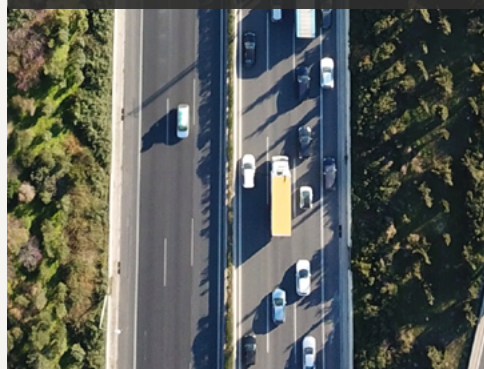


TRANSPORTATION





Canada's advantage in electric vehicles lies in its potential to develop an integrated battery and automotive value chain anchored in critical minerals, clean electricity, and existing automotive manufacturing capacity.



8. Transportation

Few things shape daily life in Canada more than the movement of people and goods. Transportation gets people to work, to school, and to one another. It carries the food, fuel, and materials that keep the economy moving. Today most transport still runs on fossil fuels, and this constitutes Canada's second-largest source of greenhouse gas emissions.

The majority of passenger journeys are made in personal vehicles: the cars and light trucks found in driveways across the country, which convey more than 80% of Canadian commuters. Most of the country's freight travels by truck, from the delivery vans threading through cities to the long-haul rigs on highways. Beyond the road, rail carries bulk freight and people over long distances; ships move cargo through ports and along the coasts and inland waterways; aircraft connect a country too large to cross easily any other way; and off-road machinery is at work in mines, farms, forests, and construction sites. All operate almost exclusively on petroleum-based fuels.

The clearest route away from fossil fuel dependence is electrification. Battery-electric vehicles already offer a mature alternative for cars and light trucks, and the technology is moving steadily into delivery vans and heavier trucks. But electrification cannot reach every mode with equal ease. Long-haul trucking, marine shipping, and aviation face distance and energy demands that batteries cannot yet meet—and here low-carbon fuels and hydrogen can close the gap. Decarbonizing transportation means electrifying wherever it is practical, turning to alternative fuels where it is not, and alongside both, reducing how much vehicle travel is required.

The discussion that follows concentrates on three elements of road transport where emissions and abatement opportunities are largest: light-duty vehicles, medium- and heavy-duty trucks, and the mass transit systems that serve commuters in Canada's larger metropolitan regions. Aviation, marine, rail, and off-road transport each raise distinct challenges that will not be examined further here but have been analyzed in other work from The Transition Accelerator.

As the following analysis will make clear, transitions in transport confront real challenges and trade-offs. Vehicle lifetimes of a decade or more mean that purchases made this decade will shape emissions into the 2040s. Progress in market segments where electrification is difficult will depend on low-carbon fuels and hydrogen. And questions remain as to whether Canada can retain a place in vehicle and battery manufacturing as global production reorganizes around electric drivetrains.

The assessments that follow do not attempt to predict how quickly the vehicle fleet will turn over or which technologies will prevail in every case. They do indicate the direction of probable advance and are intended to help decisionmakers distinguish options that appear most promising, those that face unresolved barriers, and those unlikely to deliver at the scale some anticipate.

8.1 LIGHT-DUTY VEHICLES (LDVs)

Function	Mobility for work, shopping, social activities, recreation.
GHG emissions	11.4% of Canadian emissions in 2023 (78.2 Mt CO ₂ e)[215]. Represents 41% of transportation emissions; additional emissions associated with production of gasoline.
Options for decarbonization	Decarbonization pathway: Battery electric vehicles. Bridge pathway: Plug-in hybrid vehicles. Potential niche pathway: Hydrogen fuel cell vehicles. Enabling pathways: Modal shift, shared mobility models, vehicle right-sizing.
Stage of transition	Diffusion: Battery electric vehicles. Emergence: Fuel cell.
Nature of the problem today	Structural dependence of the transportation system on private vehicle ownership; uneven charging/refuelling infrastructure; slow fleet turnover with long vehicle lifetimes (10-15 years); policy and market uncertainty; supply side challenges in scaling electric vehicle production.
Other systemic issues	Air and noise pollution; traffic congestion; car-dependent land-use patterns; automotive industry manufacturing, workforce and service ecosystem transition.
Strategic opportunities and concerns	Opportunities: Electric vehicles (EVs) offer lower fuel and maintenance costs and total cost of ownership; reduced air pollution; Canada holds strategic advantages in critical minerals, clean electricity, and existing manufacturing capacity that could anchor a domestic battery and EV value chain. Concerns: Without sufficient investment in EV manufacturing and supply chains, existing Canadian auto sector jobs and industrial capacity are at risk; loss of competitiveness to global leaders; range anxiety, cold-weather performance, charging times, high voltage and fire risks, and increased dependence on original equipment manufacturers for maintenance and servicing.

Priorities for action	Subsidies and incentives for EV purchases; infrastructure investment for home, depot, and corridor charging including in multi-unit residential buildings; government fleet and procurement standards; support for domestic EV and battery manufacturing and value chain development; enable shared mobility and modal shift; consumer education on EV costs and performance; workforce training and reskilling for mechanics and service technicians.
Longer-term issues	Managing grid integration, complementary technologies, smart charging, and vehicle-to-grid; integration with connected and autonomous vehicles; end-of-life recycling/disposal; EV and battery supply chain concentration risk.
Indicators of progress	Share of zero-emissions vehicle sales and fleet; rate of fleet turnover; availability and accessibility of charging infrastructure; domestic EV and battery production capacity and value chain development; and growth of independent aftermarket service ecosystem.

8.1.1 Current Status

The global auto industry has been a pillar of economic development for more than a century and plays two distinct but interrelated roles in Canada's economy. First, it is the backbone of personal mobility, with roughly 89% of Canadian households relying on at least one car or light-duty truck (SUVs, pickups, vans)[216]¹. Second, it is a major industrial sector, directly employing more than 125,000 workers and contributing \$16.8 billion to GDP. [217] Its role in mobility has evolved gradually with the expansion of mass transit and changing travel patterns, but its role as an economic engine is poised for a fundamental transformation in the coming decades.

On the mobility front, light-duty vehicles (LDVs) play a major role in Canada's transportation system. Between 2008 and 2024, the vehicle population grew by 37% (from 19.6 million to 26.8 million), with light-duty trucks making up the fastest-growing segment.[218,219] Today, more than 80% of Canadian commuters rely on a personal vehicle to get to work, underscoring the central role of LDVs in Canada's transportation system.[220]

In addition to its large share of personal transport, Canada has a substantial auto manufacturing sector that is a major economic driver. Five multinational companies (Stellantis, Ford, GM, Honda and Toyota) operate vehicle assembly plants, supported by a network of parts suppliers, machine tool and electronics firms, and testing and R&D facilities.

The fundamentals of this industry have changed drastically over the past two decades. In the early 2000s, production was dominated by a relatively stable cohort of North American, European, and Japanese manufacturers competing primarily on brand, features, and incremental improvements within an internal combustion engine (ICE) system. Back then, Canada was assembling roughly 2.9 million vehicles per year, accounting for about 17% of North American output.[221]

Canada's position in the global market has been in steady decline since then. By 2024, assembly had fallen to approximately 1.3 million units—a decline of more than half. Over the same period, Canada's share of North American production dropped by more than eight percentage points, as Mexico overtook Canada as the continent's lowest-cost

¹ All noted references can be found in the full Playbook document.

producer.[222] The shift to electric powertrains is moving the centre of industrial value to battery supply chains which Chinese firms now dominate. In fact, China went from producing roughly 2 million vehicles in 2000 to over 31 million by 2024.[223]

This decline in manufacturing comes at a time when supply chains are reorganizing around electrification of LDVs. The five Canadian assemblers are all legacy ICE-oriented manufacturers, and incumbent automakers across North America and Europe have struggled with this transition. U.S.-based automakers have been particularly hard hit in recent years. They belatedly began to invest heavily in EV production under the Biden administration, which provided subsidies for EV purchases and generous support for battery plants and EV assembly facilities. With the election of President Trump, the policy environment was reversed. The removal of production and consumption incentives for electrification, as well as the tariff and trade-related disruptions to the integrated North American auto market, caused billions of dollars in losses for legacy automakers.[224]

For the Canadian industry, the trade issue is existential, with the U.S. threatening to end or dramatically re-write the Canada-U.S.-Mexico free trade agreement (CUSMA), potentially robbing the export-oriented Canadian industry of access to its critical market.[225] The automotive industry provides the country's second-largest export. Most motor vehicles and parts go to the United States (94% in 2024).[226] This leaves the sector highly exposed to shifts in U.S. trade policy, continental industrial strategy, and cross-border supply chain dynamics at precisely the moment when the global industry is being reorganized around electrification and new centres of competitive advantage.[227]

In Canada, zero-emission vehicles (ZEVs) reached 18.3% of new vehicle registrations in 2024, falling back to 11.2% in 2025. These dynamics—the pace of electrification, the concentration of battery supply chains, and the repositioning of major producers—are increasingly shaping vehicle availability, costs, and competitiveness in the Canadian market.

8.1.2 Nature of the Problem

GHG emissions from LDVs are a central decarbonization challenge in Canada as they make up 11.4% of the national emissions (78.2 Mt). 41% of Canadian transportation emissions overall are from LDVs.[215] Almost all LDVs run on gasoline (95% of LDV energy consumption); the remaining 5% run on diesel, propane, electricity and natural gas.[228]

Over time, the fuel efficiency of internal combustion engine (ICE) vehicles has improved, mainly due to strict air pollution regulations.[229] Though these measures have lowered GHG emissions per vehicle, total annual LDV emissions have not declined significantly.[230] This reflects both growth in the vehicle fleet and a shift toward larger, less efficient vehicles—particularly SUVs and pickup trucks, which now dominate the market.[231,232]

The core challenge is therefore structural. Canada's transportation system is highly dependent on personal vehicles, and the existing vehicle population is overwhelmingly powered by ICEs. Vehicles also have long lifetimes, often 10–15 years or more, meaning that emissions reductions depend not only on new vehicle sales, but on the gradual turnover of the existing fleet.

Decarbonizing the LDV sector requires a system-wide transition to ZEVs, alongside supporting infrastructure and policy. Several key challenges remain:

- **Charging:** Infrastructure is expanding but remains uneven, especially in rural and remote areas and for residents of multistory buildings; access, cost, and charging time remain barriers.[233]
- **Grid capacity and infrastructure readiness:** Large-scale electrification will require significant expansion and coordination of electricity systems.
- **Affordability of ZEVs:** Higher upfront costs remain a barrier, particularly for high-demand vehicle segments such as pickup trucks and SUVs.[234]
- **Technology perceptions:** Concerns about range, cold-weather performance, and safety persist, though they are diminishing.
- **Policy and market uncertainty:** Changing ZEV sales mandates, consumer incentives, and trade measures create uncertainty for consumers and investors.
- **Workforce and service ecosystem transition:** Electrification reduces mechanical complexity and shifts maintenance needs, increasing dependence on original equipment manufacturers (OEMs) and requiring reskilling of mechanics and service workers.

The battery supply chain that underpins the new industrial architecture is concentrated in China, not North America. The window for Canada to build a meaningful position in EV and battery production is narrowing. If it closes, the long-running erosion of Canada's auto sector will accelerate as the global transition gathers pace. The problem is particularly acute in the absence of a home-grown OEM.

8.1.3 Net-Zero Pathways

Decarbonizing Canada's LDV sector requires transforming both vehicle technologies and the broader transportation system.

LDV decarbonization

There are two main technological routes to decarbonize power trains in vehicles: electrification or the use of alternative fuels. Electric vehicles are largely seen as the better solution and, therefore, the focus of this section. For an evaluation of the difficulties with alternative fuel approaches—such as blending ethanol with gasoline, switching to renewable natural gas, biofuel vehicles, or synthetic (non-fossil-derived) gasoline—see the assessment table below.

The movement to net-zero GHG emissions requires a fundamental shift in vehicle design away from ICEs. Battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs, which have auxiliary gasoline motors), hybrid-electric vehicles (HEVs, with gasoline engines and battery storage charged from regenerative braking), or hydrogen fuel cell electric vehicles (FCEVs) are alternatives. BEVs offer lower lifetime vehicle costs (reduced operating and maintenance costs), improved performance, and elimination of tailpipe air pollutants (i.e. particulate matter, nitrogen oxides, VOCs). HEVs, without plug-in capabilities, are not discussed further, as they are a dead-end pathway, not a bridge between gasoline and electric vehicles. They require gasoline to operate and do not drive the buildout of charging infrastructure required by BEVs.

BEVs are in the diffusion phase and are the dominant ZEV design. Vehicle functionality has improved, and producers are benefiting from improved economies of scale, infrastructure rollout, complementary innovations, and favourable regulatory and policy frameworks.[77] PHEVs are also in diffusion, offering a bridge pathway between

ICE and fully electric powertrains. FCEVs remain in the emergence phase with limited infrastructure and niche applications.

The total cost of ownership for BEVs is now often lower than that of ICE vehicles, driven in part by global battery pack prices dropping 25% compared to 2023 levels. [235] While EVs experience only slightly greater range reductions in cold weather than ICE vehicles (14%–39% versus 12%–28%), performance in low temperatures can

be a concern. That said, cold-weather performance and overall vehicle range (both major consumer concerns) have steadily improved over time.[236–238]

The deployment of charging infrastructure has expanded significantly across Canada, from 313 chargers in 2019 to close to 40,000 in 2024, but remains uneven across regions, particularly in rural and remote areas (Figure 22).[151,233]

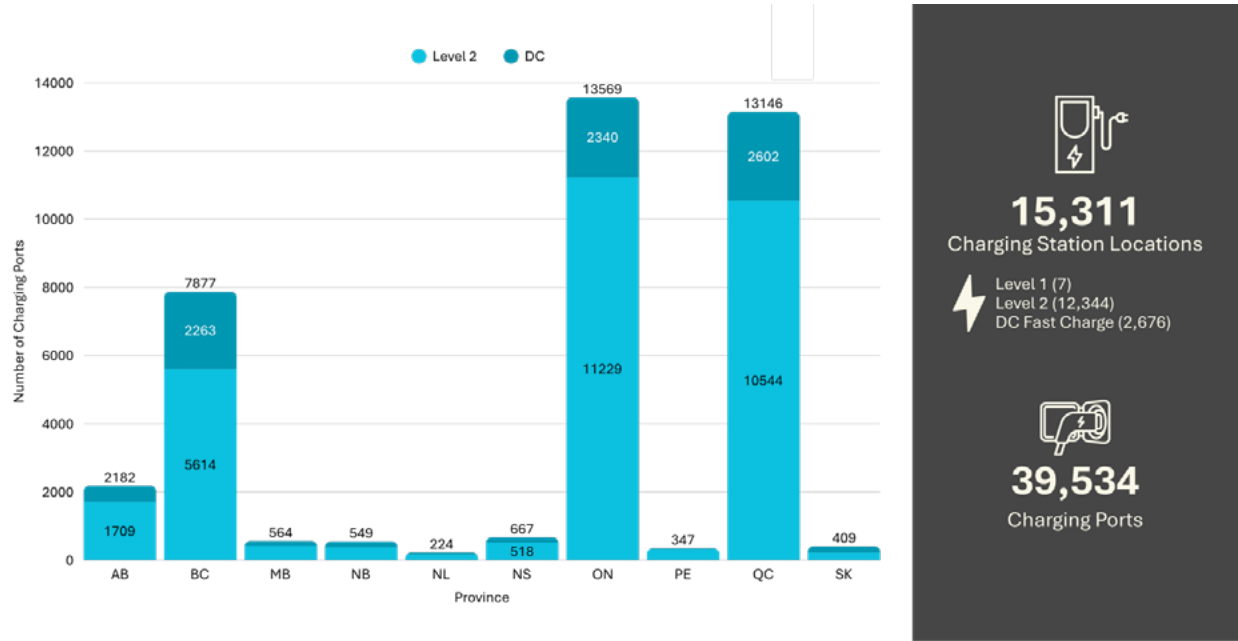


Figure 22. Total number of EV charging station locations and charging ports by province and charger type
Source: Natural Resources Canada, 2024. Electric Charging and Alternative Fuelling Stations Locator.[151]

Broader transportation system changes

Electrification alone will not achieve net-zero emissions. Reducing demand and shifting travel behaviour are also essential.

Modal shift: Increasing the share of trips made by public transit, active transportation (walking and cycling), and shared mobility (carpooling) can significantly reduce per-capita emissions, particularly in urban areas.[239]

Shared mobility services: The growth of car-sharing platforms, ride-hailing, micromobility and other mobility-as-a-service models can reduce vehicle ownership and increase utilization rates, lowering total vehicle numbers over time.[240–242]

Vehicle efficiency and right-sizing: Encouraging smaller, more efficient vehicles (particularly in urban contexts) can reduce energy demand even as electrification progresses.[243]

Efficient land-use planning: Compact, transit-oriented development can reduce reliance on personal vehicles, shorten or consolidate trip distances, and support lower-emission travel behaviours.[243]

Automotive industry transformation

Over the past decade, international EV production has ramped up to exceed 17 million in 2024, with over 70% of that production taking place in China.[244] Globally, EVs make up about 22% of car sales but have taken a larger share in a few lead markets (Norway 92%, Sweden 58%, Denmark 56%, Finland 50%, and China and the Netherlands 48%).[245] The balance of sales between types of EVs in 2024 was dominated by BEVs with 86% of sales. PHEVs made up 14%, and FCEVs remained negligible.[245]

While early innovation in modern electric vehicles was driven by new entrants such as Tesla, the current phase is characterized by the rise of Chinese manufacturers.[246] Firms such as BYD, SAIC, and Geely now lead in scale, cost competitiveness, and speed of innovation, supported by deep integration across battery supply chains, critical minerals processing, and manufacturing ecosystems. China accounts for the majority of global EV production and sales, and in 2025, BYD overtook Tesla as the world's largest EV manufacturer.[247]

In North America, the pace and structure of the transition to electric vehicles have been increasingly shaped by trade and industrial policy disruption. U.S. tariffs on vehicles, steel, and auto parts have placed significant pressure on Canada's auto industry. In response, Canada has adjusted elements of its regulatory approach, reducing the EV sales target to 75% in 2035, and developing new vehicle emissions standards. Canada has also recently announced strategic partnerships with South Korea and China that aim to strengthen domestic EV manufacturing and position Canada within a more diversified global market.[248–250] EV adoption is proceeding gradually in Canada reflecting a smaller market scale, less mature supply chains, and evolving policy and trade conditions.

Automobile production in Ontario is today based almost entirely around ICE vehicles. As the global transition in this sector gathers pace, existing manufacturing jobs face growing long-term uncertainty. Expanding EV market share and strengthening domestic industrial capacity are essential to a competitive Canadian auto industry.

While the direction of travel with vehicle electrification is clear, the pace of change remains very much in question. Breakthrough technologies rarely progress in a smooth line. The automobile's original century-long rise was punctuated by plateaus and dips that, with hindsight, look like minor ripples. The message for EVs is clear: short-term setbacks in cost, infrastructure, or supply chains are normal features of the diffusion curve—not signs that the transition is stalling.

Canada's advantage in electric vehicles lies in its potential to develop an integrated battery and automotive value chain anchored in critical minerals, clean electricity, and existing automotive manufacturing capacity. Canada holds significant reserves of key battery inputs (i.e. nickel, cobalt, lithium, and graphite) and has an established mining sector, but current analysis shows that much of the value in global supply chains is captured downstream in refining, battery materials, and cell production. Federal benchmarking highlights that while Canada has activity across the battery ecosystem, midstream capacity—such as battery-grade chemicals, cathode and anode materials, and cell manufacturing—remains limited, representing both a gap and a strategic opportunity.[251]

Canada cannot expect to be a first-rank player in the global automotive industry (like Germany, China, or the United States), but even a second-tier position with a strong presence in particular niches could generate substantial economic value. Attracting foreign partners can speed up development. It is not clear that incumbent auto makers will dominate EV production in the future. New entrants are joining the sector, and battery and drive-chain technologies are still at the beginning of their development curves. If Canada is to have a place in this future, governments must take an active role to chart a path forward, build capacity, attract capital, and support training and R&D.

8.1.4 Priorities for Action

Ensure affordability and broaden access to EVs

Currently, federal and provincial governments offer a range of incentives to encourage light-duty EV purchases, and initial investments have been made in vehicle charging networks. As of the beginning of 2026, the federal government has launched a five-year EV affordability program with purchase or lease incentives up to \$5,000 for BEVs and \$2,500 for PHEVs. This incentive prioritizes vehicles under \$50,000 and Canadian-made EVs.[248] Provincial incentives for light-duty EVs are additive to federal incentives, constantly evolving, and vary considerably by province or territory.

Purchase incentives will remain necessary in the near term but should evolve to become more targeted and efficient. Policy actions include:

- Maintaining time-limited, declining purchase incentives to bridge the upfront cost gap until parity is reached.
- Expanding support for used EV markets (i.e. tax credits, financing tools, and certification programs).
- Targeting incentives toward segments with high emissions or financial need (i.e. high-mileage drivers, fleets, rural or remote users, low and middle-income households, small business operators).
- Expanding access to lower-cost ZEV models (i.e. the recent allowance of Chinese EVs in the Canadian market).[249]

Build a targeted charging ecosystem

Infrastructure remains a major barrier, but the issue is not simply the total number of chargers. Canadian and international experience point to the need to be strategic in charging build-out. Most charging happens at home, but future adoption will increasingly depend on access in multi-unit residential buildings (MURB) and along inter-city corridors. A recent Canadian infrastructure analysis found that meeting future demand will require major retrofits in multifamily buildings and policy changes to ensure new housing is EV-ready.[252] Though the government is investing \$1.5 billion into building out charging and hydrogen fuelling infrastructure, Canada still lacks a clear roadmap for infrastructure expansion. [248,253,254]

Priority actions, therefore, include:

- Prioritizing **home and depot charging**, where most charging occurs.
- Accelerating deployment in **MURBs** through building codes, retrofit incentives, and regulatory changes.[255,256]
- Building out **fast-charging corridors** to support inter-city travel and reduce range anxiety.
- Targeting **rural, remote, and underserved regions** where private investment is less likely.
- Enabling **private-sector investment models** (utilities, charging networks, real estate developers).
- Integrating charging rollout with **grid planning and demand management** (smart charging, time-of-use pricing, “vehicle to grid” energy storage applications) to ensure sufficient grid capacity.

Provide stable policy signals and align supply with demand

A coherent and durable policy framework is essential to support both consumer adoption and industry investment. Though ZEV sales are growing, Canada lacks a time-phased roadmap that coordinates vehicle, infrastructure, and market policies. Providing long-term emissions standards, charging investments, procurement signals, aligned provincial and federal policies, and consumer incentives while avoiding abrupt stop-start changes will ensure consumer confidence and manufacturer investment. Public procurement and government fleet commitments can also play a useful anchoring role by creating predictable demand.[248,257-259]

Link consumer transition to industrial strategy and battery value chains

For Canada, the LDV transition is not only about reducing emissions from vehicles already on the road; it is also about whether the country captures economic value from the shift to electrification. The 2026 federal auto strategy explicitly links EV adoption to a broader industrial agenda, including investment support for manufacturing, tax incentives for zero-emission technology manufacturers, worker reskilling, and efforts to diversify trade relationships.[248] Priority actions should therefore support the buildout of battery and EV value chains in ways that move Canada beyond the role of raw materials supplier. This includes refining and processing capacity, battery materials, cell production, pack assembly, electric and autonomous vehicle manufacturing, and second-life battery applications and battery recycling, along with research, commercialization, and workforce development.[260,261]

Enable system-level shifts in mobility and vehicle use

Electrification alone will not fully offset emissions growth driven by increasing vehicle numbers, larger vehicles, and car-dependent land-use patterns. Actions should focus on encouraging modal shift to public transit or active transport, promoting vehicle right-sizing particularly in urban areas, enabling shared mobility models (carsharing, ridesharing, mobility-as-a-service), and integrating transportation with land-use planning to reduce travel demand and private vehicle dependence.

Build public awareness, confidence, and market readiness

Consumer perceptions remain a significant barrier, particularly around cost, range, charging access, and performance in Canadian conditions. Priority actions include:

- Implementing public information campaigns on EV costs, performance, and benefits.
- Working with dealerships, utilities, and municipalities to improve consumer education and engagement.

Prepare the workforce

Priority actions should include training for mechanics and technicians to work safely with high-voltage systems, support for independent repair and aftermarket service capacity, and measures to reduce overdependence on OEM-controlled servicing. A stronger local maintenance and repair ecosystem would improve consumer confidence, support employment, and help ensure that EV adoption does not create new service bottlenecks.



Criteria Status

- Fails to meet criteria
- Meets in some respect
- Not promising
- Potentially meets criteria
- Meets criteria

8.1.5 LDVs Pathways Table

PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS	ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
				ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
Battery Electric	Priority Decarbonization Pathway Backbone of LDV decarbonization.	Deploy Mass deployment now. Scale charging infrastructure.	Zero tailpipe emissions. Dependent on decarbonizing grid electricity and supply chain (net-zero lifecycle vehicles).	Purchase cost still higher than ICE vehicles but improving. Total cost of ownership often at or below ICE with lower fuel/maintenance.	Strategic opportunity: batteries/critical minerals and assembly. Links to autonomous vehicle development.	Mass market deployment, battery range continues to increase as costs fall. Future technological improvements possible.	Works across Canada. Winter range and multi unit home charging remain serious operational constraints.	Rapidly expanding public charging. Grid planning underway. Some regional disparities in grid readiness and charger deployment.	No particular concern.	Compelling to emerging producers. Alignment among governments and utilities with sales targets. Some opposition from incumbents.	Air quality and health gains. Vehicle-to-to-grid energy storage potential. Prepared for connection with autonomous technologies. Lifecycle emissions and pollution associated with battery production and disposal.
Plug-in Hybrid Electric	Bridge Pathway Useful in the near term to facilitate transition to battery electric. Good for long trips/cold regions when charged frequently. Not a fully decarbonized solution.	Deploy Deploy PHEVs. as a complementary option for BEVs. Scale charging infrastructure.	Meaningful reductions only with high electric miles share. Complements transition to BEVs but not compatible with net zero.	Competitive total cost of ownership in some use cases. Lower upfront cost than BEVs but higher than ICE.	Targeted value in engineering, dealerships, and service. Limited incremental manufacturing advantage vs. BEVs.	Fully commercial across segments. Extensive Canadian availability.	Works with today's fuelling plus home/workplace charging. Ideal for rural/long distance drivers who can plug in.	Compatible with existing retail fuel network and Level 2 charging. Minimal new infrastructure required.	Pragmatic. Acceptance drops when real world emissions underperform. Helps accustom consumers to vehicle charging and eases range anxieties.	Automakers and some provinces use PHEVs to meet near term ZEV targets. Crediting is bounded in the federal standard.	Mixed: benefits depend on charging behaviour. Fewer local air quality gains if driven mostly on gasoline. Lifecycle emissions and pollution associated with battery production and disposal.
Hybrid Electric (gasoline engine with battery and regenerative braking)	Dead-End Pathway Small GHG cuts but retains gasoline lock in. Absent from credible net-zero LDV end state.	Dismiss End support. Prioritize support for BEVs and PHEVs.	Limited emissions reduction and slows transition to better alternatives. perpetuates fossil fuel use.	Competitive with ICE vehicles.	Not relevant in a decarbonizing world.	Fully commercial.	Works with today's fuelling and improves vehicle acceleration.	Compatible with existing retail fuel network.	No particular concerns.	Less relevant to government and producers than BEVs and PHEVs as they are not compatible with net zero.	Continued reliance on fossil fuels. Doesn't address air quality concerns. Slows transition to better alternatives.

PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS	ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
				ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
Hydrogen Fuel Cell	<i>Potential Niche Pathway</i> Applicable in regions or remote areas where very long range is required, or local hydrogen infrastructure is well established.	Don't Prioritize Very niche applications (remote or robust hydrogen infrastructure).	Achieves zero emissions when supplied with low- carbon hydrogen.	Vehicles and hydrogen costs are high in most locations. Dependent on hydrogen cost reduction and policy support.	Could help drive local hydrogen economy growth and spur jobs in hydrogen production, refuelling, and fuel-cell manufacturing.	Some models exist. Focus is on developing medium- and heavy-duty vehicles.	Good for long-range vehicles or where hydrogen infrastructure is present. Most LDV applications are better suited for BEVs.	Need new, large-scale hydrogen fuelling network which must be built alongside vehicle adoption to overcome infrastructure and supply challenges.	Supported in regions with hydrogen build out or remote areas. Broad acceptance hinges on fuelling infrastructure, costs, and safety.	Most stakeholders backing BEVs and PHEVs for LDVs. Some interest from provincial or municipal governments where hydrogen is present or electrical infrastructure is lacking.	No air pollution. Supports renewable integration, and enables broader hydrogen use across sectors.
FUELS											
Ethanol-Blended Gasoline	Dead-End Pathway Small lifecycle GHG cuts but retains combustion lock in. Absent from credible net zero LDV end state.	Dismiss Phase out. Focus efforts on other solutions with net-zero alignment and more economic opportunity.	Delivers modest GHG reductions via blending but can't fully decarbonize LDVs.	Low incremental cost increase for E10. Viability tied to feedstock prices.	Targeted gains for farm regions and existing biorefineries. Limited growth vs. ZEV supply chains. Not relevant in a decarbonizing world.	Fully commercial and ubiquitous in Canada.	Drop in up to E10 across existing vehicle fleet. Higher blends need engine compatibility.	Uses current storage, pipelines, and retail fuelling. No new networks required.	Mixed. seen as lower carbon but concerns persist on land use and air toxins. Acceptance is context specific.	Supported by fuel producers and some provinces. Peripheral for long term LDV decarbonization.	Continued air pollution. Limited co benefits. Upstream land/water impacts can offset gains unless strong safeguards are applied.
Synthetic gasoline	<i>Potential Dead-End Pathway</i> No Canadian deployments, and outcomes hinge on scarce, costly clean power and captured CO ₂ .	Don't Prioritize May be relevant in the future in very remote applications. No action currently until maturity and economics improve.	Can be very low carbon when produced with clean hydrogen, electricity, and CO ₂ , suited for remote niches.	Production costs much higher than conventional gasoline with viability dependent on high, long-term subsidies and very cheap renewable power.	Could generate niche projects but scale is very uncertain.	Novel solution in R&D phases, no commercial supply.	Works in all current gasoline vehicles with no retrofits. Fuelling, maintenance, and driver practices remain unchanged.	Downstream distribution is compatible. Upstream supply chains are nascent and require significant new investment and coordination.	Public awareness is low. Acceptance will depend on framing. Conceptually attractive as a "drop-in" net-zero fuel.	Refineries, fuel suppliers, and some OEMs to preserve combustion assets.	Benefits are offset by large energy losses. Net benefits materialize only in narrow circumstances (i.e., no electrification option).

			ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION- MAKERS		ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA- STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
TRANSPORTATION SYSTEMS											
Modal Shift (to public transit or active mobility)	Enabling Pathway Reduces car dependence and associated emissions, applicable mostly to urban areas.	Deploy Continue to improve and build out well-designed transit systems. Provide education, incentives, and policy support to encourage modal shift.									
			Proven to reduce car trips and emissions when paired with better service.	Urban infrastructure construction and operational funding for transit poses financing challenges.	Supports service expansion and economic productivity.	Mature.	Strongest in dense cores with viable transit alternatives.	Mass transit and bicycle infrastructure investments required for urban centres.	Acceptance grows post-implementation as benefits materialize.	Cities, provinces and utilities use these to meet goals.	Traffic, safety, air-quality gains. Equity improves with targeted discounts.
Shared Mobility Models	Enabling Pathway Reduces vehicle ownership; associated with significant life-cycle emissions reductions, especially when integrated with autonomous vehicles.	Deploy Integrate with existing transit systems. Provide education on use of digital platforms.									
			Reductions depend on methods chosen, vehicles used, and integration with automation.	Reduced necessity for personal car ownership comes with significant household savings.	Growth in service-based economy. Increases transit efficiency. Benefits concentrated to urban regions.	Commercial. Ride-hailing, car-sharing, and micro mobility used today. Profitability and integration with public transit still evolving.	Strong fit in urban contexts with some changes to transit coordination, use of digital platforms, and travel behaviours. Operations more difficult in rural or low-demand areas.	Largely compatibility with existing infrastructure with modest digital, fleet, or road upgrades.	Generally accepted due to convenience and cost saving. Access and equity issues in smaller communities.	Relevant to urban locations, transit providers, and private stakeholders. Automakers have taken note. Engagement strongest in cities.	Reduced vehicle ownership, congestion, and parking demand. Can improve transportation accessibility. Some concerns with transit replacement if not integrated.

8.2 MEDIUM- AND HEAVY-DUTY VEHICLES (MHDVs)

Function of the Sector	Transport of goods, people, and services by road.
GHG emissions	9.6% of Canada's total emissions or 64.5 Mt CO ₂ e in 2023.[262]
Options for decarbonization	Decarbonization Pathways: Battery electric vehicles, hydrogen fuel cell electric vehicles, hydrogen combustion. Bridge Pathways: Renewable diesel. Niche Pathways: Renewable natural gas.
Stage of transition	Emergence: Hydrogen combustion, hydrogen fuel-cell electric vehicles. Diffusion: Battery-electric vehicles, renewable diesel, renewable natural gas.
Nature of the problem today	High costs of zero-emission vehicles, low availability and technological readiness of MHDV zero emission vehicles, fleets require operational changes to accommodate zero-emission vehicles, and insufficient energy capacity and infrastructure.
Other systemic issues	Negative health impacts and premature deaths are linked to poor air quality from diesel and gasoline vehicles.[263]
Strategic opportunities and concerns	Potential to reduce operational costs, improve air quality, and decarbonize multiple sectors through shared pathways such as electrification and hydrogen. Opportunities to lead in heavy-duty vehicles innovation and early hydrogen market development, despite lagging other countries in MHDV zero-emission vehicle deployment.
Priorities for action	Focusing on easier to decarbonize market segments, align supply and demand policies to boost adoption, build the charging and grid infrastructure, support innovation and commercialization, and raise awareness.
Longer-term issues	Stepwise buildout of clean electricity and hydrogen supply and infrastructure.
Indicators of progress	Percent of zero-emission vehicle sales in each market segment, scale of infrastructure build out, carbon intensity of grid electricity or hydrogen used for MHDVs.

8.2.1 Current Status

In Canada, roads are the arteries of commerce, and medium- and heavy-duty vehicles (MHDVs) are its lifeblood. They deliver goods, provide public services, and move passengers.[219]

MHDVs include passenger transit, multi-purpose vehicles, heavy pickup trucks, vans, service vehicles, and large trucks.[264] They fall into three main on-road categories: medium duty, heavy duty, and buses.

Medium-duty vehicles (MDVs) are typically used for services and shorter or regional delivery routes. MDVs are defined by their

weight, ranging from 4,535 kg to 11,793 kg (class 2B to 6). Heavy-duty vehicles (HDVs) typically travel greater distances and are used to carry very heavy loads. They are defined as any vehicle weighing more than 11,793 kg (class 7 and 8).[264,265] Buses can be classes 6-8 and are mainly used to transport people.[264,265]

Beyond weight classes, there are other ways to categorize MHDVs by features such as distance driven, load weight, operational characteristics, driving patterns, or nights away from home. This report breaks down MHDV fleets into five functional segments:[266–268]

Table 4 Categorization of MHDVs by functional segment

Functional Segment	Vehicle Class	Purpose	Typical Distance	Route Pattern and Operations
Passenger Transit	School buses, public buses, private coaches	Moving passengers	Varied	Fixed routes, returns to base
Urban Delivery	Class 2B–6 trucks and vans	Delivery of cargo within urban areas	<100 km/day	Typically returns to base with long overnight dwell times
Service	Class 2B–8 vehicles	Government, light construction, refuse removal, utilities, surveying, towing, snow removal, emergency response	Mostly short distances	Returns to base, high idle times
Regional Haul	Class 2B–8 vehicles	Cargo transport (e.g., moving, industrial, agricultural)	<400 km/day	Urban and interurban routes
Long Haul	Class 7–8 trucks	Large cargo movement across wide regions	>400 km/day	Urban, interurban, provincial, international

Only on-road vehicles are examined for this report, as off-road vehicles have different decarbonization challenges and solutions.

In 2023 there were 681,500 MDVs. Of these, 34% ran on gasoline, 65% on diesel, and less than 1% were battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), or

hydrogen fuel cell electric vehicles (FCEVs). In the same year, there were 576,300 HDVs on the road, with 4% running on gasoline and 96% running on diesel. There were also 65,100 buses, which typically run on diesel.[232] Figure 23 displays MHDV and bus registrations by fuel type in 2023.

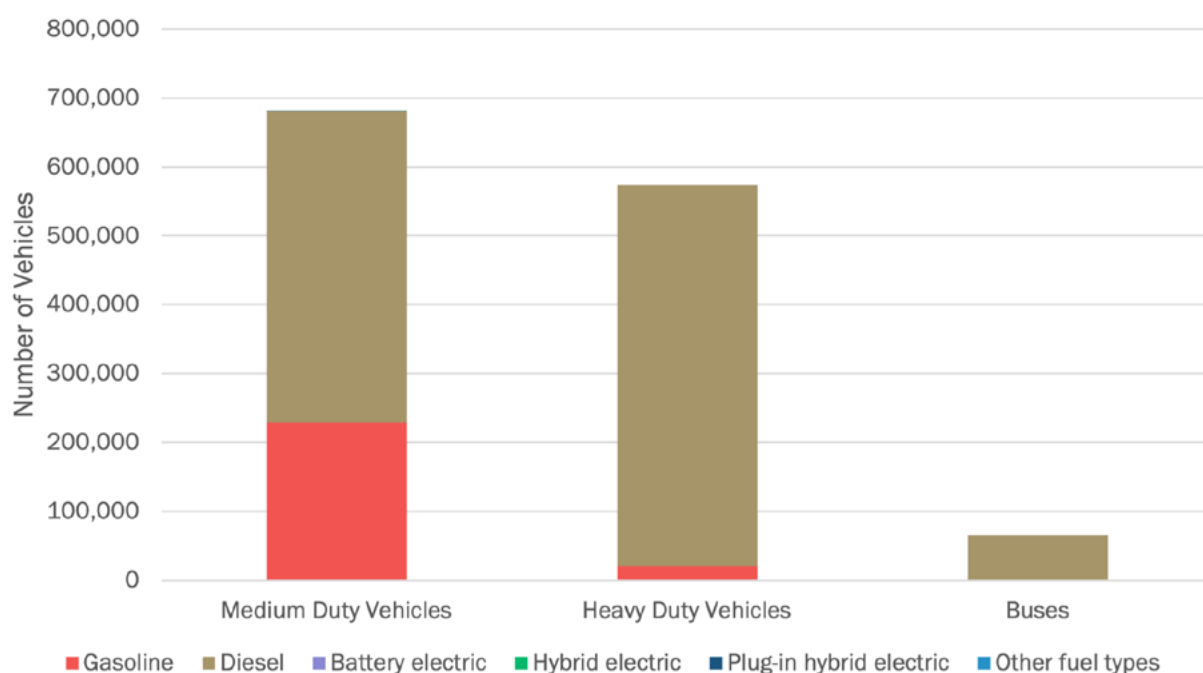


Figure 23. MHDV and bus vehicle registrations by fuel type, Canada 2023[219]

Overall, the MHDV sector is large and highly fragmented. Haulage companies often struggle with labour shortages, small profit margins, and poor load factors. Digital technologies have impacted trucking through tighter supply chain management and logistics. E-commerce has increased traffic movements in urban areas with direct-to-home delivery. Emerging technologies, including software analytics, applications of AI, and connected and autonomous vehicles, are expected to disrupt the sector, and may lead to greater ownership concentration in the future.

8.2.2 Nature of the Problem

The MHDV sector is considered one of the more difficult sectors to decarbonize given its size and complexity. Nearly all MHDVs on the road in Canada run on diesel or gasoline. The sector accounts for 9.6% (64.5 Mt) of Canada's total emissions and 39% of transport sector emissions.

Managing MHDV emissions is complicated by many factors including the different vocations and distances traveled, whether vehicles return to a base each day, and how often they stop or idle.[262] The sector cannot be decarbonized using one solution that can be implemented simultaneously across the sector.

Switching to zero-emission fuels and vehicles is challenging because of:

- **Large energy demands:** The challenge to decarbonize vehicles varies greatly by their vocation and weight. Heavier vehicles often travel longer distances and have higher energy demands making meeting the energy requirements to decarbonize MHDVs difficult.
- **Energy system and infrastructure:** The supply and capacity of net-zero energy, either electricity or hydrogen, is emerging and struggles with regulation, market education and awareness, and direction on infrastructure location.
- **High costs for zero-emission vehicles (ZEVs):** There is an ongoing need for subsidies to achieve cost parity with diesel vehicles. Operational costs of BEVs specifically are lower than ICEVs but currently parts are more expensive.
- **Technological concerns:** The technological readiness of ZEVs for MHDVs is lower than for passenger vehicles and there are fewer pilots and demonstrations.
- **Vehicle availability:** Manufacturers prioritize larger markets than Canada. Canada also has larger freight trucks than the U.S. and we are not yet catered to in product offerings.
- **Changes to operation and maintenance:** Not all companies have the ability or ownership over assets needed for change. Maintenance and operation of ZEVs may also require reskilling of labour.
- **Operational constraints:** Longer charging and fuelling times can affect duty cycles and create challenges for hours-of-service compliance, especially for long-haul and time-sensitive operations.

- **Insurance availability and cost:** In some regions, such as Alberta, fleets are reporting challenges securing insurance for ZEV MHDVs and uncertainty around potential cost increases. This adds another layer of financial risk to early adoption.

Canada is behind the rest of the world in ZEV adoption in this sector with only 1.9% of MHDVs sold in 2023 being electric, compared to the global average of 9%.[263] Supporting infrastructure remains nascent: as of 2025, 128 MHDV chargers were open nationwide, with a further 518 planned.[269]

8.2.3 Net-Zero Pathways

The road to net zero in the MHDV sector runs along two main technological routes: battery electric vehicles (BEVs) and hydrogen fuel cell electric vehicles (FCEVs). Both eliminate tailpipe emissions through electric motors, delivering high torque, lower maintenance, and quieter operations. Both technologies will play a role, but their advantages vary by use case.

BEVs: A Core Decarbonization Solution

BEVs are already suitable for some MHDV applications, particularly for smaller vehicles and those that return to a base (most delivery and service vehicles), or do not travel long distances (regional-haul vehicles or public and school buses). These applications are more amenable to overnight- or slow-charging and the lower energy densities of batteries.

Studies suggest that more than 80% of MDVs and 50% of HDVs travel less than 240 km per day. So BEVs operationally make sense for the majority of MHDVs on road today.[263] BEVs have the added benefit of lower fuel costs, as electricity is cheaper than gasoline or diesel. [263] As compared to hydrogen, battery technologies are relatively mature, and the electricity distribution system is extensive.

However, BEVs are not currently practical in all applications. For long-haul operations, charging times, battery weight, and energy density constraints start to bite. For the heaviest vehicles, batteries contribute significant weight, which reduces available payload.

FCEVs: The Long-Haul Play

Hydrogen fuel cell electric vehicles (FCEVs) are best suited to long-haul and heavy-duty applications where vehicle range and fast refuelling are critical. In Canada, this is particularly relevant for freight corridors in Western provinces and other routes with long distances between stops and limited grid capacity for high-power charging. Hydrogen could also play a role in intercity bus services and long-distance coach services, particularly for rural routes, and operations in challenging weather where range demands exceed what current batteries can deliver. In these contexts, hydrogen could offer a more practical decarbonization pathway than BEVs. FCEVs also offer faster refuelling times compared to BEVs, along with longer range and less payload impact, since fuel-cell systems are generally lighter than large battery packs. These attributes support high vehicle utilization rates essential to freight operations.

The biggest challenges with hydrogen FCEVs are the availability and cost of fuel and vehicles. Low-cost, low-carbon hydrogen is not currently available. Increased production requires the stepwise development of demand (consumption) and supply so that economies of scale can kick in and hydrogen production and distribution costs can come down. In principle, long-haul trucking could be an “anchor tenant” for the hydrogen economy, as the fuelling infrastructure would be built along major transport corridors. Coordinated deployment along road-rail freight corridors in Western Canada could further accelerate infrastructure build-out, particularly as Canadian Pacific Kansas City (CPKC) advances its fuel-cell locomotive program. The availability of cheap hydrogen can in turn facilitate decarbonization in other sectors (rail, heavy construction, cement, steel, chemicals, and in some cases building heating).

Table 5 shows the number of vehicle models available in Canada for BEVs and FCEVs by vehicle class.

Table 5. Available Electric MHDVs by Class Size[270]

Vehicle Class	Unique Models Available	
	BEV	FCEV
2B: Cargo van, chassis cab, cutaway, pickup truck	9	0
3: Cargo van, shuttle, ambulance, minivan, chassis cab	12	0
4: Step van, minivan, cutaway minivan, chassis cab, shuttle, box truck	14	0
5: Step van, straight truck, chassis cab	9	0
6: Ambulance, chassis cab, shuttle, refuse, straight, sweeper, bucket, delivery, flat bed, or terminal truck, and step van	24	0
7: Attenuator, bucket, refuse, straight, flat bed, tractor and terminal truck, chassis cab, coach, and shuttle	16	0
8: Beverage, bucket, dump, fire, refuse, roll-off, straight, sweeper, terminal, and tractor truck, chassis cab, coach, and shuttle	46	3
Total	130	3

Other Proposed Solutions for MHDVs

Other potential net-zero solutions include catenary trucks, hydrogen combustion engine vehicles, hydrogen-diesel co-combustion retrofits, renewable natural gas vehicles, and drop-in-capable fuels. Catenary systems power large trucks on overhead electrical cables, similar to the arrangements for electrified commuter trains or trolley busses. This system resolves weight and battery size issues as HDVs only need small batteries for road operation without the overhead network. These systems work best for applications that travel the same routes (refuse or snow removal, sweeper trucks, public buses, or school buses) or along high-trafficked corridors, such as inter-city highways. The difficulty here is the cost of installing the overhead network, which is particularly acute in a country like Canada with its vast distances and multiple jurisdictions.

Hydrogen combustion engines represent one pathway for long-haul and heavy-payload applications, using purpose-built engines that run on hydrogen to deliver diesel-like performance and fast refuelling with no payload penalty. While lower in energy efficiency than FCEVs (more hydrogen is consumed per km) and requiring aftertreatment to manage NOx emissions, they offer a lower-cost entry point and faster deployment. Still in the on-road testing phase, their full climate benefit depends on access to low-carbon hydrogen, but they can seed hydrogen demand and complement FCEVs as part of a broader hydrogen corridor buildout.[271,272]

Hydrogen-diesel co-combustion retrofits offer a related but nearer-term option, allowing existing long-haul diesel fleets to reduce emissions by up to 40% without replacing

vehicles or sacrificing payload and range.[273] While not a net-zero end state, retrofits can lower the cost of entry into hydrogen use and help build out hydrogen demand corridors alongside other zero-emission solutions.

Investment in natural gas as a vehicle fuel should be discontinued, as it is a dead-end pathway, slowing the transition to a decarbonized economy. Renewable diesel and renewable natural gas (RNG) may play some role but are not viable as broad solution for MHDV. Both are associated with deployment challenges related to the availability of biomass feedstocks, impacts on land use, costs, and questions around the real emissions reductions once upstream impacts have been factored in.

Service or regional-haul vehicles with a combination of limiting factors, including heavy vehicle or load weights, lack of access to clean power or viable hydrogen fuel-cell solutions, extended periods away from a base, and travel along remote or variable routes, are good candidates for renewable fuels. Examples of these vehicles include class 6-8 vehicles used in applications such as powerline service, some industrial or agricultural uses and surveying.

Electrofuels are produced using hydrogen and carbon sourced from CO₂ rather than biomass. This is still an emerging technology. In the medium term, high production costs are expected to limit widespread deployment.

Competitiveness Implications

Global OEMs are building their MHDV zero-emission platforms now, and the specifications being locked in reflect the jurisdictions generating the strongest demand signals, not Canada's. With only 130 BEV and 3 FCEV models currently available in the Canadian market and no binding national sales mandate, Canada's operating conditions remain a low priority in global product planning. The result is a specification gap that grows more consequential with each platform generation: gross vehicle weight limits exceed U.S. standards, winter performance requirements are among the most demanding in any major freight market, and corridor distances in Western Canada push the boundaries of current battery range. These are solvable engineering problems, but OEMs solve them for markets that pay for the solution through regulation, procurement, and infrastructure commitment. The longer that signal is absent, the more Canadian freight operators become price-takers for vehicles optimized elsewhere, absorbing performance penalties in a sector where margins leave little room to absorb them.

8.2.4 Priorities for Action

Canada's stated goal is for 35% of new MHDV vehicle sales to be zero-emission by 2030 and 100% by 2040.[274] Achieving this 2030 milestone would require a dramatic change from current deployment rates: approximately 414,000 zero-emission MHDVs on the road and 41,000 MHDV charging ports nationwide by 2030.[275] At the current pace, these targets remain out of reach. Progress will depend on strategic sequencing of vehicle deployment, rapid infrastructure expansion, and coordinated policy action across governments, utilities and industry.[263]

Develop a strategic transition plan

An MHDV transition plan should sequence adoption phases. Focus first on the vehicle segments that are most ready to electrify, such as school and transit buses, urban delivery, refuse/municipal service, utility/service fleets, and regional hauls under 400 km/day that return to base. Follow with regional-haul and end with long-haul as

hydrogen and megawatt charging mature. Link infrastructure planning to this sequencing, prioritizing depot and hub charging initially before expanding to corridors. Align infrastructure, regulation, and procurement timelines by coordinating actions across federal, provincial, and municipal governments. Sequencing should also reflect the financial capacity of different fleet types, as large carriers and public agencies typically have more ability to invest early than smaller operators.

Ensure an adequate supply of vehicles

Move beyond relying solely on U.S. heavy-duty emissions standards by adopting a Canadian MHDV ZEV sales regulation with early, segment-specific sub-targets (buses, urban delivery, refuse), and later-phase targets for long-haul. Provide compliance flexibilities by vocation and weight class; expedite type approvals; pre-qualify models/specs suited to Canadian conditions (gross weight variants, cold-weather packages); and align public procurement to pull supply into the priority niches.



Boost demand and reduce upfront costs

Accelerate adoption by directly reducing the total cost of ownership. Cut both upfront and operating costs with:

- Rebates tied to vehicle weight and proven use,
- Bonuses for scrapping older diesels,
- Zero- or low-interest financing with guarantees,
- Faster tax write-offs, and
- Predictable off-peak charging rates or relief from high demand charges at depots.

Enable pooled purchasing power (i.e., school districts and municipalities) to secure lower prices and reduce risk with battery leasing and resale-value guarantees. Above all, design programs around the real total cost to own and operate, not just sticker price, to directly clear the main cost barrier to zero-emission adoption. Program design should also minimize the administrative burden, particularly for smaller operators with limited capacity to navigate complex rebate and grant requirements.

Fill innovation and commercialization gaps

Target RD&D and commercialization support where readiness lags: cold-weather battery performance and depot energy management for buses/MDVs; megawatt-class charging and cost-optimized packs for Class 8; hydrogen fuel cells and storage for select long-haul corridors; zero-emission vocational body integration (refuse, utility); and high-throughput charging. Fund lighthouse demonstrations — large-scale, high-visibility pilots to prove feasibility and de-risk follow-on investment — at ports/rail hubs and along specific corridors with clear procurement pathways to scale.

Build industry awareness and capacity

Deploy segment-specific transition playbooks and work with industry associations and anchor fleets in targeted industries. Disseminate case studies, training, and operations/maintenance guidance for fleet managers, technicians, and planners. Establish a pipeline of fleet projects so manufacturers and infrastructure providers can respond to visible demand.

Criteria Status

-
- Fails to meet criteria
-
- Meets in some respect
-
- Not promising
-
- Potentially meets criteria
-
- Meets criteria

8.2.5 MHDVs Pathways Table

Not promising Potentially meets criteria Meets criteria			ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS		ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
 Vehicles											
Battery Electric	<i>Priority</i> Decarbonization Pathway Can decarbonize most MD and some HD vehicles.	Deploy Accelerate fleet adoption and charging infrastructure buildout for MHDV applications. Prioritize return-to-base and short-haul segments first.	 Runs on clean electricity with no tailpipe emissions. Requires decarbonized electricity and supply chain.	 Higher upfront costs but dropping. Cost parity in many segments expected soon as battery prices fall. Total cost of ownership can be positive, especially for medium duty, urban delivery, or passenger transit.	 Promotes battery, charger, and truck manufacturing. OEM activity and government support can allow leadership in clean transport tech and exports.	 Commercially mature for MDVs and buses. Long-haul HDVs are in early adoption, with range and weight challenges. Advances in battery chemistries may be required for the heaviest duty vehicles.	 Ideal for short-haul, return-to-base operations where daily travel is local or regional. Strong performance for most MDVs but limits in long-haul or heavy-load use. Improves driving (torque).	 Needs major charging and grid upgrades. Depot, highway chargers, and utility coordination to handle the added load.	 Acceptance growing. Range and charging concerns remain.	 Fleet interest to cut diesel and maintenance costs. Governments, utilities, manufacturers for new markets and climate goals.	 Cuts emissions, reduces noise, eliminates air pollution, and lowers maintenance costs. Supports a cleaner, smarter grid with vehicle to grid charging.
Hydrogen Fuel Cell Electric	<i>Potential</i> Decarbonization Pathway Covers long-haul/payload use cases where BEVs hit range and weight limits.	Enable Invest in hydrogen refuelling corridors and support demonstration fleets for long-haul and heavy-payload applications.	 Achieves zero emissions when supplied with low-carbon hydrogen.	 Expensive vehicles and high hydrogen prices. Competitiveness dependent on lower hydrogen cost, larger-scale production, and policy support.	 Could drive hydrogen economy growth and spur jobs in hydrogen production, fuelling, and fuel-cell and vehicle manufacturing.	 In a late-demonstration, early commercial stage—mostly in pilot use.	 Enables zero-emission operations with diesel-like range. Ideal for long-haul, heavy-duty use with high range and fast refuelling needs. Improves driving (torque).	 Need new hydrogen fuelling networks along major freight corridors which must be built alongside vehicle adoption to overcome infrastructure and supply challenges.	 Cautiously supported. Broad acceptance hinges on fuelling infrastructure, costs, and safety.	 Draws interest from energy firms, truck manufacturers, and trucking companies. Serves governments and broader hydrogen economy.	 Cuts emissions, reduces noise, eliminates air pollution, lowers maintenance costs, and preserves payload. Some concerns with fuel cell recycling.

PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS	ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
				ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
Hydrogen Combustion	<i>Potential Decarbonization Pathway</i> Covers long-haul/payload use cases where BEVs hit range and weight limits. Less efficient than FCEVs.	Enable Support demonstration fleets and investment in hydrogen fuelling corridors alongside FCEV development. Treat as a complement to FCEVs, not a replacement.	Achieves near-zero emissions when supplied with low-carbon hydrogen.	Lower base cost than FCEVs; avoids reliance on expensive minerals and catalysts, but lower efficiency overall. Competitiveness is still dependent on lower hydrogen cost, larger-scale production, and policy support.	Could drive hydrogen economy growth and spur jobs in hydrogen production and refuelling. Narrower supply chain opportunity than FCEVs as it doesn't require fuel cell components.	On-road testing has begun. Underlying high-pressure direct injection technology is commercial with many units sold globally.	Ideal for long-haul, heavy-duty use with high range and fast refuelling needs. Less suited for short urban hauls.	Need new hydrogen fuelling networks along major freight corridors which must be built alongside vehicle adoption to overcome infrastructure and supply challenges.	Cautiously supported. Broad acceptance hinges on fuelling infrastructure, costs, and safety.	Draws interest from energy firms and OEMs. Serves governments and broader hydrogen economy.	Near-zero tailpipe CO ₂ and diesel-like performance with no payload penalty. NO _x emissions require aftertreatment. Less energy-efficient than FCEVs, meaning higher hydrogen consumption per km.
Renewable Natural Gas (RNG)	<i>Potential Niche Pathway</i> Leverages existing compressed and liquified natural gas fleets and waste gas but remains niche and supply constrained.	Enable Support RNG projects tied to hauling (i.e. waste management) with secured end users.	Can be net zero with decarbonized feedstocks.	Without incentives, high production costs can make it less viable than diesel or fossil gas.	Create jobs in waste management and rural areas, but the total market is modest and capped by feedstock availability.	Drop-in fuel for compressed and liquified natural gas vehicles.	Best for transit and refuse trucks with centralized fuelling. Requires new assets with natural gas engines.	Can flow through existing gas pipelines and stations, but fuelling infrastructure for NG trucks is sparse and feedstock collection/supply chains are still developing.	Broadly accepted and seen as a practical waste-to-fuel solution when sourced from genuine waste.	Utilities, waste managers, farmers, and certain fleets view RNG as valuable.	Avoids direct methane emissions from wastes. Impact is constrained by feedstock and questions about life-cycle reductions once upstream impacts are counted. Does not address air pollution from combustion.
Natural Gas (NG)	Dead-End Pathway Does not facilitate transition to net zero. Provides limited emissions reductions relative to diesel.	Dismiss Redirect support to initiatives focused on electrification and building out production and use of renewable fuels.	Incompatible with net zero. Limited emissions reduction. Investment into assets that lengthen the timeline to decarbonization.	Natural gas is currently inexpensive. Costs can be higher where new or upgraded distribution lines, high compression, or liquification are required.	Short-term expansion of natural gas markets. Longer term prospects limited.	Technologically mature.	Best for transit and refuse trucks with centralized fuelling. Requires new assets with natural gas engines. Worse performance with lower torque.	Can flow through existing gas pipelines and stations, but fuelling infrastructure for NG trucks is sparse and feedstock collection/supply chains are still developing.	Perceived similarly to all fossil fuel use in vehicles.	Some interest from fleet operators to reduce emissions and costs. Strong relevance to existing gas suppliers.	Lowers but does not eliminate air quality concerns with cleaner combustion compared to diesel. Increases long-term reliance on natural gas, slowing the transition to electrification or clean fuels.

			ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS		ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
 Drop-in Fuels											
Renewable Diesel (RD)	Bridge Pathway Provides immediate, drop-in cuts while zero-emission trucks and charging build out. Feedstocks limit scalability.	Deploy Maximize drop-in renewable diesel use across existing fleets now while zero-emission vehicles scale up. Ensure feedstock sustainability governance is in place.	 Drop-in fuel, with lifecycle CO ₂ cuts. Net-zero requires carbon removal. Combustion persists and sustainable feedstocks are finite.	 Higher production cost than diesel. Viable where policy support offsets fuel premiums.	 Supports refinery jobs, rural economies, and feedstock markets. Growth is limited by feedstock constraints.	 Fully commercial, drop-in fuel. Dominant production processes (i.e. hydrotreated vegetable oil) mature, with several large-scale facilities operating globally. Established technology licensors.	 Drop-in fuel ideal for near-term fleet decarbonization without new equipment or operational changes.	 Existing fuel storage, pipelines, and retail networks work for RD. Main gaps are upstream (sustainable feedstock availability and refining capacity scale-up).	 Accepted when made from sustainable waste feedstocks and used as a bridge. Concerns over land-use competition.	 Fleets seeking fast GHG cuts. Fuel producers and farmers benefiting from new markets. Policymakers aiming for near-term climate progress and rural investment.	 Delivers reduced particulate matter and NO _x emissions in existing fleets. Benefits are tempered by feedstock limits and land-use change concerns.
E-Fuels	Potential Dead-End Pathway No Canadian deployments and outcomes hinge on scarce, costly clean power and captured CO ₂ .	Don't Prioritize Track international developments in e-fuel production costs and efficiency. Invest if economics fundamentally improve.	 Can be near-zero-carbon when produced with clean electricity and CO ₂ , suited to hard-to-electrify niches.	 Production costs much higher than conventional diesel with viability dependent on high, long-term subsidies and ultra-cheap renewable power.	 Could create niche projects (electrolyzers, CO ₂ capture, synthesis plants) but market scale is uncertain.	 Only small pilot plants exist globally. No commercial-scale supply for road transport.	 Works in all current diesel vehicles with no retrofits. Fuelling, maintenance, and driver practices remain unchanged.	 Downstream distribution is compatible. Upstream is nascent. Requires significant new investment and coordination.	 Public awareness is low. Acceptance will depend on framing. Conceptually attractive as a “drop-in” net-zero fuel.	 Refineries, fuel suppliers, and some OEMs to preserve combustion assets.	 Benefits are offset by large energy losses.

			ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS		ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
Complementary Technologies											
Hydrogen-Diesel Co-Combustion Retrofits	<i>Potential Bridge Pathway</i> Simultaneously helps build out hydrogen economy and lower emissions on diesel assets until they can be retired. Not a net-zero end state.	Incubate Support retrofit for existing long-haul fleets in near-term, particularly where BEV adoption faces constraints. Invest in hydrogen fuelling corridors.	 Reduces diesel use and lowers emissions but not a net-zero end state. Compatible with low-hydrogen supply buildout.	 Low-cost retrofit. Competitiveness dependent on lower hydrogen cost and policy support.	 Could drive hydrogen economy growth and spur jobs in hydrogen production and refuelling.	 Proven at scale but with limited applications. Some development still needed to adapt to broader range of makes and models.	 Requires retrofit of existing diesel vehicles. Reversible and does not void OEM warranties. Seamlessly switches back to diesel if hydrogen runs out.	 Hydrogen supply remains the primary infrastructure constraint. Retrofit kits can be installed through local fleet dealerships and mechanic shops, reducing deployment barriers compared to new vehicle purchases.	 Some concerns with hydrogen cost and safety.	 Draws interest from energy firms and OEMs. Enables operators to meet near term emission targets and build familiarity with hydrogen.	 Lowers air quality impacts but does not eliminate emissions. No loss to payload.
Catenary Electric Systems	<i>Potential Niche Pathway</i> Potentially viable on fixed, high-throughput corridors.	Don't Prioritize Redirect resources toward battery-electric and hydrogen solutions with broader applicability.	 Electrifies at point of use, but corridor-bound infrastructure limits national scalability.	 Demands high upfront investment and only becomes viable with heavy, continuous use. Depends on public or consortium funding.	 May generate localized economic activity in construction and electrical equipment.	 Proven in demos, with reliable operation on short highway stretches. Lacks large-scale integration, standardization, and commercial deployment.	 Suits fixed, high-traffic routes like freight corridors or industrial loops. Poorly matched to flexible, irregular trucking.	 Demands major infrastructure along roads, grid upgrades, and regulatory coordination. Low applicability in Canada with low population density and long transportation distances.	 Uncertain. Concerns about visual impact, cost, and relevance.	 No clear stakeholder advocates in Canada at this time.	 Cuts tailpipe emissions and noise, reduces battery mineral demand, and lessens road wear. Concerns about impacts on other road users.

8.3 MASS TRANSIT

Function of the Sector	Transport of people in urban settings.
GHG emissions	Approximately 0.2% of national emissions in 2022, 1.7 Mt CO ₂ e (1.5 Mt CO ₂ e from buses[276], 0.2 Mt CO ₂ e from trains).
Options for decarbonization	Decarbonization Pathways: Electric rail transit, battery-electric buses. Bridge Pathways: Renewable diesel for existing commuter rail. Niche Pathways: Hydrogen fuel-cell buses. Enabling Pathways: Transit-oriented urban planning, modal-shift levers.
Stage of transition	Emergence: Hydrogen fuel-cell buses. Diffusion: Electric rail transit, battery-electric buses, renewable diesel for existing commuter rail, transit-oriented urban planning, modal-shift levers.
Nature of the problem today	Emissions generated from fossil-fuel-powered rail transit and buses. Absence of convenient, accessible, affordable, frequent and safe mass transit in many locales.
Other systemic issues	Equity (mass transit more affordable than personal vehicles, but less accessible). Mass transit's ability to relieve costs related to congestion, road maintenance and infrastructure, parking, and the livability of cities. Limitations in the layout of cities and urban sprawl. Climate change stressors and the impact of flooding and fires on transit.[277]
Strategic opportunities and concerns	Opportunities: Reduced commuting times, pollution healthcare costs, and household expenses; improved quality of life; economic development leveraging Canada's leadership in manufacturing electric/hydrogen buses; infrastructure utilizes Canadian materials (steel and aluminum) and creates more jobs per dollar than highway spending.[278,279] Concerns: Poor reliability and comfort due to overcrowding and long commutes; weak transit systems limit productivity; attitudinal or cultural shifts away from car dependency are difficult to achieve.
Priorities for action	Invest in reliable, comfortable, and safe mass transit that encourages mode shifting; support decarbonizing and expansion of public transit; implement policies to ensure smart city planning with well thought out transit corridors.
Longer-term issues	Urban planning for smarter, more livable cities must include mass transit in original design.
Indicators of progress	Proportion of regular commuters using mass transit. Number of riders expressing satisfaction with service standards. Sector-wide emissions. Falling construction delays and cost overruns for major transit projects.

8.3.1 Current Status

Mass transit can play a significant role in building resilient carbon-neutral cities in Canada. By moving large numbers of people efficiently, transit systems reduce greenhouse gas (GHG) emissions, ease urban congestion, and improve access to services.

Mass transit in Canada includes public transit infrastructure such as buses, urban and commuter rail, subways, and streetcars. It is complementary to active transport (biking and walking) and operates primarily on fixed routes with regular schedules in and between urban areas. While active transport is important, the emphasis of this section will be on the public transit systems and their opportunities to reduce existing emissions and contribute to further GHG reductions across the transport sector.

Canada's public transit systems comprise a suite of well-established and often integrated services, such as:[280]

- Subway systems: Toronto and Montreal subways
- Light rail and urban trains: Vancouver's SkyTrain, Ottawa's O-Train, Calgary's CTrain, Montreal's REM, and Edmonton's LRT
- Commuter rail: GO Train (Ontario), EXO (Quebec), West Coast Express (British Columbia)
- Buses: Virtually every Canadian city
- Water-based transit: Halifax Transit Ferry Service, BC Ferries

Canada's urban structure is dominated by a small number of very large metropolitan areas and a long tail of mid-sized and smaller urban

regions.[281]² This distribution matters because feasible transit technologies, service designs, and funding models differ markedly by city size and concentration.

Public transit ridership is strongest in Canada's largest and most densely populated cities. As of May 2024, 11.4% of commuters across Canada use public transit, approaching the 12.6% pre-pandemic peak in May 2016. [282] However, in Toronto, Vancouver, and Montreal, over 20% of commuters use public transit.[283] In fact, in 2016, 75% of Toronto commuters living within 5 km of downtown used transit, walked, or cycled, compared to 28% in Winnipeg.[284] Outside urban cores, ridership declines rapidly with increasing distance, lower density, and greater reliance on personal vehicles. A breakdown of commuting by mode for Canadians in 2021 can be seen in Figure 24.

Canada has a strong industrial base in public transit manufacturing. Companies such as New Flyer, Nova Bus, and Alstom design and produce buses and rail vehicles domestically and create thousands of jobs.

In addition to contributing to a strategic economic opportunity for Canada, mass transit provides critical social benefits. It helps reduce transportation-related emissions, improve mobility for underserved populations, and support more livable, vibrant urban environments.[286]

While the zero-emission technologies for transit are relatively clear—battery-electric and, in some contexts, hydrogen fuel cell—the path to expand or redesign transit systems is highly city-specific, reflecting each metro's size, density, geography, and the configuration of its existing network. Planning starts from what already exists, not from a clean slate. Federal programs such as the Zero Emission

² Using 2021 Census metropolitan area (CMA) populations as a proxy for urban scale: 6 CMAs have 1,000,000+ residents; 3 CMAs have 750,000-999,999; 2 CMAs fall between 500,000-749,999; 6 CMAs are 250,000-499,999; and 24 CMAs are 100,000-249,999

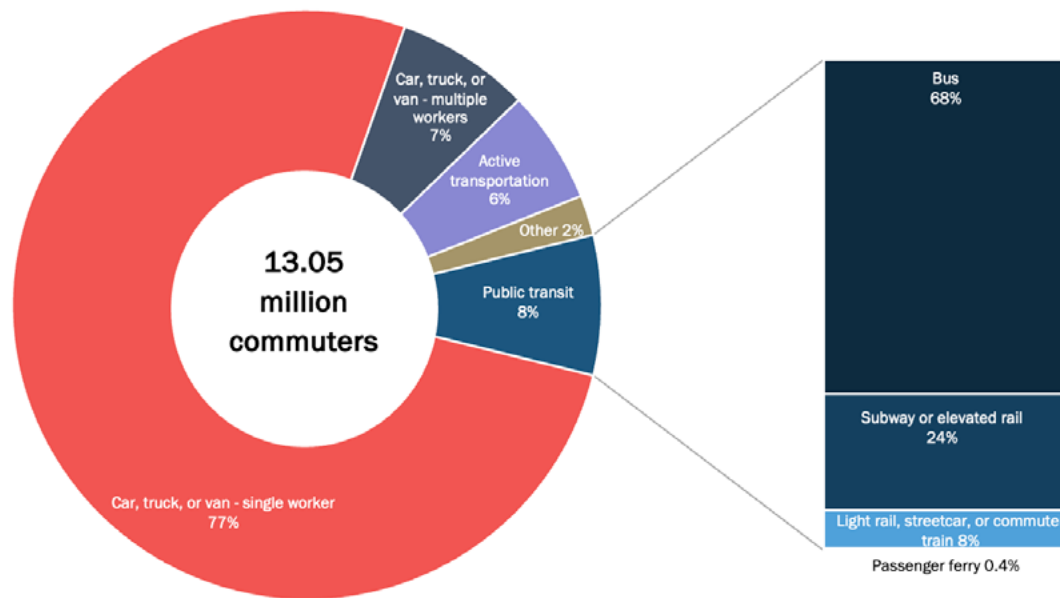


Figure 24. Main mode of commuting for the employed labour force aged 15 years and over in private households, Canada 2021[285]

Transit Fund (ZETF) explicitly support both battery-electric and hydrogen fuel cell deployments, and Canadian agencies are piloting both options (i.e., Mississauga's hydrogen bus initiative), underscoring that technology selection is contextual.

Municipal budgets alone are generally insufficient to fund major transit initiatives, and Canadian cities have historically relied on provincial and federal contributions to deliver large projects. Municipalities manage about 60% of core public infrastructure but collect only 8-10 cents of every tax dollar, constraining their ability to self-finance major expansions.[287] Senior-government tools such as the Investing in Canada Infrastructure Program, the forthcoming Permanent Public Transit Fund, Zero Emission Transit Fund, and flexible Canada Infrastructure Bank financing are necessary to deliver fleet electrification and capacity expansions across city sizes.

Ferries are not discussed further as they impact a very small portion of commuters and have very different decarbonization problems and solutions better addressed with future analysis of the marine sector.

8.3.2 Nature of the Problem

Despite offering a sustainable alternative to private vehicles, several interrelated barriers continue to limit mass transit decarbonization and its role in addressing broader transport-related problems.

Moving to low-emissions transit

To fully realize the climate benefits of mass transit, the systems themselves must be decarbonized. While public transit produces significantly lower emissions per rider than personal vehicles, diesel-powered buses and commuter rail still emit 1.5 Mt CO₂e and 0.2 Mt CO₂e respectively.[280,288,289]

Cities like Montreal, Vancouver, and Toronto have committed to providing 100% zero-emission transit by 2040, but progress is slow.[290–292] This is due to structural, financial, and political factors. For example, Toronto's Metrolinx plans to electrify 600 km of GO Train routes and add 200 km by 2032, yet faces delays due to land disputes, environmental pushback, funding gaps, and political instability.[293,294] Additionally, although Montreal's Exo plans to electrify 10

trains in its fleet, and Vancouver's Translink now uses renewable diesel for the West Coast Express, both operators lack clear timelines and detailed plans for fully decarbonizing commuter rail services.[295–297] Despite progress, vague planning and execution risks threaten the ability of all three commuter rail operators to meet their climate goals.

Bus electrification also lags, with only 2% of bus and truck sales in 2023 being electric, compared to 9% globally.[298] Canada is home to four electric bus manufacturers: Lion Electric, New Flyer, Girardin Blue Bird, and Nova Bus / Prevost.[299] A prominent barrier is the high upfront cost of battery-electric buses and the depot/on-route charging infrastructure required to operate them at scale. Currently, electric buses can be more than double the cost of diesel buses, and most Canadian-made electric buses are sold to other jurisdictions.[299,300] Upgrading charging infrastructure, installing charging along routes, and the availability of low-carbon electricity remain additional adoption barriers.[301]

Cold-weather performance is also a significant operational consideration. Transit agencies in Edmonton and Vancouver report the need for auxiliary diesel heaters to maintain interior temperatures during winter, reducing the net GHG benefit of Battery Electric Buses (BEBs). Cold temperatures also reduce vehicle range, requiring additional vehicles or on-route charging to maintain service levels.

Canada is a global leader in hydrogen fuel cell buses, with Mercedes-Benz's fuel cell manufacturing facility in Vancouver and New Flyer's in Winnipeg. In Alberta, hydrogen fuel cells are being deployed for trucks, buses, and light-duty vehicles.[302] The Alberta Zero Emission Hydrogen Transit (AZEHT) demonstration, launched in 2021, has two hydrogen fuel cell electric buses operating in Edmonton and Strathcona County since 2023. [302] Despite insights from AZEHT, Canada

still has relatively limited experience with the large-scale deployment of hydrogen fuel cell buses. Yet proponents highlight Canada's competitive advantages in hydrogen supply and the bus manufacturing value chain and believe costs will fall as supply chains mature and scale increases.[303]

Barriers to modal shift

Encouraging modal shift from personal vehicles to mass transit remains a challenge for many municipal governments. A 2018 literature review on the trends of Canadian transit ridership found that a variety of factors related to the built environment (e.g., proximity to downtown), socioeconomic conditions (e.g., household income), and external variables (e.g., weather) impact Canadians' transportation choices. Among the strongest levers are service frequency and reliability. These are areas where policy and investment can have an immediate impact. [304] Fare levels are important—especially for equity—but, on average, service quality has a larger influence on ridership; moreover, fare reductions typically require ongoing public subsidies to replace lost fare revenue.

Urban design and equity

How cities are built shapes how people move. In Canada, sprawling urban development makes it harder for transit to succeed. Cities that integrate housing, schools, workplaces, and shops within neighbourhoods have a positive impact on transit use as they generally promote shorter transit-accessible trips. Availability of affordable properties (for both renters and buyers) decreases near transit corridors. This poses issues from an equity perspective as lower-income households may face longer (and in some cases unmanageable) walking distances to access their desired routes.

Congestion in metropolitan areas and associated idling vehicles contribute to lost productivity, worsen air quality, increase GHG

emissions, and impact the health, safety, and personal finances of Canadians. It is estimated that traffic congestion in the Greater Toronto Area alone costs the economy over \$11 billion³ annually in lost productivity.[305]

The negative effects of congestion continue to put demands on public infrastructure funds to expand road networks instead of transit modes.

Systematic constraints and policy gaps

Access to transit or safe active transport is also limited by planning and policy decisions which favour roads. Government spending on roads is historically more than double that of public transit.[306] Laws that restrict high-density housing or mixed-use neighborhoods negatively impact ridership.[279] In many regions, personal vehicles remain the only viable transportation option. Addressing these systemic issues requires substantial, ongoing public investment.

8.3.3 Net-Zero Pathways

Ensure reliable, comfortable, and safe transit services

The most effective way for governments to encourage people to choose mass transit over personal vehicle use is to ensure systems are reliable, safe, comfortable, and accessible.

Adequate operation and maintenance (O&M) funding is critical to uphold service quality. This includes not only punctuality and cleanliness, but also infrastructure upgrades, security features, and accessibility improvements that allow Canadians to depend on transit for commuting and leisure activities.

Decarbonize public transit

Decarbonizing public transit will eliminate the GHG emissions and air pollution currently associated with mass transit.

For buses, electric and hydrogen fuel cell buses present scalable options. However, these options require investment in related

infrastructure (i.e., charging stations) and training programs to ensure proper maintenance and operation of newer technologies. Future transit development should include smart grids, route optimization, and charging schedules to minimize grid strain and operational inefficiencies.[301]

Most light rail and subway systems are already low-carbon. Public investment should target light rail and subways that can replace congested or slow bus routes in cities with a population greater than 100,000.

Canada also has a strategic opportunity to meet rising transit demand with made-in-Canada solutions.[278] Bus manufacturing is already concentrated in Quebec and Manitoba, and train production facilities exist in several provinces. Rather than exporting most of this output, governments could prioritize domestic procurement—using Canadian-built vehicles to support transit buildout nationwide.

Encourage modal shift away from solo car use

Shifting Canadians from personal vehicles to transit requires a combination of incentives and disincentives:

- **Incentives:** Fare discounts, passes, and promotional campaigns (e.g., municipal transit challenges with prizes).
- **Disincentives:** Fuel taxes, congestion pricing, or limited parking to raise the relative cost of car travel compared to mass transit.
- In general, the public value of mass transit goes beyond emission reduction. It also reduces congestion, cuts pollution, improves public health, and lowers household transportation costs. These positive spillovers justify strong public investment and ongoing operational subsidies.

³ 2024 Canadian dollars

Design Smart Cities with well-thought-out transit networks

Urban sprawl is a pattern of metropolitan expansion onto previously undeveloped land, characterized by low-density, discontinuous growth; single-use zoning; car-oriented design; fragmented open space; and high per-capita land consumption that makes infrastructure and public services less efficient. Sprawling neighbourhoods are generally unsuitable for mass transit because of their low population densities and lack of specific hubs of activity.

By contrast, compact, mixed-use neighbourhoods—the inverse of urban sprawl—enable mass transit and active transportation to meet most daily needs and provide a viable alternative to driving.[299] Municipalities and urban planners can design cities that have:[279]

- Dense, mixed-use developments near transit corridors,
- Integrated walking and cycling infrastructure,
- Reduced dependence on road infrastructure, and
- Vibrant urban cores with accessible green and public spaces.

Well-thought-out transit networks improve access to jobs, reduce emissions, enhance health, and raise urban livability. They also support businesses by increasing access to labour markets.[279,308,309] Municipalities and urban planners can make net zero more tangible and smart by pairing compact, mixed-use growth with smart transit operations. Using data and automation can help coordinate routes, manage service in real time with data sharing, and simplify trip planning and payment. These improvements can make transit more reliable and convenient, encouraging people to shift from private vehicles and cutting per-trip emissions.



Competitiveness Implications

Canadian-built zero-emission buses are already exported across North America, but the domestic fleet that validates them is thin. As of 2023, only 2% of Canadian bus and truck sales were electric, less than a quarter of the global rate. The transit electrification procurement wave is well underway and will lock agencies into supplier ecosystems for a fleet generation. Canadian OEMs like New Flyer and Nova Bus hold credible positions today, but that credibility erodes when the home market is visibly not buying at scale. Canada's cold-climate operating conditions add a second dimension: agencies in Edmonton and Vancouver are already navigating range loss and auxiliary heating challenges that Nordic, northern U.S., and Northeast Asian buyers will face as they electrify. Solving those problems through domestic fleet-scale deployment would give Canadian manufacturers a validated cold-climate credential that warm-weather competitors cannot replicate. But fleet-cycle lock-in sets the timeline, and fragmented municipal procurement is not moving at the pace the window demands.

8.3.4 Priorities for Action

Investing in transit and enabling infrastructure

Funding should be directed toward both infrastructure and operational needs, including safety, cleanliness, and inclusive access to balance system growth (transit access, rates, routes, and reliability) and user experience (comfort and safety on board). [306] Innovative financing models that cover operational costs—such as payment per kilometre for certified ZEVs (e.g. U.K. Bus Service Operators Grant)—or public-private partnerships that leverage private financing, can support stable long-term funding for transit systems. Careful planning and evidence-based policy are essential to ensure that investments deliver the greatest benefits in emissions reduction, accessibility and ridership growth.[310]

Moreover, incentives like the Zero Emissions Transit Fund that support the deployment of zero-emission buses and rail can be expanded and aligned to also cover the necessary charging and maintenance infrastructure.[311]

Strategic urban design

Policies for urban planning should be developed to support higher-density cities as well as mixed-use neighbourhoods, affordable housing near transit hubs, removal of municipal parking mandates, and accessible and safe active transport.[279] These will ensure that cities are designed to provide incentives for the use of existing public transit infrastructure, but also that new projects are strategically located to maximize their use.

Supporting domestic low-carbon manufacturing

Finally, Canada already has a strategic manufacturing advantage in public transit. Scaling up domestic deployment creates local jobs and strengthens Canadian manufacturing while positioning the country to export the technologies and expertise a carbon-neutral world will require.

Criteria Status

- Fails to meet criteria
- Meets in some respect
- Not promising
- Potentially meets criteria
- Meets criteria

8.3.5 Mass Transit Pathways Table

			ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			Social		
PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS		ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY	SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
 Transit Technologies											
Electric Rail Transit (subways, LRT/trams, commuter rail)	Decarbonization Pathway Already the low-carbon backbone in cities. Expanding/modernizing electrified rail displaces diesel services and high-GHG road travel.	Deploy Support deployment of electrified rail with policy, financing, and investment. Enable growth of Canadian electric rail manufacturing capacity.	 Zero tailpipe emissions when running on clean power systems.	 Capital-intensive but justified on high-demand corridors. Viability rises with ridership and public co-funding.	 Strong Canadian rail manufacturing base (i.e., Alstom) and project delivery supply chains.	 Commercially mature.	 Best fit on dense, fixed routes. Replaces congested/slow bus routes in larger cities.	 Requires major capital works and grid connection but draws on established suppliers.	 Generally popular and accepted where it improves speed/reliability.	 Cities, provinces and federal funders see it as core to mobility.	 Cuts air pollution, eases congestion, improves urban livability.
Battery-Electric Buses (BEBs)	Decarbonization Pathway Scalable option for bus decarbonization.	Deploy Scale fleet procurement and depot charging infrastructure. Coordinate with utilities to ensure grid readiness for full fleet transition.	 Zero tailpipe emissions when running on clean-power systems.	 Today higher upfront cost vs. diesel. Viability improves with public support and charging optimization.	 Canadian OEM strength (New Flyer, Nova Bus) and supply-chain jobs.	 Deployment scaling from pilots to fleets.	 Strong fit for urban routes and return-to-depot operations.	 Needs depot/on-route chargers and utility coordination. Smart charging to manage grid impacts.	 Positive where reliability and comfort improve	 Transit agencies slowly adopting. Requires strong coordination from utilities. Larger cities starting to incorporate into planning.	 Better air quality, less noise.
Hydrogen Fuel-Cell Buses	Niche Pathway Complementary option where range/uptime needs challenge BEBs. Canada has H ₂ /fuel-cell industrial strengths.	Enable Support targeted pilots in corridors where range or uptime needs exceed battery-electric capability. Invest in refuelling infrastructure alongside vehicle trials.	 Zero tailpipe emissions when supplied by low-carbon H ₂ .	 Vehicle and fuel costs are much higher. Viability hinges on H ₂ price/infrastructure.	 Domestic capabilities in fuel cells and buses. Potential to anchor H ₂ value chains.	 Some pilots underway to validate technology.	 Useful for longer uninterrupted routes/high uptime and quick refuelling.	 Requires new H ₂ production, storage and refuelling networks.	 Mixed. Interest exists, but costs, safety, and infrastructure questions remain.	 Agencies and OEMs piloting. Supported in federal programs alongside BEBs.	 Air-quality gains. Operational flexibility in cold climates and long duty cycles.

PATHWAY ELEMENTS	ROLE IN NET-ZERO SYSTEM	SIGNAL TO DECISION-MAKERS	ALIGNMENT WITH CARBON NEUTRALITY	Economic		Technical			SOCIAL ACCEPTABILITY	RELEVANCE TO STAKEHOLDERS	RELATED BENEFITS AND COSTS
				ECONOMIC VIABILITY	ECONOMIC DEVELOPMENT OPPORTUNITY	MATURITY	OPERATIONAL FIT	INFRA-STRUCTURE AND SUPPLY CHAIN SUITABILITY			
Renewable Diesel for Existing Commuter Rail	Bridge Pathway A stop-gap to cut emissions where rail electrification isn't yet possible.	Deploy Procure renewable diesel as an immediate drop-in measure for diesel commuter rail while electrification is built out. Support scaling of RD production.	Drop-in fuel, with lifecycle CO ₂ cuts. Net zero requires carbon removal. Combustion persists and sustainable feedstocks are finite.	Not competitive with incumbent, except areas where policy supports offsets fuel premiums.	Supports refinery jobs, rural economies, and feedstock markets. Growth is limited by feedstock constraints.	Fully commercial, drop-in fuel. Dominant production processes (i.e. hydrotreated vegetable oil) mature, with several large-scale facilities operating globally. Established technology licensors.	Drop-in fuel ideal for reducing near-term fleet emissions without new equipment or operational changes.	Existing fuel storage, pipelines, and retail networks work for RD. Main gaps are upstream (sustainable feedstock availability and refining capacity scale-up).	Accepted when made from sustainable waste feedstocks and used as a bridge. Concerns for forestry and food competition remain.	Fleets seeking fast GHG cuts. Fuel producers and farmers benefiting from new markets. Policymakers aiming for near-term climate progress and rural investment.	Delivers reduced particulate matter and NO _x emissions in existing fleets. Benefits are tempered by feedstock limits and land-use change concerns.
Transportation Systems											
Transit-Oriented Urban Planning	Priority Enabling Pathway Dense, mixed-use development near corridors to boost transit use and cut car dependence.	Deploy Implement and strengthen transit-oriented zoning and density policies at all levels of government now. Align housing and climate goals.	Locks in low-carbon travel by design.	Infrastructure requires significant upfront investment but can yield strong long-term economic returns including increased productivity, higher tax revenues, and reduced household transportation costs.	Infill, housing, and jobs around stations.	Mature planning tools	Works across climates. Depends on zoning and political will.	Starts from existing networks with targeted upgrades.	Support rises with affordability and good urban design. There could be some opposition to densification from local residents.	Important to city/provincial climate and housing goals. Implementation faces governance fragmentation and local opposition.	Health, safety, walkability, and affordability gains.
Modal-Shift Levers (e.g. congestion pricing, fare integration)	Enabling Pathway Reduces car dependence and associated emissions, applicable mostly to urban areas.	Deploy Advance congestion pricing, fare integration, and service improvements now. Reinvest revenues into transit expansion and equity measures.	Proven to reduce car trips and emissions when paired with better service.	Revenues can recycle into transit. Distributional design matters.	Supports service expansion and economic productivity.	Many global precedents with robust evaluations.	Strongest in dense cores with viable transit alternatives.	No major new physical Infrastructure. Enforcement/IT back-end needed.	Acceptance grows post-implementation as benefits materialize.	Cities, provinces and utilities use these to meet goals.	Traffic, safety, air-quality gains. Equity improves with targeted discounts.