econext

Discussion Paper

Marine Transportation Decarbonization in Newfoundland and Labrador

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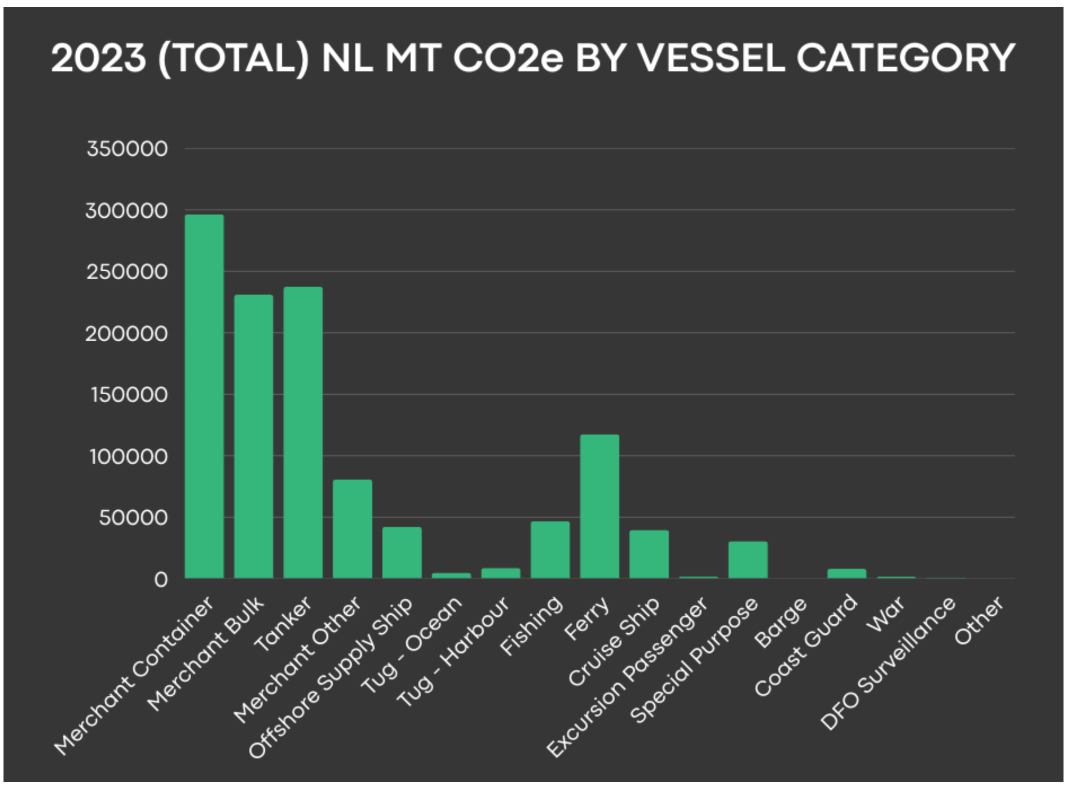
Executive Summary

Marine transportation accounts for 8% of greenhouse gas (GHG) emissions in Newfoundland and Labrador (NL). The sector is not well understood in NL from a GHG perspective, prompting the province's Net Zero Advisory Council (NZAC) to identify further examination as being a priority for NL's net zero by 2050 planning.

At the same time, research has shown that the marine transportation sector has the greatest potential for low-carbon fuel adoption within the province. This is of interest from the perspective of supporting the emerging clean fuels production industry in the province.

These factors led to *econext* prioritizing the advancement of marine transportation decarbonization planning and activities within the province.



The decarbonization of marine transportation in NL will be complex. The marine sector is deeply interwoven with rural life and livelihoods in the province, with its people culturally and commercially dependent on the ocean. Meanwhile, marine transportation in NL is diverse with many different types of vessels operating in various areas with unique operational requirements. Furthermore, NL's geography, low population density, and dispersed communities make infrastructure and technology deployment more complex and expensive.

With granular data on marine transportation GHGs recently becoming available, this discussion paper aims to advance the discussion on decarbonization within the sector in NL and support future decision-making at the government, community, and industry levels on the supply of low-carbon fuels.

Decarbonization pathways for marine transportation are difficult to predict. Pathways are likely to diverge from one another depending on the sector in question. In some of the segments of marine transportation, NL has little control over decarbonization pathways that are chosen. Yet, in other segments, NL does have a degree of control.

The following observations can be made following an analysis of marine transportation decarbonization pathways as they apply in the NL context:

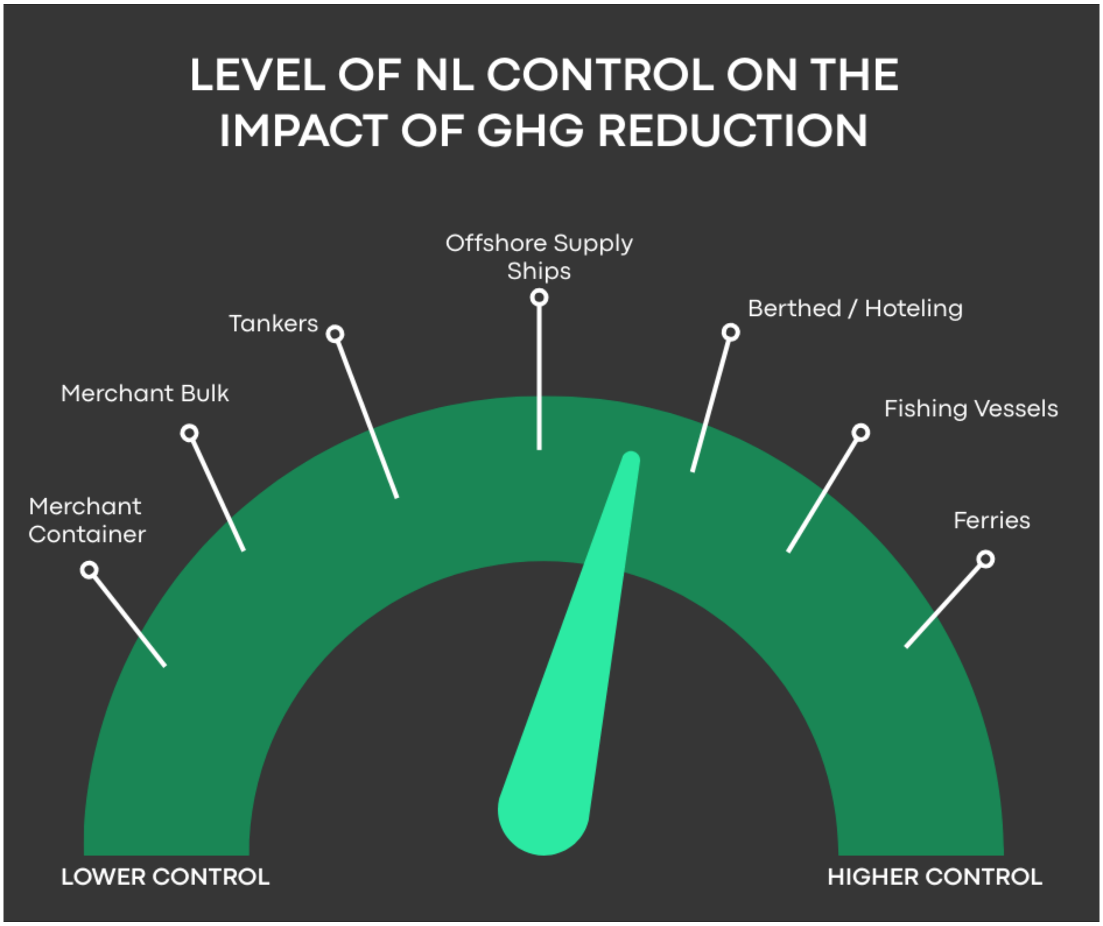
1. Container ships contributed 26% of all marine transportation GHGs for NL in 2023. NL will not influence the decarbonization decisions made by large international shipping companies, however it should pay close attention to developments to ensure that it is able to supply these vessels with the fuels that they will demand in order to (a) enable decarbonization and (b) support domestic low-carbon fuels producers.

2. Bulk shipping contributed 20% of all marine transportation GHGs for NL in 2023. NL should engage with those shipping bulk cargo (i.e., iron ore, nickel) to influence or understand plans to (a) enable decarbonization and (b) support domestic low-carbon fuels producers.

3. Ferries contribute 21% of all domestic marine transportation GHGs in NL. Federal and provincial governments are owners, operators, and/or contractors of these services. Therefore, there is a direct opportunity for Canada and NL to control future decisions that impact the environment and the economy.

4. Tankers and offshore supply ships make up 25% of NL's marine transportation GHGs. Much of the traffic of these vessels is within NL jurisdiction. There may be an opportunity to develop a decarbonization strategy that supports local low-carbon fuel producers while supporting the reduction of GHGs in NL's offshore oil and gas supply chain.

5. A low-hanging fruit in marine transportation decarbonization in NL is reducing 'berthed' or hoteling GHGs – which were estimated to be 8% of all sector GHGs in NL in 2023. NL is an ideal location for shorepower given its 90%+ clean electricity grid. Shoreside infrastructure is a key enabler and is within NL's direct control to provide. More search is required to better understand the demand and supply particulars in vessel electrification.



6. While different decarbonization pathways exist for each vessel type, the potential for fuel blending is a common factor. More focus needs to be placed on testing and trialing fuel blends in NL. This can begin with low-carbon fuels that are already produced in the province (i.e., renewable diesel) and advance to include hydrogen and its derivates in the future. This also creates an opportunity for local biofuel production. To achieve the above, a focus must be placed on local R&D and training in these areas.

7. More research is required to better characterize emissions relating to the fisheries, ferries, and intra-provincial shipping.

8. As the marine transportation sector is so intricately tied with the culture and livelihoods of NLers, it will be important to consider what decarbonization pathways will mean for people, workers, and communities.

There are environmental and economic benefits to be achieved in NL through the decarbonization of marine transportation. This discussion paper contains new analysis of data that has only recently become available; econext hopes that this effort helps advance net zero planning and activities in NL's marine transportation sector.

Marine Transportation and Greenhouse Gas Emissions in Newfoundland and Labrador

Introduction

In 2025 *econext* completed a study with KPMG titled "*Opportunities for Domestic Clean Fuels Use in Newfoundland and Labrador*". This study explored potential low-carbon fuel use categorized according to sector within the province.

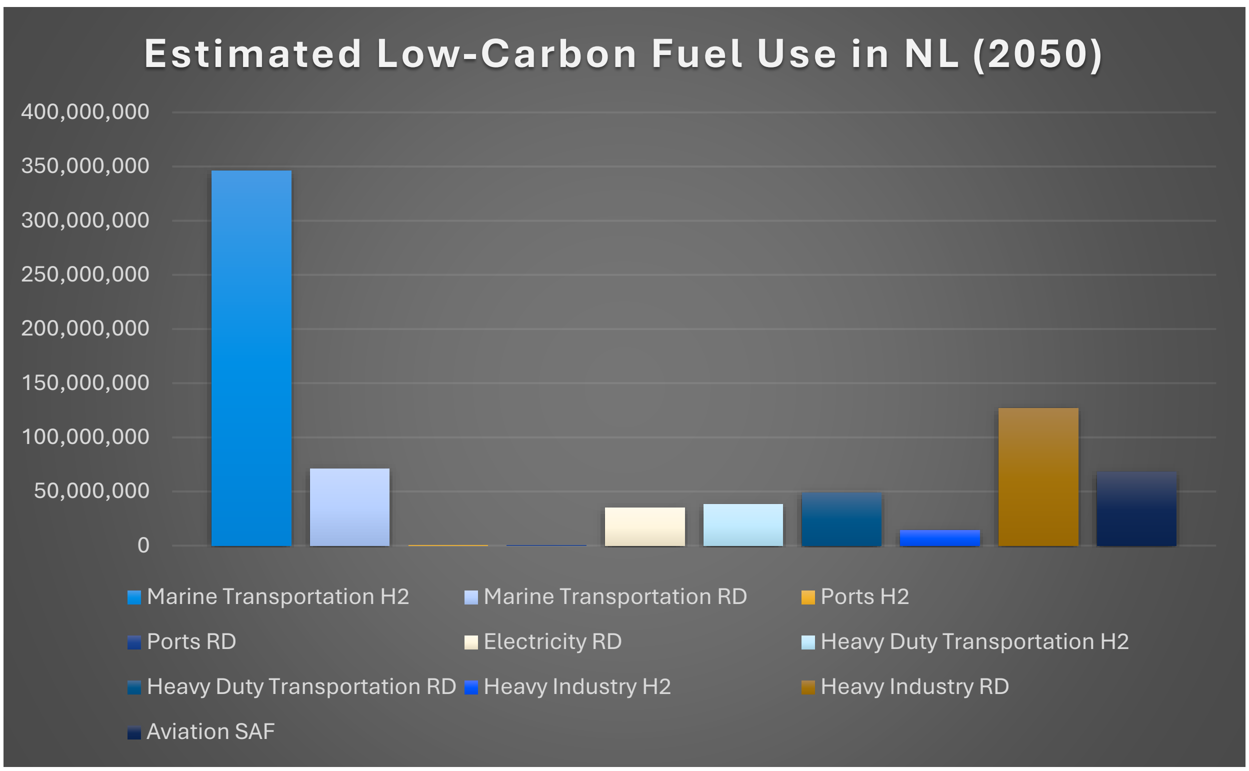


Figure 1: Estimated Low-Carbon Fuel Use in NL in the Year 2050
with H2 = hydrogen and its derivatives, RD = renewable diesel, and SAF = sustainable aviation fuel

These estimates are based on high-level assumptions using available greenhouse gas (GHG) data, International Energy Agency (IEA), and practical observations. The outlook for the future adoption of low-carbon fuels is based on many different variables and is difficult to predict – particularly within a localized geography.

However, what the research does clearly illustrate is the relative importance of marine transportation as it pertains to potential low-carbon fuel use in Newfoundland and Labrador (NL).

Until recently, the marine transportation sector in NL has not been well understood from a GHG perspective, making determinations on net zero pathways and the supply of alternative fuels difficult.

The decarbonization of marine transportation in NL will be complex. The marine sector is deeply interwoven with rural life and livelihoods in the province, with its people culturally and commercially dependent on the ocean. Meanwhile, marine transportation in NL is diverse with many different types of vessels operating in various areas with unique operational requirements. Furthermore, NL's geography, low population density, and dispersed communities make infrastructure and technology deployment more complex and expensive.

With granular data on marine transportation GHGs recently becoming available, this discussion paper aims to advance the discussion on decarbonization within the sector in NL and support future decision-making at the government, community, and industry levels on the supply of low-carbon fuels.

About *econext*

econext is a not-for-profit association with a mission to accelerate clean growth in NL. *econext* has been working for over 30 years on behalf of its members across many sectors to support environmentally sustainable economic development. *econext* is focused in the following areas:

- **Innovation** – *econext* works with partners in the public, private, and academic sectors to stimulate and support R&D and innovation that advances clean growth in Newfoundland and Labrador.
- **Workforce** – *econext* coordinates with private, public, and academic partners to ensure Newfoundland and Labrador's workforce is prepared for the emerging green economy.
- **Net zero** – *econext* is a catalyst for climate change action within Newfoundland and Labrador, helping industry, businesses, and communities find a better balance between economy and environment.

econext is a driver for clean growth innovation in the province, a coordinator of green workforce development, and a catalyst for net zero by 2050 planning within NL's communities and industries. More information can be found at https://econext.ca/.

Background

NL has the longest coastline in Canada and has relied on the ocean for sustenance and economic activity since it was first populated. From the fisheries, to offshore oil and gas, to tourism, to aquaculture, to science and research, the people of NL have relied on marine transportation for their livelihoods and it is ingrained in their culture.

Most marine transportation methods in the last 150 years have involved combustion engines and the burning of fossil fuels for propulsion. Therefore, it is not surprising that marine transportation is a significant source of greenhouse gas (GHG) emissions for the province.

At 47%, transportation is the single largest contributor to GHGs in NL[1]. Marine transportation accounts for a quarter of these emissions. At almost 8%, NL has the highest share of GHGs attributed to its marine transportation sector amongst the provinces in Canada.

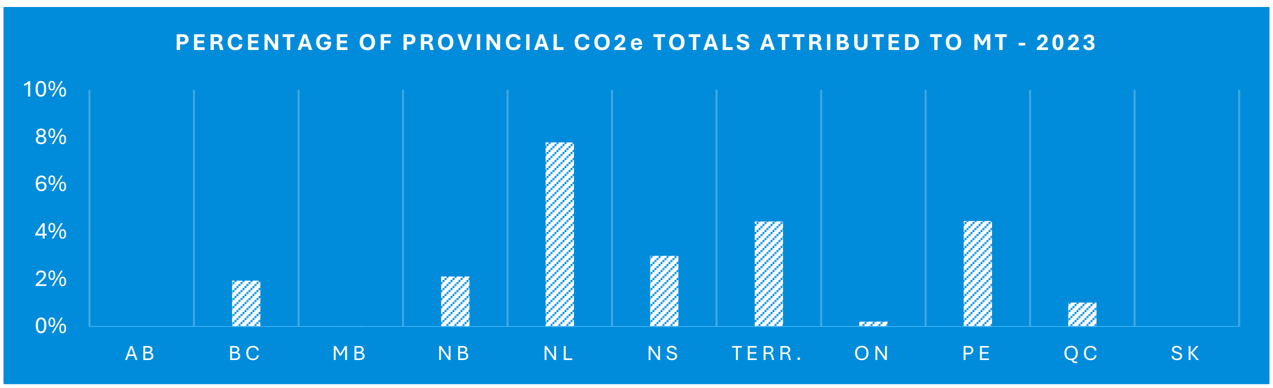


Figure 2: Percentage of Provincial CO2e Totals Attributed to MT – 2023

Data from Canada's Official Greenhouse Gas Inventory[2]

In terms of absolute emissions, NL's marine transportation sector is one of the largest emitters in Canada with British Columbia (BC) and Quebec (QC) the leaders nationally.

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[1] https://www.gov.nl.ca/eccc/files/Historical-GHG-Emissions-Summary-NL-1990-2023-Mar-2025.pdf

[2] https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-official-greenhouse-gas-inventory?lang=en

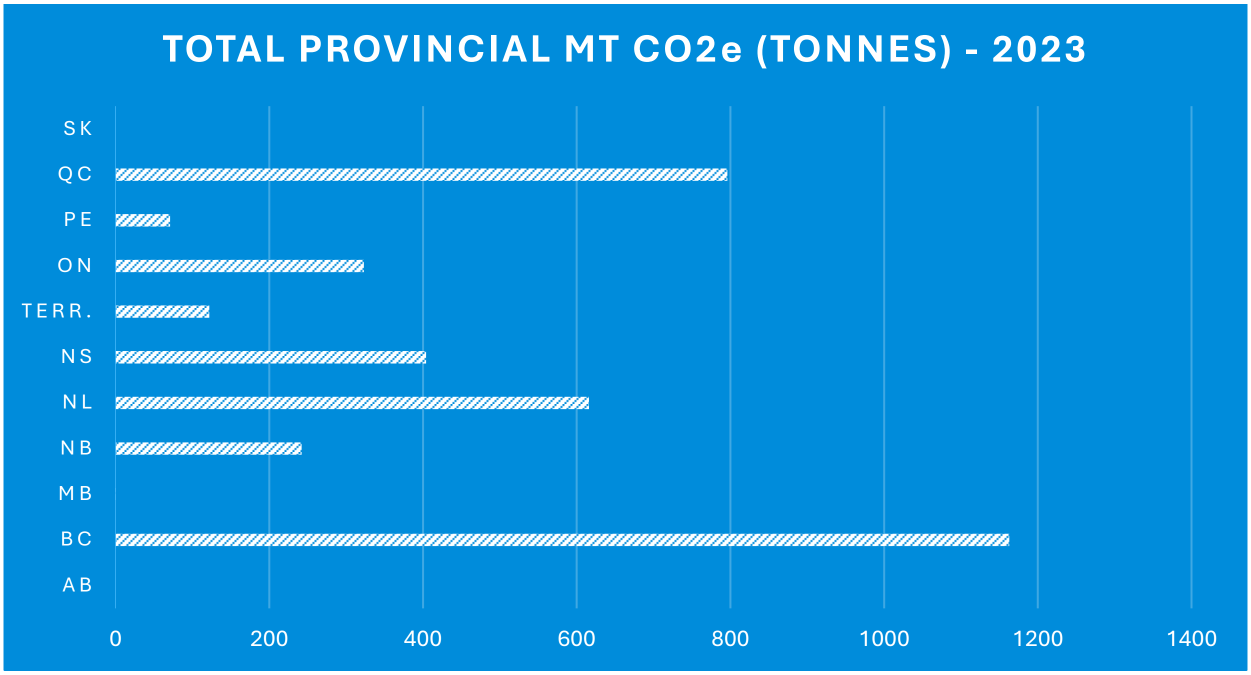

Figure 3: Total Provincial MT CO_2e – 2023
Data from Canada's Official Greenhouse Gas Inventory[3]

On a proportional basis, NL has more reason to focus on marine transportation decarbonization than any other province in Canada. In totality, Canada's efforts in marine transportation decarbonization would be most impactful in BC, QC, and NL.

The sector is multi-faceted. Vessel types are designed differently, have unique applications, and have many ports of call. Therefore, the decarbonization of the sector will be complex.

However, with a rich history in ocean industries, the private sector and research institutions are well positioned to advance initiatives to address it. This is why the province's Net Zero Advisory Council (NZAC) highlighted marine transportation as an area that NL should prioritize in its pursuit of carbon neutrality by the year 2050 and recommended that the provincial government 'develop a marine transportation decarbonization strategy by 2025 with ports and clean energy as the focus'[4].

[3] https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-official-greenhouse-gas-inventory?lang=en
[4] https://econext.ca/wp-content/uploads/2025/07/Attachment-NZAC-Summary-of-Recommendations-2024-12-30.pdf

Greenhouse Gas Data

Decisions in support of marine transportation decarbonization must be data and evidence driven. Fortunately, sufficiently granular data is becoming available.

The Canadian government is able to track marine traffic and make a variety of different determinations on routes, ship design, and more. Marine Communication and Traffic Services (MCTS) under the Canadian Coast Guard (CCG) leads these vessel traffic services. The MCTS undertakes its work through the exchange of information between ships and shore-based control centers. The MCTS communicates traffic information to vessels in all navigable Canadian waterways – all which must comply with Canadian marine traffic regulations.

The data that MCTS acquires includes a vessel's geospatial information (current position, origin, destination, estimated arrival time, passage times at specific points, source position, etc.), design characteristics (e.g. main engine power, length, deadweight, build year, flag, main and auxiliary engine ratings, engine stroke type, engineer RPM, scrubber information, etc.), detailed itineraries and other trip specific details (e.g. cargo information or tug/barge towing data).[5]

Collectively this information can be used to make GHG emissions calculations.

In 2025 Environment and Climate Change Canada (ECCC) published its updated Marine Emissions Inventory Tool (MEIT). The tool utilizes information obtained from MCTS to provide an inventory of shipping activity, energy use, and air pollutants and GHGs from marine vessels in Canadian waters. The MEIT tool allows users to: view marine emissions geospatially; filter emissions by year, region or other basic conditions; and generate emissions reports[6].

This tool provides rich information from which substantive research can be undertaken. The data provided through this tool is used in this discussion paper in detailing marine transportation and GHG emissions in NL.

[5] Publication forthcoming

[6] https://www.canada.ca/en/environment-climate-change/services/managing-pollution/marine-emissions-inventory-tool.html

Vessel Classes and Types

There are many forms of marine transportation in NL ranging from fishing boats, ferries, supply ships, cargo vessels, tankers, tugs, science vessels, recreational boats, and much more. To decarbonize the sector, priorities must be established and this requires an understanding of where the majority of GHGs are created.

The MEIT categorizes vessels according to ‘classes’ and ‘types’. This information is taken from MCTS which in turn is informed by vessels in Canadian waters through automated processes. Ship builders, owners, and operators are expected to align their vessel classification according to norms established by the International Maritime Organization (IMO) and classification societies such as DNV and Lloyd’s Register.

However, there are no standardized definitions of vessel classes and types that are universally used worldwide. A number of factors complicate efforts at universal classification: marine transportation often crosses national boundaries; shipbuilding involves international supply chains and customers; there are many different types of vessels and vessel use cases; and vessels can have long lifespans. The lack of a fully standardized classification scheme can create difficulties in the analysis of data.

Therefore, in interpreting the data from tools like the MEIT, assumptions must be made through an examination of vessel travel patterns, origins and destinations, etc. to gain a fulsome understanding of the vessel types being characterized. With a working knowledge of economic activity and marine transportation norms within a region, reasonable deductions can be made to produce useful definitions for analysis.

For example, an analysis of traffic in the MEIT classified as ‘tug – supply’ reveals that almost all traffic categorized in this manner applies to vessels moving back and forth between offshore oil and gas installations. Thus, this category represents vessels that are most often referred to locally as ‘offshore supply vessels’.

Using the MEIT, the table below outlines vessel classes and types are active in NL. The order of appearance is roughly aligned with the level of GHG emissions emitted in NL per class and type. A third column has been added which defines these classes and types within the NL context. These definitions allow for a productive analysis of marine transportation GHGs within the province and are used throughout the remainder of this discussion paper.

Vessel Classes	Vessel Types	NL Descriptions
Merchant Container		A large cargo vessel designed to transport goods in standardized intermodal containers, which are stacked both above and below deck. In NL this would include container ships that operate at ports in St. John's and Corner Brook.
Merchant Bulk		A specialized merchant vessel designed to transport large quantities of unpackaged, dry cargo in its large cargo holds. In the NL context this would mostly involve the transportation of iron ore, nickel, etc.
Tanker		"Tanker". A tanker ship is a vessel designed to transport liquid or gaseous cargo in bulk, such as crude oil, chemicals, and liquefied natural gas (LNG).
	Merchant crude	A tanker ship that moves unrefined crude oil from extraction sites to refineries or intermediary destinations. In the NL context this would mostly involve the transportation of crude from offshore oil production facilities.
	Merchant chemical/oil products tanker	A tanker ship that moves chemical or oil products. In the NL context this would mostly involve the distribution of refined products to and throughout ports in NL.
	Merchant chemical	A tanker ship that moves chemical products. In the NL context this would mostly involve the distribution of refined products to and throughout ports in NL.
	Merchant (tanker)	A tanker ship that moves unrefined crude oil or refined petroleum products like gasoline and diesel.

	Tanker (other)	A catch-all for tankers moving non-oil or non-chemical products.
Merchant Passenger	Merchant Ferry Merchant Passenger	"Ferry". A commercial vessel designed primarily to transport more than 12 passengers. In the NL context this includes all ferries in the province such as those operated by Marine Atlantic, the provincial government, and contractors to the provincial government.
Merchant Other	Merchant general Merchant RO/RO Merchant auto Merchant reefer Merchant coastal Merchant cement	A commercial vessel transporting cargo not as containers as not as defined in 'bulk'. This would include any cargo that is not container or classified as 'bulk'.
Tug	Tug supply	"Offshore supply ship". In the NL context, this refers mostly to supply vessels carrying cargo (people, equipment, and other goods) to offshore oil and gas facilities.
	Tug ocean	A marine vessel used to tug a large payload (e.g., propelled ship, barge, etc.) by pushing or pulling them, with direct contact or a tow line, over a long distance.
	Tug – tug / harbour	"Tug - harbour". A marine vessel that manoeuvres other vessels over a shorter distance by pushing or pulling them, with direct contact or a tow line, such as those found within harbours and docking wharves.

Fishing	Fishing vessel	A boat or ship used for catching, harvesting, transporting, or processing fish and other aquatic life.
	Trawler	A commercial vessel designed to drag a large, funnel-shaped net called a trawl through the water to catch fish.
	Factory ship	A commercial vessel with extensive on-board facilities for processing and freezing caught fish.
Cruise	Cruise Merchant passenger	"Cruise ship". A large ship that carries people on voyages for pleasure, typically calling at several places. In NL cruise ships dock in St. John's, Corner Brook, and St. Anthony.
Special Purpose	Special purpose supply VSL Special purpose Special purpose crane ship Special purpose VSL Special purpose pilot boat Special purpose pipe-layer Special purpose survey ship	A vessel with a unique design and function, such as a research or icebreaker ship, built for specific tasks rather than general cargo. In NL can include survey ships, pilot boats, crane ships, etc.
Coast Guard	Coast guard icebreaker Coast guard scientific Coast guard rescue Coast guard lifeboat Coast guard tender	All Coast Guard vessels active in NL which could include science vessels, rescue vessels, icebreakers, lifeboats, etc.

Excursion Passenger		A vessel used for short trips for pleasure or recreation, such as sightseeing, dinner cruises, or tours, and carries passengers for hire. In NL these would be vessels used within the tourism industry.
War	Warship surface Warship – general	Vessels owned and operated by the Department of National Defence or militaries from other jurisdictions.
DFO Fishing Surveillance Vessel	DFO fishing surveillance vessel Coast guard patrol Marine security patrol CCG-RCMP	Vessels operated by both DFO and the RCMP for the purposes of surveillance, patrol, and security.
Barge		Barges are flat-bottomed, box-shaped or nearly box-shaped vessels with simple configurations. Barges are used for a wide variety of purposes, from general-purpose cargo carriage to heavy lifting of structures such as offshore platforms.
Other		A collection of vessel types not found within the categories above with minimal GHGs.

This discussion paper will use the categories described above in its subsequent analysis and conclusions.

Emissions Sources

Measurement

The MEIT calculates a variety of air contaminants, pollutants, and GHGs including: nitrogen oxides (NOx); non-methane hydrocarbons (HC); particulate matter (PM, PM10, and PM2.5); sulphur oxides (SOx); carbon monoxide (CO); black carbon (BC); carbon dioxide (CO2); nitrous oxide (N2O); and methane (CH4).

The MEIT also calculates 'carbon dioxide equivalent' or CO2e. CO2e is a standardized unit (usually expressed in million metric tonnes) used to measure a greenhouse gas's impact on the basis of their global-warming potential (GWP). The unit converts amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential[7]. This allows for blended use of a number of GHGs simultaneously to understand total climate impacts. This analysis uses CO2e as the comparable metric.

Below is a table which summarizes MT GHGs in NL from 2015-2024 in tonnes.

Category	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Merchant container	170,970	168,836	252,228	273,274	275,411	251,909	226,009	287,557	296,265	273,819
Merchant bulk	142,879	159,911	215,346	209,389	209,673	242,304	229,674	247,604	231,005	287,606
Tanker	224,976	255,548	273,644	299,845	298,590	298,164	253,093	249,728	237,514	323,512
Merchant other	75,810	70,372	86,848	83,316	87,909	77,885	73,533	71,999	80,850	122,827
Offshore supply ship	71,707	53,307	58,362	55,291	72,036	41,095	33,037	43,616	42,215	45,471
Tug - ocean	28,496	23,840	33,549	35,810	29,227	13,210	8,161	5,568	4,866	12,181
Tug - harbour	7,627	9,167	9,419	10,226	9,944	10,976	7,846	9,415	8,754	7,606

[7] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_equivalent

Fishing	38,824	44,652	45,144	55,477	44,413	40,644	64,922	51,365	46,852	91,320
Ferry	88,436	108,298	104,797	103,409	112,711	103,140	107,363	117,976	117,356	105,287
Cruise ship	17,874	16,330	26,835	27,890	36,554	208	-	30,077	39,704	46,108
Excursion passenger	870	2,875	1,889	1,940	1,921	-	1,485	1,958	1,901	1,292
Special purpose	15,417	19,374	32,226	34,278	39,704	33,433	22,667	28,779	30,450	29,939
Barge	734	71	2,813	730	659	2,666	736	501	-	4,583
Coast guard	18,063	10,307	10,951	11,605	10,080	10,220	8,675	12,117	8,067	7,551
War	5,746	2,447	1,783	2,008	1,258	773	1,704	857	1,652	335
DFO Surveillance	4,861	2,582	1,991	1,956	1,791	1,188	1,233	1,489	969	-
Other	188	607	450	844	392	505	440	246	184	47
TOTAL	913,478	948,524	1,158,275	1,207,288	1,232,273	1,128,320	1,040,578	1,160,852	1,148,604	1,359,484

Figure 4: 2015-2024 NL Marine Transportation Emissions – CO2e
Results recorded from the Marine Emissions Inventory Tool

Total Emissions vs. Accounted Emissions

The data referenced above includes international marine transportation, i.e., ships with international origins that arrive in NL or ships that depart from NL for international destinations.

For the purposes of this study, it was decided that GHGs associated with international marine transportation would be included in analysis. This is based on the fact that international marine transportation is a significant contributor of GHGs within NL's jurisdiction and its decarbonization presents a variety of opportunities for research and development, international collaborations, and uses of domestically produced clean fuels.

However, it should be noted that GHGs associated with international marine transportation are not considered 'Canadian' under internationally standardized GHG accounting practices. International marine transportation emissions are intended to be covered under possible future International IMO regulations. Therefore, the MT GHG data used for analysis in the report will differ from what is officially reported Canada and its provinces.

The graph below shows the difference between total NL MT CO2e (including international marine traffic) versus what is accounted for and reported on in Canada (not including international marine traffic).

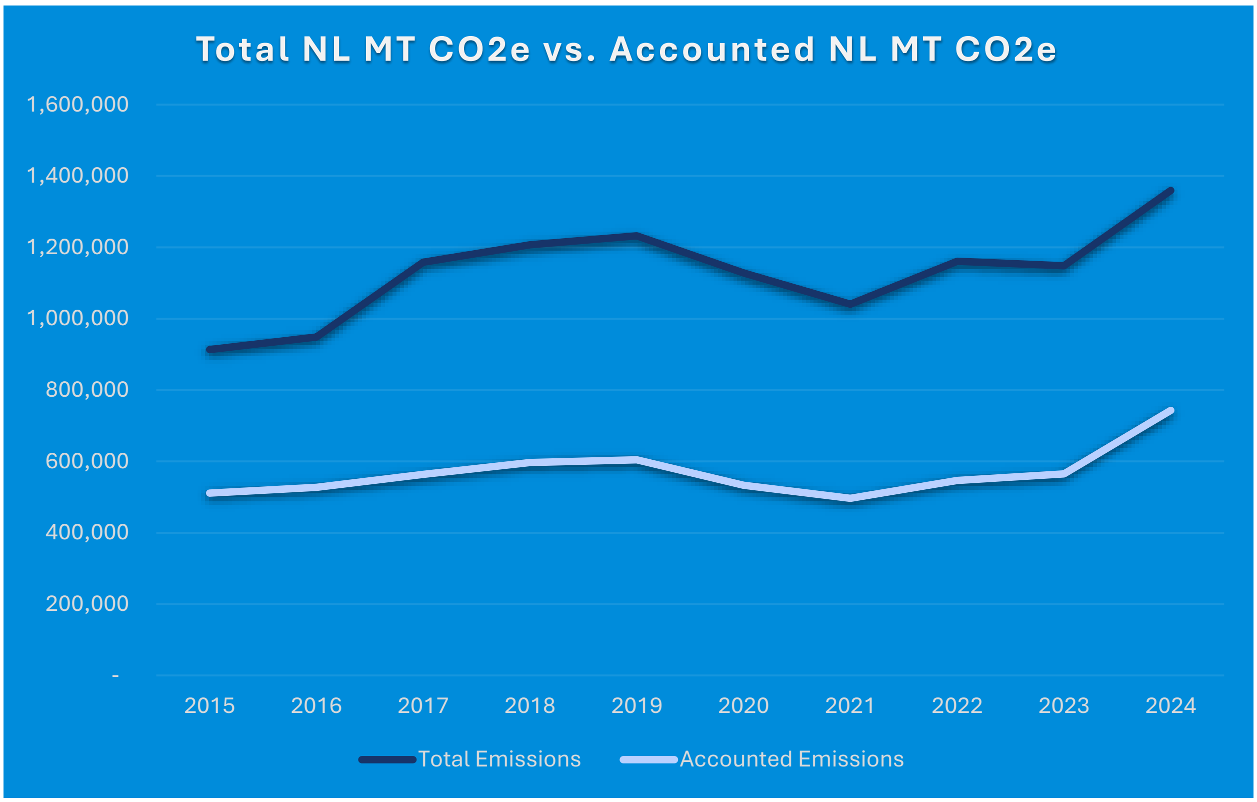

Figure 5: Total NL MT CO2e vs. Accounted NL MT CO2e

As would be expected, ‘tanker’, ‘merchant container’, ‘merchant bulk’, and ‘merchant other’ vessel types account for significantly more GHGs when including transportation to and from international destinations.

Note that the figures presented above and used for analysis do not include any transportation that is classified as 'innocent passage' - or marine traffic that traveled through NL waters but did not depart or arrive at an NL port.

Emissions Over Time

Total GHGs emanating from marine transportation have grown from 913,478 CO2e in 2015 to 1,359,484 CO2e in 2024, represented a growth of almost 49%.

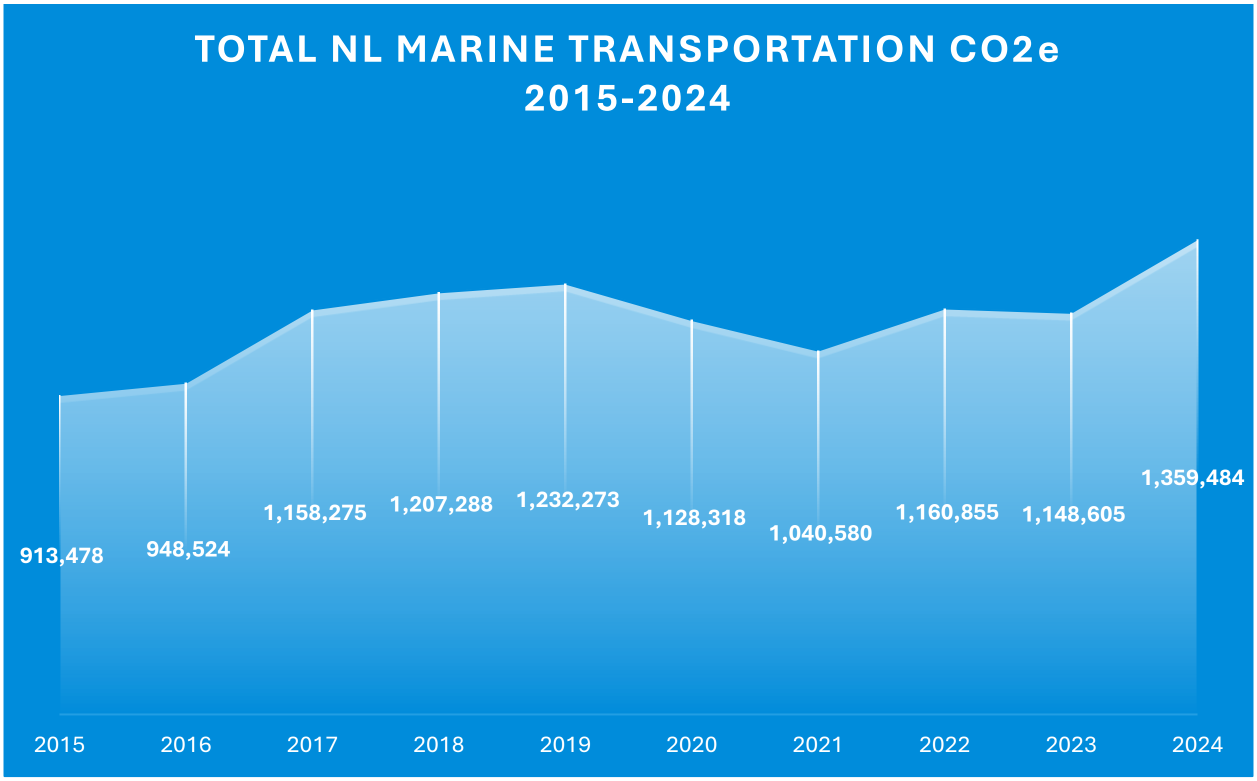

Figure 6: TOTAL NL Marine Transportation CO2e 2015-2024

As the data for 2024 has been recently published as of the time of this writing, it is recognized that there may be some adjustments made to it. There is a significant jump between 2023-2024 MT GHGs and therefore the data should be used with caution until such time that it is confirmed. For these reasons, 2023 will be the base year from which the remainder of this analysis is drawn from. Total GHGs emanating from marine transportation have grown from 913,478 CO2e in 2015 to 1,148,605 CO2e in 2023, represented a growth of almost 26%.

CO2e by Vessel Category

Decisions around the prioritization of marine transportation decarbonization can be informed by the total GHGs associated within each vessel category. The higher the emissions in a category – the more impetus there may be to drive solutions to reduce them.

It is worthwhile comparing MT GHG totals in NL against those that would be accounted for with the purpose of provincial and federal reporting as the results may impact the decarbonization priorities of industry versus governments,

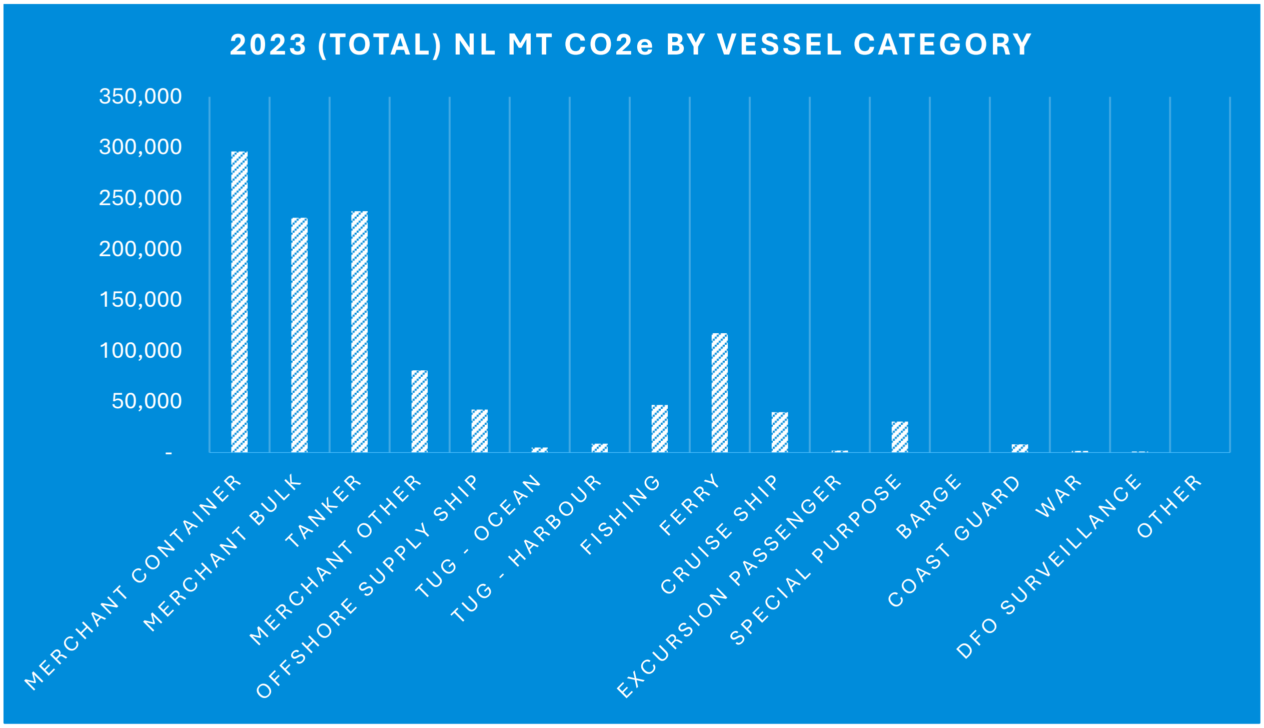

Figure 7: 2023 (Total) NL MT CO2e by Vessel Category (Bar)

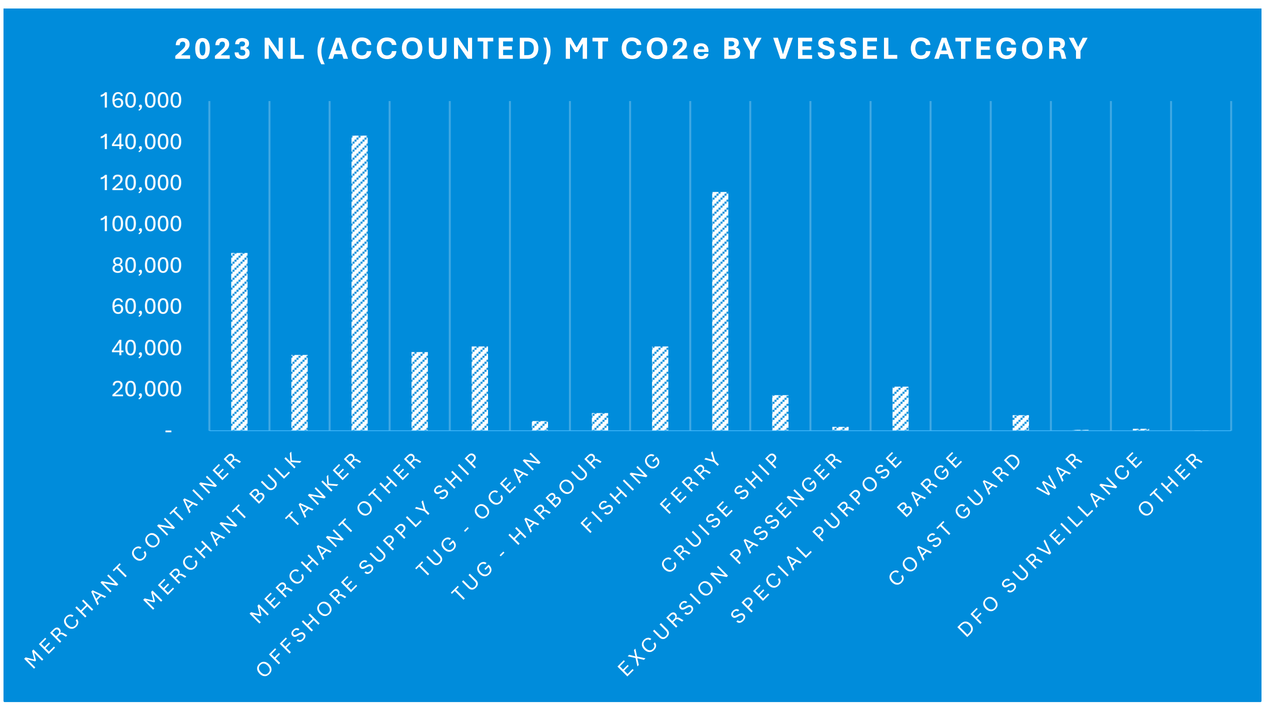

Figure 7: 2023 (Accounted) NL MT CO2e by Vessel Category (Bar)

Overall 2023 marine transportation GHGs in NL rise from 565,052 tonnes of CO2e to 1,148,605 tonnes of CO2e when including traffic with either an international origin or destination.

Of particular interest when comparing these data sets is the prevalence of merchant container, merchant bulk, and tanker vessel categories when including all GHG data. This is unsurprising as there is a significant amount of goods and services that arrives in NL from international origins via container shipping. Additionally, markets for NL's primary natural resource exports (crude oil, iron ore, nickel, etc.) are international and would be represented by bulk and tanker traffic.

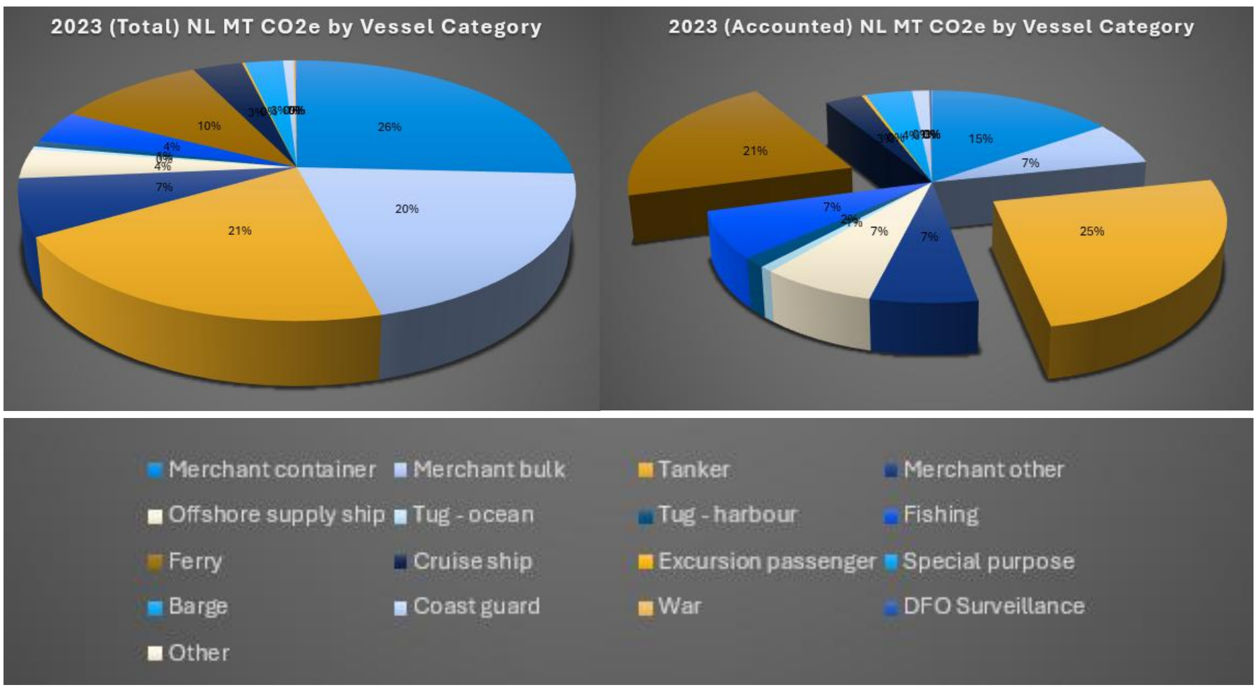

Figure 9: 2023 (Total vs. Accounted) NL MT CO2e by Vessel Category (Pie)

Notable when considering the accounted GHGs (official figures that would be reported federally/provincially) is the increased share that ferry and tanker traffic have relative to other emissions sources.

Examining each vessel category in greater detail – including a high-level overview of decarbonization pathways for each in NL – will help to inform training and workforce development considerations. However, in advance of this examination it is important to have a general understanding of the technologies that can be deployed to assist in and drive emissions reductions within maritime transportation.

Marine Transportation Decarbonization in NL

To outline marine transportation decarbonization pathways for NL, it is first necessary to have a general understanding of the primary technologies that are being developed and deployed internationally in support of it.

Marine Transportation Decarbonization Technologies

Vessel Optimization

In the same way that changes in habits and energy efficiency measures in a home or building can reduce GHGs, the optimization of marine vessel operations can yield emissions reductions. Energy efficiency measures on ships can be classified as follows[8]:

- *Energy consumers* – improvement in energy efficiency of onboard consumers such as lighting equipment and cargo handling systems.
- *Energy harvesting* – measures that capture energy from the surroundings, converting it to propulsion power or electricity (e.g. sails and solar panels).
- *Propulsion and hull* – measures that improve the hydrodynamical performance of the vessel.
- *Machinery* – measures that relate to the machinery on board the vessel, including main engines, auxiliary engines, and related systems.
- *Operational* – measures that relate to the way in which the ship is maintained and operated (i.e., route optimization) and the cargo is handled.

It is estimated that operational and technical energy-efficiency measures can reduce fuel consumption in the maritime industry by 4% to 16% by 2030[9]. The effect of each energy efficiency measure varies depending upon a range of factors such as vessel type, size, age, location, and route[10]. As optimization can achieve both emissions reductions and cost savings, this is the first best place for vessel owners / operators to start in their decarbonization journey.

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[8] https://brandcentral.dnv.com/original/gallery/10651/files/original/216954a7-8cc8-49b6-b99e-37e76a41410a.pdf
[9] https://www.dnv.com/expert-story/maritime-impact/strategies-for-meeting-upcoming-decarbonization-targets/
[10] https://www.dnv.com/maritime/insights/topics/ship-energy-efficiency/solutions/

Electrification

Batteries on ships allow stored electrical energy to be used for propulsion and other onboard systems instead of the burning of fuel. Fully battery-powered ships produce zero direct emissions of GHGs and harmful pollutants during operation (while it should be noted that the overall GHG reduction potential is dependent on the characteristics of the electricity used to charge the battery). Electric propulsion systems powered by batteries are significantly quieter than traditional engines, reducing noise pollution in marine environments. Batteries can provide quick and precise power adjustments for better control and manoeuvrability and can provide power to smooth peak loads in the ship network. Fewer energy conversions are required than when using fuel, and therefore fewer energy losses. Additionally, electric motors are more efficient than combustion engines.

There are some challenges associated with fully electric ships. First, they have a limited range compared to ships using liquid fuels. The recharging batteries takes longer than conventional refuelling of ships, impacting scheduling and operational efficiencies. Electrified ships also require significant infrastructure port-side to enable their chargingOnboard batteries also present a risk of uncontrolled exothermic chemical reactions which are not present on conventional ships[11].

Over the last decade the maritime industry has started to embrace hybrid and electric technology – particularly in smaller vessels such as workboats, pleasure craft and ferries[12]. This is because electric ships are most ideal for shorter routes due to limitations in range and charging infrastructure[13]. Short voyages allow frequent battery-charging and for batteries to cover a substantial amount of a ship's annual energy needs[14].

Hybrid Electric

The use of batteries in hybrid power systems (i.e. in combination with other higher energy density technologies) increases potential applications. A hybrid vessel is one where a battery is supplemented by a more conventional ship engine. The battery can be charged through shoreside power or the ship's engine itself. To achieve greater decarbonization, hybrid vessels can be built to use alternative fuels when the propulsion shifts to using the engine.

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[11] https://www.lr.org/en/knowledge/research/zcfm/electrification/

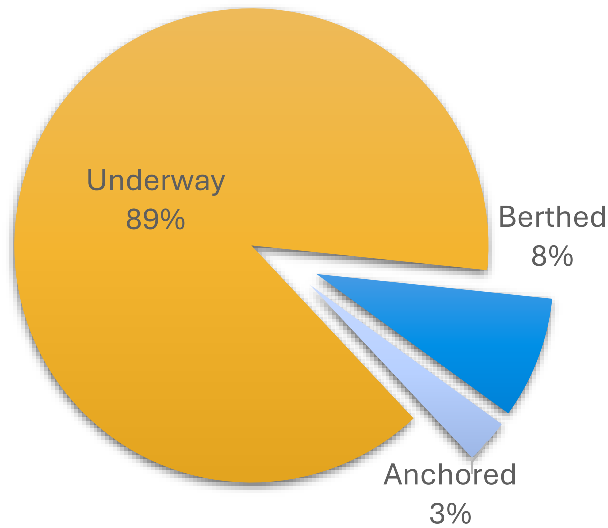
[12] https://www.idtechex.com/en/research-report/electric-boats-and-ships/948

[13] https://brandcentral.dnv.com/original/gallery/10651/files/original/216954a7-8cc8-49b6-b99e-37e76a41410a.pdf

[14] https://www.dnv.com/expert-story/maritime-impact/strategies-for-meeting-upcoming-decarbonization-targets/

Shore Power

The use of shoreside electricity when berthed is an additional GHG reduction opportunity. Most vessels run at all times, even with docked, burning fuel in the process. This is also referred to as 'hotelling'. The MEIT calculates 'berthed' emissions in 2023 in NL as being 91,000 CO2e or being responsible for 8% of all marine transportation GHGs in the province.



Retrofitting ships with the capability to 'plug in' to access shoreside electricity – and providing the enabling infrastructure at the port – can result in meaningful GHG reductions. This is particularly true when vessels are able to access clean electricity.

The presence of batteries (and associated equipment) on vessels presents the potential for different types of chemical reactions which previously did not need to be considered by crew and maintenance workers. Therefore, electrification in marine settings requires specialised training.

Low-Carbon Fuels

'Low-carbon fuels' is a catch-call term which refers to fuels that have a lower carbon intensity that conventional fuels – which in the marine transportation sector would include fuels such as heavy fuel oil (HFO), marine diesel oil (MDO), etc. There is a wide variety of different low-carbon fuels relevant to marine transportation, each with their own characteristics to consider.

Liquified Natural Gas (LNG)

While still a fossil fuel, the use of LNG as a marine fuel offers several benefits, including reduced emissions: LNG combustion produces lower levels of sulphur oxides (SOx), nitrogen oxides (NOx), particulate matter, and carbon dioxide (CO_2) compared to HFO. LNG is a potential transitional fuel as the industry looks towards a carbon-neutral future that includes non-fossil fuels[15].

[15] https://www.lr.org/en/knowledge/research/fuel-for-thought/lng/

Renewable Natural Gas (Bio-LNG)

Renewable natural gas is a term used to describe biogas that has been upgraded for use in place of fossil natural gas. The biogas used to produce RNG comes from a variety of sources, including municipal solid waste landfills and anaerobic digester plants at water resource recovery facilities (wastewater treatment plants), livestock farms, food production facilities and organic waste management operations. Bio-LNG is interchangeable with conventional natural gas; bio-LNG can be mixed with conventional LNG or fully replace it.

Biofuels

Biofuels are renewable fuels made from recently living organic matter (biomass) like plants, agricultural waste, or animal fats, offering alternatives to fossil fuels. There are a wide variety of different types of biofuels depending on the type of biomass used and the processes used in their creation. Biomass can be converted to fuels through a number of different processes including direct combustion, thermochemical and chemical conversion, and biological conversion. A biofuel can be produced with much lower GHGs than their fossil fuel-based counterparts, and when 'burned' can also be less harmful. However, biofuels cannot directly replace their fossil fuel-based counterparts at a 1:1 ratio without causing harm to equipment. To achieve environmental benefits, biofuels are most often blended with petroleum-based products to reduce the GHG intensity of their use. 'First generation' biofuels are those made from sugar, starch, or vegetable oil. Their feedstocks are those that might have an impact on food supply if used in large quantities. 'Second generation' biofuels are those made from sustainable feedstocks as defined by the feedstock's availability, its impact from a GHG perspective, and land use [16].

Renewable Biofuels

Produced through a different method ('catalytic pyrolysis'), renewable biofuels are chemically identical to their petroleum-based counterparts (i.e., diesel and renewable diesel). This means that renewable biofuels can potentially be used as a direct replacement (i.e., as a 'drop-in') for conventional fuels in existing technology (i.e., combustion turbines, car/truck/ship engines, other heavy equipment) if not a heavy additive in blending. This also means that existing transportation, storage, and refueling infrastructure can be used – simplifying the logistics of decarbonization. Relevant examples in marine transportation include renewable diesel. There are different terms used, sometimes interchangeably, when various types of biofuels are referenced. For the remainder of this paper the term 'biofuels' will serve as a catchall for both traditional biofuels and renewable fuels – recognizing that there are important distinctions. Overall, biofuels are considered technologically ready for deep-sea shipping, as they can be used as drop-ins or blends

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[16] https://econext.ca/wp-content/uploads/2025/06/Biomass-Energy-Potential-NL-Version-1.0-2025-06-11.pdf

with minor modifications to existing engines, machinery, and storage systems. This simplifies the transition from existing fossil-derived fuels.[17].

Methanol

Methanol as a fuel is a light, versatile, colourless and flammable alcohol. In an internal combustion engine, methanol reacts with the oxygen in the air and creates carbon dioxide and water as well as heat/energy. Despite the carbon dioxide emitted, methanol shipping is a viable option to achieve net-zero carbon lifecycle emissions if the methanol is produced using biomass or renewably sourced hydrogen and carbon dioxide (i.e., 'green methanol', 'e-methanol'). Methanol as a fuel has several potential benefits, including low emissions, low cost, and excellent energy density. It is biodegradable and miscible in water – reducing the environmental impacts of a potential spill. However, methanol does have corrosive characteristics which requires specific storage and handling arrangements. It has a low flashpoint and toxicity, requiring increased safety systems[18].

Ammonia

Unlike traditional marine fuels, ammonia is virtually free of sulphur oxide (SOx) and particulate matter (PM) emissions, contributing to cleaner air quality. When produced using renewable energy, ammonia (i.e., 'green ammonia, 'e-ammonia') can achieve a lifecycle GHG emissions reductions of up to 90% compared to conventional fossil fuels. Ammonia can be used in a variety of marine engines, including dual-fuel engines that can switch between ammonia and conventional fuels. Its high energy density and low viscosity make it a suitable option for long-range shipping operations. Challenges such as its toxicity, storage, and handling safety need to be addressed when discussing ammonia's suitability as a marine fuel[19].

Hydrogen

Green hydrogen, produced through electrolysis powered by renewable energy, could hold the key to sustainability. When used in fuel cells, it generates electricity with only water vapor as a byproduct, eliminating harmful pollutants. Hydrogen's low energy density compared to conventional fuels necessitates larger storage tanks, impacting ship design and cargo capacity. Additionally, the technology is nascent, with infrastructure for production, distribution, and bunkering still in its early stages. While pure hydrogen might struggle with long-distance journeys, it could be suitable for short-sea shipping or powering port equipment[20]. Hydrogen's role in shipping,

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[17] https://www.lr.org/en/knowledge/research/fuel-for-thought/biofuel/

[18] https://www.lr.org/en/knowledge/research/fuel-for-thought/methanol/

[19] https://www.lr.org/en/knowledge/research/fuel-for-thought/ammonia/

[20] https://www.lr.org/en/knowledge/research/fuel-for-thought/hydrogen/

however, is seen to be significant overall as it is a key input into low-carbon methanal, ammonia, and various biofuels.

Additional Considerations

Retrofits

Newbuilds can be constructed to be 'fuel-ready' for methanol, ammonia, or other alternative fuels, ensuring long-term flexibility and regulatory alignment. But it should be understood that the retrofit of existing vessels is also an option. Retrofitting existing vessels enables shipowners to extend the operational life of their assets while adapting to a decarbonizing market. Through targeted upgrades – such as engine modifications, fuel system conversions, and energy-saving technologies – retrofitted ships can meet evolving regulatory requirements and reduce their carbon footprints without the need for full replacement[21]. Extensive techno-economic feasibility assessments would need to be undertaken in advance of vessel retrofitting.

Fuel Blends

It is important to highlight the opportunity that blending conventional fuel with low-carbon fuels can provide in marine transportation decarbonization. While the blending of fuels does not provide the environmental benefits that wholesale adoption of fuels like green ammonia and green methanol might, given the long lifespans of vessels and low turnover rate, it presents an immediate opportunity to achieve GHG emissions reductions. Fuel blending can be done in many different existing engine types and does not require expensive vessel retrofits. For example, the Canadian Coast Guard is already testing fuel blends composed of 10% biodiesel, 40% renewable diesel, and 50% conventional diesel[22] in its ships. There are many different possible fuel blends with optimizations unique to engine types and their uses indicating a need to focus on R&D that meet the needs of particular regions and the nature of marine transportation within them.

Dual-Fuel Engines

Dual-fuel marine engines are designed to run on multiple types of fuel. These engines can seamlessly transition between fuels without any interruption in power output. The use of dual-fuel engines can help to optimize fuel consumption, reduce environmental impact, and ensure

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[21] https://brandcentral.dnv.com/original/gallery/10651/files/original/216954a7-8cc8-49b6-b99e-37e76a41410a.pdf

[22] https://www.ccg-gcc.gc.ca/corporation-information-organisation/greening-initiatives-ecologisation-eng.html

operational flexibility in different maritime conditions. Within the context or marine transportation decarbonization, dual-fuel engines allow for vessel owners / operators to de-risk the energy transition; they can commit to the use of low-carbon fuels while also protecting against supply, logistics, or reliability issues that may be associated with them.

Other Technologies

The decarbonization of marine transportation is a pursuit attracting global interest. A discipline unto itself, there are many innovations occurring on a regular basis. While there are other technologies relevant to marine transportation decarbonization that exist or are in development (such as nuclear propulsion and on-board carbon capture and storage systems), the above highlighted solutions provide the context necessary for this paper.

International Shipping Regulations

Marine traffic with international origins or destinations are not included in federal or provincial GHG reporting, and this is consistent with internationally standardized methodology. GHGs that result from international marine transportation are envisioned to be regulated under the IMO.

In 2023, the IMO adopted a revised GHG strategy targeting net zero by or around 2050. To ensure that shipping reaches these ambitions, the IMO plans to implement a basket of measures consisting of both technical and economic elements. The IMO Net-Zero Framework (IMO NZF), which incorporates these two elements, had its draft legal text approved in April 2025, though a vote on its adoption was later postponed until October 2026[23].

While the framework has become heavily political with its adoption in doubt[24], industry continues to move towards decarbonization. Cargo owners are increasingly facing customer and investor expectations to decarbonize their operations across the entire supply chain. In response, many have announced their own GHG reduction targets – some even ahead of regulatory requirements – and are integrating these goals into their business strategies. In some industry segments, there is a clear green premium for low- or zero-emission products[25].

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[23] https://brandcentral.dnv.com/original/gallery/10651/files/original/216954a7-8cc8-49b6-b99e-37e76a41410a.pdf

[24] https://www.bbc.com/news/articles/c3vnl0yxg53o

[25] https://brandcentral.dnv.com/original/gallery/10651/files/original/216954a7-8cc8-49b6-b99e-37e76a41410a.pdf

In parallel with the IMO's ongoing process, national and regional GHG regulations are also moving forward. The EU ETS and FuelEU Maritime have already entered into force in 2024 and 2025, respectively, imposing higher costs on the use of fossil fuels and effectively facilitating the transition toward low-GHG fuels. Other national and regional GHG regulations are emerging, and their actual implementation is heavily connected to the outcome of the IMO sessions on a global framework. For instance, the UK plans to incorporate ships over 5,000 GT into the UK Emissions Trading Scheme starting in 2026[26].

While delays and uncertainty with IMO regulations may delay the adoption of new technologies, it is evident that the decarbonization of marine transportation will move forward regardless.

Vessels on Order

Statistics on vessels on order (or 'in the order book') provides important insights into future low-carbon fuel adoption.

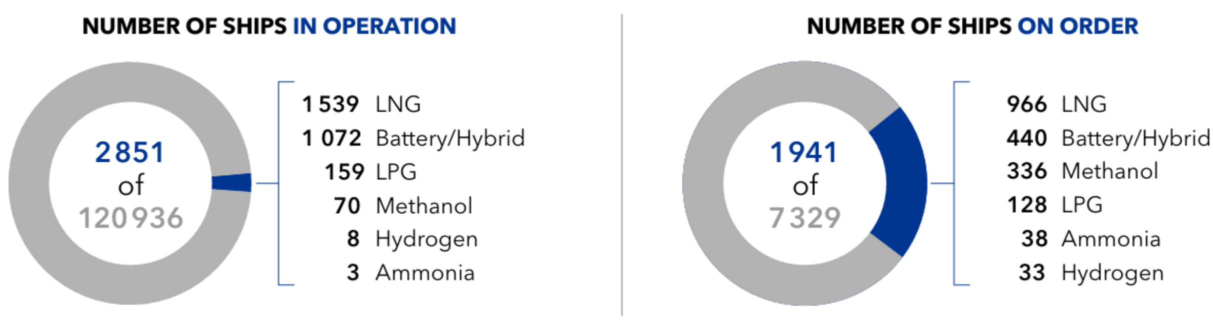

Figure 10: Alternative fuel technology uptake in the world fleet in the number of ships[27]

As of August 2025, the increasing trend of ordering larger ships with dual-fuel propulsion capabilities continues, with a similar share of the gross tonnage on order being alternative fuel-capable, indicating that the fuel technology transition is progressing at a similar rate to last year. The uptake of LNG is dominating, followed by methanol-capable vessels. The containership segment continues to have the highest number of methanol-fuelled ships on order[28].

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[26] https://brandcentral.dnv.com/original/gallery/10651/files/original/216954a7-8cc8-49b6-b99e-37e76a41410a.pdf
[27] https://www.dnv.com/maritime/maritime-forecast/
[28] https://www.dnv.com/maritime/maritime-forecast/

While these insights have great value, the number of vessels currently in operation and the typically long lifespans of vessels must be factored into decision-making. For example, while over 25% of vessels on the order book are alternative fuel capable, this still means that just under 75% of orders are being made with conventional fuels in mind. Thus. the importance of decarbonizing marine transportation fuels currently in use (i.e., through blending) will be significant

Summary

Significant uncertainty remains as to the speed at which marine transportation decarbonization will occur and what technologies that will be adopted in support. However, there are a number of important observations that can be made which will help decision-makers understand how marine transportation decarbonization can occur in NL.

LNG, methanol, and ammonia are considered three of the most promising alternative shipping fuels due to their potential to significantly reduce ships' emissions, decrease in cost over time, and achieve the scale of production needed to decarbonise the sector

- LNG is emerging as a near term choice for shipping. While LNG is a fossil fuel, this creates opportunities for Bio-LNG production and use.
- Methanol is moving towards initial scale, with around 60 methanol-capable vessels on the water, more than 300 further ships on order, and just under 20 ports offering green methanol bunkering.
- Meanwhile, ammonia is rapidly approaching proof of concept as a shipping fuel, with the first ammonia-powered vessels successfully piloted, engine testing near completion, and bunkering trials underway at major ports[29].

Green ammonia is expected to be the most popular maritime fuel in the long term – on average the share of green ammonia is 35% in 2050. Hydrogen-based fuels overall are seen as the leading candidates for decarbonizing shipping. On average, they can make up 14% of the total fuel mix by 2030 and reach 66% by 2050[30].

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[29] https://globalmaritimeforum.org/news/zero-emission-shipping-fuels-methanol-and-ammonia/
[30] https://maritime.lr.org/l/941163/2023-09-04/86cyj/941163/1693881339KV19NyGO/LR_Fuel_Mix_Report_v1.pdf

Interviews and analysis of planned investments suggest that over 60% of future vessel purchases are focused on low-carbon methanol and ammonia, although most remain at an early stage. Analysis shows that the container segment has seen the greatest increase in demand for green shipping solutions, while decisions around bulk are made closely with those that are shipping specific cargo[31]

Despite their drop-in compatibility with current ships, biofuels are not expected to be as scalable as ammonia or methanol and life cycle emissions can vary significantly depending on feedstock and production process[32]. However, the potential for biofuels to reduce GHGs in the near term through blending should not be ignored, nor should its potential to continue to factor into the energy mix in the long term – albeit at a smaller scale. By 2050, biodiesel and bio-LNG are predicted to continue to be used widely[33].

Electric vessels are not expected to be suitable for long-distance shipping but are ideal for powering short-sea ferries and small vessels[34]. Battery-powered vessels are particularly appropriate for relatively short routes (recognizing the limitations of battery ranges) and/or routes with consistent ports of call (recognizing challenges associated with providing charging infrastructure shoreside).

The provision of shorepower for 'berthing' or hotelling vessels is applicable to all almost all vessel categories. The positive GHG impact of vessel electrification is directly connected to the carbon intensity of the electricity used for charging/power – i.e., an electricity grid with significant renewable energy penetration will result in a more positive outcome.

Given the diversity of vessels operating within NL performing different tasks in different settings – the path to decarbonization will be slightly different in each case.

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[31] https://www.shell.com/business-customers/marine/decarbonising/_jcr_content/root/main/section_945430094/promo_copy_copy_1424/links/item0.stream/1685556533872/b8cfc522e207d5e92a19b9f5943f9eb1f73a9d10/all-hands-on-deck-digital-thirty-first-may.pdf

[32] https://globalmaritimeforum.org/news/zero-emission-shipping-fuels-methanol-and-ammonia/

[33] https://maritime.lr.org/l/941163/2023-09-04/86cyj/941163/1693881339KV19NyGO/LR_Fuel_Mix_Report_v1.pdf

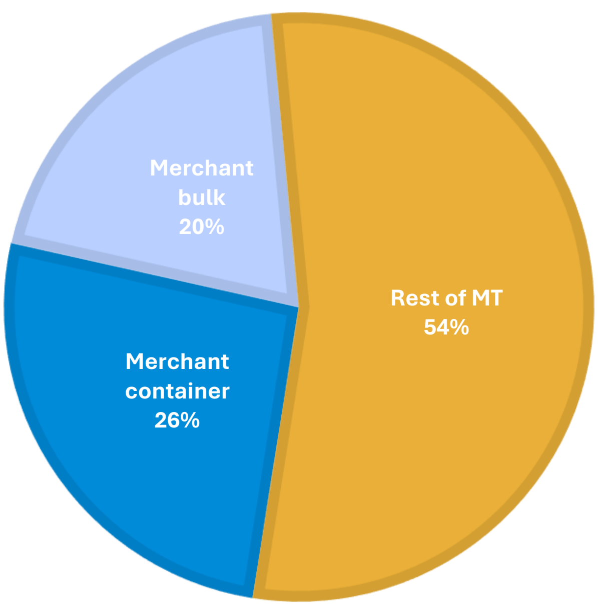
[34] https://globalmaritimeforum.org/news/zero-emission-shipping-fuels-methanol-and-ammonia/

Marine Transportation Decarbonization Pathways for NL

With an understanding of the technologies being deployed to support marine transportation decarbonization, a more in-depth examination of sectoral GHG sources in NL can yield important insights that will help inform training and skills development priorities and how they might relate to Indigenous Nations and their values and activities.

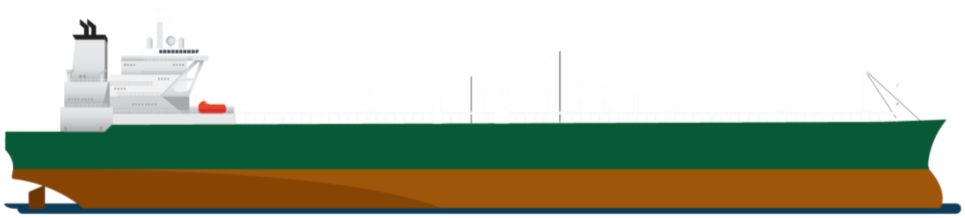
Shipping (Merchant Container, Merchant Bulk)

In 2023, 'merchant container' was responsible for 26% of NL's marine transportation GHGs, while 'merchant bulk' was responsible for 20%. These categories both involve the movement of goods oftentimes to or from international ports. Therefore, for a significant portion of NL's marine transportation GHGs (46%), a high degree of international collaboration is required between vessel owner / operators, ports, fuel suppliers, etc. is required for decarbonization.



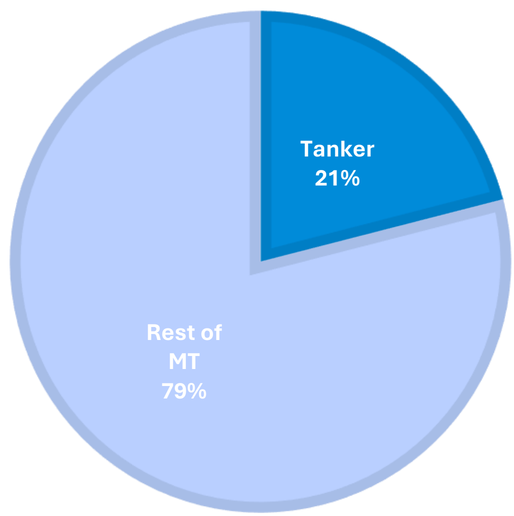
A significant majority of this traffic arrives at the Port of St. John's, with further analysis required to fully delineate points of origin and destinations involving NL.

International shipping will be the driver for the adoption of low-carbon fuels. NL should be aware of the technology pathways key owners/operators (that have a port of call in in the province) are choosing to ensure that ports are in a position to provide supply. For example, Maersk planned to add 19 dual-fuel container ships capable of running on traditional fuel or methanol between 2023-25[35]. As decisions around merchant bulk are made closely with those that are shipping specific bulk cargo (i.e., iron ore, nickel), NL should maintain close dialogue with relevant industrial operators.



Tanker

In 2023, 'tanker' was responsible for 21% of NL's marine transportation GHGs. At least 70% of tanker traffic is the transport of crude oil, with the vast majority being between Whiffen Head / Come by Chance and offshore oil and gas facilities like Hebron, Hibernia, White Rose, and Terra Nova.



Tankers are similar to large container and bulk ships in terms of their potential for low-carbon fuels adoption yet have more routes with both NL departures and arrivals. 60% of tanker traffic has both a Canadian origin and destination. These factors suggest that there is more of an opportunity to influence the speed and type of technology adoption in the tanker category (versus container and bulk) as much of the marine traffic is within national jurisdiction.

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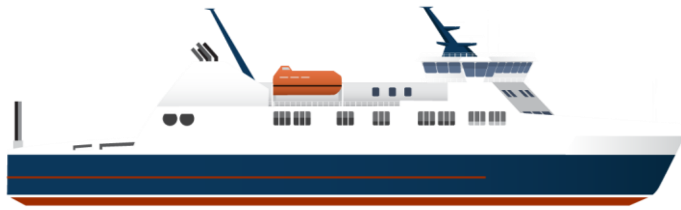
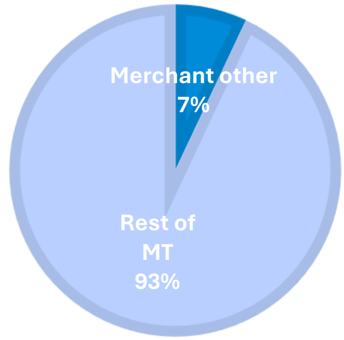
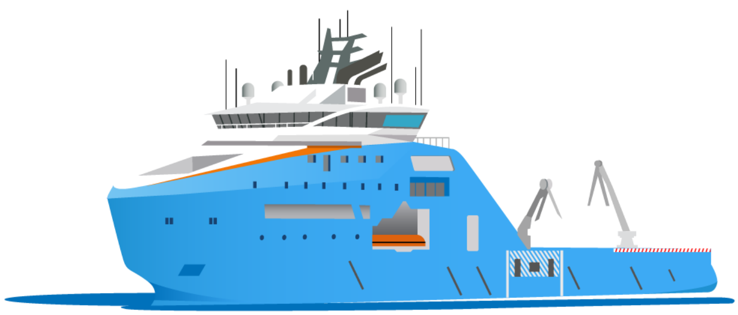
[35] https://www.reuters.com/business/sustainable-business/maersk-agrees-project-with-spain-make-e-methanol-its-fleet-2022-11-03/

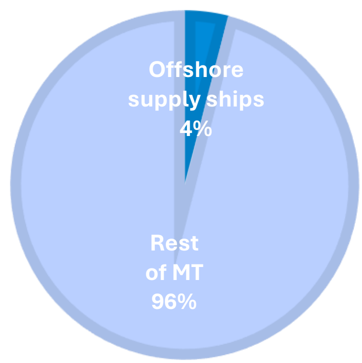




Domestic Shipping (Merchant Other)

In 2023, 'Merchant other' was responsible for 7% of NL's marine transportation GHGs. This category typically involves the movement of goods that are not containerized or classified as 'bulk'. More work is required to fully characterize this activity in NL, but vessels within this segment typically share the characteristics of shorter routes. This may present opportunities for electrification[36].





Offshore Supply Vessels

In 2023, offshore supply ships were responsible for 4% of NL's total marine transportation GHGs, a percentage that rises to 7% if viewing through the lens of Canadian GHG accounting and reporting. The vast majority of offshore supply traffic is between offshore oil and gas installations (Hebron, Hibernia, White Rose, Terra Nova) and the Port of St. John's with some traffic to the Port of Long Pond, Bull Arm, and Bay Bulls. Fuel blending presents a significant decarbonization opportunity for

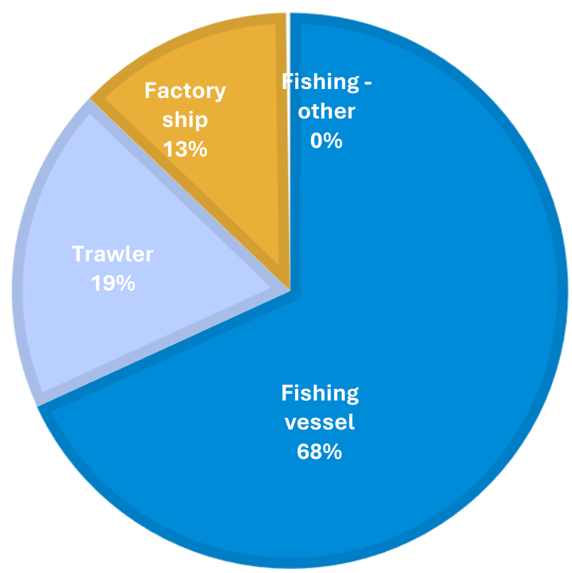
[36] https://www.shell.com/business-customers/marine/decarbonising/_jcr_content/root/main/section_945430094/promo_copy_copy_1424/links/item0.stream/1685556533872/b8cfc522e207d5e92a19b9f5943f9eb1f73a9d10/all-hands-on-deck-digital-thirty-first-may.pdf

offshore supply vessels. Due to their relatively short transit routes, they are also a candidate for increased electrification or hybrid propulsion systems. For example, in 2021 Atlantic Towing began working to retrofit one of their four offshore supply ships, the Atlantic Shrike, with electric battery technology. Following the retrofit, the Atlantic Shrike has delivered strong and measurable results: 11% fuel savings across all operations; 362 tonnes of CO_2 reductions in 2024, verified by operational data; reduced engine noise, improving crew comfort; and lower engine running hours, extending maintenance intervals and enhancing working conditions in the engine room[37].

Fishing

In 2023, fishing vessels were responsible for 4% of NL's total marine transportation GHGs, a percentage that rises to 7% if viewing through the lens of Canadian GHG accounting and reporting. There are many fishing vessels in NL, many of which are small, and most of which are independently owned and operated.

The MEIT differentiates between fishing vessels (68% of fishing GHGs), trawlers (19% of fishing GHGs), factory ships (a large ocean-going vessel with extensive on-board facilities for processing and freezing – 13% of fishing GHGs), and 'other' (close to 0% of fishing GHGs). More research is required to better characterize vessels in the province's fishery.



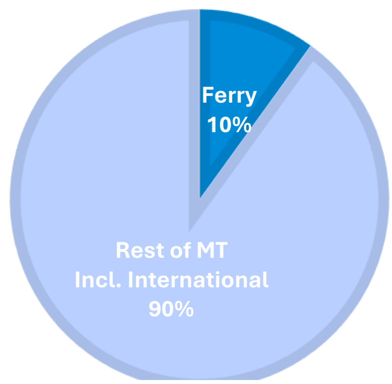
With so many variables to consider in fishing, and the fact each trip is often so important to its owner's livelihood, propulsion needs to be highly reliable and easy to use. Decarbonization solutions must meet the needs of the vessel owners and operators; these needs

[37] https://www.vard.com/articles/atlantic-shrike-achieves-11-fuel-reduction-with-seaq-energy-storage-system

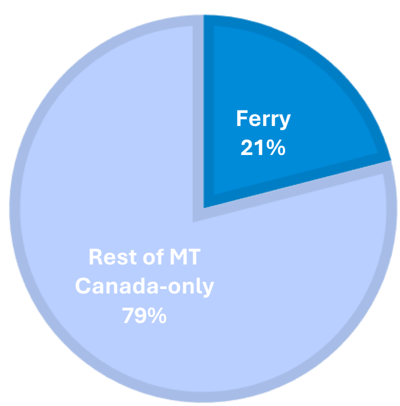
vary significantly between the sub-categories listed – with many being small boats with small crews.

These factors challenge the adoption of low-carbon fuels which would require new and different safety protocols.[38] To ease the transition towards new fuels those which are more similar to fossil marine diesels should be used. This suggests that the most direct decarbonization opportunity in the near term is fuel blending. Electrification may be suitable for fishing vessels which are typically have shorter routes. This is less true of larger fishing vessels like trawlers operated by larger companies. These companies have the capacity to progress more quickly towards electrification and the adoption of clean fuels.

Ferries



In 2023, ferries were responsible for 10% of NL's total marine transportation GHGs, a percentage that rises to 21% if viewing through the lens of Canadian GHG accounting and reporting. This is particularly relevant because NL's provincial government is directly responsible for 14 ferry routes as either the owner/operator of vessels or the contracting party for ferry services. Meanwhile, a federal crown corporation (Marine Atlantic) is responsible for ferry traffic between NL and NS. The ferry service between Fortune, NL and Saint-Pierre and Miquelon is owned and operated by the French territorial government.



While more research is needed to confirm the analysis, 44,667 tonnes of CO2e of ferry traffic in 2023 can be attributed to Marine Atlantic routes between Sydney and Port

[38] https://www.tandfonline.com/doi/full/10.1080/1059924X.2025.2453056?src=exp-la

aux Basques and Argentia. This represents 39% of all ferry emissions.

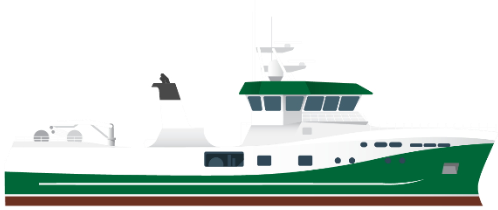
Meanwhile the remainder can be attributed to routes operated (or contracted) by the provincial government[39]:

- Bell Island – Portugal Cove
- St. Brendan's – Burnside
- Fogo Island – Change Islands – Farewell
- Long Island – Pilley's Island
- Charlottetown – Norman's Bay
- Goose Bay – Rigolet – Ports North to Nain
- Goose Bay – Cartwright – Black Tickle
- Blanc Sablon – St. Barbe (Strait of Belle Isle Area)
- La Poile – Rose Blanche
- Ramea – Grey River – Burgeo
- Francois – Grey River – Burgeo
- Gaultois – McCallum – Hermitage
- Rencontre East – Bay L'Argent – Pool's Cove
- South East Bight – Petite Forte

More research is required to estimate the GHG emissions that are associated with specific ferry routes. Ferries are the perfect segment for electrification and battery power. Short, regular routes between the same ports makes it easier to charge regularly and reduces the need for large batteries[40]. Hybrid systems provide similar opportunity in situations where there is increased risk averseness. In the near term the most direct decarbonization opportunity is fuel blending.

[39] https://www.gov.nl.ca/ti/ferryservices/schedules/

[40] https://www.dnv.com/expert-story/maritime-impact/showcasing-innovations-in-the-ferry-industry/



Tug - Harbour

Tugboats escort vessels from the open ocean into ports to provide extra layers of safety in case the ship loses power, or its rudder fails. These tasks require tugs to be powerful and maneuverable. Despite the relatively small size of tugboats, their powerful propulsion systems allow them to exert enormous force – a necessity given the important role that they play. Tugs used for short distances (such as for ports or small harbours) are prime for full electrification with backup generators and can provide quicker and more powerful tugging. Tugs used for longer hauls would typically be more suited for hybrid electric configurations[41]. In the near term the most direct decarbonization opportunity is fuel blending. Harbour tugs represented 1% of NL's marine transportation GHGs in 2023, with 'tug-ocean' representing just under 0.5%. While these are not significant contributions on a provincial level, the decarbonization of these vessels may be more meaningful to the ports that industries that they serve.

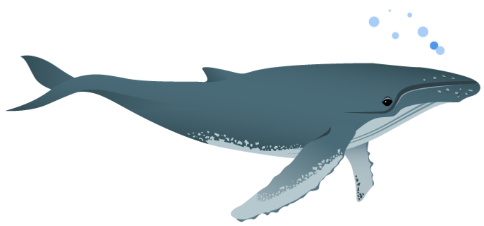
Cruise Ships

Cruise ships can vary significant in size, which would influence their movement towards either low-carbon fuels adoption or battery electrification. More than 15% of the vessels set to launch over the next five years will be fully equipped to integrate fuel cells or batteries and 85% of CLIA-member vessels coming online between now and 2028 will be able to plug into shoreside electricity[42]. Most cruise ships arriving in NL are relatively large. Shoreside power connectivity is particularly

[41] https://clearseas.org/insights/why-make-tugs-electric/

[42] https://porthole.com/cruise-industry-commits-to-pursue-net-zero-carbon-for-global-cruising-by-2050/

important to the cruise industry as it improves air quality for its passengers when docked. Therefore, from an environmental and business development perspective, the provision of electricity infrastructure in ports like St. John's, Corner Brook, and St. Anthony should be considered, Meanwhile, cruise companies are actively testing the use of low-carbon fuels in their fleet. In the near term the most direct decarbonization opportunity is fuel blending.



Excursion passenger

This type of vessel is similar to ferries in that the voyages of tourism boats in NL are typically short and regular between the same ports. Therefore, this segment is ideal for electrification and battery power as inventory turns over. In the near term the most direct decarbonization opportunity is fuel blending.


Other (Special purpose, Coast guard, War, DFO Fishing Surveillance Vessell)

The types of vessels can vary significantly in these categories. In most cases these vessels travel great distances and spend significant time offshore. Electrification will not likely be the most practical decarbonization solution. Owners of these vessels are typically more risk averse (i.e., governments, contractors on strict timelines conducting complex tasks and maneuvers) therefore it is likely these segments will not be the first movers in adopting new fuel technologies. In the near term the most direct decarbonization opportunity is fuel blending. –

Conclusions

Decarbonization pathways for marine transportation are difficult to predict. Pathways are likely to diverge from one another depending on the sector in question. In some of the segments of marine transportation, NL has little control over decarbonization pathways that are chosen. Yet, in other segments, NL does have a degree of control.

The following observations can be made following an analysis of marine transportation decarbonization pathways as they apply in the NL context:

1. Container ships contributed 26% of all marine transportation GHGs for NL in 2023. NL will not influence the decarbonization decisions made by large international shipping companies, however it should pay close attention to developments to ensure that it is able to supply these vessels with the fuels that they will demand in order to (a) enable decarbonization and (b) support domestic low-carbon fuels producers.

2. Bulk shipping contributed 20% of all marine transportation GHGs for NL in 2023. NL should engage with those shipping bulk cargo (i.e., iron ore, nickel) to influence or understand plans to (a) enable decarbonization and (b) support domestic low-carbon fuels producers.

3. Ferries contribute 21% of all domestic marine transportation GHGs in NL. Federal and provincial governments are owners, operators, and/or contractors of these services. Therefore, there is a direct opportunity for Canada and NL to control future decisions that impact the environment and the economy.

4. Tankers and offshore supply ships make up 25% of NL's marine transportation GHGs. Much of the traffic of these vessels is within NL jurisdiction. There may be an opportunity to develop a decarbonization strategy that supports local low-carbon fuel producers while supporting the reduction of GHGs in NL's offshore oil and gas supply chain.

5. A low-hanging fruit in marine transportation decarbonization in NL is reducing 'berthed' or hoteling GHGs – which were estimated to be 8% of all sector GHGs in NL in 2023. NL is an ideal location for shorepower given its 90%+ clean electricity grid. Shoreside infrastructure is a key enabler of marine transportation decarbonization and is within NL's direct control to provide. More search is required to better understand the demand and supply particulars in vessel electrification.

6. While different decarbonization pathways exist for each vessel type, the potential for fuel blending is a common factor. More focus needs to be placed on testing and trialing fuel

blends in NL. This can begin with low-carbon fuels that are already produced in the province (i.e., renewable diesel) and advance to include hydrogen and its derivates in the future. This also creates an opportunity for local biofuel production. To achieve the above, a focus must be placed on local R&D and training in these areas.

7. More research is required to better characterize emissions relating to the fisheries, ferries, and intra-provincial shipping.

8. As the marine transportation sector is so intricately tied with the culture and livelihoods of NLers, it will be important to consider what decarbonization pathways will mean for people, workers, and communities.