

TRANSPORTATION

Medium- and Heavy-duty Vehicles



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.

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

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.

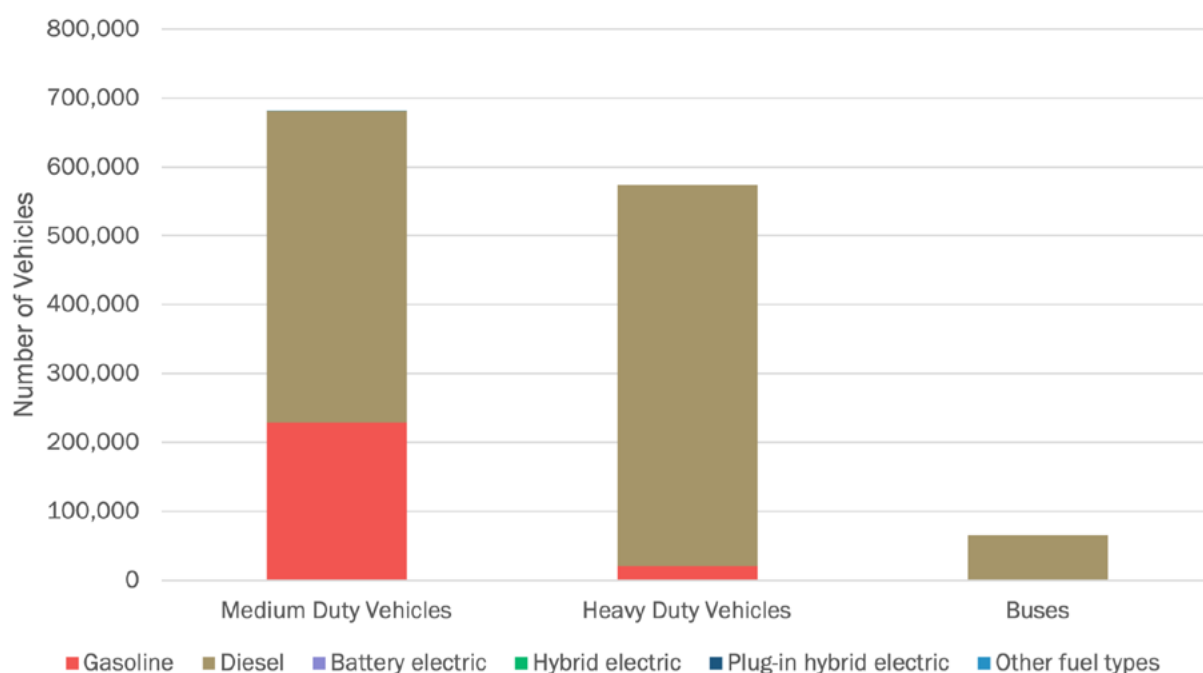


Figure 23. MHDV and bus vehicle registrations by fuel type, Canada 2023[219]

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.