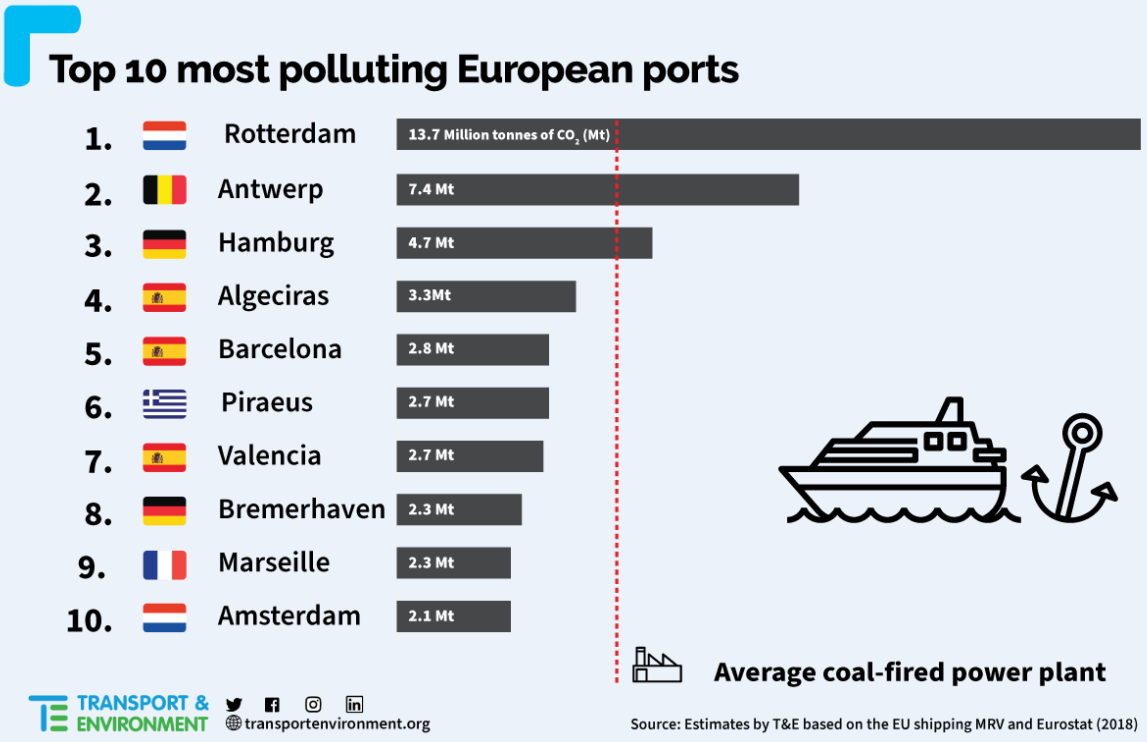
EU Ports' Climate Performance

An analysis of maritime supply chain and at berth emissions

February 2022

Policy-makers must act to address EU ports' climate impact

New analysis from Transport & Environment quantifies emissions for the first time to ships at berth (i.e loading, unloading or refuelling in ports) and attributes maritime supply chain emissions - often referred to as scope 3 emissions for the land sector - to European ports. The results show the extent to which European ports currently facilitate GHG emissions along the shipping supply chain and the need for ports and policy-makers to commit to green solutions such as port electrification and e-fuel bunkering infrastructure.



Maritime supply chain emissions from Europe's largest port, Rotterdam are significant at 13.7Mt, nearly twice its largest competitor, Antwerp and comparable to the biggest coal plants. But while the

Dutch government has promised to shut down its coal plants by 2029,[1] investments in clean port infrastructure remain low with few credible plans to provide clean fuel to the highly polluting ships operating in their ports. Spain is also shown to have a large shipping climate problem: 3 of the top 10 ports for maritime supply chain emissions are Spanish. Algeciras has the highest emissions, responsible for 3.3 million tonnes (Mt) of CO_2, while Barcelona and Valencia follow closely behind with 2.8 Mt and 2.7 Mt respectively.

Rotterdam similarly scores highly in emissions from ships at berth, with 640 thousand tonnes (kt), followed by Antwerp and Piraeus in second and third place. Despite having no individual ports in the top 10, Italy comes out top in the country rankings for emissions at berth, with a total of 1,165 kt, followed by Spain (1,039 kt) and the Netherlands (1,001 kt). Containerships are the largest source of emissions at berth in 7 out of the top 10 ports, with oil tankers the highest emitters in the other 3 (Rotterdam, Antwerp and Vlissingen). Oil tankers similarly make up the highest single emitting ship type in Italy, Netherlands, UK and France, compared to containerships in Spain, Belgium and Germany.

The results show the urgent need to abate supply chain emissions related to European ports. To address the problem, T&E recommends, among others, a large geographical scope of EU carbon pricing scheme to cover all inbound/outbound voyages, more stringent SSE requirements and alternative fuel targets to focus on sustainable e-fuels in the ongoing Alternative Fuels Infrastructure Regulation (AFIR) revision.[2] In detail, European policy-makers should:

- Ensure that at least half, ideally, all inbound and outbound shipping emissions are covered by the EU Emissions Trading Scheme (ETS).
- Require all European ports to provide shore-side electricity (SSE) to ships at berth:
    - From 2025 at all passenger terminals;
    - From 2030 at all terminals for containerships, tankers and refrigerated-bulk carriers;
    - From 2035 at all remaining terminals.
- Discontinue the mandate on maritime ports to install LNG infrastructure to avoid stranded assets in fossil fuels.
- Introduce targets for the installation of hydrogen and ammonia refuelling infrastructure in ports, to enable ships to use green e-fuels. ETS revenues should also contribute to funding this infrastructure.

[1] Beyond Coal (22 March 2021). Overview: National coal phase-out announcements in Europe. Retrieved at https://beyond-coal.eu/wp-content/uploads/2021/03/Overview-of-national-coal-phase-out-announcements-Europe-Beyond-Coal-22-March-2021.pdf

[2] Transport & Environment (18 November 2021). AFIR: How can the EU's infrastructure law make Europe 'fit for 55'? Retrieved from https://www.transportenvironment.org/discover/afir-how-can-the-eus-infrastructure-law-make-europe-fit-for-55/

1. Introduction

Europe stands at an important moment in its efforts to achieve climate neutrality. The Commission has proposed its landmark climate package - fit-for-55 - and attention now turns to the European Parliament and Council to ensure the proposals are on track with Europe's climate goals and obligations as per the Paris Agreement. To support that process, T&E has analysed data on port emissions to understand the nature of contributions to climate action that will be required from European ports.

We firstly looked into maritime supply chain emissions, allocating emissions from ships calling at European ports, from the 2019 Monitoring, Reporting and Verification (MRV) Regulation,[3] to different ports based on the cargo and passengers handled in each of them, provided by Eurostat.[4] Secondly, we investigated emissions at berth: pollution emitted while ships are at berth, loading, unloading or refuelling. We calculated total emissions at berth for European ports using the auxiliary engine emissions calculated in a recent study by Stolz et al.[5], which used MRV and Automatic Identification System (AIS) data. Full results are listed in the Annex.

INFO BOX: Calculating ports' maritime supply chain emissions

The calculation of maritime supply chain emissions of ports can be complicated, given the uncertainty of shipping emissions on individual voyages and the complexity of global logistics. Ideally, in the case for freight, each product delivered to or sent from a port would have its origin and destination known, the type of ship it was shipped on with its fuel consumption on that route, with emissions associated to it. In lieu of that data, there are several ways to approximate these emissions.

Emissions can be attributed to ports based on fuel sales, however this can over allocate emissions to ports with high bunkering capacity and underallocate to those without bunkering capacity. Emissions allocation could alternatively be done according to the value of the goods being transported, but this does not consider the mass of the products or their shipping intensity. An alternative method - a route-based allocation method consists in attributing emissions of the full voyages of ships to the ports in which they call. This would require modelling ship voyage emissions using AIS data, as was done in the IMO Fourth GHG study.[6] However, this method doesn't account for products that are transhipped to ports despite originating from other continents. Without allocating

[3] It should be noted that emissions reported in the MRV do not reflect the entirety of maritime emissions; emissions from ship types including yachts, fishing, service and offshore vessels as well as from ships under 5,000GT are not recorded in the MRV. The true climate impact of ports will therefore be higher. See here for more details.

[4] Eurostat databases mar_go_am_* (for each country) and mar_pa_qm_* (for each country)

[5] B. Stolz, M. Held, G. Georges, and K. Boulouchos, 'The CO2 reduction potential of shore-side electricity in Europe', *Applied energy*, 285 (2021), 116425.

[6] J. Faber, A. Kleijn, S. Hanayama, S. Zhang, P. Pereda, B. Comer, E. Hauerhof, W. S. van der Loeff, T. Smith, Y. Zhang, H. Kosaka, M. Adachi, J.-M. Bonello, C. Galbraith, Z. Gong, K. Hirata, D. Hummels, D. S. Lee, Y. Liu, A. Lucchesi, X. Mao, E. Muraoka, L. Osipova, H. Qian, D. Rutherford, S. S. de la Fuente, H. Yuan, C. V. Perico, L. Wu, D. Sun, D.-H. Yoo, and H. Xing, *Fourth IMO Greenhouse Gas Study*, (2020).

trade data to the voyages, it is also not trivial to determine the origin of the goods nor differentiate the final destination port from the intermediate port calls for a given voyage.

At the time of writing, however, we did not have this data at our disposal. **The method used in this paper allocates emissions reported in the MRV to individual ports via freight data.**[7] Total emissions are calculated from each ship type (e.g. gas carrier, containership…), then allocated to ports depending on how much of the cargo related to that ship type (e.g. LNG, containers) is handled in every port. A standard amount of emissions is therefore allocated to every unit of good handled. This method may penalise ports that receive goods from nearby areas: a port that trades 1 million containers exclusively with local ports will be allocated the same amount of emissions as a port that trades 1 million containers with a port on the other side of the globe. Also, this methodology is limited to operational emissions of ships in the MRV scope, covering only the last and first leg of journeys to and from the EU and all emissions between the EU ports. As such, the emissions allocation does not necessarily cover the full extent of shipping emissions associated with the product transportation from the production to the consumption site.

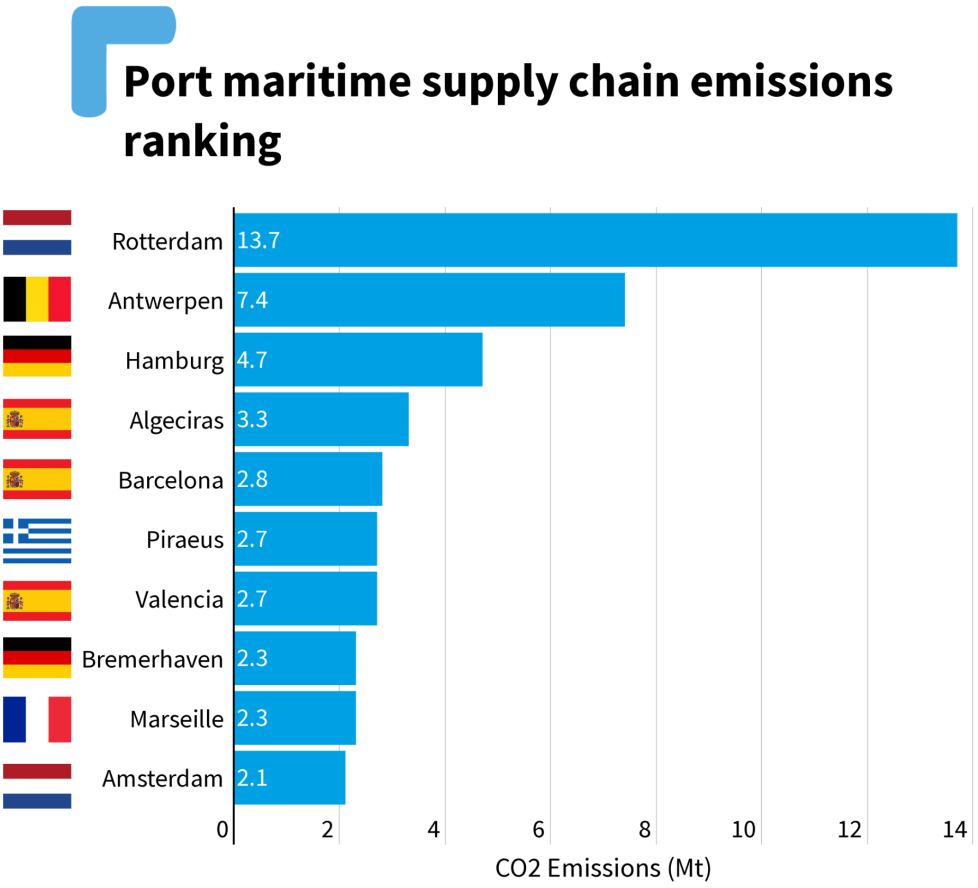
More information on the methodology used can be found in a previous publication.[8] This method should not be considered as the *ideal* way to calculate these emissions, but rather as a balanced and simple way to investigate the maritime supply chain emissions of the cargo and passengers transiting through and calling at EU ports under the geographical scope of the EU MRV. The analysis uses 2018 MRV data, which included emissions of the EU 27, but also the emissions linked to the United Kingdom, Norway and Iceland.

2. Maritime supply chain emissions

Ports are central to the green transition due to their role as bunkering facilities for the ships importing and exporting our goods. Their role as energy hub is to become increasingly important during the green transition, given that much green hydrogen will be produced, refined and used near ports, as well as imported and exported via the ports. Ports therefore have an important responsibility to provide clean energy infrastructure to the share of the maritime supply chain they are responsible for. Arguably, they also have an ethical responsibility to deploy their political resources to promote regulatory policies that will speed up green transition in maritime transport.

Figure 1 shows the top 10 European ports by maritime supply chain emissions covered by the EU MRV (2018). Spain has three ports in the top 10, whilst Germany and the Netherlands each have two. The biggest ports of Belgium, France and Greece - Antwerp, Marseille and Piraeus - complete the ranking. Rotterdam's climate impact is notable at 17.6 Mt, nearly twice that of second-placed Antwerp with 7.4 Mt.

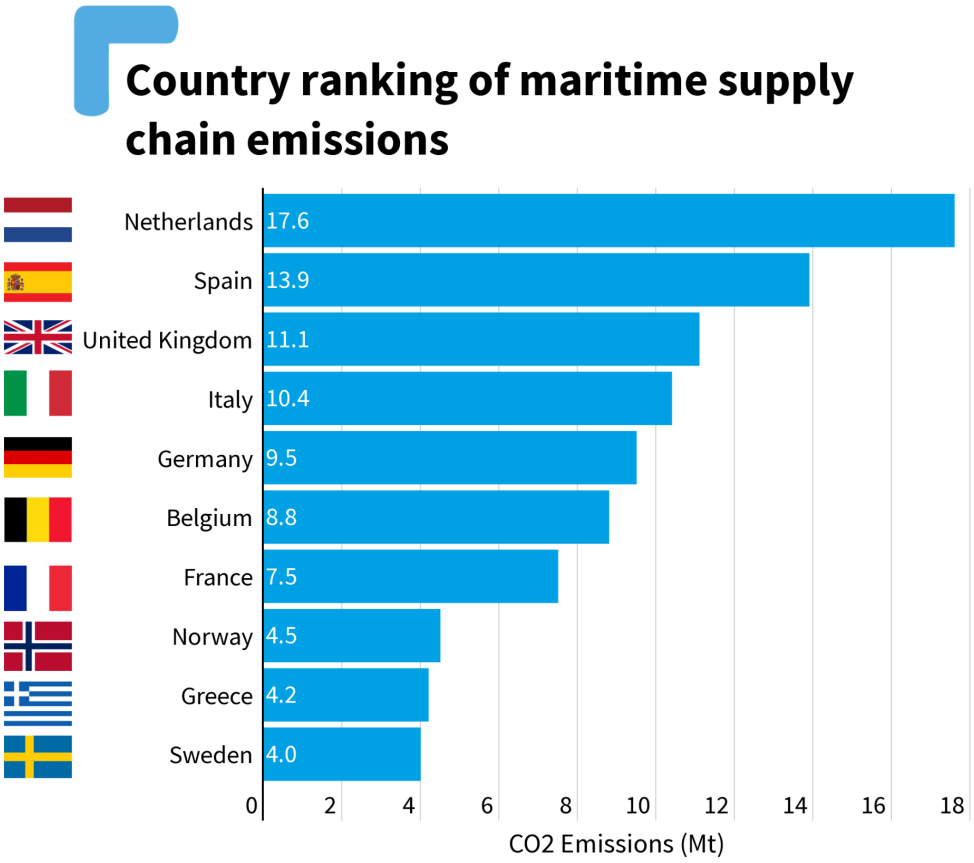
[7] Eurostat databases mar_go_am_* (for each country) and mar_pa_qm_* (for each country)
[8] Transport & Environment (December 2019). EU shipping's climate record. Retrieved from https://www.transportenvironment.org/wp-content/uploads/2021/07/Study-EU_shippings_climate_record_20191209_final.pdf



Note: This includes emissions associated with ports across the maritime supply chain in 2018 falling under the scope of shipping emissions reported in the EU MRV. Calculations are based on MRV figures and ports' cargo trade from Eurostat databases mar_go_am and mar_pa_qm.

Figure 1: Maritime supply chain emissions ranking by port

Given the large emissions from Rotterdam, it is therefore unsurprising that the Netherlands comes first in the top 10 when looking at the national results in Figure 2. Spain takes second place, aided by the large emissions of its top three ports. The United Kingdom and Italy take third and fourth place in spite of having no single port in the top 10. This is a result of the large number of ports for the UK, an island nation and the high emissions from oil tankers in Italy.



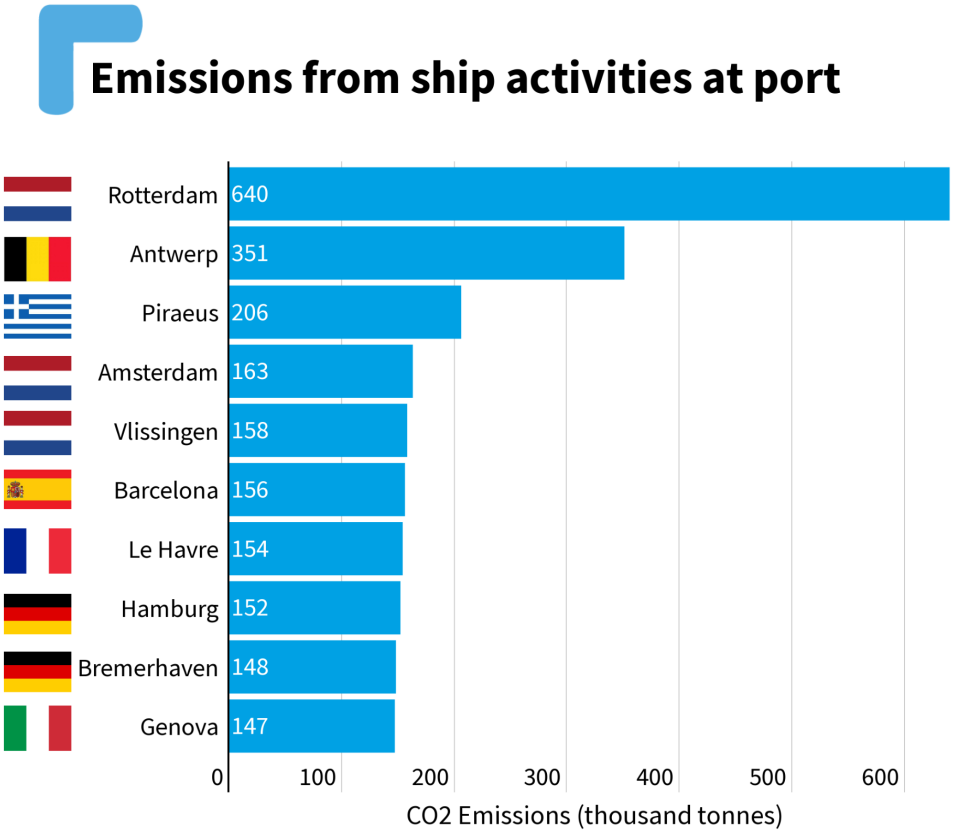
Note: This includes emissions associated with ports across the maritime supply chain in 2018 falling under the scope of shipping emissions reported in the EU MRV. Calculations are based on MRV figures and ports' cargo trade from Eurostat databases mar_go_am and mar_pa_qm.

Figure 2: Maritime supply chain emissions ranking by Member States

3. Emissions at berth

The analysis on maritime supply chain emissions include emissions from ships while at berth in ports, loading, unloading or refuelling. It is of interest to take a granular look at this data for two reasons: firstly, emissions at berth are easiest for ports to address through the use of shore-side electrification (SSE); and secondly because pollution from ports is significant for the health of the local populations.

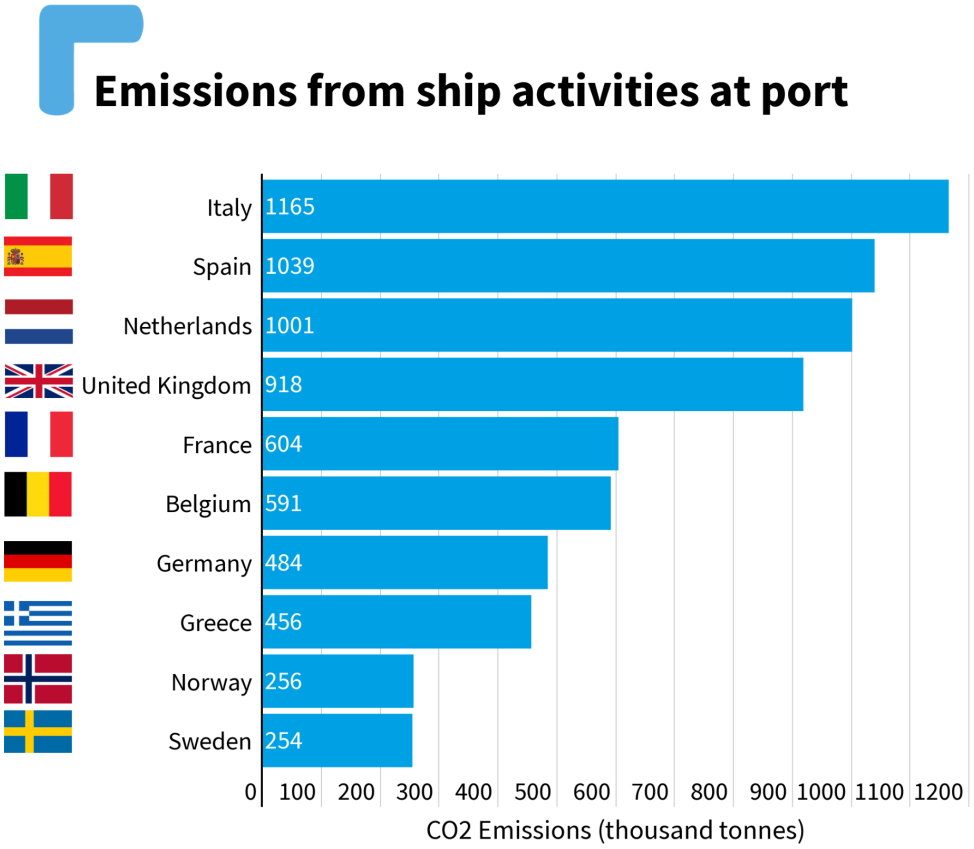
The results in Figure 3 reveal significant amounts of pollution in the main European ports. Rotterdam and Antwerp lead the ranking, with Piraeus third. Emissions at berth are fairly similar - around 150 kt - for the other ports in the top 10: Amsterdam, Vlissingen, Barcelona, Le Havre, Hamburg, Bremerhaven and Genova. Rotterdam's berth emissions are conspicuous: at 640 kt, far higher than any of its competitors. Containerships are the most polluting shipping segment in all of the top 10 ports but three: Antwerp, Piraeus, Barcelona, Le Havre, Hamburg, Bremerhaven and Genova. Oil tankers have the highest emissions per ship type in the remaining three ports, Rotterdam, Amsterdam and Vlissingen.



Note: Ship emissions at port, referred to as 'at-berth' emissions, are those that come from port activities like loading, unloading and refuelling. An alternative to running the ship engine using traditional fuels would be to plug in to shore-side electrification infrastructure at port. Data from 2018.

Figure 3: Emissions from ship activities at port

The results in Figure 4 gather the emissions from all European ports into national totals. Italy, without any port within the top 10 at berth polluters, scores highest with 1.2 Mt. Oil tankers account for the highest emissions from a single ship type in Italy. Oil tankers similarly account for the highest emissions in the Netherlands, the United Kingdom, France and Greece. Containerships account for the highest at berth emissions in Spain, Belgium and Germany, while Norway and Sweden's largest polluting ship types are passenger ships and ro-pax ships respectively, a result of Norway's distinctive geography and both Nordic country's reliance on shipping for transport to the European mainland.



Note: Ship emissions at port, referred to as 'at-berth' emissions, are those that come from port activities like loading, unloading and refuelling. An alternative to running the ship engine using traditional fuels would be to plug in to shore-side electrification infrastructure at port. Data from 2018.

Figure 4: Emissions from ship activities at port by Member State

4. Discussion and Conclusions

Results from emissions in ports and in the maritime supply chain lay bare the climate impact of ports and the need for that sector to invest in green solutions. One limitation of the data analysed is that the only greenhouse gas reported is CO_2. Air pollutants such as nitrogen oxide (NO_x) and sulphur dioxide (SO_x) are not reported in the MRV, but the high CO_2 emissions should nonetheless convince policy-makers of the need to secure the right regulatory framework to apply carbon pricing to all maritime emissions in Europe, as well as for the rollout of comprehensive port electrification and e-fuel bunkering infrastructure. This will not only bring down ports' climate impact, but immeasurably improve the air quality and health of port-city residents. Carbon pricing under the EU ETS will also generate a significant amount of revenues, part of which can be used to finance port infrastructure for shipping's green transition.

Currently, the European Commission has proposed 2030 as the deadline for ports to install shore-side electricity to some shipping sectors: containers, passenger vessels and cruise lines. However, the

Commission proposal includes exemptions depending on the number of port calls for certain types of ships and completely excludes other ship types, such as oil tankers and bulk carriers. The amount of emissions exempted is significant: the limited scope of the current SSE mandate to passenger and container ships only as part of the FuelEU Maritime proposal leaves out 57% of EU emissions at berth, or 5 Mt of CO_2 and 3 kt of sulphur oxide (SO_x) per year, equivalent to the SO_x emissions of the entire EU passenger car fleet (250 million cars).[9]

Electrification, while important, will only go so far in addressing ports' climate problem. The huge power needs of individual sea-going vessels make ship electrification for sea operations unlikely, so there is a clear need to build up infrastructure for the clean liquid fuels of the future. While fossil liquid natural gas (LNG) and biofuels have been erroneously proposed as sustainable options, the only sustainable and scalable fuels for the maritime sector are hydrogen based e-fuels, such as e-ammonia, e-methanol or hydrogen itself (all made from renewable energy and whenever relevant from direct air capture).

However, there is currently an unfortunate chicken and egg problem where ports will not invest in clean fuels infrastructure until they are sure there will be demand from shipowners for that fuel, yet shipowners hold off investing in zero-emission vessels until there is a clear supply infrastructure of clean fuels. The package of legislation proposed by the European Commission, in particular the FuelEU Maritime legislation and the AFIR, may hold the key for de-risking investments. But the current proposals mandate LNG infrastructure and no clean fuel infrastructure whatsoever. This will bind the hands of port authorities to invest in fossil gas, running the risk of stranded assets and locking Europe's shipping industry into fossil gas for decades to come.

The fit-for-55 shipping proposals are without a doubt the most important legislative package for shipping in history. It presents a golden opportunity to provide European shipping with the green refuelling and recharging infrastructure that will finally address its climate impact. With the right requirements, the shipping proposals can chart the course now for a clean maritime future. Port authorities and representatives of the European Parliament and the EU Council must now get behind ambitious targets for clean port infrastructure to ensure shipping's green transition.

4.1 Recommendations

- Ensure that at least half, ideally, all inbound and outbound shipping emissions are covered by the EU Emissions Trading Scheme.
- Require all European ports to provide shore-side electricity (SSE) to ships at berth:
    - From 2025 at all passenger terminals.
    - From 2030 at all terminals for containerships, tankers and refrigerated-bulk carriers.
    - From 2035 at all remaining terminals.
- Discontinue the mandate on maritime ports to install LNG infrastructure, to avoid stranded assets in fossil fuels.

[9] See T&E's forthcoming report *"FuelEU Maritime: T&E analysis and recommendations: How to drive the uptake of sustainable fuels in European shipping"*

- Introduce targets for the installation of hydrogen and ammonia refuelling infrastructure in ports, to enable ships to use green e-fuels. ETS revenues should also contribute to funding this infrastructure.

Further information

Jacob Armstrong
Sustainable Shipping Officer
Transport & Environment
jacob.armstrong@transportenvironment.org
Mobile: +32(0)470 83 55 17

Annex: Results

1. Maritime supply chain emissions per port

Ranking	Port	Maritime supply chain emissions (Mt)
1	Rotterdam	13.7
2	Antwerpen	7.4
3	Hamburg	4.7
4	Algeciras	3.3
5	Barcelona	2.8
6	Piraeus	2.7
7	Valencia	2.7
8	Bremerhaven	2.3
9	Marseille	2.3
10	Amsterdam	2.1

2. Maritime supply chain emissions per country

Ranking	Port	Maritime supply chain emissions (Mt)
1	Netherlands	17.6
2	Spain	13.9
3	United Kingdom	11.1
4	Italy	10.4
5	Germany	9.5
6	Belgium	8.8
7	France	7.5
8	Norway	4.5
9	Greece	4.2
10	Sweden	4.0

3. At berth emissions per port

Ranking	Port	Total berth emissions (kt)	Highest polluting ship type
1	Rotterdam	640	Oil tanker
2	Antwerp	351	Container ship
3	Piraeus	206	Container ship
4	Amsterdam	163	Oil tanker
5	Vlissingen	158	Oil tanker
6	Barcelona	156	Container ship
7	Le Havre	154	Container ship
8	Hamburg	152	Container ship
9	Bremerhaven	148	Container ship
10	Genova	147	Container ship

4. At berth emissions per country

Ranking	Port	Total berth emissions (kt)	Highest polluting ship type
1	Italy	1165	Oil tanker
2	Spain	1039	Container ship
3	Netherlands	1001	Oil tanker
4	United Kingdom	918	Oil tanker
5	France	604	Oil tanker
6	Belgium	591	Container ship
7	Germany	484	Container ship
8	Greece	456	Oil tanker
9	Norway	256	Passenger ship
10	Sweden	254	Ro-pax ship