for marine mammals
15. Life on land
    - Supporting local projects regarding nature development and biodiversity
    - Recovering and protecting nature and biodiversity in the port surroundings
    - Preventing deforestation through the usage/procurement of sustainably certified wood and paper
    - Offering nature and environmental education programs to employees
    - Port area development in balance with ecosystems
    - Minimising environmental externalities of port operations
16. Peace, justice and strong institutions
    - Constructive dialogue between employer and employees

- Good governance (a clear policy statement, stakeholder analysis, defined measurements, consistent reporting)
- Peace initiatives
- Addressing security: cyber security measures, commercial and operational data protection, improving the careful use and protection of personal data
- Open dialogue and collaboration with all stakeholders (including emergency services, customs and armed forces) and availability of a hotline for complaints and questions
- Transparent internal and external communication

17. Partnership for the goals
    - Partnerships with local communities for port-city relation initiatives
    - Partnering with other ports and parties in the logistics chain in joint projects of common interest
    - Public-private partnerships for funding and implementing sustainability projects
    - Establishing supply chain partnerships for ensuring CSR values throughout the chain
    - Cooperating with other ports for educational/training purposes (e.g. joint port training programs and centres)
    - Joint research and development projects involving port stakeholders, academia, industry and authorities