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Railway Association of Canada

Locomotive Emissions Monitoring / Report

2024

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Executive Summary

INTRODUCTION

The Locomotive Emissions Monitoring Program (LEM) data filing for 2024 has been completed in accordance with the terms of the 2023–2030 Memorandum of Understanding (referred hereafter as "the MOU") signed on December 5, 2023, between the Railway Association of Canada (RAC) and Transport Canada (TC) concerning the emissions of greenhouse gases (GHGs) and criteria air contaminants (CACs) from locomotives operating in Canada. This is the second report prepared under the current MOU, though it is based on reporting for the LEM program governed by MOUs dating back to 1995.

2023–2030 MOU

In 2023, RAC and TC jointly announced a renewed MOU for reducing locomotive emissions, recognizing ECCC and NRCan as partners. This MOU reflects a shared vision of working toward net-zero emissions by 2050 and builds upon the meaningful progress made to date by the Canadian rail sector. TC, MOU partners, and RAC members agreed to work together to:

- advance low-carbon fuel use,
- move more goods and people by rail where possible,
- accelerate the development of advanced net-zero solutions for locomotives, and
- advance knowledge of climate risks to rail infrastructure and enhance climate resiliency of Canada's rail network.

As stated in the MOU, RAC will continue to encourage its members to reduce their GHG emissions intensity and CAC emissions from railway operations.

Reporting by RAC of CAC emissions as agreed under the MOU and included in this LEM report does not fulfil any member reporting requirements under the *Locomotive Emissions Regulations* (LER), which came into force on June 9, 2017.

The 2023 LEM Report introduced a methodological improvement over previous reports, as it introduced year-specific GHG emissions factors that account for the use of biofuels in the overall fuel mix used by locomotives. In earlier LEM reports, all fuel content was assumed to be fossil diesel fuel. The 2024 LEM report improves the methodology further, as RAC now collects locomotive biofuel consumption directly from the railways. Historical emissions factors and GHG emissions have been updated accordingly.

In 2024, the GHG emissions intensity (combustion emissions) of Canada's freight railways improved by 2.8% - largely attributed to the industry's increased use of biofuels. In 2024, CO_2e per litre of fuel (industry average mix of biofuels and diesel fuel) was 2.5% lower than in 2023, and 7.2% lower than 100%

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diesel fuel. Year over year, freight traffic (measured in revenue tonne-kilometres) increased by 3.1% and fuel consumption increased by 2.7%. There was almost no change (a 0.1% increase) in absolute GHG emissions, as improvements in fuel efficiency and lower GHG emissions factors nearly entirely offset increases in fuel consumption. The GHG emissions intensity of intercity passenger railways increased by 2.9% compared to 2023. A 6.4% increase in passenger-kilometres was outpaced by a relatively larger increase in fuel consumption and GHG emissions. However, the 2024 intercity passenger railway GHG emissions intensity was the second best on record and reflects an improvement of 33.9% from 2005.

In 2024, Canadian railways continued to invest in fleet modernization, acquiring higher-tiered locomotives and retiring non- and lower-tiered locomotives. Fleet modernization contributed to lower freight emissions intensities for NO_x, PM_{10} and HC. Because total traffic and fuel consumption increased, however, absolute CAC emissions rose modestly from 2023 while remaining substantially below 2005 levels.

Since the 2005 base year, GHG emissions intensities have been reduced by 25.4% (regional & shortline), 32.1% (Class 1 freight) and 33.9% (intercity passenger). Despite a significant growth in freight traffic since 2005, Canada's Class 1 freight railways (CN and CPKC) reduced their absolute GHG emissions by 10.7%. In the same period, absolute CAC emissions have been cut by 47.9% (NO_x), 62.2% (PM_{10}), 3.5% (CO), 56.1% (HC), and 98.9% (SO_2).

2024 RESULTS

2023–2030 MOU Progress - GHG Emissions Intensities

Railway Operation	Productivity Units	2005 Base Year	2022	2023	2024	Change from 2005–2024	Change from 2023–2024
Class 1 Freight	kg CO_2e per 1,000 RTK	17.06	12.10	11.87	11.58	-32.1%	-2.4%
Intercity Passenger	kg CO_2e per passenger-km	0.128	0.089	0.082	0.085	-33.9%	2.9%
Regional & Shortline	kg CO_2e per 1,000 RTK	16.80	13.71	13.55	12.54	-25.4%	-7.5%

Note: GHG emissions (combustion) for all years have been calculated based on IPCC Fifth Assessment Global Warming Potentials (CO_2: 1, CH_4: 28, N_2O: 265) and emissions factors that consider the mix of biodiesel, renewable diesel, and diesel fuel oil used in locomotives. Historical values have been updated.

2023–2030 MOU Progress - Class 1 Freight Railways' Locomotive GHG Emissions

		2005	2022	2023	2024	Change from 2005–2024	Change from 2023–2024
Locomotive GHG Emissions*	Kilotonnes of CO_2e	5,788.04	5,179.39	5,158.56	5,171.31	-10.7%	0.2%

*Includes CN and CPKC GHG emissions from locomotive operations in Canada.

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2023–2030 MOU Progress - Absolute CAC Emissions (kilotonnes, unless otherwise specified)

CAC Emission	2005 Base Year	2022	2023	2024	Change from 2005–2024	Change from 2023–2024
NO_x	126.50	66.30	64.65	65.95	-47.9%	2.0%
PM_{10}	3.41	1.32	1.27	1.29	-62.2%	1.4%
CO	15.43	14.12	14.39	14.90	-3.5%	3.5%
HC	5.78	2.60	2.50	2.54	-56.1%	1.5%
SO_2 (tonnes)	4,974.49	49.75	50.70	52.49	-98.9%	3.5%

Note: The table presents CAC emissions for total rail operations (including line haul freight, yard switching and work train, and total passenger train operations).

Freight Railway Traffic

	2023	2024	Change from 2023–2024
GTK (billion)	824.19	866.34	5.1%
RTK (billion)	444.56	458.21	3.1%
Intermodal Tonnage (million)	37.68	38.50	2.2%

- *Gross Tonne-Kilometres (GTK):* In 2024, Canada's freight railways handled 866.34 billion GTK compared to 824.19 billion GTK in 2023, representing a 5.1% increase. GTKs were 29.6% higher than in 2005, the reference year, having increased at an average rate of 1.4% per year.[1] In 2024, Class 1s accounted for 94.7% of total GTKs.
- *Revenue Tonne-Kilometres (RTK):* In 2024, Canada's freight railways handled 458.21 billion RTK compared to 444.56 billion RTK in 2023, representing a 3.1% increase. RTKs were up 29.8% compared to 2005, having increased at an average rate of 1.4% per year. In 2024, Class 1s accounted for 94.5% of total RTKs.
- *Intermodal Traffic:* In 2024, intermodal tonnage increased by 2.2% to 38.50 million tonnes from 37.68 million tonnes in 2023. Despite the increase, intermodal tonnage remained below recent (2017–2022) levels. Intermodal traffic was heavily impacted by several work stoppages throughout 2024.[2] Overall, intermodal tonnage comprising both container-on-flat-car and trailer- on-flat-car traffic for railways in Canada has risen 24.8% since 2005.

1 Growth rates are calculated using the compound annual growth rate (CAGR) formula.
2 See RAC's Rail Trends 2025, p. 20, for details.

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Passenger Railway Traffic

	Intercity Passengers (million)	Commuter Passengers (million)
2019	5.05	101.94
2020	1.15	22.75
2021	1.55	13.32
2022	3.36	27.83
2023	4.19	47.45
2024	4.46	58.21
Change from 2023-2024	6.5%	22.7%

- *Passenger Traffic:* In 2024, passenger rail traffic continued to rebound from the low ridership levels experienced during, and following, the COVID-19 pandemic. Despite these gains, ridership remained below 2019 (pre-pandemic) levels. Year over year, intercity rail ridership increased by 6.5% to 4.46 million passengers, yet remained down 11.7% from 2019. The number of commuters increased by 22.7% to 58.21 million, remaining 42.9% below 2019.

Fuel Consumption

	Million litres		Change from 2023–2024
	2023	2024	
Total	2,057.07	2,129.67	3.5%
Total Freight Operations	1,946.65	2,000.05	2.7%
Class 1 Freight	1,774.22	1,826.68	3.0%
Regional & Shortline	113.75	115.12	1.2%
Yard Switching and Work Train	58.68	58.26	-0.7%
Passenger Operations	110.41	129.61	17.4%

- Fuel consumed by railway operations in Canada increased by 3.5%, from 2,057.07 million litres in 2023 to 2,129.67 million litres in 2024.
- Of the total fuel consumed by all railway operations, Class 1 freight line-haul operations consumed 85.8% and regional & shortline line-haul operations consumed 5.4%. Freight yard switching and work train operations (including Class 1s and regional & shortlines) consumed 2.7%, and passenger operations accounted for 6.1%.
- Total freight operations consumed 2,000.05 million litres, a 2.7% increase from 2023 but 5.1% below 2005. In 2024, Canada's freight railways could move one tonne of freight 229.10 kilometres on just one litre of fuel.
- Total passenger operations consumed 129.61 million litres, a 17.4% increase from 2023, to service an increasing number of passengers.

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Active Locomotive Fleet

	2023	2024	Change from 2023–2024
Total Locomotives	4,249	4,306	1.3%
Line Haul Freight	3,417	3,428	0.3%
Class 1	3,138	3,133	-0.2%
Regional	150	151	0.7%
Shortline	129	144	11.6%
Freight Yard Switching and Work Train	567	600	5.8%
Passenger	265	278	4.9%
Intercity	86	99	15.1%
Commuter	157	157	0.0%
Tourist/Excursion	22	22	0.0%

The reported number of locomotives and diesel multiple units (DMUs) in active service in Canada operated by MOU signatory railways totaled 4,306 in 2024 versus 4,249 in 2023, an increase of 1.3%. The active fleet is reported as it existed on December 31st of each year. As the data represents the fleet on one particular day in the calendar year, significant year-over-year fluctuations are possible.

For line haul freight operations in 2024, 3,133 locomotives were operated by Class 1s, 151 by regional railways, and 144 by shortlines. An additional 600 locomotives were used in freight yard switching and work train operations. A total of 278 locomotives and DMUs were used in 2024 to support passenger railway operations in Canada, of which 99 were for intercity passenger services, 157 for commuter railway services, and 22 for tourist and excursion services.

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LOCOMOTIVES MEETING EMISSION STANDARDS

Investments in new and remanufactured locomotives continue to improve the emissions performance of the active fleet. In 2024, 88.9% of the active fleet met emission standards (as set out under the LER)[3] compared to 88.7% in 2023, and a notable improvement from 29.7% in 2005.

As per the locomotive inventory on December 31st, 2024, the active fleet increased by 57 locomotives compared to 2023. Across the active fleet, 23 new locomotives were added, 426 locomotives were remanufactured, and 63 were retired. 17 of the 23 added locomotives, and all 426 remanufactured locomotives, met an emission standard (including 14 new Tier 4s and 44 remanufactured Tier 4s). Most of the 63 retired locomotives either did not meet an emission standard or were lower-tier-level locomotives.

In 2024, 451 locomotives (10.5% of the total active fleet) met Tier 4 standards, an increase from 416 Tier 4 locomotives in 2023 (9.8% of the total active fleet).

LOCOMOTIVES EQUIPPED WITH ANTI-IDLING DEVICES

The number of locomotives in 2024 equipped with a device to minimize unnecessary idling, such as an automatic engine stop-start (AESS) system or auxiliary power unit (APU), was 4,011, which represented 93.1% of the fleet, which was similar to 2023 (3,960 locomotives, 93.2% of the fleet, equipped).[4]

Tropospheric Ozone Management Areas (TOMA)

TOMAs are geographically defined areas in which governments, stakeholders, and other interested parties work together to improve local air quality and manage air pollutant concentrations. Of the total GHGs emitted by the railway sector in 2024, an estimated 2.7% were emitted in the Lower Fraser Valley of British Columbia, 13.8% in the Québec City-Windsor Corridor, and 0.3% in the Saint John area of New Brunswick. Estimated CAC emissions for each TOMA were at the same ratios as GHGs.

3 The active fleet is reported as it existed on December 31st of each year, and reflects all locomotives classified as active on that date, not just those in operation. As the data represents the fleet on one particular day in the calendar year, significant year-over-year fluctuations are possible, and changes may reflect fleet acquisitions.

4 Ibid.

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1. Introduction

This report contains the Locomotive Emissions Monitoring (LEM) data filing for 2024 in accordance with the terms of the Memorandum of Understanding (MOU) signed on December 5, 2023, between the Railway Association of Canada (RAC) and Transport Canada (TC) concerning the emissions of greenhouse gases (GHGs) and criteria air contaminants (CACs) from locomotives operating in Canada.

In 2023, RAC and TC jointly announced a renewed MOU for reducing locomotive emissions. The 2023–2030 MOU is the fifth MOU signed by RAC and the federal government since 1995.

The MOU establishes a framework through which RAC, its MOU signatory member companies (as listed in Appendix A), and TC commit to address GHG and CAC emissions produced by locomotives in Canada. The MOU, which can be found on RAC's Website and the Government of Canada's website, includes several collaborative objectives.

This MOU reflects a shared vision of working toward net-zero emissions by 2050 and builds upon the meaningful progress made to date by the Canadian rail sector. TC and RAC members agreed to work together to:

- advance low-carbon fuel use,
- move more goods and people by rail where possible,
- accelerate the development of advanced net-zero solutions for locomotives, and
- advance knowledge of climate risks to rail infrastructure and enhance climate resiliency of Canada's rail network.

Transportation is Canada's second largest source of GHG emissions. In 2024, the transportation sector emitted 189 Mt of CO_2e, accounting for 27.6% of Canada's total GHG emissions (Figure 1).[5] The majority of transportation GHGs are attributed to on-road vehicles. Canadian railways accounted for 0.9% of Canada's total GHG emissions and 3.1% of transportation GHGs, which is less than light-duty on-road vehicles (41.4% of transportation GHGs), heavy-duty on-road vehicles (20.8%), pipelines (5.5%), aviation (4.3%), and several other transportation categories.[6]

In 2024, Canadian railways accounted for 0.9% of Canada's total GHG emissions and 3.1% of transportation GHG emissions.

5 Source: Canada's National Inventory Report, 1990–2024: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2026, Table ES-1 and Table 2-4.
6 Ibid.

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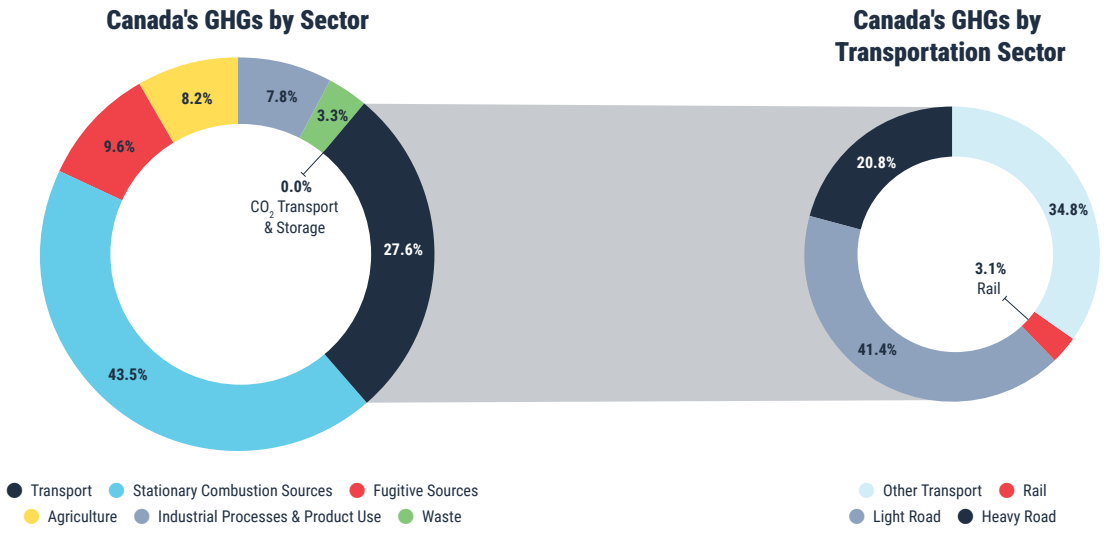
Figure 1: Canada's GHGs by IPCC Sector, 2024



Source: Railway Association of Canada analysis based on Canada's National Inventory Report, 1990–2024: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2026, Table 2-4.

Note: IPCC is the abbreviation for Intergovernmental Panel on Climate Change.

Note: Other transport includes aviation, motorcycles, propane & natural gas vehicles; marine; off-road transportation; and pipelines. Light road includes light-duty gasoline and diesel vehicles and trucks. Heavy road includes heavy-duty gasoline and diesel vehicles.

To meet Canada's commitment to reduce GHGs by 40-45 percent below 2005 levels by 2030, 45-50 percent below 2005 levels by 2035, and achieve net-zero by 2050, the transport sector must make a significant contribution. While each transport mode works to improve its efficiency, modal shift from truck to rail can be promoted to achieve immediate, significant reductions in total transportation sector emissions where feasible.

Figure 2 shows that rail accounts for about 60% of combined rail and heavy truck RTKs, but only about 15% of the associated GHG emissions, indicating that rail's GHG intensity per RTK is roughly one-tenth that of trucking.

Rail's GHG emissions intensity per revenue tonne-kilometre is roughly one-tenth that of trucking.

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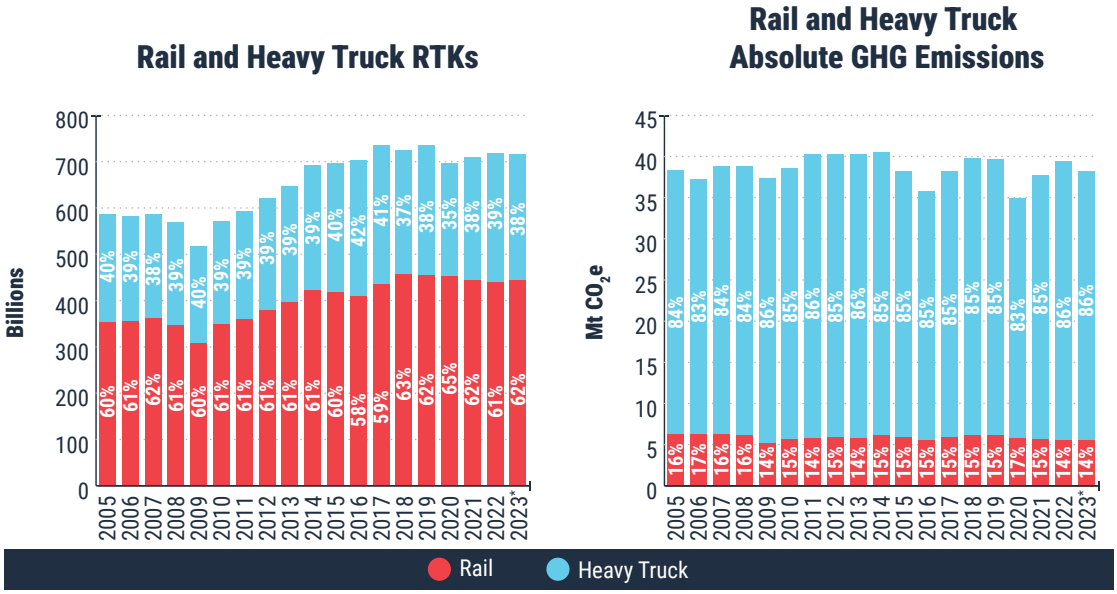
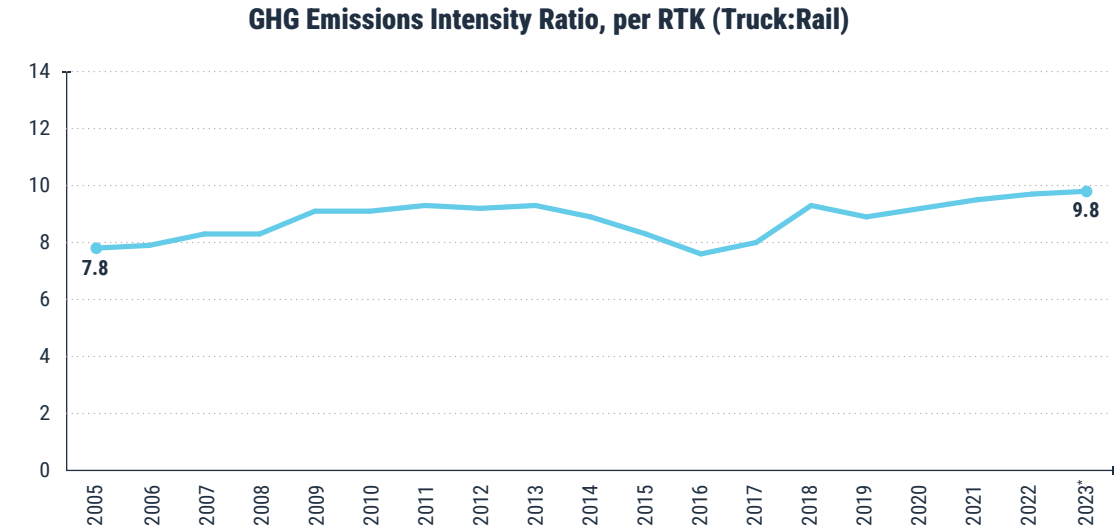
Figure 2: Rail vs Heavy Trucks - The Case for Modal Shift





* As of July 27, 2026, the 2024 data for heavy trucks were not yet available.

Note 1: Results are based on rail and heavy truck data (RTKs and GHGs). Other transportation modes are not included.

Note 2: Heavy truck RTKs and GHG emissions are sourced from Natural Resources Canada, Comprehensive Energy Use Database - Transportation Sector - Canada, Table 59. Available online: Transportation Sector – Canada | Natural Resources Canada

Figure 3 shows CAC emissions for railways and heavy-duty vehicles and buses. Despite railways moving greater volumes of traffic (as shown in Figure 2), in 2024, heavy-duty vehicles and buses emitted between 1.8 and 8.4 times as much of the selected CACs as railways, with the difference varying by pollutant.

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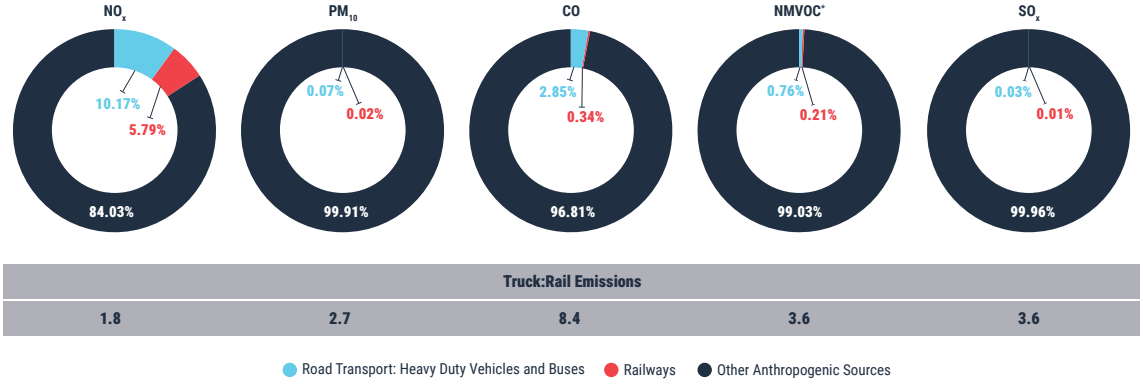
Figure 3: Canada's Rail and Heavy Truck Absolute CAC Emissions, 2024



Truck:Rail Emissions				
1.8	2.7	8.4	3.6	3.6

Road Transport: Heavy Duty Vehicles and Buses · Railways · Other Anthropogenic Sources

Note: Road transport: Heavy duty vehicles and buses represent NFR Code 1A3biii, and railways represent NFR code 1A3c.
Source: UNECE Canada 2026 Annex I - Emissions Report. (CA - 05.02.2024 - v1.0)
* Non-Methane Volatile Organic Compounds

Railways have played and will continue to play a key role in contributing to Canada's climate targets. Since 2005, freight railways have reduced their GHG intensity by 32.1%. During the same timeframe, railways have experienced a 29.8% increase in revenue traffic. Canada's Class 1 freight railways (CN and CPKC) have reduced their Canadian, absolute locomotive GHG emissions by 10.7%.

Passenger railways continue to invest in training, technology and equipment to reduce emissions, while contributing to emissions reductions by providing a sustainable transportation option for commuters and intercommunity travelers. Since 2005, intercity passenger railways have reduced their GHG intensity by 33.9%. Canada's railways will continue to contribute to national emissions reductions through investments in innovative solutions to increase efficiency and sustainability.

Continued emissions reductions will help protect the environment, the health of Canadians, and address climate change. This is the second report prepared under the 2023–2030 MOU.

Data for this report were collected via a survey sent to each RAC member. Based on these data, the GHG and CAC emissions produced by in-service locomotives in Canada were calculated. The GHG emissions in this report are expressed as carbon dioxide equivalent (CO_2e), the key constituents of which are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). CAC emissions include nitrogen oxides (NO_x), particulate matter (PM_{10}), carbon monoxide (CO), hydrocarbons (HC), and sulphur oxides (SO_x). The SO_x emitted is a function of the sulphur content of diesel fuel and is expressed as SO_2. The survey and calculation methodology are available upon request to RAC.

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1.1 OVERVIEW OF REPORT

This report provides an overview of 2024 rail performance including traffic, fuel consumption, the locomotive fleet inventory, and GHG and CAC emissions. Also included are sections on partnerships and initiatives being undertaken or examined by the sector to reduce fuel consumption and emissions.

1.2 GHG COMMITMENTS

As stated in the MOU (Section 4.0 Reducing Greenhouse Gas Emissions), RAC encourages its members to improve their GHG emissions (combustion emissions) intensity from railway operations. The 2005 baseline, 2022, 2023, and 2024 data on annual emissions (expressed as kilograms of CO_2e per productivity unit) are outlined in Table 1.

For historical comparison purposes and alignment with the Government of Canada's 2030 Emissions Reduction Plan (ERP), the year 2005[7] has been set as the reference year. The 2023 LEM Report methodology introduced year-specific GHG emissions factors that account for the use of biofuels in the overall fuel mix used by locomotives. In earlier LEM reports, all fuel content was assumed to be diesel. The 2024 LEM report improves the methodology further, as RAC now collects locomotive biofuel consumption directly from the railways (see Appendix I). The division of total biofuel between biodiesel and renewable diesel is based on total provincial volumes of biofuels published by Advanced Biofuels Canada in the *"Biofuels in Canada 2025"* report. Historical emissions factors and GHG emissions have been updated accordingly. Readers should use the data in this report rather than in previous editions of the LEM, including when referencing historical years, as this report incorporates the latest available information and any revisions to previously reported data. Unless otherwise specified, metric units are used and quantities are expressed to two significant figures, while percentages are expressed to the number of significant digits reflected in the tables. Data in imperial units are available upon request to RAC.

In addition, this report contains data on fuel consumed and emissions produced by railways operating in three designated Tropospheric Ozone Management Areas (TOMA): the Lower Fraser Valley in British Columbia, the Québec City-Windsor Corridor, and the Saint John area in New Brunswick.

Table 1: 2023–2030 MOU Progress - GHG Emissions Intensities

Railway Operation	Productivity Units	2005 Base Year	2022	2023	2024	Change from 2005–2024	Change from 2023–2024
Class 1 Freight	kg CO_2e per 1,000 RTK	17.06	12.10	11.87	11.58	-32.1%	-2.4%
Intercity Passenger	kg CO_2e per passenger-km	0.128	0.089	0.082	0.085	-33.9%	2.9%
Regional & Shortline	kg CO_2e per 1,000 RTK	16.80	13.71	13.55	12.54	-25.4%	-7.5%

Note: GHG emissions (combustion) for all years have been calculated based on IPCC Fifth Assessment Global Warming Potentials (CO_2: 1, CH_4: 28, N_2O: 265) and emissions factors that consider the mix of biodiesel, renewable diesel, and diesel fuel oil used in locomotives. Historical values have been updated.

7 Starting with the 2020 LEM Report, 2005 has been set as the reference year, as it aligns with the Government of Canada's climate targets, among other merits. In previous reports, 1990 was set as the reference year.

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1.3 CAC COMMITMENTS

TC developed regulations to control CAC emissions under the *Railway Safety Act*. The *Locomotive Emissions Regulations* (LER) came into force on June 9, 2017, and apply to federally regulated railways.[8] The Canadian regulations are aligned with the United States Environmental Protection Agency (US EPA) emissions regulations (*Title 40 of the Code of Federal Regulations of the United States, Part 1033*).

Prior to the implementation of the Canadian regulations, RAC encouraged all members to conform to the US EPA emission standards and to adopt operating practices aimed at reducing CAC emissions. Under the MOU, RAC continues to encourage its members (Section 5.0 Reducing Criteria Air Contaminant Emissions), including those not covered by the LER, to improve their CAC emissions performance. Through this MOU, RAC continues to report on annual CAC emissions, in a manner and format that is agreeable to all parties. It should be noted that CAC reporting under the MOU does not fulfill reporting requirements under the LER.

Table 2: 2023–2030 MOU Progress - Absolute CAC Emissions (kilotonnes, unless otherwise specified)

CAC Emission	2005 Base Year	2022	2023	2024	Change from 2005–2024	Change from 2023–2024
NO_x	126.50	66.30	64.65	65.95	-47.9%	2.0%
PM_{10}	3.41	1.32	1.27	1.29	-62.2%	1.4%
CO	15.43	14.12	14.39	14.90	-3.5%	3.5%
HC	5.78	2.60	2.50	2.54	-56.1%	1.5%
SO_2 (tonnes)	4,974.49	49.75	50.70	52.49	-98.9%	3.5%

Note: The table presents CAC emissions for total rail operations (including line haul freight, yard switching and work train, and total passenger train operations).

8 Baseline and some historical CAC performance reflected in this report predates the *Locomotive Emissions Regulations* for CACs. The *Locomotive Emissions Regulations* came into force on June 9, 2017. https://laws-lois.justice.gc.ca/PDF/SOR-2017-121.pdf

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2. Emissions Reduction Initiatives

Rail is a highly capital-intensive industry. Each year, Canada's railways invest billions of dollars in improved operating practices, new technologies, equipment and infrastructure to enhance emissions performance and advance other objectives, including safety and service quality. In 2024, railways invested $4.5 billion in their Canadian networks, bringing the total to $35.5 billion over the past decade. This section of the report highlights how Canadian railways continue to drive emissions reductions through investments in fleet renewal/modernization, fuel saving technologies, operational efficiencies, and use of low-carbon fuels. In addition, pilot projects and various partnerships that reduce emissions and advance low- and zero-emission technologies are discussed.

Continued investments in key areas outlined above support the decoupling of emissions from traffic growth. At this point, there is no clear one-size-fits-all solution to rail decarbonization; pathways may vary depending on geography, operational requirements, infrastructure, and other considerations. Collaboration among railways, equipment manufacturers, fuel producers, government, and others is critical to developing and deploying deep decarbonization solutions.

Note that company- and organization-specific initiatives described in *Section 2 Emissions Reduction Initiatives*, may use scopes, baselines or units that differ from those used elsewhere in the LEM Report.

2.1 FLEET RENEWAL/MODERNIZATION

Fleet renewal/modernization is a key driver of locomotive emissions reductions.

In 2024, CN received a delivery of 83 modernized units out of a multiyear modernization program, where existing locomotives from the CN fleet are upgraded with the latest technology, extending their life and enhancing fuel efficiency. All new and modernized locomotives are equipped with energy management systems, data telemetry systems as well as distributed power functionality to help maximize locomotive operating effectiveness and fuel efficiency.

In 2024, CN received a delivery of 83 modernized locomotives.

Since 1993, CN has reduced its rail locomotive GHG intensity by 48% and remains a leader in fuel efficiency in the North American rail industry, consuming approximately 15% less locomotive fuel per gross tonne-kilometre (GTK) than the industry average.

In 2024, CN spent approximately $3.5 billion in its capital program, of which approximately $800 million was on rolling stock, including the acquisition of 750 new grain hopper cars. Through this multiyear initiative, CN has acquired a total of 4,250 new high-capacity grain hopper cars, which save fuel as the cars enable more volume per train.

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CPKC implements strategic investments in its rail network, equipment and locomotive fleet through its annual capital program to improve the fuel efficiency of operations. Locomotives upgraded through this program have a direct and positive impact on CPKC's fuel efficiency and corresponding GHG and air pollutant emissions. Supported by these investments, CPKC recorded a 2024 fuel efficiency of 1.033 U.S. gallons of locomotive fuel per 1,000 GTM. CPKC continues to advance climate-related initiatives, including efforts to reduce locomotive fuel consumption and enhance operational performance.

In 2024, CPKC remanufactured 127 locomotives.

In 2024, CPKC invested $346M to renew depleted assets, encompassing $335M in locomotive upgrades and $11M in rail car improvements, including the acquisition of new freight cars and remanufacturing of 127 tiered locomotives in its fleet.

Following the completion of a multi-year fleet renewal initiative in 2022, CPKC had 5,900 new high-capacity grain hopper cars operating across its network, replacing its legacy grain hopper fleet. The capacity improvements associated with this project have enabled CPKC to grow Canadian grain products shipments. Based on the successful implementation in Canada, CPKC expanded the program to the U.S. in 2023 by launching and landing its first 8,500-foot train in the U.S. CPKC plans to continue expanding use of its 8,500-foot High Efficiency Product (HEP) trains across the network. 49 percent of CPKC's origin facilities were upgraded to HEP trains by the end of calendar year 2024, with 61 percent expected to be upgraded by the end of 2027.

In 2024, VIA Rail secured the funding for the replacement of its long-distance, regional, and remote (LDRR) fleet—trains that connect communities across Canada. Given the age of VIA's LDRR equipment, this investment ensures that VIA Rail continues to serve Canadians in every region. By the end of the year, VIA Rail launched a Request for Qualifications process to engage providers for 313 new cars and 42 Tier 4 locomotives, marking the beginning of the largest fleet renewal in VIA Rail's history.

In 2024, VIA Rail launched a Request for Qualifications process to engage providers for 313 new cars and 42 Tier 4 locomotives, marking the beginning of the largest fleet renewal in VIA Rail's history.

The transformation also extended to the rollout of VIA Rail's new fleet in the Québec City-Windsor corridor, with a new train set arriving each month. One of the highlights of the year was the official launch of these trains in Southwestern Ontario, in London and Windsor.

West Coast Express (WCE) continued to progress on upgrading six of its locomotives from Tier 0 engines to Tier 2+ (Tier 3 equivalent). In 2024, two additional units were upgraded (bringing the total to four), of which one was put into service, and one was set for commissioning. WCE expects to ship the 5th unit for refurbishment in summer 2026. Once these refurbishments are complete, CAC emissions should be reduced by 48 per cent, based on U.S. EPA standards.

In 2021, exo awarded a contract to replace 10, aging Tier 0+ F59PH locomotives with locomotives that meet Tier 4 emission standards. Work progressed throughout 2024 and all units are expected to enter service before the end of 2026.

In 2024, exo initiated plans to refurbish 11 F59PHi locomotives. The first overhauled locomotive is anticipated to enter service in 2026.

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2.2 FUEL SAVING TECHNOLOGIES

Fuel saving technologies, several of which use big data and AI, reduce fuel consumption for a given movement. These technologies drive fuel efficiencies by optimizing train settings, horsepower-to-tonnage ratios, distributed power, train speeds, train pacing, braking, and anti-idling.

CN and CPKC are using Energy Management Systems (EMS) such as Trip Optimizer™ to improve both fuel economy and train handling. These systems can operate the train using real-time GPS positioning, terrain mapping, speed restrictions and detailed train characteristics to run as efficiently as possible.

CPKC enhanced its use of Trip Optimizer systems in 2019 to include pacing technology to drive deeper fuel efficiency and system fluidity improvements. Pacing technology accounts for a specific train's location in relation to other trains operating within the same area of the network. The system detects opportunities to reduce train speed in certain areas along the right-of-way to minimize wait times at stations, thus facilitating continued progression at the optimum speed to deliver on time, in the most fuel-efficient manner possible.

CN continues to explore and invest in innovative technologies to maximize locomotive operating effectiveness and efficiency. This includes collecting data and installing new locomotive technologies such as EMS, locomotive telemetry systems, and anti-idling devices. CN's in-house-built Horsepower Tonnage Analyzer (HPTA) also instructs crews on how to optimize the train power utilization to minimize fuel consumption. Distributed Power is used to remotely control locomotives and improve braking performance, train handling and fuel efficiency.

Pursuing efficiency improvements remains a top priority for VIA Rail, as efficiency gains will assist in reducing the burden of decarbonization of fuels and propulsion technologies. Among other things, VIA Rail continued to explore how to minimize traction energy consumption and maximize onboard energy efficiency. In 2024, VIA Rail continued to test an artificial intelligence-powered application that provides recommendations for fuel-efficient train handling.

2.3 OPERATIONAL EFFICIENCIES

In 2024, CN continued to leverage real-time information on train operations, enabling on-the-job guidance on practices that reduce fuel consumption. Capacity upgrades, including lengthening sidings and doubling sections of mainline track, allow CN to drive fluidity in its busiest corridors, improving fuel and carbon efficiency.

In 2024, CN's commitment to a disciplined scheduled operating plan, with a focus on velocity, helped to quickly restore network fluidity following impacts from labour disruptions and cold weather operations in Western Canada, maintaining gains in fuel efficiency.

CPKC leverages a precision scheduled railroading (PSR) operating approach. PSR focuses on operational efficiency including fuel efficiency metrics to drive performance improvements. CPKC has also established a Fuel Center of Excellence to integrate fuel data monitoring and operational data and implement changes in work practices to improve fuel efficiency. CPKC's Hypermiler program recognizes locomotive engineers who use their railroading expertise to maximize fuel savings and reduce excess fuel burn.

CPKC – What is a Hypermiler?
LEARN MORE

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2.4 LOW-CARBON FUELS

Throughout the 2023-2030 MOU period, low-carbon fuels will be a key driver of GHG emissions reductions. The MOU commits the parties to explore the feasibility of achieving 10 to 20% of low-carbon fuels use within the rail sector by 2030. However, this is dependent on fuel availability at competitive costs.

Railways currently make use of renewable fuels, including biodiesel blends and hydrogenation-derived renewable diesel (HDRD) blends. North American engine manufacturers generally endorse a B5 biodiesel blend and higher blends for testing or for use in specific engines. Some important caveats to note include:

- the energy density of biodiesel and renewable diesel varies depending on feedstocks used, and is slightly lower than that of diesel fuel;
- railways do not always have visibility on blend levels since fuel providers are not required to disclose exact blend levels; and
- locomotive performance may be adversely impacted with renewal fuel content above approved blend levels and manufacturer warranties may be voided.

Canadian railways continue to work collaboratively with a variety of partners to explore the opportunities and challenges of increasing the use of low-carbon fuels in locomotives. See Section 2.6 Partnerships for more details.

CN and CPKC collaborated with their partners, including locomotive manufacturers, fuel producers, and other Class 1 railways, to advance testing of renewable fuels in railway operations. These trials will allow railways and industry to better understand the operational impacts of advanced blends of renewable fuels, including long-term durability, especially in cold weather, and any modifications, if necessary, to increase their usage over the next decade. In 2024, trials and qualifications on CN's existing locomotive fleet of up to 100% renewable fuel blends continued to progress. In 2023, a three-year (mid-2023 through 2026) renewable fuel trial was launched in British Columbia – operating 10 of CPKC's locomotives fueled by a blend of 20 percent biodiesel and conventional diesel (B20). During 2024, CPKC successfully conducted more than 1,100 fueling events and fueled over eight million litres of B20 locomotive biofuel.

In 2024, CN increased its use of renewable fuels to close to 10%.

In 2024, CN significantly increased its use of renewable fuels, which represented close to 10% of its locomotive fuel in the year.

VIA Rail's new fleet recently introduced in the Québec City–Windsor corridor is designed to accommodate higher blends of low-carbon fuels (above 5%), offering greater flexibility in the fuel mix as VIA Rail progresses on decarbonizing its operations.

In 2024, exo went out to tender for the supply of diesel for its locomotives from 2025. The contract requires a minimum of 5% of biodiesel during the warmer months.

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2.5 ALTERNATIVE PROPULSION

Since 2020, CPKC has been developing North America's first line-haul hydrogen-powered locomotive. CPKC's engineering and mechanical experts are leading this program to research, develop and test the conversion of existing diesel-powered units into hydrogen-electric locomotives. CPKC's program is intended to spur innovation, demonstrate leadership and encourage collaboration to expedite the advancement of zero-emission fuel cell technology for the freight rail sector.

In 2024, CPKC expanded its hydrogen locomotive fleet to three locomotives and deployed hydrogen production and refueling facilities at rail yards in Calgary and Edmonton.

CPKC continues to make meaningful progress on its Hydrogen Locomotive Program. Through this initiative CPKC is retrofitting diesel-electric locomotives with hydrogen fuel cells and battery technology to drive the locomotive's electric traction motors. In 2024, CPKC's hydrogen locomotive fleet was expanded to include three hydrogen-powered locomotives. Also, CPKC together with ATCO EnPower commissioned hydrogen production and refueling facilities at CPKC rail yards in Calgary and Edmonton. Each facility includes a 1-megawatt (MW) electrolyzer, compression, storage and dispensing system for locomotive hydrogen refueling. The Calgary electrolyzer is powered in part by renewable electricity from CPKC's existing 5 MW solar power facility co-located at CPKC's headquarters. In September 2024, CPKC's first line-haul locomotive completed its first phase of testing as part of a fully loaded bulk train from Sparwood to Golden, B.C. More information on CPKC's Hydrogen Locomotive Program is available at cpkcr.com/sustainability.

In 2021, CN announced the purchase of a Wabtec battery-electric freight locomotive, the first 100% battery heavy-haul locomotive in support of CN's long-term goals. The anticipated efficiencies and emission reductions from this technology are expected to be significant and will help open the door to new alternatives beyond the diesel-powered locomotives used today. In 2024, design of the locomotive and of the method of charging continued to progress. CN also engaged in discussions with the electricity provider and undertook engineering work to assess the necessary infrastructure changes to deliver power.

In 2024, CN announced the purchase of a plug-in hybrid mainline locomotive, a first of its kind in North America, which will be tested on CN's mainline in British Columbia. The testing of this locomotive will increase CN's knowledge of battery technology (which is used in different alternative propulsion options, such as hydrogen fuel cell locomotives, for example) under varying operational and weather conditions. CN expects to receive the locomotive in 2026.

Over the long term, VIA Rail will prepare to adapt and deploy alternative propulsion technologies, such as electrification via battery or catenary systems, hydrogen fuel cells, or another technology. VIA Rail has also identified grid decarbonization, energy retrofits, operational efficiency and the transition to zero-emission vehicles as main decarbonization levers to achieve its climate goals.

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As Metrolinx advances capital programs and looks to future operations, there will be the introduction of electric light rail vehicles on the Finch West, Eglinton Crosstown, Hazel McCallion and Hamilton lines, all of which will improve emission intensity as more people travel across the region with greener modes of transit.

- In 2024, the Eglinton Crosstown Light Rail Transit (ECLRT) project continued advancing through operational readiness and training activities in collaboration with the Toronto Transit Commission (TTC) operations team. Continuing on the 2023 Train-the-Trainer activities, all 76 Light Rail Vehicles (LRVs) remained stationed at the Eglinton Maintenance and Storage Facility (EMSF), with key milestones completed in preparation for revenue service.
- The Finch West Light Rail Transit (FWLRT) project continued progressing through the commissioning and testing phases in 2024. All 18 Light Rail Vehicles (LRVs) had been commissioned by year end, followed by the initiation and advancement of system integration testing. These activities represented key milestones toward operational readiness and future revenue service.
- The Hazel McCallion Light Rail Transit (HMLRT) project continued with the manufacturing of Light Rail Vehicles (LRVs) at the Alstom production facility. Similarly, the Hamilton LRT project remained in the early stages of capital project planning, with no major change in project phase compared to the previous year.

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2.6 PARTNERSHIPS

Partnerships between and among industry, governments, academia, and others will play a critical role in developing policy and technological solutions for continued decarbonization of the rail sector in Canada.

TC - Audit of the LEM Report and Process

In 2024, TC commissioned Niewe Consulting to perform a third-party verification of the reporting for the 2021 LEM report. The audit examined data sources, collection methodologies, and reporting related to the locomotive inventory and activity data, the GHG emission intensity data, GHG and CAC emission data, and fuel consumption data. The audit found that all collaboration goals as outlined in the MOU were achieved; that the 2021 LEM report met all MOU requirements; and the quality assurance process and methodology for LEM data collection, processing and aggregation contributed to accurate reporting. The audit also identified opportunities for continuous improvement, which resulted in improvements to facilitate technical review and better leverage the LEM report data to develop actionable insights.

TC - Rail Decarbonization Workshop

In February 2024, TC and Change Energy Services hosted a workshop to explore the conditions required to enable the sector's decarbonization by mid-century. Workshop participants identified and characterized near-term opportunities and long-term challenges to decarbonization, covering needs across areas such as technology, infrastructure, and pricing.

TC - Energy-Economy Analysis

TC built upon 2023 work from ECCC and Navius Research Inc. to continue modeling rail decarbonization under several policy scenarios to better understand costs, technological choices, and emission reduction trajectories. In the scenarios modelled, biofuels emerged as the most economical pathway to reduce emissions.

TC - Engagement with the U.S.

In 2024, TC continued to engage with the U.S. Department of Energy and U.S. Federal Railroad Administration to advance common objectives on emerging rail technologies. This included sharing information through existing platforms, advancing efforts to research and test the safe integration of new technologies (e.g., low-carbon fuels, alternative propulsion systems, etc.), and developing a Canada-U.S. rail model.

Transport Canada and High Frequency Rail Project

The Government of Canada's High Speed Rail (HSR) initiative will transform intercity passenger rail in the Quebec City to Toronto Corridor, bringing faster, more frequent, and reliable service to travelers.

Budget 2024 provided $371.8 million over six years, starting in 2024-25, for the Co-Development Phase of the initiative, during which Alto will work with the private developer partner to advance the design and development of high-speed rail.

The HSR initiative supports many priorities of the MOU, including the vision for green and innovative transportation in Canada, and an improvement in the GHG and CAC emissions intensity of the rail sector. This will be achieved primarily through the electrification of HSR and inducing a modal shift from cars to passenger rail for travel in the Corridor.

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Natural Resources Canada - Lignin-Derived Diesel Fuel

Through Natural Resources Canada, CanmetENERGY-Ottawa completed a project in Fall 2022 to develop a process to produce lignin-derived diesel fuel as a potential drop-in low-carbon biofuel. Lignin is present in softwoods, hardwoods, grasses, and other plants. It is a waste product as a residue from chemical pulp mills and from agriculture that can be converted into a drop-in replacement for diesel. Results to date have demonstrated that 100% lignin-derived diesel met 9 locomotive diesel specifications from CGSB-3.18-2010 and the same 9 from CGSB-3.517-2020.[9]

The low cloud point of 100% lignin-derived diesel (-36 °C by ASTM D5773) indicates that it has fairly good low-temperature operability. The specifications not met were for electrical conductivity, lubricity, and derived cetane number. These properties could be brought to standard by using fuel additives that are commonly used in ultra-low sulphur diesel, and a cetane enhancer additive that would boost the ignition quality of 100% lignin-derived diesel (from 39.1 to 40). These results indicate that the lignin-derived diesel that was produced is suitable for use in diesel locomotives at any blend up to and including 100% and would be compatible with existing infrastructure. NRCan has licensed this technology to CRB Innovations for further scale-up.

Natural Resources Canada - Hydrogen Strategy

Natural Resources Canada released Canada's Hydrogen Strategy in 2020. The strategy aims to position Canada's ports as hosts for early deployment hubs of fuel cell equipment, with marine, rail, and on-road vehicles that could share hydrogen infrastructure at scale. The Hydrogen Strategy Progress Report[10] highlights major developments across the hydrogen value chain from 2021–2024. Companies such as CPKC and Alstom are exploring hydrogen rail demonstration.[11]

Transport Canada - Innovation Centre

Transport Canada's Innovation Centre undertakes research and development activities to support the rail industry in overcoming technical challenges and building knowledge about how to operate new technologies safely.

TC Innovation Centre - Clean Rail Research, Development, and Demonstration

In 2024, the Clean Rail RD&D research stream focused on facilitating the adoption of power sources such as hydrogen and battery electricity, or fuels with lower carbon intensity than petroleum diesel.

In 2024, Innovation Centre's Clean Rail RD&D research stream produced the following products:

1. Technical specifications covering safety guidance and design recommendations for hydrogen fuel cell locomotives and lithium-ion battery locomotives produced by CSA Group. Transport Canada is working with industry to continue to refine these specifications and exploring how they can be leveraged to mitigate the unique risks these locomotives have.
   - CSA TS-601:24 - Hydrogen Fuel Cell Power Systems for Rolling Stock,
   - CSA TS-602:23 - Onboard Lithium-ion Traction Batteries

9 In September 2021, the CAN/CGSB-3.18-2010 standard was withdrawn, and standard CAN/CGSB-3.517-2020 may be used for applications that were formerly covered by CAN/CGSB-3.18-2010.

10 Hydrogen Strategy for Canada: Progress Report, Natural Resources Canada.

11 Alstom's Coradia iLint, the world's first hydrogen-powered passenger train, will demonstrate green traction in Quebec. https://www.alstom.com/press-releases-news/2023/2/alstoms-coradia-ilint-worlds-first-hydrogen-powered-passenger-train-will-demonstrate-green-traction-quebec

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2. With Innovation Centre's support, CSA Group published a Standards Research Paper about the strengths and gaps in existing standards for hydrogen fuel cell locomotives and lithium-ion battery locomotives. This report helps Transport Canada and the rail industry identify where the greatest unknowns about risk and operational viability are so that research efforts can be prioritized.
   - Advancing the Use of Hydrogen and Electrification in the Rail Industry
3. A system-by-system qualitative risk assessment conducted by the National Research Council of Canada. This risk assessment examines and divides a reference hydrogen and battery locomotive into its systems, sub-systems and components to understand, identify, and classify the individual risks. Examined within are:
   - the automatic safety system, the fuel cell system (FCS),
   - the battery system, the control units,
   - the thermal management system,
   - the fuel supply (on board), and
   - the fuel dispensing system (ground equipment).
   - Hydrogen and Battery Locomotive Risk Assessment -Companion Report - Federal Open Science Repository of Canada
4. Transport Canada and the National Research Council of Canada also produced a report that summarizes the different types of batteries that could be used in the design of a battery powered locomotive and compiled literature about the ways lithium-ion batteries fail.
   - Technical report: Battery Electric Locomotives - Federal Open Science Repository of Canada
5. Transport Canada and the National Research Council of Canada produced a report documenting laboratory testing of a small-scale hydrogen-diesel combustion engines to investigate upper limits of hydrogen replacement for diesel in the mixture and the impact on criteria air contaminant emissions.
   - Literature Review and Experimental Testing of Hydrogen/Diesel Blends for Heavy-Duty Compression Ignition Engines Operating at Typical Locomotive Engine Load Conditions
6. Canadian Nuclear Laboratories conducted semi-quantitative and quantitative risk assessments of failure modes in hydrogen fuel cell locomotives. Key activities included a literature review on hydrogen locomotives and risk assessment methods, industry engagement to identify system configurations, and a comprehensive evaluation of hazards associated with hydrogen-containing systems.
   - Hydrogen Risk Assessment and Hazard Analysis for Rail Applications
7. Transport Canada and Southern Railway of British Columbia evaluated canola-based B100 biodiesel in a freight locomotive during winter conditions. The evaluation identified that the fuel remained effective down to approximately −12 °C with no adverse effects, while also highlighting considerations related to fuel supply consistency and cold-weather handling for wider implementation.
   - Viability of 100% Biodiesel (B100) in a Locomotive at mild sub-zero temperatures - Federal Open Science Repository of Canada

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Projects undertaken by Innovation Centre are selected through a consultation process that includes recommendations from federal government, academia, and the railway industry. The main forum for this consultation is the Rail Research Advisory Board. The Rail Research Advisory Board was created by Transport Canada in 1989.

TC Innovation Centre - Climate Change Adaptation Research

Transport Canada's Innovation Centre has a long history of conducting and facilitating research into natural hazards. This research has focused on monitoring how natural hazards are changing because of influences from climate change and helping railway companies evolve their strategies to mitigate them. Initiatives in this area include the Railway Ground Hazard Research Program and the Rail Climate Change Adaptation program. This theme has also been supported through Transport Canada's Innovation Centre's own research and development work.

RAILWAY GROUND HAZARD RESEARCH PROGRAM

Established in 2003, the Railway Ground Hazard Research Program (RGHRP) draws upon the resources of CN, CPKC, the University of Alberta, University of Saskatchewan, École de technologie supérieure (ÉTS), and Transport Canada. This group collaborates on research that produces a better understanding and management of ground hazard risks in the Canadian railway industry. The network of researchers also includes Natural Resources Canada via the Geological Survey of Canada.

The members of this program work together in the spirit of shared values for continuous improvement in rail safety, mitigating risks, and working together to develop the scientific, technical and methodological solutions needed to do so.

1. Theme 1: Monitoring technologies and investigation of ground hazard mechanisms.
2. Theme 2: Climate adaptation and extreme weather events.
3. Theme 3: Identification and control of hazards associated with weak sub grade conditions.
4. Theme 4: Large dataset management and application of machine learning and artificial intelligence to ground hazard risk management.

Information about the RGHRP and the products of its research are available on its website:
Railway Ground Hazard Research Program

RAIL CLIMATE CHANGE ADAPTATION PROGRAM (R-CCAP)

From 2022–2024, Transport Canada's Rail Climate Change Adaptation Program (R-CCAP) aimed to help Canada's rail sector better understand and respond to the growing risks of climate change and extreme weather. R-CCAP provided federal funding to railways to research, develop, and implement innovative tools, technologies, and practices that assessed climate risks and improved the resilience of rail infrastructure and operations. R-CCAP provided approximately $5.4 million in federal funding to support 20 projects led by Class I, II, and III railways across Canada. Funded projects focused on areas such as climate risk assessments, monitoring hazards like flooding, erosion, wildfires, landslides, and permafrost degradation, and tested monitoring and mitigation measures to reduce the impacts of extreme weather on Canada's rail network.

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More information can be found at the program webpage and Federal Open Science Repository of Canada:

Rail Climate Change Adaptation Program – Transport Canada

- Last Mountain Railway: Bridge Erosion Mitigation and Monitoring - Federal Open Science Repository of Canada
- Railway Infrastructure Monitoring Framework (RIMF) for Hudson Bay Railway - Federal Open Science Repository of Canada
- Big Sky Rail: Bridge Erosion Mitigation and Monitoring - Federal Open Science Repository of Canada

EVALUATION OF REMOTE SENSING TOOLS FOR RAILWAY WILDFIRE RISK ASSESSMENT

This study assessed the strengths and limitations of emerging drone and satellite based wildfire risk assessment tools through targeted field trials with railways in Saskatchewan, British Columbia, and Northern Ontario. The work demonstrated that drone based, AI enabled vegetation analysis can effectively identify localized wildfire hazards such as dead, stressed, or highly flammable vegetation, within small areas along the rail right of way, while satellite tools supported network level identification of wildfire hot zones and potential fire spread risks to critical infrastructure and communities. Together, the findings showed that remote sensing technologies can enhance evidence based wildfire detection, monitoring, and mitigation planning for railways, particularly when integrated as a complementary, two level system within broader safety, inspection, and asset management programs.

The full report for this project is available at the following link:

Evaluation of Remote Sensing Tools for Railway Wildfire Risk Assessment

CN - Collaboration with the Université de Montréal

CN continues its investment in operations research and AI, partnering with Université de Montréal to shape applied models for uncovering new operational and fuel efficiencies. More optimal assignment and routing of locomotives, loading of intermodal trains to improve aerodynamics, more efficient routing of trucks, and integrated planning can drive possible carbon emission reductions and are focus areas within this research. CN is reviewing model performance to evaluate their potential to drive business impact.

CN - Progress Rail and Chevron Renewable Energy Group to Test High-Level Renewable Fuel Blends

CN is building important partnerships, actively working with the industry on testing and exploring the greater use of sustainable renewable fuel blends, beyond regulated amounts, in its locomotives. Along with Progress Rail and Chevron Renewable Energy Group, CN continues to test high-level renewable fuel. See 2.4 Low-Carbon Fuels.

CN - Customer Engagement on Environmental Issues

In 2024, CN continued to promote its publicly-available web-based carbon calculator, which is a business tool that allows existing and potential customers to estimate the emissions from rail, marine and truck transportation.

Launched in 2023, CN also offers a self-service sustainability tool, My Carbon Emissions. This tool provides customers with a detailed report of their estimated GHG emissions based on all their loaded shipments moved on CN, as well as the emissions avoided by choosing rail over truck.

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CN's EcoConnexions partnership program aims to both partner with and recognize customers who are committed to building an efficient and more sustainable future, including leveraging the environmental benefits of shipping heavy freight over long distances by rail rather than truck to reduce emissions.

Clean Fuels Industry Engagement

In 2024, CPKC and CN both joined the Clean Fuels Alliance America to strengthen the knowledge and network surrounding biofuels. Membership of the Class 1 railways supports Clean Fuels' efforts to advance policies that expand access to lower-carbon fuel alternatives and encourage investment in renewable fuel markets. Such policies and regulations can influence the environmental performance of the transportation sector by supporting the adoption of lower-carbon fuels, helping to reduce greenhouse gas emissions and contributing to broader climate objectives.

CPKC - Customer Engagement

CPKC provides its customers with resources and GHG planning tools, including CPKC's publicly available online rail transport Carbon Emissions Calculator. In 2023, the Carbon Emissions Calculator was updated for the combined CPKC network.

This web-based tool is designed to give customers greater insight into the carbon footprint of their freight rail transportation services. The tool allows for complex, tailored emissions calculations, enabling current and prospective customers to compare an estimate of the GHG emissions related to transportation of freight by CPKC's rail services versus heavy haul trucking alternatives. This information assists potential and current customers in estimating the GHG emissions savings of shipping freight across user-selected origin and destination pairs for a wide variety of commodities commonly shipped by rail.

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3. Traffic Data

3.1 FREIGHT TRAFFIC HANDLED

As shown in Table 3 and Figure 4, there was an increase in freight traffic in 2024. Traffic handled by Canadian railways totaled 866.34 billion gross tonne-kilometres (GTK) compared to 824.19 billion GTK in 2023, an increase of 5.1%. Revenue traffic in 2024 increased to 458.21 billion revenue tonne-kilometres (RTK) from 444.56 billion RTK in 2023, an increase of 3.1%. Since 2005, both GTK and RTK have grown at an average annual rate of 1.4%. Compared to the 2005 base year, GTKs were up 29.6% and RTKs were up 29.8%.

Table 3: Total Freight Traffic, 2005, 2015–2024 (billion tonne-kilometres)

	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
GTK											
Class 1	628.09	752.30	722.33	778.86	820.67	824.53	807.01	793.87	779.42	780.97	820.73
Regional & Shortline	40.45	42.09	44.07	44.59	43.98	39.45	39.75	39.33	43.20	43.22	45.61
Total	668.54	794.39	766.40	823.45	864.66	863.98	846.76	833.21	822.62	824.19	866.34
RTK											
Class 1	328.24	394.10	383.47	411.22	433.45	432.38	430.39	421.23	415.03	420.91	432.99
Regional & Shortline	24.67	23.98	25.05	24.25	22.27	22.68	21.29	21.73	23.70	23.65	25.22
Total	352.91	418.08	408.53	435.46	455.72	455.06	451.67	442.97	438.73	444.56	458.21
*Ratio RTK/GTK**	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.54*	*0.53*

* A higher RTK/GTK ratio may be indicative of greater asset utilization efficiency. However, this ratio may be influenced by non-efficiency factors such as a change in the composition of a railway's commodity portfolio (for example, increasing share of carloads of relatively lighter goods leading to a lower RTK/GTK ratio).

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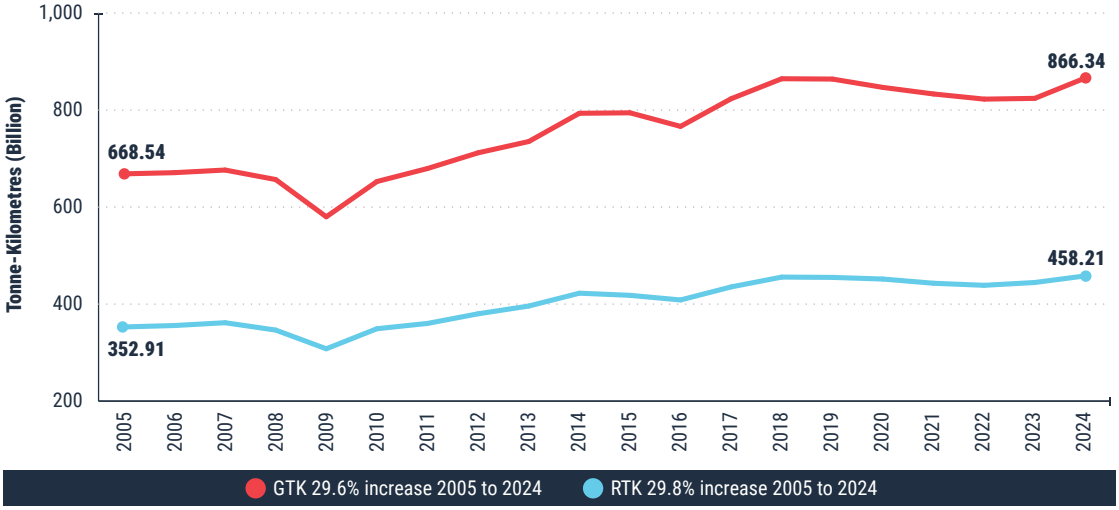
Figure 4: Total Freight Traffic, 2005–2024



In 2024, Class 1 GTK traffic increased by 5.1% to 820.73 billion from 780.97 billion in 2023 (Table 3) and accounted for 94.7% of the total GTK hauled. Class 1 RTK traffic increased by 2.9% in 2024 to 432.99 billion from 420.91 billion in 2023 and accounted for 94.5% of the total RTK.

Of the total freight traffic in 2024, regional & shortline railways were responsible for 45.61 billion GTK (or 5.3% of total GTK) and 25.22 billion RTK (or 5.5% of total RTK). In 2024, regional & shortline railways experienced a 6.6% increase in RTK compared to 2023 while GTK increased by 5.5%.

3.1.1 Intermodal Traffic

Intermodal service includes the movement of trailers or containers by rail and other modes. Intermodal traffic is, in general, more truck-competitive than other types of freight moved by rail. Each intermodal train replaces hundreds of long-haul truck loads, thus reducing highway congestion and emissions. Modal shift to rail is an objective of the 2023–2030 MOU to create immediate GHG emissions reductions from Canada's transportation sector. Railways account for about 60% of combined rail and heavy truck RTKs, but only about 15% of total GHG emissions, indicating that rail's GHG intensity per RTK is roughly one-tenth that of trucking (see Figure 2: Rail vs Heavy Trucks – The Case for Modal Shift).

In 2024, intermodal tonnage increased by 2.2% to 38.50 million tonnes from 37.68 million tonnes in 2023. Despite the increase, intermodal tonnage remained below recent (2017–2022) levels. Intermodal traffic was heavily impacted by several work stoppages throughout 2024.[12]

Overall, since 2005, intermodal tonnage has risen by 24.8%, as illustrated in Figure 5.

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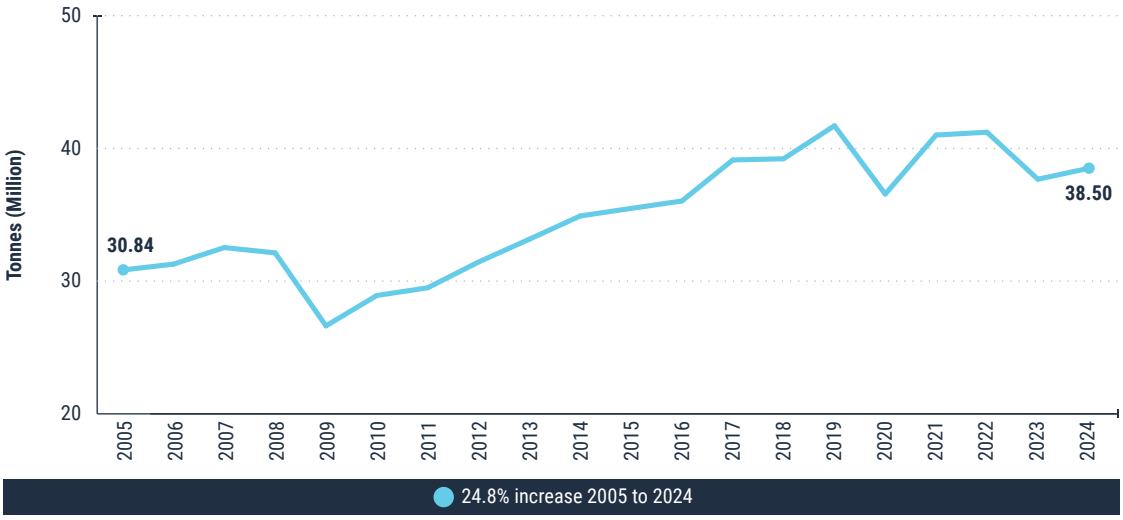
12 See RAC's Rail Trends 2025, p. 20, for details.

Figure 5: Intermodal Tonnage, 2005–2024

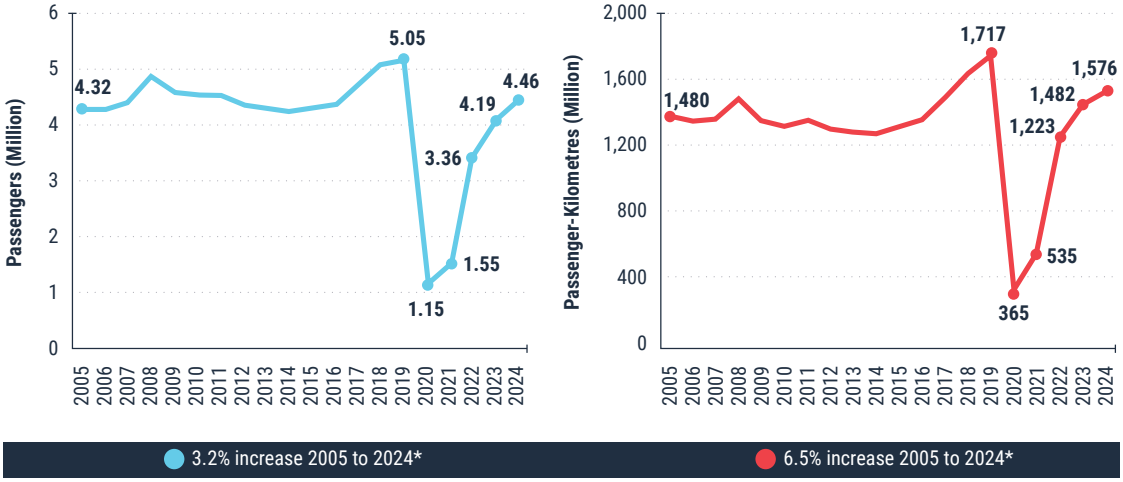


3.2 PASSENGER TRAFFIC HANDLED

3.2.1 Intercity Passenger Services

In 2024, intercity passenger traffic continued to recover from the COVID-19 pandemic and was 11.7% below the 2019 (pre-pandemic) level of 5.05 million passengers. 2024 traffic totaled 4.46 million passengers compared to 4.19 million passengers in 2023, an increase of 6.5%, and was 3.2% above the 2005 level of 4.32 million passengers (Figure 3).

Figure 6: Intercity Rail Passenger Traffic, 2005–2024



* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

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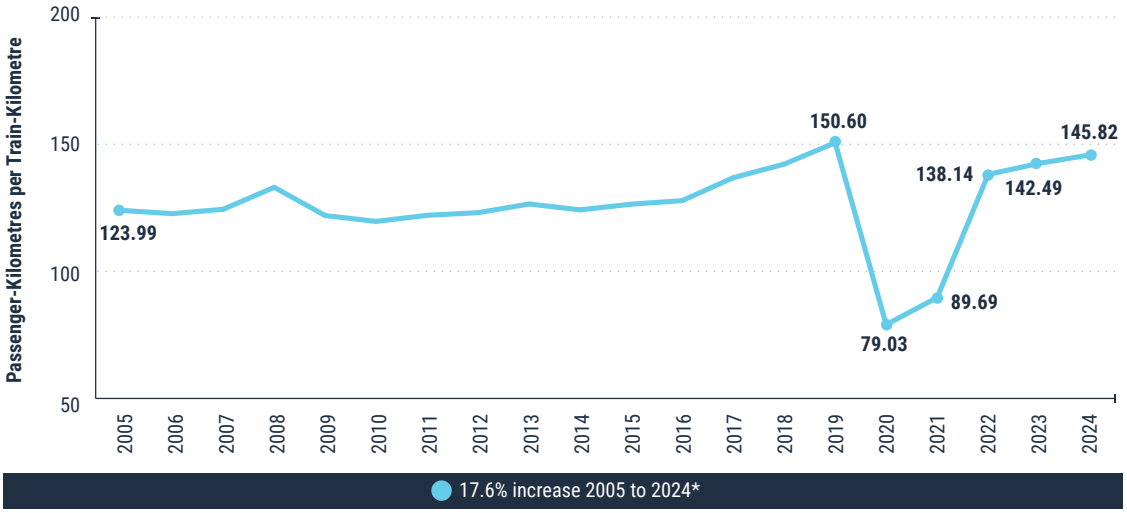
Revenue passenger-kilometres (RPK) for intercity passenger traffic totaled 1,576.43 million. This is an increase of 6.4% compared to 1,481.58 million in 2023 and 6.5% from 1,479.61 million in 2005 (Figure 3).

Intercity train efficiency is expressed in terms of average passenger-kilometres (km) per train-km. As shown in Figure 7, intercity train efficiency in 2024 was 145.82 passenger-km per train-km, a 2.3% improvement from 142.49 in 2023 and a 17.6% improvement compared to 123.99 in 2005.

Intercity train efficiency peaked in 2019 at 150.60 passenger-km per train-km, and then fell to 79.03 in 2020 as a result of fewer passengers per train during COVID-19 pandemic restrictions and a reduction in overall travel. However, as seen in Figure 7, since the initial steep decline in 2020, intercity rail efficiency has improved each year with a continued increase in ridership.

Figure 7: Intercity Rail Train Efficiency, 2005–2024



* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

3.2.2 Commuter Rail

In 2024, commuter rail passengers totaled 58.21 million (Figure 8), up 70.5% from 47.45 million in 2023.[13] Following increases over each of the past three years, commuter traffic climbed back to its 2005 base year level, but remained 42.9% below the 2019 peak of 101.94 million. A shift to remote and hybrid work arrangements during and following the pandemic is a contributing factor to the trends.

Commuter operations in Canada using diesel locomotives and/or diesel multiple units (DMUs) included exo (Reseau de Transport Métropolitain) serving the Montreal-centered region (previously Agence de Transport Métropolitain), Capital Railway serving Ottawa,[14] Metrolinx serving the Greater Toronto Area, and West Coast Express serving the Vancouver-Lower Fraser Valley region.

13 The significant decrease in commuters since 2019 is due to an unprecedented drop in ridership on commuter rail services, as a consequence of the COVID-19 pandemic.

14 Capital Railway's DMUs were not in operation in 2024 due to construction of the expanded passenger rail service.

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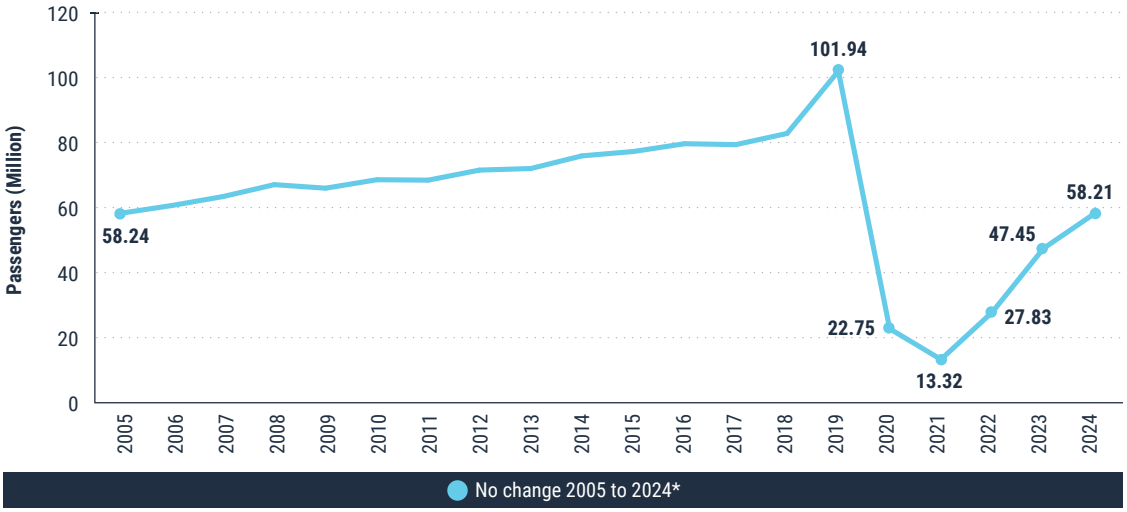
Figure 8: Commuter Rail Passengers, 2005–2024



* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

3.2.3 Tourist and Excursion Services

Canada's tourist and excursion railways provide a unique experience to domestic and foreign travellers alike. In 2024, tourist and excursion railways served 388,981 passengers while consuming 3.73 million litres of fuel—9.59 litres per passenger.

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4. Fuel Consumption Data

Total rail sector fuel consumption in 2024 was 2,129.67 million litres, a 3.5% increase from 2023 but a 3.6% decrease from 2005. In 2024, freight operations consumed 2,000.05 million litres of fuel, a 5.1% reduction from 2,107.90 million litres in 2005. Over this same period (2005–2024), freight traffic (RTKs) increased by 29.8%. From 2023 to 2024, passenger rail fuel consumption increased by 17.4% to support a 22.7% increase in commuters, 6.5% increase in the number of intercity passengers, and 4.6% increase in tourist passengers.

The industry's increased adoption of biofuels, accounting for 8.3% of total fuel litres in 2024, drove a 7.2% reduction in the carbon intensity of the industry's total blended fuel mix since 2005. Combined with improvements in locomotive fuel efficiency, since 2005, freight GHG intensity has improved by 32.1% and intercity passenger GHG intensity has improved by 33.9%.

Of the total fuel consumed by all railway operations, line-haul operations consumed 91.2% (85.8% Class 1 and 5.4% regional & shortline), yard switching and work train operations consumed 2.7%, and passenger operations accounted for 6.1%.

Table 4 shows biofuels usage in locomotives in Canada. 2024 biofuel consumption is obtained by RAC through its annual member survey, whereas biofuel consumption in previous years is provided by ECCC.

In 2024, an estimated 176.43 million litres of biofuels (8.3% of total fuel litres) were consumed by locomotives in Canada. In 2024, the use of biofuels contributed to a 7.2% reduction in GHG emissions compared to using 100% diesel fuel (through lower emissions factors). The methodology[15] estimates the division of total biofuel between biodiesel (FAME) and renewable diesel (HDRD) based on total provincial volumes of biofuels published by Advanced Biofuels Canada in the *"Biofuels in Canada 2025"* report.[16]

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15 The LEM data collection and emissions calculation methodologies will continue to evolve with the industry's adoption of renewable fuels.
16 Report available online: https://advancedbiofuels.ca/biofuels-in-canada-2025-report/.

Table 4: Canadian Rail Operations Fuel Consumption, 2005, 2015–2024 (million litres)

	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Class 1 Freight	1,893.19	1,852.98	1,732.20	1,864.83	1,949.92	1,950.71	1,857.42	1,796.77	1,750.57	1,774.22	1,826.68
Regional & Shortline	140.13	105.45	101.83	114.15	111.88	111.99	108.69	106.56	113.24	113.75	115.12
Yard Switching	67.85	52.97	46.95	50.29	51.56	51.71	46.81	47.07	49.43	51.76	51.31
Work Train	6.73	11.35	10.84	10.01	7.10	9.94	8.41	9.04	6.73	6.92	6.94
Total Freight Operations	2,107.90	2,022.75	1,891.82	2,039.28	2,120.46	2,124.35	2,021.34	1,959.44	1,919.98	1,946.65	2,000.05
Intercity*	64.05	46.98	47.93	51.02	52.77	51.05	21.74	26.15	38.07	43.30	48.62
Commuter*	35.31	60.50	59.43	64.46	65.74	79.53	47.85	47.28	57.28	64.39	77.27
Tourist/ Excursion*	1.74	2.65	2.79	3.22	3.22	4.30	0.00	0.46	3.28	2.72	3.73
Total Passenger Operations*	101.10	110.13	110.15	118.70	121.72	134.89	69.60	73.89	98.63	110.41	129.61
Total Rail Operations	*2,209.00*	*2,132.88*	*2,001.97*	*2,157.98*	*2,242.19*	*2,259.24*	*2,090.94*	*2,033.33*	*2,018.61*	*2,057.07*	*2,129.67*
*Biofuels consumption***	*0.13*	*39.52*	*41.01*	*52.66*	*51.32*	*57.65*	*65.61*	*65.85*	*69.40*	*113.17*	*176.43*
Biofuels share of total fuel litres	0.0%	1.9%	2.0%	2.4%	2.3%	2.6%	3.1%	3.2%	3.4%	5.5%	8.3%
Freight Fuel Efficiency (L per 1,000 RTK)	*5.97*	*4.84*	*4.63*	*4.68*	*4.65*	*4.67*	*4.48*	*4.42*	*4.38*	*4.38*	*4.36*

* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

** 2024 biofuel consumption is obtained by RAC through its annual Rail Trends survey. Biofuel consumption for previous years is provided by ECCC.

Note: See Appendix I for information on the impact of biofuels on GHG emissions factors in 2005 through 2024.

4.1 FREIGHT OPERATIONS

Fuel consumption in 2024 for all freight train, yard switching, and work train operations was 2,000.05 million litres, an increase of 2.7% from 1,946.65 million litres consumed in 2023. Fuel consumption, however, was 5.1% below the 2005 level of 2,107.90 million litres, while RTKs were up 29.8%. Based on total traffic moved by railways in Canada, measured in RTKs, in 2024, railways could move one tonne of freight 229.10 kilometres on just one litre of fuel.

Member railways have implemented many practices to improve fuel efficiency over the years. Improved fuel efficiency has been achieved primarily by replacing older locomotives with modern, fuel-efficient locomotives that meet higher emissions standards, investing in fuel saving technologies, and efficient asset utilization.

Additionally, operating practices and various strategies that reduce fuel consumption have been implemented. Section 2 presented initiatives that are being undertaken by the railways, including details on partnerships with government, academia, equipment manufacturers, fuel providers, and other industry stakeholders to continue the transition to a more sustainable future.

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4.2 PASSENGER SERVICES

Overall passenger rail fuel consumption—the sum of intercity, commuter, and tourist and excursion train operations—totaled 129.61 million litres in 2024, an increase of 17.4% from the 110.41 million litres consumed in 2023. The increase in passenger rail fuel consumption supported strong increases in ridership, including a 22.7% increase in commuters, 6.5% increase in the number of intercity passengers, and 4.6% increase in tourist passengers.

Intercity passenger rail fuel consumption increased by 12.3% from 43.30 million litres in 2023 to 48.62 million litres in 2024. Fuel consumption for commuter rail increased by 20.0% from 64.39 million litres in 2023 to 77.27 million litres in 2024. Lastly, tourist and excursion rail fuel consumption increased from 2.72 million litres in 2023 to 3.73 million litres in 2024.

4.3 DIESEL FUEL PROPERTIES

The sulphur content of railway diesel fuel in Canada is regulated by the *Sulphur in Diesel Fuel Regulations* at 15 parts per million (ppm).

Beginning in 2023, the carbon intensity of diesel fuel in Canada is regulated by the *Clean Fuel Regulations*. Under the regulations, the carbon-intensity limit of diesel fuel in Canada is reduced by 1.5 gCO_2e/MJ each year, from 89.5 gCO_2e/MJ in 2023 to 79.0 gCO_2e/MJ in 2030—resulting in an 11.7% reduction in diesel fuel's carbon intensity throughout the 2023-2030 period. In addition, the regulations include a national minimum renewable fuel blending requirement of 2% in diesel.

In 2024, some provinces, including British Columbia, Manitoba, Ontario, and Quebec, required a minimum renewable fuel content above 2% for diesel.[17]

For details on low-carbon fuels, see sections 2.4 Low-Carbon Fuels and 2.6 Partnerships.

17 In 2024, provincial blend mandates required a range of minimum renewable fuel content for diesel: 4% in British Columbia (increased to 8% April 1, 2025), 5% in Manitoba, 4% in Ontario, and 3% in Quebec (increased to 5% January 1, 2025).

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5. Locomotive Inventory

5.1 FLEET OVERVIEW

Table 5 presents an overview of the active locomotive fleet in Canada for freight and passenger railways.[18] The detailed locomotive fleet inventory is presented in Appendix B.

Table 5: Active Canadian Locomotive Fleet Summary, 2024

	Locomotives	Share of Fleet
Line Haul: Class 1	3,133	72.8%
Line Haul: Regional	151	3.5%
Line Haul: Shortline	144	3.3%
Yard Switching and Work Train: Class 1	476	11.1%
Yard Switching and Work Train: Regional	17	0.4%
Yard Switching and Work Train: Shortline	107	2.5%
Total Freight Operations	4,028	93.5%
Passenger Locomotives	260	6.0%
Passenger DMUs	18	0.4%
Total Passenger Operations	278	6.5%
Total Rail Operations	4,306	100.0%

5.2 LOCOMOTIVES MEETING EMISSION STANDARDS

Locomotives operated by federally regulated railways are subject to the emission standards set out under the *Locomotive Emissions Regulations* (LER), which came into force on June 9, 2017. These emission standards align with US EPA emission standards. RAC's member railways that are not federally regulated will continue to be encouraged to meet the emission standards on a voluntary basis.

The CAC emissions intensity for the Canadian fleet is expected to decrease as railways continue to acquire new locomotives, retrofit high-horsepower and medium-horsepower in-service locomotives when remanufactured, and retire older locomotives.

Table 6 shows the total number of active locomotives meeting emission standards[19] compared to the total number of active locomotives in the fleet. Since the locomotive fleet as reported under the LER and in the LEM Report is based on a snapshot of the locomotive fleet on December 31 of a given year, year-to-year variations are to be expected.

18 The active fleet is reported as it existed on December 31st.
19 The emission standards include the following Tier levels: Tier 0, Tier 0+, Tier 1, Tier 1+, Tier 2, Tier 2+, Tier 3, and Tier 4 (see Appendix D).

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Table 6: Active Locomotives in Canadian Fleet Meeting Emission Standards, 2005, 2015–2024

	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Locomotives meeting an emission standard	888	1,266	1,267	2,157	2,995	2,982	3,108	2,989	3,136	3,769	3,829
Locomotives in Canadian Fleet	2,986	2,400	2,318	3,177	3,782	3,840	3,756	3,606	3,715	4,249	4,306
Percentage of locomotives meeting an emission standard	29.7%	52.8%	54.7%	67.9%	79.2%	77.7%	82.7%	82.9%	84.4%	88.7%	88.9%

Note 1: Includes all active Canadian freight and passenger locomotives.

Note 2: Canada's *Locomotive Emissions Regulations* came into force on June 9, 2017. Prior to this date, locomotives in Canada were not subject to regulations but were encouraged to meet emission standards under the MOU.

Note 3: Not all locomotives need to meet emission standards. Provincially regulated railways are not subject to the *Locomotive Emissions Regulations*; and not all locomotives of federally regulated railways are subject to the regulations. Exceptions include: steam- and electric-powered locomotives; locomotives manufactured prior to 1973 that have not been upgraded; and locomotives with less than 1,006 horsepower. Only new locomotives, not active existing locomotives, are required to meet emissions standards. Locomotives become new when they are freshly manufactured, remanufactured, upgraded or imported.

In 2024, 88.9% of the fleet (3,829 of 4,306) met emission standards (set-out under the LER or the US EPA regulations), a notable improvement from 29.7% in 2005. In 2024, a total of 449 locomotives were remanufactured or added to the active fleet, including 58 locomotives that met Tier 4 emission standards.

In 2024, 451 locomotives (10.5% of the total active fleet) met Tier 4 standards, an increase from 416 Tier 4 locomotives in 2023 (9.8% of the total active fleet).

Table 7 provides an overview of the 2024 locomotive fleet and includes details about the total number of locomotives meeting each tier level, including those that were added, remanufactured, retired, or inactive (in storage) in 2024. It also presents the number of locomotives with anti-idling devices.

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Table 7: Locomotive Fleet Breakdown by Tier Level, 2024

	Active Fleet			Inactive	Changes in 2024		
Tier Level*	Number	% of fleet	With anti-idling devices		Added	Remanufactured	Retired
Elec/Steam/Other	14	0.3%	–	4	–	–	1
No Tier	463	10.8%	279	69	6	–	25
Tier 0	148	3.4%	140	29	–	–	9
Tier 0+	792	18.4%	749	108	–	90	26
Tier 1	31	0.7%	31	2	–	–	–
Tier 1+	874	20.3%	855	51	3	166	1
Tier 2	167	3.9%	162	12	–	–	–
Tier 2+	746	17.3%	728	20	–	71	1
Tier 3	620	14.4%	616	1	–	55	–
Tier 4	451	10.5%	451	–	14	44	–
Total	*4,306*	*100.0%*	*4,011 (93.1%)*	*296*	*23*	*426*	*63*

* See Appendix D for additional information regarding tier levels.

Note: In the LEM reports, an added locomotive is a locomotive with active new status for railways that report to TC under the LER, as well as locomotives defined as "acquired in 2024" for railways that report their fleet directly to RAC. A remanufactured locomotive is a locomotive that was remanufactured and put into service in 2024 with active new status for railways that report to TC under the LER, as well as locomotives identified as "remanufactured in 2024" for railways that report their fleet directly to RAC.

In 2024, the active fleet increased year over year by 57 locomotives, from 4,249 to 4,306. There were 11 fewer No Tier locomotives in the Canadian active fleet (474 in 2023 vs 463 in 2024), while the number of locomotives meeting an emission standard increased by 60 (from 3,769 in 2023 to 3,829 in 2024). The number of electric/steam/other locomotives increased by 8, from 6 in 2023 to 14 in 2024.

In 2024, 23 locomotives were added to the Canadian fleet, including six No Tier, three Tier 1+, and 14 Tier 4. A total of 426 locomotives were remanufactured, 90 to Tier 0+, 166 to Tier 1+, 71 to Tier 2+, 55 to Tier 3, and 44 to Tier 4. 63 mostly non-tier-level and lower-tier-level locomotives were retired and 296 locomotives were inactive (in storage).

Anti-idling devices on locomotives reduce emissions by ensuring that locomotive engines are shut down during periods of inactivity. The number of active locomotives in 2024 equipped with a device to minimize unnecessary idling, such as an automatic engine stop-start (AESS) system or auxiliary power unit (APU), exceeded four thousand (4,011 – 93.1% of the fleet), compared to 3,960 in 2023 (93.2% of the 2023 fleet).

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6. Locomotive Emissions

6.1 GREENHOUSE GASES

6.1.1 Emission Factors for Greenhouse Gases

The emissions factors (EFs) and global warming potentials (GWPs) used to calculate GHGs (i.e., CO_2, CH_4, and N_2O) emitted from diesel locomotive engines are the same factors used by ECCC to create the *National Inventory Report 1990–2024: Greenhouse Gas Sources and Sinks in Canada*, which is submitted annually to the United Nations Framework Convention on Climate Change (UNFCCC).[20]

The year-specific GHG EFs are presented in Table 8. The EFs account for the mix of biodiesel, renewable diesel, and diesel fuel oil used in locomotives each year. In 2022 and earlier LEM reports, all fuel litres were assumed to be diesel fuel oil (B0). In this report, historical EFs have been updated to account for estimated biofuel consumption. In 2024, the industry's increased use of biofuels reduced the carbon intensity of locomotive fuel by 2.5% year over year, and by 7.2% compared to 2005.

The 2024 LEM report uses the 100-year GWP values from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (CO_2: 1, CH_4: 28, N_2O: 265), consistent with ECCC's latest National Inventory Report.

Table 8: GHG Emission Factors for Diesel Locomotives, 2005, 2015–2024

	Global Warming Potential	Emissions Factors (kg/L)										
	All years	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
CO_2	1	2.680349	2.633174	2.628195	2.618205	2.622075	2.615385	2.600450	2.597864	2.592774	2.540495	2.469319
CH_4	28	0.000149	0.000149	0.000149	0.000149	0.000149	0.000149	0.000149	0.000149	0.000149	0.000149	0.000149
N_2O	265	0.001029	0.001028	0.001028	0.001028	0.001028	0.001028	0.001028	0.001027	0.001027	0.001027	0.001027
CO_2e	Not Applicable	2.957205	2.909705	2.904714	2.894699	2.898604	2.891916	2.876952	2.874314	2.869205	2.816884	2.745700

Note: Hydrofluorocarbons (HFC), Perfluorocarbons (PFC), and Sulphur hexafluoride (SF6) are not present in diesel fuel.

Source: Calculation based on global warming potential and emissions factors for biodiesel, renewable diesel, and diesel fuel oil contained in the National Inventory Report 1990-2024: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2026. The GHG emissions factors presented in the table are calculated based on the mix of biodiesel, renewable diesel, and diesel fuel oil used in locomotives in each year. Historical values have been updated.

6.1.2 Greenhouse Gas Emissions

In 2024, RAC members' locomotive operations produced 5,847.42 kilotonnes (kt) of CO_2e. This represents a 0.9% increase compared to 2023 but a 10.5% decrease compared to 2005.

In 2024, railways accounted for just 0.9% of Canada's total GHG emissions and 3.1% of Canada's transportation sector emissions.[21] Table 9 displays the GHG emissions produced in 2005 and annually since 2015; Figure 9 presents the annual trend graphically. GHG emissions for years prior to 2015 are available upon request to RAC.

20 National Inventory Report 1990–2024: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2026, Table 1-1.

21 RAC analysis based on National Inventory Report 1990–2024: Greenhouse Gas Sources and Sinks in Canada, Table 2-4, Environment and Climate Change Canada, 2026.

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Table 9: GHG Emissions by Railway Service in Canada, 2005, 2015–2024 (kilotonnes)

	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Line Haul Freight											
CO_2	5,450.01	5,156.89	4,820.19	5,181.38	5,406.19	5,394.75	5,112.79	4,944.59	4,832.44	4,796.39	4,794.92
CH_4	8.48	8.16	7.64	8.25	8.59	8.60	8.19	7.93	7.76	7.86	8.09
N_2O	554.45	533.41	499.50	538.93	561.56	561.80	535.44	518.25	507.45	513.95	528.59
CO_2e	6,012.94	5,698.46	5,327.33	5,728.55	5,976.34	5,965.15	5,656.43	5,470.76	5,347.65	5,318.20	5,331.59
Yard Switching and Work Train											
CO_2	199.90	169.37	151.89	157.88	153.82	161.25	143.61	145.77	145.63	149.08	143.86
CH_4	0.31	0.27	0.24	0.25	0.24	0.26	0.23	0.23	0.23	0.24	0.24
N_2O	20.34	17.52	15.74	16.42	15.98	16.79	15.04	15.28	15.29	15.97	15.86
CO_2e	220.55	187.15	167.87	174.56	170.04	178.30	158.88	161.28	161.15	165.30	159.96
Total Freight Operations											
CO_2	5,649.91	5,326.26	4,972.07	5,339.26	5,560.01	5,556.00	5,256.40	5,090.36	4,978.07	4,945.47	4,938.77
CH_4	8.79	8.43	7.88	8.50	8.84	8.85	8.42	8.16	8.00	8.11	8.33
N_2O	574.79	550.92	515.24	555.35	577.53	578.60	550.48	533.52	522.74	529.93	544.45
CO_2e	6,233.49	5,885.61	5,495.20	5,903.11	6,146.38	6,143.45	5,815.30	5,632.04	5,508.81	5,483.50	5,491.55
Total Passenger Operations*											
CO_2	270.99	289.99	289.49	310.78	319.17	352.78	180.98	191.95	255.73	280.50	320.05
CH_4	0.42	0.46	0.46	0.49	0.51	0.56	0.29	0.31	0.41	0.46	0.54
N_2O	27.57	30.00	30.00	32.32	33.15	36.74	18.95	20.12	26.85	30.06	35.28
CO_2e	298.98	320.45	319.95	343.60	352.83	390.08	200.22	212.37	282.99	311.02	355.87
Total Rail Operations											
CO_2	5,920.90	5,616.25	5,261.56	5,650.04	5,879.18	5,908.79	5,437.38	5,282.30	5,233.79	5,225.97	5,258.83
CH_4	9.22	8.89	8.34	8.99	9.34	9.41	8.71	8.47	8.41	8.57	8.87
N_2O	602.36	580.92	545.24	587.68	610.69	615.34	569.44	553.64	549.60	559.98	579.73
CO_2e	6,532.47	6,206.05	5,815.15	6,246.71	6,499.21	6,533.54	6,015.53	5,844.41	5,791.80	5,794.52	5,847.42

* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

Note: GHG emissions (combustion) for all years have been calculated based on IPCC Fifth Assessment Global Warming Potentials (CO_2: 1, CH_4: 28, N_2O: 265) and emissions factors that consider the mix of biodiesel, renewable diesel, and diesel fuel oil used in locomotives. Historical values have been updated.

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Figure 9: GHG Emissions, 2005–2024

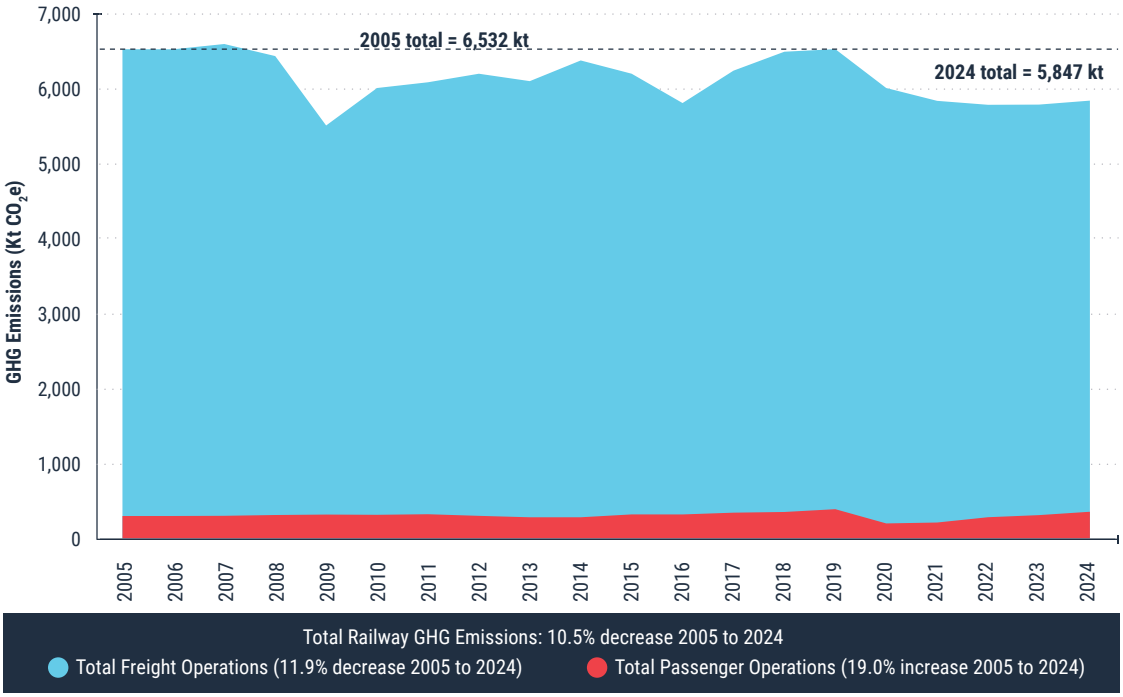

Table 10 presents GHG emissions intensities by category of railway operation, including total freight operations, Class 1 freight, regional & shortline freight, intercity passenger, and commuter rail.

Table 10: GHG Emissions Intensities by Railway Service in Canada, 2005, 2015–2024

	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Freight Operations (kg CO_2e/1,000 RTK)**	17.66	14.08	13.45	13.56	13.49	13.50	12.87	12.71	12.56	12.33	11.98
Class 1 Freight (kg CO_2e/1,000 RTK)	17.06	13.68	13.12	13.13	13.04	13.05	12.42	12.26	12.10	11.87	11.58
Regional & Shortline Freight (kg CO_2e/1,000 RTK)	16.80	12.79	11.81	13.63	14.56	14.28	14.69	14.09	13.71	13.55	12.54
Intercity Passenger (kg CO_2e/ Passenger-km)*	0.128	0.099	0.099	0.095	0.094	0.086	0.171	0.140	0.089	0.082	0.085
Commuter Rail (kg CO_2e/Passenger)*	1.79	2.28	2.17	2.35	2.30	2.26	6.05	10.20	5.91	3.82	3.64

* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

** Includes yard switching and work train GHG emissions.

Note: GHG emissions (combustion) for all years have been calculated based on IPCC Fifth Assessment Global Warming Potentials (CO_2: 1, CH_4: 28, N_2O: 265) and emissions factors that consider the mix of biodiesel, renewable diesel, and diesel fuel oil used in locomotives. Historical values have been updated.

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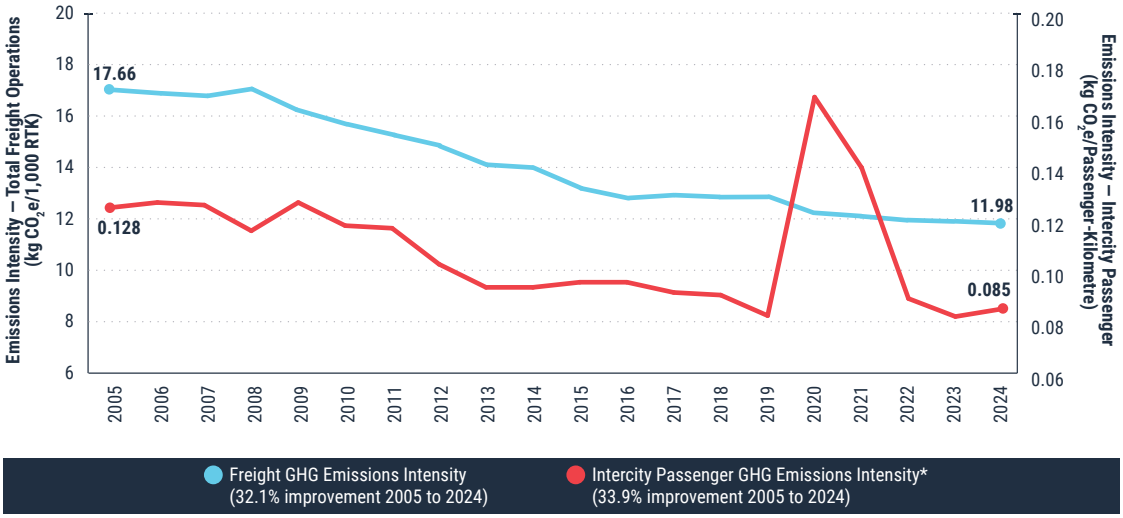
The GHG emissions intensity for total freight traffic (which includes yard switching and work train operations) decreased by 2.8%, from 12.33 kg CO_2e/1,000 RTK in 2023 to 11.98 kg CO_2e/1,000 RTK in 2024. Since 2005, the GHG emissions intensity of total freight has decreased by 32.1%. At 11.58 kg CO_2e/1,000 RTK, the emissions intensity of Class 1 freight improved by 2.4% compared to 2023. Regional & shortline freight emissions intensity notably improved, decreasing by 7.5%, from 13.55 kg CO_2e/1,000 RTK in 2023 to 12.54 kg CO_2e/1,000 RTK in 2024.

In 2024, emissions intensity of intercity passenger railways increased by 2.9% to 0.085 kg CO_2e/passenger-km compared to 0.082 in 2023. However, the 2024 level is the second best on record and reflects an improvement of 33.9% from 2005.

A recovery in the number of commuters in 2024 supported an improvement in emissions performance. Commuter rail operations reduced emissions intensity by 4.7%, from 3.82 kg CO_2e/passenger in 2023 to 3.64 kg CO_2e/passenger in 2024.

Figure 10 shows the trend in GHG emissions intensities for total freight and for intercity passenger railways since 2005.

Figure 10: GHG Emissions Intensities, 2005–2024



* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

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6.2 CRITERIA AIR CONTAMINANTS

6.2.1 Emission Factors for Criteria Air Contaminant Emissions

Criteria Air Contaminant (CAC) EFs are calculated in grams per litre (g/L) of fuel consumed for NO_x, PM_{10}, CO, HC, and SO_2, for each category of operation (i.e., line haul freight, yard switching and work train, and passenger operations).

Fleet modernization, including the acquisition of higher-tier locomotives and retirement of non-tier and lower-tier locomotives, reduces CAC EFs. In 2024, weighted-average EFs[22] for NO_x, PM_{10}, and HC were reduced by 1.5%, 2.0%, and 1.9%, respectively, compared to 2023. NO_x EFs decreased by 1.4% for line haul freight, 0.1% for yard switching and work train, and 4.8% for passenger operations. PM_{10} EFs decreased by 2.0% for line haul freight, 0.3% for yard switching and work train, and 5.9% for passenger operations. HC EFs decreased by 1.8% for line haul freight, 0.2% for yard switching and work train, and 5.5% for passenger operations.

The EPA emissions factors (reconstituted to account for ultra-low sulphur diesel) used in the LEM for CO and SO_2 are constant across all locomotive tier levels, and thus fleet modernization does not affect these two CACs' EFs.[23]

The CAC EFs used are those for diesel fuel and are not adjusted to account for the share of biofuels within the total fuel mix. MOU signatories will keep abreast of CAC emissions research and testing of renewable fuels, with an opportunity to consider updating the LEM report's EFs in the future.

The CAC EFs are estimated based on the active fleet on December 31 of each year. The CAC EFs are listed in Table 11 for 2005 and 2015–2024. EFs for years prior to 2015 are available upon request to RAC.

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22 EFs weighted by the amount of fuel used in each service (line haul freight, yard switching and work train, and total passenger).

23 The CO EF is constant across locomotive tiers, however, it varies by railway service (7.03 grams of CO per litre for Class 1 freight and passenger line-haul; 6.35 g/L for shortline & regional, and 7.35 g/L for yard switching and work trains). As such, the weighted average CO EF can vary from year to year.

Table 11: CAC Emission Factors for Diesel Locomotives, 2005, 2015–2024 (g/L)

Year	NO_x	PM_{10}	CO	HC	SO_2
Line Haul Freight					
2024	29.88	0.58	6.98	1.12	0.02
2023	30.30	0.59	6.98	1.14	0.02
2022	31.76	0.63	6.98	1.21	0.02
2021	31.67	0.63	6.98	1.21	0.02
2020	32.97	0.66	6.99	1.29	0.02
2019	34.17	0.69	6.99	1.34	0.02
2018	34.56	0.78	7.02	1.54	0.02
2017	34.79	0.72	7.04	1.46	0.02
2016	38.17	0.78	7.05	1.54	0.02
2015	39.50	0.81	7.13	1.68	0.02
2005	56.12	1.54	6.97	2.56	2.25
Yard Switching and Work Train					
2024	53.67	1.05	7.35	3.04	0.02
2023	53.74	1.05	7.35	3.05	0.02
2022	55.42	1.10	7.35	3.17	0.02
2021	54.96	1.10	7.35	3.16	0.02
2020	55.34	1.13	7.35	3.23	0.02
2019	57.32	1.18	7.35	3.34	0.02
2018	56.15	1.15	7.35	3.27	0.02
2017	69.14	1.50	7.35	4.01	0.02
2016	65.68	1.46	7.35	3.92	0.02
2015	68.38	1.48	7.35	3.96	0.02
2005	69.88	1.64	7.35	4.06	2.25
Total Passenger Operations					
2024	37.04	0.76	7.03	1.44	0.02
2023	38.90	0.80	7.03	1.52	0.02
2022	40.40	0.84	7.03	1.58	0.02
2021	42.45	0.88	7.03	1.68	0.02
2020	40.87	0.85	7.03	1.64	0.02
2019	45.13	0.92	7.03	1.77	0.02
2018	40.87	0.85	7.03	1.64	0.02
2017	56.34	1.15	7.03	2.19	0.02
2016	54.05	1.11	7.03	2.12	0.02
2015	48.96	1.00	7.03	1.91	0.02
2005	71.44	1.58	7.03	2.64	2.25

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6.2.2 Criteria Air Contaminant Emissions

Table 12 displays the CAC emissions produced annually by locomotives in operation in Canada, including NO_x, PM_{10}, CO, HC, and SO_2. Absolute CAC emissions are presented for both passenger and freight operations, and CAC emissions intensity is provided for freight operations. CAC emissions data for years prior to 2015 are available upon request to RAC.

From 2023 to 2024, increases in CACs were smaller than the 3.5% increase in fuel consumption—a result of improved EFs. Absolute NO_x emissions increased by 2.0%, PM_{10} by 1.4%, and HC by 1.5%. CO and SO_2 emissions increased by 3.5%, equal to the increase in total fuel consumption.[24]

In 2024, freight operations accounted for 92.7% of the rail industry's NO_x emissions, 92.4% of PM_{10}, 93.9% of CO, 92.7% of HC, and 93.9% of SO_2.

In 2024, total freight CAC emissions intensities, measured in kg/1,000 RTK, improved for NO_x (-1.7%), PM_{10} (-2.3%), and HC (-2.1%), while they remained relatively flat for CO and SO_2 (both decreased by 0.3%).

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24 Within the methodology for calculating CAC emissions, the CO emission factors are the same for each tier level. As a result, fleet modernization through the acquisition of higher-tiered locomotives does not affect the calculated CO emissions. The reduction in CO emissions is primarily driven by the reduction in locomotive diesel fuel consumption. Similarly, within the methodology for calculating SO_2 emissions, since 2013, the SO_2 emission factor has been constant as Canadian railways have been using ultra-low sulphur diesel (ULSD). As a result, the reductions in SO_2 since 2013 are driven by reductions in locomotive fuel consumption.

Table 12: Locomotive CAC Emissions, 2005, 2015–2024 (kilotonnes, unless otherwise specified)

Year	NO_x	PM_{10}	CO	HC	SO_2 (tonnes)
Line Haul Freight					
2024	58.02	1.13	13.56	2.18	47.86
2023	57.20	1.12	13.18	2.15	46.53
2022	59.20	1.17	13.01	2.26	45.93
2021	60.28	1.20	13.29	2.31	46.91
2020	64.83	1.30	13.73	2.53	48.46
2019	70.49	1.42	14.41	2.77	50.84
2018	71.25	1.61	14.48	3.18	50.81
2017	68.84	1.43	13.93	2.89	48.77
2016	70.01	1.42	12.94	2.82	45.20
2015	77.35	1.59	13.96	3.28	48.27
2005	114.12	3.13	14.18	5.21	4,580.20
Yard Switching and Work Train					
2024	3.13	0.06	0.43	0.18	1.44
2023	3.15	0.06	0.43	0.18	1.45
2022	3.11	0.06	0.41	0.18	1.38
2021	3.08	0.06	0.41	0.18	1.38
2020	3.02	0.06	0.40	0.17	1.34
2019	3.53	0.07	0.45	0.21	1.52
2018	3.32	0.07	0.43	0.20	1.45
2017	4.17	0.09	0.44	0.24	1.49
2016	3.80	0.08	0.42	0.23	1.42
2015	4.40	0.10	0.47	0.25	1.59
2005	5.21	0.12	0.55	0.30	168.00
Total Freight Operations[1]					
2024	61.15	1.19	13.99	2.35	49.29
2023	60.35	1.18	13.61	2.33	47.98
2022	62.31	1.23	13.42	2.44	47.32
2021	63.36	1.26	13.71	2.49	48.29
2020	67.85	1.36	14.13	2.71	49.80
2019	74.02	1.49	14.86	2.98	52.36
2018	74.58	1.68	14.91	3.38	52.26
2017	73.01	1.52	14.37	3.13	50.26
2016	73.80	1.51	13.36	3.05	46.63
2015	81.75	1.69	14.43	3.54	49.85
2005	119.33	3.25	14.73	5.52	4,748.19

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Table 12: Locomotive CAC Emissions, 2005, 2015–2024 (kilotonnes, unless otherwise specified) (cont'd)

Year	NO_x	PM_{10}	CO	HC	SO_2 (tonnes)
Total Passenger Operations*					
2024	4.80	0.10	0.91	0.19	3.19
2023	4.29	0.09	0.78	0.17	2.72
2022	3.98	0.08	0.69	0.16	2.43
2021	3.14	0.06	0.52	0.12	1.82
2020	2.84	0.06	0.49	0.11	1.72
2019	6.09	0.12	0.95	0.24	3.32
2018	6.56	0.13	0.85	0.25	2.97
2017	6.63	0.14	0.83	0.26	2.90
2016	5.89	0.12	0.77	0.23	2.69
2015	5.33	0.11	0.77	0.21	2.69
2005	7.18	0.16	0.71	0.26	226.29
Total Rail Operations[2]					
2024	65.95	1.29	14.90	2.54	52.49
2023	64.65	1.27	14.39	2.50	50.70
2022	66.30	1.32	14.12	2.60	49.75
2021	66.50	1.32	14.23	2.61	50.11
2020	70.70	1.42	14.62	2.82	51.51
2019	80.11	1.62	15.81	3.22	55.68
2018	81.14	1.81	15.76	3.63	55.23
2017	79.64	1.66	15.20	3.38	53.16
2016	79.70	1.63	14.13	3.28	49.31
2015	87.08	1.80	15.20	3.75	52.54
2005	126.50	3.41	15.43	5.78	4,974.49
Total Freight Emissions Intensity (kg/1,000 RTK)					
2024	0.1334	0.0026	0.0305	0.0051	0.00011
2023	0.1358	0.0027	0.0306	0.0052	0.00011
2022	0.1420	0.0028	0.0306	0.0056	0.00011
2021	0.1430	0.0028	0.0309	0.0056	0.00011
2020	0.1502	0.0030	0.0313	0.0060	0.00011
2019	0.1627	0.0033	0.0327	0.0065	0.00012
2018	0.1636	0.0037	0.0327	0.0074	0.00011
2017	0.1677	0.0035	0.0330	0.0072	0.00012
2016	0.1807	0.0037	0.0327	0.0075	0.00011
2015	0.1955	0.0040	0.0345	0.0085	0.00012
2005	0.3381	0.0092	0.0417	0.0156	0.01345

* Since 2020, passenger rail performance metrics have been impacted by the COVID-19 pandemic and hybrid work arrangements.

[1] Total Freight Operations = Line Haul Freight + Yard Switching and Work Train

[2] Total Rail Operations = Total Freight Operations + Total Passenger Operations

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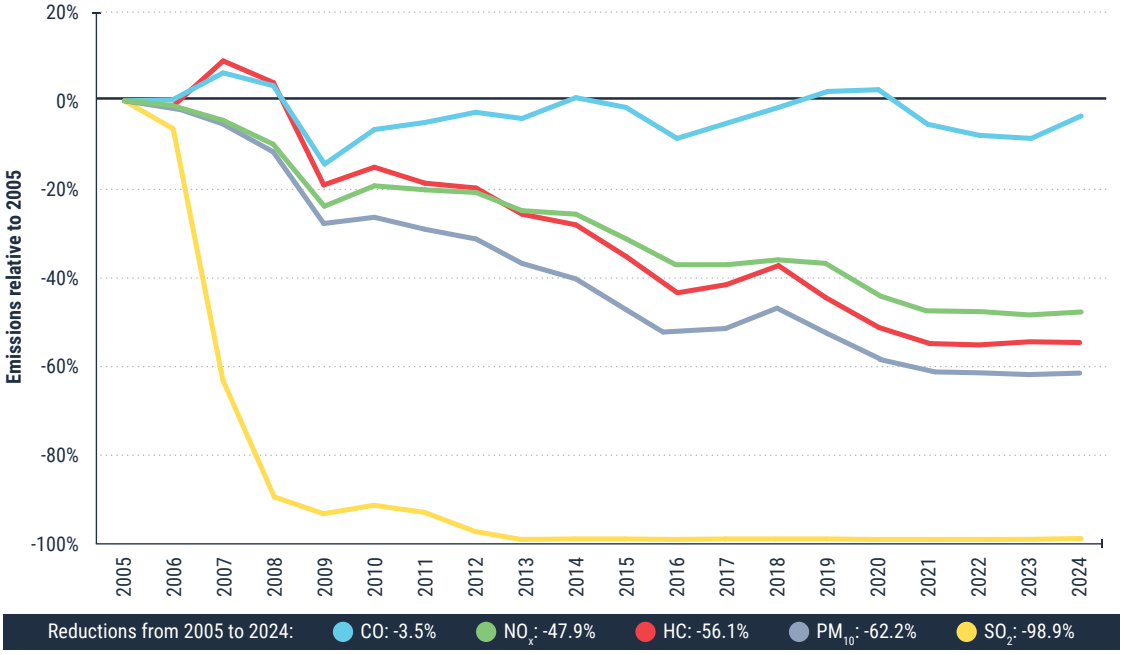
Figure 11 shows the reductions in CAC emissions from total railway operations in Canada since 2005. Despite a general increase in traffic over this time, absolute CAC emissions have decreased for CO (-3.5%), NO_x (-47.9%), HC (-56.1%), PM_{10} (-62.2%), and SO_2 (-98.9%).

Figure 11: CAC Emissions, 2005–2024



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7. Tropospheric Ozone Management Areas

Tropospheric Ozone Management Areas (TOMA) are geographically defined areas in which governments, stakeholders, and other interested parties work together to improve local air quality and manage air pollutant concentrations. The three TOMAs include the Lower Fraser Valley in British Columbia, the Québec City-Windsor Corridor, and the Saint John area in New Brunswick.

Tropospheric ozone is a greenhouse gas and atmospheric pollutant that contributes to global warming and is harmful to human health, agriculture, and ecosystems. Tropospheric ozone is the product of the reaction of several precursor pollutants in the atmosphere. Conventional railway activities, including diesel combustion, contribute to tropospheric ozone.

The following Tropospheric Ozone Management Areas are of interest both from an air quality and rail activity perspective.

TOMA NO. 1

The Lower Fraser Valley in British Columbia represents a 16,800 km^2 area in the southwestern corner of the province averaging 80 km in width and extending 200 km up the Fraser River Valley from the mouth of the river in the Strait of Georgia to Boothroyd, British Columbia. Its southern boundary is the Canada/United States (US) international boundary, and it includes the Metro Vancouver Regional District.

TOMA NO. 2

The Québec City-Windsor Corridor in Ontario and Québec represents a 157,000 km^2 area consisting of a strip of land 1,100 km long and averaging 140 km in width stretching from the City of Windsor (adjacent to Detroit in the US) in Ontario to Québec City. The Québec City-Windsor Corridor TOMA is located along the north shore of the Great Lakes and the St. Lawrence River in Ontario and straddles the St. Lawrence River from the Ontario/Québec border to Québec City. It includes the urban centres of Windsor, London, Hamilton, Toronto, Ottawa-Gatineau, Montréal, Trois- Rivières, and Québec City.

TOMA NO. 3

The Saint John TOMA is represented by two counties in southern New Brunswick—Saint John County and Kings County. The area covers 4,944.67 km^2.

7.1 FUEL CONSUMPTION AND EMISSIONS

Passenger railways' fuel consumption is provided directly for each TOMA and the freight fuel consumption is calculated by multiplying GTKs in the TOMA by the average national freight fuel rate (which was 2.31 litres per 1,000 GTK in 2024). Passenger and freight fuel are combined to obtain total fuel consumption within each TOMA region.

GHGs for the TOMA regions are calculated by multiplying the total TOMA fuel consumption by the emissions factors as described in section 6.1.1 (Table 8).

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CACs for the TOMA regions are calculated by multiplying the total TOMA fuel consumption by a weighted average of the calculated line haul freight, yard switching and work train, and passenger operations CAC EFs, as presented in section 6.2.1 (Table 11).

Table 13 shows the fuel consumption and GHG emissions in the TOMA regions as a percentage of total fuel consumption and GHG emissions for all rail operations in Canada. Table 14 shows NO_x emissions in the TOMA regions as a percentage of the total NO_x emissions for all rail operations.

Table 15 presents detailed calculations for GHGs and CACs in the TOMA regions in 2024.

Table 13: TOMA Percentage of Total Fuel Consumption and GHG Emissions, 2005, 2015–2024

	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Lower Fraser Valley, B.C.	3.2	2.3	2.5	2.4	2.3	2.4	2.3	2.4	2.6	2.8	2.7
Québec City-Windsor Corridor	17.4	14.1	14.0	13.8	13.0	13.5	11.5	12.3	13.2	13.7	13.8
Saint John, N.B.	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.3	0.3

Table 14: TOMA Percentage of Total NO_x Emissions, 2005, 2015–2024

	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Lower Fraser Valley, B.C.	3.2	2.3	2.5	2.4	2.3	2.4	2.3	2.4	2.6	2.8	2.7
Québec City-Windsor Corridor	17.9	14.1	14.0	13.8	13.0	13.5	11.5	12.3	13.2	13.7	13.8
Saint John, N.B.	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.3	0.3

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Table 15: Tropospheric Ozone Management Areas, 2024

			TOMA No.1 Lower Fraser Valley, B.C.	TOMA No.2 Québec City-Windsor Corridor	TOMA No.3 Saint John Area, New Brunswick
Traffic (Million GTK)					
CN			16,259.55	57,191.37	594.55
CPKC			7,063.98	21,720.87	–
Regional & Shortline Railways			236.01	1,052.69	2,038.08
Total Freight Traffic			23,559.53	79,964.93	2,632.63
Fuel Consumption (Million Litres) Freight Fuel Rate (L/1,000 GTK) = 2.31[1]					
Total Freight Fuel Consumption			54.39	184.61	6.08
Passenger Fuel Consumption					
Intercity Passenger Rail			0.54	33.68	–
Tourism Rail			1.50	–	–
Commuter Rail			1.30	75.97	–
Total Passenger Fuel Consumption			3.34	109.65	0.00
Total Rail Fuel Consumption			57.73	294.26	6.08
Emissions					
Emission Factors (g/L)[2]			**Kilotonnes**	**Kilotonnes**	**Kilotonnes**
CACs	NO_x	30.97	1.79	9.11	0.19
	PM_{10}	0.60	0.03	0.18	0.00
	CO	7.00	0.40	2.06	0.04
	HC	1.19	0.07	0.35	0.01
	SO_2	0.02	0.00	0.01	0.00
GHGs[3]	CO_2	2,469.32	142.55	726.62	15.01
	CH_4	4.16	0.24	1.23	0.03
	N_2O	272.22	15.71	80.10	1.65
	CO_2e	2,745.70	158.50	807.95	16.69

[1] The freight fuel rate has been calculated by dividing the total Canadian freight fuel usage (see Table 4) by the total Canadian freight GTK (see Table 3). In 2024, the Freight Fuel Rate was 2.31 litres per 1,000 GTK.

[2] The emission factors used in the emissions calculations are a weighted average of the overall freight, yard and passenger emission factors based on the quantity of freight and passenger fuel used.

[3] The emission factors for each GHG include their respective global warming potentials (CO_2:1; CH_4:28; N_2O:265).

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8. Summary and Conclusions

The 2024 Locomotive Emissions Monitoring Report highlights the successful, long-standing collaboration between RAC and TC to advance initiatives that reduce locomotive emissions and disseminate the results to the public. Canadian railways continued to improve their emissions performance through investments in fleet renewal/modernization, fuel saving technologies, operational efficiencies, and use of low-carbon fuels. Furthermore, railways' partnerships with government, academia, and industry stakeholders made progress in advancing the development of alternative propulsion and other zero-emission technologies that support the transition to a more sustainable future.

Over the past several decades, Canada's railways have made significant progress in reducing both GHG and CAC emissions. Since the 2005 base year, GHG emissions intensities have been reduced by 25.4% (regional & shortline), 32.1% (Class 1 freight) and 33.9% (intercity passenger). In the same period, absolute CAC emissions have been cut by 47.9% (NO_x), 62.2% (PM_{10}), 3.5% (CO), 56.1% (HC), and 98.9% (SO_2).

From 2023 to 2024, the GHG emissions intensity of Canada's freight railways (including all line haul, yard, and work train operations) improved by 2.8% (including a 7.5% reduction in regional & shortline line haul and 2.4% reduction in Class 1 line haul). These improvements were supported by an approximately 50% increase in biofuel consumption, which increased the share of biofuels in the industry's total blended fuel mix and reduced its average GHG emissions factor by 2.5% year over year. The GHG emissions intensity of intercity passenger railways increased by 2.9%, as the increase in passenger-kilometres was outpaced by a relatively larger increase in fuel consumption and greenhouse gas emissions. However, the 2024 level is the second best on record.

In 2024, Canadian railways' investments in fleet modernization improved the CAC EFs as well as freight CAC emissions intensity.[25] The CAC EFs used are those for diesel fuel and are not adjusted to account for the share of biofuels within the total fuel mix. Year over year, as total fuel consumption increased by 3.5%, absolute CAC emissions increased by between 1.4% and 3.5%.

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25 Intercity passenger CAC emissions intensity is not tracked in the LEM reports.

Table 16: 2023–2030 MOU Progress - GHG Emissions Intensities

Railway Operation	Productivity Units	2005 Base Year	2022	2023	2024	Change from 2005–2024	Change from 2023–2024
Class 1 Freight	kg CO_2e per 1,000 RTK	17.06	12.10	11.87	11.58	-32.1%	-2.4%
Intercity Passenger	kg CO_2e per passenger-km	0.128	0.089	0.082	0.085	-33.9%	2.9%
Regional & Shortline	kg CO_2e per 1,000 RTK	16.80	13.71	13.55	12.54	-25.4%	-7.5%

Note: GHG emissions (combustion) for all years have been calculated based on IPCC Fifth Assessment Global Warming Potentials (CO_2: 1, CH_4: 28, N_2O: 265) and emissions factors that consider the mix of biodiesel, renewable diesel, and diesel fuel oil used in locomotives. Historical values have been updated.

Table 17: 2023–2030 MOU Progress - Absolute CAC Emissions (kilotonnes, unless otherwise specified)

CAC Emission	2005 Base Year	2022	2023	2024	Change from 2005–2024	Change from 2023–2024
NO_x	126.50	66.30	64.65	65.95	-47.9%	2.0%
PM_{10}	3.41	1.32	1.27	1.29	-62.2%	1.4%
CO	15.43	14.12	14.39	14.90	-3.5%	3.5%
HC	5.78	2.60	2.50	2.54	-56.1%	1.5%
SO_2 (tonnes)	4,974.49	49.75	50.70	52.49	-98.9%	3.5%

Note: The table presents CAC emissions for total rail operations (including line haul freight, yard switching and work train, and total passenger train operations).

Through continued progress on emissions reduction initiatives and aspirational goals as outlined in the 2023-2030 MOU, industry and government will continue to collaborate to reduce GHG and CAC emissions in the railway sector and broader transportation sector.

This report meets the filing requirements for the 2024 reporting year.

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Appendix A

RAC Member Railways Participating in the 2023–2030 MOU by Province

Railway	Province(s) of Operation
Agawa Canyon Railroad	Ontario
Alberta Prairie Railway Excursions	Alberta
Cartier Railway (Arcelor Mittal Infrastructure Canada s.e.n.c.)	Québec
Barrie-Collingwood Railway	Ontario
Battle River Railway	Alberta
BCR Properties	British Columbia
Big Sky Rail Corp.	Saskatchewan
Boundary Trail Railway Co.	Manitoba
Canadian National Railway	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia, Northwest Territories
Canadian Pacific Kansas City Limited	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec
Cape Breton & Central Nova Scotia Railway	Nova Scotia
Capital Railway	Ontario
Carlton Trail Railway	Saskatchewan
Central Manitoba Railway Inc.	Manitoba
Chemin de fer Arnaud Québec	Québec
Compagnie du Chemin de Fer Lanaudière Inc.	Québec
Essex Terminal Railway Company	Ontario
exo	Québec
GIO Rail Holdings Corp.	Ontario
Goderich-Exeter Railway Company Ltd.	Ontario
Great Canadian Railtour Company Ltd.	British Columbia, Alberta
Great Western Railway Ltd.	Saskatchewan
Hudson Bay Railway	Manitoba, Saskatchewan
Huron Central Railway Inc.	Ontario
Immeuble VDS inc.	Québec
Keewatin Railway Company	Manitoba
Knob Lake and Timmins Railway	Québec, Newfoundland and Labrador
Last Mountain Railway	Saskatchewan
Metrolinx (GO Transit)	Ontario
New Brunswick Southern Railway Company Ltd.	New Brunswick
Nipissing Central Railway Company	Ontario, Québec
Ontario Northland Transportation Commission	Ontario
Ontario Southland Railway Inc.	Ontario
Ottawa Valley Railway	Ontario, Québec
Prairie Dog Central Railway	Manitoba
Québec Gatineau Railway Inc.	Québec
Québec Iron Ore Inc.	Québec
Québec North Shore and Labrador Railway Company Inc.	Québec, Newfoundland and Labrador
Roberval and Saguenay Railway Company	Québec
Romaine River Railway Company	Québec
Société du chemin de fer de la Gaspésie	Québec
South Simcoe Railway	Ontario
Southern Ontario Railway	Ontario
Southern Railway of British Columbia Ltd.	British Columbia
St. Lawrence & Atlantic Railroad (Québec) Inc.	Québec
Train Touristique de Charlevoix Inc.	Québec
Toronto Terminals Railway Company Limited	Ontario
Tshiuetin Rail Transportation Inc.	Québec, Newfoundland and Labrador
VIA Rail Canada Inc.	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia
West Coast Express Ltd.	British Columbia
White Pass and Yukon Route Railroad	Yukon, British Columbia

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Appendix B-1

2024 Active Canadian Locomotive Fleet - Freight Train Line Haul Operations

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
GM/EMD									
RM1-SLUG	Elec/ Steam/ Other	NA	NA	1970-1972	-	-	3	3	3
GP9	No Tier	12V-645C	1800	1950-1959	-	-	1	1	1
GP9	No Tier	645E	2000	1950-1959	-	1	-	1	1
GP35	No Tier	16-645E	2500	1960-1969	1	-	-	-	1
GP38-2	No Tier	16-645E	2000	1960-1969	-	-	8	8	8
GP38-2	No Tier	645E	2000	1960-1969	-	-	3	3	3
GP38-3	No Tier	16-645E	2000	1960-1969	-	-	1	1	1
GP38-3	No Tier	645E	2000	1960-1969	-	-	6	6	6
GP40-2	No Tier	16-645E3B	3000	1960-1969	-	-	3	3	3
GP40-3	No Tier	16-645E3	3000	1960-1969	-	-	3	3	3
GP40-3M	No Tier	16-645E3	3000	1960-1969	-	-	3	3	3
RM-1 SLUG	No Tier	NA	0	1960-1969	-	-	1	1	1
RM-1 SLUG	No Tier	NA	0	1960-1969	-	-	1	1	1
RM1 - SLUG	No Tier	NA	0	1960-1969	-	-	1	1	1
SD40-3	No Tier	16V-645E3B	3000	1960-1969	3	-	-	-	3
GP38-2	No Tier	16-645E	2000	1970-1972	-	-	4	4	4
GP38-3	No Tier	645E	2000	1970-1972	-	-	2	2	2
GP40-2	No Tier	16-645E3B	3000	1970-1972	-	-	2	2	2
GP40-3M	No Tier	16-645E3	3000	1970-1972	-	-	1	1	1
RM-1 SLUG	No Tier	NA	0	1970-1972	-	-	1	1	1
SD38-2	No Tier	16V-645 or 16V-645E	2000	1970-1972	-	-	1	1	1
SD38AC	No Tier	16V-645 or 16V-645E	2000	1970-1972	-	-	1	1	1
SD40	No Tier	645	3000	1970-1972	-	1	-	1	1
SD40-2	No Tier	16V-645E3	3000	1970-1972	-	-	1	1	1
SD40-2	No Tier	645E3	3000	1970-1972	-	2	-	2	2
SD40-2	No Tier	16-645E3	3000	1970-1972	-	-	3	3	3
SD40-3	No Tier	16-645E3B	3000	1970-1972	-	-	2	2	2
SD40-3	No Tier	16V-645E3B	3000	1970-1972	1	-	-	-	1
GP15-1	No Tier	12-645E	1500	1973-1979	-	-	2	2	2
GP38-2	No Tier	645E	2000	1973-1979	-	-	2	2	2
GP38-2	No Tier	16-645E	2000	1973-1979	-	-	2	2	2
GP38-2/QEG	No Tier	16V-645E	2000	1973-1979	-	-	2	2	2
GP38-3	No Tier	16V-645E	2000	1973-1979	-	-	4	4	4

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2024 Active Canadian Locomotive Fleet - Freight Train Line Haul Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
GP40-2	No Tier	16V-645E3B	3000	1973-1979	10	-	-	-	10
GP40-2	No Tier	645E	2000	1973-1979	-	-	1	1	1
GP40-2LW	No Tier	16-645E3	3000	1973-1979	-	-	2	2	2
GP40-2W	No Tier	16-645E3	3000	1973-1979	-	-	4	4	4
GP9	No Tier	16V-645C	1800	1973-1979	-	-	7	7	7
SD38-2	No Tier	16V-645 or 16V-645E	2000	1973-1979	-	-	1	1	1
SD40-2	No Tier	16V-645E3B	3000	1973-1979	2	-	-	-	2
SD40-2	No Tier	645E	3000	1973-1979	-	6	1	7	7
SD40-2	No Tier	16-645E3B	3000	1973-1979	2	-	1	1	3
SD40-2	No Tier	16-645E3	3000	1973-1979	6	-	-	-	6
SD40-2/QEG	No Tier	16V-645E3B	3000	1973-1979	-	-	1	1	1
SD40-2	No Tier	16V-645E3B	3000	1980-1989	3	-	-	-	3
SD40-2	No Tier	16-645E3B	3000	1980-1989	2	-	1	1	3
SD40-2	No Tier	16-645E3	3000	1980-1989	3	-	-	-	3
SD40-2/QEG	No Tier	16V-645E3B	3000	1980-1989	-	-	1	1	1
SD40-2F	No Tier	16-645E3	3000	1980-1989	1	-	-	-	1
SD70ACE	No Tier	16-710G3B-ES	4375	2010-2019	-	3	-	3	3
SD40-3	Tier 0	16-645E3B	3000	1960-1969	1	-	-	-	1
GP38-2	Tier 0	16-645E	2000	1970-1972	-	-	2	2	2
GP40-2	Tier 0	16V-645E3B	3000	1973-1979	19	-	-	-	19
SD40-2	Tier 0	16-645E3B	3000	1973-1979	1	-	-	-	1
SD40-2	Tier 0	16-645EB	3000	1973-1979	1	-	-	-	1
SD40-2	Tier 0	16V-645E3B	3000	1973-1979	12	-	-	-	12
SD40-2	Tier 0	16V-645E3B	3000	1980-1989	1	-	-	-	1
SD40-2	Tier 0	16-645E3	3000	1980-1989	3	-	-	-	3
SD60	Tier 0	16V-710G3	3800	1980-1989	34	-	-	-	34
SD60-3	Tier 0	16-710G3	3800	1980-1989	2	-	-	-	2
SD60-3	Tier 0	16-710G3	3350	1980-1989	4	-	-	-	4
SD60M	Tier 0	16-710G3	3800	1980-1989	1	-	-	-	1
SD60M	Tier 0	710G3A	3800	1980-1989	-	2	-	2	2
SD60M	Tier 0	710G3A	3800	1990-1999	-	3	-	3	3
SD70I	Tier 0	16V-710G3B	4000	1990-1999	3	-	-	-	3
SD75I	Tier 0	710G3C	4300	1990-1999	-	5	-	5	5
SD75I	Tier 0	16V-710G3C	4300	1990-1999	17	-	-	-	17
GP40-2	Tier 0+	645E	3000	1960-1969	-	1	-	1	1
GP40-3	Tier 0+	16-645E3C	3000	1960-1969	1	-	-	-	1
SD40-3	Tier 0+	16V-645E3B	3000	1960-1969	19	-	-	-	19
GP38-2	Tier 0+	16-645E	2000	1970-1972	-	-	2	2	2
GP39-2C	Tier 0+	12-645E3	2300	1970-1972	-	-	2	2	2

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2024 Active Canadian Locomotive Fleet - Freight Train Line Haul Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
GP40-3M	Tier 0+	16-645E3B	3000	1970-1972	-	-	1	1	1
SD30C-ECO	Tier 0+	12-710G3B	3000	1970-1972	2	-	-	-	2
SD40-2	Tier 0+	645E3	3000	1970-1972	-	1	-	1	1
SD40-3	Tier 0+	16V-645E3B	3000	1970-1972	3	-	-	-	3
GP38-2	Tier 0+	645E	2000	1973-1979	-	4	4	8	8
GP38-2	Tier 0+	16-645E	2000	1973-1979	-	-	4	4	4
GP40-2	Tier 0+	16V-645E3B	3000	1973-1979	30	-	-	-	30
GP40-2	Tier 0+	645E	3000	1973-1979	-	4	-	4	4
GP40-3M	Tier 0+	16-645E3B	3000	1973-1979	-	-	1	1	1
SD30C-ECO	Tier 0+	12-710G3B	3000	1973-1979	25	-	-	-	25
SD40-2	Tier 0+	16V-645E3B	3000	1973-1979	43	-	-	-	43
SD40-2	Tier 0+	16-645E3B	3000	1973-1979	5	-	2	2	7
GP38-2	Tier 0+	645E	2000	1980-1989	-	2	-	2	2
GP40-3M	Tier 0+	16-645E3B	3000	1980-1989	-	-	1	1	1
SD30C-ECO	Tier 0+	12-710G3B	3000	1980-1989	22	-	-	-	22
SD40-2	Tier 0+	16-645E3	3000	1980-1989	4	-	-	-	4
SD40-2	Tier 0+	16-645E3B	3000	1980-1989	14	-	-	-	14
SD40-2	Tier 0+	16V-645E3B	3000	1980-1989	21	-	-	-	21
SD40-2	Tier 0+	16-645E3C	3000	1980-1989	1	-	-	-	1
SD40-2F	Tier 0+	16-645E3B	3000	1980-1989	7	-	-	-	7
SD40-3	Tier 0+	16-645E3	3000	1980-1989	3	-	-	-	3
SD40-3	Tier 0+	16-645E3B	3000	1980-1989	7	-	-	-	7
SD50	Tier 0+	645	3600	1980-1989	-	3	-	3	3
SD60	Tier 0+	16V-710G3	3800	1980-1989	51	-	-	-	51
SD60	Tier 0+	16-710G3A	3800	1980-1989	26	-	-	-	26
SD60-3	Tier 0+	16-710G3A	3800	1980-1989	2	-	-	-	2
SD60-3	Tier 0+	16-710G3A	3350	1980-1989	2	-	-	-	2
SD60M	Tier 0+	16-710G3A	3800	1980-1989	4	-	-	-	4
SD70I	Tier 0+	16V-710G3B	4000	1990-1999	16	-	-	-	16
SD75I	Tier 0+	16V-710G3C	4300	1990-1999	71	-	-	-	71
SD75IACC	Tier 0+	16V-710G3C	4300	1990-1999	23	-	-	-	23
SD70M	Tier 1	710G3C	4000	2000-2009	-	5	-	5	5
SD 70 MAC	Tier 1+	16-710G3C	4000	1990-1999	-	-	1	1	1
SD70 MAC	Tier 1+	16-710G3C	4000	1990-1999	-	-	2	2	2
SD70ACU	Tier 1+	16-710G3C	4300	1990-1999	58	-	-	-	58
SD70MAC	Tier 1+	16-710G3C	4000	1990-1999	-	-	5	5	5
SD70MACE	Tier 1+	16-710G3C	4000	1990-1999	11	-	-	-	11
SD70MACE	Tier 1+	16-710G3B	4000	1990-1999	1	-	-	-	1
SD70MACE	Tier 1+	16-710G3C	4000	2000-2009	4	-	-	-	4

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2024 Active Canadian Locomotive Fleet - Freight Train Line Haul Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
SD70ACE	Tier 2	16-710G3C	4300	2000-2009	14	-	-	-	14
SD70M-2	Tier 2	16V-710G3C	4300	2000-2009	21	-	-	-	21
SD70ACE	Tier 2	16-710-G3C-T2	4400	2010-2019	-	3	-	3	3
SD70ACE	Tier 2	16-710G3C	4300	2010-2019	10	-	-	-	10
SD70M-2	Tier 2	16V-710G3C	4300	2010-2019	28	-	-	-	28
SD70ACE	Tier 2+	16-710G3C	4300	2000-2009	96	-	-	-	96
SD70ACE	Tier 2+	16-710G3C-ES	4375	2000-2009	-	5	-	5	5
SD70M-2	Tier 2+	16V-710G3C	4300	2000-2009	64	-	-	-	64
SD70M-2	Tier 2+	16V-710G3C	4300	2010-2019	47	-	-	-	47
SD70ACE	Tier 3	16-710G3C-ES	4375	2000-2009	-	6	-	6	6
SD70ACE	Tier 3	16-710G3B-ES	4375	2000-2009	-	6	-	6	6
SD70ACE	Tier 3	16-710-G3C-T2+	4400	2010-2019	-	2	-	2	2
SD70ACE	Tier 3	16V-710G3C	4300	2010-2019	4	-	-	-	4
SD70ACE	Tier 3	16-710G3C	4300	2010-2019	60	-	-	-	60
SD70ACE	Tier 3	16-710G3B-ES	4375	2010-2019	-	11	-	11	11
GM/EMD Sub-Total					953	76	111	187	1,140
				GE					
B23-7	No Tier	7FDL12	2000	1973-1979	-	-	2	2	2
Dash 8-40CM	No Tier	7FDL16	4000	1990-1999	-	-	3	3	3
Dash-9 44CW	No Tier	16-7FDL	4400	1990-1999	-	3	-	3	3
AC4400CM	No Tier	16-7FDL	4400	2000-2009	-	6	-	6	6
C40-8	Tier 0+	7FDL-16	4000	1990-1999	1	-	-	-	1
AC4400CW	Tier 1	7FDL16	4400	2000-2009	-	26	-	26	26
AC4400CW	Tier 1+	7FDL16	4400	1990-1999	153	-	-	-	153
AC44C6M	Tier 1+	7FDL-A16	4400	1990-1999	9	-	-	-	9
AC44CWM	Tier 1+	7FDL16	4400	1990-1999	141	-	-	-	141
C44-9W	Tier 1+	7FDL-16	4400	1990-1999	64	-	-	-	64
AC4400CM	Tier 1+	16-7FDL	4400	2000-2009	-	6	-	6	6
AC4400CW	Tier 1+	7FDL16	4400	2000-2009	192	-	-	-	192
AC44C6M	Tier 1+	7FDL-A16	4400	2000-2009	1	-	-	-	1
C44-9W	Tier 1+	7FDL-16	4400	2000-2009	77	-	-	-	77
ES44DC	Tier 2	GEVO-12	4400	2000-2009	20	-	-	-	20
ES44AC	Tier 2	GEVO12	4360	2010-2019	-	6	-	6	6
ES44AC	Tier 2	GEVO-12	4400	2010-2019	12	-	-	-	12
ES44DC	Tier 2	GEVO-12	4400	2010-2019	3	-	-	-	3
ES44AC	Tier 2+	GEVO-12	4365	2000-2009	198	-	-	-	198
ES44AC	Tier 2+	GEVO-12	4400	2000-2009	108	-	-	-	108
ES44DC	Tier 2+	GEVO-12	4400	2000-2009	69	-	-	-	69

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2024 Active Canadian Locomotive Fleet - Freight Train Line Haul Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
ES44AC	Tier 2+	GEVO-12	4400	2010-2019	16	-	-	-	16
ES44AC	Tier 2+	GEVO-12	4365	2010-2019	61	-	-	-	61
ES44DC	Tier 2+	GEVO-12	4400	2010-2019	31	-	-	-	31
ES44AC	Tier 3	GEVO-12	4365	2010-2019	30	-	-	-	30
ES44AC	Tier 3	GEVO12	4400	2010-2019	52	-	-	-	52
ES44AC	Tier 3	GEVO-12	4400	2010-2019	409	-	-	-	409
ET44AC	Tier 3	ES44AC	4400	2010-2019	1	-	-	-	1
ET44AC	Tier 3	GEVO-12	4400	2010-2019	8	-	-	-	8
ES44AC	Tier 4	GEVO-12	4400	2010-2019	81	-	-	-	81
ET44AC	Tier 4	GEVO-12	4400	2010-2019	232	-	-	-	232
ET44AC	Tier 4	ET44AC	4400	2010-2019	5	-	-	-	5
ET44AC	Tier 4	GEVO-12	4400	2020-2024	40	-	-	-	40
GE Sub-Total					2,014	47	5	52	2,066
Wabtec									
AC44C6M	Tier 1+	7FDL-16-A	4400	1990-1999	60	-	-	-	60
AC44C6M	Tier 1+	7FDL-A16	4400	1990-1999	21	-	-	-	21
AC44C6M	Tier 1+	16-7FDLA	4500	1990-1999	-	19	-	19	19
AC44CWM	Tier 1+	7FDL16	4400	1990-1999	30	-	-	-	30
AC44C6M	Tier 1+	7FDL-A16	4400	2000-2009	19	-	-	-	19
ES44AC	Tier 3	GEVO-12	4400	2010-2019	1	-	-	-	1
ET44AC	Tier 4	GEVO-12	4400	2010-2019	25	-	-	-	25
ET44AC	Tier 4	GEVO-12	4400	2020-2024	10	-	-	-	10
Wabtec Sub-Total					166	19	-	19	185
NRE									
SD40-2	Tier 0+	645E3B	3000	1970-1972	-	8	-	8	8
SD40-2	Tier 0+	645E3	3000	1970-1972	-	1	-	1	1
NRE Sub-Total					-	9	-	9	9
Other									
Booster (cab)	Elec/ Steam/ Other	NA	0		-	-	3	3	3
Booster (slug)	Elec/ Steam/ Other	NA	0		-	-	2	2	2
Other Sub-Total					-	-	5	5	5

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2024 Active Canadian Locomotive Fleet - Freight Train Line Haul Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
EMCC									
SD70M-2	Tier 2+	16V-710G3B	4000	2000-2009	-	-	18	18	18
EMCC Sub-Total					-	-	18	18	18
MLW									
RS-18	No Tier	12V-251	1800	1950-1959	-	-	5	5	5
MLW Sub-Total					-	-	5	5	5
Total Mainline Freight					*3,133*	*151*	*144*	*295*	*3,428*

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Appendix B-2

2024 Active Canadian Locomotive Fleet - Freight Yard Switching & Work Train Operations

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
GM/EMD									
Cab slug	Elec/ Steam/ Other	NA	0	1950-1959	-	-	2	2	2
SLUG	Elec/ Steam/ Other	NA	0	1980-1989	-	-	1	1	1
SLUG	Elec/ Steam/ Other	NA	0	2000-2009	-	-	1	1	1
FP9	No Tier	16V-567C	1750	1950-1959	-	-	2	2	2
FP9A	No Tier	16-645C	1750	1950-1959	1	-	-	-	1
FP9A-3	No Tier	16-645E	1750	1950-1959	1	-	-	-	1
GP7	No Tier	16V-567	1500	1950-1959	-	-	2	2	2
GP9	No Tier	16V-645	1750	1950-1959	-	-	2	2	2
GP9	No Tier	16V-567	1750	1950-1959	-	-	2	2	2
GP9	No Tier	567C	1750	1950-1959	-	3	-	3	3
GP9	No Tier	16V-645C	2000	1950-1959	-	-	2	2	2
GP9	No Tier	16V-567C	1750	1950-1959	-	-	4	4	4
GP9	No Tier	16V-645	2000	1950-1959	-	-	1	1	1
GP9 master	No Tier	16V-567	1750	1950-1959	-	-	5	5	5
GP9-3	No Tier	16-567C	1750	1950-1959	-	-	1	1	1
GP9-RM	No Tier	16V-645	2000	1950-1959	-	-	1	1	1
GP9-RM	No Tier	16V-645C	1800	1950-1959	63	-	-	-	63
SW1200RB	No Tier	12V-645C	1200	1950-1959	1	-	-	-	1
SW1200RS	No Tier	12V-567	1200	1950-1959	-	-	1	1	1
SW14	No Tier	12V-567	1400	1950-1959	-	-	1	1	1
SW900	No Tier	8V-645C	1000	1950-1959	-	-	1	1	1
SW900RS	No Tier	8V-567	900	1950-1959	-	-	8	8	8
GP38	No Tier	16V-645C	2000	1960-1969	-	-	1	1	1
GP38	No Tier	645	2000	1960-1969	-	2	-	2	2
GP38-2	No Tier	16V-645E	2000	1960-1969	1	-	1	1	2
GP40-3	No Tier	16V-645E3	3000	1960-1969	-	-	2	2	2
GP9	No Tier	16V-567C	1750	1960-1969	-	-	1	1	1
GP9	No Tier	16V-567	1750	1960-1969	-	-	1	1	1

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2024 Active Canadian Locomotive Fleet - Freight Yard Switching & Work Train Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
GP9	No Tier	16V-645	1700	1960-1969	-	-	1	1	1
SD35-3	No Tier	16V-645E	2500	1960-1969	-	-	1	1	1
SW1000RS	No Tier	8V-645	1000	1960-1969	-	-	2	2	2
SW1200RS	No Tier	12V-567	1200	1960-1969	-	-	3	3	3
SW900	No Tier	8V-567	900	1960-1969	-	-	1	1	1
SW900RS	No Tier	8V-567	900	1960-1969	-	-	1	1	1
GP38	No Tier	16V-645C	2000	1970-1972	-	-	1	1	1
GP38-2	No Tier	16V-645E	2000	1970-1972	11	-	-	-	11
GP38-3	No Tier	16-645E	2000	1970-1972	2	-	-	-	2
GP38AC	No Tier	16-645E	2000	1970-1972	1	-	-	-	1
SD40	No Tier	645	3000	1970-1972	-	-	1	1	1
SD40-2	No Tier	16V-645E3	3000	1970-1972	-	-	2	2	2
SW1500	No Tier	12-645E	1500	1970-1972	-	-	1	1	1
GP38-2	No Tier	16V-645E	2000	1973-1979	30	-	13	13	43
GP38-3	No Tier	16-645E	2000	1973-1979	1	-	-	-	1
GP40-2	No Tier	16V-645E3	3000	1973-1979	-	-	7	7	7
MP1500	No Tier	12V-567	1500	1973-1979	-	-	3	3	3
SD40-2	No Tier	16V-645E3	3000	1973-1979	-	-	4	4	4
GP38-2	No Tier	16-645E	2000	1980-1989	32	-	-	-	32
GP38-3	No Tier	16-645E	2000	1980-1989	3	-	-	-	3
MP15	No Tier	12V-645	1500	1980-1989	-	-	3	3	3
SD40-2	No Tier	16V-645E3	3000	1980-1989	-	-	2	2	2
GP15-1	Tier 0	12-645E	1500	1973-1979	-	-	3	3	3
GP38-2	Tier 0	16-645E	2000	1973-1979	12	-	-	-	12
GP38-2	Tier 0	16V-645E	2000	1973-1979	4	-	-	-	4
GP38-2	Tier 0	16-645E	2000	1980-1989	1	-	-	-	1
FP9B-3	Tier 0+	16-645E	1750	1950-1959	1	-	-	-	1
GP20C-ECO	Tier 0+	8-710G3B	2000	1950-1959	127	-	-	-	127
GP38-2	Tier 0+	16V-645E	2000	1960-1969	2	-	-	-	2
GP382	Tier 0+	EMD 645E	2000	1960-1969	-	7	-	7	7
GP38	Tier 0+	EMD 645E	2000	1970-1972	-	2	-	2	2
GP38-2	Tier 0+	16-645E	2000	1970-1972	3	-	-	-	3
GP38-2	Tier 0+	16V-645E	2000	1970-1972	10	-	-	-	10
GP382	Tier 0+	EMD 645E	2000	1970-1972	-	1	-	1	1

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2024 Active Canadian Locomotive Fleet - Freight Yard Switching & Work Train Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Class 1	Regional	Shortline	Total Regional & Shortline	Total Freight Fleet
GP382	Tier 0+	645E	2000	1970-1972	10	-	-	-	10
GP38AC	Tier 0+	16-645E	2000	1970-1972	5	-	-	-	5
GP39-2C	Tier 0+	12-645E3	2300	1970-1972	-	-	2	2	2
GP40-3	Tier 0+	645E3B	3000	1970-1972	1	-	-	-	1
GP38	Tier 0+	EMD 645E	2000	1973-1979	-	2	-	2	2
GP38-2	Tier 0+	16-645E	2000	1973-1979	29	-	2	2	31
GP38-2	Tier 0+	16-645E3	2000	1973-1979	-	-	1	1	1
GP38-2	Tier 0+	16V-645E	2000	1973-1979	57	-	-	-	57
GP38-3	Tier 0+	16-645E	2000	1973-1979	3	-	-	-	3
GP382	Tier 0+	645E	2000	1973-1979	3	-	-	-	3
GP40-3	Tier 0+	645E3B	3000	1973-1979	1	-	-	-	1
SD38-2	Tier 0+	16V-645E	2000	1973-1979	3	-	-	-	3
GP38-2	Tier 0+	16V-645E	2000	1980-1989	1	-	-	-	1
GP38-2	Tier 0+	16-645E	2000	1980-1989	50	-	-	-	50
GP38-3	Tier 0+	16-645E	2000	1980-1989	6	-	-	-	6
SD70ACE	Tier 0+	16V-710G3C	4400	1990-1999	-	-	4	4	4
SD70ACE	Tier 2+	16V-710G3C	4400	2000-2009	-	-	3	3	3
GM/EMD Sub-Total					476	17	104	121	597
ALCO									
RS-18	No Tier	12V-251-B	1800	1950-1959	-	-	1	1	1
S-13	No Tier	Inline 6 251	1000	1950-1959	-	-	1	1	1
ALCO Sub-Total					-	-	2	2	2
MLW									
RS18	No Tier	12V-251B	1800	1950-1959	-	-	1	1	1
MLW Sub-Total					-	-	1	1	1
Yard Switching & Work Train Total					*476*	*17*	*107*	*124*	*600*

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Appendix B-3

2024 Active Canadian Locomotive and DMU Fleet - Passenger Train Operations

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Intercity	Commuter	Tourist/ Excursion	Total
GM/EMD								
GMD-1	No Tier	12V-567C	1200	1950-1959	-	-	1	1
GP9	No Tier	16V-567C	1750	1950-1959	-	-	1	1
GP9	No Tier	16V-645	1750	1950-1959	-	-	2	2
F40-PH	No Tier	16V-645E3B	3000	1973-1979	-	-	2	2
F40-PH	No Tier	16V-645E3B	3000	1973-1979	2	-	-	2
F40-PH-2D	No Tier	16-645E3C	3000	1980-1989	45	-	-	45
GP40-2	Tier 0	645E3B	3000	1960-1969	-	-	4	4
GP40-2LW	Tier 0	645E3B	3000	1973-1979	-	-	5	5
F59-PH	Tier 0	710	3000	1990-1999	-	5	-	5
F59-PHI	Tier 0	710	3000	1990-1999	-	3	-	3
F40-PH	Tier 0+	16V-645E3B	3000	1973-1979	-	-	1	1
F40-PH-2D	Tier 0+	16-645E3C	3000	1980-1989	6	-	-	6
GP38-2	Tier 0+	645E	2000	1980-1989	3	-	-	3
F59-PHI	Tier 0+	710	3000	1990-1999	-	3	-	3
F59-PH	Tier 2	12V-710G3	3000	1980-1989	-	10	-	10
F59-PHI	Tier 2	12V-710G3	3000	1990-1999	-	11	-	11
F59-PH	Tier 2+	710	3000	1980-1989	-	1	-	1
F59-PHI	Tier 2+	710	3000	1990-1999	-	2	-	2
GM/EMD Sub-Total					56	35	16	107
Motive Power								
MP36PH-3C	Tier 0+	645E3B	3600	2000-2009	-	1	-	1
MP40PH-3C	Tier 2	16V-710G3C	4000	2010-2019	-	29	-	29
MP40PH-3C	Tier 2+	16V-710G3C	4000	2000-2009	-	27	-	27
MP40PH-3C	Tier 3	16V-710G3C	4000	2010-2019	-	10	-	10
MP40PHT-T4-AC	Tier 4	16V-QSK95	4000	2010-2019	-	16	-	16
MP40PHTC-T4-DC	Tier 4	16V-QSK95	4000	2010-2019	-	1	-	1
Motive Power Sub-Total					-	84	-	84

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2024 Active Canadian Locomotive and DMU Fleet - Passenger Train Operations (cont'd)

Model	US EPA Tier Level	Engine	HP	Year of Manufacture	Intercity	Commuter	Tourist/ Excursion	Total
GE								
70 ton	No Tier	V12 - 1710	600	1940-1949	-	-	1	1
Other	No Tier	Cummins	1200	1950-1959	-	-	2	2
P42DC	No Tier	7FDL16	4250	2000-2009	20	-	-	20
GE Sub-Total					20	-	3	23
Siemens								
Charger	Tier 4	16V-QSK95	4200	2020-2024	23	-	-	23
Siemens Sub-Total					23	-	-	23
Bombardier								
ALP45-DP	Tier 3	3512C HD	4200	2010-2019	-	20	-	20
Bombardier Sub-Total					-	20	-	20
Baldwin								
Consolidation	Elec/Steam/Other	2-8-0		1920-1929	-	-	1	1
Baldwin Sub-Total					-	-	1	1
Dubs								
Rogers 4-4-0 steam	Elec/Steam/Other	Other	0	1880-1889	-	-	1	1
Dubs Sub-Total					-	-	1	1
Other								
Other	Tier 0+	EMD16-645E3B	3000	2020-present	-	-	1	1
Other Sub-Total					-	-	1	1
Passenger Operations Total					*99*	*157*	*22*	*278*

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Appendix C

RAILWAYS OPERATING IN TROPOSPHERIC OZONE MANAGEMENT AREAS

TOMA Region No. 1: Lower Fraser Valley, British Columbia

CN	
Division:	Mountain South
Subdivisions:	Rawlison, Yale

CPKC	
Division:	Pacific
Subdivisions:	Cascade, Mission, Page, Westminster

Other	
Southern Railway of BC Ltd	All
VIA Rail Canada	Part
Great Canadian Railtour Company	Part
West Coast Express	All

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TOMA Region No. 2: Québec City-Windsor Corridor, Ontario And Québec

CN	
District:	Champlain
Subdivisions:	Becancour, Rouses Point, Bridge, Sorel, Deux Montagnes, St. Hyacinthe, Drummondville, St. Laurent, Joliette, Valleyfield, Montréall
District:	Great Lakes
Subdivisions:	Alexandria, Grimsby, Strathroy, Caso, Halton, Talbot, Chatham, Kingston, Uxbridge, Dundas, Oakville, Weston, Guelph, Paynes, York

CPKC	
Division:	Canada Québec
Subdivisions:	Adirondack, Adirondack CMQ, Lacolle, Moosehead West, Newport North, Outremont Spur, Sherbrooke, St Luc Branch, Vaudreuil, Winchester
Division:	Canada Ontario
Subdivisions:	Belleville, Brockville, Dunnville spur, Galt, Hamilton, Havelock, Mactier, Montrose, Nephton, North Toronto, Stamford, Stevensville Spur, Waterloo, Windsor

Other	
Essex Terminal Railway	All
Goderich—Exeter Railway	All
Ontario Southland Railway	All
Québec Gatineau Railway	All
Southern Ontario Railway	All
St-Lawrence & Atlantic (Canada)	All
GIO Rail Holdings	All
VIA Rail Canada	Part
Metrolinx (GO Transit)	All
exo	All
Capital Railway	All

TOMA Region No. 3: Saint John Area, New Brunswick

CN	
District:	Champlain
Subdivisions:	Denison, Sussex

Other	
New Brunswick Southern	All

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Appendix D

LOCOMOTIVE EMISSION STANDARDS

Locomotive Emissions Regulations

THE LOCOMOTIVE EMISSIONS REGULATIONS

- Came into force on June 9, 2017 and were published in Canada Gazette, Part II on June 28, 2017.
- Were developed by Transport Canada under the *Railway Safety Act* subsection 47.1(2).
- Align with existing regulations in the U.S. (i.e., *Title 40 of the U.S. Code of Federal Regulations (CFR), Part 1033* administered by the U.S. Environmental Protection Agency (EPA)).
- Limit emissions of criteria air contaminants (CACs), including, nitrogen oxides (NOx), particulate matter (PM), hydrocarbons (HC), and carbon monoxide (CO), as well as smoke.
- Apply to railway companies that operate under federal jurisdiction in Canada and the locomotives that they operate.

The *Locomotive Emissions Regulations* require railway companies to:

- meet emission standards for new locomotives;
- carry out emissions testing;
- follow labelling and anti-idling requirements;
- keep records; and
- file reports with Transport Canada.

More information on the *Locomotive Emissions Regulations* can be found on the Transport Canada website at: https://tc.canada.ca/en/rail-transportation/rail-safety/regulations/overview-locomotive-emissions-regulations

More information on the U.S. regulations can be found on the U.S. EPA website at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-emissions-locomotives

EMISSION STANDARDS

Based on the type of locomotive (line haul or switch locomotive) and the year of original manufacture, new locomotives are required to meet the increasingly stringent tier of standards for NO_x, PM, HC and CO emissions, as well as smoke opacity. Locomotives are required to meet the applicable tier of standards for their entire useful life and, in certain cases, for their entire service life.

The U.S. first started regulating emissions from locomotives in 2000 under 40 CFR Part 92. These regulations included emission standards for 3 Tier levels (Tier of standards): Tier 0, Tier 1, and Tier 2.

The U.S. regulations were updated in 2008 under 40 CFR Part 1033. These are the current regulations, which set out emission standards for 5 Tier levels (Tier of standards): Tier 0, Tier 1, Tier 2, Tier 3 and Tier 4. Note: Tier 0, Tier 1, and Tier 2 are sometimes referred to as Tier 0+, Tier 1+, and Tier 2+ as these current emission standards under 40 CFR Part 1033 are more stringent than those under the older emission standards under 40 CFR Part 92.

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The emission standards under the *Locomotive Emissions Regulations* are identical to the current emission standards set out in the U.S. regulations under 40 CFR Part 1033.

The *Locomotive Emissions Regulations* incorporate by reference specific tables, footnotes and paragraphs of 40 CFR Part 1033, which set out the emission standards and can be found online at: eCFR : 40 CFR 1033.101 - Exhaust emission standards.

The older emission standards, under the U.S. regulations 40 CFR Part 92, typically no longer apply, unless a locomotive is covered by an EPA certificate that sets out family emission limits (FELs), as family emission limits (FELs) are valid for the locomotive's service life. The older emission standards, which were set out in section 92.8 of 40 CFR Part 92 can be found online at: eCFR : Appendix A to Part 1033, Title 40 - Original Standards for Tier 0, Tier 1 and Tier 2 Locomotives.

A railway company's fleet can contain locomotives that:

- meet the current emission standards;
- meet the older emission standards; and
- do not meet any emission standards.

When reporting on Tier of standards for regulatory reporting, there are 9 Tier of standards options:

Tier of standards for regulatory reporting	Description	Tier of standards for LEM reporting
CDN/40 CFR 1033 Tier 0	Meets the current Canadian emission standards or the current U.S. emission standards under Title 40 CFR Part 1033. This Tier of standards is sometimes referred to as Tier 0+.	Tier 0+
CDN/40 CFR 1033 Tier 1	Meets the current Canadian emission standards or the current U.S. emission standards under Title 40 CFR Part 1033. This Tier of standards is sometimes referred to as Tier 1+.	Tier 1+
CDN/40 CFR 1033 Tier 2	Meets the current Canadian emission standards or the current U.S. emission standards under Title 40 CFR Part 1033. This Tier of standards is sometimes referred to as Tier 2+.	Tier 2+
CDN/40 CFR 1033 Tier 3	Meets the current Canadian emission standards or the current U.S. emission standards under Title 40 CFR Part 1033.	Tier 3
CDN/40 CFR 1033 Tier 4	Meets the current Canadian emission standards or the current U.S. emission standards under Title 40 CFR Part 1033.	Tier 4
40 CFR 92—Tier 0	Meets the older emission standards in the U.S. emission standards under Title 40 CFR Part 92.	Tier 0
40 CFR 92—Tier 1	Meets the older emission standards in the U.S. emission standards under Title 40 CFR Part 92.	Tier 1
40 CFR 92—Tier 2	Meets the older emission standards in the U.S. emission standards under Title 40 CFR Part 92.	Tier 2
No Tier	Does not meet any emission standards.	No Tier

For further information on the *Locomotive Emissions Regulations*, please contact Transport Canada's Rail Safety Directorate:

- Telephone: 613-998-2985, 1-844-897-7245 (toll-free)
- Email: TC.RailSafetyandSecurity-Securiteetsureteferroviaires.TC@tc.gc.ca

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Appendix E

GLOSSARY OF TERMS

Terminology Pertaining To Railway Operations

CLASS 1 RAILWAY

Class 1 rail carrier means a railway company that realized gross revenues of at least $250 million for the provision of rail services in each of the two previous calendar years, as defined in federal regulations.

DIESEL MULTIPLE UNIT (DMU)

A self-propelled passenger train consisting of one or more rail vehicles powered by onboard diesel engines, with propulsion equipment integrated into the train rather than provided by a separate locomotive.

INTERMODAL SERVICE

The movement of trailers on flat cars (TOFC) or containers on flat cars (COFC) by rail and at least one other mode of transportation. Import and export containers generally are shipped via marine and rail. Domestic intermodal services usually involve truck and rail modes.

LOCOMOTIVE ACTIVE FLEET

Refers to all locomotives, owned or leased, being used by a railway company for its railway operations in Canada. Not included in the active fleet are locomotives put in storage or removed as a result of being scrapped, sold or destroyed.

LOCOMOTIVE POWER RANGES

Locomotives are categorized as high horsepower (having engines greater than 3,000 hp), medium horsepower (2,000 to 3,000 hp) or low horsepower (less than 2,000 hp).

LOCOMOTIVE PRIME MOVERS

The diesel engine is the prime mover of choice for locomotives in operation on Canadian railways. Combustion takes place in a diesel engine by compressing the fuel and air mixture until auto-ignition occurs.

LOCOMOTIVE REMANUFACTURE

The “remanufacture” of a locomotive is a process in which all the power assemblies of a locomotive engine are replaced with freshly manufactured (containing no previously used parts) or refurbished power assemblies or those inspected and qualified. Inspecting and qualifying previously used parts can be done in several ways, including such methods as cleaning, measuring physical dimensions for proper size and tolerance, and running performance tests to ensure that the parts are functioning properly and according to specifications. Refurbished power assemblies could include some combination of freshly manufactured parts, reconditioned parts from other previously used power assemblies, and reconditioned parts from the power assemblies that were replaced. In cases where all the power assemblies are not replaced at a single time, a locomotive will be considered to be “remanufactured” (and therefore “new”) if all power assemblies from the previously new engine had been replaced within a 5-year period.

This definition for remanufactured locomotives is taken from the *U.S. Federal Register Volume 63, No. 73 April 16, 1998/Rules and Regulations for the Environmental Protection Agency* (US EPA) 40 CFR Parts 85, 89 and 92 *(Emission Standards for Locomotives and Locomotive Engines).*

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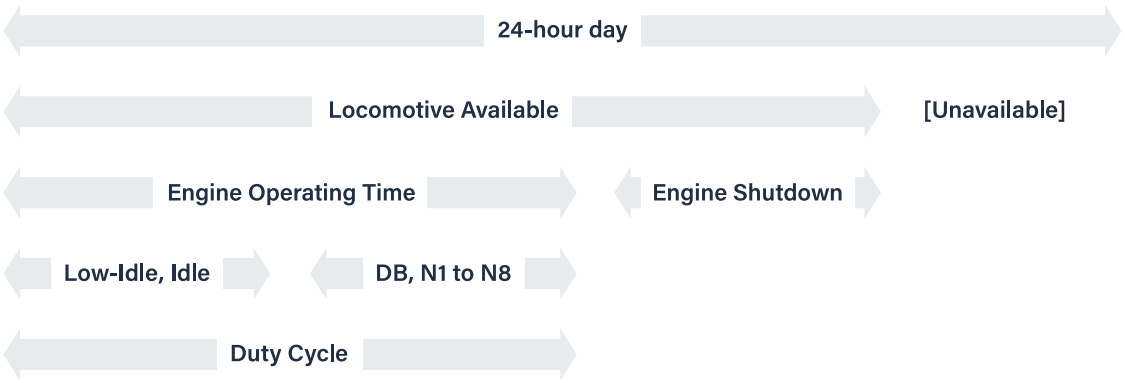
LOCOMOTIVE UTILIZATION PROFILE

This is the breakdown of locomotive activity within a 24-hour day (based on yearly averages).

The elements in the above diagram constitute, respectively:



- **Locomotive Available:** This is the time expressed in % of a 24-hour day that a locomotive could be used for operational service. Conversely, Unavailable is the percentage of the day that a locomotive is being serviced, repaired, remanufactured, or stored. Locomotive available time plus unavailable time equals 100%.
- **Engine Operating Time:** This is the percentage of Locomotive Available time that the diesel engine is turned on. Conversely, Engine Shutdown is the percentage of Locomotive Available time that the diesel engine is turned off.
- **Idle:** This is the % of the operating time that the engine is operating at idle or low-idle setting. It can be further segregated into Manned Idle (when an operating crew is on-board the locomotive) and Isolate (when the locomotive is unmanned).
- **Duty Cycle:** This is the profile of the different locomotive power settings (Low-Idle, Idle, Dynamic Braking, or Notch levels 1 through 8) as percentages of Engine Operating Time.

RAILWAY PRODUCTIVITY UNITS

- **Gross Tonne-Kilometres (GTK):** This term refers to the product of the total weight (in tonnes) of the trailing tonnage (both loaded and empty railcars) and the distance (in kilometres) the freight train travelled. It excludes the weight of locomotives pulling the trains. Units can also be expressed in gross ton-miles (GTM).
- **Revenue Tonne-Kilometres (RTK):** This term refers to the product of the weight (in tonnes) of revenue commodities handled and the distance (in kilometres) transported. It excludes the tonne-kilometres involved in the movement of railway materials or any other non-revenue movement. The units can also be expressed in revenue ton-miles (RTM).
- **Passenger-Kilometres per Train-Kilometre:** This term is a measure of intercity train efficiency, which is the average of all revenue passenger kilometres travelled divided by the average of all train kilometres operated.
- **Revenue Passenger-Kilometres (RPK):** This term is the total of the number of revenue passengers multiplied by the distance (in kilometres) the passengers were transported. The units can also be expressed in revenue passenger-miles (RPM).

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TERMINOLOGY OF DIESEL LOCOMOTIVE EMISSIONS

Emission Factors (EFs): An emission factor is the average mass of a product of combustion emitted from a particular locomotive type for a specified amount of fuel consumed. The EF units are grams, or kilograms, of a specific emission product per litre of diesel fuel consumed (g/L).

Emissions of Criteria Air Contaminant (CAC): CAC emissions are by-products of the combustion of diesel fuel that impact on human health and the environment. The principal CAC emissions are:

- Nitrogen Oxides (NO_x): These result from high combustion temperatures. The amount of NO_x emitted is a function of peak combustion temperature. NO_x reacts with hydrocarbons to form ground-level ozone in the presence of sunlight which contributes to smog formation.
- Carbon Monoxide (CO): This toxic gas is a by- product of the incomplete combustion of fossil fuels. Relative to other prime movers, it is low in diesel engines.
- Hydrocarbons (HC): These are the result of incomplete combustion of diesel fuel and lubricating oil.
- Particulate Matter (PM): This is residue of combustion consisting of soot, hydrocarbon particles from partially burned fuel and lubricating oil and agglomerates of metallic ash and sulphates. It is known as primary PM. Increasing the combustion temperatures and duration can lower PM. It should be noted that NO_x and PM emissions are interdependent such that technologies that control NO_x (such as retarding injection timing) result in higher PM emissions, and conversely, technologies that control PM often result in increased NO_x emissions.
- Sulphur Oxides (SO_x): These emissions are the result of burning fuels containing sulphur compounds. For LEM reporting, sulphur emissions are calculated as SO_2. These emissions can be reduced by using lower sulphur content diesel fuel. Reducing fuel sulphur content will also typically reduce emissions of sulphate based PM.

EMISSIONS OF GREENHOUSE GASES (GHG)

In addition to CACs, GHG emissions are also under scrutiny due to their accumulation in the atmosphere and contribution to global warming. The GHG constituents produced by the combustion of diesel fuel are listed below:

- Carbon Dioxide (CO_2): This gas is by far the largest by-product of combustion emitted from engines and is the principal GHG, which due to its accumulation in the atmosphere, is considered to be the main contributor to global warming. It has a Global Warming Potential of 1.0. CO_2 and water vapour are normal by-products of the combustion of fossil fuels.
- Methane (CH_4): This is a colourless, odourless, and flammable gas, which is a by-product of incomplete diesel combustion. Relative to CO_2, it has a Global Warming Potential of 28.
- Nitrous Oxide (N_2O): This is a colourless gas produced during combustion that has a Global Warming Potential of 265 (relative to CO_2).

The sum of the constituent GHGs expressed in terms of their equivalents to the Global Warming Potential of CO_2 is depicted as CO_2e. This is calculated by multiplying the volume of fuel consumed by the emission factors of each constituent, then, in turn, multiplying the product by the respective Global Warming Potential, and then summing them. See Table 8 for conversion values pertaining to diesel fuel combustion.

EMISSIONS METRICS

The unit of measurement for the constituent emissions is grams per brake horsepower-hour (g/bhp-hr). This is the amount (in grams) of a particular constituent emitted by a locomotive's diesel engine for a given amount of mechanical work (brake horsepower) over one hour for a specified duty cycle. This measurement allows a ready comparison of the relative cleanliness of two engines, regardless of their rated power.

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Appendix F

Conversion Factors Related to Railway Operations

Imperial gallons to litres	4.5461
US gallons to litres	3.7853
Litres to Imperial gallons	0.2200
Litres to US gallons	0.2642
Miles to kilometres	1.6093
Kilometres to miles	0.6214
Metric tonnes to tons (short)	1.1023
Tons (short) to metric tonnes	0.9072
Revenue ton-miles to Revenue tonne-kilometres	1.4599
Revenue tonne-kilometres to Revenue ton-miles	0.6850

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Appendix G

Abbreviations and Acronyms Used in the Report

ABBREVIATIONS OF UNITS OF MEASURE

bhp	Brake horsepower	*kg/1,000 RTK*	Kilograms per 1,000 revenue tonne-kilometres
g	Gram	*km*	Kilometre
g/bhp-hr	Grams per brake horsepower hour	*kt*	Kilotonne
g/GTK	Grams per gross tonne-kilometre	*L*	Litre
g/L	Grams per litre	*L/hr*	Litres/hour
g/RTK	Grams per revenue tonne-kilometre	*lb*	Pound
hr	Hour	*ppm*	Parts per million

ABBREVIATIONS USED IN RAILWAY OPERATIONS

AESS	Automatic Engine Stop-Start	*MOU*	Memorandum of Understanding
APU	Auxiliary Power Unit	*N1, N2 . . .*	Notch 1, Notch 2... Throttle Power Settings
COFC	Container-on-Flat-Car	*RDC*	Rail Diesel Car
DB	Dynamic Brake	*RPK*	Revenue Passenger-Kilometres
DMU	Diesel Multiple Unit	*RPM*	Revenue Passenger-Miles
EMU	Electric Multiple Unit	*RTK*	Revenue Tonne-Kilometres
GTK	Gross Tonne-Kilometres	*RTM*	Revenue Ton-Miles
LEM	Locomotive Emissions Monitoring	*TOFC*	Trailer-on-Flat-Car
LER	*Locomotive Emissions Regulations*	*ULSD*	Ultra-low Sulphur Diesel Fuel
LRV	*Light Rail Vehicle*		

ABBREVIATIONS OF EMISSIONS AND RELATED PARAMETERS

CAC	Criteria Air Contaminant	*HC*	Hydrocarbons
CO_2	Carbon Dioxide	*NO_x*	Nitrogen Oxides
CO_2e	Carbon Dioxide equivalent of all six Greenhouse Gases	*PM*	Particulate Matter
		SO_x	Sulphur Oxides
CO	Carbon Monoxide	*SO_2*	Sulphur Dioxide
EF	Emission Factor	*TOMA*	Tropospheric Ozone Management Areas
GHG	Greenhouse Gas		

ACRONYMS OF ORGANIZATIONS

AAR	Association of American Railroads	*IPCC*	Intergovernmental Panel on Climate Change
ALCO	American Locomotive Company	*MLW*	Montreal Locomotive Works
CGSB	Canadian General Standards Board	*OEM*	Original Equipment Manufacturer
CN	Canadian National Railway	*RAC*	Railway Association of Canada
CP	Canadian Pacific	*TC*	Transport Canada
CPKC	Canadian Pacific Kansas City Limited	*UNFCCC*	United Nations Framework Convention on Climate Change
ECCC	Environment and Climate Change Canada		
GE	General Electric Transportation Systems	*US EPA*	United States Environmental Protection Agency
GM/EMD	General Motors Corporation Electro-Motive Division	*VIA*	VIA Rail Canada

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Appendix H

CALCULATIONS METHODOLOGY

Data Collection

RAC members complete an annual statistical survey that forms the basis of the yearly LEM reports. The survey collects information pertaining to (but not limited to):

TRAFFIC DATA:

- Freight railways: revenue tonne-kilometres; gross tonne-kilometres; carloads by commodity.
- Passenger railways: number of passengers; passenger-kilometres; train kilometres; average length of journey; average number of passengers per train.

FUEL CONSUMPTION DATA:

- Fuel consumed across four service categories: line haul service; yard switching service; work train service; and passenger service.
- Total biofuel consumption.

LOCOMOTIVE INVENTORY:

- For each locomotive in the railway's fleet, details on: manufacturer, model, EPA tier level, engine, horsepower, year of original manufacture, anti-idle devices, and service type (line haul; yard).

Data Analysis

Internally, the RAC aggregates the information to produce industry statistics. In many cases, information is aggregated either by type of railway (Class 1; regional & shortline; intercity passenger; commuter passenger; and tourist/excursion passenger), by service (line haul, yard, work train, etc.), or by region (TOMAs).

Data on GHG emission factors are from Environment and Climate Change Canada, and data on CAC emission factors are from the United States Environmental Protection Agency.

Data Review

RAC's calculations are submitted to a consultant for a Quality Assurance / Quality Control process to validate the calculations. Afterwards, the calculations and a report draft are submitted to the Technical Review Committee, consisting of railway, non-governmental, and government representatives, to further review and approve the calculations.

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Appendix I

IMPACT OF BIOFUELS ON GHG EMISSIONS FACTORS

Under the MOU, parties committed to exploring the feasibility of achieving 10 to 20% of low-carbon fuels use within the rail sector by 2030. In 2024, the use of low-carbon fuels contributed to a reduction in locomotive emissions.

In 2022 and earlier LEM reports, all fuel litres were assumed to be diesel fuel oil (B0). In this report, historical EFs have been updated to account for estimated biofuel consumption. 2024 locomotive biofuel consumption was obtained by RAC through its annual member survey, whereas biofuel consumption in previous years was provided by ECCC.

The table below illustrates the impact of accounting for biofuels in the GHG emissions factors.

		Assuming zero biofuel		2024 LEM Report			Biofuels' impact on the GHG emissions factor and total emissions
Year	Total Fuel Consumption (million litres)	GHG emissions factor (kg CO_2e/L)	Total CO_2e emissions (kilotonnes)	Biofuels consumption (million litres)	GHG emissions factor (kg CO_2e/L)	Total CO_2e emissions (kilotonnes)	
2005	2,209.00	2.9574	6,532.81	0.13	2.9572	6,532.47	-0.0%
2006	2,210.50	2.9574	6,537.24	2.03	2.9550	6,532.02	-0.1%
2007	2,237.24	2.9574	6,616.31	5.57	2.9509	6,601.92	-0.2%
2008	2,185.12	2.9574	6,462.18	8.12	2.9478	6,441.21	-0.3%
2009	1,871.18	2.9574	5,533.75	6.85	2.9479	5,516.06	-0.3%
2010	2,044.37	2.9574	6,045.93	11.79	2.9425	6,015.56	-0.5%
2011	2,087.49	2.9574	6,173.46	31.66	2.9183	6,091.98	-1.3%
2012	2,131.49	2.9574	6,303.59	37.98	2.9115	6,205.85	-1.6%
2013	2,100.39	2.9574	6,211.60	40.59	2.9076	6,107.13	-1.7%
2014	2,197.17	2.9574	6,497.81	44.76	2.9050	6,382.74	-1.8%
2015	2,132.88	2.9574	6,307.69	39.52	2.9097	6,206.05	-1.6%
2016	2,001.97	2.9574	5,920.54	41.01	2.9047	5,815.15	-1.8%
2017	2,157.98	2.9574	6,381.92	52.66	2.8947	6,246.71	-2.1%
2018	2,242.19	2.9574	6,630.95	51.32	2.8986	6,499.21	-2.0%
2019	2,259.24	2.9574	6,681.38	57.65	2.8919	6,533.54	-2.2%
2020	2,090.94	2.9574	6,183.65	65.61	2.8770	6,015.53	-2.7%
2021	2,033.33	2.9574	6,013.27	65.85	2.8743	5,844.41	-2.8%
2022	2,018.61	2.9574	5,969.74	69.40	2.8692	5,791.80	-3.0%
2023	2,057.07	2.9574	6,083.48	113.17	2.8169	5,794.52	-4.7%
2024	2,129.67	2.9574	6,298.18	176.43	2.7457	5,847.42	-7.2%

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