Discussion Paper

Low-Carbon Fuels Opportunities for Newfoundland and Labrador's Surface Transportation Sector

July 2026

econext
Advancing Newfoundland & Labrador's
Green Economy

Contents

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1. Executive Summary

The objective of this paper is to generate discussion and encourage further exploration of the adoption of low-carbon fuels in Newfoundland and Labrador (NL)'s surface transportation sector – or transportation that takes place on-land.

Surface transportation is responsible for 31% of NL's GHGs[1]. 56% of these GHGs are related to gasoline use, while 44% are related to diesel use. 54% of surface transportation GHGs stem from light-duty vehicles (i.e., passenger vehicles), with 46% from heavy-duty and off-road vehicles involved in freight transportation (18%) and in residential, commercial, and industrial off-road settings (28%).

Electrification is expected to play a significant role in the decarbonization of surface transportation across Canada. However, electric vehicle (EV) adoption rates in NL – while accelerating – remain very low. Other zero-emission vehicle (ZEV) technologies have the potential to play an important role in heavy-duty and off-road segments, however the speed at which adoption will occur is uncertain. As a result, it is expected that gasoline and diesel will be used as fuel for vehicles for many years to come. Therefore, there are significant benefits to be realized in NL related to low-carbon fuels in NL within this sector.

The benefits of the local production and adoption of low-carbon fuels in NL's surface transportation sector are: (1) decreased greenhouse gas (GHG) emissions from both the electricity and waste sectors; (2) reduced air pollutants in the atmosphere; (3) increased energy security; (4) the valorization of under-utilized waste resources; and (5) economic development for communities.

Specific opportunities in NL include the blending of ethanol within gasoline, the blending of biodiesel and renewable diesel within conventional diesel, and supporting the adoption of hydrogen-powered vehicles. There are technical and financial challenges in each of these areas which will first need to overcome.

NL can advance the adoption of low-carbon fuels in its surface transportation sector by: (1) defining best use cases for available biomass in NL and techno-economic feasibility of low-carbon fuels production; (2) pursuing opportunities for biofuel and renewable biofuel blends in conventional fuels; (3) investing in fuel blending and testing infrastructure; (4) aligning provincial climate and energy strategy with domestic production capabilities; (5) creating a greater awareness of the benefits of fuel blending; and (6) investing in hydrogen refueling infrastructure.

[1] https://www.gov.nl.ca/eccc/files/Historical-GHG-Emissions-Summary-NL-1990-2024-April-2026.pdf

2. Background and Context

2.1 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 according to various economic sectors within the province.

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, the research did help to advance discussions and outline some of the opportunities and challenges for low-carbon fuels adoption within specific sectors in Newfoundland and Labrador (NL).

One sector which required further analysis following this study was the province's transportation sector – specifically transportation that takes place on-land. This segment of the transportation sector includes on-road and off-road vehicles and is sometimes referred to as 'surface transportation' to distinguish this mode of transport from that which takes place in the marine environment.

Discussion Paper Objective

The objective of this paper is to generate discussion and encourage further exploration of the adoption of low-carbon fuels in NL's surface transportation sector.

While every effort has been made to provide sources for information provided, this discussion paper is not an academic publication and is not intended to be. This is a document produced internally by econext staff informed by secondary research and information known to be available in the public domain.

econext welcomes all feedback that can help improve the quality and usefulness of this discussion paper. Feedback can be sent to info@econext.ca.

2.2 About econext

econext is a not-for-profit industry association dedicated to advancing environmentally sustainable economic growth in Newfoundland and Labrador. With a network of approximately 200 member businesses, research institutions, governments, and organizations, econext serves as a leading voice for the province's green economy.

econext has four key areas of focus:

Member Opportunities
We connect our members with opportunities to grow their businesses in the green economy.

Public Policy & Advocacy
We identify, analyze, and champion policy frameworks that support sustainable economic growth in NL.

Capacity Building
We equip NL's businesses, communities, and workforce with skills, experience, and knowledge needed to contribute to green economic growth.

Innovation
We identify emerging trends and provide insights that inform policy, investment, and innovation that advance clean growth in NL.

Together, we strengthen NL's green economy by supporting our members and help drive sustainable growth and innovation across the province. Learn more at econext.ca.

3. Surface Transportation in NL

To understand present-day transportation infrastructure in NL, it is helpful to be aware of how it came to be.

While Indigenous peoples have lived within the geography of NL since time immemorial, the growth of the fishery in waters near the island (Newfoundland) and mainland (Labrador) greatly influenced population growth and distribution as it exists today.

European fishers would arrive seasonally by boat in many different areas of what is now NL, with many of these seasonal operations eventually becoming permanent residencies. The locations of these settlements were chosen for reasons related to the fishery with fishers from different countries or different expeditions anchoring in very different areas which were not interconnected.

Over time this amounted to a small population that has never exceed 600,000 people dispersed over a large geography. The estimated length of Newfoundland's coastline is approximately 17,542 km, while the estimated length of Labrador's coastline is approximately 7,886 km[2]. NL is vast, covering 405,720 km^2, which is larger than many countries, including Germany, Japan, and New Zealand. The province is roughly 66% larger than the United Kingdom and about 4.4 times larger than Portugal.

After NL's Confederation with Canada in 1949, the federal and provincial governments devised a series of road-building programs to better connect communities across the province with each other and the rest of Canada[3].

The end result is a large road network which serves as the connection for and between small communities across significant land masses. With the closure of the railway in 1988[4] due in part to its narrow-gauge rail design, roads quickly became the primary mode of transport for people, goods, and services within the province.

With such a reliance on road transport, surface transportation sector greenhouse gas (GHG) emissions represent a large portion of the NL's total emissions profile.

Surface Transportation Sector and GHGs in NL

At an estimated 3,737 kt CO2e in 2024, the transportation sector is the single largest contributor to NL's GHGs – accounting for 43% of the provincial total[5].

Total transportation GHG emissions include those attributed to marine, aviation, and rail (a contained line servicing mining operations in Labrador West). The remaining categories represent the 'surface' transportation GHGs in NL for 2024:

Emissions Category	2024 GHGs Kt CO2e	% of Total NL GHGs	% of Surface Transportation
Light-Duty Gasoline Vehicles	355	4%	13%
Light-Duty Gasoline Trucks	1072	12%	40%
Heavy-Duty Gasoline Vehicles	70	1%	3%
Motorcycles	15	0%	1%
Light-Duty Diesel Vehicles	2	0%	0%
Light-Duty Diesel Trucks	12	0%	0%
Heavy-Duty Diesel Vehicles	407	5%	15%
Propane and Natural Gas Vehicles	0	0%	0%
Off-Road Agriculture and Forestry	60	1%	2%
Off-Road Commercial and Institutional	62	1%	2%

[2] https://www.gov.nl.ca/eccc/waterres/flooding/coastal-flooding/
[3] https://www.heritage.nf.ca/articles/society/post-1949-communication.php
[4] https://www.heritage.nf.ca/articles/society/post-1949-communication.php
[5] https://www.gov.nl.ca/eccc/files/Historical-GHG-Emissions-Summary-NL-1990-2024-April-2026.pdf

Off-Road Manufacturing, Mining & Construction	524	6%	19%
Off-Road Residential	16	0%	1%
Off-Road Other Transportation	117	1%	4%
Total Surface Transportation GHGs	2712	31%	100%

Figure 1: Surface Transportation GHGs in NL in 2024 by category, with information from https://www.gov.nl.ca/eccc/files/Historical-GHG-Emissions-Summary-NL-1990-2024-April-2026.pdf

Surface transportation accounts for 73% of NL's transportation GHGs – or 31% of the entire province's GHGs. Surface transportation is thus a substantive contributor to GHGs in NL, driven primarily by light-duty gasoline vehicles and trucks, and heavy-duty vehicles on-road and off-road.

3.1 Definitions

To interpret the data presented in Figure 1 and throughout the remainder of this discussion paper, it is helpful to understand what types of vehicles are included within each category and a little bit about what differentiates them.

Gross Vehicle Weight Rating (GVWR): The maximum weight a vehicle is designed to carry.

Light-Duty Gasoline Vehicles: Includes light-duty on-road vehicles with gasoline engines with a GVWR less than or equal to 4,536 kilograms (10,000 pounds)[6]. These vehicles are primarily designed for transporting people or property and include passenger cars.

Light-Duty Gasoline Trucks: Includes medium-duty on-road vehicles with gasoline engines with a GVWR between 4,536 kilograms to 11,793 kilograms (10,001 to 26,000 pounds)[7]. These vehicles are primarily designed for transporting people or property and include SUVs, vans, and most pickup trucks.

Heavy-Duty Gasoline Vehicles: Includes a diverse variety of on-road medium-duty and heavy-duty vehicles with gasoline engines that are used across a wide range of activities and includes local delivery vehicles, garbage trucks, buses, long-haul tractor trailers, and others[8]. Heavy-duty vehicles have a GVWR of more than 3 856 kg (8,500 pounds) but the classification does not include medium-duty passenger vehicles[9] (i.e., pickup trucks).

[6] https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2022023-eng.htm
[7] https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2022023-eng.htm
[8] https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/heavy-duty-vehicle-engines-zero-emission-future-discussion-paper.html
[9] https://laws-lois.justice.gc.ca/eng/regulations/SOR-2013-24/section-1.html?txthl=class

Motorcycles: A two- or three-wheeled on-road motor vehicle.

Light-Duty Diesel Vehicles: Includes light-duty on-road vehicles with diesel engines with a GVWR less than or equal to 4,536 kilograms (10,000 pounds)[10]. These vehicles are primarily designed for transporting people or property and include passenger cars.

Light-Duty Diesel Trucks: Includes medium-duty on-road vehicles with diesel engines with a GVWR between 4,536 kilograms to 11,793 kilograms (10,001 to 26,000 pounds)[11]. These vehicles are primarily designed for transporting people or property and include SUVs, vans, and most pickup trucks.

Heavy-Duty Diesel Vehicles: Includes a diverse variety of on-road medium-duty and heavy-duty vehicles with diesel engines that are used across a wide range of activities and includes local delivery vehicles, garbage trucks, buses, long-haul tractor trailers, and others[12]. Heavy-duty vehicles have a GVWR of more than 3 856 kg (8,500 pounds) but does not include a medium-duty passenger vehicle[13] (i.e., pickup trucks).

Propane and Natural Gas Vehicles: Includes all on-road vehicles which use propane and/or natural gas as their fuel source.

Off-Road Agriculture and Forestry: Vehicles used within the agriculture and forestry sectors that are typically used on unpaved roads and surfaces that are not licensed for roads or highways. This includes tractors, forklifts, cranes, backhoes, bulldozers, etc.

Off-Road Commercial and Institutional: Vehicles used within commercial and institutional sectors that are typically used on unpaved roads and surfaces that are not licensed for roads or highways. This includes tractors, forklifts, cranes, backhoes, bulldozers, etc.

Off-Road Manufacturing, Mining and Construction: Vehicles used within the mining and construction sectors that are typically used on unpaved roads and surfaces that are not licensed for roads or highways. This includes tractors, forklifts, cranes, backhoes, bulldozers, etc.

Off-Road Residential: Recreational off-road vehicles typically used on unpaved roads and surfaces that are not licensed for roads or highways. This includes ATVs, snowmobiles, etc.

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[10] https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2022023-eng.htm
[11] https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2022023-eng.htm
[12] https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/heavy-duty-vehicle-engines-zero-emission-future-discussion-paper.html
[13] https://laws-lois.justice.gc.ca/eng/regulations/SOR-2013-24/section-1.html?txthl=class

Off-Road Other Transportation: A category for off-road transportation GHGs which do not fit within other descriptions.

3.2 Consideration by Fuel Type

Another approach to categorize surface transportation GHGs is by fuel source. There are two primary fuel sources for surface transportation: gasoline and diesel. The below tables categorize GHG sources by fuel type.

It is important to consider that not all categories are homogenous in their fuel source; for example, off-road commercial and institutional vehicles could conceivably be made up of both gas and diesel vehicles. However, these differentials would be minor compared to overall GHGs and thus these broad categorizations are reasonable to work with.

Propane and natural gas vehicles register as 0 kt CO2e of GHGs in 2025 (and average close to zero since 1990) and are thus not included in the below categorization.

Gasoline	2024 GHGs kt CO2e	% of Total NL GHGs	% of Surface Transportation
Light-Duty Gasoline Vehicles	355	4%	13%
Light-Duty Gasoline Trucks	1072	12%	40%
Heavy-Duty Gasoline Vehicles	70	1%	3%
Motorcycles	15	0%	1%
Off-Road Residential	16	0%	1%
Total Surface Transportation GHGs (Gas)	1528	18%	56%

Figure 2: Surface Transportation GHGs in NL in 2024 by fuel type (gasoline), with information from https://www.gov.nl.ca/eccc/files/Historical-GHG-Emissions-Summary-NL-1990-2024-April-2026.pdf

Diesel	2024 GHGs kt CO2e	% of Total NL GHGs	% of Surface Transportation
Light-Duty Diesel Vehicles	2	0%	0%
Light-Duty Diesel Trucks	12	0%	0%
Heavy-Duty Diesel Vehicles	407	5%	15%
Off-Road Agriculture and Forestry	60	1%	2%
Off-Road Commercial and Institutional	62	1%	2%
Off-Road Manufacturing, Mining and Construction	524	6%	19%
Off-Road Other Transportation	117	1%	4%
Total Surface Transportation GHGs (Diesel)	1184	14%	44%

Figure 3: Surface Transportation GHGs in NL in 2024, by fuel type (diesel) with information from https://www.gov.nl.ca/eccc/files/Historical-GHG-Emissions-Summary-NL-1990-2024-April-2026.pdf

It is estimated that 56% of surface transportation GHGs are related to gasoline use and 44% of surface transportation GHGs are related to diesel use. This is an important observation as it suggests that interventions related to either gasoline or diesel use in NL have the potential to be meaningful.

4. Approaches to the Decarbonization of Surface Transportation

There are three general routes to reducing GHGs from transportation: increasing the efficiency of vehicle technology, changing how we travel and transport goods, and using lower-carbon fuels[14].

Vehicle Technology: Weight reduction and improvements to engines, tires, and aerodynamics can positively influence fuel efficiency in vehicles – and thus reduce the GHGs that they produce for any given distance. Vehicle technology improvements are sometimes mandated by governments through fuel efficiency standards.

Using Lower-Carbon Fuels: The carbon intensity of the fuels that vehicles currently use can be reduced, resulting in corresponding GHG reductions for any given distance. Moreover, the type of fuel that vehicles use can be switched entirely – with fuels like electricity, natural gas, and hydrogen becoming more common.

Changing 'How' We Transport: Increasing active transit (i.e., walking, biking), the use of public transportation, and ride-sharing are common approaches to reducing GHGs in transportation as these actions displace passenger vehicle use. These concepts can be extended to commercial and industrial theatres where optimizing logistics, deliberate planning, and investments in infrastructure can assist in GHG reductions by changing how goods, services, and people move from one place to another.

Vehicle technology decisions are driven by both policy at the North American level and through the actions of vehicle manufacturers (often in response to policy decisions). It is beyond NL's control to influence these factors.

This discussion paper focuses on the use of low-carbon fuels, which also has some considerations relating to 'how' we transport.

[14] https://www.epa.gov/greenvehicles/routes-lower-greenhouse-gas-emissions-transportation-future

4.1 Surface Transportation Decarbonization Trends

Jurisdictions across the world are approaching the decarbonization of their transportation sectors in different ways. Approaches can differ based on geographic factors, resource availability, energy prices, technology strengths, etc.

For example, almost 30% of all cars on Norway's roads are electric with electric vehicles accounting for almost 90% of new registrations in 2024[15]. Meanwhile, Japan has a target to have 800,000 fuel-cell (hydrogen) passenger vehicles on its roads by 2030[16]. Jurisdictions are also sometimes approaching vehicle segments (i.e., light duty vs. heavy duty) with different strategies.

Recent surface transportation decarbonization trends in Canada and NL are instructive in considering the role that low-carbon fuels can play in NL.

Types of Vehicle Technologies

In describing surface transportation decarbonization trends, it is helpful to have an understanding of the vehicle technologies that are being deployed.

Zero Emissions Vehicle (ZEV): A vehicle that either produces no tailpipe emissions or has the potential to produce no emissions. There are three types of ZEVs on the market: battery-electric (BEV); plug-in hybrid electric (PHEV); and hydrogen fuel cell (FCV)[17].

Battery-Electric (BEV): A type of ZEV, BEVs use electric motors that draw electricity from on-board rechargeable batteries. They are the most fuel-efficient vehicles available. BEVs produce no tailpipe emissions[18].

Plugin-Hybrid Electric (PHEV): A type of ZEV, PHEVs have rechargeable batteries and gas engines, so users have the flexibility of charging at home, or filling up at a conventional gas station. When operating in electric-only mode, PHEVs produce no tailpipe emissions[19].

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[15] https://www.gridserve.com/why-norway-leads-the-world-in-ev-adoption/
[16] https://www.sphericalinsights.com/reports/japan-automotive-fuel-cell-market
[17] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/zero-emission-vehicles/types-zero-emission-vehicles
[18] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/zero-emission-vehicles/types-zero-emission-vehicles
[19] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/zero-emission-vehicles/types-zero-emission-vehicles

Hydrogen Fuel Cell (FCV): A type of ZEV, FCVs use hydrogen to power the electric motor that propels the vehicle. FCVs emit water vapour and warm air only—they produce no tailpipe emissions[20].

Hybrid: A vehicle combining a gas engine with an electric motor that is recharged by the engine and regenerative breaking and cannot be plugged in to charge. Hybrid vehicles are not considered ZEVs because they do not have the ability to run entirely on the battery.

There are passenger and commercial models featuring the above technologies across vehicle classes (e.g., light-duty and heavy-duty vehicles).

The source of fuel for ZEVs impacts their GHG reduction potential. For example, the GHG reduction potential of an electric vehicle depends on the 'cleanliness' of the electricity which is used to charge it. Similarly, the GHG reduction potential of a hydrogen-powered vehicle depends on how the hydrogen was produced (i.e., via fossils fuels or clean electricity).

Technology Adoption Rates – Light-Duty Vehicles

There are different technologies to consider in surface transportation decarbonization, but not all are being embraced at the same speed. Adoption rates in Canada and NL help us to understand what technologies are being favoured and are likely to continue to gain market share.

The 'light-duty vehicle' category includes on-road vehicles with a GVWR less than or equal to 4,536 kilograms (10,000 pounds)[21]. These vehicles are primarily designed for transporting people or property and include passenger cars. Almost all light duty vehicles in NL feature engines that run on gasoline.

In 2024 there were 270,985 new light-duty vehicle registrations of ZEVs in Canada, accounting for just over one in seven of all new motor vehicle registrations (14.6%). This was an increase from 2023, when ZEVs made up 11.0% of all new registrations. In 2024, new registrations for ZEVs increased by 43.6% from 2023 and by 119.2% from 2022.[22]. 2025 saw a drop in ZEV adoption rates drop to 9% of all new vehicle registrations, however weaker ZEV sales during this period are generally attributed to increased levels of economic uncertainty associated with tariffs, backlash against one of the top selling ZEV brands, as

[20] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/zero-emission-vehicles/types-zero-emission-vehicles
[21] https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2022023-eng.htm
[22] https://www150.statcan.gc.ca/n1/daily-quotidien/250313/dq250313c-eng.htm

well as a pause, cancellation, and/or winddown of EV incentive programs across Canada[23]. The 'Electric Vehicle Affordability Program' for passenger vehicles was re-introduced in early 2026[24].

Among ZEVs, 74.6% of new registrations in 2024 were BEVs and 25.4% were PHEVs. During this same period, only 20 new vehicles (or 0.001%) were registered in Canada that were classified as "Other fuel type" – a classification which includes hydrogen fueled vehicles as well as those fueled by natural gas and propane[25].

	New Vehicle Registrations Canada			
Fuel Type	**2022**	**2023**	**2024**	**2025**
All fuel types	1,513,105	1,714,999	1,853,441	1,866,714
Gasoline	1,233,181	1,316,512	1,333,390	1,372,322
Diesel	75,247	74,028	79,748	87,244
Battery electric	98,620	143,666	202,333	115,049
Plug-in hybrid electric	24,990	45,090	68,895	61,985
Hybrid electric	81,049	135,687	169,055	230,081
Other fuel types	18	16	20	33

Figure 4: New passenger motor vehicle registration in Canada by fuel type 2022-2025, with info from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002501

Data captured in NL around vehicle registrations is historically less granular as a distinction was not made between PHEVs and hybrid vehicle registrations until 2023. However, the data is still informative.

	New Vehicle Registrations Newfoundland & Labrador						
Fuel Type	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025***
All fuel types	454	16,033	814	-1,270	-3,248	-13,976	
All Hybrid	129	269	592	655	1,663	2,300	2,516
Plug-in hybrid electric						338	164
Hybrid electric						1,962	2,352
Electric	72	21	116	362	450	416	330

Figure 5: New passenger motor vehicle registrations in NL by fuel type 2019-2025, derived from http://stats.gov.nl.ca/statistics/Statistics.aspx?Topic=transportation. A distinction was not made between PHEV and hybrid election until 2023. 2025 totals are only available until Q3 and do not represent the full year. Negative registration values represent net negative expired registrations for all fuel types.

[23] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2025/market-snapshot-zero-emission-vehicles-in-canada-latest-trends-including-region-and-makemodel-level-insights.html
[24] https://tc.canada.ca/en/road-transportation/innovative-technologies/electric-vehicles/electric-vehicle-affordability-program
[25] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002501&pickMembers%5B0%5D=1.1&pickMembers%5B1%5D=3.1&cubeTimeFrame.startMonth=01&cubeTimeFrame.startYear=2024&cubeTimeFrame.endMonth=10&cubeTimeFrame.endYear=2024&referencePeriods=20240101%2C20241001

Canada-wide the ratio of PHEV to hybrid electric is approximately 1:3.5. Based on limited data this ratio appears to be much lower in NL. For the purposes of a rough analysis of ZEV adoption, a 1:8 ratio is used to estimate PHEV vs. hybrid electric new vehicle registrations retroactively to 2019.

Fuel Type	Total Vehicle Registrations Newfoundland & Labrador						
Fuel Type	2019	2020	2021	2022	2023	2024	2025*
All fuel types	251,390	267,423	268,237	266,967	263,719	249,743	
Hybrid	702	971	1,563	2,218	3,881	6,181	8,799
Plug-in hybrid electric	88	121	195	277	330	668	934
Hybrid electric	614	850	1,368	1,941	3551	5,513	7,865
Electric	175	196	312	674	1,124	1,540	1,870

Figure 6: Total passenger motor vehicle registrations in NL by fuel type 2019-2025, derived from http://stats.gov.nl.ca/statistics/Statistics.aspx?Topic=transportation. Total registration numbers are not available for 2025 at the time of this paper's publication. Grey numbers represent estimates.

Overall, ZEV adoption rates in NL are much lower than the rest of Canada, however these rates are accelerating. In 2019 it is estimated that only 0.1% of vehicles registered in NL were ZEVs, but by 2024 this percentage had risen to 0.88%. This is an 800% increase over 5 years, with the rate of adoption clearly increasing. Since 2023, PHEVs made up almost 45% of new ZEV vehicle purchases in NL – which is just below twice the national average.

With no natural gas or hydrogen vehicle refueling infrastructure in NL, it is reasonable to assume that there are zero light-duty vehicles in the province which use these fuels.

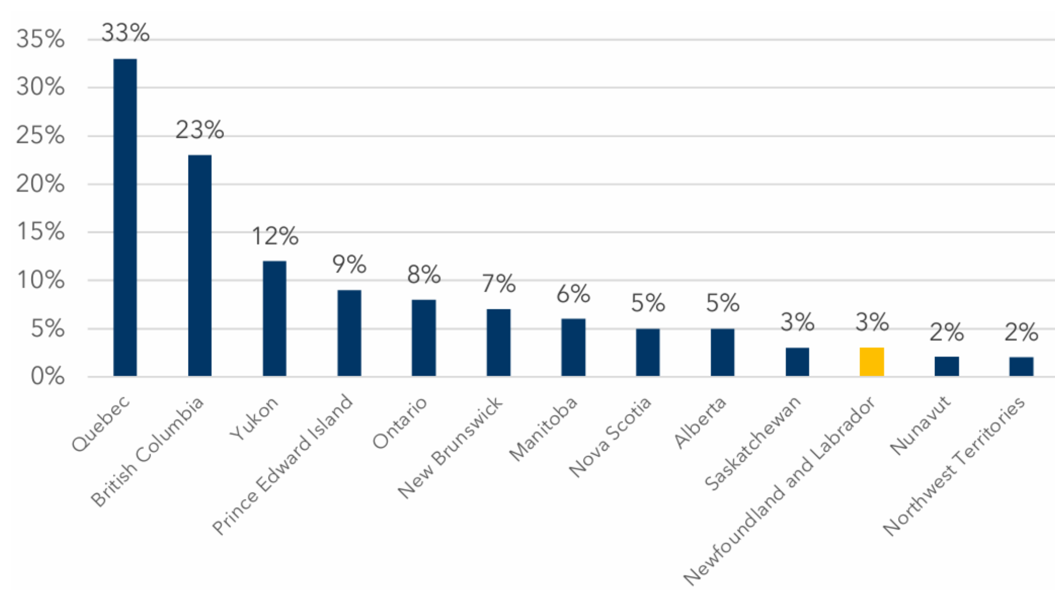

Figure 7: 2024 ZEV share of new vehicle sales by province and territory (Dunsky Energy + Climate) (https://emc-mec.ca/wp-content/uploads/2025/10/23014_Powering-Up_Provincial-Report_NewfoundlandLabrador_EN-30Sept2025.pdf)

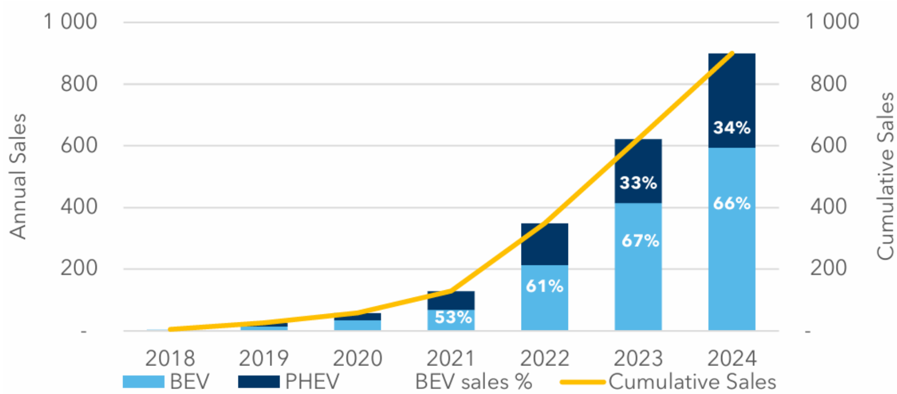

Figure 8: Historical ZEV sales, Newfoundland and Labrador (Dunsky Energy + Climate) (https://emc-mec.ca/wp-content/uploads/2025/10/23014_Powering-Up_Provincial-Report_NewfoundlandLabrador_EN-30Sept2025.pdf)

Overall, NL is positioned well for the electrification of transportation due to the fact its electricity grid is 90%+ derived from clean renewable energy sources. This high rate of clean energy penetration ensures that the GHG benefits of ZEV vehicles are maximized.

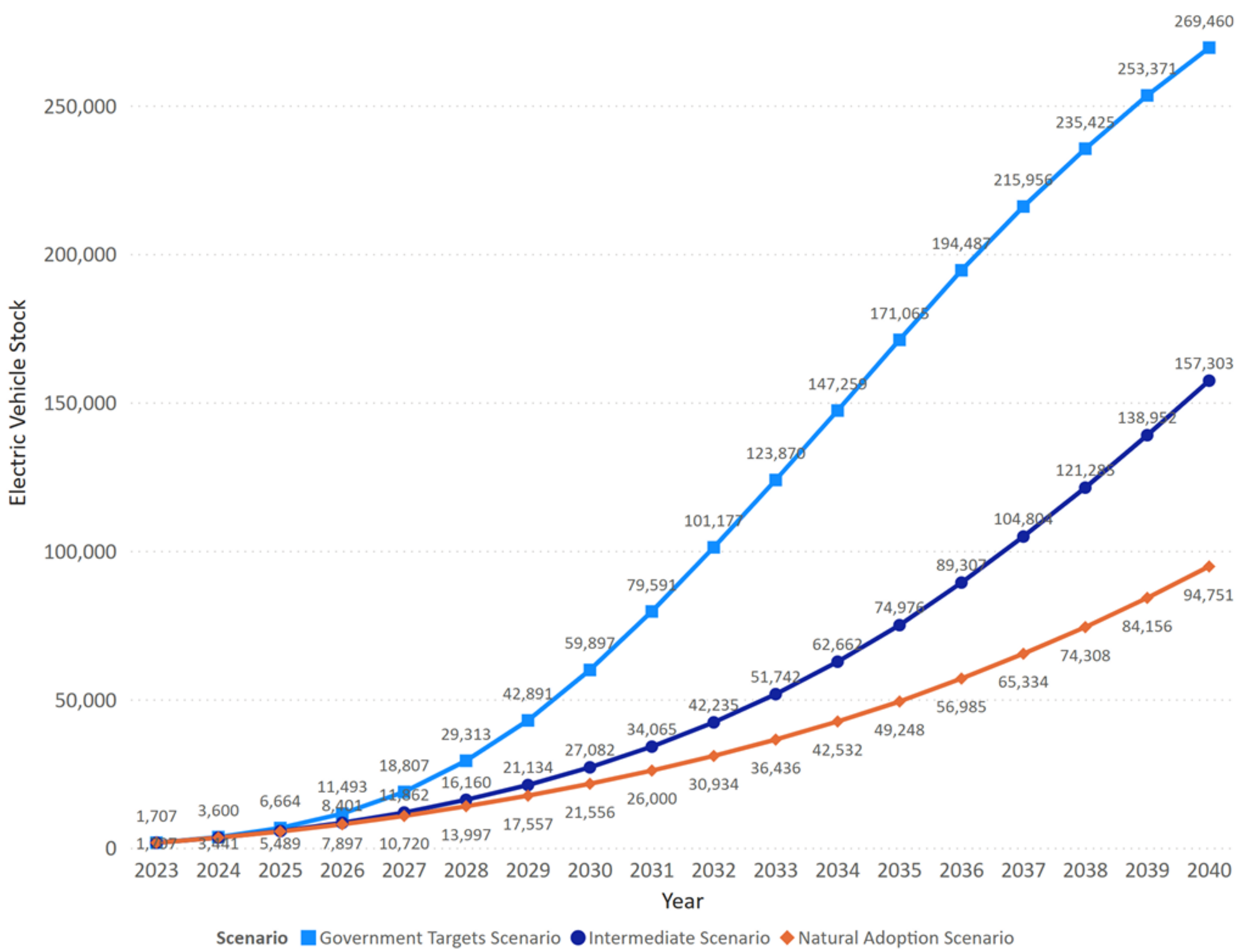

Figure 9: Forecasted ZEV Stock in NL by Scenario (Energy Solutions Potential Study)[26]

[26] http://www.pub.nl.ca/applications/NLH2025AvalonCombustionMarch/correspondence/From%20NLH%20-%20Conservation%20and%20Demand%20Management%20Potential%20Study%20-%202025-11-05.PDF

But the rate of adoption of ZEVs in NL is difficult to predict. At the time of this discussion paper's publication, ZEV adoption rates in NL are closest to the 'natural adoption scenario' outlined in the Energy Solutions Potential Study[27] for the provincial utilities.

This suggests that internal combustion engine technology will continue to be prevalent (and potentially even still dominant) beyond 2040, noting that (in addition) PHEVs still run on gasoline in many scenarios.

All of this data suggests a number of conclusions:

Conventional fuels are likely to continue to be used for surface transportation in NL for many years to come. The adoption rate of ZEVs in the light-duty sector – while accelerating – is slow in NL and ICE technology may still dominate into the 2040s. This is important because light-duty vehicle use is responsible for over 50% of surface transportation GHGs in NL. This means that interventions related to decreasing the carbon intensity of gasoline and diesel have the potential to be very meaningful from an environmental perspective.

Electric technologies dominate Canadian ZEV adoption in the light-duty vehicle category. For passenger cars, SUVs, and pick-up trucks the use of hydrogen fuel cell technology is almost non-existent in the country. It would be unlikely for NL to be an outlier to these trends, meaning that hydrogen is not likely to play a significant role in the decarbonization of this vehicle segment. Decarbonization in the light-duty vehicle category will occur as a result of the adoption of BEVs and PHEVs and a reduction in the carbon intensity of gasoline and diesel being used in ICE vehicles.

Heavy-Duty and Off-Road Vehicle Potential

The 'heavy duty vehicle' category Includes a diverse variety of on-road medium-duty and heavy-duty vehicles that are used across a wide range of activities and includes local delivery vehicles, garbage trucks, buses, long-haul tractor trailers, and others[28]. Heavy-duty vehicles have a GVWR of more than 3 856 kg (8,500 pounds) but does not include a medium-duty passenger vehicle[29] (i.e., pickup trucks) which in the context of this paper are consider 'light duty vehicles'.

[27] http://www.pub.nl.ca/applications/NLH2025AvalonCombustionMarch/correspondence/From%20NLH%20-%20Conservation%20and%20Demand%20Management%20Potential%20Study%20-%202025-11-05.PDF
[28] https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/heavy-duty-vehicle-engines-zero-emission-future-discussion-paper.html
[29] https://laws-lois.justice.gc.ca/eng/regulations/SOR-2013-24/section-1.html?txthl=class

Heavy-duty vehicles are responsible for approximately 18% of surface transportation GHGs in NL. The vast majority of fuel use in this category is diesel.

Heavy-duty vehicles are regulated by Canada's 'Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations[30]' which set performance-based GHG emissions standards for new on-road heavy-duty vehicles and their engines made in 2014 and later years - mirroring stringent U.S. Environmental Protection Agency frameworks.

Canada had set an aggressive target of 100% of new medium- and heavy-duty vehicles sales being ZEV by 2040, where feasible[31]. While these targets are no longer in effect, the federal government has signalled increasing emissions standards will drive high adoption rates[32].

Variable factors in heavy-duty vehicle use such as distance traveled, location of travel, utility, and payloads create different conditions where alternative technologies have greater potential than in passenger vehicle segments.

Electric Heavy-Duty Vehicles

Electric technology is expected to have significant penetration in the heavy-duty vehicle segment.

A 2025 report from Electric Mobility Canada[33] predicted that the following electrification would occur by the year 2040 in Canada: 72% of transit buses; 67% of school buses; between 42% and 71% of the total Class 3-6 vehicles (medium and heavy-duty pickup and delivery trucks); and between 32% and 35% of freight trucks.

As with passenger vehicles, BEV penetration in the heavy-duty vehicle categories are much lower in NL than in other parts of the country. As of mid-2025, the total number of medium to heavy-duty vehicles in NL that were BEV or PHEV was 224[34] – which represents just over 0.2% of all registered vehicles in this category.

[30] https://pollution-waste.canada.ca/environmental-protection-registry/regulations/view?Id=119
[31] https://tc.canada.ca/en/binder/41-zero-emissions-vehicles
[32] https://www.esgtoday.com/canada-drops-zero-emission-vehicle-sales-mandate-for-automakers/
[33] https://emc-mec.ca/wp-content/uploads/2025/10/FINAL_Report_MHDV-Study_EMC-UWG.pdf
[34] https://stats.gov.nl.ca/Statistics/Topics/transportation/PDF/Hybrid_Electric_Quarterly_NL.pdf

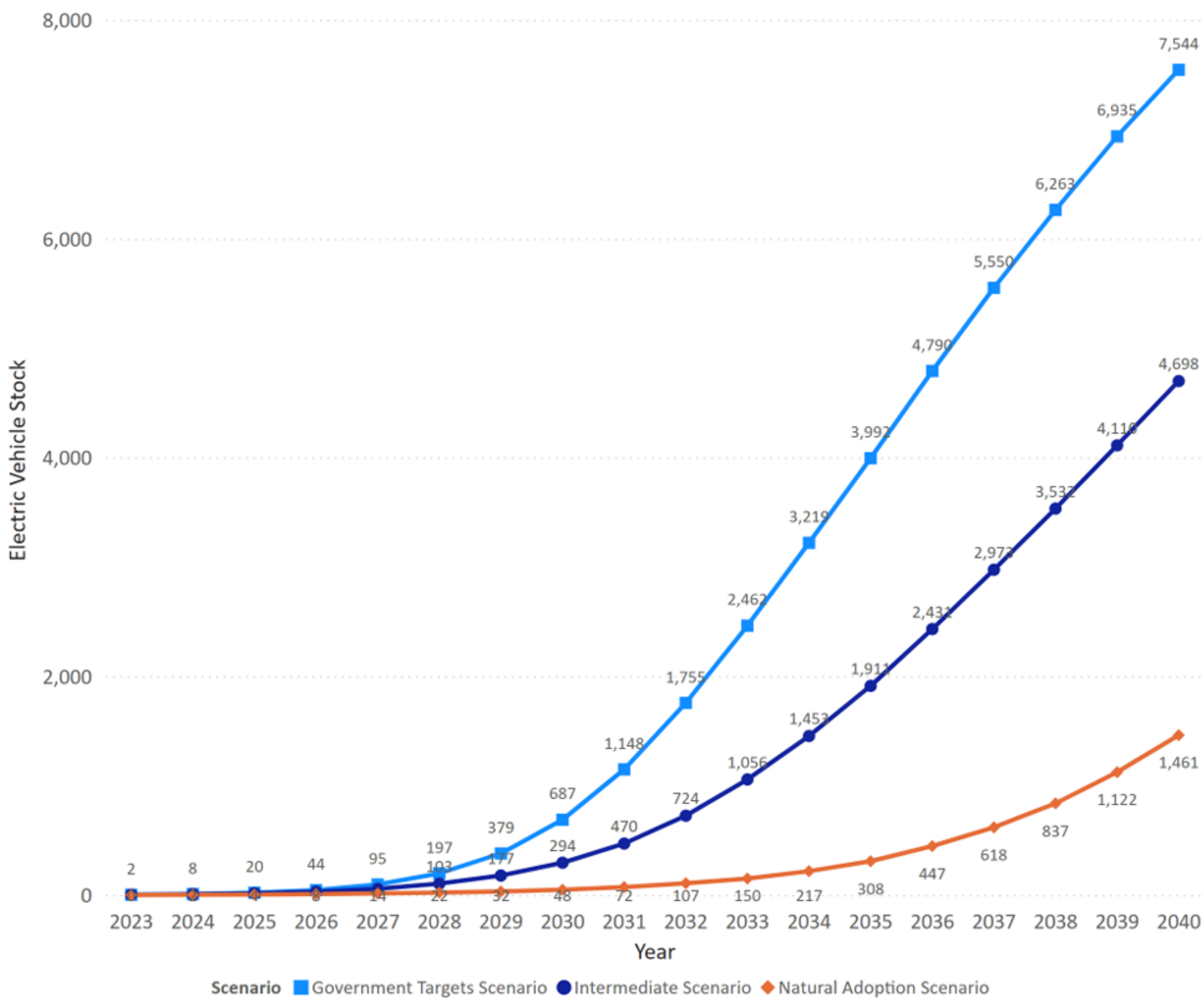

Figure 10: Forecasted MHDVs in NL by Scenario (Energy Solutions Potential Study)[35]

It should be noted that registration of vehicles in this category is not necessarily an adequate reflection of the category's activity in the province or the GHGs that are generated from it. Many freight trucks, for example, cross provincial boundaries into NL and travel great distances within the province – but are not registered within it.

Most battery-electric trucks around the world so far have been deployed on shorter, more predictable routes, but the economic case for BEV heavy-duty trucks is improving. New charging technology and battery-switching concepts allow for full re-charges in 5-30 minutes.[36]

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[35] http://www.pub.nl.ca/applications/NLH2025AvalonCombustionMarch/correspondence/From%20NLH%20-%20Conservation%20and%20Demand%20Management%20Potential%20Study%20-%202025-11-05.PDF
[36] https://www.cbc.ca/news/science/hydrogen-battery-electric-trucks-9.7266083

Hydrogen Heavy-Duty Vehicles

Canada's Hydrogen Strategy[37] noted that hydrogen FCVs show strong promise in long-haul, heavy-duty trucking applications where batteries have limitations.

FCV technologies are considered to have strong potential for long-haul trucking compared to battery electric technologies. They feature similar fueling time, range, hauling capabilities, and performance to internal combustion engine vehicles. The high energy efficiency that stems from fuel cell technology results in significantly lower fuel consumption compared to a comparable conventional internal combustion engine[38].

Hydrogen's high energy density makes it well-suited for long-haul trucks, buses, and other heavy-duty vehicles that require extended range and fast refuelling[39]. FCV technologies retain most of their range in cold conditions, unlike some battery-electric trucks which can lose up to 20–40% of their range in similar weather[40].

Hyundai's Xcient FCV truck (Hyundai)

[37] https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen%20Strategy%20for%20Canada%20Dec%2015%202200%20clean_low_accessible.pdf
[38] https://www.hydrogen.ca/hydrogen-technology-and-zero-emission-vehicles-an-overview
[39] https://www.optiom.com/the-future-of-hydrogen-fuel-cell-vehicles-in-canada-a-sustainable-alternative-to-evs/
[40] https://www.htec.ca/hydrogen-fuel-cell-trucks-a-promising-path-for-heavy-duty-fleets/

FCVs can offer advantages in remote and Indigenous communities in colder climates where battery chemistries are negatively impacted. Fuel cells do not suffer the same inherent performance degradation in cold temperatures, and waste heat from the fuel cells can be used for cabin heating to further differentiate extended range of FCEVs in these cold climates[41].

Heavy-duty FCVs are still at an early production phase, with major vehicle manufacturers like Hyundai, Honda, Toyota, BMW, and others now with commercial offerings[42]. However, pilot and demonstration projects using Heavy-duty FCVs are only recently emerging in Canada[43]. Purchasing costs are high with heavy-duty FCVs estimated to cost 45%-75% more[44], with fuel costs also expected to be much higher (i.e., diesel versus low-carbon hydrogen). Fueling infrastructure is absent, with just eight hydrogen refueling stations listed on Natural Resources Canada's Electric Charging and Alternative Fuelling Stations Locator[45].

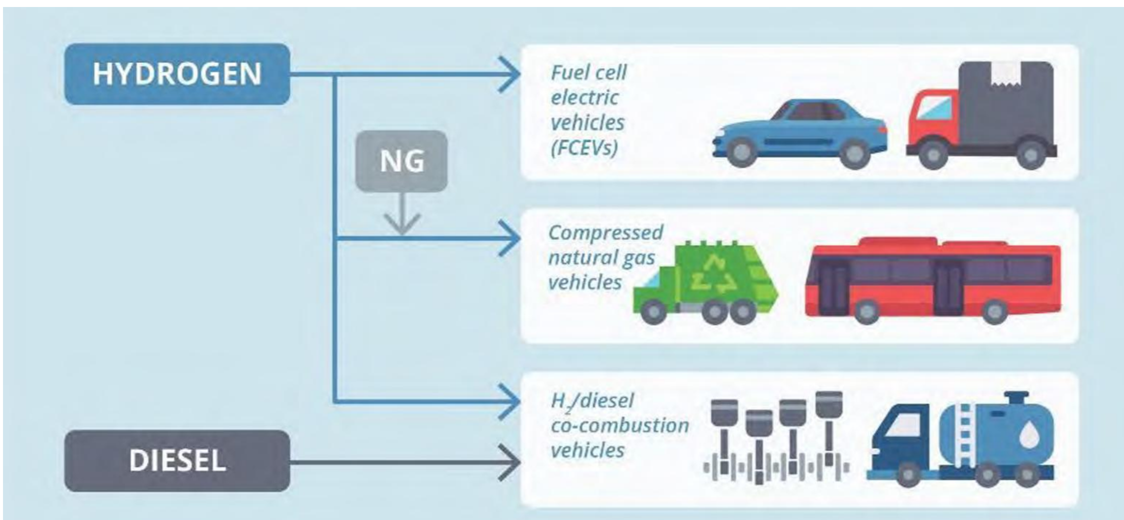

Figure 11: Hydrogen uses in transportation (Canada's Hydrogen Strategy)[46]

There are other pathways for hydrogen use in heavy-duty vehicles beyond FCV. For example, hydrogen 'combustion' engines are currently being prototyped and have the potential to be used in heavy-duty applications which have severe duty cycles requiring

[41] https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen%20Strategy%20for%20Canada%20Dec%2015%202200%20clean_low_accessible.pdf
[42] https://fchea.org/fueling-the-future-hydrogen-in-heavy-duty-trucking/
[43] https://www.biv.com/news/transportation/hydrogen-powered-trucking-in-bc-faces-a-long-road-ahead-11736425
[44] https://thundersaidenergy.com/downloads/is-natural-gas-a-competitive-truck-fuel/
[45] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/electric-charging-alternative-fuelling-stationslocator-map#/find/nearest?fuel=HY&hy_nonretail=true&country=CA
[46] https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen%20Strategy%20for%20Canada%20Dec%2015%202200%20clean_low_accessible.pdf

large energy demands and long operational hours[47]. The concept of 'dual fuel' vehicles is also gaining traction. Dual fuel vehicles feature the use of both diesel and hydrogen ('co-cumbustion'), with the retrofit of existing diesel vehicles being a possibility[48]. Lastly, hydrogen can be blended with natural gas in natural gas technology vehicles (see below).

Natural Gas Heavy-Duty Vehicles

Natural gas powers more than 175,000 vehicles in the United States and roughly 23 million vehicles worldwide. There are about 20,000 natural gas vehicles in Canada. Several vehicle manufacturers offer vehicles that run on natural gas, while conventional gasoline vehicles can also be converted to natural gas[49].

Natural gas vehicles are good choices for high-mileage, centrally fueled fleets. For vehicles that travel long distances, liquefied natural gas (LNG) offers a fuel range more comparable to conventional fuel. The horsepower, acceleration, and cruise speed of natural gas vehicles are comparable with those of equivalent, conventionally fueled vehicles.

Natural gas may be a lower-carbon fuel than diesel and heavy-duty natural gas trucks can emit up to 20% less than diesel trucks[50]. However, natural gas is not generally defined as a low-carbon fuel unless referring to renewable natural gas or RNG (see Section 4 of this paper). Very little infrastructure for natural gas vehicles exists in Canada; Natural Resources Canada's Electric Charging and Alternative Fuelling Stations Locator identifies 37 compressed natural gas stations in Canada[51] distributed across the country in British Columbia, Alberta, Ontario, and Quebec.

Off-Road Vehicles

The discussion on heavy-duty vehicles up to this point have focused on freight transportation. However, many off-road vehicles (i.e., those used in support of mining, construction, forestry, agriculture, etc.) would be considered heavy-duty vehicles. Off-road vehicles account for approximately 29% of surface transportation GHGs in NL – or 9% of the entire province's GHGs. This is a category of vehicles which is deserving of attention and also lends itself well to ZEV technologies.

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[47] https://www.hydrogen.ca/hydrogen-technology-and-zero-emission-vehicles-an-overview
[48] https://natural-resources.canada.ca/funding-partnerships/hydrogen-dual-fuel-heavy-duty-long-haul-vehicles
[49] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/natural-gas-transportation
[50] https://www.freightliner.com/blog-and-newsletters/natural-gas-trucks-vs-diesel-trucks/
[51] http://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/electric-charging-alternative-fuelling-stationslocator-map#/find/nearest?fuel=ELEC&hy_nonretail=true&country=CA

In 2025 Environment and Climate Change Canada (ECCC) procured a study to chart practical decarbonization pathways for industrial off-road equipment[52].

The analysis revealed several key findings:

- Electrification emerged as the most dominant pathway, with BEV models already accounting for the majority of low-carbon deployments in equipment such as forklifts, welders and surface machines. These solutions are also delivering operational cost savings and regulatory compliance benefits.
- In applications where continuous runtime is required and charging networks are underdeveloped, hybrids offered a pragmatic bridge, delivering 20–40 percent reductions in fuel consumption and CO_2 emissions.
- Meanwhile, hydrogen technologies were found to be promising but at an earlier stage of adoption. However, the study underscored that hydrogen's future depends heavily on new production, storage and refueling infrastructure, which currently lags behind demand.

Much of the off-road heavy duty vehicle activity in NL is tied to industrial activities where there are a relatively small number of large operators or decision-makers.

Overall, interventions relating to accelerating the adoption rates of FCV and other technologies in the heavy-duty vehicle segment (on-road and off-road) in NL have the potential to reduce GHGs in an area that is responsible for 15% of all of NL's total GHGs.

Forward Assumptions

Based on the information and logic presented above, the remainder of this discussion paper assumes the following:

1. Conventional fuels are likely to continue to be used for surface transportation in NL for many years to come, including within PHEVs.
2. Electric technologies dominate Canadian ZEV adoption in the light-duty vehicle category, and this trend is expected to be the same for NL.
3. Alternative fuel technologies such as hydrogen and natural gas have more potential for adoption in heavy-duty and off-road applications, but the rate of adoption is unclear.

[52] https://www.ghd.com/en/projects/decarbonizing-pathways-for-canadas-industrial-sector

5. About Low-Carbon Fuels

Clean fuels, or 'low-carbon' fuels are fuels that produce lower GHGs than traditional (or conventional fossil) fuels on a life-cycle basis[53]. Their increased production and use is viewed as being vital in the world's fight against climate change and the pursuit of net zero.

Before exploring the opportunities for low-carbon fuels within NL's surface transportation sector, it is important to have a general understanding of the relevant types of fuels and how they are generally produced and used.

5.1 Categorizing Low-Carbon Fuels

There are many types of low-carbon fuels.

Low-carbon fuels can be produced from a variety of feedstocks, such as agricultural and forest biomass, waste materials, electricity, and fossil fuels with carbon capture and storage[54].

Some low-carbon fuels can be used to supplement conventional fuels; some can be used as a direct replacement for conventional fuels within existing equipment and infrastructure; while others are replacements that require new equipment and infrastructure.

It is helpful to categorize low-carbon fuels into three categories that acknowledge these important differences: (1) biofuels; (2) renewable biofuels; and (3) e-fuels.

Biofuels

Biofuels are 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 biofuels depending on the type of biomass used and the processes used in their creation. Biomass can be converted to fuels through 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, as they are not chemically identical to their conventional fuel counterpart (i.e., biodiesel vs. diesel), most often biofuels cannot

[53] https://natural-resources.canada.ca/energy-sources/clean-fuels/clean-fuels-fueling-future
[54] https://natural-resources.canada.ca/energy-sources/clean-fuels/clean-fuels-fueling-future

directly replace fuels at a 1:1 ratio without affecting 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 [55].

Renewable Biofuels

Produced through a different method (‘catalytic pyrolysis’) than biofuels but with similar feedstocks, ‘renewable’ biofuels are chemically identical to their petroleum-based counterparts (i.e., diesel and renewable diesel).

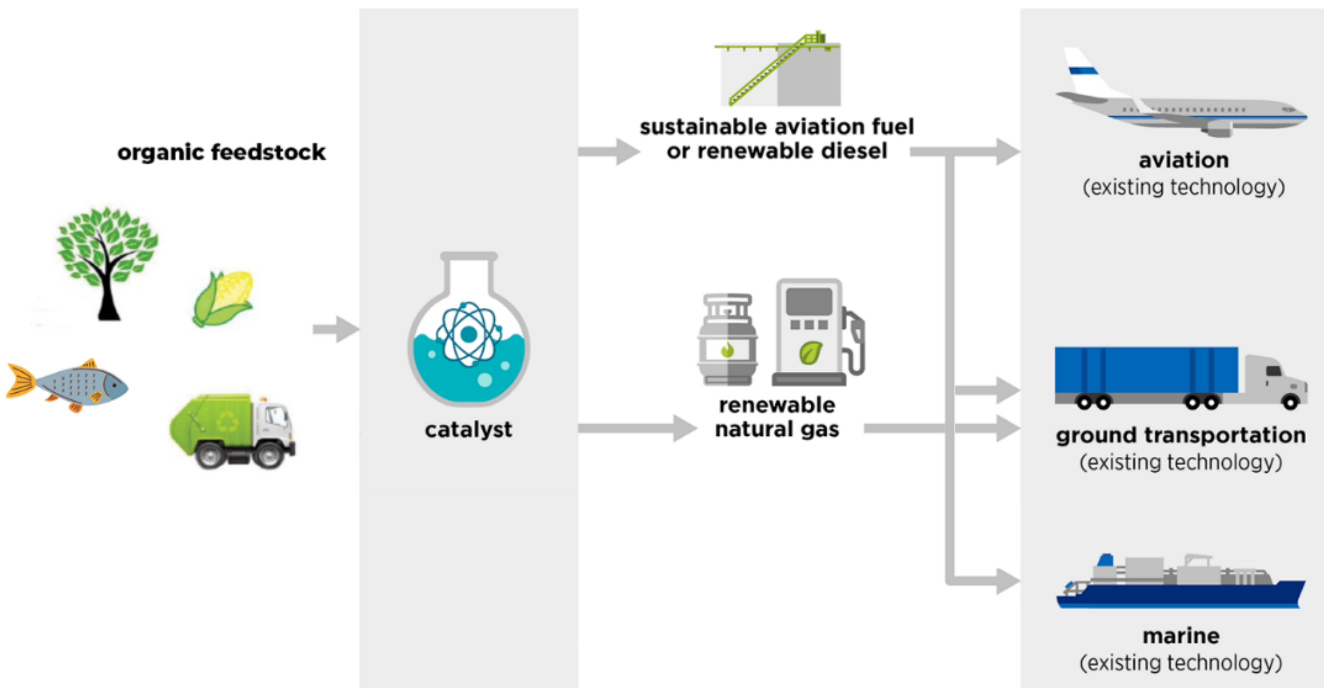

Figure 12: Examples of renewable biofuel pathways

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. The concept of blending is defined explored in detail further in the report. This also means that existing transportation, storage, and refueling infrastructure can be used for these fuels – simplifying the logistics of decarbonization.

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

E-Fuels

E-fuels (electro-fuels) are synthetic fuels produced through electrolysis, which splits water molecules into hydrogen and oxygen using renewable electricity[56]. The most commonly discussed e-fuel is hydrogen, but the category includes fuels that have hydrogen as one of the key components. E-fuels are viewed as being instrumental in the fight against climate change and the global pursuit of net zero as they generally emit significantly less GHGs than fossil fuel alternatives, and their main component – hydrogen – can be produced using clean energy sources.

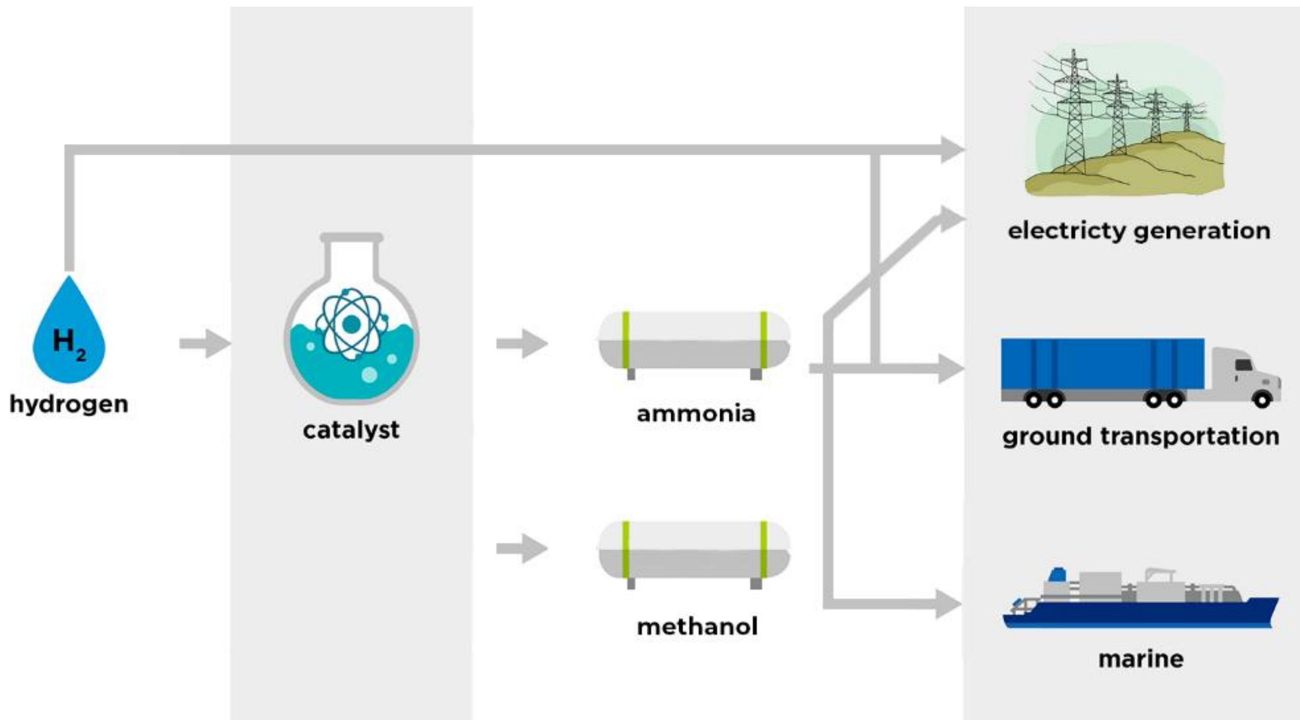

Figure 13: Examples of e-fuel pathways

There are a number of different terms that are being used to describe fuels with a lower carbon intensity that conventional fuels, often used interchangeably and sometimes incorrectly. However, in econext's experience, using these three terms (biofuels, renewable biofuels, and e-fuels) has proven to be the most effective approach to categorizing and communicating these fuels.

'Low-carbon fuels' is a catch-all term describing any fuel with a lower carbon intensity than the status quo fuel.

[56] https://spectra.mhi.com/energy-transition/what-are-e-fuels-and-can-they-help-decarbonization

5.2 Low-Carbon Fuels Relevant to Surface Transportation

Below is a summary of low-carbon fuels that are relevant within the context of the surface transportation sector. This summary begins with conventional fossil fuels that are lower-carbon, moves into biomass derived fuels, and then e-fuels produced via electricity.

Ethanol

Ethanol is a renewable, alcohol-based fuel made primarily from the fermentation of plant materials like corn, sugarcane, wheat, wood fibres, or other biomass feedstocks – potentially even wood waste from the construction and demolition industry. Ethanol reduces greenhouse gas (GHG) emissions because the grain or other biomass used to make the ethanol absorbs carbon dioxide as it grows. Although the conversion of the biomass to ethanol and the burning of the ethanol produce emissions, the net effect can be a large reduction in GHG emissions compared with fossil fuels such as gasoline. The reduction depends on the feedstock and the production processes used to make ethanol[57].

Natural Gas

Conventional natural gas is found in subsurface rock formations and is extracted through a well drilled into that formation. Once extracted, the gas is separated from free liquids, such as crude oil, hydrocarbon condensate, water, and entrained solids – and then processed[58]. While still a fossil fuel, the use of natural gas within vehicles offers several benefits compared to gasoline or diesel. Burning natural gas for energy results in fewer emissions of nearly all types of air pollutants and carbon dioxide (CO_2) emissions than petroleum products to produce an equal amount of energy[59].

Biomethane / Renewable Natural Gas (RNG)

Biogas is a renewable source of methane gas produced when organic matter breaks down without oxygen[60]. Biogas can come from a variety of sources, including municipal solid waste landfills, anaerobic digester plants at water resource recovery facilities (wastewater

[57] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/ethanol
[58] https://afdc.energy.gov/fuels/natural-gas-conventional
[59] https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php
[60] https://biogasassociation.ca/biogas_101/

treatment plants), livestock farms, food production facilities, and organic waste management operations[61] for use in place of (or in tandem with) fossil natural gas.

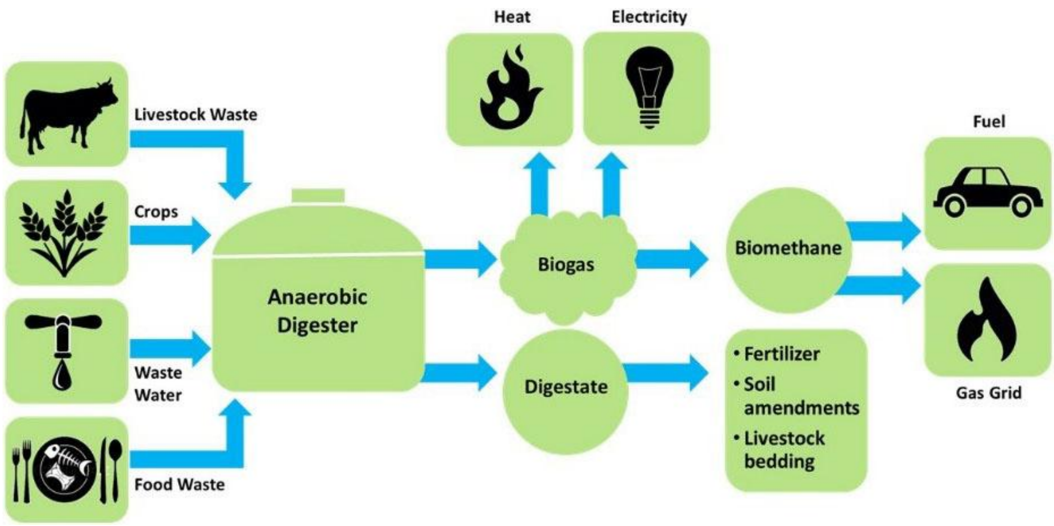

Figure 14: Examples of biomethane pathways[62]

The biological matter that's used to produce biogas will naturally decay anyway, so capturing the gases produced by this decay, and using them as an energy source, causes less harm to the environment than allowing them to escape into the atmosphere[63]. Biomethane – or 'Renewable Natural Gas (RNG)' – refers to biogas that has also been cleaned and conditioned to remove or reduce non-methane elements allowing it to be used as a replacement for (or supplement to) traditional natural gas or LNG[64].

Biohydrogen

Biohydrogen refers to hydrogen obtained from biogenic sources (for example, biogases and biomass) using a variety of technologies including biological, thermochemical, and bioelectrochemical processes[65]. For example, the vast majority of hydrogen used today is produced via natural gas through a process called 'steam methane reforming' (SMR). Consider that RNG is chemically identical to natural gas; a low-carbon hydrogen can be produced with biomass as the original feedstock via SMR using RNG. While biohydrogen itself is not expected to be used in large quantities in NL, it is mentioned here because of the potential uses of green hydrogen and the potential for biohydrogen as a supplement.

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[61] https://afdc.energy.gov/fuels/natural-gas-renewable
[62] https://www.eesi.org/papers/view/fact-sheet-biogasconverting-waste-to-energy
[63] https://www.nationalgrid.com/stories/energy-explained/what-is-biogas
[64] https://afdc.energy.gov/fuels/natural-gas-renewable
[65] https://www.europeanbiogas.eu/wp-content/uploads/2025/06/Decarbonising-Europes-hydrogen-production-with-biohydrogen.pdf

Biodiesel

Biodiesel is a diesel fuel substitute made from renewable materials such as: plant oils (canola, soy, flax, etc.), waste cooking oil (yellow or tap grease), other oils (tall, fish, and algae), animal fats (beef or sheep tallow, pork lard, or poultry fat); and potentially from cellulosic feedstock consisting of agriculture and forest biomass. The process to create biodiesel is called 'transesterification.' Made from renewable resources biodiesel has the potential to reduce GHG emissions by over 80% on a lifecycle basis.[66] Biodiesel is most often used blended with conventional diesel (see 'Fuel Blends' below).

Renewable Diesel

Similar to biodiesel in terms of feedstock, renewable diesel is a fuel made from fats and oils, such as soybean oil or canola oil – however the process utilized in fuel production is different. Produced most often by hydrotreating, and also via gasification, pyrolysis, and other biochemical and thermochemical technologies, the resulting fuel is chemically identical to conventional diesel[67] but has a much lower lifecycle carbon footprint. This means that renewable diesel can be used as a direct replacement for conventional diesel (i.e., as a 'drop-in'), if not a heavy additive in blending. While renewable diesel has a similar chemical structure to diesel, it has been shown to produce equal or lower levels of NOx and PM emissions when burned. In addition, traditional diesel contains aromatic compounds present in distillates that contribute to toxicity, whereas renewable diesel does not contain such compounds and as a result, has a decreased environmental toxicity and a higher degradation rate. As such, in the case of a spill, renewable diesel has less short and long-term environmental effects compared to conventional fossil fuels[68]. Renewable diesel is produced in NL; Braya Renewable Fuels has converted the Come by Chance refinery to produce up to 18,000 barrels per day of renewable diesel[69].

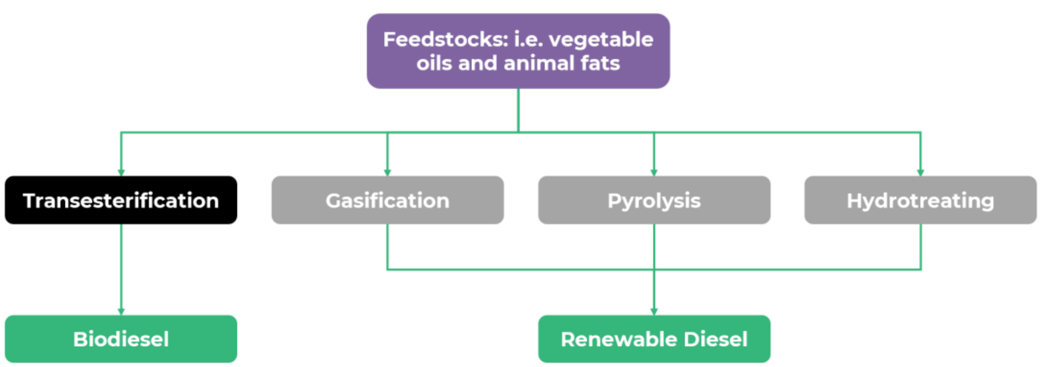

Figure 15: Example of Fuel Production Pathways for Biodiesel and Renewable Diesel (econext: Forthcoming)

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[66] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/biodiesel
[67] https://afdc.energy.gov/fuels/renewable-diesel
[68] https://econext.ca/discussion-paper-opportunities-for-domestic-clean-fuels-use-in-newfoundland-and-labrador/
[69] https://brayafuels.com/

Green Hydrogen

Hydrogen is the most abundant element in the universe. When burned, hydrogen produces only water vapour, resulting in zero GHG emissions which makes it an attractive fuel source. Hydrogen has been a widely used input in a variety of industry for many years and can be produced through a variety of methods[70]. The vast majority of hydrogen used today is produced via natural gas through a process called 'steam methane reforming' ('grey hydrogen'). This process can be paired with carbon capture and storage (CCS) to produce hydrogen with much fewer resulting GHGs ('blue hydrogen').

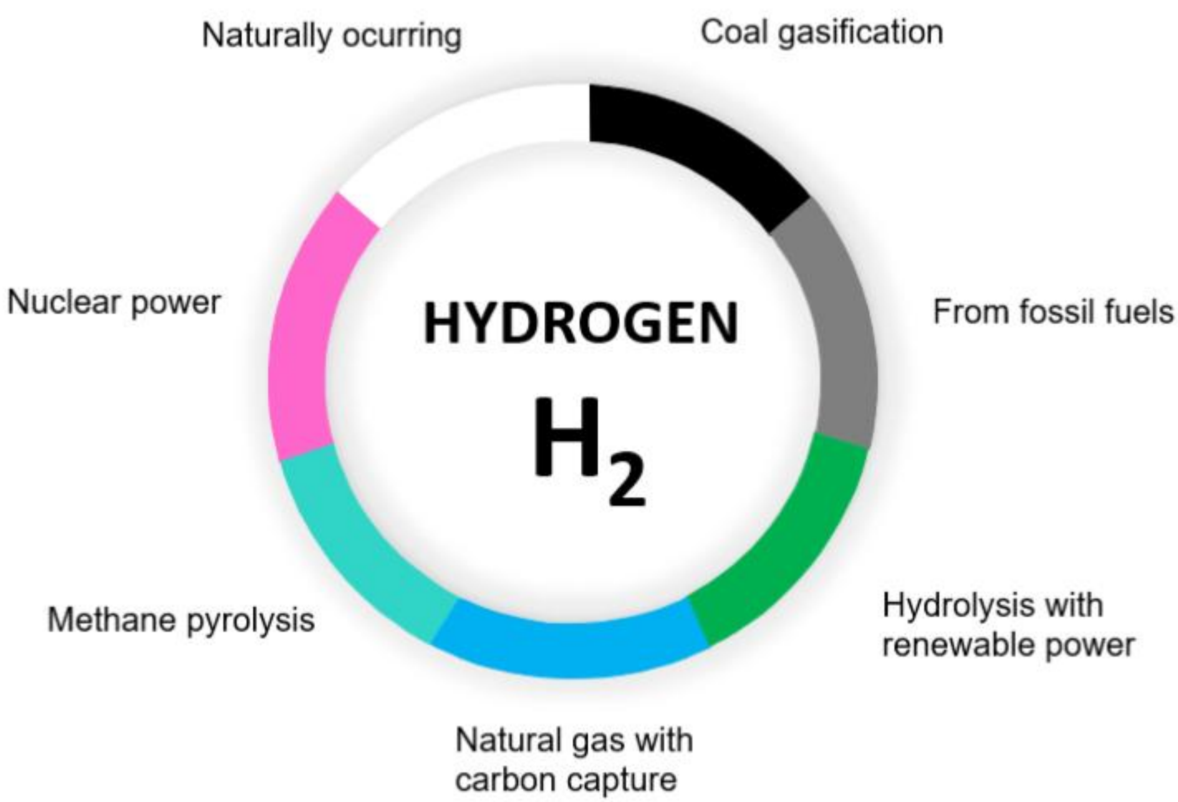

Figure 16: Hydrogen production pathways and colour associations[71]

'Green hydrogen' is when hydrogen is produced through a process called 'electrolysis' utilizing renewable energy. Green hydrogen can be produced with zero GHGs and be 'burned' resulting in zero GHGs – positioning it strongly as an important contributor in the fight against climate change. Green hydrogen is expected to be produced in NL in the early 2030s and will therefore be the primary focus of discussion for the purposes of this discussion paper.

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[70] https://www.siemens-energy.com/global/en/home/products-services/solutions-usecase/sustainable-fuels.html#Hydrogen-tab-0

[71] https://jpt.spe.org/twa/the-color-palette-of-the-colorless-hydrogen

Liquid Organic Hydrogen Carrier (LOHC)

Hydrogen is light gas with low energy density, making storage and transportation costly. For this reason, a number of different fuels which feature hydrogen as one of the primary elements are being considered as 'hydrogen carriers' as they have more favourable characteristics for transport and storage. LOHC is one of these 'hydrogen derivative' fuels, and allows hydrogen to be chemically bonded to a liquid carrier making it safer and more efficient to handle. LOHCs can be transported easily using existing diesel infrastructure, with the organic compound removed near the point where hydrogen is to be used. These organic compounds are capable of reversible hydrogenation – binding and releasing hydrogen through chemical reactions[72]. Much of the organic compound can be 'recycled' and bonded with hydrogen again many times. Given the potential LOHC has as a hydrogen carrier and the fact it may be produced within NL by the early 2030s[73], it presents opportunities for hydrogen use within the province that are not practical if transporting and storing hydrogen in its pure state.

Green Methane

Methane has been used as a fuel and, later, a chemical feedstock since it was discovered and isolated in the 18th century. It is four parts hydrogen and one part carbon. Methane is a key component of natural gas (90%) and historically has been taken either directly from natural gas fields or as a by-product of other fossil fuel extraction[74]. However, methane can be synthetically created through the combination of hydrogen and carbon dioxide. When green hydrogen is used in this process (along with sustainably sourced carbon dioxide), the resulting fuel is green methane (or 'e-methane'). Similar to biomethane, green methane is chemically identical to conventional methane and thus can be used as a heavy blend (or replacement for) natural gas. Green methane production has been commercialized at a relatively small scale, with most projects tied to existing biogas/biomethane plants; supplying green hydrogen in addition to anaerobic digestion can reportedly increase methane output by 60% compared to typical biogas upgrading[75].

Conventional Fuel	Biofuel	Renewable Biofuel	e-Fuel
Gasoline	Ethanol		
Diesel	Biodiesel	Renewable Diesel	
Natural Gas	Biogas	Biomethane / RNG	Green Methane
Hydrogen		Biohydrogen	Green Hydrogen

Figure 17: Categorization of Fuels Relevant to Surface Transportation

[72] https://www.deassociation.ca/newsfeed/what-is-lohc-liquid-organic-hydrogen-carrier
[73] https://www.greenenergyhub.ca/
[74] https://enapter.com/en/blog/the-promise-of-green-methane/
[75] https://www.idtechex.com/en/research-article/e-fuels-explained-methanol-methane-diesel-and-saf/34444

Figure 17 presents these fuels in a chart. While an oversimplification, this chart does help to quickly classify the relevant fuels on the vertical columns. The horizontal rows articulate the direct relationships that exist between fuels for supplemental blending or direct replacement.

There are many additional relationships between these fuels that exist; the most relevant of these relationships from the perspective of NL and its surface transportation sector are articulated in Section 5. The interplay between these fuels can help de-risk decisions around future fuel production. While fuel X may decrease in demand over time, fuel X may have the ability to be further refined or blended with another fuel, or the feedstock for that fuel can be used in the production of other fuels.

5.3 Benefits of Low-Carbon Fuels

There are a number of benefits to the adoption of low-carbon fuels that should be considered in decision-making.

Decreased GHGs: The use of low-carbon fuels allows for lifecycle GHG reductions. These reductions will either be associated with the direct use of the fuel (e.g., a clean fuel will produce far fewer GHGs) and/or the displacement of conventional fossil fuels. The amount of GHGs replaced will depend on the low-carbon fuel used and what is displacing.

Reduced air pollutants: The use of low-carbon fuels is often associated with the reduction of other air pollutants such as particulates (tiny particles of solid matter that lodge in the lungs and deposit on buildings), carbon monoxide, sulfur dioxide, hydrocarbon, and other air toxins[76]. Each low-carbon fuel and the process used in their deployment will result in unique reductions. The amount of air pollutants reduced will depend on the low-carbon fuel used and what it is displacing.

Energy security: Many low-carbon fuels can be produced using local renewable resources (i.e., biomass, electricity, etc.) Even when locally produced fuels are blended with conventional fuels, this: (1) displaces the volume of fuel that must be imported; (2) protects against supply and supply chain disruptions caused by geopolitical events; (3) protects against price volatility of globally traded commodities; and (4) provides for domestic fuel production and supply capabilities that can be called on when needed in an emergency. For example, a diesel fuel blended with 30% locally produced biodiesel and renewable diesel displaces 30% of the required diesel to be imported and the geopolitical impacts on that import which are out of the user's control.

[76] https://advancedbiofuels.ca/net-zero

Valorization of wasted resources: Oftentimes organic waste material (e.g., household organic waste, forestry residues, fishing and aquaculture discards, agricultural waste) are sent to landfill. This 'waste' is actually a resource which has value and can be considered as feedstock for low-carbon fuels production. Moreover, the diversion of these waste streams away from landfills reduces the harmful GHGs that are caused by the decomposition of biomass.

Economic development and growth: The production and distribution of low-carbon fuels (including the diversion of biomass from landfills) creates jobs, wealth, and improved environmental outcomes for communities. Many low-carbon fuels have value and opportunity domestically, while also are tradeable commodities on a regional, national, and global scale. As various biomass-derived fuels are interoperable with their e-fuel counterparts, there are opportunities for the scaling of production utilizing electricity as an additional feedstock.

5.4 Blending Fuels

Fuel types do not necessarily need to be homogeneous or used exclusively. As alluded to above, fuels can often be blended.

Purpose of Blending

Blending allows for the realization – even if in part – of the benefits to low-carbon fuel use as described above. While the blending of fuels does not provide the environmental benefits that the wholesale adoption of low-carbon fuels might, given the prevalence of internal combustion engine technologies in vehicles and the reality that they will exist for many years to come, blending presents an immediate opportunity to achieve GHG emissions reductions.

Fuel blending is likely to become more important over time as (a) pressures continue to mount worldwide to lower the carbon intensity of fuels produced and consumed, while (b) the availability of low-carbon fuels to meet this demand is likely to be in short supply.

Blending of Different Fuels

In some cases, the degree to which fuels can be blended is limited or there is an optimal blending ratio.

For example, ethanol is commonly blended with gasoline; more than 98% of U.S. gasoline contains ethanol to oxygenate the fuel. In most of Canada, ethanol blending is a requirement for gasoline. Typically, gasoline contains E10 (10% ethanol, 90% gasoline), which reduces air pollution[77]. Quebec has recently introduced legislation which will require a 12% ethanol blend by 2026 and 15% by 2030[78], with other provinces already having made these commitments.

With a higher octane value than gasoline, ethanol improves the effectiveness of fuel by preventing engine knocking and keeps fuel systems clean. Ethanol burns more cleanly and completely than gasoline or diesel fuel[79]. Ethanol blends reduce nitrogen oxides, air toxins, particulate matter, and other tailpipe emissions[80]. From a GHG perspective, the use of E10 can reduce lifecycle GHGs by 3-8%.

Through the Renewable Fuels Regulations, the government of Canada currently requires that gasoline at the pump contains an average of five per cent ethanol, with some provinces requiring more[81]. Higher ethanol blends can result in corrosion and performance problems[82], with the emerging E15 (or 15% ethanol blend) only for use in vehicles manufactured after 2001.

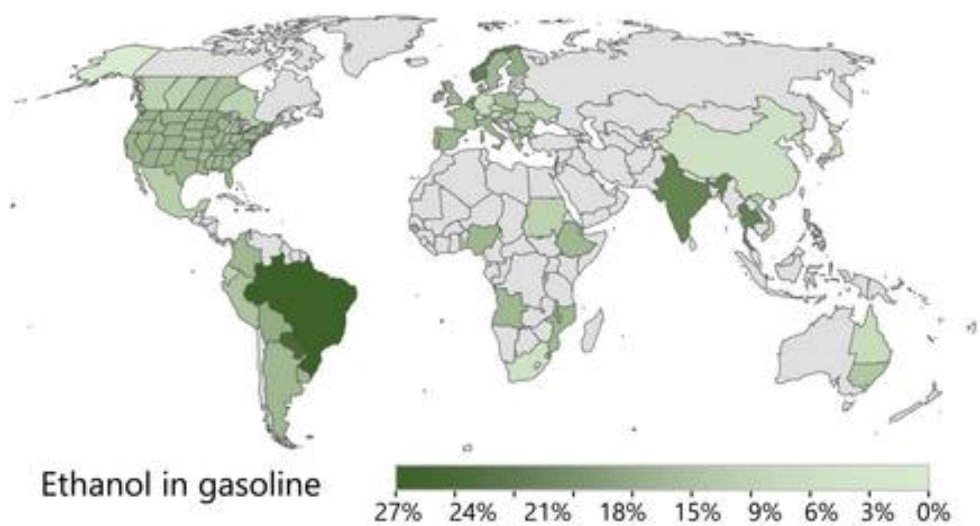

Figure 18: Global Ethanol Blending Mandates[83]

Biodiesel is another example. As biodiesel is not chemically identical to conventional diesel, it is most often an additive in a blend with conventional diesel. A blend classified as

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77 https://afdc.energy.gov/fuels/ethanol-fuel-basics
78 https://www.ctvnews.ca/montreal/article/quebec-rolling-out-higher-ethanol-blend-in-gasoline-starting-this-week/
79 https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/ethanol
80 https://ethanolrfa.org/ethanol-101/environment
81 https://www.canadianfuels.ca/industry-facts/low-carbon-fuels/ethanol/
82 https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/ethanol
83 Biofuel Technologies: Lessons Learned and Pathways to Decarbonization - https://onlinelibrary.wiley.com/doi/10.1111/gcbb.13091

B2, for example, is 98% petroleum diesel and 2% biodiesel. B20 is a blend of 80% petroleum diesel and 20% biodiesel. Blending of biodiesel with diesel has become commonplace; the majority of North American engine manufacturers now endorse up to a B5 biodiesel blend[84] and the practice is common in Canada as incentivized by the Renewable Fuels Regulations (which NL is exempt from). Generally, B20 and lower-level blends can be used in current engines without modifications. In fact, many diesel engine manufacturers approve the use of B20[85].

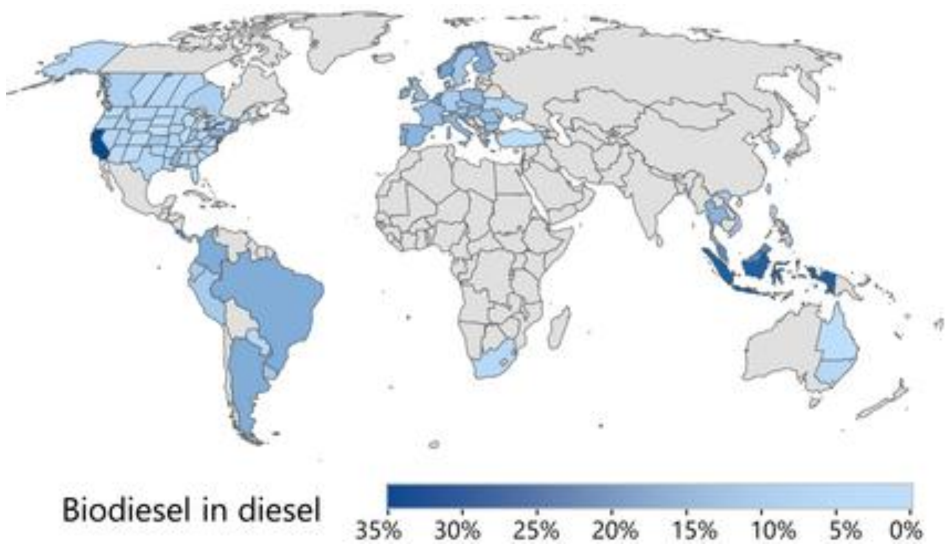

Figure 19: Global Biodiesel Blending Mandates ***Error! Bookmark not defined.***

Another similar case is the potential to blend low-carbon methane with natural gas. While a significant amount of low-carbon methane can be blended due to having the same chemical makeup as the methane component of natural gas, methane totals 90% of the makeup of natural gas so 100% replacement is not possible. Similarly, there is the potential to blend low-carbon hydrogen with natural gas. Hydrogen can be blended with natural gas and delivered through its existing infrastructure for end-use appliances such as stoves, water heaters, generators, etc[86]. Existing natural gas equipment can typically handle a blend of up to 15% hydrogen without compromising performance or safety[87]. Blending natural gas with other fuels is less common than other blends for end-use in surface transportation purposes because natural gas vehicles are not as prevalent as other technologies.

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[84] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/biodiesel
[85] https://afdc.energy.gov/fuels/biodiesel-blends
[86] https://www.cga.ca/natural-gas-101/hydrogen-a-lower-emitting-and-versatile-fuel
[87] https://www.csagroup.org/article/research/appliance-and-equipment-performance-with-hydrogen-enriched-natural-gases

Blending of Same Fuels

In other cases, the low-carbon fuel is chemically identical to its fossil fuel counterpart and can be blended at any ratio at it will not change the composition or characteristics of the original or resulting fuel. This is the case with diesel and renewable diesel.

Multi-Fuel Blends

Blending does not necessarily need to be limited to two fuels. For example, the Canadian Coast Guard is testing fuel blends composed of 10% biodiesel, 40% renewable diesel, and 50% conventional diesel[88] in its ships[89]. It is anticipated that multi-fuel diesel blends will become more common for surface transportation over time.

6. Low-Carbon Fuels Opportunities for NL's Surface Transportation Sector

There are a number of opportunities for low-carbon fuels use within NL's surface transportation sector relating to: (1) fuel blending, (2) ZEV adoption, and (3) logistics.

6.1 Important Factors

Before identifying specific opportunities for low-carbon fuels use within NL's surface transportation sector, there are a number of important factors that should be considered.

Infrastructure

Wholesale fuel-switching will face challenges due to lack of supporting infrastructure. Natural gas is rarely used in NL, and as such there is no local supply, storage, or refueling infrastructure. While it is expected that hydrogen will be produced within NL in the 2030s, there is currently no local supply, storage, or refueling infrastructure. Until infrastructure exists to support natural gas and/or hydrogen vehicles, no adoption of these technologies can be expected.

[88] https://www.ccg-gcc.gc.ca/corporation-information-organisation/greening-initiatives-ecologisation-eng.html
[89] https://www.canada.ca/en/canadian-coast-guard/corporate/about-us/greening-initiatives.html

Economics

The price of fuel is an important factor in consumption decisions. Until economies of scale can be realized, low-carbon fuels are expected to cost more than the conventional fuels that they would be replacing in NL. All tools available to producers, distributors, and adopters will need to be leveraged to reduce costs. Some of these supports are explore in further detail below.

Clean Fuel Regulations

Canada's Clean Fuel Regulations (CFRs) came into effect in 2023 and create incentives for the development and adoption of clean fuels, technologies and processes[90].

The stated goal of the CFRs is to significantly reduce pollution by making the fuels Canadians use every day cleaner over time. The CFR require liquid fossil fuel (gasoline and diesel) suppliers to gradually reduce the carbon intensity – or the amount of pollution – from the fuels they produce and sell for use in Canada over time, leading to a decrease of approximately 15% (below 2016 levels) in the carbon intensity of gasoline and diesel used in Canada by 2030.

There are a number of methods for regulated industry to be compliant with the CFR.

econext's emissions reduction fund is a mode of compliance under the CFR (www.nlerf.ca)

The first approach is the creation of compliance credits. There are three compliance categories, with the first two being relevant in the context of low-carbon fuels:

[90] Government of Canada: What are the Clean Fuels Regulations? - https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/about.html

Compliance Category 1: Undertaking projects that reduce the lifecycle carbon intensity of liquid fossil fuels (e.g., carbon capture and storage, on-site renewable electricity, co-processing). This includes the blending of fuels with lower carbon GHG intensity with conventional fuels.

Compliance Category 2: Supplying low carbon intensity fuels (e.g., biodiesel, hydrogen, e-methanol, etc.)[91].

There is, therefore, an incentive structure that exists for the production and supply of low-carbon fuels – including when those fuels are blended.

The second approach to compliance is for regulated industry to contribute to an Emissions Reduction Fund (ERF) authorized by the Minister of Environment and Climate Change Canada (ECCC). econext's Newfoundland and Labrador Emissions Reduction Fund is one of a select few organizations in Canada with a registered ERF approved as a compliance mechanism under the CFR. ERF funded projects could also conceivably involve partnerships between low-carbon fuel producers, distributors, and users.

Investment Tax Credits

A number of tax credits have been released at the federal and provincial levels in recent years which can help offset some of the capital costs associated with low-carbon fuels production and infrastructure. Federally, the passage of Bills C-59 and C-69 on June 20, 2024[92], activated four tax credits at the federal level with relevance to biomass energy:

- **Clean Technology Investment Tax Credit**[93] – The CT ITC is a refundable tax credit of up to 30% for capital invested in the adoption and operation of new clean technology (CT) property. This includes various electricity generation, energy storage, refueling, etc. equipment – much of which could apply to portions of biomass energy projects.
- **Clean Hydrogen Investment Tax Credit**[94] – The CH ITC is a refundable tax credit of up to 40% that applies to eligible expenses incurred for property that produces hydrogen. These are expenditures that may be applicable to portions of low-carbon fuel production projects if they do involve hydrogen. Property used to convert clean

[91] https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/compliance.html

[92] Government of Canada Launches the First Clean Economy Investment Tax Credits - https://www.canada.ca/en/natural-resources-canada/news/2024/06/government-of-canada-launches-the-first-clean-economy-investment-tax-credits.html

[93] Clean Technology Investment Tax Credit - https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/corporations/business-tax-credits/clean-economy-itc/clean-technology-itc.html

[94] Clean Hydrogen Investment Tax Credit - https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/corporations/business-tax-credits/clean-economy-itc/clean-hydrogen-itc.html

hydrogen to clean ammonia is also eligible at a 15% ITC rate, but unfortunately the ITC is not applicable to property that is used to convert hydrogen to other fuels like methanol.

- **Clean Technology Manufacturing Investment Tax Credit**[95] – The CTM ITC is a refundable tax credit that applies to investment of capital for clean technology manufacturing and processing and critical mineral extraction and processing. This tax credit may not have applicability within the context of low-carbon fuel production, however it should be explored.
- **Clean Electricity Tax Credit**[96] – The CE ITC is a refundable tax credit of up to 15% of investments in projects that generate clean electricity, store electricity without the use of fossil fuels, or transmit electricity between provinces and territories. These are expenditures that may be applicable to portions of low-carbon fuel production projects.
- **Carbon Capture, Utilization, and Storage Investment Tax Credit**[97] – The CCUS ITC is a refundable tax credit of up to 60% that applies to eligible expenditures incurred for a qualified CCUS project. Note that NL, at this time, is not one of the eligible jurisdictions for the CCUS ITC as the credit requires a jurisdiction to have 'sufficient environmental laws and enforcement governing the permanent storage of captured CO^2. This ITC is related to the acquisition of property used to capture CO_2 emissions from fuel combustion, industrial process or directly from the air, to transport the captured carbon and to store it or use it in industry. This is relevant for any low-carbon fuels project which includes CCUS components.

NL's provincial government introduced two investment tax credits in 2022 which are potentially relevant to new biomass energy projects:

- **Green Technology Tax Credit**[98] – The GTTC is a refundable tax credit of up to 20% of capital investments in equipment that generates or conserves renewable-source energy, uses fuels from waste, or makes efficient use of fossil fuels.
- **Manufacturing and Processing Investment Tax Credit**[99] – The MPITC is a refundable tax credit of up to 10% if capital investments in qualified activities that may include aspects of biomass energy projects.

[95] Clean Technology Manufacturing Tax Credit - https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/corporations/business-tax-credits/clean-economy-itc/clean-technology-manufacturing-itc.html
[96] Budget 2024, Chapter 4 - https://www.budget.canada.ca/2024/report-rapport/chap4-en.html
[97] Carbon Capture, Utilization, and Storage Tax Credit - https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/corporations/business-tax-credits/clean-economy-itc/carbon-capture-itc.html
[98] Green Technology Tax Credit - https://www.gov.nl.ca/fin/tax-programs-incentives/business/green-tech-tax-credit-gttc/
[99] Manufacturing and Processing Investment Tax Credit - https://www.gov.nl.ca/fin/tax-programs-incentives/business/manufacturing-and-processing-investment-tax-credit/

In addition to the above, there is a specific investment tax credit available throughout Atlantic Canada:

- **Atlantic Investment Tax Credit**[100] – The ATC is based on specified percentages available for certain investments in new buildings, and new machinery and equipment used in the Atlantic Canada and Atlantic Region including expenditures relating to biomass energy projects: prescribed new energy generation and conservation property; the production or processing of electrical energy or steam in certain areas; and manufacturing and processing.

The above tax credits should be considered and included where appropriate for any future economic analysis of low-carbon fuels production and adoption projects in NL.

Carbon Offsets

The production and use of low-carbon fuels can be net negative in terms of GHGs, making production and adoption projects potentially eligible to achieve carbon offsets.

The federal government has created a Greenhouse Gas Offset Credit System, which will allow for the purchase and trading of eligible carbon offsets as a means of compliance for federally regulated activities[101]. Eligible offsets must meet the stringent requirements of 'protocols' which are developed for each specific type of negative emissions activity.

The system was introduced in 2022, but only a few protocols have been developed thus far including: (1) Landfill Methane Recovery and Destruction; (2) Reducing Greenhouse Gas Emissions from Refrigeration Systems; and (3) and Improved Forest Management on Private Land; and (4) Reducing Enteric Methane Emissions from Beef Cattle. ECCC is currently developing more protocols including Direct Air Carbon Dioxide Capture and Geological Storage, Reducing Manure Methane Emissions, Enhanced Soil Organic Carbon, Improved Forest Management on Public Land, and Bioenergy with Carbon Dioxide Capture and Geological Storage[102].

[100] Atlantic Investment Tax Credit - https://www.canada.ca/en/revenue-agency/services/tax/individuals/topics/about-your-tax-return/tax-return/completing-a-tax-return/deductions-credits-expenses/line-41200-investment-tax-credit/atlantic-investment-tax-credit.html
[101] https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system.html
[102] https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system/protocols.html

These offsets can currently be traded under federal output-based pricing system (OBPS)[103]. Note that NL has its own federally authorized carbon pricing system for large emitters within the province (see above), and this system is independent of the federal OBPS. Emitters in NL cannot achieve compliance through the purchase of federal offsets. It is expected that federal carbon offsets will be tradeable under the forthcoming Clean Electricity Regulations (CER).

It is possible that some of the protocols under the federal system will present opportunities for generation of credits from low-carbon fuels production and adoption initiatives – creating a revenue stream to improve project economics.

Displacement of Waste Management Costs

Organic waste – an important feedstock for various low-carbon fuels – is currently sent directly to landfill in NL. Organic waste makes up approximately 30%[104] of waste that enters into landfills, with much more estimated to be disposed of elsewhere. Landfilling is not free, and therefore there are financial benefits associated with the diversion of this volume of material.

Robin Hood Bay Waste Management Facility in St. John's, NL (Tract Consulting Inc.)

[103] https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system.html

[104] https://mmsb.nl.ca/education/composting/

Each region within the province sets a 'tipping fee', or the cost per tonne of waste disposed of at their site(s). Tipping fees can vary depending on the material being disposed and who is disposing of it but, generally speaking, fee ranges from $90.75 per tonne in Eastern Newfoundland[105] to $145 per tonne in Central Newfoundland[106] to $164 in Corner Brook and area[107] (amongst a variety of areas across the province).

Approximately 155,000 MT of organics waste is generated annually in NL with only a small fraction (2.5%) diverted[108]. If all organic waste was diverted at an average tipping fee of $100 per tonne, $15,500,000 in annual savings would be realized. In municipalities, it is often the case that tipping fees are paid by the municipality itself with costs blended into tax rates for residents; in these cases, direct savings are possible for municipalities.

Tipping fees are not a perfect indicator of organic waste management costs as they are often reflective of landfill operational costs and may not cover the true cost of landfill waste (capital expenses, closure/post closure expenses etc.). If organic waste makes up 30% of all waste, landfill operators may face difficulties operating with 30% less revenue from lost tipping fees. 100% diversion of organic waste is also, of course, highly unlikely. However, this serves as a starting point for stakeholders to consider expenses that could be used instead as investments in solutions that are more economically impactful and environmentally sustainable – such as the decarbonization of NL's surface transportation sector.

Policy Drivers

Canada's CFR were not the first national policy intervention to decrease the carbon intensity of fuels in the country.

The **Renewable Fuels Regulations** came into force in 2010. These standards required fuel producers and importers across Canada to have an average renewable fuel content of at least 5% based on the volume of gasoline that they produce or import[109]. NL has a permanent exemption from these regulations[110]; this exemption was linked with 'the generally poor extreme cold-weather performance of fuels containing some renewable fuels, limited logistical infrastructure for the distribution of fuels, limited supply options, and factors related to security of supply and availability of renewable fuel in these

[105] Eastern Regional Service Board - https://easternregionalserviceboard.com/residents/fees-and-payment/
[106] Central Newfoundland Waste Management - https://www.cnwmc.com/services/fee-schedule/
[107] Western Regional Waste Management - https://wrwm.ca/corner-brook-area/
[108] Report on Review of Provincial Waste Management Strategy - https://www.gov.nl.ca/releases/2020/mae/0129n08/
[109] https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/renewable.html
[110] https://stikeman.com/en-CA/kh/canadian-energy-law/2017/08/23/21/19/canada-requires-2-percent-biofuel-content-in-diesel-fuel-and-heating-oil-as-of-july-1

regions[111]', i.e., ethanol and biodiesel. Specifically there are concerns around the performance of biodiesel blends in cold-weather conditions experience within the province and the high prevalence of 'recreational' vehicle use (even in non-recreational / essential contexts) which would present issues for ethanol blends and their use in smaller engines. Small engines are more susceptible to water contamination and can performance and corrosion problems can result[112].

Beyond these regulations, individual provinces have taken additional steps that require fuel blending.

British Columbia established its 'low carbon fuel standard' in 2008 which adds an additional requirement on fuel suppliers to progressively decrease the average carbon intensity of their fuels to achieve a 10% reduction in 2020 relative to 2010[113].

Saskatchewan enacted regulations in 2007 establishing an ethanol fuel mandate. The standard requires fuel suppliers to blend their fuel to contain at least 7.5% ethanol for gasoline and 2% ethanol for diesel[114].

Manitoba enacted a regulation in 2007 that established a renewable fuel standard. The standard requires fuel suppliers in the province to blend their fuel to contain at least 8.5% ethanol for gasoline and 2.0% ethanol for diesel[115].

Ontario's Cleaner Transportation Fuels regulation requires that fuel suppliers blend 10% of renewable content in gasoline from 2020 to 2024. The renewable content requirement increases to 11% in 2025, 13% in 2028, and 15% in 2030 and onward. This renewable content must emit 45% fewer greenhouse gas emissions than fossil gasoline on a lifecycle basis before 2030, and 50% fewer from 2030 onward[116].

In **Quebec**, fuel blending requirements for conventional gasoline and diesel are included under the **Regulation Respecting the Integration of Low-Carbon Intensity Fuel Content into Gasoline and Diesel Fuel** (2021). Under this regulation, distributors must include an increasing percentage of low-carbon intensity fuel into gasoline, requiring 10%, 12%, 14%, and 15% by volume in 2023, 2025, 2028, and 2030, respectively. Similarly for distributors of conventional diesel, there is a low-carbon intensity fuel requirement of 3%, 5%, and 10% by volume for 2023, 2025, and 2030, respectively.[117] Under this regulation, qualifying low-

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[111] https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/revised-questions-answers-renewable-fuels/part-1.html
[112] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/ethanol
[113] https://www.c2es.org/document/canadian-provincial-renewable-fuel-standard/
[114] https://www.c2es.org/document/canadian-provincial-renewable-fuel-standard/
[115] https://www.c2es.org/document/canadian-provincial-renewable-fuel-standard/
[116] https://www.ontario.ca/page/cleaner-transportation-fuels
[117] https://www.legisquebec.gouv.qc.ca/en/document/cr/P-30.01,%20r.%200.1

carbon intensity fuels are those that are manufactured from organic material, waste materials, or carbon monoxide (CO) and CO_2.

While the motivations for these policy interventions may differ from GHG reductions to supporting the success of adjacent industries (i.e., agriculture, forestry), it does demonstrate that there is a precedent across Canada for making fuel blending a requirement.

Subsidies

There have been a number of funding programs in Canada to support the adoption of low-carbon fuels technologies in surface transportation. $5,000 rebates for the purchase of light-duty ZEVs (including FCVs) were paused in 2025 but reintroduced in 2026[118]. Direct subsidies for the purchase of medium and heavy-duty ZEVs up to $200,000 were available through the federal government's iMHZEV Program up until 2025[119]. Hydrogen-powered vehicles were eligible under this program. Funding was also available from 2016-2026 for ZEV infrastructure investments which included hydrogen fueling stations. While many of these programs have now been sunset, Canadian organizations and businesses can still benefit from an enhanced first-year capital cost allowance on the purchase of an eligible ZEV[120].

Partnerships

The considerations and supports above are relevant to different potential future actors in the adoption of low-carbon fuels within the surface transportation sector – from those with feedstock(s), to regional service boards, to project developers and fuel producers, to fuel suppliers and distributors, to municipal, provincial, and federal governments. All are likely to be involved in the low-carbon fuels adoption; there may be opportunities for strategic partnerships between these stakeholders to maximize the opportunity for low-carbon fuels adoption and to help the province realize the associated environmental, economic, and security benefits.

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[118] https://tc.canada.ca/en/road-transportation/innovative-technologies/electric-vehicles/electric-vehicle-affordability-program
[119] https://tc.canada.ca/en/road-transportation/innovative-technologies/electric-vehicles/incentives-medium-heavy-duty-zero-emission-vehicles?utm_campaign=tc-zev-hub-ongoing&utm_medium=doormat-link&utm_source=zev-hub-incentives-page-en&utm_content=imhzev-program-medium-heavy-duty-vehicles
[120] https://www.canada.ca/en/services/transport/zero-emission-vehicles/zero-emission-vehicles-incentives.html

Other Fuel Demands

Future low-carbon fuels demand in NL is not restricted to the surface transportation sector. For example, a recent discussion paper released by econext exploring decarbonization of the marine transportation sector within the province[121] points to expected future demand for RNG, biodiesel, renewable diesel, and methanol. According to research undertaken by econext[122], the demand for low-carbon fuels in the marine sector may be significant.

Moreover, there are significant fuel demands in heavy industry, electricity, and construction sectors which are also potential users of low-carbon fuels.

The above means there are a variety of potential domestic uses for low-carbon fuels produced in NL. As there are myriad fuel pathways for different available feedstocks, analysis will be required to determine what resources should be used for what purpose to maximise environmental, economic, and security benefits for NL.

Safety

The production, handling, transportation, storage, and use of different fuels presents different safety considerations. For example, hydrogen has high ignition energy and flame speed[123]. RNG would also present different considerations as natural gas is not used in NL and users would not be used to its characteristics. Each of these fuels (or their chemically identical conventional alternative) have been widely and globally used at scale safely for many years. Processes, procedures, and measures exist that allow for their safe use. However, as these fuels would be 'new' to NL, a degree of training and skills development would be required in advance of their domestic use. This is the subject of a future econext discussion paper.

Culture

Culture plays a role in the acceptance of different products and process. Those engaged in the adoption of low-carbon fuels have reported resistance to change from front line personnel. It is econext's experience that there is a very low level of understanding in NL on the important benefits that low-carbon fuels can yield. As the province has had an exemption from the Renewable Fuels Regulations, the concept of blended fuels is not

[121] https://econext.ca/discussion-paper-marine-transportation-decarbonization-in-newfoundland-and-labrador/
[122] https://econext.ca/discussion-paper-opportunities-for-domestic-clean-fuels-use-in-newfoundland-and-labrador/
[123] https://www.siemens-energy.com/global/en/home/products-services/solutions-usecase/sustainable-fuels.html#Hydrogen-tab-0

commonly known. Continued education, testing, and demonstrations are needed to demystify low-carbon fuels and the benefits that they can present to NL.

Fuel Blending and Testing Capabilities

Fuels can be blended in liquid, gaseous, or solid forms, with liquid blending being the most common.

Effective liquid blending often requires precise flow measurement, calibrated equipment, filtration, and sampling to manage risks such as phase separation, contamination, incorrect blend ratios, cold-weather gelling (particularly for biodiesel), corrosion, and clogging. Gaseous blending most commonly involves injecting hydrogen into natural gas pipelines, with blend limits determined by infrastructure constraints and safety considerations such as hydrogen embrittlement and energy density differences[124].

There are many different possible fuel blends with optimizations unique to their specific use cases and application. As industry is averse to affecting the integrity of their equipment, the safety of their employees, and the experience of its customers – risks to low-carbon fuels adoption must be mitigated to greatest extent possible.

To achieve this risk mitigation and enable the adoption of low-carbon fuels, adequate research and deployment capabilities in terms of equipment and personnel is required. The availability of accessible blending and testing equipment appears to be scarce. econext is undertaking work to delineate capabilities in Canada that can be leveraged and gaps that may need to be filled within NL to advance the adoption of low-carbon fuels.

6.2 Fuel Blending

Vehicles that run gasoline and diesel will be in use for a long time in NL, meaning that efforts to decarbonize these fuels can be meaningful and long-lasting. Fuel blending is a common practice elsewhere in Canada; in fact, fuel blending is mandatory in most parts of Canada.

Gasoline

Other parts of Canada require the blending of ethanol in gasoline. Blends of up to 10% are the most common, with movement towards 15% in some regions[125]. Total GHGs in NL in

[124] Forthcoming discussion paper from econext on Fuel Blending
[125] https://www.canadianfuels.ca/industry-facts/low-carbon-fuels/ethanol/

2024 from gas use in surface transportation is estimated to be 1,528 kt CO2e. These estimates are based on fuel volumes multiplied by 'emissions factors' that are attributed to the combustion of gasoline – or the CO2e that results from the combustion of 1 litre of gasoline. Canada applies an emissions factor of 2.307 for gasoline combustion[126]. Therefore, it can be roughly estimated that over 662 million litres of gasoline is burned for surface and off-road transportation in NL.

If NL were to adopt ethanol requirements, this could translate to 62 million litres of ethanol. This presents significant opportunity for local biofuel production, while also reducing the need for NL to import 10% of its gasoline requirements. Low-blend ethanol (like E10) made from wood or agricultural cellulosic materials would produce 6 to 8 percent fewer emissions compared with gasoline[127]. This would represent a GHG reduction of potentially over 120 kt CO2e per year, or 1.5% of all of NL's GHGs. Ethanol production contributes to regional economic growth and job creation in Canada, particularly in rural communities. There is great potential to capitalize on ethanol fuel because Canada (including NL) has the forest resources needed to support the production of ethanol feedstocks[128].

Most manufacturers of small engines, ATVs, snowmobiles, motorcycles, and outboard motors allow for the use of up to 10% ethanol-blended fuel in their products[129]. However, concerns in NL persist regarding ethanol blends and how they would impact performance and equipment, and these concerns will need to be addressed.

Diesel

Other parts of Canada require the blending of renewable fuels in diesel. Blends of 5% are required, with some jurisdictions requiring 10% and up to 20% being accepted. Total GHGs in NL in 2024 from diesel use in surface transportation is estimated to be 1,184 kt CO2e. These estimates are based on fuel volumes multiplied by 'emissions factors' that are attributed to the combustion of gasoline – or the CO2e that results from the combustion of 1 litre of diesel. Canada applies an emissions factor of 2.681 for diesel combustion[130]. Therefore, it can be roughly estimated that over 441 million litres of diesel is burned for on-road and off-road transportation in NL.

Biodiesel: There is an opportunity to decarbonize diesel use in NL's surface transportation sector through the blending of biodiesel with conventional diesel. At a conservative blend

[126] https://unfccc.int/sites/default/files/resource/NIR%20EN%202026.pdf
[127] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/ethanol
[128] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/ethanol
[129] https://www.gov.mb.ca/sd/environment_and_biodiversity/energy/pubs/ethanol_small_engines.pdf
[130] https://unfccc.int/sites/default/files/resource/NIR%20EN%202026.pdf

of B5 this would amount to over 22 million litres annually of biodiesel that could be blended. This presents significant opportunity for local biofuel production, while also reducing the need for NL to import 5% of its diesel requirements. Compared to diesel, while tailpipe CO2 emissions are similar, on a lifecycle basis biodiesel has the potential to reduce GHG emissions by over 80%[131]. Contextually, this would mean a reduction of 0.5% of all NL GHGs if the biodiesel was produced locally from materials that otherwise would have been discarded. Various biomass waste sources in NL would lend themselves well to biodiesel production – i.e., fisheries, aquaculture, agriculture. Reductions would be determined by the feedstock used in production, the production method, and the degree to which the biodiesel is blended with conventional diesel. Concerns around the use of biofuel blends in colder climates would need to be addressed.

Renewable Diesel: The use of renewable diesel can have a similar lifecycle impact from a GHG perspective as biodiesel, but as the fuel is chemically identical to conventional diesel it can be used as a direct replacement as at a much higher blend ratio. Compared to diesel, renewable diesel has the potential to reduce GHG emissions by up to 90% on a lifecycle basis[132]; reductions would be determined by the feedstock used in production, the production method, and the degree to which the renewable diesel is blended with conventional diesel. As renewable diesel can be blended at a much higher rate than biodiesel (up to 100%), the environmental benefits have the potential to be much more significant. To help put these quantities into context, the Braya Renewable Fuels plant in NL can produce up to 18,000 barrels per day of renewable diesel[133]; this translates to 2,861,771 litres per day. Assuming continuous production (365 days per year), the facility can produce over 1 billion litres per year; potential NL demand within the surface transportation sector represents approximately 45% of the facility's current production potential.

Triple Blend: An alternative is for NL's surface transportation sector to use a triple blend of conventional diesel, biodiesel, and renewable diesel at rates that could change over time. This would allow for some of the benefits of the use of low-carbon fuels to be accrued while doing so on an incremental basis to reduce risk and align with supply and/or cost constraints.

The above is an oversimplification of how supply and demand operates for transportation fuels in the real world in NL. Receipt and use of fuel is not centralized and there are various suppliers and distributors independently involved. Fuel blending requires technology and infrastructure that does not yet exist in NL. However, it is instructive in helping to understand the scale of the low-carbon fuels opportunity that exists.

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[131] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/biodiesel
[132] https://www.technoilogy.it/insights/sustainable-biofuels-2025-biodiesel-vs-renewable-diesel/
[133] https://brayafuels.com/

6.3 ZEV Adoption

While fuel blending can provide near term GHG and possibly economic development benefits that extend into the long term, the decarbonization potential has its limits. Biodiesel can only be used at a low blend rate[134]. Meanwhile, competition for biofuels and renewable fuels (and their feedstocks), and the reality that these fuels still produce GHGs at the tailpipe, means that other solutions are likely needed for the decarbonization of NL's surface transportation sector. There is likely a limit to what the volume of biofuels that can reasonably be produced in NL.

In the light-duty vehicle segment, it is expected that electrification (via BEVs and PHEVs) will be the dominant trend.

As noted in Section 3.1, in the heavy-duty and off-road vehicle segments it is expected that hydrogen-powered vehicles will play a role. National organizations like the Transition Accelerator advocate for jurisdictions to focus on ZEV adoption for heavy-duty vehicles versus biofuels and blending[135]. In the NL context, given that storage and refueling infrastructure exists for neither natural gas nor hydrogen at this time, it would be logical to focus on one of these technologies (and not both) for the future of heavy-duty transportation in the province.

In choosing between the two fuels, hydrogen has a supply advantage in that it is expected to be produced in the province by the early 2030s. Green hydrogen also features much lower lifecycle GHGs than natural gas or renewable natural gas, meaning the GHG reduction impacts for NL would be much greater.

Hydrogen-powered vehicles in the heavy-duty segment can include transport trucks, busses, tractors, dump trucks, concrete mixers, cranes, haulers and much more.

However, an important enabling condition for hydrogen-powered vehicles is access to refueling stations. Without the ability to refuel, transportation providers cannot consider adopting hydrogen technologies within their fleets. Therefore, investments into hydrogen refueling infrastructure are a requirement to advance this approach to surface transport decarbonization in NL.

[134] https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/biodiesel
[135] https://transitionaccelerator.ca/wp-content/uploads/2023/05/TA_Pathways-to-Net-Zero_Heavy-Duty-Vehicles-Table.pdf

6.4 Logistics

While the reduction of conventional gasoline and diesel use in existing transportation systems (via fuel blending or fuel-switching) is the primary focus of surface transportation decarbonization strategies, there are other options that can be considered which involve low-carbon fuels.

Distribution Channels – a unique partnership in Vancouver sees hydrogen-powered trucks being leased to fleet operators within ports in the movement of goods and shipping containers from ship to terminals and vice versa[136]. While not directly analogous to NL, significant freight arrives at ports in St. John's, Corner Brook, and Channel-Port-aux-Basques which are subsequently transported province-wide. Much of this transport is restricted to the island of Newfoundland and detached from long-haul transportation on the mainland. This could be considered to be a closed system that could be a driver of heavy-duty vehicle ZEV adoption.

Trains – The island of Newfoundland has no operational passenger or freight railways, following the closure of its last line in September 1988. Given that key ports are at each side of the island with the largest population centre being furthest away from mainland Canada, the absence of rail transportation is regrettable. Hydrogen-powered trains are commercially available and becoming more common globally, including within Canada[137]. If NL is to be a producer of green hydrogen, leveraging access to this clean fuel may present and opportunity to change the manner with which people and goods are transported within the province.

While these 'logistics'-based decarbonization possibilities are less direct and high in ambition, they may be worth further investigation.

7. Recommendations

The analysis undertaken in this discussion paper points to five next steps that should be taken in order to advance the adoption of low-carbon fuels within NL's surface transportation sector.

[136] https://blog.ballard.com/truck/fueling-port-of-vancouver-hydrogen-fuel-cells
[137] https://www.alstom.com/solutions/rolling-stock/alstom-coradia-ilint-worlds-1st-hydrogen-powered-passenger-train

7.1 Define best use cases for available biomass in NL and techno-economic feasibility of low-carbon fuels production

There are multiple fuel production pathways using locally available biomass that are relevant in the surface transportation context. Moreover, there are multiple different sources of biomass that each has their own characteristics influencing how they would be best used in fuel production. Lastly, there are other fuel demands that are expected to arise over time – particularly in support of marine transportation decarbonization and electricity generation. A techno-economic analysis is required to determine the best end uses at a provincial level for each of these organic waste materials (in addition to landfill gas) and the feasibility of low-carbon fuel production and adoption business cases. This study should include research identifying the best available commercial technologies that align with best use cases and the NL context, as well as consideration for the various supports and frameworks (i.e., ITCs, CRF, CER, waste diversion, etc.) that can impact economics.

7.2 Pursue opportunities for biofuel and renewable biofuel blends in conventional fuels

There are environmental and potentially economic benefits to be gained in NL from the blending of ethanol within its gasoline and biodiesel and renewable diesel within its diesel. These blends are standard across North America; policies and technologies may have advanced to allow for blending to be economically feasible within the province. All evidence points to the expectation that conventional fuels like gasoline and diesel are going to be prevalent in NL's transportation sector for many more years. Therefore, efforts to advance fuel blending will yield important environmental, energy security, and economic development benefits.

7.3 Invest in fuel blending and testing infrastructure

To overcome risk aversion with the adoption of new technologies, adequate research and deployment capabilities in terms of equipment and personnel is required. These capabilities must be relevant to the NL context and accessible. Blending and testing capabilities are understood to be few and difficult to access in Canada, presenting an opportunity for investment attraction. The testing of biodiesel, renewable diesel, and ethanol blends in real-world NL scenarios should be a priority – quantifying their impacts in order to better define problems that needs to be solved (or dispel myths).

7.4 Align provincial climate and energy strategy with domestic production capabilities

The fact that renewable diesel is already in production in NL should drive low-carbon fuels adoption decision-making in the near term as it is directly compatible with all of the existing generation assets and equipment. Meanwhile, if and when final investment decisions are made on hydrogen production projects in NL and development commences, this development should drive low-carbon fuels adoption decision-making in the medium and long term. Only when locally produced low-carbon fuels are used are the full benefits relating to environment, economy, and energy security realized.

7.5 Create a greater awareness of the benefits of fuel blending

The concept of blended fuels is not commonly known in NL. Where in other parts of Canada the blending of ethanol in gasoline and biofuels in diesel is commonplace, these activities have not taken place in NL. Continued education, testing, and demonstrations are needed to demystify low-carbon fuels and the benefits that they can present to NL – to ensure that its people are comfortable and ready to adopt these fuels when the time comes.

7.6 Invest in hydrogen refueling infrastructure

If and when final investment decisions are made on hydrogen production projects in NL and development commences, investments should be made into hydrogen refueling infrastructure for FCVs. Owners of on-road and off-road vehicles will not consider adopting hydrogen technologies unless the infrastructure exists to fuel them. The establishment of hydrogen refueling infrastructure can take place at a small scale initially to prove the concept with a smaller number of users and enable other early adopters. Demonstration-scale projects will prove the concept of hydrogen-powered vehicle use in NL and encourage broader adoption over time.

8. Conclusion

There are important benefits to be realized from the adoption of low-carbon fuels in NL's surface transportation sector: decreased GHGs; reduced air pollutants; increased energy security; the valorization of wasted biomass resources; and economic development and growth within NL. Further investment into techno-economic research, applied R&D, and demonstration projects in this space is required to advance the realization of these benefits.