Emissions from ships in Faxaflóahafnir 2025

Report number: U11228
Authors: Nils Jutblad, Rasmus Parsmo

[Emission, Shipping, Inventory, Harbor, Port]

Summary

In this study we calculate and present the ship to air emissions for Faxaflóahafnir's harbours in 2025. Emissions are presented for four operational modes; *in port basin*, *at anchor*, *manoeuvring* and *at berth*. Further, emissions are allocated to different engine types, ship types, and also to the four harbour areas of Faxaflóahafnir: Akranes harbour, Grundartangi harbour, Old harbour, and Sunda harbour. The results are compared to the emissions calculated for the years 2016 to 2024.

For each port call, emissions of greenhouse gases (*Well-To-Wake, WTW, and Tank-To-Wake, TTW*), nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC), particulate matter (PM), and sulphur dioxide (SO_2) are calculated using an emission inventory model specifically developed for port areas. Total emissions in 2025 are presented in Table 1.

Table 1: Summary of emissions for 2025.

	Greenhouse gases			NO_X (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)
	CO2-e (tonne) WTW	CO2-e (tonne) TTW	CO2 (tonne) TTW				
Total emissions 2025	65 900	53 900	53 100	603	25	16	19

The largest emitting ship categories are cruise ships, container ships and fishing vessels in that order. They account for 43%, 29% and 13% of the WTW CO_2-equivalent (CO_2e) emissions respectively, which is a similar distribution to last year. Total emissions from all categories decreased in 2025, except for "Other" vessels. WTW CO_2e emissions from fishing vessels notably went down by 17% despite the number of calls only decreasing by around 2%.

Port calls from whale watching boats see a slight decline after having risen steadily since the pandemic, dropping from 4589 to 4428 calls between 2024 and 2025. Because these vessels generally have small engines, their contribution to the total WTW CO_2e is calculated to be only 1.2%.

WTT emission factors were updated this year, which resulted in 1.3% less WTW CO_2e emissions compared to if the old emission factors have been used. Previous years' results were also recalculated, leading to their WTW CO_2e total decreasing by around the same percentage.

Use of OPS (On-shore Power Supply) went down overall in 2025. Also, the vessel Dettifoss which is usually a large consumer of electricity at Sunda harbour did not use OPS this year due to equipment failure. In total, consumed electric power decreased by around 22% from last year.

Like in previous years, Sunda harbour and Old harbour receive significantly more ship calls than Akranes and Grundartangi. Sunda harbour received the most calls from container (314) and cruise (146) ships out of the four ports in 2025, which are the ship categories with the most emissions in total. Ships calling at Sunda harbour were responsible for around 69% of the CO_2e emissions in Faxaflóahafnir.

Table of contents

1 Introduction

IVL Swedish Environmental Research Institute, on assignment from Faxaflóahafnir, has calculated the emissions from ships visiting its harbours in 2025. Faxaflóahafnir comprises the four ports of Akranes harbour, Grundartangi harbour, and Sunda harbour and Old harbour in Reykjavik. The locations of the different ports are shown in Figure 1, which also indicates with red lines the traffic areas covered in the emission inventory.

The inventory includes emissions of greenhouse gases (*Well-To-Wake, WTW* and *Tank-To-Wake, TTW*) carbon dioxide (CO_2) and carbon dioxide equivalent (CO_2e, including the global warming potentials of nitrous oxide (N_2O) and methane (CH_4)), nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC), particle matter (PM), and sulphur dioxide (SO_2). The emission calculations are based on call statistics provided by the port.

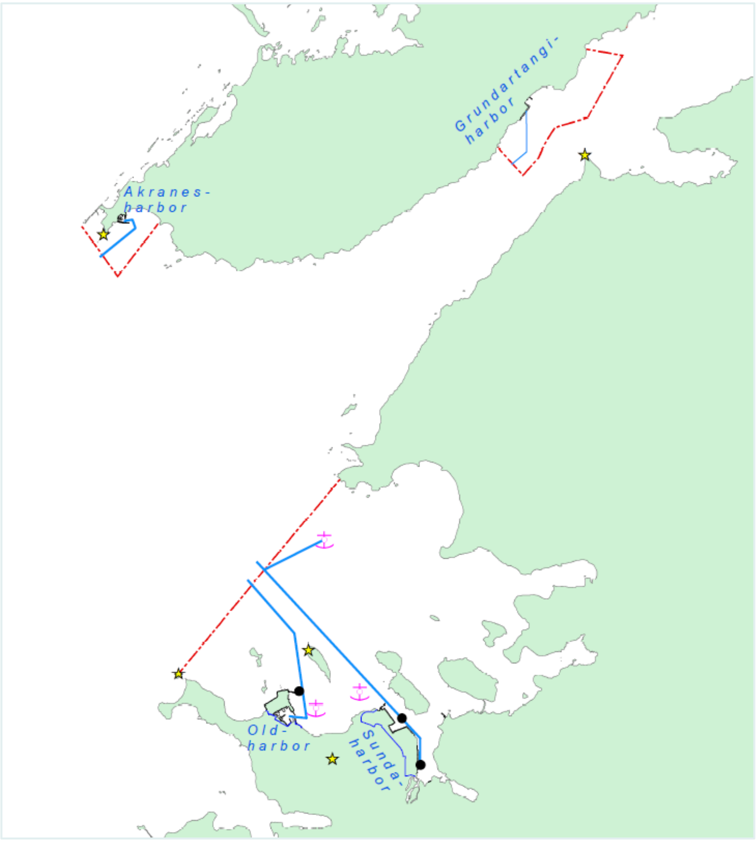

Figure 1: The four ports of Faxaflóahafnir and the areas outside the ports included in the emission inventory.

This report describes the emission calculation model, the data used, and the results. Results for 2025 are analyzed and discussed in relation to emission calculations made from ships calling the port in the years 2016 - 2024.

2 Ship traffic

In total, this inventory covers 5 813 port calls comprising in total 1 385 larger vessels. In addition to these calls, the port received 4 428 calls from whale watching boats in 2025, which are all included in the inventory.

The ship traffic to the different harbours in Faxaflóahafnir comprises several different ship types and ship sizes, from large container vessels to small whale watching boats. These ships have been categorized into nine ship types, depending on the type of cargo they carry or the service they provide. The ship types are "Dry bulk carriers", "Container ships", "Cruise ships", "Oil- and chemical tankers", "RoRo-vessels/Ferries", "General cargo ships", "Fishing vessels", "Whale watching boats" and "Other ships". In cases where a ship visits different ports during the same port call, the call is allocated to the final port visited before departure. A summary of the traffic to the four harbours is shown in Table 2.

Table 2: Number of port calls and ship movements registered in 2025 in the different harbours in Faxaflóahafnir. The number of ship movements in the used data are lower than in the data from port call statistics since some ships are omitted, for example due to being military vessels or lacking information.

Harbor	Port calls (cargo, cruise, fishing and "other")	Port calls (whale watching boats)	Ship movements (cargo, cruise, fishing and "other")	
			Used data	Port call statistic indata
Akranes harbour	26	0	32	32
Grundartangi harbour	149	0	265	267
Old harbour	571	4 428	703	715
Sunda harbour*	639	0	863	870
TOTAL	**1 385**	**4 428**	**1 863**	**1 884**

*Includes anchorage outside the harbour at berth 951 "Kollafjörður".

For each of the four harbours, a surrounding area has been identified within which emissions from the ships are calculated. These areas are indicated by red lines in Figure 1. The emissions from ships in these areas are calculated for four different operational modes: *in port basin*, *maneuvering*, *at berth*, and *at anchor*. Emissions from *in port basin* operations are calculated from the time each ship spends in transit between the outer boundary of the port area and their assigned berth. *Maneuvering* operations are assumed to be twenty minutes per call, during which the ships are maneuvered with high precision before and after standing stationary at the quayside, a period which often requires rapid engine load changes that strongly influences emissions. During periods *at berth*, the ships are assumed to use auxiliary engines for electricity requirements on board. An exception are cruise ships with diesel electric power trains that provides auxiliary power from the main engines. The time in the *port basin* is estimated from the distance between a quay and the limits of the traffic area, and ship speed, which is assumed to be relative to the size of the vessel. Therefore, ship size has been used as a proxy to estimate time in the port basin. All time estimates have been provided by Faxaflóahafnir and can be found in Appendix 1. Whale watching boats are assumed to be berthing if they stay longer than one hour in the port area.

Several of the ships in Faxaflóahafnir also use On-shore Power Supply (OPS) when at berth. Statistics on time at berth and shore side power use for individual ship calls have been provided by Faxaflóahafnir. There are also four anchoring sites in the traffic areas covered by the inventory. During periods at anchor, operation of ship engines is similar to operation at berth, although power needs are lower for certain ship types.

3 Emission calculation

For each ship call, engine emissions are calculated as a product of emission factors, the utilised engine power, and time. For each engine and during each of the four operational modes equation (1) is applied.

$$E = EF \cdot t \cdot P \qquad (1)$$

Where E is the emission in grams of a certain substance from an engine in a certain operating mode, EF is the emission factor for a pollutant in g/kWh in a certain operating mode, t is the time in hours when the engine operates in this mode, and P is the power output in kW from the engine during this operating mode.

3.1 Emission factors

The emission factors for marine engines used in this report are presented in Appendix 2. The main parameters determining emission factors are the fuel used and the engine speed. To give two examples: Heavy Fuel Oil (HFO) with high sulphur content results in significantly higher emission factors for sulphur dioxide and particles than lighter fuel qualities, while NO_x

emissions depend on engine speed to a large extent with less emissions per unit energy from high-speed engines than from slow speed engines.

Emission factors for CO_2, CH_4, N_2O, and NMVOC for main engines and auxiliary engines are taken from Cooper and Gustavsson (2004). NO_X-emission factors follow regulatory standards for post-2000 ships: Tier I levels for ships constructed after 2000 and before 2011, and Tier II levels for ships constructed after 2011 (IMO, 2017). As Iceland is not within a NO_X Emission Control Area (NECA), Tier III regulations do not apply. This will change, however, with the adoption of the *North-East Atlantic Ocean ECA*, which will cause ships constructed after 1 January 2027 to be covered by Tier III regulations (DNV, 2025). Due to lack of data availability, it is not possible to identify which ships from before 2000 fulfil Tier I requirements. For these vessels, no NO_x reduction measures are assumed to be used.

Fishing vessels are assumed to use different qualities of fuel, depending mainly on vessel size, with fuel sulphur content varying from 0.001% to 0.46%. Whale watching boats are assumed to use only marine gas oil (MGO), which has an assumed sulphur content of 0.06%. For any ship using Very Low Sulphur Fuel Oil (VLSFO) or HFO with scrubbers, we assume the same SO_2 emission factor as for MGO.

The emission factors for particulate matter (PM) are to a certain extent dependent on the sulphur content of the fuel. A literature review of emission measurement results shows no clear relationship between fuel sulphur content and PM emissions at low sulphur content (<0.1 %), and, further, that a dependence on engine load is uncertain. Here, a distinction between PM emission factors is made for fuels that have an assumed sulphur content of <0.1 %, such as Ultra-Low Sulphur Fuel Oil (ULSFO)/MGO and fuels that have an assumed sulphur content of <0.5 % (such as VLSFO). The emission factors for PM emissions are presented in Appendix 2.

It is common to use diesel-fired boilers onboard ships to produce steam and heat. When the main engine is running on high loads, the boiler is often replaced by an exhaust gas economizer that uses excess heat from the exhausts for heat and steam production. However, when at berth or operating on low main engine loads, the diesel-fired boilers are needed since the exhaust gas heat is too low to meet heating demands. Only a few studies report emission factors from boilers. In this study, emission factors from USEPA (1999) reported for boilers in relevant sizes for ship installations are used (Appendix 2). Emissions of CO_2 and SO_2 from boilers are calculated from the carbon and sulphur fuel contents, assuming complete combustion. The uncertainties in the calculated emissions from boilers are relatively high due to the lack of reliable emission factors, average fuel consumption, and limited available information on the utilization of boilers.

Some ships are assigned individual emission factors. These include ships that are known to always use OPS, which are assumed to have no emissions at berth except for the time used to connect and disconnect to the power grid. The fishing vessels in the HB Grandi fleet are also treated as special cases as these are known to use fuel with very low sulphur content.

Another subset of ships, those registered for the Environmental Ship Index (ESI), are assigned individual emission factors for NO_X. The ESI is an index that indicates a ships emission performance, particularly regarding NO_X. The ESI system combines NO_X emission factors for all engines on board via a weighing process to a single value. Details on these calculations are presented in Appendix 3.

3.2 Engines and fuels

Emissions are calculated for main engines, auxiliary engines and auxiliary boilers separately. The database *Sea-web Ships* contains information on all ships with IMO-numbers (IHS, 2026). *Sea-web Ships* has been used for retrieving information on installed main engine power for an absolute majority of the ships visiting Faxaflóahafnir. For a limited number of ships, the installed main engine power has been estimated from ship size and ship type according to statistics developed by the IMO (IMO, 2014). *Sea-web Ships* also contains information on engine speed for most main engines. If this information is not given in the database, an estimated engine speed based on known engine speeds for similar ship types and ship sizes is calculated.

The installed power for auxiliary engines is not given in the database. Instead, empirical relations from a large number of ships of similar types that relate installed auxiliary engine power to ship size are used (Sjöbris et al., 2005). All auxiliary engines are assumed to be high speed diesel engines, except for container ships at berth and anchor, and product tankers at anchor, for which auxiliary engine powers are determined from the specific power demand instead (Appendix 2).

The installed main engine power for fishing vessels is taken from *Sea-web*. Auxiliary engine powers for fishing vessels are instead estimated as central values in a span of likely installed auxiliary power for ships of different sizes and installed main engine power. A categorization of fishing vessels has, in a previous study, been provided by HB Grandi (2017)[1]. Each category was assigned a typical range of installed main engine and auxiliary engine power. The categories and the installed main engine power of shipping vessels in Faxaflóahafnir stated in the *Sea-web Ships* data base have been matched. As a result, fishing vessels are divided into five

[1] HB Grandi is a large sea food company based in Reykjavík and owner of ten large fishing vessels.

categories primarily based on installed main engine power. The categories and the central values for installed auxiliary engine power used in the calculations are presented in Table 3.

Table 3: Categories of installed power on fishing vessels, main engines and aux engines.

Category No.	Fishing vessel - Main engine power category (min – max, kW)	Fishing vessel - Aux engine power category (min – max, kW)	Aux Engine central value (kW)
1	37 – 559	0	0
2	600 – 1 035	220 – 600	410
3	1 036 – 1 762	220 – 600	410
4	1 763 – 3 699	700 – 900	800
5	3 700 – 9 000	1 500 – 2 000	1 750

The utilization of power from the engines during the different operational modes is required for the emission calculations. This information is often relatively uncertain and differs greatly between different ships. For this study, general values first reported by Entec UK (2002) are used. These values are presented in Table 4. However, for container, vehicle carriers, large RoRo ships at berth and at anchor, as well as product tankers at anchor, special auxiliary power demand factors are used (Appendix 2).

Table 4: Estimated power utilization (as share of installed engine power) at different operational modes (Entec UK Ltd, 2002).

In port basin	In port basin	Manoeuvring	At anchor/at berth[1]
Main Engine	20%	20%	0%
Auxiliary Engine	40%	50%	40%

[1]Cruise ships with diesel electric drives use main engine power at berth. 12% power utilization is assumed, corresponding to power needs of cruise ships with diesel mechanic drive and aux engines installed.

The main engine load of fishing vessels is assumed to be the same as for the other ship categories. However, the installed auxiliary engine power on certain categories of fishing vessels is, to a large extent, designed to manage the electricity needs for freezing fish or for trawling. From information and values provided by HB Grandi (2017), we have made assumptions on utilization of auxiliary engine power as presented in Table 5.

Table 5: Estimated power utilization or power requirements of auxiliary engines in different categories of fishing vessels.

Category Nr.	In port basin	Mano-euvring	At berth	Comment
1	0	0	0	No auxiliary engines are installed on these vessels
2	0	50%	21%	Auxiliary engine system dimensioned for trawling. Therefore, lower aux engine load at berth assumed than for other ship types. 21 % is an estimated value.
3	0	50%	40%	These ships often use shaft generators, and the engine dimensions and utilization can be assumed to be similar to most ship types.
4	40%	50%	26%	These ships can process and freeze fish on board. Between 17% and 43% of installed aux engine power is needed for freezing. At berth, shore side electricity is not always enough. It is assumed that for 50% of the time these vessels need power for freezing and un-loading (up to 300 kW). For 50% of the time, during lay-up, 150 kW is assumed to be needed. 26% auxiliary engine utilization is an approximate average for time at berth.
5	40%	50%	23%	These ships can process and freeze fish on board. Between 15% and 40% of installed auxiliary engine power is used at berth. At berth, shore side electricity is not always enough. It is assumed that for 50% of the time these vessels need power for freezing and un-loading (500-600 kW). For 50% of the time, during lay-up, 300 kW is assumed to be needed. 23% aux engine utilization is an approximated average for time at berth.

For ships using shore-side power, the power values listed in the port call statistics for various calls are used to calculate how much of the fuel consumed at berth is offset by electricity use. It is assumed that the ships only use electricity produced as "green" electricity and therefore the associated emissions are considered negligible for the purposes of these calculations[3].

Tankers often use electricity from the auxiliary engines to run cargo pumps. This is accounted for by adding fuel consumption that relates to the carrying capacity of the individual tanker. According to information from a tanker operator, the typical fuel consumption for cargo pumps is 3 tonnes/day at off-loading. An off-loading operation for 14 000 tonnes oil requires about 15 hours. Based on this information, a general value of 0.13 kg fuel/tonne cargo has been calculated and is used for all tanker ships at off-loading operations. Further, the amount of cargo on the tankers is estimated as 42% of the ships' dead weight tonnage. The value is based on a study made for Port of Gothenburg in 2017. Thus, for each tanker call, additional fuel consumption (in kg) according to equation (2) is assumed.

[3] As a comparison, the lifecycle emissions from the Icelandic electricity were 28 g CO_{2e}/kWh_{el} in 2025 (Electricity Maps, 2026), while the emission at berth from auxiliary engine was calculated to be about 870 g CO_{2e}/kWh_{el} on average.

$$Fuel\ consumption = 0.42 * DWT * 0.13 \qquad (2)$$

Large tankers sometimes use steam from boilers to run their cargo pumps. However, here it is assumed that all cargo pumps use electricity from auxiliary engines. This seems to be the most common arrangement for tankers of the size classes that are common in Faxaflóahafnir; tankers of smaller sizes tend to use electricity driven pumps while larger ships use steam driven pumps.

The main engines' fuel during operations *in* port basin, and manoeuvring is assumed to be MGO, or VLSFO or residual oil (RO) for ships that have a scrubber installed. For auxiliary engines, the fuel is assumed to be MGO. More detailed information on the use of different fuel qualities by fishing vessels has been possible to include in the model after communication with HB Grandi (2017). Large fishing vessels are assumed to use fuel qualities in line with other ships of the same size, but always MGO in the auxiliary engines. Small fishing vessels are reported to use MGO exclusively. Furthermore, all small fishing boats in the HB Grandi fleet use diesel oil with a very low sulphur content of 0.001%. These fuel types as reported by Grandi are assumed for all fishing vessels of the respective size in the inventory. Further, whale watching boats are assumed to use only MGO.

A size dependent generic value on fuel consumption in ship boilers has been calculated for all visiting ships from values from a report from the Port of Los Angeles (2010). Exceptions are made for the category RoRo/ferry and container ships, for which values from a study in Gothenburg is used (Winnes and Parsmo, 2016). The values are presented in Table 6. It is assumed that the boilers exclusively use MGO as fuel.

Table 6: Fuel consumption in oil fired boilers for operational modes at anchor, in port basin, manoeuvring, and at berth. Fuel consumption is given per thousand gross tonnes and hour.

Ship type	Fuel consumption/ (1000 GT *hour)
Bulk carriers	1.4
Oil- and chemical tankers	4
Container ships (0–5 000 TEU)	4.2
Container ships (< 17 000 TEU)	0.8
Cruise ships	4
General cargo ships	0.9
Other ships	4
Reefers	5.4
RoRo/Ferries	2

3.3 Calculating upstream emissions

To calculate the upstream emissions, the amount of primary energy found in the unburned fuel is first calculated. Then the upstream emissions can be calculated using the upstream emission factors (shown in Table 8 in *Section 3.4 Update of upstream emission factors*). The fuel consumption for main and auxiliary engines is calculated using Equation 3:

$$\mathrm{Fuel}_{\mathrm{MJj}} = \mathrm{t} \cdot \mathrm{P} \cdot \mathrm{LCV} \cdot \mathrm{SFOC} \qquad (3)$$

Where:

t: is the time in hours when the engine is operating in this mode

P: is the power output in kW from the motor during this operating mode

LCV: Lower calorific value (also known as heating value) of the fuel in MJ / kg fuel. Values for the most common fuels are shown in Table 8.

SFOC: Specific fuel oil consumption is the engines' assumed fuel consumption in kilograms per kWh, i.e. including the assumed efficiency, see Appendix 2 for more detailed information.

Fuel consumption for the boilers has been calculated by Equation 4.

$$\mathrm{Fuel}_{\mathrm{MJ}} = \mathrm{FC}_{\mathrm{GT}} \cdot \mathrm{LCV} \cdot \mathrm{GT} \cdot \mathrm{t} \qquad (4)$$

Where:

FC_{GT}: are standard values for the boilers' fuel consumption

GT: is the ship's gross tonnage

t: is the time the boilers have been used

Table 7: Lower heating value for different fuels.

Fuel type	Lower heating value	Source
MD	43.0	Bengtsson et. al. (2011)
RO	40.4	Bengtsson et. al. (2011)
LNG	48.0	Bengtsson et. al. (2011)
VLSFO	40.4	Assumed same as RO

3.4 Update of upstream emission factors

This year, the upstream Well-To-Tank (WTT) emission factors have been updated, and all previous years have been recalculated with these new emission factors. WTT emissions arise from the extraction, production, and distribution of fuels and can constitute a significant portion of the total climate impact, especially for biofuels and alternative fuels. This includes, for example, greenhouse gas emissions such as methane released at oil wells, or fuel used during fuel transport.

This resulted in the calculated total WTW CO_2e being around 1.3% lower than before.

The following is an explanation of the purpose for upstream emission factors and how they have been chosen.

In order to gain a complete picture of the climate impact of shipping, it is not sufficient to only account for direct emissions (Tank-to-Wake). To provide you with a full and accurate understanding of the climate impact, upstream emissions (Well-to-Tank, WTT) must also be included.

These emissions are also central to:

- **Science Based Targets initiative (SBTi)** – For companies setting climate targets under SBTi, it is mandatory to include upstream emissions in Scope 3 to ensure accurate reporting and effective climate actions. This reflects the principle that companies have climate responsibility across their entire supply chain.
- **CSRD** – The EU's new directive requiring companies to report comprehensively on their climate-impacting emissions, including upstream emissions within Scope 3.
- **Regulations and reporting requirements** – Within the EU and globally, it is becoming increasingly important to maintain transparent and comprehensive climate reporting. For the maritime sector, upstream emissions are included in the EU's Fit for 55 package.

The best option is to use *supplier-specific data* for biofuels, electricity usage, and other alternative fuels. It is, for example, sometimes possible to require certification of greenhouse gas emissions from fuel suppliers or to request GHG reporting under the CSRD for their products. This approach provides a more accurate picture of the operation's real upstream emissions. However, for the purpose of this assignment, standard emission factors per fuel type have been used.

The choice of emission factors depends on *the fuel type*, *data source*, and *fuel quality*. For example, biofuels can have highly variable upstream emissions depending on the feedstock and production method. Different production sites also have different emissions. For example, FuelEU Maritime provides values for marine gas oil (MGO) currently used in the EU, which results in a WTT factor of 14.4 g CO_2e/MJ. The IMO's LCA guideline on the other hand presents a standard value based on global average data at 17.7 g CO_2e/MJ for MGO.

A summary of commonly used values and our recommended figures is provided in Table 8.

Table 8: Common emission factors for upstream GHG emissions (CO2 equivalents/MJ fuel).

		FuelEU Maritime default values (2023/1805)	IMO LCA guideline default values (MEPC 80/17)	Bengtsson et al (2012)	Brynolf et al (2014)	Comer and Osipova (2021)	Kanchiralla et al. (2023)	Brynolf et al. (2023)	JRC (European Commission: Joint Research Centre, 2020)	Recommended value
Fuel	Fuel name (full)	CO_2e/MJ	CO_2e/MJ	CO_2e/MJ	CO_2e/MJ	CO_2e/MJ	CO_2e/MJ	CO_2e/MJ	CO_2e/MJ	CO_2e/MJ
MGO/MDO	Marine Gas Oil Marine Diesel Oil	14.4	17.7	15.95	9.10	16.84	14.2	11.2	18.9 (13.7–18.9)	17.7
HFO	Heavy Fuel Oil	13.5	14.9–16.8	15.95	8.54	13.77	14.2	-	-	14.9
VLSFO/ULSFO	Very/Ultra Low Sulphur Fuel Oil	13.2	-	-	-	16.2	-	-	-	16.2
LNG	Liquefied Natural Gas	18.5	-	10.82	9.17	22.5	-	17.2	16.6	18.5
LBG	Liquefied Biogas	-78.2–48	-	12.17–17.17	-	-	-	-	-30.1 (-98.7–30.5)	10
HVO	Hydrotreated Vegetable Oil	0–33.4	14.9	-	-	-	-	-	11.1 (10.8–62.4)	11.1

It is particularly important to include upstream emissions when using biofuels and electricity. This is because greenhouse gas emissions from these sources are not usually accounted for at the exhaust pipe/propeller. Instead, emissions are reported during the production of these fuels. We refer to the total emissions as Well-To-Wake (WTW), which encompasses both WTT and TTW emissions.

3.5 Global warming potential (GWP100)

To assess the emissions of the greenhouse gases CH_4 and N_2O, their total emissions are multiplied by their global warming potential over a 100-year time horizon (GWP100) to produce CO_2e. The GWP100 used are 25 for CH_4 and 298 for N_2O (IPCC, 2013).

3.6 Shore power data

The shore power values reported alongside the port calls are given as electric energy consumption (kWh). Frequently multiples of 400 kWh appear in these statistics, for which the following explanation has been given:

- 400 kWh is the least electric energy the customer can pay for, meaning that if an entry says 400 kWh the charged amount could be anywhere in the range 0-400 kWh. If there are multiples of 400 kWh (such as 800, 1200 etc.) this means that several cables have been connected. So, 800 kWh would be 2 cables each charging 0-400 kWh.

- For cruisers, Faxaflóahafnir has informed that entries of 400 kWh are not actual OPS connections, but smaller cables powering for example reefers and conveyor belts. This power is not replacing any fuel consumption. Therefore, entries with multiples of 400 kWh can be removed for all cruisers.

The emission reduction of using OPS is determined by calculating how much fuel consumption at berth is replaced by the reported OPS usage.

3.7 Sulphur limit

There is a sulphur limit of 0.1% within Iceland's territorial sea and internal waters starting from 2020 (Government of Iceland, 2019). This is further clarified by the Environment Agency of Iceland as:

"Where sulphur content of marine fuels is restricted to 0,10 % (m/m), the maximum emission ratio of SO2 (ppm)/CO_2 (%v/v) is 4.3"

What this means is that ships using fuels with sulphur content above 0.1% need to use scrubbers in order to reduce SO_2 in the exhaust gas to reach an equivalent amount. The sulphur content of HFO/VLSFO has therefore been set to the same value as for MGO, assuming that the exhaust is cleaned below the limit with some margin (emission factors for sulphur are provided in Appendix 2).

4 Results

Table 9 presents the emissions of the different substances per engine type and operational mode. The period at berth accounts for the largest share of emissions of all substances. Auxiliary engines are the dominant source for all the emissions.

In the result tables, CO_2 values are rounded to the nearest hundred where the results are aggregated for all four ports, and rounded to the nearest ten in the port-specific tables. NO_x values are rounded to the nearest whole number, and NMVOC, PM, and SO_2 values to one decimal place. We recommend using only two digits of significance in communication of any results within this report, as there are always uncertainties when performing an emission inventory such as this.

Emissions of SO_2 are directly related to the sulphur content in the fuel except for the ships with scrubbers. Even though most of the fuel is consumed in the auxiliary engines, SO_2 emissions from main engines are higher relative to auxiliary engines, since it is assumed that main engines run on high sulphur fuel to a large extent. Further, main engines are almost exclusively used for propulsion which is the reason for the relative importance of emissions during the in-port basin operational mode. The diesel electric driven cruise ships are an exception as they use their main engines at berth as well, although they use exclusively low sulphur fuel or after-treatment. CO_2 (TTW) emissions are almost directly related to the fuel consumption and are therefore a good proxy to use for fuel consumption in the analysis. In a comparison between the different operational modes, for 2025, the operations at berth can be attributed approximately 81% of the total CO_2 emissions. The CO_2 emissions from the auxiliary engines is calculated to be 42% of the total fuel consumed by all three engine types. Emissions of the greenhouse gases, dominated by CO_2 emissions, reached a value of 65 900 tonnes of CO_{2e} (WTW).

Table 9: Overview of emissions from ships in Faxaflóahafnir 2025.

		Greenhouse gases			NO_x (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)
		CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW				
Main Engines	In port basin	7 300	6 200	6 100	94	2.8	5.1	2.2
	At anchor**	0	0	0	0	0.0	0.0	0.0
	Manoeuvring	1 100	900	900	14	0.4	0.7	0.3
	At berth*	16 200	13 500	13 200	164	5.6	3.4	4.8
Auxiliary Engines	In port basin	2 000	1 600	1 600	22	1.2	0.4	0.6
	At anchor**	500	400	400	6	0.3	0.1	0.1
	Manoeuvring	400	300	300	5	0.3	0.1	0.1
	At berth*	24 900	20 100	19 900	287	14.6	5.4	6.8
	Tankers at berth using cargo pumps	200	100	100	1	0.1	<0.05	0.1
Boilers	In port basin	1 000	800	800	1	<0.05	0.1	0.3
	At anchor**	100	100	100	<0.5	<0.05	<0.05	<0.05
	Manoeuvring	100	100	100	<0.5	<0.05	<0.05	<0.05
	At berth*	12 100	9 800	9 600	9	0.1	0.8	3.7
TOTAL (Engines and boilers)	Main engines	**24 600**	**20 600**	**20 200**	**272**	**8.8**	**9.2**	**7.3**
	Auxiliary engines	**28 000**	**22 500**	**22 300**	**321**	**16.4**	**6.0**	**7.7**
	Boilers	**13 300**	**10 800**	**10 600**	**10**	**0.1**	**0.8**	**4.0**
TOTAL (Operational modes)	In port basin	**10 300**	**8 600**	**8 500**	**117**	**4.0**	**5.6**	**3.1**
	At anchor**	**600**	**500**	**500**	**6**	**0.3**	**0.1**	**0.2**
	Manoeuvring	**1 600**	**1 300**	**1 300**	**19**	**0.7**	**0.8**	**0.5**
	At berth*	**53 400**	**43 400**	**42 700**	**461**	**20.4**	**9.6**	**15.4**
TOTAL	All engines and boilers, all operational modes	**65 900**	**53 900**	**53 100**	**603**	**25**	**16**	**19**

*Only cruise ships with diesel electric power trains

**Includes emissions from ships in shipyard

In Table 10 the emissions from 2016-2025 are presented together. All years have been recalculated according to the new WTT emission factors (see *Section 3.3 Update of upstream emissions*).

Table 10: Emissions and number of calls from 2016 to 2025 for ships visiting Faxaflóahafnir.

Year	Greenhouse gases			N_2O	NO_x	HC	PM	SO_2	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW						
2016	45 300	36 800	36 400	1.4	505	21	11	73	7 136
2017	51 900	42 200	41 700	1.6	557	23	13	89	7 059
2018	57 000	46 300	45 800	1.8	614	25	14	94	6 006
2019	67 100	54 600	54 000	2.1	730	29	16	104	6 955
2020	49 900	40 300	39 900	1.5	496	23	11	13	2 818
2021	43 900	35 700	35 300	1.3	427	19	11	14	3 670
2022	62 500	50 900	50 300	1.9	601	26	15	18	5 394
2023	72 100	59 000	58 200	2.2	683	28	18	21	5 892
2024	72 000	58 800	58 000	2.2	679	28	18	20	5 999
2025	65 900	53 900	53 100	2.0	603	25	16	19	5 813

In Figure 2, CO_2 emissions are presented for the different ship types for 2016 to 2025, demonstrating trends over time. This year's decrease in emissions is mainly seen in the container ship, cruise ship and fishing vessels categories.

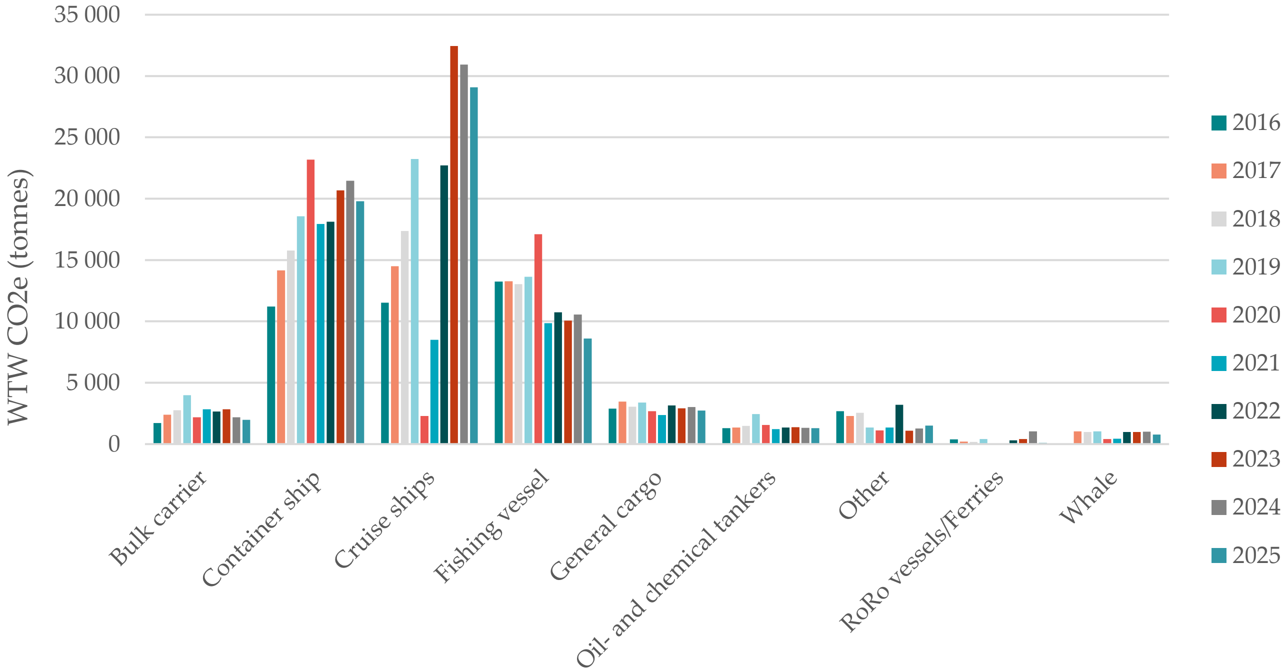

Figure 2: WTW CO2e emissions for different ship types from 2016 to 2025.

Figure 3 illustrates the number of port calls by each ship type for the above-mentioned years, excluding whale-watching boats. The just mentioned emission decreases are also coupled with fewer port calls from said ship categories. Apart from that, the most noticeable relative changes are the drop in RoRo/Ferry traffic and the increase in traffic from "Other" ships. However, these categories also have few total calls and can therefore fluctuate easily. They also have a small impact on the total emissions.

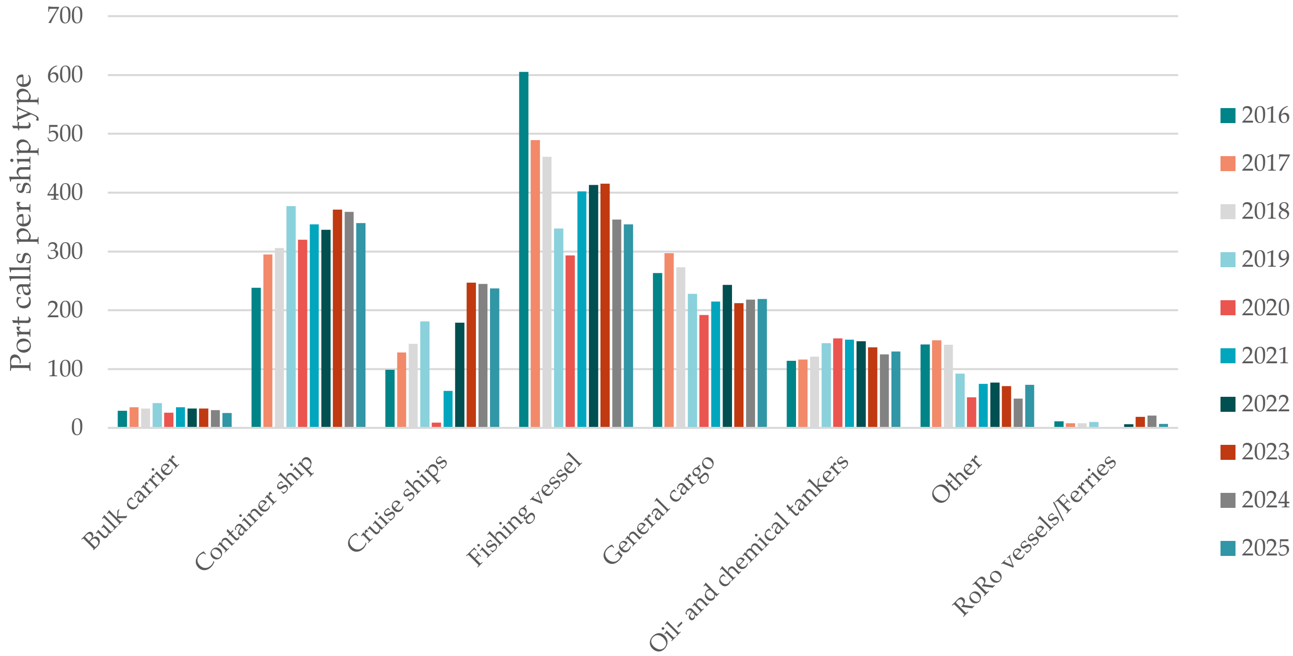

Figure 3: Port calls for different ship types from 2016 to 2025.

In Figure 4, a calculation of the average CO_2 emission per port call for different ship categories provides an insight into the impact that a single port call can have. Cruise ships cause the most emission per port call by far due to their high emissions at berth, while for example RoRo-vessels and whale watching boats have very low impact per individual call.

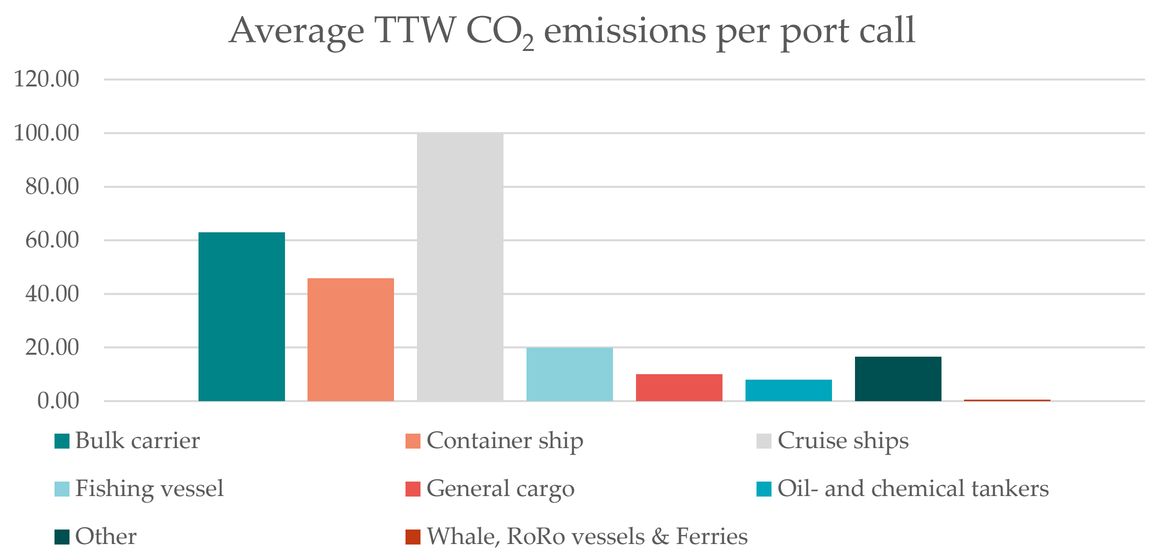

Figure 4: Emission intensity of different ship type in 2025.

The average port call intensity across all ship types is higher now than before the pandemic, as shown in Figure 5. This can largely be attributed to traffic from cruise ships increasing after 2020, as seen in Figure 3. Because cruise ships are such heavy emitters they single-handedly push up the average. The spike for 2020 in Figure 5 is driven by the dip in port calls for that particular year (at berth emissions especially were still high, but spread out on much fewer port calls).

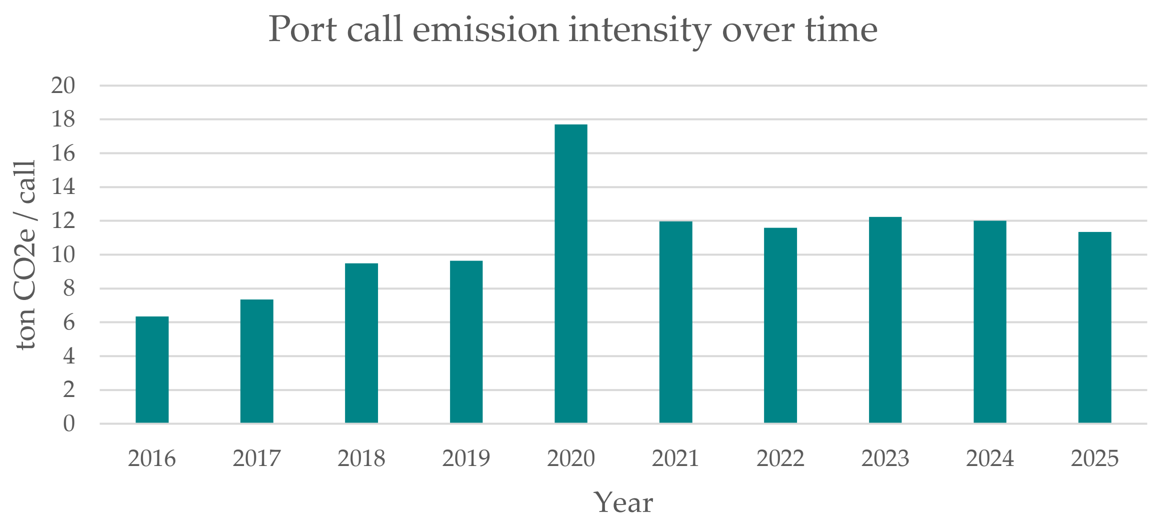

Figure 5: Average Well-To-Wake CO_{2e} emissions per port call per year.

Faxaflóahafnir provides connections to shore side electricity in Old harbour, Sunda harbour, and Akranes harbour, and many ships use shore side power at berth. By assuming these ships used electricity from onboard diesel generators if the shore side connections were not available, a measure of "avoided emissions" is estimated. This is the difference between emissions at berth if no ships were to use shore side power and the calculated actual emissions at berth. The avoided emissions are presented in Table 11 for the four harbour areas, and Table 12 shows the emissions divided by ship type.

Table 11: Avoided emissions from on-shore power use.

Harbour	Greenhouse gases			NO_x (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW				
Akranes harbour	<5	<5	<5	<0.05	<0.05	<0.05	<0.05
Grundartangi harbour	0	0	0	0	0.0	0.0	0.0
Old harbour	1 210	970	960	14	0.7	0.3	0.3
Sunda harbour*	70	60	60	0.5	<0.05	<0.05	<0.05
TOTAL	**1 290**	**1 030**	**1 020**	**14**	**0.8**	**0.3**	**0.3**

*Savings from Herjólfur III being connected to OPS is not included as the ship was inactive. See *Section 5.2 Herjólfur III* for more details.

Table 12: Emissions for 2025 divided into ship type.

Ship type	Greenhouse gases			N_2O (tonne)	NO_x (tonne)	HC (tonne)	PM (tonne)	SO_2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW						
Dry bulk carriers	2 000	1 600	1 600	0.1	16	1.0	0.5	0.6	25
Container ships	19 800	16 100	15 900	0.6	183	8.1	5.4	6	348
Cruise ships	29 100	24 100	23 700	0.9	258	9.1	7.3	9	237
Oil- and chemical tankers	1 300	1 100	1 000	<0.05	8	0.6	0.3	0.4	130
RoRo vessels/Ferries	100	100	100	<0.05	1	0.1	<0.05	<0.05	7
General cargo ships	2 700	2 200	2 200	0.1	31	1.5	0.6	0.8	219
CRUISE AND CARGO SHIPS*	**55 000**	**45 200**	**44 500**	**2**	**496**	**20**	**14**	**17**	966
OTHER SHIPS	1 500	1 200	1 200	<0.05	10	0.4	0.2	0.4	73
FISHING VESSELS	8 600	6 900	6 800	0.3	88	4.2	1.7	1.90	346
WHALE WATCHING BOATS	800	600	600	<0.05	9	0.4	0.2	0.2	4428
TOTAL 2025	**65 900**	**53 900**	**53 100**	**2.0**	**603**	**25**	**16**	**19**	**5 813**

* "CRUISE AND CARGO SHIPS" contains the sum of emissions from "Dry bulk carriers", "Container ships", "Cruise ships", "Oil- and chemical tankers", "RoRo vessels/Ferries", and "General cargo ships".

Whale-watching boats stick out be having the most port calls by far while contributing very little to the overall emissions.

4.1 Emissions from ships in the different harbour areas

The different harbour areas in the port serve different ship and have large differences in the total emissions. Sunda harbour is the busiest cargo and cruise port with roughly 45 490 tonnes of emissions of CO2e. Akranes harbour is the least emitting harbour with approximately 430 tonnes of CO2e emitted in 2025. Table 13 shows an overview of the emissions in the different harbour areas of Faxaflóahafnir.

Table 13: Emissions from ships in the different harbour areas of Faxaflóahafnir in 2025.

Harbour	Greenhouse gases			NO_x (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)	Port calls (cargo, cruise, fishing and "other")	Port calls (whale watching boats)
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW						
Akranes harbour	430	350	340	4	0.2	0.1	0.1	26	0
Grundartangi harbour	6 400	5 170	5 110	64	3.0	1.4	1.9	149	0
Old harbour	13 560	10 960	10 820	126	6.5	2.6	3.4	571	4428
Sunda harbour*	45 490	37 400	36 830	409	15.6	11.9	13.7	639	0
TOTAL	**65 900**	**53 900**	**53 100**	**603**	**25**	**16**	**19**	**1 385**	**4 428**

*Includes anchorage outside the harbour at berth 951 "Kollafjörður".

Further details on emissions per ship type in the different harbour areas are presented in Table 14 (Akranes harbour), Table 16 (Grundartangi harbour), Table 18 (Old harbour), and Table 20 (Sunda harbour). The total emissions from each harbour area for the last seven years are accounted for in separate tables, Table 15 (Akranes harbour), Table 17 (Grundartangi harbour), Table 19 (Old harbour), and Table 21 (Sunda harbour).

Akranes harbour

Table 14. Akranes harbour - emissions from different ship types 2025 and the number of calls.

Ship type	Greenhouse gases			NOx (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
Dry bulk carriers	170	130	130	1	0.09	0.03	0.05	10
Container ships	0	0	0	0	0	0	0	0
Cruise ships	0	0	0	0	0	0	0	0
Oil- and chemical tankers	<5	<5	<5	<0.05	<0.05	<0.05	<0.05	1
RoRo vessels/Ferries	0	0	0	0	0	0	0	0
General cargo ships	130	110	110	1	0.07	<0.05	<0.05	11
CRUISE AND CARGO SHIPS*	**300**	**240**	**240**	**2**	**0.2**	**0.1**	**0.1**	22
OTHER SHIPS	70	50	50	1	<0.05	<0.05	<0.05	2
FISHING VESSELS	60	50	50	1	<0.05	<0.05	<0.05	2
WHALE WATCHING BOATS	0	0	0	0	0	0	0	0
TOTAL 2025	**430**	**350**	**340**	**4**	**0.2**	**0.1**	**0.1**	**26**

Table 15. Emissions from ships calling Akranes harbour 2016 to 2025, and the number of calls.

Year	Greenhouse gases			NOx (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
2016	2 610	2 100	2 070	29	1.4	0.5	1.1	34
2017	3 310	2 660	2 630	29	1.6	0.6	0.8	44
2018	1 290	1 040	1 020	12	0.7	0.3	0.5	34
2019	1 240	1 000	980	14	0.6	0.3	0.6	26
2020	210	170	170	2	0.1	0.05	0.1	15
2021	490	400	390	6	0.3	0.1	0.2	31
2022	900	730	720	10	0.5	0.2	0.2	57
2023	870	700	690	9	0.4	0.2	0.2	38
2024	400	320	320	4	0.2	0.1	0.1	26
2025	430	350	340	4	0.2	0.1	0.1	26

Grundartangi harbour

Table 16: Grundartangi harbour – emissions from different ship types in 2025.

Ship type	Greenhouse gases			NOx (tonne)	NMVOC (tonne)	PM (tonne)	SO2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
Dry bulk carriers	1 810	1460	1440	15	0.9	0.4	0.5	14
Container ships	3 210	2610	2580	34	1.4	0.7	1.0	32
Cruise ships	0	0	0	0	0	0	0	0
Oil- and chemical tankers	0	0	0	0	0	0	0	0
RoRo vessels/Ferries	0	0	0	0	0	0	0	0
General cargo ships	1 340	1080	1070	15	0.7	0.3	0.4	101
CRUISE AND CARGO SHIPS*	**6 360**	**5 150**	**5 090**	**64**	**3.0**	**1.4**	**1.9**	147
OTHER SHIPS	30	20	20	<0.5	<0.05	<0.05	<0.05	2
FISHING VESSELS	0	0	0	0	0	0	0	0
WHALE WATCHING BOATS	0	0	0	0	0	0	0	0
TOTAL 2025	**6 400**	**5 170**	**5 110**	**64**	**3.0**	**1.4**	**1.9**	**149**

Table 17: Emissions from ships calling Grundartangi harbour 2016 to 2025, and the number of calls.

Year	Greenhouse gases			NOx (tonne)	NMVOC (tonne)	PM (tonne)	SO2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
2016	4 780	3 870	3 830	52	2.3	1.1	10.7	203
2017	5 960	4 820	4 770	62	2.8	1.3	11.5	166
2018	6 210	5 030	4 970	63	2.9	1.4	11.2	179
2019	5 540	4 490	4 440	58	2.6	1.3	10.5	153
2020	6 080	4 920	4 870	62	2.8	1.5	1.8	144
2021	6 630	5 370	5 300	70	3.2	1.5	2.3	160
2022	7 170	5 800	5 730	73	3.4	1.6	2.2	166
2023	7 250	5 870	5 800	71	3.5	1.6	2.2	155
2024	6 690	5 410	5 350	68	3.2	1.5	2.0	150
2025	6 400	5 170	5 110	64	3.0	1.4	1.9	149

Old harbour

Table 18: Old harbour – emissions from different ship types in 2025.

Ship type	Greenhouse gases			NO_x (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
Dry bulk carriers	0	0	0	0	0	0	0	0
Container ships	40	30	30	<0.5	<0.05	<0.05	<0.05	2
Cruise ships	3 190	2 590	2 560	28	1.6	0.7	1.0	91
Oil- and chemical tankers	1 240	1 000	970	7	0.6	0.2	0.4	124
RoRo vessels/Ferries	100	80	80	1	0.0	0.0	0.0	6
General cargo ships	20	20	20	<0.5	<0.05	<0.05	<0.05	1
CRUISE AND CARGO SHIPS*	**4 590**	**3 720**	**3 660**	**36**	**2.3**	**0.9**	**1.4**	224
OTHER SHIPS	1 010	820	810	6	0.3	0.1	0.3	56
FISHING VESSELS	7 200	5 790	5 730	74	3.5	1.4	1.5	291
WHALE WATCHING BOATS	770	630	620	9	0.4	0.2	0.2	4 428
TOTAL 2025	**13 560**	**10 960**	**10 820**	**126**	**6.5**	**2.6**	**3.4**	**4 999**

Table 19: Emissions from ships calling Old harbour 2016 to 2025, and the number of calls.

Year	Greenhouse gases			NO_x (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
2016	13 270	10 710	10 580	147	6.4	2.6	8.6	6412
2017	12 680	10 250	10 120	139	6.1	2.5	9.5	6209
2018	16 290	13 150	12 990	175	8.0	3.2	9.3	5182
2019	17 620	14 210	14 040	192	8.8	3.5	9.6	6138
2020	14 460	11 650	11 510	149	7.1	2.8	3.1	2217
2021	10 730	8 680	8 570	103	5.1	2.1	3.2	2960
2022	15 840	12 790	12 620	155	7.7	3.1	4.3	4554
2023	13 330	10 790	10 650	126	6.3	2.6	3.6	5002
2024	14 300	11 550	11 390	138	7.0	2.8	3.6	5146
2025	13 560	10 960	10 820	126	6.5	2.6	3.4	4999

Sunda harbour

Table 20: Sunda harbour – emissions from different ship types in 2025.

Ship type	Greenhouse gases			NO_x (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
Dry bulk carriers	<5	<5	<5	<0.5	<0.05	<0.05	<0.05	1
Container ships	16 540	13 430	13 290	149	6.6	4.7	5	314
Cruise ships	25 880	21 490	21 100	229	7.5	6.6	8	146
Oil- and chemical tankers	70	50	50	<0.5	<0.05	<0.05	<0.05	5
RoRo vessels/Ferries	<5	<5	<5	<0.5	<0.05	<0.05	<0.05	1
General cargo ships	1 250	1 010	990	14	0.7	0.29	0.4	106
CRUISE AND CARGO SHIPS	**43 740**	**35 980**	**35 430**	**393**	**14.8**	**11.6**	**13.2**	**573**
OTHER SHIPS	410	330	330	3	0.1	0.1	0.1	13
FISHING VESSELS	1 340	1 090	1 070	13	0.7	0.3	0.4	53
WHALE WATCHING BOATS	0	0	0	0	0.0	0.0	0.0	0
TOTAL 2025	**45 490**	**37 400**	**36 830**	**409**	**15.6**	**11.9**	**13.7**	**639**

Table 21: Emissions from ships calling Sunda harbour 2016 to 2025, and the number of calls.

Year	Greenhouse gases			NO_x (tonne)	NMVOC (tonne)	PM (tonne)	SO_2 (tonne)	Ship calls
	CO_2-e (tonne) WTW	CO_2-e (tonne) TTW	CO_2 (tonne) TTW					
2016	24 650	20 110	19 880	277	10.3	5.9	52.2	487
2017	29 920	24 460	24 180	328	12.0	7.3	67.5	640
2018	33 170	27 110	26 790	364	13.2	8.1	72.6	611
2019	40 820	33 390	33 000	448	16.2	10.0	82.2	619
2020	29 130	23 590	23 320	283	12.7	6.9	7.8	442
2021	26 080	21 250	21 020	249	10.5	7.3	8.8	519
2022	38 550	31 630	31 190	364	14.0	10.4	11.5	617
2023	50 660	41 600	41 030	477	18.1	13.2	14.9	697
2024	50 590	41 540	40 920	468	17.9	13.2	14.8	677
2025	45 490	37 400	36 830	409	15.6	11.9	13.7	639

5 Discussion

5.1 Differences in emissions

Emissions of all pollutant types are lower than last year, primarily due to a decrease in calls. The largest decrease happened within the category Cruise and cargo ships with 4.3 ton WTW CO_2 emission less than in 2024. CO_2 emissions are now similar to the last pre-pandemic year of 2019. However, 2019 had around 1100 more port calls than 2025. As demonstrated in the results section, the increase in traffic of cruise ships after the pandemic has increased the average CO_2 emissions per port call, which leads to a situation with fewer calls but similar emissions levels to 2019.

The number of calls from the different ship categories were similar to last year. But it can be noted that whale watching ship port calls decreased for the first time since after 2020.

There were unusually large changes for fishing vessels this year. Time at berth for fishing vessels was greatly reduced in Akranes and Sunda harbour but increased in Old harbour. This does not correlate with changes in number of calls, which decreased somewhat for all ports. Instead, it shows a change in the operation of the fishing vessel fleet. These changes resulted in emissions for fishing vessels went down.

OPS use (excluding the separate data from Sunda) decreased by 17% from last year. If the Sunda data is included, the decrease amounts to 22% due to Dettifoss not using OPS in 2025. If the OPS use had stayed at the same level as last year, roughly 400 tons more WTW CO_2e emissions would have been avoided.

5.2 Herjolfur III

During the work it was noted that Herjólfur III, a RoRo ship of 3354 GT, was at berth for the entire year. The harbour master at Faxa explained via email that this was correct, but that it had been connected to OPS with its engines off. Because the model normally assumes that the aux engines are running when at berth, emissions had to be manually set to zero. If the modelling had not been manually changed, the calculated WTW CO_2e emissions would have been 1850 tonnes higher, which shows what difference a single ship can make if the data is not interpreted correctly.

The only other vessels at berth for the entire year were Hvalur 8 and Hvalur 9, presumably not running their engines. But because these were small vessels, the effects on the results were minimal and their emissions were left as calculated. However, this acts as a reminder to keep checking for abnormally long quay times in the port call data.

5.3 Model considerations

The model used includes generalized values in many instances. These are often based on averages from many observations or reports, which include variations around the average value. Examples of such general values are the emission factors and engine loads at different operational modes. This causes uncertainty in the results. However, in an emission inventory like this with many ships and ship calls, the total results will present a fair view of the actual emissions. If the scope is narrowed to a few ships or single ship types, the uncertainty in the result increases. The model is therefore unsuitable for analysis of emissions from individual ships or small groups of ships.

5.4 Comparison between ports

It is difficult to compare one port to another since the characteristics of ports vary considerably. Differences in ship sizes, logistic requirements, and ship types can all influence emissions; large ships need longer time at berth, small tankers in general cause more emissions at berth than small RoRo vessels, and the fairway channel varies in length in different ports, to give some examples.

These comparisons are most relevant to make for Sunda harbour and Old harbour which each year receives a high number of calls. The "emission per call" ratios in these harbour areas are less sensitive to single calls that may cause very high emissions and that may influence the results significantly.

Given this information, here is a comparison of average values in tonne CO_2 emissions (Tank-to-propeller) per call in the four port areas from 2016 to 2025. Table 22 below shows how the CO_2 "intensity" for the different ports have changed over time.

Table 22: Tank-To-Wake CO_2 emissions per port call and year for the four different harbours in Faxaflóahafnir.

Year	TTW CO_2 emissions per port call			
	Akranes	Grundartangi	Old harbour	Sunda
2016	61	19	13	41
2017	60	29	14	38
2018	30	28	18	44
2019	38	29	22	53
2020	11	34	25	53
2021	13	33	14	41
2022	13	35	20	51
2023	18	37	16	59
2024	12	36	19	60
2025	13	34	18	58

Due to the total number of port calls being low for Akranes, the average can fluctuate heavily dependent on the individual ships that call the port. This year did not see any significant change, but the level has remained lower overall since after the pandemic.

In Grundartangi, container ship calls were a bit less CO_2 intensive this year, especially because their time at anchor more than halved. The container ships calling this year also had slightly less installed aux engine power on average.

As for Old harbour, emissions remained at a similar level. The increase in berth time for fishing vessels worked to push the average up but did not have any major effect. It was counteracted by the average values of cruise ships decreasing somewhat as their average installed engine power was smaller. Also, calls from “other” ship had lower CO_2 intensity this year.

Finally, for Sunda harbour, the major difference this year was that the fishing vessels spent around 65% less time at birth on average. Fishing vessels only make up around 3% of CO_2 emissions in Sunda harbour, but would have made up around 7% if calls from fishing vessels in Sunda had the same CO_2 intensity as in 2024. For the wider *Cruise and cargo ships* category, there was practically no difference in CO_2 emissions per call.

6 Reference list

Bengtsson, S., Andersson, K., Fridell, E. (2011). A comparative life cycle assessment of marine fuels: liquefied natural gas and three other fossil fuels

Bengtsson, S., Andersson, K., Fridell, E. (2012). Environmental Assessment of Two Pathways Towards the Use of Biofuels in Shipping. *Energy Policy* 44 (May 2012): 451-63. https://doi.org/10.1016/j.enpol.2012.02.030.

Bengtsson, S., Andersson, K., Fridell, E. (2014). Environmental assessment of marine fuels: liquefied natural gas, liquefied biogas, methanol and bio-methanol. Journal of Cleaner Production 74:86-95

Brynolf, S. (2014). Environmental assessment of present and future marine fuels. Chalmers Tekniska Högskola, Sweden.

Brynolf, S., J. Hansson, Fayas Malik Kanchiralla, E. Malmgren, E. Fridell, H. Stripple. (2023). Nordic Roadmap Publication No.1-C/1/2022

Comer, B., Osipova, L. (2021). Accounting for well-to-wake carbon dioxide equivalent emissions in maritime transportation climate policies. International council on clean transportation.

Cooper, D. and Gustafsson, T. (2004), Methodology for calculating emissions from ships: 1, Update of emission factors, Report series SMED and SMED&SLU Nr 4 2004. http://www.smed.se/

DNV. (2025). IMO MEPC 83: GHG requirements approved, taking effect from 2028. https://www.dnv.com/news/2025/imo-mepc-83-ghg-requirements-approved-taking-effect-from-2028/

Electricity Maps. (2026). https://app.electricitymaps.com

European Commission. 2023/1805. REGULATION (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the Use of Renewable and Low-Carbon Fuels in Maritime Transport, and Amending Directive 2009/16/Ec (Text with Eea Relevance).

European Commission: Joint Research Centre, PRUSSI, M., YUGO, M., DE PRADA, L., PADELLA, M., EDWARDS, R. and LONZA, L., 2020. JEC Well-to-Tank report v5, Publications Office of the European Union, Luxembourg, https://data.europa.eu/doi/10.2760/959137, JRC119036.

Entec UK Ltd. (2002) Quantification of emissions from ships associated with ship movements between ports in the European Community. Northwich, Entec UK Limited.

Environment Agency of Iceland. (2024). Guidelines for masters of cruise and passenger ships arriving in Iceland.

Fridell, E., Winnes, H., and Eklund, V. (2020). SMED Emission factors for shipping in scenarios.

Government of Iceland. (2019). Regulation banning the use of heavy fuel oil in the territorial sea of Iceland. https://www.government.is/news/article/?newsid=05452daa-183d-11ea-944f-005056bc530c

HB Grandi. (2017). Personal communication with Guðmundur Hafsteinsson

IHS. (2026). Sea-web Ships, available at: https://maritime.ihs.com

IMO. (2014) Third IMO GHG Study 2014; International Maritime Organization (IMO) London, UK, June 2014; Smith, T. W. P.; Jalkanen, J. P.; Anderson, B. A.; Corbett, J. J.; Faber, J.; Hanayama, S.; O'Keeffe, E.; Parker, S.; Johansson, L.; Aldous, L.; Raucci, C.; Traut, M.; Ettinger, S.; Nelissen, D.; Lee, D. S.; Ng, S.; Agrawal, A.; Winebrake, J. J.; Hoen, M.; Chesworth, S.; Pandey,A.

International Maritime Organization (IMO). (2017). Annex VI – Regulations for the prevention of air pollution from ships, Regulation 13: Nitrogen oxides (NOx). In MARPOL consolidated edition 2017. IMO.

IPCC, 2013, Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

Kanchiralla, Fayas Malik, Selma Brynolf, Tobias Olsson, Joanne Ellis, Julia Hansson, and Maria Grahn. "How Do Variations in Ship Operation Impact the Techno-Economic Feasibility and Environmental Performance of Fossil-Free Fuels? A Life Cycle Study." *Applied Energy* 350 (2023/11/15/ 2023): 121773.

Malmgren, E., S. Brynolf, E. Fridell, M. Grahn, and K. Andersson. "The Environmental Performance of a Fossil-Free Ship Propulsion System with Onboard Carbon Capture - a Life Cycle Assessment of the Hymethship Concept.". *Sustainable Energy & Fuels* 5, no. 10 (May 21 2021): 2753-70. https://doi.org/10.1039/d1se00105a. <Go to ISI>://WOS:000646583000001.

MEPC, Guidelines on life cycle GHG intensity of marine fuels in MEPC 80/17, IMO.

Parsmo R. and Winnes H, 2018, Emissions from ships in Faxaflóahafnir 2017, Report U5953

Parsmo R. and Winnes H., 2019, Emissions from ships in Faxaflóahafnir 2018, Report U6107

Port of Los Angeles, 2010, Inventory of air emissions 2009

Sjöbris A., Gustafsson J and Jivén K., 2005. ARTEMIS Sea transport emission modelling For the European Commission DG Tren, Mariterm AB

USEPA, 1999, AP42, 5th ed, Vol1 Ch1 External Combustion Sources, sections 1.3 and 1.4.

Swedish Environmental
Research Institute

STOCKHOLM
Box 21060, 100 31 Stockholm

GOTHENBURG
Box 53021, 400 14 Gothenburg

MALMÖ
Nordenskiöldsgatan 24
211 19 Malmö

KRISTINEBERG
(Center for Marine Research and Innovation)
Kristineberg 566
451 78 Fiskebäckskil

SKELLEFTEÅ
Kanalgatan 59
931 32 Skellefteå

BEJING, CHINA
Room 612A
InterChina Commercial Building No.33
Dengshikou Dajie
Dongcheng District
Beijing 100006
China

This report has been reviewed and approved in accordance with IVL's audit and approval management system.