
# Electrifying Fleet Trucks

## A case study estimating potential in the GTHA

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These acknowledgements are part of the start of a journey of several generations. We share them in the spirit of truth, justice and reconciliation, and to contribute to a more equitable and inclusive future for all.

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# Executive summary

Electrifying Canada's medium- and heavy-duty vehicles (MHDVs) presents a transformative opportunity to drive economic growth, improve public health and strengthen Canada's industrial competitiveness. This transition can reduce healthcare costs from pollution, save businesses money on fuel and maintenance, strengthen energy security, and revitalize Canada's declining MHDV manufacturing sector. These advantages make electrification a strategic investment in Canada's long-term prosperity.

Governments worldwide are embracing electrification, setting ambitious sales targets for zero-emission vans and trucks. Jurisdictions such as Europe, China, California and, in Canada, British Columbia and Quebec aim for about 35% of new MHDV sales to be zero-emission vehicles by 2030 and nearly 100% by 2040. Ontario's Driving Prosperity plan, aimed at transforming the province's automotive sector, also emphasizes the need for increased electrification, while the City of Toronto targets having 30% of all registered vehicles be electric by 2030.

To assess the feasibility of these targets, we analyzed the Greater Toronto and Hamilton Area (GTHA) as a case study. Assuming battery-electric trucks as the dominant technology, we analyzed the driving patterns, trip behaviour and dwell duration of Class 3 to 8 trucks in Toronto, Brampton, Mississauga, Hamilton and Markham.[1] Our analysis considered readiness for electrification in the short term (up to 2027), medium term (2028–2034) and long term (beyond 2035).

We found that existing battery-electric truck models can meet the daily range requirements of most Class 3 to 8 trucks in the GTHA, even accounting for a 50% reduction in rated range due to cold weather in the winter months. Additionally, about 40% of these trucks could meet their daily charging needs using chargers installed at their home base, almost completely eliminating any reliance on public charging stations.

We conservatively estimated the following electrification potential for the different time periods:

### Short term

- 35% of Class 3 and 20% of Class 4
- 20% of Class 5 and 15% of Class 6

[1] Our analysis focuses on technical parameters such as daily duty cycles, range capability, return-to-base operations and vocation. It does not consider financial factors (e.g., ZEV MHDV costs) or non-financial factors (e.g., operator reluctance due to limited awareness of ZE MHDVs).

- 10% of Class 7 and 8

**Medium term**

- 59% of Class 3 and 49% of Class 4
- 43% of Class 5 and 36% of Class 6
- 35% of Class 7 and 34% of Class 8

**Long term**

- 90% of Class 3
- 86% of Class 4 and 5
- 75% of Class 6 and 7
- 68% of Class 8

Our analysis revealed that truck travel behaviour varied significantly across jurisdictions, highlighting the need for localized analyses based on real-world data when determining electrification potential, rather than relying on national or provincial averages.

Overall, we found that the GTHA can achieve over 30% zero-emission new MHDV sales by 2030, aligning with targets in Quebec and British Columbia and supporting the City of Toronto's goal for 2030. This objective can be reached through a staggered approach for the different truck classes, focusing on accelerating the adoption of zero-emission Class 3 and 4 trucks. Achieving 50% sales in these lighter classes by 2030 could offset lower targets (<10%) in the heavier Class 5 to 8 trucks.

# 1. Introduction

Canada's medium- and heavy-duty vehicle (MHDV) sector is essential to the nation's economy, enabling the movement of goods and supporting industries. However, its reliance on diesel-powered vehicles creates challenges, including rising operational costs, energy security concerns and health impacts from air pollution. As global markets transition to zero-emission transportation, Canada has a critical opportunity to modernize its MHDV sector, unlocking economic, health and social benefits while strengthening its competitiveness. Among these benefits are:

- significant savings for businesses through lower fuel and maintenance costs
- quieter, more efficient vehicles for operators
- decreased air pollution, resulting in reduced healthcare costs and healthier communities
- enhanced energy security through reduced reliance on imported fossil fuels, ensuring more predictable energy costs for businesses and consumers
- an opportunity to produce electric vehicles domestically, export globally and revitalize Canada's declining MHDV manufacturing sector

Globally, governments are accelerating the shift to zero-emission vehicles with ambitious sales targets. Jurisdictions such as Europe, California (as well as 10 other U.S. states), and British Columbia and Quebec have set or are anticipated to set milestones requiring about 35% of new MHDV sales to be zero-emission by 2030, increasing to nearly 100% by 2040.[2] In Ontario, the government's Driving Prosperity plan aims to transform the province's automotive sector, emphasizing the need for increased electrification.[3] And the City of Toronto has a target that

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[2] European Commission, "Reducing $CO_2$ emissions from heavy-duty vehicles." https://climate.ec.europa.eu/eu-action/transport/road-transport-reducing-co2-emissions-vehicles/reducing-co2-emissions-heavy-duty-vehicles_en

California Air Resources Board, "Advanced Clean Trucks Fact Sheet." https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet

California Air Resources Board, "States that have Adopted California's Vehicle Regulations." https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/states-have-adopted-californias-vehicle-regulations

Government of British Columbia, "Zero-Emission Vehicles Act." https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/clean-transportation-policies-programs/zero-emission-vehicles-act

Mehanaz Yakub, "Quebec introduces bill to boost zero-emission truck sales," *Electric Autonomy Canada*, November 2024. https://electricautonomy.ca/policy-regulations/2024-11-27/quebec-bill-for-zero-emission-heavy-duty-truck/

[3] Government of Ontario, *Driving Prosperity: Ontario's Automotive Plan – Phase 2* (2021). https://files.ontario.ca/medjct-driving-prosperity-ontario-automotive-plan-phase-2-en-2021-11-23.pdf

30% of all registered vehicles (including light and heavy-duty vehicles) be electric by 2030.[4] At the national level, Canada has indicated its intent to align with international efforts by endorsing the global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles, which calls for 30% zero-emission new MHDV sales by 2030 and 100% by 2040.[5]

In this report, we explore the feasibility of transitioning Canada's MHDV sector to zero-emission technologies, focusing on battery-electric trucks (BETs) as the dominant technology. Using the Greater Toronto and Hamilton Area (GTHA) as a case study, we examine whether BETs can meet the operational demands of various truck classes, including range, duty cycle and charging requirements. Our analysis also highlights regional variations in truck usage, emphasizing the need for localized strategies to achieve electrification effectively. These issues are briefly discussed next.

## 1.1 Truck travel behaviour

A common research approach to evaluate suitability for electrification is to compare the technical demands of trucks' travel behaviour (including annual distance, number of trips per year and average distance per trip) to commercially available BET model ranges and their associated battery sizes. Table 1 summarizes the results from some of this research.

The 2022 study in Iceland, which accounted for the harsh cold climate in the region, found that 100% of delivery trucks could satisfy their daily travel demand with existing BETs, though long-distance regional trucks would need charging infrastructure. Similarly, the study in China, which compared detailed trip-level data from over 60,000 electric trucks with daily mileage distributions of diesel trucks, found that, conservatively, 23% of lighter delivery trucks and 30% of heavy-duty semi-trailers could be electrified.

[4] City of Toronto, "TransformTO Net Zero Strategy." https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/

[5] Global Commercial Vehicle Drive to Zero, "Global Memorandum of Understanding On Zero Emission Medium-and Heavy-Duty Vehicles." https://globaldrivetozero.org/mou-nations/

Table 1. Summary of select studies estimating MHDV electrification potential

| Region | Year | Truck electrification potential |
|---|---|---|
| California, USA[6] | 2020 | 62–76% of Class 2B to 7 trucks |
| Germany[7] | 2022 | 60% of all trucks |
| China[8] | 2024 | 23% delivery trucks; 32% heavy-duty semi-trailers |
| Iceland[9] | 2022 | 100% delivery trucks; <50% regional trucks |

Overall, these studies highlight two critical factors in determining the technical suitability for electrification:

- the extent to which existing BET models have the range to cover the daily duty cycles of a typical commercial truck
- the accessibility and availability of charging infrastructure

Regarding the latter, operators of truck fleets should be able to charge their BETs without having to change their truck trip behaviour. This means having charging stations where the trucks dwell (or stop) for the longest time during a typical day (their residence or home-base depot), as well as possibly along their trip routes.

## 1.2 Variation across MHDV classes

Different classes of MHDVs, depicted in Figure 1, are at different stages of market readiness for the transition to zero-emission vehicles. In this study, Classes 3 to 6 are referred to as medium-duty vehicles and Classes 7 and 8 are referred to as heavy-duty vehicles.[10]

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[6] Kate Forrest, Kate, Michael Mac Kinnon, Brian Tarroja, and Scott Samuelsen, "Estimating the technical feasibility of fuel cell and battery electric vehicles for the medium and heavy duty sectors in California," *Applied Energy* 276 (2020), 115439. https://doi.org/10.1016/j.apenergy.2020.115439

[7] Steffen Link, Steffen, and Patrick Plötz, "Technical Feasibility of Heavy-Duty Battery-Electric Trucks for Urban and Regional Delivery in Germany—A Real-World Case Study." *World Electric Vehicle Journal* 13, no. 9 (2022), 161. https://doi.org/10.3390/wevj13090161

[8] Pei Zhao et al. "Challenges and opportunities in truck electrification revealed by big operational data," *Nature Energy* (2024), 1-11. https://www.nature.com/articles/s41560-024-01602-x

[9] Albert Alonso-Villar et al., "Technical, economic, and environmental feasibility of alternative fuel heavy-duty vehicles in Iceland." *Journal of Cleaner Production* 369 (2022), 133249. https://doi.org/10.1016/j.jclepro.2022.133249

[10] Statistics Canada, "Table 23-10-0308-01: Vehicle registrations, by type of vehicle and fuel type." https://doi.org/10.25318/2310030801-eng

The lighter commercial medium-duty vehicles, Classes 3 and 4, are currently the most ready to transition as there are many electric models available, they tend to operate on relatively short and predictable routes, and they often return to the same depot at the end of a shift with sufficient time to recharge overnight. These vehicles are closely followed by the heavier medium-duty vehicles (Classes 5 and 6), such as urban delivery trucks. They often travel longer distances than the Class 3 and 4 vehicles and have fewer models available. Finally, the least market-ready, are heavy-duty vehicles (Classes 7 and 8). They travel long distances and therefore need access to very fast recharging/refuelling options, which are still scarce.

| Class | GVWR (lb) | Vehicle examples | |
|---|---|---|---|
| 2B | 8,501 – 10,000 |  | Full-size pickup |
| 3 | 10,001 – 14,000 |  | Conventional cargo van |
| 4 | 14,001 – 16,000 |  | Medium-duty step van |
| 5 | 16,001 – 19,500 |  | City delivery truck |
| 6 | 19,501 – 26,000 |  | Single-axle truck |
| 7 | 26,001 – 33,000 |  | Medium conventional truck |
| 8 | 33,000+ |  | Heavy conventional truck |

Figure 1. MHDV classes defined in regulation

Adapted from: Government of Canada[11]

## 1.3 Regional/localized variation

The population and behaviour of commercial MHDVs is not uniform across Canada. For example, the GTHA is home to about 50% of all vehicles in Ontario, and the cities of Toronto and Hamilton account for 40% of all commercial vehicles in the GTHA (Table 2). There are also

[11] Government of Canada, "Discussion paper on heavy-duty vehicles and engines in Canada: transitioning to a zero-emission future," December 2021. https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/heavy-duty-vehicle-engines-zero-emission-future-discussion-paper.html

regions where commercial MHDV traffic and movement are concentrated, such as the municipal region of Peel. It is a key industrial hub in Ontario, home to more than 87,000 businesses of all kinds and sees about 68,000 vehicles daily transporting goods. In addition, goods movement in the region contributes over $125 million in taxes.[12]

Table 2. Vehicle population across the GTHA

| Vehicle class | Durham | Halton | Hamilton | Toronto | Peel | York |
|---|---|---|---|---|---|---|
| Commercial | 158,792 | 119,261 | 143,418 | 352,788 | 302,386 | 239,619 |
| Bus | 3,120 | 6,708 | 2,091 | 12,034 | 4,672 | 4,645 |
| Moped | 687 | 520 | 713 | 2,863 | 706 | 666 |
| Motorcycle | 28,323 | 20,038 | 21,950 | 59,237 | 29,181 | 32,906 |
| Off road | 29,210 | 9,674 | 9,987 | 18,128 | 12,343 | 22,048 |
| Passenger | 901,514 | 686,328 | 703,791 | 2,629,211 | 1,615,555 | 1,306,720 |
| Snow vehicle | 25,351 | 9,055 | 9,033 | 19,185 | 11,095 | 23,647 |
| Trailer | 146,491 | 97,429 | 107,609 | 19,6521 | 299,035 | 166,863 |

Daily usage behaviour is also important. A recent study by Natural Resources Canada points to the variation in daily distance travelled in MHDV classes across provinces, finding that distance travelled by MHDVs in some provinces (e.g., Manitoba) is less than half of the daily distance travelled in others (e.g., Alberta). A Class 4 truck in Manitoba travels on average 46 km per day compared to 99 km in Alberta and 91 km in B.C.[13]

Any assessment of the suitability of electrification of MHDVs (and, in turn, the setting of zero-emission MHDV sales targets) must account for the variability in truck population and daily usage behaviour across jurisdictions.

[12] Region of Peel, "Goods movement in Peel." https://www.peelregion.ca/transportation/goods-movement

[13] Dunsky Energy + Climate, "Electric Vehicle Charging Infrastructure for Canada," Table 42: Kilometres Driven per Day per Vehicle (2019), prepared for Natural Resources Canada, February 2024. https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/resource-library/electric-vehicle-charging-infrastructure-for-canada/25756#cc

## 1.4 Research objective

The aim of our research, which addresses the above issues, is to use the GTHA as a case study to estimate the share of trucks that are suitable for electrification based on duty cycle and trip behaviour, taking into account the differences across regions and MHDV classes.

# 2. Methodology and data

We used truck travel behaviour captured through telematics data for our analysis. In Canada, about 50% of trucks are outfitted with telematics devices that collect detailed operational data, including vehicle location, speed and other information from various internal systems such as the engine, transmission and chassis. This data provides robust insights into the real-world potential for truck electrification.

For this research, we partnered with Altitude by Geotab, a leading North American telematics provider. Altitude by Geotab has roughly 250,000 telematics units installed in light-, medium- and heavy-duty vehicles across Canada. The telematics data spanned two one-month periods, January 2023 and July 2023, to capture potential seasonal variations between winter and summer.

Truck travel behaviour was analyzed across all MHDV classes (Classes 3 to 8) and industry classifications. The data included information on each truck's home province, census division and forward sortation area[14] (FSA). Driving duration and distance, average daily speed, details about daily visits to home FSA, stops outside of home FSA, and vehicle vocation were also captured.

To analyze the Altitude by Geotab telematics data, we were guided by the methodology from a 2022 Rocky Mountain Institute (RMI) study that assessed truck electrification potential in California and New York,[15] and used the Altitude by Geotab's analytics platform, Altitude.

Our analysis involved evaluating the suitability of electrification based on specific criteria over the short, medium and long term (section 2.1). Electrification potential was compared for alternative scenarios of sales targets (similar to targets in other jurisdictions), capturing varying electrification across MHDV classes (section 2.2) and across different GTHA regions (section 2.3).

## 2.1 Truck behaviour

Two key factors were used to determine the share of trucks deemed electrifiable in this study: vehicle range (daily travel distance) and access to a public or shared charging network. The extent to which these two factors were considered to have an impact on electrification changed over the short, medium, and long term to reflect advances in battery technology (leading to

[14] A forward sortation area is a geographical area based on the first three characters in a Canadian postal code.

[15] Jessie Lund, Dave Mullaney, Emily Porter and John Schroeder, *Charting the Course for Early Truck Electrification* (Rocky Mountain Institute, 2022). https://rmi.org/insight/electrify-trucking/

longer vehicle ranges) and greater deployment of fast chargers across Canada. We explain in greater detail below how these factors were applied.

### 2.1.1 Daily driving distance (or duty cycle)

#### Short-term assumptions

Over the short term (two to three years), we assumed that an electrifiable vehicle is one that travels less than 160 km a day. In the 2022 RMI study, vehicles with daily usage under 480 km were considered electrifiable in the United States. Globally, multiple electric medium- and heavy-duty truck models with ranges exceeding 300 km are available, with the number of available models increasing each year.[16]

Multiple BET models in Canada offer rated ranges around 320 km. For example:

- Class 2B Ford F-150 Lightning: 510 km.[17]
- Class 4 Ford E-Transit cargo van: About 240 km.[18]
- Class 6 Lion electric truck: 350 km.[19]
- Class 7 Freightliner truck: Exceeding 400 km.[20]
- Class 8 Volvo VNR electric truck: Exceeding 400 km.[21]

Table 3 depicts average driving ranges for commonly available electric trucks in Canada.

Real-world data, however, also indicates that electric vehicles can lose up to 50% of their range at temperatures around −20°C.[22] For Toronto, the average temperature in January, its coldest month, is −8°C. Given these conditions, we have taken a conservative approach in estimating the electrification potential of trucks in the region. Our short-term assumption therefore is based on a likely 50% range loss during winter months, meaning only vehicles that travel less than 160 km per day are electrifiable in Canada.

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[16] International Energy Agency, *Global EV Outlook 2023* (2023). https://www.iea.org/reports/global-ev-outlook-2023/trends-in-electric-heavy-duty-vehicles

[17] Ford, 2023 F-150 Lightning. https://www.ford.com/trucks/f150/f150-lightning/

[18] Ford, “E-Transit Cargo Van.” https://www.ford.ca/commercial-trucks/e-transit/models/cargo-van/

[19] Lion Electric, “Lion 6 Chassis: Technical specifications.” https://thelionelectric.com/lion6/

[20] Freightliner, “Freightliner eM2 Specs.” https://www.freightliner.com/trucks/em2/specifications/

[21] Volvo, “The Volvo VNR Electric.” https://www.volvotrucks.ca/en-ca/trucks/vnr-electric/#overview

[22] Mark Gollom, “Yes, frigid weather may reduce your EV battery range. Here’s how to prepare,” *CBC News*, January 19, 2024. https://www.cbc.ca/news/ev-cold-weather-battery-range-1.7087293

Kelsey Blongewicz and Lucy McKenzie, *Factsheet: Combating range loss in extreme cold* (Atlas Public Policy, 2023). https://atlaspolicy.com/wp-content/uploads/2023/12/Combatting-Winter-Range-Loss-in-E-Trucks.pdf

Charlotte Argue, “To what degree does temperature impact EV range?,” Altitude by Geotab, February 6, 2023. https://www.geotab.com/blog/ev-range/

Table 3. Average driving ranges of commercially available electric trucks in Canada

| Category | Average range, according to manufacturer (km) | Number of models available in Canada |
|---|---|---|
| Cargo van (Classes 3, 4) | 325 | 11 |
| Medium-duty step van (Classes 4, 5) | 250 | 19 |
| Medium-duty truck (Classes 5, 6) | 250 | 32 |
| Heavy-duty truck (Classes 7, 8) | 300 | 22 |

Data source: Calculations based on data from Clean Energy Canada[23]

## Medium- and long-term assumptions

In their technology feasibility assessment of electric vehicles as an option for complying with greenhouse gas emissions standards for heavy-duty vehicles, the U.S. EPA noted that the BET market has been growing significantly since 2018, with more than 160 models from over 60 manufacturers. These models cover a broad range of applications, including school buses, transit buses, straight trucks, refuse haulers, vans, tractors and utility trucks.[24] Similarly, CALSTART highlighted that the number of BET models in the U.S. has increased sharply from about a dozen in 2019 to over 160 models in 2024.[25] The International Energy Agency also anticipates continued global growth in the number of BET models available each year.[26]

As such, we assumed that over the medium and long term, advances in battery technology will lead to a greater number of BET models with higher ranges, even in cold temperatures, becoming available in Canada. For example, as of 2024, the Tesla semi can travel up to 800 km on a single charge.[27] We expect that over the long term, there will be a number of new BET models from other manufacturers with a rated range of 800 km or more readily available in Canada.

[23] Clean Energy Canada and CALSTART, *Zero-Emission Medium and Heavy-Duty Vehicle: Canadian Model Availability Catalogue*, (May 2024). https://cleanenergycanada.org/wp-content/uploads/2024/06/ZEMHDV-AvailabilityCatalogue-V8-Online.pdf

[24] "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3," Federal Register 89 (April 22, 2024), 29440. https://www.govinfo.gov/content/pkg/FR-2024-04-22/pdf/2024-06809.pdf

[25] Jacob Richard, Jessie Lund, and Baha Al-Alawi, *Zeroing in on zero emission trucks: The state of the U.S. market* (CALSTART, 2024), 6. https://calstart.org/wp-content/uploads/2024/01/ZIO-ZET-2024_010924_Final.pdf

[26] *Global EV Outlook 2023*.

[27] Tesla, "Semi – The Future of Trucking is Electric." https://www.tesla.com/en_ca/semi

Steve Hanley, "Tesla Semi Real World Report, Standard Range Model S & Model X Introduced," *Clean Technica*, August 2023. https://cleantechnica.com/2023/08/16/tesla-semi-real-world-report-standard-range-model-s-model-x-introduced/

Vehicle manufacturers are also finding ways to extend the effective range of BETs in cold climates, such as by increasing battery insulation or changing battery chemistry.[28] With further advances in battery chemistry, the effective range of BETs is expected to reach 480 km. We therefore assumed that trucks with a daily travel distance of up to 320 km will be electrifiable in the medium term, and trucks with a daily distance of up to 480 km will be electrifiable in the long term.

### 2.1.2 Charging availability and charging time

In the short term, we assumed that BETs will rely on private depot charging, with limited or no access to public charging stations. As such, trucks that are electrifiable are only those that return to a designated base at the end of each day. This assumption reflects the current scarcity of public charging infrastructure in Canada, which is insufficient to support rapid BET adoption.[29] Moreover, interviews and pilot tests by the North American Council for Freight Efficiency, such as the Run on Less project,[30] indicate that BET operators will likely rely on home-base charging and not on public charging over the next several years.

Table 4 depicts the average charging times for electric trucks using different charger types. In the short term, it is anticipated that electrifiable trucks will use overnight chargers (around 90–100 kW), requiring about 1.5 to 4 hours of idle stop time, depending on vehicle class, to fully charge their batteries.

Table 4. Average charging times for different categories of electric MHDVs

| Category | Average battery size (kWh) | Time to charge (hours) | | |
|---|---|---|---|---|
| | | Level 2 (20 kW) | Level 3 (90–100 kW) | Level 3+ (250 kW) |
| Cargo van (Classes 3, 4) | 100–125 | 8 | 1.5 | 0.9 |
| MD step van (Classes 4, 5) | 125–150 | 8 | 1.7 | 0.9 |
| MD truck (Classes 5, 6) | 150–200 | 10 | 2.5 | 1.2 |
| HD truck (Classes 7, 8) | 400–800 | 20+ | 4+ | 2.5 |

[28] EV Charging Summit, "What EV Carmakers Are Doing to Increase Range in Cold Weather," August 16, 2023. https://evchargingsummit.com/blog/what-ev-carmakers-are-doing-to-increase-range-in-cold-weather

[29] "Electric Vehicle Charging Infrastructure for Canada."

[30] North American Council for Freight Efficiency, "Run on Less – Electric." https://nacfe.org/research/run-on-less-electric/

Over the medium term, we assumed that all Class 3 to 8 trucks operating within the GTHA will have access to at least one overnight charger, even if the trucks stop overnight outside their designated home base. Thus, all trucks that begin and end their daily trips in the GTHA will be electrifiable.

Over the long term, we assumed that there will be a network of fast charging stations spread across Canada, except for in remote areas, which account for roughly 10% of the vehicles in Canada.

Further, over the medium term, electrifiable trucks are assumed to be those that have an idling duration of 1.5 hours or more per day at a single location. In the long term, with greater availability of fast chargers, electrifiable trucks are assumed to be those that have a stop duration of 45 minutes or more per day at a single location.

### 2.1.3 Vocation

The purpose, or vocation, of a truck's journey is another way to understand truck driving behaviour, helping to identify vehicles with a higher potential for electrification. For example, trucks with hub-and-spoke routines (defined below) are stronger candidates for electrification since they return to a centralized hub. On their website, Altitude by Geotab[31] defines vocations as follows:

- **Door-to-door:** The vehicle makes significantly more stops than most per workday but also tends to spend very little time per stop (e.g., last-mile delivery, waste collection).
- **Hub-and-spoke:** The vehicle spends many of its workdays making multiple round trips from a singular location (a centralized hub). Typically, the vehicle would average more than one round trip per working day, with these round trips accounting for most of its total mileage (e.g., auto parts delivery).
- **Local:** The vehicle's range of activity is below 150-air-miles [240-air-kilometres[32]] (e.g., beverage distribution). In addition, the vehicle does not exhibit behavior in line with other vocations such as hub-and-spoke and door-to-door.
- **Regional:** The vehicle has a wide range of activity, over the 150-mile [240 km] threshold, but tends to rest in the same location often. The vehicle is also neither hub-and-spoke nor door-to-door (e.g., building supplies, fuel carrier).

[31] "New vocation classifications unveiled." https://altitude.geotab.com/product-resources/new-vocation-classifications-unveiled/

[32] Air-kilometres are "as the crow files." In other words, measured in a straight line between two points. Therefore, they do not reflect total kilometres driven, but rather the radius from the original location.

- **Long-distance:** The vehicle has a very large range of activity and typically does not rest in the same location. The vehicle is also neither hub-and-spoke nor door-to-door (e.g., long-haul freight).

Vocation distributions serve as upper thresholds for determining electrification potential. Over the short term, the share of electrifiable trucks should be less than the share of trucks with a local vocation. Over the long term, all vocations other than long-distance and regional should be suitable for electrification (assuming the trucks meet the other criteria discussed above).

### 2.1.4 Other criteria (payload capacity, total cost of ownership)

There are concerns that the additional weight and volume of battery packs in BETs will lower a truck's payload capacity and hence negatively impact its electrification potential. However, academic research finds that payload impacts are minimal. For example, a 2021 study by Lawrence Berkeley National Laboratory used a bottom-up vehicle dynamic model to estimate the required battery pack size (in kWh) and the associated weight of the battery pack based on the standard performance requirements of a Class 8 diesel truck. The study found that electric trucks with a range up to 480 km do not have a compromised payload capacity, as their light-weight electric powertrain offsets the battery weight.[33] For 800-kilometre-range electric trucks, the truck is about 19% heavier than a diesel truck, but this can be reduced to only 2% with commercially available lightweighting options, resulting in only a minor payload reduction.

Relatedly, results from the National Roadside Study suggest that about half of all trips made by freight trucks in Canada are made by trucks that are less than half full,[34] thus potentially leaving enough capacity for electric batteries.

Based on the findings from both studies, we assumed that payload capacity will not constrain electrification, consistent with the U.S. Environmental Protection Agency's approach in its 2024 greenhouse gas regulations for MHDVs.[35]

While technical factors are essential, financial considerations, such as the total cost of ownership of BETs compared to diesel trucks, are equally important. BETs are approaching cost

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[33] Amol Phadke, Aditya Khandekar, David Wooley, and Deepak Rajagopal, "Why regional and long-haul trucks are primed for electrification now," *Lawrence Berkeley National Laboratory*, 2021. https://escholarship.org/uc/item/3kj8s12f

[34] Richard Gilbert, *Reducing Greenhouse Gas Emissions from Truck Activity in Urban Areas* [Unpublished manuscript] (2004), 11. http://www.richardgilbert.ca/Files/2004/Reducing%20Greenhouse%20Gas%20Emissions%20from%20Truck%20Activity.pdf

[35] "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3."

parity with diesel trucks across various vehicle classes. We therefore did not include cost parity as a criterion in our analysis.[36]

### 2.1.5 Electrification potential calculation

A vehicle is deemed suitable for electrification if it simultaneously meets all four criteria outlined in Table 5. Thus, for a particular MHDV class, the share of vehicles suitable for electrification is:

$$T\% = A\% \times B\% \times C\% \times D\%$$

where:

A% = Vehicles with a duty cycle lower than the distance threshold

B% = Vehicles with access to charging

C% = Vehicles that spend more time at the base than the charging time threshold

D% = Vehicles that qualify under the vocation threshold

Table 5. Criteria used to assess suitability for truck electrification

| Truck electrification criteria | Short term (to 2027) | Medium term (2028–2034) | Long term (2035 and beyond) |
|---|---|---|---|
| Daily distance threshold | 160 km | 320 km | 480 km |
| Charging availability: location | Access to 100 kW overnight charging only at designated home base or home FSA every night | Access to 100 kW (or more) overnight charging at designated home base or home FSA every night, and overnight public chargers across the GTHA | Access to charging at designated home base and overnight/fast public chargers in urban centres and across the province |
| Charging availability: charging time | Overnight chargers (~100 kW) require 1.5 hours (Class 3) to 4 hours (Class 8) of charging time | Overnight chargers (~100 kW) require 1.5 hours (Class 3) to 4 hours (Class 8) of charging time | Ultra-fast chargers require a few minutes of charging time |
| Vocation | Only "local" trips | All vocations, except for "long-distance" and "regional" | All vocations, except for "long-distance" and "regional" |

[36] For a detailed analysis of total cost of ownership, see Chandan Bhardwaj, *Helping Fleets Charge: Barriers and solutions to charging electric medium- and heavy-duty vehicles in Ontario* (Pembina Institute, 2024). https://www.pembina.org/pub/helping-fleets-charge

## 2.2 Variation across MHDV classes

We considered three scenarios to demonstrate the significant variation across MHDV classes in terms of travel behaviour — and in turn electrification potential — and to assess whether policy-induced rapid BET adoption is feasible.

- **Baseline scenario:** BET adoption occurs under existing policies, such as the carbon tax and vehicle emission standards, with no zero-emission MHDV sales targets at the federal or provincial level. This scenario was used as a reference point for comparison.
- **Uniform scenario:** BET adoption is the same for all MHDV classes, with sales targets uniform, such that all new Class 3 to 8 BET sales are 35% zero emission by 2030 and 100% by 2040.
- **Staggered scenario:** BET adoption is varied, with sales targets higher for the lighter MHDV classes.
  - BET sales in Class 3 and 4 reach 50% zero emission by 2030 and 100% beyond 2036.
  - BET sales in Class 5 and 6 reach 10% zero emission by 2030 and 100% by 2040.
  - BET sales in Class 7 and 8 reach 5% zero emission by 2030 and reach 100% beyond 2040.

  On average, light freight trucks (mostly Class 3 and 4) account for about 63% of commercial MHDV sales, followed by medium trucks (Class 5 and 6) at 30%, and heavy trucks at 7%.[37] This scenario captures the differences in ease of electrification across the MHDV classes, while still meeting the overall target of 35% sales by 2030. Numerous BET models are available to satisfy the duty cycles for Class 3 and 4 trucks, but fewer electric options exist for heavy-duty long-haul trucking. Hence, the adoption of electric trucks will likely be staggered.

## 2.3 Regional variation

Our project covered the five most populated municipalities in the GTHA: City of Brampton, City of Mississauga, City of Toronto, Town of Markham, and City of Hamilton. Within these municipalities, we analyzed truck behaviour for each FSA.

Canada has about 1,600 FSAs.[38] Of these, about 500 FSAs are in Ontario, while Toronto has 95.

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[37] Natural Resources Canada, "Transportation Sector Canada: Table 60: Truck Explanatory Variables." https://oee.rncan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=tran&juris=ca&rn=60&page=0

[38] Statistics Canada, "Forward Sortation Area Boundary File, Reference Guide, Census year 2016," September 13, 2017. https://www150.statcan.gc.ca/n1/pub/92-179-g/92-179-g2016001-eng.htm

# 3. Results

## 3.1 Operational criteria

### 3.1.1 Daily driving distance/duty cycle

Table 6 depicts the average duty cycles for MHDV Classes 3 to 8 for the five municipalities. It also includes the variation in duty cycles, measured between the 10th and the 90th percentiles of the vehicles analyzed.

As expected, duty cycles varied significantly across vehicles classes, tripling in value between Class 3 and Class 8. On average, Class 3 and 4 trucks travel 80 km per day; Class 5 and 6 trucks 85 km; Class 7 trucks 95 km; and Class 8 trucks 180 km. These findings are similar to data from Natural Resources Canada for Ontario, which estimates daily travel distances of 70 km for Class 3 trucks, 70 km for Class 4 and 5 trucks, 70 km for Class 6 and 7, and 330 km for Class 8 trucks.[39] However, in our study, the duty cycle of Class 8 trucks in the GTHA was about 40% lower than in the Natural Resources Canada study. One possible explanation is that trucks in rural areas travel significantly more daily than those in urban areas, raising the province-wide average.

Duty cycles also varied across the municipalities in our study. For example, Class 3 trucks in Brampton and Hamilton travel longer distances per duty cycle than those in Toronto, Mississauga and Markham. In addition, local variation is seen in Toronto, where the top five FSAs — M9W, M9Y, M9L, M1P and M3J — account for about 30% of all trips in the city. These differences highlight the importance of conducting localized, region-specific analyses rather than relying on province-wide or national averages.

A notable finding is that 85–90% of Class 3 and 4 trucks, 75–80% of Class 5 and 6 trucks, and 60–70% of Class 7 and 8 trucks had duty cycles of less than 160 km. As discussed in the methodology section, several commercially available electric trucks can accommodate these duty cycles. Additionally, data from Natural Resources Canada indicates that the average distance travelled by light- and medium-duty trucks has been slowly declining since 2005.[40] Our study assumed that truck duty cycles will remain within a similar range over the medium and long term.

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[39] Natural Resources Canada, "Electric Vehicle Charging Infrastructure for Canada," Table 42: Kilometres Driven per Day per Vehicle (2019)." https://natural-resources.canada.ca/energy-efficiency/transportation-energy-efficiency/resource-library/electric-vehicle-charging-infrastructure-canada#dd

[40] Natural Resources Canada, "Transportation Sector Canada: Table 60: Truck Explanatory Variables."

Table 6. MHDV duty cycles by class and region

| | Toronto | | Brampton | | Mississauga | | Hamilton | | Markham | |
|---|---|---|---|---|---|---|---|---|---|---|
| Class | Variation (km) | Average (km) | Variation (km) | Average (km) | Variation (km) | Average (km) | Variation (km) | Average (km) | Variation (km) | Average (km) |
| 3 | 0–87 | 64 | 0–157 | 102 | 0–140 | 57 | 0–236 | 112 | 0–137 | 64 |
| 4 | 0–92 | 50 | 0–216 | 77 | 0–220 | 98 | 0–192 | 80 | 0–248 | 125 |
| 5 | 0–110 | 70 | 0–197 | 84 | 0–158 | 70 | 0–235 | 102 | 0–184 | 79 |
| 6 | 0–130 | 96 | 0–200 | 89 | 0–265 | 112 | 0–304 | 148 | 0–278 | 120 |
| 7 | 0–160 | 90 | 0–320 | 102 | 0–270 | 112 | 0–248 | 96 | 0–200 | 91 |
| 8 | 0–324 | 160 | 0–640 | 280 | 0–500 | 230 | 0–408 | 184 | 0–256 | 118 |

### 3.1.2 Stop duration/dwell time

Table 7 shows the dwell times at the trucks' home FSAs. Across the municipalities and MHDV classes, trucks spend on average eight hours at their home base. Trip data reveals that most of the dwell time corresponds to vehicle stops or rest time. These findings suggest that many trucks would have ample time to charge if they transitioned to BETs, assuming charging infrastructure is deployed where vehicles park.

Notably, 85–90% of Class 3 and 4 trucks spend a minimum of 1.5 hours at their home base, 80–85% of Class 5 and 6 trucks two hours or more, and 70–75% of Class 7 and 8 trucks four hours or more.

Table 7. Dwell times at home FSAs across classes and GTHA municipalities

| | Toronto | | Brampton | | Mississauga | | Hamilton | | Markham | |
|---|---|---|---|---|---|---|---|---|---|---|
| Class | Variation (hours) | Average (hours) | Variation (hours) | Average (hours) | Variation (hours) | Average (hours) | Variation (hours) | Average (hours) | Variation (hours) | Average (hours) |
| 3 | 3.5–18 | 9.5 | 5.5–10 | 7 | 5.5–13 | 8 | 2.5–20 | 12.5 | 4–21 | 11 |
| 4 | 1.5–17 | 8.5 | 0.5–13 | 8 | 3.5–21 | 14 | 1.5–18 | 14.5 | 3.5–20 | 14.5 |
| 5 | 3–22 | 9 | 2–11 | 6.5 | 4–11 | 7 | 3–19 | 10 | 5–20 | 12 |
| 6 | 2.5–20 | 10 | 1.5–20 | 10 | 4–17 | 7.5 | 4–23 | 10.5 | 5–17 | 11.5 |
| 7 | 2–18 | 9.5 | 4.5–11 | 6 | 1.5–22 | 8 | 4.5–18.5 | 9.5 | 8–19 | 13.5 |
| 8 | 3.5–15 | 5.5 | 5–10 | 6.5 | 5–15 | 6.5 | 5–16 | 8 | 4–20 | 10.5 |

### 3.1.3 Return to base

Table 8 depicts the distribution of truck trips.

#### Start and end at home FSA

This table section shows the share of trips where trucks return to the same FSA from which they started.

On average, 40% of truck trips end in the FSA of origin. However, trip behaviour varies widely across municipalities. For instance, 53% of Class 3 truck trips in Mississauga end in their home FSA, compared to only 35% in Toronto.

Across vehicle classes, there is minor variation. On average, 45% of Class 8 truck trips return to their home FSA, slightly higher than the class-wide average of around 40%.

Trucks returning to the same FSA at the end of the day are stronger candidates for electrification since they can rely on depot charging, reducing dependence on public charging stations.

#### Start and end within the GTHA

This table section shows the share of trips that both start and end within the GTHA. Overall, 60% of trips fall into this category, though there is significant variation across the municipalities. For instance, 80% of truck trips in Brampton remain within the GTHA, compared to 47% in Toronto.

Class-wise, 70% of Class 8 truck trips start and end within the GTHA, compared to the class-wide average of about 60%.

#### Start and end within Ontario

This table section shows the share of trips that start and end within Ontario. On average, 97% of truck trips that start in the five municipalities end within Ontario. This percentage is consistent across the municipalities. For Class 3 trucks, 99% of trips remain in Ontario, slightly higher than the 95% observed for Class 8 trucks.

Table 8. Truck trip distribution across GTHA municipalities and MHDV classes

| | Toronto | | Brampton | | Mississauga | | Hamilton | | Markham | |
|---|---|---|---|---|---|---|---|---|---|---|
| Class | Variation | Average | Variation | Average | Variation | Average | Variation | Average | Variation | Average |
| Start and end at home FSA | | | | | | | | | | |
| 3 | 25–79% | 35% | 20–50% | 40% | 35–61% | 53% | 26–48% | 46% | 31–43% | 39% |
| 4 | 24–90% | 43% | 10–38% | 21% | 27–70% | 31% | 17–53% | 37% | 10–20% | 15% |
| 5 | 27–57% | 34% | 21–56% | 48% | 50–77% | 56% | 23–48% | 47% | 39–63% | 48% |
| 6 | 31–63% | 37% | 20–52% | 37% | 30–70% | 52% | 25–51% | 40% | 15–54% | 33% |
| 7 | 30–73% | 38% | 26–52% | 44% | 44–64% | 57% | 24–67% | 52% | 20–48% | 25% |
| 8 | 38–55% | 45% | 29–56% | 50% | 32–55% | 53% | 34–59% | 56% | 16–56% | 45% |
| Start and end within the GTHA | | | | | | | | | | |
| 3 | 25–79% | 40% | 68–89% | 82% | 70–93% | 81% | 36–66% | 60% | 57–82% | 76% |
| 4 | 43–93% | 50% | 79–84% | 86% | 73–95% | 87% | 17–53% | 40% | 27–49% | 43% |
| 5 | 38–66% | 45% | 34–90% | 81% | 65–87% | 81% | 34–64% | 57% | 45–77% | 70% |
| 6 | 32–65% | 45% | 39–85% | 72% | 57–85% | 77% | 32–56% | 50% | 32–56% | 50% |
| 7 | 48–73% | 54% | 48–83% | 77% | 64–89% | 80% | 34– 61% | 57% | 34–62% | 58% |
| 8 | 56–77% | 60% | 54–84% | 76% | 46–86% | 77% | 43–71% | 67% | 46–82% | 74% |
| Start and end within Ontario | | | | | | | | | | |
| 3 | 98–100% | 99% | 98–100% | 99% | 98–100% | 99% | 98–100% | 99% | 98–100% | 99% |
| 4 | 98–100% | 99% | 98–100% | 99% | 98–100% | 99% | 98–100% | 99% | 98–100% | 99% |
| 5 | 96–100% | 97% | 96–100% | 97% | 96–100% | 97% | 96–100% | 97% | 96–100% | 97% |
| 6 | 96–100% | 97% | 96–100% | 97% | 96–100% | 97% | 96–100% | 97% | 96–100% | 97% |
| 7 | 90–100% | 95% | 90–100% | 95% | 90–100% | 95% | 90–100% | 95% | 90–100% | 95% |
| 8 | 90–100% | 95% | 90–100% | 95% | 90–100% | 95% | 90–100% | 95% | 90–100% | 95% |

### 3.1.4 Vocation

Table 9 shows the vocation (purpose) of a truck's daily trip.

Trip vocation varies by vehicle class. The following are the averages:

**Local**

- about 65% of Class 3 and 4 trucks
- 60% of Class 5 and 55% of Class 6 trucks
- 40% of Class 7 and 30% of Class 8 trucks

**Door-to-door**

- 15% of Class 3 and 4 trucks
- 10% of Class 5 and 6 trucks
- 5% of Class 7 and 8 trucks

**Hub-and-spoke**

- 15% for Class 3 and 4 trucks
- 20% for Class 5 and 6 trucks
- 30% for Class 7 and 8 trucks

**Regional and long-distance**

- About 10% of Class 3, 4 and 5 trucks
- About 20% of Class 6, 7 and 8 trucks

Variation across the municipalities is also evident. For example, regional and long-distance trips account for 13% of Class 8 truck trips in Markham but exceed 30% in Brampton.

Table 9. Trip vocation by vehicle class and region

| Vocation | Class 3 | Class 4 | Class 5 | Class 6 | Class 7 | Class 8 |
|---|---|---|---|---|---|---|
| Toronto | | | | | | |
| Door-to-door | 13.5% | 19% | 9% | 3.5% | 7% | 5% |
| Hub-and-spoke | 19% | 15% | 21% | 20% | 27% | 32% |
| Local | 60% | 59% | 58% | 54% | 48% | 41% |
| Regional | 6.5% | 6% | 10% | 20% | 16% | 15% |
| Long-distance | 1% | 1% | 2% | 2.5% | 2% | 7% |

| Vocation | Class 3 | Class 4 | Class 5 | Class 6 | Class 7 | Class 8 |
|---|---|---|---|---|---|---|
| Brampton | | | | | | |
| Door-to-door | 4% | 13% | 2% | 3% | 5% | 6% |
| Hub-and-spoke | 16% | 6% | 19% | 27% | 31% | 37% |
| Local | 62% | 69% | 65% | 50% | 36% | 25% |
| Regional | 16% | 12% | 13% | 13% | 18% | 20% |
| Long-distance | 2% | 0% | 1% | 7% | 10% | 12% |
| Mississauga | | | | | | |
| Door-to-door | 8% | 28% | 20% | 6% | 6% | 6% |
| Hub-and-spoke | 28% | 11% | 17% | 23% | 34% | 33% |
| Local | 53% | 51% | 52% | 48% | 39% | 39% |
| Regional | 9% | 10% | 10% | 20% | 18% | 20% |
| Long-distance | 2% | 0% | 1% | 3% | 3% | 2% |
| Hamilton | | | | | | |
| Door-to-door | 5% | 22% | 3% | 2% | 0% | 7% |
| Hub-and-spoke | 14% | 9% | 25% | 20% | 24% | 29% |
| Local | 66% | 53% | 60% | 58% | 53% | 34% |
| Regional | 14% | 15% | 12% | 17% | 19% | 21% |
| Long-distance | 1% | 1% | 0% | 3% | 4% | 9% |
| Markham | | | | | | |
| Door-to-door | 4% | 13.5% | 4% | 2% | 2% | 18% |
| Hub-and-spoke | 8% | 10.5% | 17% | 27% | 26% | 26% |
| Local | 81% | 68% | 64% | 53% | 55% | 43% |
| Regional | 6% | 0% | 14% | 13% | 15% | 9% |
| Long-distance | 1% | 8% | 1% | 5% | 2% | 4% |

# 3.2 Share of trucks suitable for electrification

An estimate is provided for the share of Class 3 to 8 trucks that are suitable for electrification in the short, medium and long term across the five GTHA municipalities.

### Short-term potential

Over the short term (up to 2027), commercially available BETs have an effective range of 160 km, rely primarily on home base charging, and use a 100kW charger for overnight charging.

Based on these factors, the approximate percentage of trucks suitable for electrification over the short term are listed below and reflected in Figure 2:

- 32% of Class 3 and 20% of Class 4
- 20% of Class 5 and 16% of Class 6
- 10% of Class 7 and 11% of Class 8

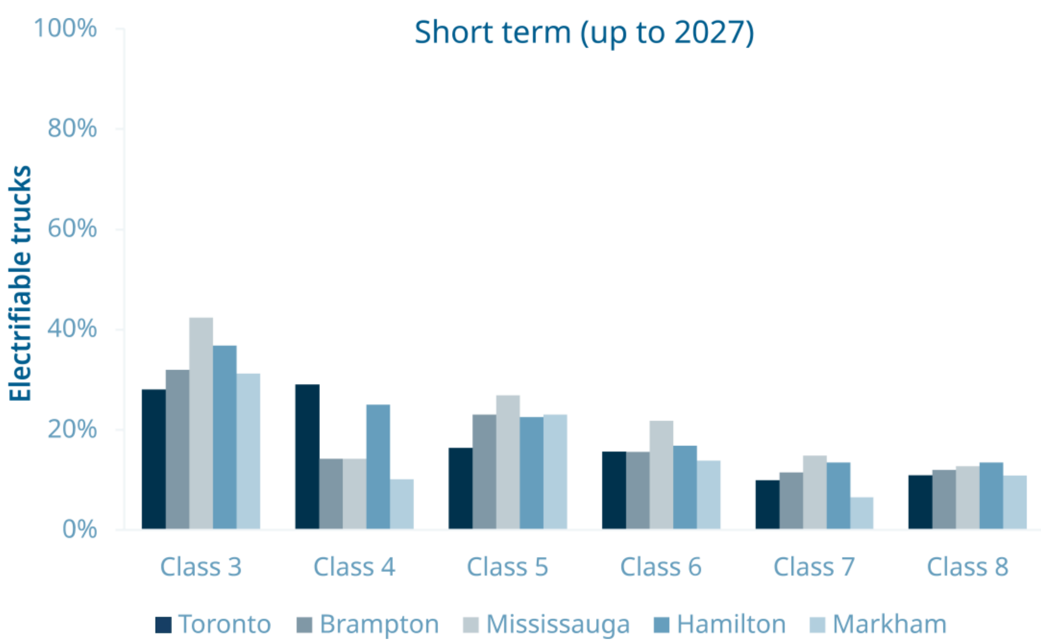


Figure 2. Share of electrifiable trucks across vehicle classes and GTHA municipalities (short term)

Regional differences exist due to differences in duty cycles, vocation, trip behaviour and dwell times. For example, close to 45% of Class 3 trucks are electrifiable in Mississauga, compared to 26% in Toronto.

## Medium-term potential

Over the medium term (2028–2034), with multiple models having an effective range of 320 km and with rich deployment of public charging stations in the GTHA, the approximate percentage of electrifiable trucks, as captured in Figure 3, rises to the following:

- 59% of Class 3 and 49% of Class 4
- 43% of Class 5 and 36% of Class 6
- 35% of Class 7 and 34% of Class 8 trucks

Notably, the potential varies greatly across the municipalities. For example, the share of Class 4 trucks suitable for electrification in Markham (35%) is significantly lower than that in Brampton or Mississauga (around 75%). These results, a function of the differences in truck behaviour across jurisdictions, highlight the need for conducting detailed, localized analyses using real-world data, rather than relying on provincial or national averages.

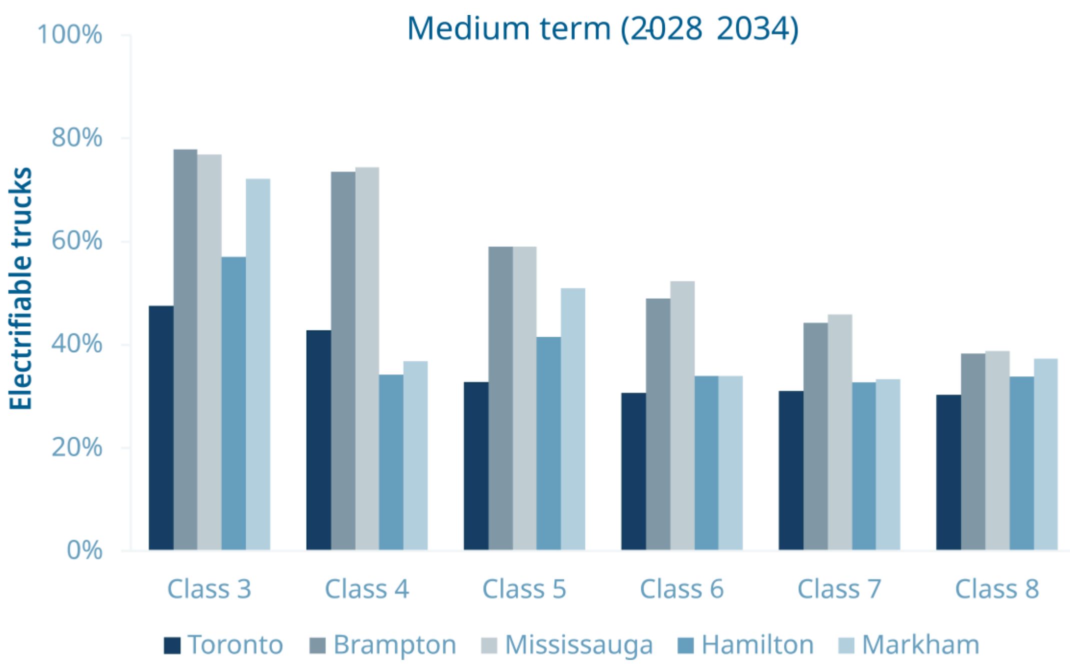


Figure 3. Share of electrifiable trucks across vehicle classes and GTHA municipalities (medium term)

## Long-term potential

The outcome, admittedly, over the long term (beyond 2035) is more uncertain. However, with expected progress in battery technology leading to more high-range BET models,[41] and the deployment of fast charging infrastructure, the estimated percentage of trucks suitable for electrification is anticipated to rise further, as presented below and in Figure 4:

- 90% of Class 3 and 88% of Class 4
- 86% of Class 5 and 76% of Class 6
- 75% of Class 7 and 68% of Class 8

As noted earlier, these are conservative estimates. Under more optimistic conditions, such as if a number of longer-range BETs become available sooner or if charger deployment is accelerated, the number of electrifiable trucks could be higher by 5 to 7 percentage points.

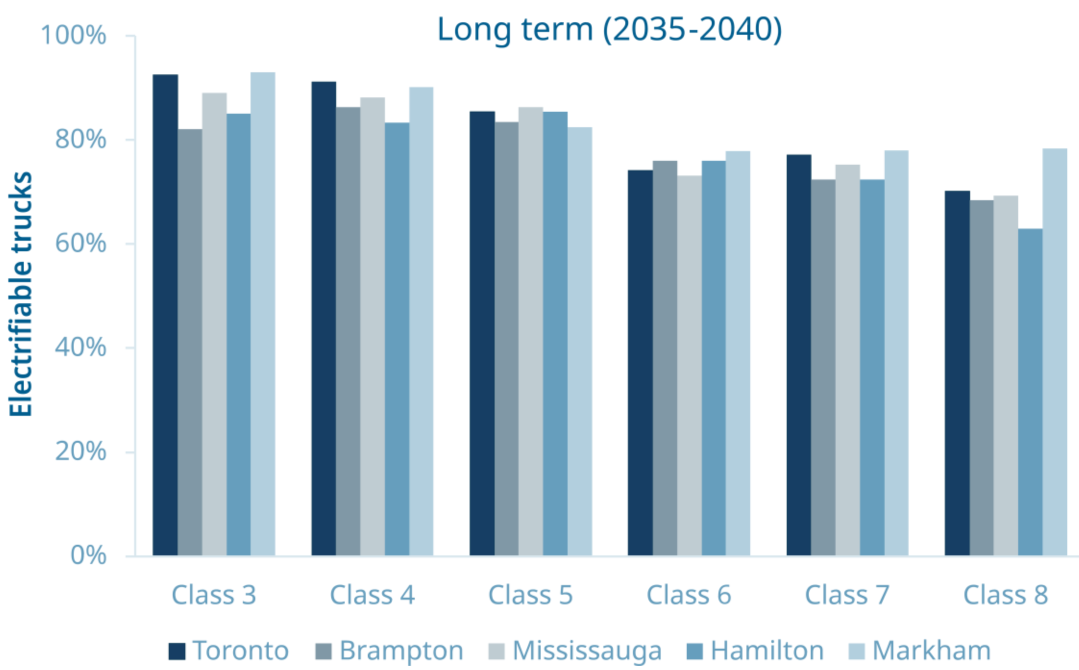


Figure 4. Share of electrifiable trucks across vehicle classes and GTHA municipalities (long term)

[41] Steffen Link, Annegret Stephan, Daniel Speth, and Patrick Plötz. "Rapidly declining costs of truck batteries and fuel cells enable large-scale road freight electrification." *Nature Energy* (2024), 1–8. https://www.nature.com/articles/s41560-024-01531-9

## 3.3 Feasibility of targets for electric vehicle adoption

As noted earlier, governments across the world are implementing sales targets for zero-emission vans and trucks, requiring around a third of all new MHDV sales to be zero-emission by 2030 and nearly 100% of all new sales by 2040. To achieve these targets, in November 2024, the Quebec government proposed a bill requiring truck manufacturers to sell an increasing number of zero-emission heavy-duty vehicles each year. Similarly, the Government of British Columbia is considering sales standards for automakers requiring that 35% of all new MHDV sales must be zero-emission MHDVs by 2030 and 100% by 2040. For benchmarking purposes, we assumed sales targets of 35% by 2030 and 100% by 2040 for our analysis.

Figures 5 to 10 depict the projected stock of Class 3 to 8 BETs under the three scenarios (refer to section 2.2), converting the new sales targets under each case to total vehicle stock. In each figure, the green line indicates the BET stock resulting from the 35% by 2030 targets applied uniformly across all MHDV classes. The blue line indicates the BET stock if the sales targets are staggered to suit truck electrification potential in each class. The black line is the baseline case indicating the evolution of BET stock under current policies. The dotted lines indicate the share of trucks suitable for electrification for each MHDV class under the short, medium and long term. If for a particular year, the dotted line is higher than the projected BET stock, it indicates that the targets for that particular year are feasible.

Under the staggered scenario, the stock of electric Class 3 and 4 trucks is approximately 14% of the total Class 3 and 4 truck population in 2030 (Figure 5 and Figure 6). This is lower than what we have identified in our study as the total short-term electrification potential for Class 3 (30%) and Class 4 (20%) trucks. As such, meeting the 35% MHDV sales target is possible with a new sales target of 50% for Class 3 and 4 trucks by 2030. This would allow sales targets for heavy-duty long-haul trucks to remain low (<10%), while still achieving the overall MHDV target. This is seen in Figure 7 and Figure 8. Under the staggered scenario, the stock of electric Class 5 and 6 trucks is approximately 4% of the total Class 5 and 6 truck population in 2030, falling below the total short-term electrifiable potential of 20% for Class 5 and 16% for Class 6 trucks. Similarly, BET stock for Class 7 and 8 is lower than the corresponding truck electrification potential for those classes for the short and medium term (Figure 9 and Figure 10). Moreover, if deployment of public charging stations advances, the projected share of electric Class 3 to 8 truck stock by 2040 will remain lower than the long-term electrification potential, implying that the sales targets for 2040 can also be achieved.

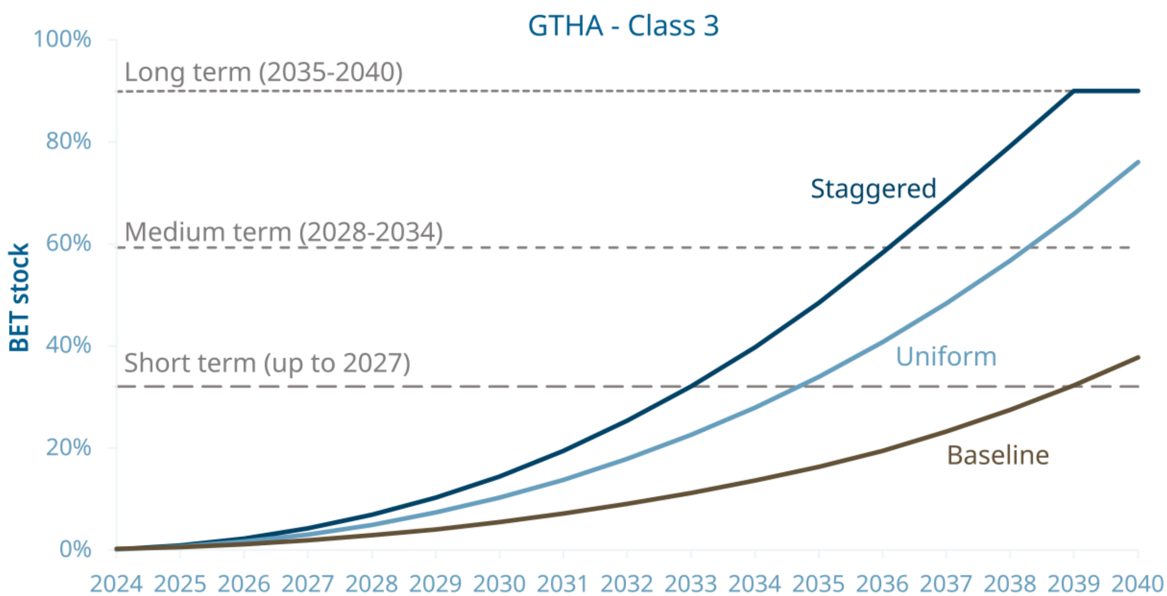


Figure 5. Total Class 3 BET stock under different policy scenarios vs. truck electrification potential in the short, medium and long term in the GTHA

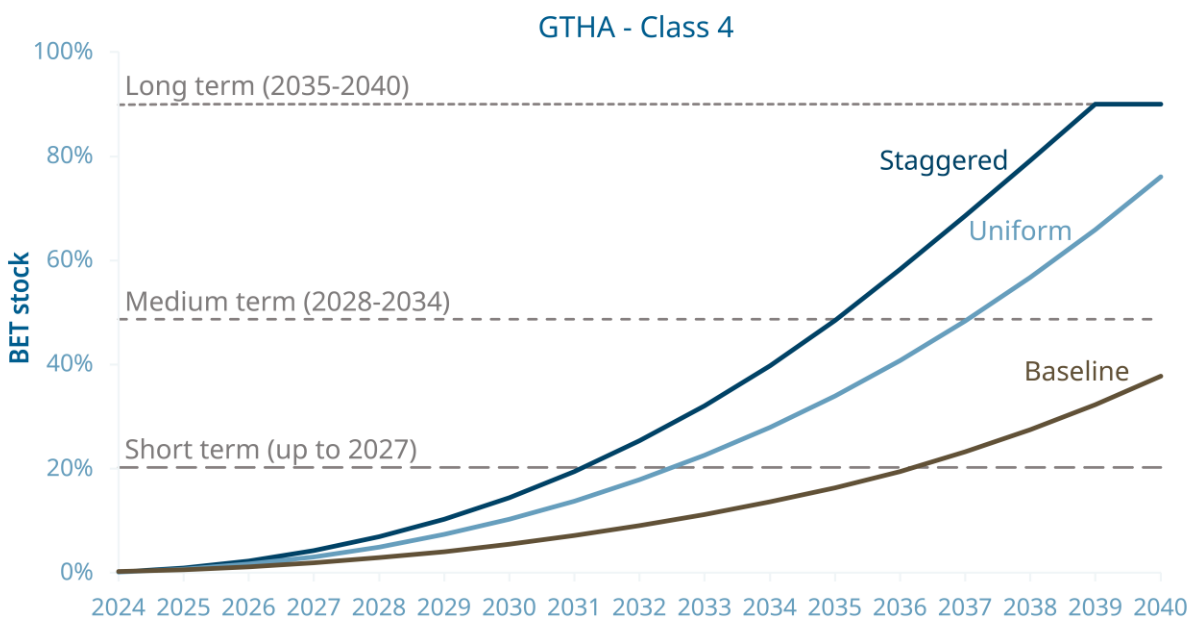


Figure 6. Total Class 4 BET stock under different policy scenarios vs. truck electrification potential in the short, medium and long term in the GTHA

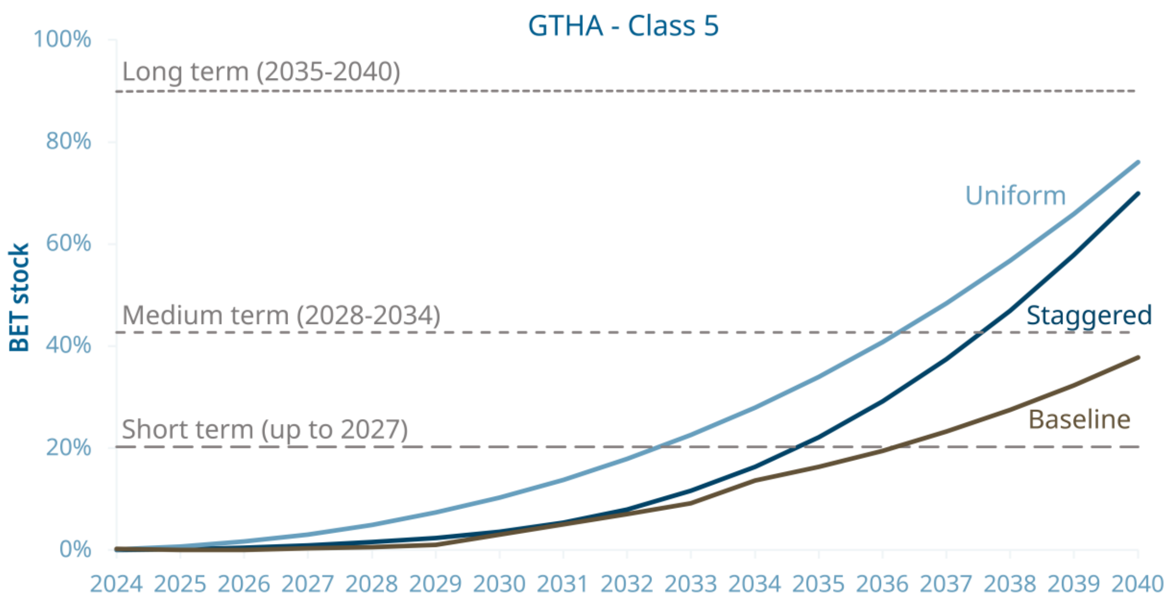


Figure 7. Total Class 5 BET stock under different policy scenarios vs. truck electrification potential in the short, medium and long term in the GTHA

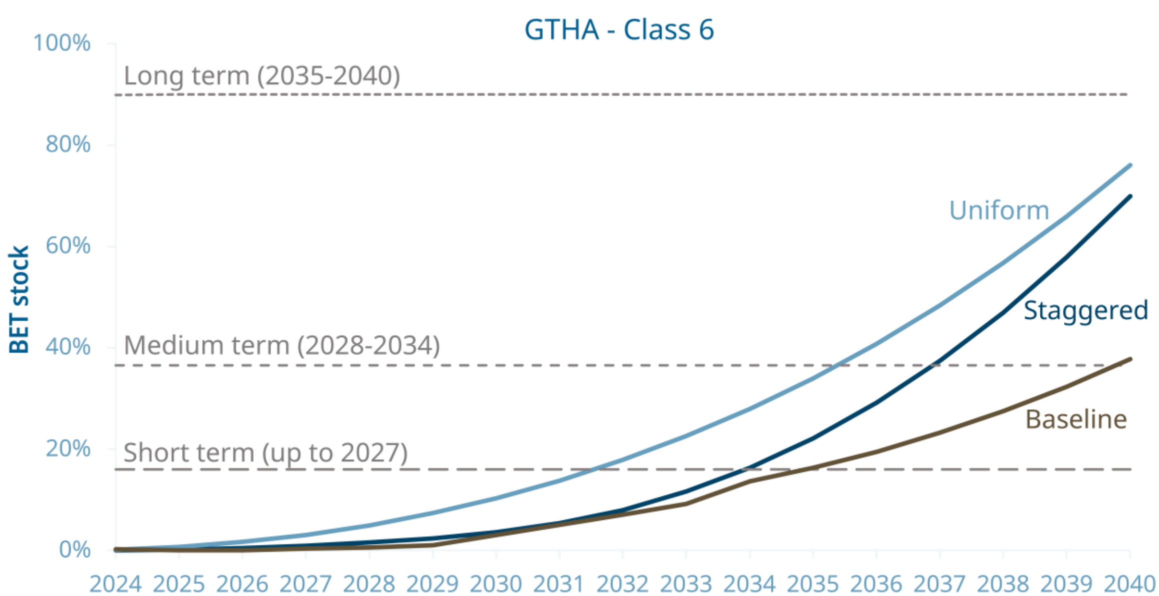


Figure 8. Total Class 6 BET stock under different policy scenarios vs. truck electrification potential in the short, medium and long term in the GTHA

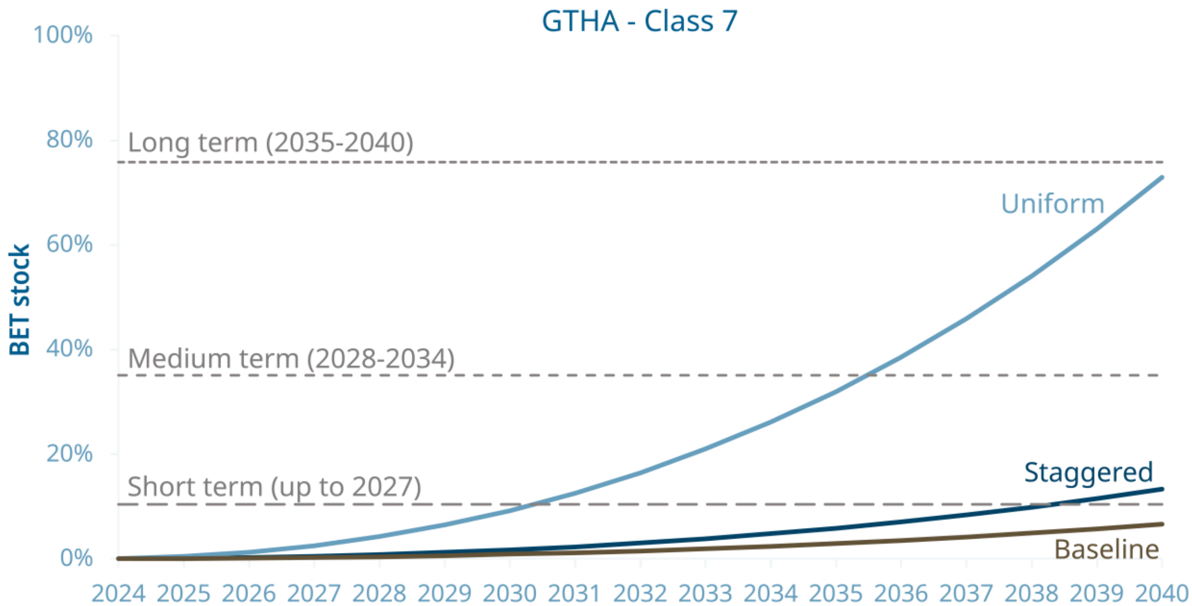


Figure 9. Total Class 7 BET stock under different policy scenarios vs. truck electrification potential in the short, medium and long term in the GTHA

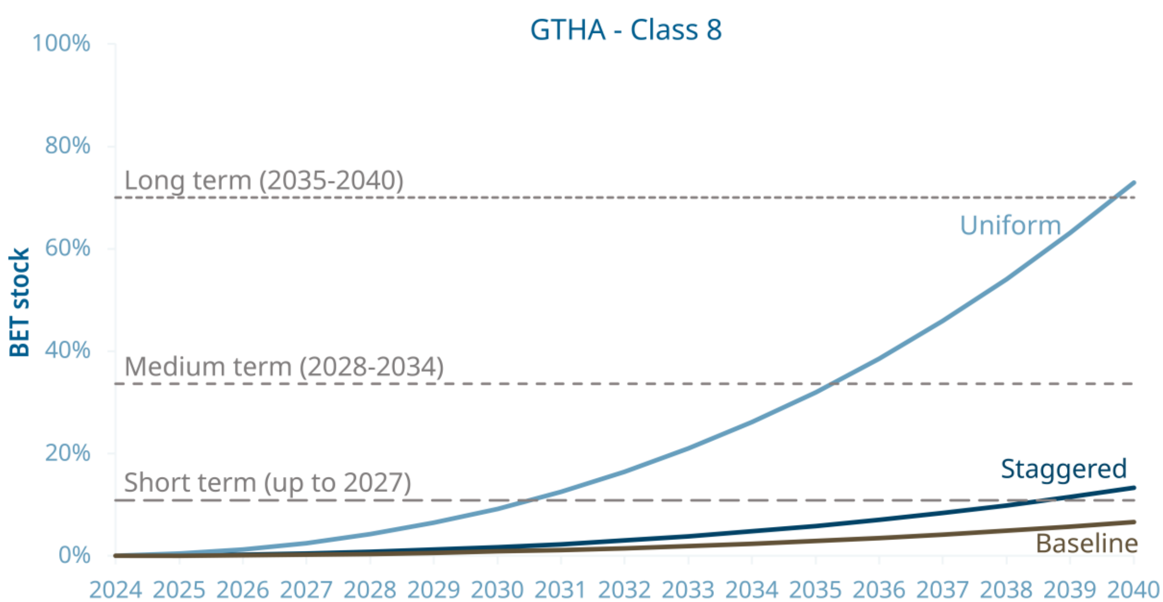


Figure 10. Total Class 8 BET stock under different policy scenarios vs. truck electrification potential in the short, medium and long term in the GTHA

# 4. Conclusion

MHDVs play an important role in Canada's economy. Reducing the reliance on diesel-fuelled vehicles by increasing electrification in the sector can provide a range of social, economic and health benefits. Our research, using the GTHA as a case study, shows that BETs are a technically viable solution for many applications in the short term (up to 2027), medium term (2028–2034) and long term (beyond 2035).

## 4.1 Summary findings

We found that existing BET models offer enough range to cover the daily needs of most Class 3 to 8 trucks in the GTHA, even considering a potential 50% reduction in rated range due to cold weather. Moreover, about 40% of Class 3 to 8 trucks in the GTHA will likely be able to cover their charging needs by using electric chargers installed at their home base.

We also established the following conservative estimates of the percentage of trucks that could be electrified for the different time periods.

**Short term**

- 35% of Class 3 and 20% of Class 4
- 20% of Class 5 and 15% of Class 6
- 10% of Class 7 and 8

**Medium term**

- 59% of Class 3 and 49% of Class 4
- 43% of Class 5 and 36% of Class 6
- 35% of Class 7 and 34% of Class 8

**Long term** (could be 5–7 percentage points higher under more optimistic conditions)

- 90% of Class 3
- 86% of Class 4 and 5
- 75% of Class 6 and 7
- 68% of Class 8

Truck travel behaviour varied significantly across the jurisdictions, underscoring the need for localized analyses informed by real-world truck data rather than relying solely on national or provincial averages.

If Ontario adopted a policy requiring the sale of new zero-emission vans and trucks similar to that in Quebec and British Columbia, the GTHA — home to over 50% of the province's vehicle stock — could meet a target of 35% zero-emission MHDV sales by 2030 through a staggered approach for the different classes. For example, achieving 50% sales for lighter Class 3 and 4 vehicles by 2030 could offset lower targets (<10%) for heavier Class 5 to 8 trucks.

Our study has shown that Ontario can accelerate the transition to zero-emission trucks, unlocking economic opportunities, improving public health and positioning itself as a leader in the clean transportation sector.

## 4.2 Limitations and scope for future research

- The data we used covered a one-month period in January 2023 and another in July 2023, for a subset of the total vehicle population. As a result, it may not have fully captured all truck travel behavioural patterns.
- We did not include in our analysis factors such as total cost of ownership, supply-side feasibility and behavioural considerations that influence a truck operator's decision to replace an existing diesel-powered truck with a BET.
- While our study focused on truck-specific factors (e.g., duty cycle, dwell duration), the readiness of the local electricity distribution grid to support the increased demand from electric truck charging is also a critical consideration. Future research should examine the charging demand and evaluate the capacity of electrical infrastructure in the GTHA to accommodate this transition.

Photo: Roberta Franchuk, Pembina Institute

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