PHASE II - NORDIC PILOT PROJECT FOR THE ESTABLISHMENT OF GREEN SHIPPING CORRIDORS

Potential green shipping corridors between the Nordic region and neighbouring countries

Nordic Council of Ministers

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EXECUTIVE SUMMARY

The Nordic Council of Ministers have initiated a pre-piloting project to support the establishment of Nordic green shipping corridors, as a follow-up to the Clydebank Declaration launched at COP26. In Phase I (2022-2023), specific intra-Nordic shipping routes with the potential for early establishment of green shipping corridors was identified.[2] In Phase II (2024-2025), the focus is put on the cost gap and public funding opportunities, in addition to identifying potential corridors between the Nordics and other (non-Nordic) neighbouring countries. In this report, we have investigated ship traffic between the Nordics and other countries in Europe, seeking to identify potential green shipping corridors.

We have applied a voyage-based modelling framework utilising AIS data from 2023 to perform a screening analysis and identify port-to-port connections between the Nordics and other European countries, including the number of ships and voyages, and estimates on energy consumption and emissions. In this AIS-based screening analysis, we refer to 'potential corridors' as shipping routes with high regularity of ship traffic (number of voyages) and CO_2 emissions.

We have also conducted a more detailed corridor analysis for three countries; Germany, the Netherlands, and the United Kingdom (UK). In addition, we have mapped relevant green shipping corridor initiatives that have been announced in the region.

Overview of ship traffic and CO_2 emissions between the Nordics and other European countries

In 2023, the ship traffic between the Nordics and other countries in Europe consisted of 62 500 ship voyages (including voyages both ways), performed by 2 700 unique ships of 5 000 gross tonnage (GT) or more. This resulted in more than 9 million tonnes of CO_2 emissions. Sweden has the highest number of voyages towards other countries in Europe, followed by Finland, Norway, Denmark, and Iceland. Sweden and Norway together account for around 50% of the voyages and CO_2 emissions towards other countries in Europe (incoming and outgoing voyages). Passenger vessels stand out as the ship type with the highest number of voyages, while cargo ships (container ships, general cargo and Ro-ro cargo ships, etc.), wet/dry bulk (including crude oil tankers, chemical tankers, and gas tankers, etc.), and cruise vessels also contribute substantially to the total CO_2 emissions.

Voyages to and from Germany, the Netherlands, and the UK account for almost 50% of the voyages and annual CO_2 emissions towards the Nordics. The ship traffic between the Nordics and Germany has around twice as many voyages compared to the ship traffic between the Nordics and the Netherlands and the UK combined, and more than double the CO_2 emissions. Establishing initial green shipping corridors between the Nordics and Germany could therefore potentially reduce CO_2 emissions significantly.

Potential Nordic corridors with Germany, the Netherlands, and the United Kingdom

Table A below shows the top three port-to-port connections (in terms of total CO_2 emissions) between the Nordics and Germany, the Netherlands, and the UK. Our screening analysis of potential Nordic corridors shows that:

- Germany is the country with the highest number of direct voyages towards the Nordic countries, with passenger and cargo vessels as the main ship segments. Some port-to-port connections towards Germany stand out, including the passenger vessels operating on routes such as Helsinki (FI) – Travemünde, Malmö (SE) – Travemünde, Oslo (NO) – Kiel, and Trelleborg (SE) – Rostock. We also see some regular Ro-Ro cargo routes from Hanko (FI) to Lübeck and Rostock.
- When looking at direct voyages between the Nordics and the Netherlands, the picture of the ship traffic is a bit more "chaotic", mainly due to cargo ships and tank ships with a more diverse operational pattern. However, Rotterdam stands out as a key port hub in a Nordic perspective, with several potential corridors relevant for further development. This includes several ship segments, such as wet and dry bulk and cargo ships.
- In the UK, Immingham stands out as the most important cargo port in a Nordic perspective. The few Ro-Ro cargo ships operating on the route Esbjerg (DK) – Immingham and Gothenburg (SE) – Immingham could be

potential green shipping corridors. The same applies for the single Ro-Ro cargo ship operating on the Helsinki (FI) – Hull route. In addition, there is considerable cruise traffic between the UK and the Nordics (especially Norway, Iceland, and Denmark), with Southampton as a central UK cruise port.

Table A: Top port-to-port connections (in terms of total CO_2 emissions) between the Nordics and Germany, the Netherlands, and the UK, including main ship segments. For information about the number of voyages and CO_2 emissions per corridor, see Tables 4, 7, and 10.

Top port-to-port connections	Main ship segments
Germany	
1. Helsinki – Travemünde	Passenger ships and RoRo cargo ships
2. Malmö – Travemünde	Passenger ships
3. Oslo – Kiel	Passenger ships and some cruise ships
Netherlands	
1. Mongstad – Rotterdam	Crude oil tankers
2. Gothenburg – Rotterdam	Crude oil tankers, chemical tankers, and container ships
3. Helsinki – Rotterdam	Container ships
United Kingdom	
1. Esbjerg – Immingham	Ro-Ro cargo ships
2. Gothenburg – Immingham	Ro-ro cargo ships and some chemical tankers
3. Haugesund – Southampton	Cruise ships

Key conclusions

- Our screening analysis shows that there is regular ship traffic and considerable CO_2 emissions on routes between the Nordics and Germany, the Netherlands, and the UK, with several routes with the potential to be green shipping corridors.
- For det establishment of initial green shipping corridors between the Nordics and European countries, our analysis identifies passenger ships and Ro-Pax routes, especially towards Germany (focusing on Travemünde, Kiel, and Rostock) as potential corridors. Beyond focusing on passenger and Ro-Pax routes, potential corridors include cargo and bulk vessels operating on relatively fixed routes, and routes that involve few individual ports. Here, Rotterdam, Bremerhaven, Immingham, and Southampton are key ports from a Nordic perspective.
- There are already some announced green shipping corridor initiatives on the identified potential corridors. To support the realization of these corridors and other potential corridors, it is critical to engage with forward-leading stakeholders that are eager to take the steps towards zero-emission operation on Nordic routes, including shipowners, ports, and zero-emission fuel suppliers.

We emphasize that after this initial screening, a further feasibility assessment of the identified routes should be conducted. Corridor specific feasibility assessments should address economic, technical and operational aspects. This includes (but is not limited to) stakeholder engagement and collaboration cross the value chain, emission reduction potential, regularity of ship traffic and cargo volumes, technical and operational feasibility, maturity of ports ('port readiness') and fuel availability (production volumes and bunkering infrastructure), willingness to pay for zero-emission ('green') transport, as well as policies and support mechanisms.

1 INTRODUCTION

The Clydebank Declaration, which defines *green shipping corridors* as "zero-emission maritime routes between two (or more) ports", was launched during COP26 in 2021.[1] Over 20 countries have signed the Declaration, including all the Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden). Signatories to the Declaration have committed to develop at least six green shipping corridors by 2025 and "many more" by 2030.

To follow-up this political initiative, the Nordic Council of Ministers awarded in 2022 a Phase I project on establishing Nordic green shipping corridors, which developed a shortlist of six intra-Nordic green shipping corridors which could potentially be realized in 2025, or towards 2030.[2] In 2024, the Nordic Council of Ministers awarded a Phase II project[i] to support realizing the first green shipping corridors, and to identify potential corridors between the Nordic region and other neighbouring countries in Europe.

This report presents potential green shipping corridors between the Nordic region and other (non-Nordic) European countries[ii], focused on Germany, the Netherlands, and the UK. The report is structured as follows:

- Chapter 2 presents an overview of ship traffic and CO_2 emissions on voyages between the Nordics and other European countries.
- Chapter 3 identifies potential green shipping corridors between the Nordics and Germany, the Netherlands, and the UK.
- Chapter 4 provides an overview of already announced green shipping corridor initiatives involving Nordic countries.

While this report provides an AIS-based screening analysis of 'potential corridors', it is crucial to consider other factors that will be relevant for establishing the first corridors. In this report, we refer to 'potential corridors' as shipping routes with high regularity of ship traffic (based on number of voyages) and considerable CO_2 emissions, indicating that the routes have a potential to be further feasibility assessed and developed as green shipping corridors. Although the analysis is limited to direct port-to-port voyages, the AIS-based screening can be used as a first pre-assessment to identify corridor opportunities between the Nordics and neighbouring countries.

This work was carried out in collaboration with the *Nordic Roadmap for Future Fuels* project (2022-2025), which recently delivered the *Fuel Transition Roadmap for Nordic Shipping*, detailing actions specifically related to realizing the first green shipping corridors (see Actions 1-4[3]).

[i] The Phase II project on establishing Nordic green shipping corridors includes two reports. The second report, titled "Funding Opportunities for Nordic Green shipping Corridors", assesses existing public funding opportunities for Nordic green shipping corridors and discusses how to close the cost gap.

[ii] European countries other than the Nordic countries that are included in this ship-based analysis: Albania, Belgium, Bulgaria, Croatia, Estonia, France, Germany, Gibraltar, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Moldova, Monaco, Montenegro, the Netherlands, Poland, Portugal, Romania, Russia, Slovenia, Spain, Switzerland, Ukraine, and the United Kingdom.

2 OVERVIEW OF SHIP TRAFFIC AND CO_2 EMISSIONS BETWEEN THE NORDICS AND OTHER EUROPEAN COUNTRIES

In this chapter, we give an overview of ship traffic and emissions between the Nordics and neighbouring countries. A voyage-based modelling framework utilising 2023 AIS data is applied to identify port-to-port connections, covering all vessels of 5 000 GT or more[iii], grouped into six main ship categories. The modelling framework and details on ship categories are described in further detail in Appendix A.

Table 1 shows an overview of incoming and outgoing ship traffic between the Nordic countries and other countries in Europe. In 2023, the ship traffic between the Nordics and other European countries consisted of a total of 62 535 ship voyages, performed by 2 691 unique ships[iv] of 5 000 GT or more. In total, ships on voyages between the Nordics and other European countries emitted more than 9 million tonnes of CO_2.

An overview of the ship traffic between the different Nordic countries and other (non-Nordic) countries in Europe is summarized below (Table 1):

- **Sweden:** Ship traffic to/from Sweden is dominated by passenger vessels and cargo ships, in addition to some wet and dry bulk. Sweden has the highest number of voyages (a total of approximately 30 000 voyages) and the highest level of CO_2 emissions (in total almost 3 million tonnes for incoming and outgoing voyages) in relation to ship traffic towards neighbouring countries in Europe.
- **Norway:** Norway has the second highest level of CO_2 emissions (in total around 2.7 million tonnes for incoming and outgoing voyages) and the third highest number of voyages (a total of approximately 10 000 voyages). The ship traffic to neighbouring countries outside the Nordics is dominated by wet and dry bulk, cargo, and cruise ships.
- **Finland:** Finland has the second highest number of voyages (a total of approximately 16 400 voyages) and has the third highest level of CO_2 emissions (in total around 2.1 million tonnes for incoming and outgoing voyages). The ship traffic to neighbouring countries outside the Nordics is dominated by passenger vessels and cargo ships, in addition to some wet and dry bulk.
- **Denmark:** Denmark has the second lowest number of voyages (a total of 6370 voyages) and CO_2 emissions (in total around 1.1 million tonnes for incoming and outgoing voyage). The ship traffic is dominated by cargo vessels, followed by wet and dry bulk.
- **Iceland:** Iceland is the country with the lowest CO_2 emissions (in total around 312 000 tonnes for incoming and outgoing voyage) and fewest voyages (a total of 680 voyages) and vessels going to/from neighbouring countries. The Icelandic ship traffic to neighbouring countries outside the Nordics is dominated by cargo ships and cruise ships.

[iii] This study only includes voyages by ships above 5 000 GT, excluding voyages performed by smaller ships. We acknowledge that smaller vessels (< 5000 GT), such as smaller bulk and cargo vessels, operate between the Nordics and other non-Nordic European countries. More information about the ship activity of vessels below 5000 GT can be found in DNV (2022), Nordic Roadmap Publication No. 2-A/1/2022: AIS Analysis of Nordic Ship Traffic, https://futurefuelsnordic.com/ais-analysis-of-the-nordic-ship-traffic-and-energy-use

[iv] Unique vessels: In this voyage analysis, we assess the port-to-port ship traffic in one direction. Hence, when comparing incoming and outgoing ship traffic, it is not assessed whether the voyages on specific routes are performed by the same unique vessels or by other vessels. It is likely that most of these vessels are the same, particularly in certain segments like passenger ships. However, other vessels may have only completed a single voyage on this route before moving on to different areas.

Table 1: Incoming (left) and outgoing (right) ship traffic between Nordic countries and other European countries, showing country overview of CO_2 emissions, direct voyages and number of ships, categorized by ship segments.

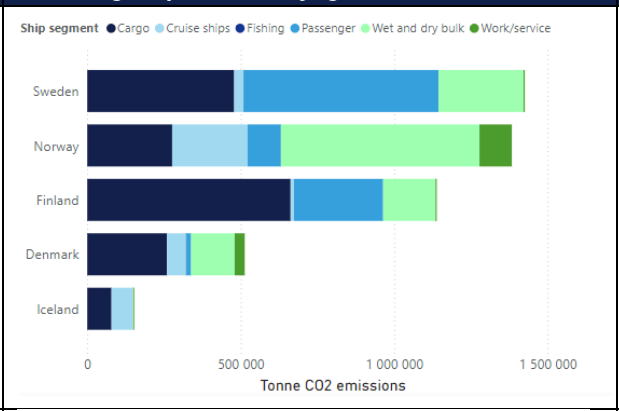
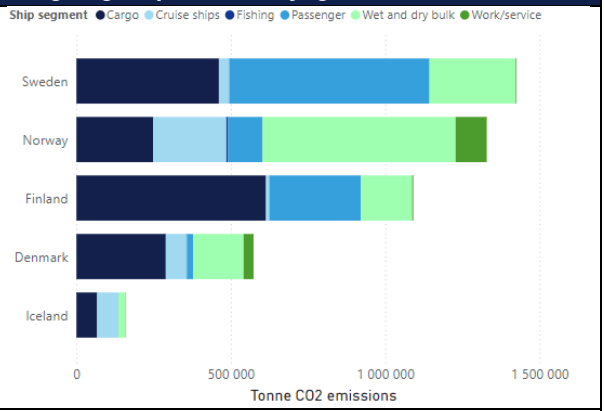
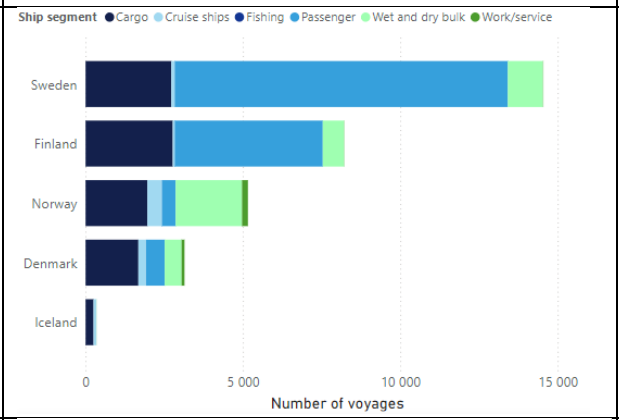
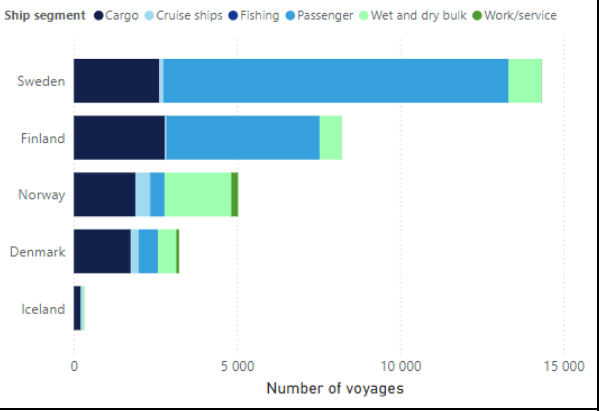
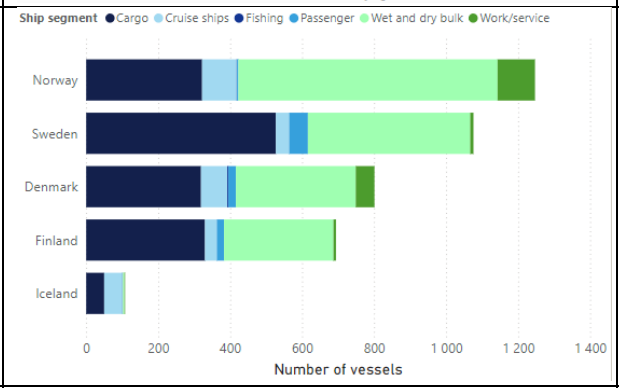
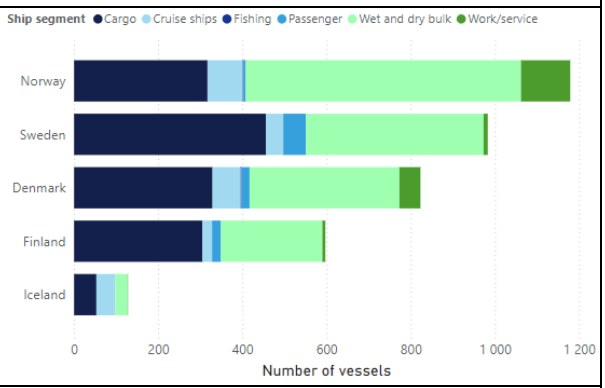
	Incoming ship traffic: Voyages into the Nordics	Outgoing ship traffic: Voyages out of the Nordics
CO_2 emissions		
Number of voyages		
Number of vessels		
Totals	**CO_2 emissions:** 4 614 000 tonnes **Number of voyages:** 31 407 **Number of unique vessels:** 2 691	**CO_2 emissions:** 4 579 000 **Number of voyages:** 31 128 **Number of unique vessels:** 2 529

Figure 1 below illustrates the flow of direct ship voyages between the Nordic countries and other countries in Europe. Direct ship voyages between the Nordics and Germany, the Netherlands, and the UK represent most of the annual CO_2 emissions. In the next chapter, we deep-dive into the ship traffic between the Nordics and these three countries. In the overall picture, we also find direct voyages to and from countries like Poland, Belgium, Spain, and Estonia (representing in total some 30% of the CO_2 emissions), as well as range of other European countries with less traffic (see Figure 1).

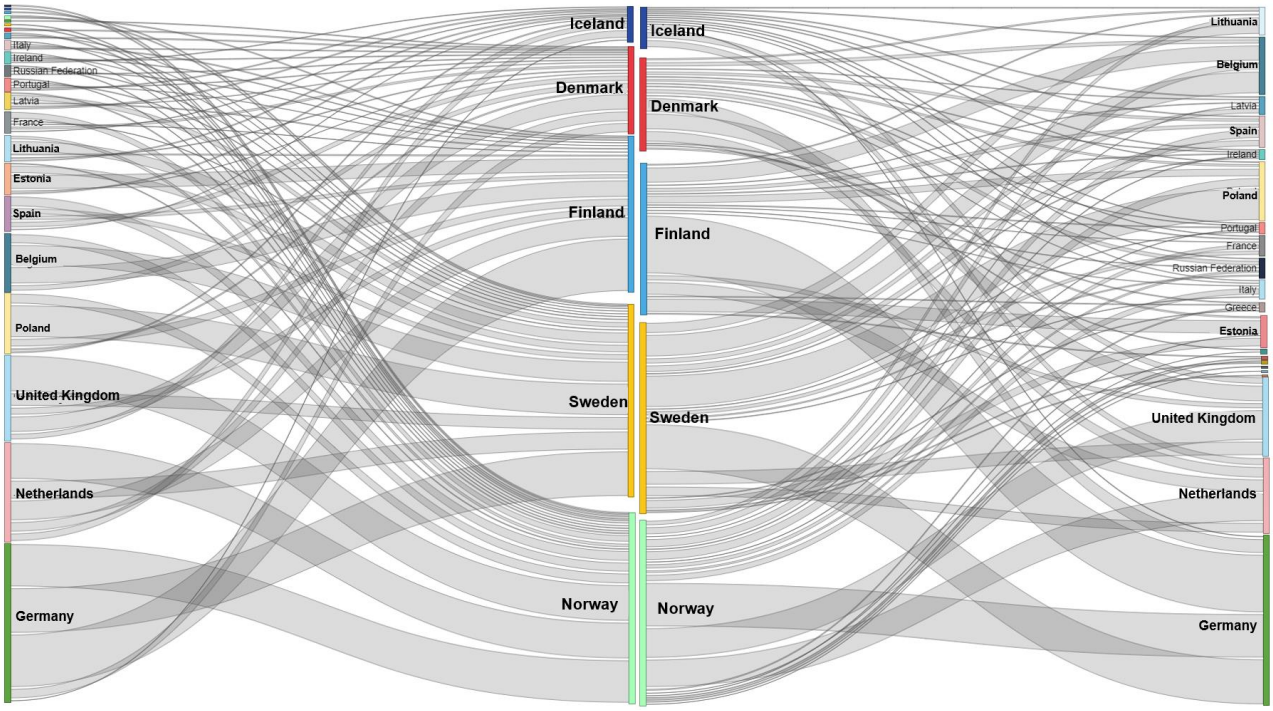


Figure 1: Illustration of direct ship voyages in (left) and out (right) of the Nordics to/from other European countries. The width of each line scales with the annual CO_2 emissions for voyages between the different countries.

3 POTENTIAL NORDIC CORRIDORS WITH GERMANY, THE NETHERLANDS, AND THE UNITED KINGDOM

In this chapter, we analyse potential corridors between the Nordic countries and Germany, the Netherlands, and the UK, using the same voyage-based modelling framework and results from the analysis in Chapter 2. In this AIS-based screening analysis, we refer to 'potential corridors' as shipping routes with high regularity of ship traffic (based on number of voyages) and considerable CO_2 emissions.

3.1 Geographical distribution of ship traffic and operational patterns

Figure 2 illustrates the traffic of ships that have been involved in voyages between the Nordics and Germany, the Netherlands, and the UK. In Figure 2, ships' CO_2 emissions are charted to reflect trading patterns and routes in northern Europe for 2023. The figure shows that the high-density areas of ship traffic, with associated fuel consumption and emissions, are situated in the southern part of Norway, around Denmark, and in various trading routes in the Baltic Sea. The main shipping route to and from the Nordic countries goes through the English Channel, with multiple port locations in Norway, Denmark, Sweden, and Finland. Ship traffic to European ports in Germany, the Netherlands, and the UK, is also highly visible.

Cargo ship types have large variation in traffic patterns, reflecting differences in transport of oils, imports of raw materials for manufacturing industry, and trade in manufactured products. Compared with container ships and oil tankers, bulk vessels have a more diverse trading pattern with high number of transits.

Figure 2 shows the density of ship CO_2 emissions from direct voyages between the Nordics and Germany, the Netherlands and UK. The routes with higher density (green, yellow and red colours) indicate geographical locations of potential green shipping corridors and energy hubs. Combining the geographical locations of the corridors with the voyage-based analysis (Chapters 3.1-3.4) provides an overview of activity (number of ships and voyages), emissions, and geographical location of the potential green shipping corridors. In the following sub-chapters, we identify potential port-to-port corridors between the Nordics and Germany, the Netherlands, and the UK.

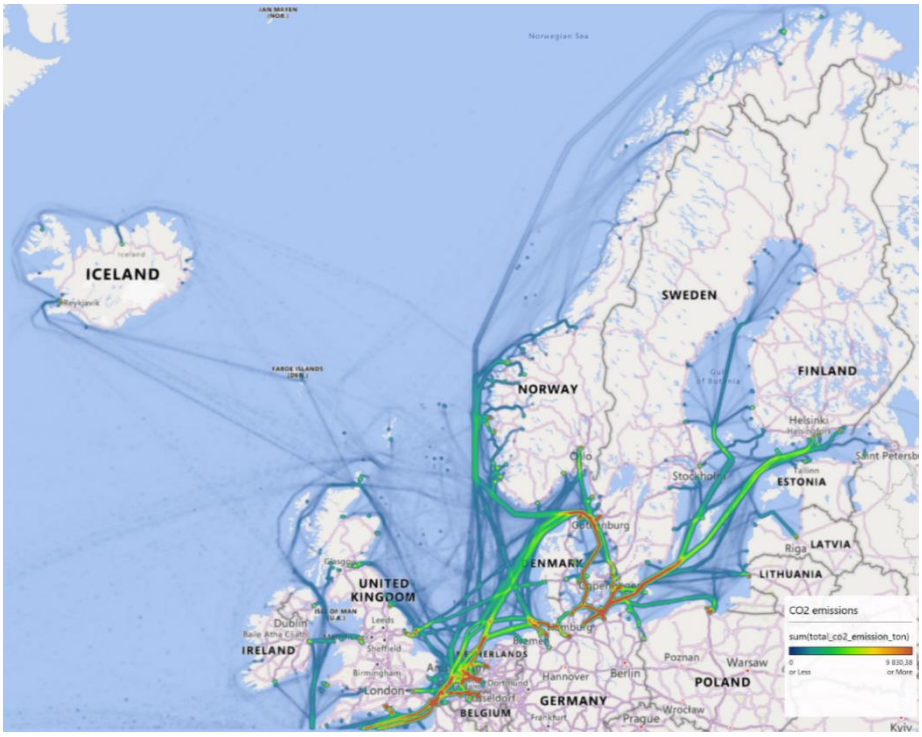


Figure 2: Density plot of ship CO_2 emissions for the direct voyages between the Nordics and Germany, the Netherlands, and the UK (All ship types ≥ 5 000 GT, 2023 AIS data).

3.2 Nordics – Germany

Table 2 presents data on the number of ships, voyages, and CO_2 emissions from all ships operating on direct port-to-port routes between the Nordics and Germany in 2023. A total number of 864 unique ships of 5 000 GT or more have operated on direct port-to-port voyages, performing a total of 19 439 voyages to or from Germany. The annual fuel consumption and total CO_2 emissions for all ships on direct voyages is estimated to 884 300 tonnes oil equivalents (toe) and 2 730 600 tonnes CO_2.

In addition, the annual fuel consumption and CO_2 emissions for use in the end ports of all voyages is estimated to 48 400 toe and 150 000 tonnes CO_2 (not included in Table 2), representing approximately 5% of the voyage and port emissions combined. The fuel consumption and CO_2 emissions in port are excluded from the analysis of shipping routes, as port emissions can be addressed separately using other alternative energy sources than fuels, such as onshore power supply (if available).

Table 2: Summary for all ship categories on direct port-to-port voyages between the Nordics and Germany.

	Nordics → Germany	Germany → Nordics	Total	Main ship types
Total CO_2 emissions [tonnes]	1 430 000	1 300 600	**2 730 600**	Passenger and cargo vessels
Total number of voyages	10 014	9425	**19 439**	Passenger vessels, followed by cargo
Number of vessels	864	826		Cargo ships and wet/dry bulk

Table 3 below gives an overview of incoming and outgoing ship traffic between the different Nordic countries and Germany. Passenger ships and cargo vessels represent the largest share of the ship traffic between the Nordics and Germany. Ship traffic between Germany and Finland represents the largest share of CO_2 emissions, followed by Sweden and Norway. It should be noted that Finland has a longer sailing distance towards Germany, resulting in more fuel consumption and CO_2 emissions on these voyages. Sweden has the most frequent ship traffic towards Germany in terms of voyages, with approximately 10 000 voyages in total, mostly due to passenger traffic. Sweden has almost six times as many voyages to/from Germany as Norway, Finland, and Denmark, which have approximately 1 500 voyages each to or from Germany.

Table 3: Incoming (left) and outgoing (right) ship traffic between Nordic countries and Germany, showing country overview of CO_2 emissions, direct voyages, and number of ships, categorized by ship segments.

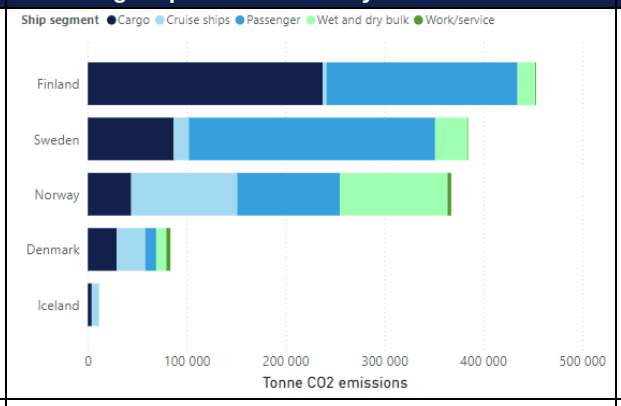
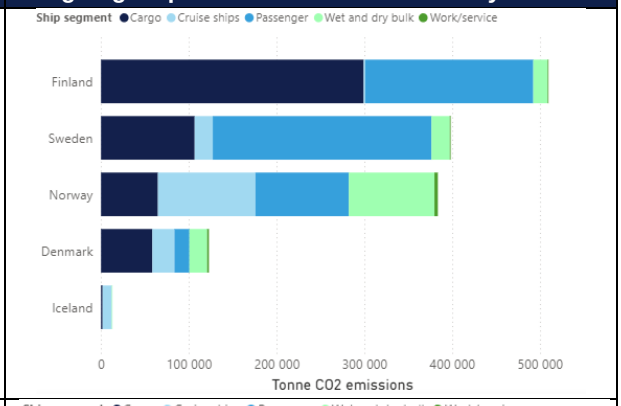
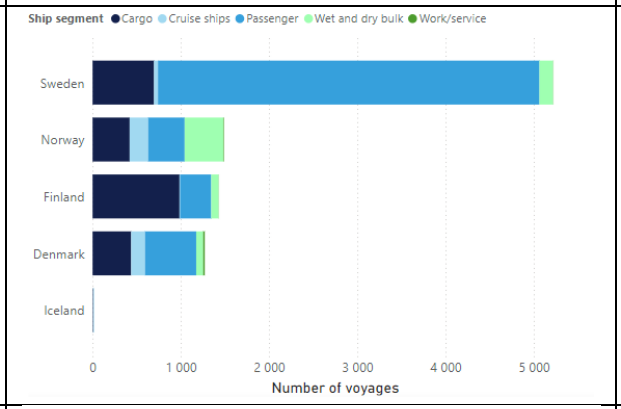
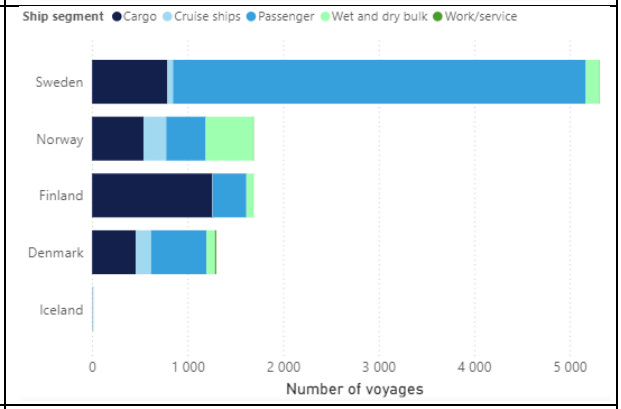
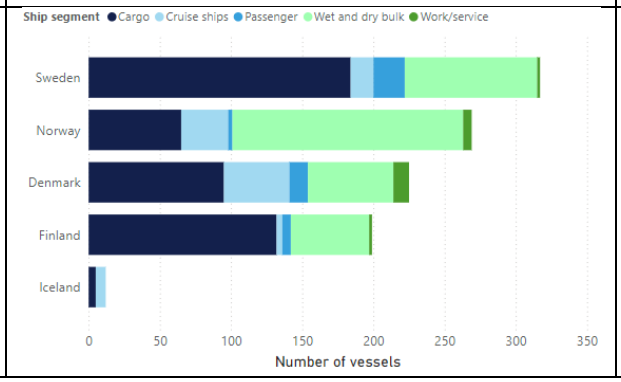
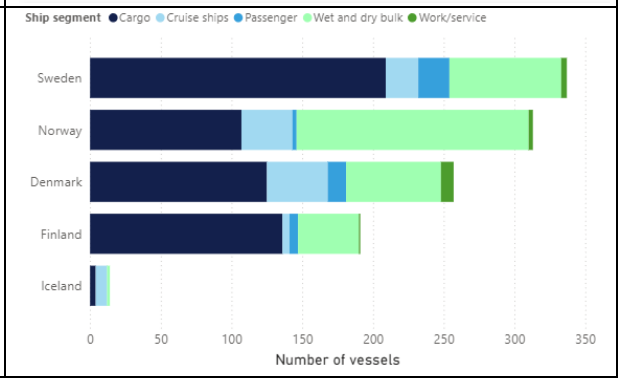
	Incoming ship traffic: Germany → Nordics	Outgoing ship traffic: Nordics → Germany
CO_2 emissions		
Number of voyages		
Number of vessels		

Table 4 below presents an overview of the top port-to-port connections, with key characteristics such as total CO_2 emissions on the route, and the number of voyages and vessels operating on the route. The table provides a screening of potential green shipping corridors between the Nordics and Germany, as well as potential energy hubs. In Germany, key ports with ship connections to the Nordic region are Travemünde, Kiel, Rostock, Hamburg, Bremerhaven, and Lübeck.

Helsinki – Travemünde is the route with the highest emissions, having more than 2 voyages per day (on average). The highest number of voyages is for Trelleborg – Rostock, with more than 10 voyages per day. Both routes are top candidates with regards to emission and voyages, also when considering routes to/from the Netherlands (Table 7) and UK (Table 10).

Table 4: Overview of potential green shipping corridors between the Nordics and Germany.

Top port-to-port connections (A → B)	Total CO_2 emissions [tonnes]	No. of voyages	Unique no. of vessels		Main ship types
			A→B	B→A	
Helsinki – Travemünde	435 000	882	11	10	Passenger ships and RoRo cargo ships
Malmö – Travemünde	205 000	1925	5	5	Passenger ships
Oslo – Kiel	197 800	725	6	8	Passenger ships, also some cruise ships
Trelleborg – Rostock	135 000	3 843	12	12	Passenger ships
Hanko – Lübeck	128 150	592	8	12	Ro-Ro cargo ships
Hanko – Rostock	99 400	330	4	5	Ro-Ro cargo ships
Gothenburg – Kiel	84 100	747	11	7	Passenger ships, but also cruise and bulk
Trelleborg – Travemünde	70 500	1 706	9	9	Passenger ships

3.3 Nordics – Netherlands

Table 5 presents data on the number of ships, voyages, and CO_2 emissions from all ships operating on direct port-to-port routes between the Nordics and the Netherlands in 2023. A total number of 995 unique ships of 5 000 GT or more have operated on direct port-to-port routes, performing a total of 5 922 voyages to or from the Netherlands. The annual fuel consumption and total CO_2 emissions for all ships on direct routes is estimated to 447 000 toe and 1 384 000 tonnes CO_2. In addition, the annual fuel consumption and CO_2 emissions for use in the end ports of all voyages is estimated to 39 300 toe and 122 000 tonnes CO_2 (not included in Table 5), representing approximately 8% of the voyages and port emissions combined.

Table 5: Summary for all ship categories on direct port-to-port voyages between the Nordics and the Netherlands.

	Nordics → Netherlands	Netherlands → Nordics	Total	Main ship types
Total CO_2 emissions [tonnes]	595 500	788 500	**1 384 000**	Cargo and wet/dry bulk
Total number of voyages	2 593	3 329	**5 922**	Cargo and wet/dry bulk
Number of vessels	817	995		Wet/dry bulk, followed by cargo ships

In 2023, cargo ships and wet and dry bulk represented the largest share of the ship traffic between the Nordic countries and the Netherlands. There were also some cruise and work/service ship traffic between Norway and the Netherlands, and between Denmark and the Netherlands. In addition, one passenger vessel sailed between Kristiansand and Eemshaven.

Table 6 shows the incoming and outgoing ship traffic between the different Nordic countries and the Netherlands. Among the Nordic countries, Norway is the country with most ship traffic to and from the Netherlands. Ship voyages between Norway and the Netherlands account for around half of the number of ships, and almost half of the number of voyages and total CO_2 emissions between the Nordics and the Netherlands.

Table 6: Incoming (left) and outgoing (right) ship traffic between Nordic countries and the Netherlands, showing country overview of CO_2 emissions, direct voyages, and number of ships, categorized by ship segments.

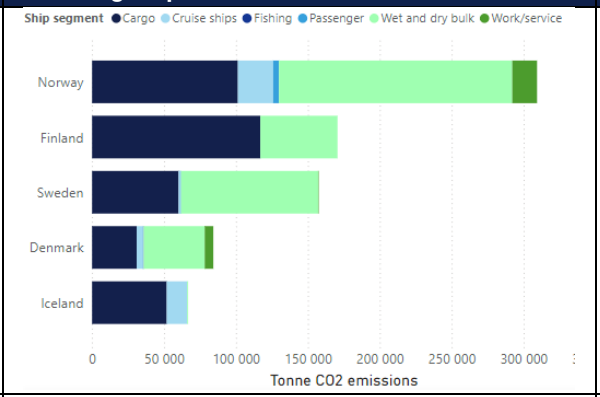
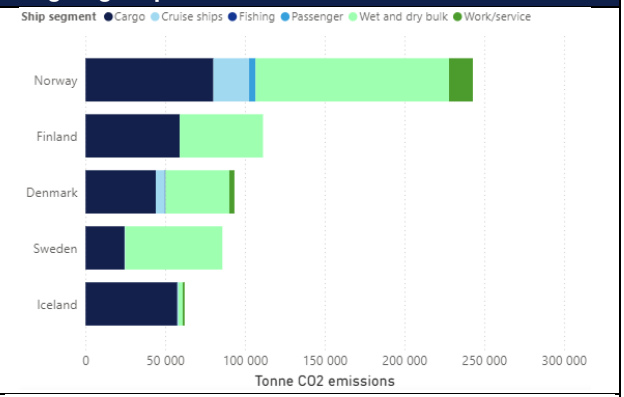
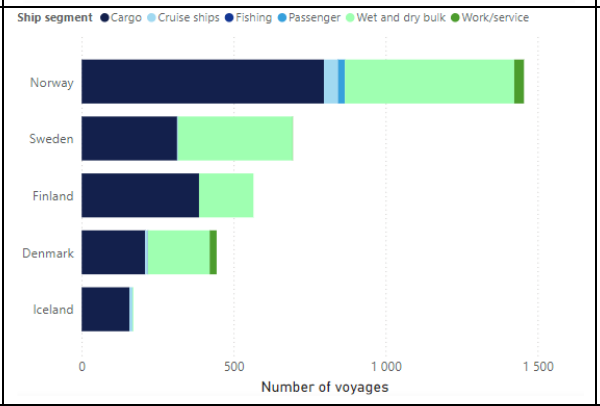
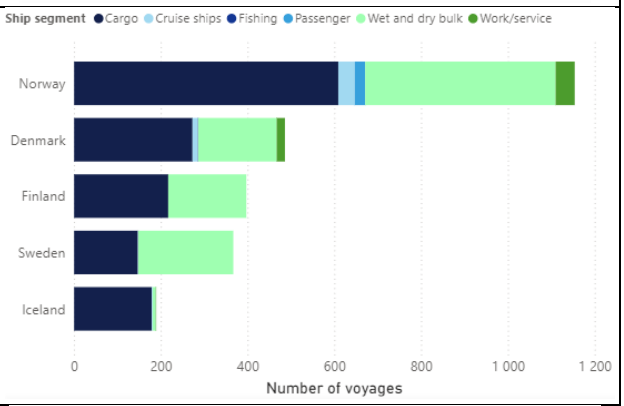
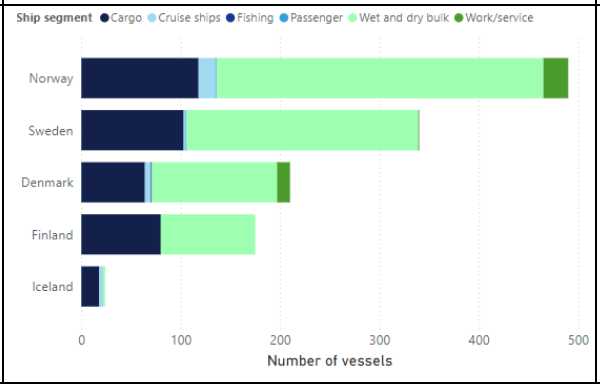
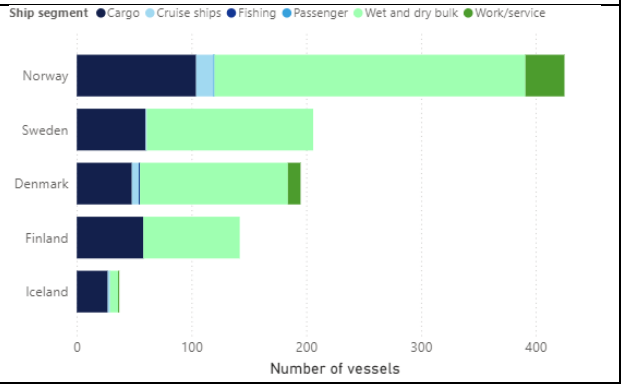
	Incoming ship traffic: Netherlands → Nordics	Outgoing ship traffic: Nordics → Netherlands
CO_2 emissions		
Number of voyages		
Number of vessels		

Table 7 below presents an overview of the top port-to-port connections, with key characteristics such as total CO_2 emissions on the route, and the number of voyages and vessels operating on the route. The table provides a screening of potential green shipping corridors between the Nordics and the Netherlands, as well as energy hubs. In the Netherlands, Rotterdam and Amsterdam are key ports with ship connections to the Nordic region. Wet and dry bulk vessels are the main ship types in the Nordic ship traffic towards Amsterdam, mainly to the ports Brofjorden (SE), Kilpilathi (FI), and Mongstad (NO). In addition, there are some direct cruise connections from Amsterdam to Akureyri (IS), Reykjavik (IS), Bergen (NO), and Copenhagen (DK). Voyages to and from Rotterdam represent more than half of the CO_2 emissions from direct ship traffic between a Nordic country and the Netherlands.

Top connections with regards to the number of voyages and CO_2 emissions are Gothenburg – Rotterdam with close to one voyage per day (second highest on CO_2 emissions), and Mongstad – Rotterdam with voyages every second day (highest on CO_2 emission). Both are “longer” distance routes.

Table 7: Overview of potential green shipping corridors between the Nordics and the Netherlands.

Top port-to-port connections (A → B)	Total CO_2 emissions [tonnes]	No. of voyages	Unique no. of vessels		Main ship types
			A→B	B→A	
Mongstad – Rotterdam	74 600	216	61	97	Crude oil tankers
Gothenburg – Rotterdam	61 800	334	39	106	Crude oil tankers, chemical tankers, and container ships
Helsinki – Rotterdam	56 400	187	3	23	Container ships
Reykjavik – Rotterdam	54 200	110	11	11	Container ships
Roytta – Terneuzen	51 400	189	6	6	General cargo ships
Kilpilahti (Skoldvik) – Rotterdam	42 000	144	24	47	Chemical tankers and crude oil tankers
Brofjorden – Rotterdam	36 800	87	20	46	Crude oil tankers and chemical tankers
Torshavn – Rotterdam	29 400	111	3	3	Ro-Ro cargo ships
Melkøya – Rotterdam	26 700	36	10	5	Gas tankers and chemical tankers
Kristiansand – Eemshaven	7 840	46	1	1	Passenger vessels

3.4 Nordics – United Kingdom

Table 8 presents data on the number of ships, voyages, and CO_2 emissions from all ships operating on direct port-to-port routes between the Nordics and the UK in 2023. A total of 710 unique ships of 5 000 GT or more have operated on direct port-to-port routes, performing a total of 4 296 voyages to or from the UK. The annual fuel consumption and total CO_2 emissions for all ships on direct voyages is estimated to 416 900 toe and 1 292 940 tonnes CO_2. In addition, the annual fuel consumption and CO_2 emissions for use in the end ports of all voyages is estimated to 31 800 toe and 98 100 tonnes CO_2 (not included in Table 8), representing approximately 7% of the voyages and port emissions combined.

Table 8: Summary for all ship categories on direct port-to-port voyages between the Nordics and the UK.

	Nordics → UK	UK → Nordics	Totals	Main ship types
Total CO_2 emissions [tonnes]	624 930	668 010	**1 292 940**	Cargo, wet/dry bulk, and cruise
Total number of voyages	2203	2 193	**4 296**	Cargo ships, followed by bulk
Number of vessels	596	710		Wet and dry bulk, followed by cargo ships

Cargo ships and wet and dry bulk represent the largest share of the ship traffic between the Nordics and the UK. In addition, there is some cruise ship traffic, and some work/service activity. The cruise traffic is mostly between the UK and Norway and Iceland.

Table 9 below gives an overview of incoming and outgoing ship traffic between the different Nordic countries and the UK. Ship traffic between the UK and Norway represent around half of the CO_2 emissions, number of voyages and number of unique vessels. The ship traffic between the UK and Norway is mostly wet and dry bulk, cargo ships, and cruise traffic, in addition to some work/service vessels. Denmark is second on the list in terms of traffic volume, mostly due to cargo traffic to/from the UK.

Table 9: Incoming (left) and outgoing (right) ship traffic between Nordic countries and UK, showing country overview of CO_2 emissions, direct voyages, and number of ships, categorized by ship segments.

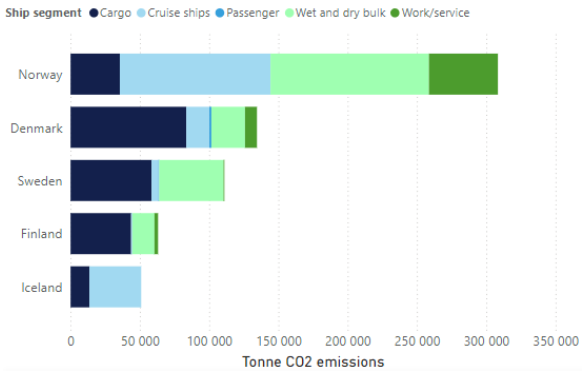
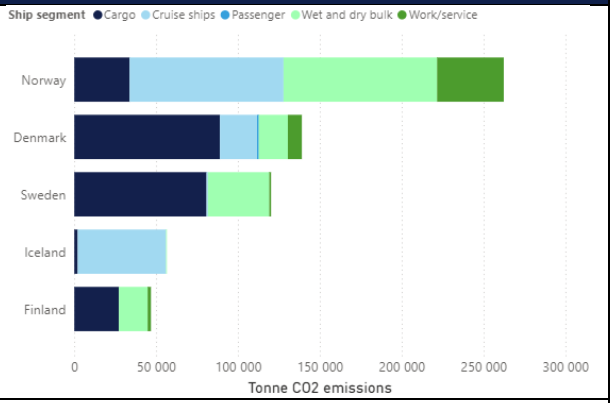
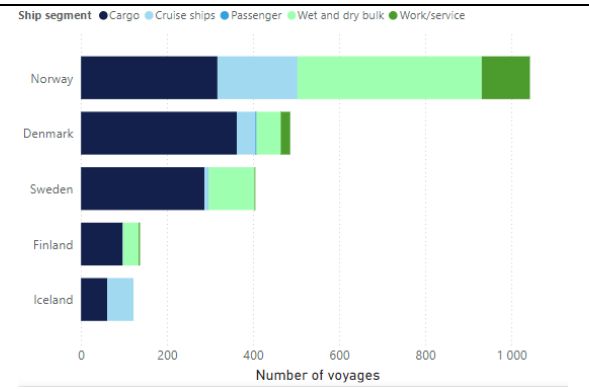
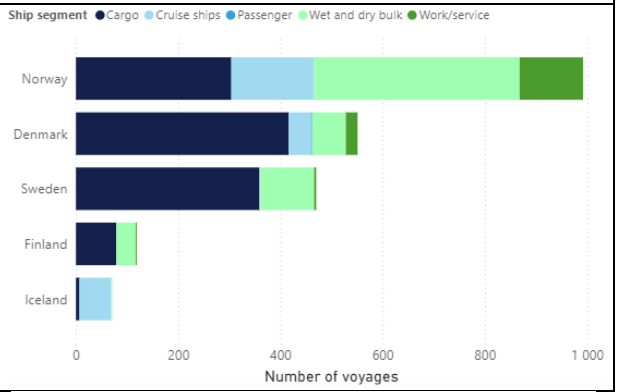
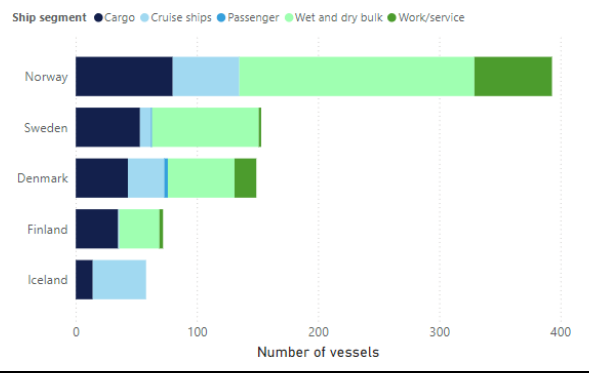
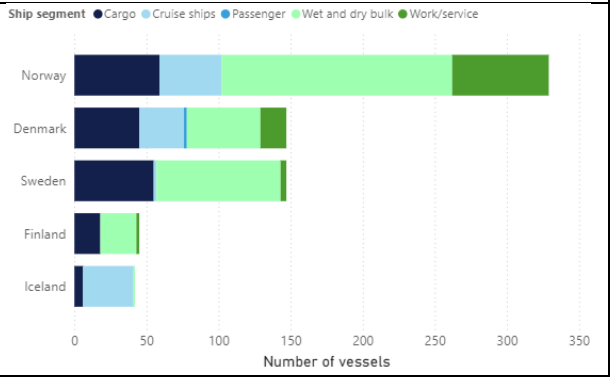
	Incoming ship traffic: UK → Nordics	Outgoing ship traffic: Nordics → UK
CO_2 emissions		
Number of voyages		
Number of vessels		

Table 10 presents an overview of the top port-to-port connections, with key characteristics such as total CO_2 emissions on the route, and number of voyages and vessels operating on the route. The table provides a screening of potential green shipping corridors between the Nordics and the UK, as well as potential energy hubs. In the UK, Immingham is the strongest port connection to the Nordic region, both in terms of emissions, number of voyages, and number of vessels. Top connections with regards to emission and voyages are Esbjerg – Immingham with around two voyages per day, followed by Gothenburg – Immingham with around one voyage per day on average. Regarding wet and dry bulk, key UK ports with connections to the Nordics are Immingham, Milford haven, Fawley, Liverpool, Thamesport, and Port Clarence. When looking into cargo ships, key UK ports are Immingham, Hull, and Tilbury. Southampton stands out as a key port for cruise ships.

Table 10: Overview of potential green shipping corridors between the Nordics and the UK.

Top port-to-port connections (A → B)	Total CO_2 emissions [tonnes]	No. of voyages	Unique no. of vessels		Main ship types
			A→B	B→A	
Esbjerg – Immingham	147 400	606	5	4	Ro-Ro cargo ships
Gothenburg – Immingham	87 950	448	14	7	Ro-ro cargo ships, and some chemical tankers
Haugesund – Southampton	43 940	52	7	8	Cruise ships
Helsinki – Hull	33 300	91	1	1	Ro-Ro container ship
Stavanger – Southampton	33 980	41	8	6	Cruise ships
Kotka – Felixstowe	16 800	29	0	13	Container ships
Mongstad – Milford haven	12 300	29	9	12	Gas tankers, crude oil tankers, and chemical tankers
Stura – Fawley	9 880	21	15	4	Crude oil tankers
Lindo – Dover	3 040	6	2	4	Passenger ships

3.5 Summary of potential corridors

Table 11 shows a summary of direct ship traffic between the Nordics and Germany, the Netherlands, and the UK. The ship traffic between the Nordics and Germany has around twice as many voyages compared to ship traffic between the Nordics and the Netherlands and the UK combined, and more than double the CO_2 emissions. Table 12 below summarizes top three port-to-port connections (in terms of total CO_2 emissions) between the Nordics and Germany, the Netherlands, and the UK.

Table 11: Top port-to-port connections (in terms of total CO_2 emissions) between the Nordics and Germany, the Netherlands, and the UK, including main ship segments.

	Nordics – Germany	Nordics – Netherlands	Nordics – United Kingdom
Total CO_2 emissions [tonnes]	2 730 600	1 384 000	1 292 940
Total number of voyages	19 439	5 922	4 296
Number of vessels	1 690*	1 812*	1 306*
Main ship types	Passenger vessels, cargo ships, and some wet/dry bulk	Cargo ships and wet/dry bulk	Cargo and wet/dry bulk, also some cruise traffic

*Note that the total number of vessels operating on the route does not indicate unique vessels, as some vessels operate in both directions.

Table 12: Potential green shipping corridors between the Nordics and Germany, the Netherlands, and the United Kingdom. The table also includes main ship segments on key port-to-port connections.

Top port-to-port connections	Main ship segments
Germany	
1. Helsinki – Travemünde	Passenger ships and RoRo cargo ships
2. Malmö – Travemünde	Passenger ships
3. Oslo – Kiel	Passenger ships and some cruise ships
Netherlands	
1. Mongstad – Rotterdam	Crude oil tankers
2. Gothenburg – Rotterdam	Crude oil tankers, chemical tankers, and container ships
3. Helsinki – Rotterdam	Container ships
United Kingdom	
1. Esbjerg – Immingham	Ro-Ro cargo ships
2. Gothenburg – Immingham	Ro-ro cargo ships and some chemical tankers
3. Haugesund – Southampton	Cruise ships

Summing up, our analysis shows that:

- Of all the European countries, **Germany** has the most ship traffic towards the Nordic countries, with passenger vessels and cargo ships as the main ship segments. Some port-to-port connections towards Germany stand out, including the passenger vessels operating on routes such as Helsinki – Travemünde, Malmö – Travemünde, Oslo – Kiel, and Trelleborg – Rostock. We also see some regular RoRo cargo routes from Hanko (FI) to Lübeck and Rostock. Sweden is the Nordic country with the most voyages towards Germany.
- When looking at direct routes between the Nordics and the **Netherlands**, the picture of the ship traffic is a bit more “chaotic”, mainly due to cargo ships and tank ships with a more diverse operational pattern. However, Rotterdam stands out as a key port hub in a Nordic perspective. Several of the trafficked routes between Rotterdam and the Nordics has the potential to be initial green shipping corridors. This includes several ship segments, such as wet and dry bulk (including crude oil tankers, chemical tankers, and gas tankers) and cargo ships (including container ships, general cargo and Ro-ro cargo ships). There is also one passenger vessel operating on the Kristiansand – Eemshaven route. Norway is the Nordic country with the most voyages towards the Netherlands.
- In the **UK**, Immingham stands out as the most important cargo port in a Nordic perspective. The few Ro-Ro cargo ships operating on the route Esbjerg-Immingham and Gothenburg-Immingham could be relevant for further assessment as green shipping corridors. The same applies for the one Ro-Ro cargo ship operating on the Helsinki – Hull route. In addition, there is considerable cruise traffic between the UK and the Nordics (especially Norway, Iceland, and Denmark), with Southampton as a central UK cruise port. Norway is the Nordic country with the most voyages towards the UK.

This analysis is limited to direct port-to-port voyages and can be used as a first pre-assessment to identify corridor opportunities between the Nordics and neighbouring countries. It should be noted that this study only includes voyages by ships above 5 000 GT, and voyages performed by smaller ships are not included in this analysis. There are uncertainties in the voyage-based AIS modelling, as discussed in Appendix A.

It should be recognized that the identified routes are based only on AIS-based screening of traffic and CO_2 emissions, and further feasibility assessment will be needed for selecting potential green shipping corridors for further development.[4] Corridor specific feasibility assessments should address economic, technical and operational aspects. This includes (but is not limited to)[5] stakeholder engagement and collaboration cross the value chain, emission reduction potential, regularity of ship traffic and cargo volumes, technical and operational feasibility, maturity of ports ('port readiness') and fuel availability (production volumes and bunkering infrastructure), willingness to pay for zero-emission ('green') transport, as well as policies and support mechanisms.

4 RELEVANT ANNOUNCED CORRIDOR INITIATIVES

This chapter gives an overview of announced green shipping corridor initiatives involving the Nordic countries. By "announced corridor initiative", we mean a publicly disclosed initiative aimed at creating green shipping corridors – or maritime routes between ports that support the use of zero-emission fuels and technologies to reduce environmental impact.[v] The overview is based on a desktop screening, mainly based on DNV's Green Shipping Corridor Database (status as of January 2025) and Global Maritime Forum's Annual progress report on Green Shipping Corridors (2024 edition).[6]

As of January 2025, 65 green shipping corridor initiatives have been announced. However, most of them are at an early stage where only agreements of collaboration or feasibility assessments have been made, and none are under realisation with zero-emission vessels in operation. So far, the signatories of the Clydebank Declaration are behind the schedule of their aim to "supporting the establishment at least six green shipping corridors by the middle of this decade" (year 2025).[1]

We have identified 12 corridor announcements between Nordic countries and other countries in Europe, as well as four intra-Nordic corridor initiatives (Table 13). Some of these overlap with what we have identified as potential corridors in the voyage-based analysis, showing frequent voyages and significant CO_2 emissions on the route, such as Esbjerg – Immingham and Gothenburg – Rotterdam. More information about the corridor initiatives can be found in the References.

Table 13: Announced corridor initiatives relevant for Nordic corridor collaboration with neighbouring countries.

	Announced corridor initiatives
Nordic – Neighbouring countries	UK, US, Norway, and the Netherlands: Green Shipping Corridor Task Force (COP27)[7]
	UK – Norway Green Shipping Corridor Partnership[8]
	UK – Denmark Green Shipping Corridors Pre-Feasibility Study
	Oslo – Rotterdam Green Shipping Corridor[9]
	Finland and Estonia (FIN-EST)[10]: Helsinki – Tallinn and Vousaari – Muuga[11]
	Rotterdam – West-coast Norway Green Corridor[12]
	Gothenburg – Rotterdam Green Shipping Corridor[13]
	Sweden (Gothenburg) – Belgium Green (Ammonia) Shipping Corridor[14,15]
	Green transport corridors – linking Europe and Scandinavia: Gothenburg – Kiel – Hamburg[16]
	Esbjerg – Immingham Green Shipping Corridor[17]
	Trelleborg – Lübeck Green Shipping Corridor (Sweden – Germany)[18]
	European Green Corridor Network[19,20]
Intra – Nordic	Stockholm – Turku (Åbo)[21,22]
	Umeå – Vaasa[23,24]
	Åland Mega Green Port[25]
	Nordic roadmap green shipping corridor pilot study: Gothenburg – Frederikshavn[26]

[v] To reflect green corridors as a mechanism for decarbonising shipping, the focus is put on projects that aim to implement zero-emission ocean-going vessels that operates on routes between two or more different countries. Efforts focused on domestic ship traffic and "single point corridors", such as zero-emission harbour crafts, offshore vessel, inland barges and other smaller, non-ocean-going vessels are not included.

APPENDIX A

Voyage-based AIS method for identifying potential green shipping corridors

A voyage-based Automatic Identification System (AIS) method is used to identify port-to-port connections between the Nordic countries and other countries in Europe.[27] The analysis includes:

- Number of ships and voyages
- Estimates on energy consumption and emissions
- Description of geographical distribution of the ship traffic
- Identification of regular routes with high fuel consumption (potential green shipping corridors)

DNV's Voyage Model generates port-to-port voyages for individual vessels using AIS data and DNV's Port Shape database. For each voyage, the model estimates fuel oil consumption and CO_2 emissions by aggregating data from DNV's MASTER-model.[vi] An illustration of the Voyage Model is shown in Figure 3.

The fuel consumption and CO_2 emissions in port are excluded from the analysis of shipping routes. The port emissions can be addressed separately using alternative energy sources, such as onshore power supply in relevant ports (if available).

The Voyage Model uses the criteria that if it has registered AIS points separated in time for 1 hour or more within that port shape, it registers a port-to-port voyage. AIS data from 2023 is applied for a world fleet covering all ships in service and above 5 000 GT, covering approximately 36 000 vessels globally. We see in our analysis that approximately 3 500 of these vessels have entered a Nordic port in 2023.

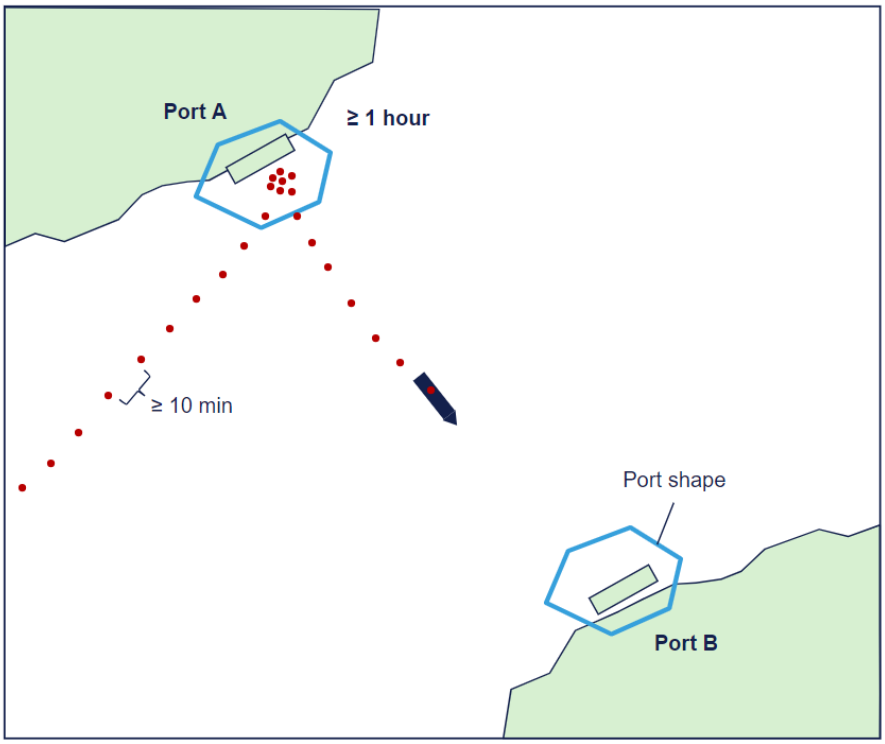


Figure 3: Illustration of the Voyage Model, including AIS data points and port shapes, as well as requirements for defining a port-to-port voyage.

[vi] MASTER - Mapping of Ship Tracks, Emissions and Reduction potentials, an AIS-based model for estimating and geographical distribution of ship fuel consumption, emission and emission reduction potentials.

Uncertainty and quality considerations of modelled results

It is important to note that there are uncertainties in the voyage-based modelling. The CO_2 emissions reported are modelled by DNV and will have deviations from real data. The modelling boundaries and thresholds set for the definition of a voyage also provide uncertainties when applying the same thresholds for all types of ship traffic. For example, the 1-hour time threshold for a port visit may not suit all ship types, such as ferries.

We would also like to highlight that this analysis is limited to direct voyages. The analysis can be used as a first pre-feasibility assessment to identify corridor opportunities between the Nordics and other countries in Europe. However, before selecting specific routes for corridor development, we recommend preparing a more detailed assessment also including roundtrips and identification of regular routes with frequent voyages and also prepare a feasibility assessment that consider other economic, technical and operational aspects.

Quality assurance and control efforts have been taken to minimise uncertainties in the modelled results. The uncertainties are mainly related to quality of input data, the applied model algorithms to estimate energy consumption, fuel consumption and emissions, and the systematics for distribution of modelled results on individual ship voyages and potential green corridors. Frequent update of the databases, validation and calibration routines are established to secure that the input data hold highest possible standard.

From the MASTER model, the estimated energy consumption, fuel consumption, and emissions for cargo carrying ships correspond well with reported data from the IMO Data Collection System (DCS) and the reported results from the EU MRV scheme. A deviation of up to 5% is observed when comparing a large dataset of modelled results with reported data from DCS and EU MRV (Longva & Sekkesæter, 2021). However, large uncertainties could occur for individual ships, and particularly for non-cargo ships. This is in line with the activity-based modelling and uncertainties related to the use of AIS data as reported by the Fourth IMO GHG study (Faber et al., 2020). Similar error sources and quality considerations for AIS data are also reported by the UN Statistics Wiki (2020). We expect that potential errors in the data sources and AIS modelled results will not have significant impact on the modelled results.

Definition of ship categories, ship types and size segments

In this report, the results are aggregated into 6 *ship categories*, 17 specific *ship types,* and 7 *size segments* based on gross tonnage (GT)[vii,viii], as shown in Table 14. The specific ship types are lumped together in ship categories for convenience and report readability. Throughout the report, we primarily mention the ship categories but mention the specific ship types where this is appropriate. The specific ship type for each individual ship in the dataset is based on ship type specifications registered in IHS Fairplay.[ix] Some of the ship types, typically fishing and work vessels are only found in the smaller ship size segments.

[vii] For reference, the median LOA (ship length) of the ships in our data material within the various size groups is approximately: < 1000 GT: 32 m, 1000 - 5000 GT: 88 m, 5000 - 10000 GT: 124 m, 10000 – 25 000 GT:170 m, 25 000 – 50 000 GT: 200 m, 50 000 GT – 100 000: 250 m, and > 100 000 GT: 320 m.

[viii] Gross Tonnage (GT) is a measure of a ship's overall internal volume. It is useful since all ships possess this metric, unlike for example DWT (dead weight tonnage).

[ix] Lloyd's Register of Ships IHS Markit, https://ihsmarkit.com/products/maritime-ships-register.html.

Table 14: Definition of ship categories, ship types, and size segments.

Ship category	Ship type	Ship size segments (GT)
Cargo vessels	Container ship	All ship types are divided into these size categories: < 1 000 GT 1 000 – 5 000 GT 5 000 – 10 000 GT 10 000 – 25 000 GT 25 000 – 50 000 GT 50 000 – 100 000 GT > 100 000 GT
	General cargo ship	
	Refrigerated cargo ship	
	Ro-ro cargo ship	
Wet and dry bulk vessels	Bulk carrier	
	Chemical tanker	
	Crude oil tanker	
	Gas tanker	
	Oil product tanker	
Passenger vessels	Ro-pax	
	High speed passenger vessel	
	Other passenger ship	
Cruise vessels	Cruise ship	
Work/service vessels	Aquaculture vessel	
	Offshore vessel	
	Other activities (incl. tugs, work boats etc.)	
Fishing vessels	Fishing vessel	

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[9] Oslo-Rotterdam Green Shipping Corridor:
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