Industry Research Paper

VANCOUVER ECONOMIC COMMISSION

Researching Opportunities to Reduce Financial Barriers to

Purchasing Zero-Emissions Commercial Vehicles

Prepared by
Aigerim Akiltayeva
UBC Sustainability Scholar, 2023

Commissioned for
George P.R. Benson,
Senior Manager, Economic Transformation,
Vancouver Economic Commission

Territory Acknowledgment

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Executive Summary

Despite considerable progress in lowering emissions in buildings in Vancouver and British Columbia (B.C.), transportation emissions remain a major challenge.

Zero-emissions medium- and heavy-duty vehicles (MDHVs) – the vast majority of which are commercially operated – continue to be one of the most difficult sectors to decarbonize, especially considering the many technological and workforce challenges in the broader transportation sector.

This report aims to assess existing Canadian policies driving the uptake of zero-emissions vehicles (ZEV) among businesses; review policies and programs in California, New York State, and Scotland, related to commercial vehicle decarbonization; identify key costs for commercial ZEV adoption; and conduct high-level financial modelling on possible pathways forward.

Policy Overview

Canadian Policies and Programs

- All levels of government have light-duty vehicle (LDV) sales targets and mandates, some of which will impact small businesses; B.C. is the first province to come out with a MDHV mandate that will mirror California's.
- B.C. operates several programs to support ZEV uptake for businesses.

Programs and Policies from California, New York State, and Scotland

- California operates the largest number of programs, with generous grants that support vehicle purchase and lease, as well as infrastructure.
- New York and Scotland have fewer, but many similar, programs, and New York has allied with California in setting ZEV MDHV mandates on top of existing ones for LDVs.

Local Context and Cost Considerations

- The commercial vehicle population in Vancouver, as of 2021, is largely comprised of vans (>8,000), crewcabs (<5,000), and pick-up trucks (>3,900).
- Whole lifecycle costing consistently models a lower whole lifecycle cost for light- and medium-duty ZEVs, with mixed cases for HDVs.
- Most commercial fleets in Vancouver have fewer than 50 vehicles.

Recommendations

The findings in this report should not be taken as comprehensive to the point of being conclusive; however, they highlight several areas of work that VEC can consider undertaking to advance progress on commercial fleet decarbonizations. These include, but are not limited to suggestions that VEC could:

- Undertake further research and financial modelling in hard-to-decarbonize vehicle categories and classes (e.g., garbage trucks);
- Work collaboratively with the ecosystem to site and develop commercially oriented charging infrastructure;
- Explore partnerships with organization such as CALSTART, the North American Council on Freight Efficiency, or the Race to Zero, to support local businesses; and
- Continue engaging with the Government of Canada and Province of British Columbia on further incentives and capacity-building supports for commercial fleet owners.

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Abbreviations	
ZEVs	Zero-emissions vehicles
LDVs	Light-duty vehicles
MDVs	Medium-duty vehicles
HDVs	Heavy-duty vehicles
GHG	Greenhouse gas emissions
MHDVs	Medium- and heavy-duty vehicles
VEC	Vancouver Economic Commission
B.C.	British Columbia
CAPEX	Capital expenditures
OPEX	Operating expenses
BEVs	Battery electric vehicles
ICE	Internal combustion engine

1. Introduction

Transportation stands as a significant contributor to British Columbia's greenhouse gas emissions, accounting for 37% of the total. In 2015, GHG emissions of the transportation sector are coming from on-road light-duty vehicles (36%), on-road heavy duty vehicles (34%), off-road vehicles (14%), marine vehicles (8%), aircraft (6%) and by rail (3%) (Government of British Columbia 2021). In the City of Vancouver, approximately 40% of GHG emissions stem from transportation, primarily attributed to the combustion of gasoline and diesel fuels. Recognizing these figures highlights the pressing need to address and mitigate the environmental impact of the transportation sector in pursuit of a more sustainable future (City of Vancouver 2023).

However, as identified in **Clean Energy Canada's "On the Road to Net Zero"** report, the transportation sector is responsible for 42% of all emissions in B.C. (Clean Energy Canada 2023). Moreover, it is identified that a quarter of these emissions come from commercial transport.

In B.C., medium- and heavy-duty road transport contribute 14% of the province's total emissions (Clean Energy Canada 2023). Decarbonizing commercial fleets – especially medium- and heavy- duty vehicles in Vancouver – will help drive sectoral emissions reductions and contribute to B.C. decarbonization goals. The International Energy Agency anticipates that commercial EV sales will reach 100% of total sales in a net-zero scenario, compared to only 0.1% in 2020 (International Energy Agency 2021).

Table 1 demonstrates the vehicles category as defined by Canadian regulations. Based on Transport Canada definitions, ZEV are defined as vehicles that do not generate any tailpipe emissions, including battery-electric, plug-in hybrid and hydrogen fuel cell vehicles. However, since plug-in hybrid vehicles partially utilize fossil fuels, they were not considered in this report, while commercial-scale utility of hydrogen fuel cell vehicles remains premature. The report therefore refers to battery electric vehicles simply as electric vehicles (EVs).

Table 1: Definition of vehicle category by Canada's regulations (Transport Policy 2023)

Vehicle Categories	
Class	**GVWR, kg (lb)**
Motorcycle	≤793 (1,749)
Light-duty vehicle	≤3,856 (8,500)
Light-duty truck	≤3,856 (8,500)
– Light light-duty truck	≤2,722 (6,000)
– Heavy light-duty truck	>2,722 to 3,856 (6,000 to 8,500)
Medium-duty passenger vehicle	3,856 to <4,536 (8,500 to 10,000)
Complete heavy-duty vehicle (Otto cycle only)	3,856 to 6,350 (8,500 to 14,000)
Heavy-duty vehicle/Heavy-duty engine	>3,856 (8,500)
– Light heavy-duty engine	<8,847 (19,500)
– Medium heavy-duty engine	8,847 to 14,971 (19,500 to 33,000)
– Heavy heavy-duty engine	>14,971 (33,000)

Despite the short-term increase in battery prices due to current supply-demand constraints, the industry is united in anticipation of a long-term decline in battery costs. In the case of light-commercial-vehicles (LCVs), battery electric vehicles (BEVs) are projected to reach a cost per mile that is 90 to 95 percent comparable to internal combustion engine (ICE) vehicles by 2025. With these promising prospects, fleet operators are incentivized to strategically consider and prepare for the decarbonization journey. However, the timing and extent of this transition will be influenced by three critical variables, such as (i) infrastructure development and availability, (ii) vehicle procurement, and (iii) influence on daily operational activities.

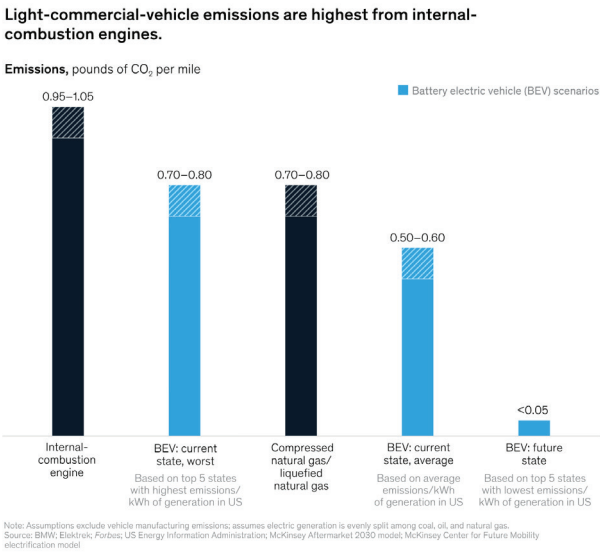
The findings from McKinsey and Company report (2022) are shown in Figure 1.

McKinsey and company reports that the industry is increasingly favouring battery electric vehicle (BEV) solutions when it comes to **light-commercial-vehicles** (LCV) and **medium-duty-trucks** segments (Figure 1).

However, some operators view compressed natural gas (CNG) or liquefied natural gas (LNG) as intermediate options to achieve partial decarbonization, considering their lighter impact on infrastructure and operations. Others are considering renewable natural gas in the short-term, offering up to a 100 percent reduction in emissions compared to diesel fuel, although it comes with a higher total cost of ownership (TCO) than BEVs. The average carbon intensity of the local electricity supply will be a significant factor in determining the viability of BEVs in most jurisdictions. Thanks to the low greenhouse gas intensity (GHGi) of B.C.'s electricity grid, Vancouver is well-positioned to go truly zero emissions through BEVs.

However, for the **heavy-duty sector**, the technology landscape is less clear. While BEVs may offer synergies within an operator's fleet and enable shared charging, maintenance, and operations, they may face challenges with high electrical load requirements, leading to peak-demand surcharges in the near-to-medium term and potential additional costs related to grid upgrades.

Figure 1: Battery electric vehicle scenarios from McKinsey report on commercial fleets (McKinsey and Company 2022)



This project was developed under the guidance of the Vancouver Economic Commission (VEC), the City of Vancouver's economic development agency. VEC's Zero Emissions Economic Transition Action Plan (ZEETAP) identified the need to work on novel financing mechanisms that can help small and medium enterprises (SMEs) overcome financial barriers to acquiring ZEVs and other relevant climate technologies. Therefore, this project was developed with the following objectives:

1. Understand the range of programs and policies in B.C. and in other comparable jurisdictions that are driving ZEV uptake in commercial fleets;
2. Understand Vancouver-specific financial pain points for commercial fleet owners looking to transition to ZEVs;
3. Identify programs, financial products, and other interventions that VEC and other actors could undertake to support commercial fleets' uptake of ZEVs;
4. Recommend next steps for partnerships, programs, and further research for VEC, and other organizations where relevant.

The report has been divided into the following parts:

1. Provide an overview of some of the general considerations of achieving zero emissions vehicles for commercial fleets in Vancouver
2. Outline key transportation decarbonization policies at all levels of government in Canada, as well as notable programs offered to support commercial fleet decarbonization
3. Develop case studies of jurisdictions of interest, including California, New York State, and Scotland. These jurisdictions were chosen to balance size and physical similarities to B.C. and Vancouver, while including those that view climate action with a similar level of urgency.
4. Lay out the context of commercial vehicles and fleets in Vancouver
5. Conduct high-level financial modelling looking at capital and operating costs of ZEVs for commercial operators.
6. Provide recommendations for VEC and other actors and lays out future research questions.

2. Summary of Policies and Programs

This chapter briefly explains the policies that were introduced to support sustainable transportation at the federal, provincial, and municipal levels.

2.1 Government of Canada

The National Emissions Reduction Plan (2023) reported that transportation emissions accounted for 25% of total emissions in Canada, with a total of 186 million tons in 2019. Most of these emissions are attributed to light-duty passenger vehicles, including cars, SUVs, and pick-up trucks, as well as heavy-duty freight vehicles (Environment and Climate Change Canada 2022).

To address this, the Government of Canada has:

- Set a target to achieve 100% zero-emission vehicle sales for light-duty vehicles by 2035.
- Has stated it intends to develop an MDV and HDV sales target in the near future.
- Created programs, such as Incentives for Zero-Emission Vehicles (iZEV) program has already helped over 136,000 Canadians receive up to $5,000 in rebates to offset the purchase price. Recommend next steps for partnerships, programs, and further research for VEC, and other organizations where relevant.
- Introduced a 100% same-year tax write-off for businesses that purchase eligible off-road and heavy-duty electric vehicles up to a maximum of $55,000.

2.2 Government of British Columbia

Through the CleanBC Roadmap to 2030 and its sectoral targets, the Government of British Columbia has set a target of reducing GHG emissions from transportation by 27-32% by 2030 (baseline year 2007), including emissions from on-road light-duty vehicles (LDVs), on-road heavy-duty vehicles (HDVs), off-road vehicles and other transportation.

To support these goals, the Government of British Columbia has:

- Set a legislative sales target of 100% light-duty ZEV sales by or before 2035.
- Stated an intention to develop, and released a consultation paper to further refine, an MDV and HDV sales targets aligned to those in California.
- Created numerous incentive programs and supports specifically for commercial vehicles, such as the **Clean B.C. Go Electric Specialty Use Vehicle Incentive** (SUVI) Program, or the **Clean B.C. Go Electric Commercial Vehicle Pilot Programs** provide support for early market of ZEVs and installing charging/fuelling infrastructure.

2.3 Regional and City-level Policies

Metro Vancouver and TransLink – the two regional entities with authority on the major road network, air quality, and land use – have all committed decarbonization of transportation and, through TransLink, of commercial vehicles specifically. The City of Vancouver and other local governments are making similar, aligned commitments.

To support these goals, several targets and initiatives have been announced:

- Metro Vancouver, through the *Clean Air Plan*, has targeted a 35% reduction in commercial vehicle GHGs by 2030 (below 2010 levels).
- TransLink, through *Transport 2050* has a commitment to "support the transition of medium and heavy-duty vehicles" to ZEVs through policy interventions, programmatic supports, certifications, and financial supports.
- The City of Vancouver, through the Climate Emergency Action Plan (CEAP), has a target of seeing 50% of all vehicle kilometers travelled within city boundaries as being zero emissions by 2030.

3. Case Studies in other Countries and Organizations

This report reviews policies and programs related to commercial vehicles in three jurisdictions: California, New York State, and Scotland. These three case studies were chosen based on their leadership and market similarities to B.C. They are not one-to-one analogies to the local context in Vancouver, but they provide a useful, high-level view of places that actors in B.C. and Vancouver could look to learn from in the development of new programs to support the transition to ZEVs, especially in medium and heavy-duty vehicle classes.

Summary of Programs

California
Policy Objectives:

- 1 million ZEVs by 2023
- 1.5 million ZEVs by 2025
- Created programs, such as Incentives for Zero-At least 5 million ZEVs by 2030.

Programs of Interest

- **California HVIP** – provides vouchers to businesses, nonprofits, governments, and individuals in California of up to US$100,000 (annually) to reduce upfront costs of purchasing or leasing eligible zero-emission and hybrid trucks and buses, with a focus on promoting the adoption of cleaner commercial vehicles to reduce emissions and enhance air quality.
- **Clean Mobility Options** – Provides US$34 million (2022-2023) for clean mobility projects and community transportation needs assessments.
- **Energize Commercial Vehicles** – a broad range of programs for businesses and other organizations, including incentives, grants, and infrastructure support to the adoption of ZEVs in commercial fleets, including supports for vehicle purchase and lease and infrastructure costs.
- **California Clean Off-road Equipment Voucher Incentive Program (CORE)** – US$237 million worth of incentives to encourage California off-road equipment users to purchase or lease currently commercialized zero-emission off-road equipment.

New York State
Policy Objectives:

- 100% of in-state sales of passenger cars or light duty trucks will be zero-emissions by 2035.
- 100% of in-state sales of off-road vehicles and equipment will be zero-emissions by 2035.
- 100% of in-state MHDV sales will be zero-emissions by 2045.
- Deploy 850,000 electric vehicles across the state by 2025.

Programs of Interest

- **New York Truck Voucher Incentive Program** – provides vouchers, or discounts, of up to US$385,000 (for Class 8 vehicles) to fleets across New York that purchase or lease medium- and heavy-duty zero-emission battery electric (BEV) or hydrogen fuel cell electric (FCEV) vehicles.
- **New York City Clean Trucks Program** – both an incentive program (of up to US$185,000 per truck) and a network of resources, the NYC Clean Trucks Program incentivizes local commercial fleet operators to transition away from diesel and towards clean, advanced trucks and transportation technologies.
- **Electric Vehicle Make-ready Program** – offered by the Joint Utilities of New York, the program supports the deployment of EV infrastructure through up-front capital grants, with a total program budget of US$701 million (with US$206 million earmarked to directly benefit historically disadvantaged communities).

Scotland
Policy Objectives:

- 100% ZEV sales in LDVs by 2030
- 30% ZEV sales in MHDVs by 2030, 100% by 2040.

Programs of Interest

- **EV Infrastructure Fund** – a £60 million program targeted at local authorities in Scotland, with the intention to leverage at least half as much from the private sector, to double the EV charging network in the country.
- **Low Carbon Transportation loan** - a £85 million program for which offers Scottish businesses up to £150,000 interest-free to help reduce the carbon impact and fuel costs of their transport arrangements through the purchase of new and more efficient vehicles.
- **Zero Emission Mobility Industry Advisory Group** – a forum established in 2019 to bring together industry stakeholders to advise on shaping a collective approach to Scotland's zero emissions mobility sector.
- **Zero Emissions Energy for Transport Forecast** – a series of publications the Scottish Government produces regularly to ensure up-to-date industry knowledge of transportation decarbonization trends.

3.1 California

The California Air Resources Board (CARB) is using these light-duty vehicle investments to accelerate deployment of the cleanest feasible vehicle technologies to meet California's air quality, climate change, and petroleum reduction goals. These goals include deploying: ·

- 1 million ZEVs by 2023, as directed by SB 1275.
- 1.5 million ZEVs by 2025, as directed in Executive Order B-16-2012.
- At least 5 million ZEVs by 2030, as directed in Executive Order B-48-18.

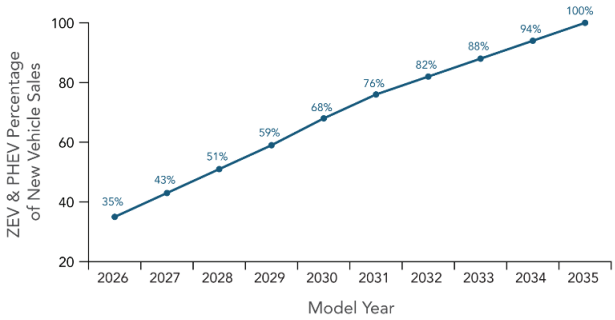


Figure 3. ZEVs new sales is anticipated to increase by 2035 (Source: California Energy Commission)

According to the 2020-2023 Investment Plan Update, the California Energy Commission (CEC) has provided more than US$125 million in Clean Transportation Program funding for fifty-four separate projects on various types of MDVs and HDVs.

There are several funding mechanisms available under CEC, with variations for all classes of vehicles:

- **Competitive solicitation for grants.** The CEC may issue a request for proposals (RFP) or a competitive solicitation to invite organizations, businesses, or individuals to submit project proposals for funding. The proposals are evaluated based on specific criteria, and grants are awarded to the most promising projects that align with the CEC's goals and priorities.
- **First-come, first-served.** In some cases, the CEC may offer funding on a first-come, first-served basis. This means that eligible applicants who meet the specified requirements and submit their applications early will receive the funding until the available funds are exhausted.
- **Production or operation incentives.** The CEC may provide incentives or financial support for the production or operation of specific energy technologies. For example, incentives can be offered to encourage the generation of renewable energy or the deployment of energy-efficient equipment.

- **Loan loss reserve/Loan guarantees.** The CEC may establish programs that provide loan loss reserves or loan guarantees to reduce the financial risk associated with loans for energy projects. This mechanism helps attract private investment and encourages lenders to offer favorable financing terms to energy-related ventures.
- **Block grants** involve providing a fixed amount of funding to a recipient or group of recipients for a specific purpose. These grants offer flexibility in how the funds are allocated and can be used to support a range of energy projects or initiatives.
- **Direct agreements.** The CEC may enter into direct agreements with organizations or entities to provide financial support or incentives for energy-related activities. These agreements can involve funding for research and development projects, pilot programs, or technology demonstrations.
- **Federal cost sharing.** The CEC may collaborate with federal agencies or programs that provide cost-sharing opportunities. This means that the CEC and the federal agency share the costs of a specific project or program, reducing the financial burden on the CEC and leveraging resources from both entities.
- **Alternative financing mechanisms.** The CEC explores and promotes alternative financing mechanisms to support energy projects. These mechanisms can include public-private partnerships, energy performance contracts, energy service agreements, and other innovative financing models that facilitate the implementation of energy efficiency or renewable energy projects.

These funding mechanisms and programs enable the CEC to allocate resources strategically and support a wide range of energy-related initiatives, ultimately driving the transition to a cleaner, more sustainable energy future in California.

The California Air Resources Board (CARB) is responsible for establishing regulations aimed at reducing vehicle emissions, but they cannot work alone in terms of supporting industry and other players. To effectively implement and operationalize these regulations, organizations like CALSTART play a vital role. CALSTART actively works towards making these programs successful and impactful.

CALSTART collaborates with the following agencies:

Table 8. Collaboration of CALSTART with other agencies

Organization	Relevant Programs Supporting EV Deployment
California HVIP (California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project)	The program is aimed at the decarbonization of commercial vehicles, including fleet owners, operators, and dealerships. An approved vehicle purchaser could receive a monetary voucher or discount at the time of purchase.
Clean Mobility Options (Clean Mobility Voucher Pilot Program)	The program focuses to improve clean transportation access and to promote better mobility choices for disadvantaged and low-income communities. There are two types of vouchers available: i. Clean Mobility Project Voucher ii. Community Transportation Needs Assessment Voucher
Communities in Charge	Incentives are provided for Level 2 EV charging infrastructure up to US$3,500 or 75% of eligible costs, whichever is less. Additional funding of US$3500 is available for multi-housing project site and project site for Tribal government
Energize Commercial Vehicles	The nation's first commercial vehicle fleet infrastructure incentive project, which is funded by California Energy Commission's Clean Transportation Program and realized by CALSTART. The program aims to provide incentives for medium- and heavy-duty battery electric and hydrogen fuel cell vehicles infrastructure equipment in California.
California Core	Voucher incentive project (US$273 million available) is focused to promote the use of off-road equipment in California, in particular purchasing or leasing commercialized zero-emission off-road equipment.

3.2 New York State

New York has implemented robust clean transportation policies and programs made possible by the Federal Clean Air Act, which allows the state to adopt California's ZEV standards. Therefore, New York's low emissions vehicles (LEV) program mirrors California's LEV program. This program encompasses all new on-road motor vehicles, motor vehicle engines, and emission control systems that are sold or delivered for sale within the state.

New York aims to promote the use of low- and zero-emission vehicles, thereby reducing pollution and greenhouse gas emissions from the transportation sector. The LEV program serves as a regulatory framework to ensure that newly introduced vehicles meet stringent emission standards and contribute to a cleaner and more sustainable transportation system in New York.

Through this program, New York encourages the adoption of electric vehicles (EVs), hydrogen fuel cell vehicles, and other zero-emission alternatives. By setting high standards for vehicle manufacturers and providing incentives for consumers, the state aims to accelerate the transition towards a greener and more environmentally friendly transportation infrastructure.

In complying with LEV, large and intermediate volume manufacturers are required to deliver and place in service within New York a certain share of ZEVs, such as battery electric, fuel cell vehicles, plug-in hybrids, hybrids, and clean gasoline vehicles with near-zero tailpipe emissions.

According to the latest publicly available report of LEV (2021), more than 220,000 vehicles were delivered for the sale in New York. The following table summarizes the sales.

Table 9. Summary of vehicle production delivered for sale in New York. (PC – passenger cars, LDT – light duty trucks)

Large and Intermediate Volume Manufacturer 2021 Vehicle Production Delivered for Sale in NY	
Manufacturer	**PC and LDT**
BMW	30,566
Fiat Chrysler	124,077
Ford	62,583

The manufacturers generate credits that may be exchanged between manufacturers. If a manufacturer has a positive balance, it indicates the manufacturer complied with the ZEV regulation. Negative credit balances indicate noncompliance with the ZEV regulation and must be offset within a specified timeframe.

As a result of the ZEV regulation, as of October 1, 2022, approximately 114,600 ZEVs and plug-in hybrids are currently operating in New York State.

There are two programs available for New York State to drive the uptake of commercial fleet decarbonization, such as New York Truck Voucher Incentive Program and Electric Vehicle Make Ready Program.

New York Truck Voucher Incentive Program

The New York Truck Voucher Incentive Program (NYT-VIP) is a state initiative designed to promote the adoption of clean and fuel-efficient trucks in New York. The program provides financial incentives in the form of vouchers to help fleet owners and operators transition to cleaner and more environmentally friendly trucks.

Under the NYT-VIP, eligible participants can receive vouchers towards the purchase or lease of new or retrofit clean trucks. These vouchers are available for a range of commercial vehicles, including medium-duty and heavy-duty trucks, as well as buses and associated charging or fuelling infrastructure.

The program aims to reduce greenhouse gas emissions, improve air quality, and enhance energy efficiency in the transportation sector. By incentivizing the adoption of clean trucks, the program helps accelerate the deployment of advanced technologies and alternative fuels, such as electric, hybrid, and natural gas-powered vehicles.

Voucher amounts vary based on the vehicle type, technology, and other factors. NYT-VIP is administered through participating dealerships, where applicants can apply for and redeem their vouchers. Fleet owners and operators are encouraged to take advantage of the program to upgrade their vehicles and contribute to a cleaner and more sustainable transportation system in New York.

New York City Clean Trucks Program

The funding is available from US$12,000 Up to US$185,000 per truck replacement, depending on the fuel type and truck class size.

Businesses engaged in goods transportation and commercial truck operators situated in or operating within 0.5 miles of program-approved Industrial Business Zones (IBZs) in New York City may apply for rebate incentive funding. This funding aims to facilitate the replacement of older, heavily polluting diesel trucks with clean and advanced trucks as well as innovative transportation technologies. By supporting this transition, the program seeks to promote cleaner and more sustainable transportation practices within the city.

Electric Vehicle Make-Ready Program supports the implementation of electric infrastructure and equipment to promote the deployment of EVs within New York State through the reduction of upfront costs of building charging stations for EVs. The program includes the installation of L2 charging stations, as well as a plan for converting LDVs, MDVs and HDVs to electric alternatives and understanding the potential cost savings and introducing MHD Make-Ready Pilot. MHD Make-Ready Pilot helps converting MDVs and HDVs to electric alternatives and access funding to install chargers.

3.3 Scotland

Transportation accounts for 37% of greenhouse gas (GHG) emissions in Scotland, with emissions distributed across various sectors: cars (40%), aviation and shipping (15%), and light goods vehicles and heavy goods vehicles (25%).

Scotland has launched the Mission Zero initiative, which aims to invest in a net-zero transport system. The country has set ambitious targets, including a 56% reduction in transport carbon emissions by 2030 and complete decarbonization by 2045. A substantial £2 billion has been allocated to the Low Carbon Fund in support of these goals, specifically targeting low emission technologies such as battery- and hydrogen-powered transport.

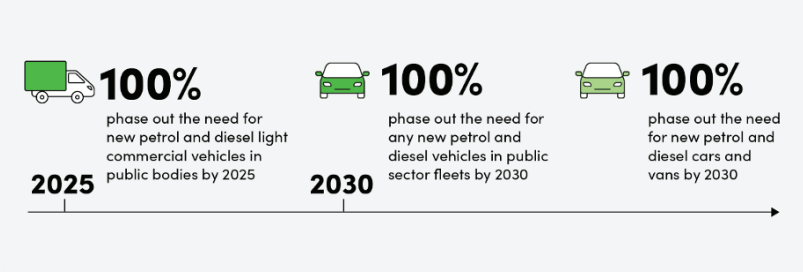


Figure 4. Scotland's objectives in adopting ZEVs. (Transport Scotland) (Transport Canada 2020)

Recognizing the importance of sustainable modes of transportation, Scotland is investing £500 million over five years to strengthen Active Travel initiatives across the country. This prioritizes walking, cycling, and other environmentally friendly modes of transport. Scotland has also committed to reducing car kilometers by 20% by 2030, demonstrating its determination to foster sustainable transportation practices.

Scotland is actively working towards the decarbonization of flights within its borders by 2040, allocating £100 million to transform the bus fleet into fully electric and hydrogen-powered vehicles. The Scottish Ultra-Low Emissions Bus Scheme has been implemented to facilitate this transition. Incentives are provided to individuals and businesses to encourage the adoption of electric vehicles, both new and used, and Scotland is actively establishing a publicly available charging network throughout its territories.

By investing in innovation and promoting the development of zero-emission skills, Scotland aims to position itself as a global leader in sustainable transportation. The country also seeks international collaboration, sharing its world-leading targets and knowledge to contribute to a global zero-emission economy. Through this collaborative and comprehensive approach, Scotland aims to thrive in the transition to a sustainable future.

Within the Government of the United Kingdom's 2040 target, Scotland encourages individuals and businesses to use ultra-low emission vehicles (ULEVs) and it is anticipated to phase out the need for new petrol and diesel cars and vans by 2032.

The programs and initiatives supporting the deployment of low carbon and electric vehicles in Scotland:

- EV infrastructure
- Electric A9
- Used electric vehicle vans
- Switched-on Towns and Cities program
- Low carbon travel and transport
- Hydrogen fuel cells
- Transport emissions in Scotland

Under the Switched-on Towns and Cities program, financial incentives in the form of interest-free loans up to £35,000 were offered towards the cost of purchasing a new electric vehicle until 2020. Moreover, this amount may be used towards the costs of installing charge points at homes and for fleet vehicles. It is stated that Transport Scotland is planning to work closely with the Government of the United Kingdom's Office for Low Emission Vehicles (OLEV) on the EV Homecharge Scheme on duty and tax incentives for EVS and grants for electric cars, vans, trucks, taxis and motorbikes.

Moreover, there is a Low Carbon Travel and Transport Challenge Fund administered by the Energy Saving Trust on behalf of Transport Scotland, which supports low carbon transport and active travel hubs, including EV charging points, and hydrogen and gas refuelling stations.

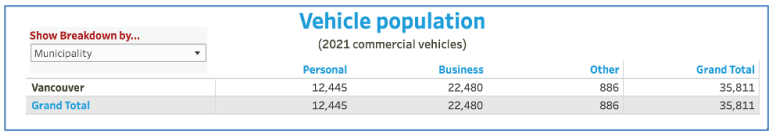
Under the Hydrogen Fuel Cells initiative, it is stated that hydrogen is best suited to heavy-duty applications – for example, buses, taxis, freight and rail. Although hydrogen fuel vehicles have shown a greater range and faster fuelling times, they are more complex and expensive, as well as lacking in infrastructure. The main projects are Aberdeen Hydrogen Bus Project, Levenmouth Community Energy Project/ Fife Council Hydrogen Station, Orkney Surf 'n' Turf and Big Hit hydrogen projects, Dundee City Council, Perth and Kinross Council and Scottish Cities Alliance.

4. Commercial Vehicles and Costs in Vancouver

4.1 Context of commercial vehicles in Vancouver

According to the latest available data (2021) from the ICBC vehicle population census of commercial vehicles 2021, the total number of commercial vehicles in Vancouver owned by businesses in Vancouver was 22,480. This includes both internal combustion engine and electric vehicles (Figure 5).

Figure 5. Screenshot from ICBC data on commercial vehicles. (ICBC, 2021)[1]



Vehicle population

(2021 commercial vehicles)

Show Breakdown by... Municipality

	Personal	Business	Other	Grand Total
Vancouver	12,445	22,480	886	35,811
Grand Total	12,445	22,480	886	35,811

The most common types of commercial vehicles available in Vancouver are shown in Table 10. Vans, crewcabs, pickups, and taxis are the most commonly used by businesses. Of the total number of commercial vehicles in Vancouver (480), only 79 were electric vehicles owned by businesses. However, it is worth noting that this data is from 2021, and the share of EVs has likely increased considerably since then.

Table 10. The most common types of commercial vehicles available in Vancouver (ICBC, 2021)

Van	8171
Crewcab	5050
Pickup	3988
Taxi	725
FlatDeck	722
Box	615
Dump	557
Truck Tractor	542
Bus	290
Cement mixer	254
Giraffe	177
Fork Lift	174
Loader	164
Utility	122
Limousine (Commercial)	96
Truck	81

Table 11. Battery electric commercial medium and heavy vehicles in Vancouver (ICBC, 2021)

Type of vehicle	Number of BEVs (MDV, HDVs) in Vancouver based on data of 2021 from ICBC
Pickup	3
Taxi	2
Limousine Commercial	1
Van	1
Total	7

[1] Parameters for the search are: municipality set to Vancouver; uses set to only commercial (excluding personal and other for commercial vehicles), and across all fuel- and vehicle-types.

In addition to these general statistics, a 2023 survey of fleet owners found that most fleets in B.C. have fewer than 50 vehicles, while more than 90% of fleet vehicles have ten or fewer vehicles. (Bassam, 2023).

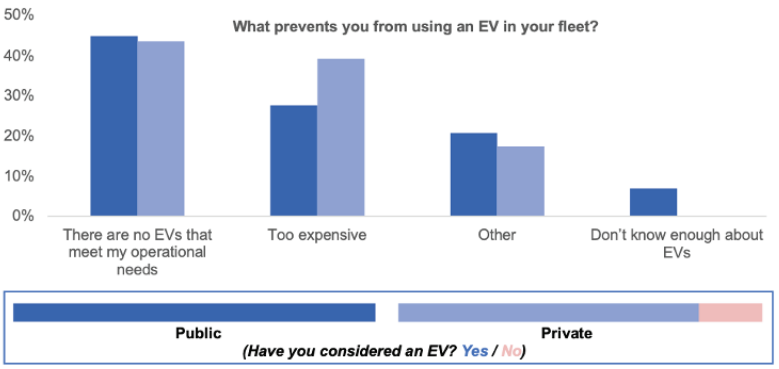
Challenges for Fleet Owners to Decarbonize

There are many barriers to electrification for fleet owners. The most commonly cited challenges, as re-stated by Clean Energy Canada's Road to Net Zero report earlier this year, includes:

1. Costs (both hard and soft) for ZEV adoption;
2. Availability, predictability, and cost of electricity and infrastructure;
3. The complexity of adoption, especially from a fleet perspective and the capacity and awareness necessary to navigate relevant processes;
4. Vehicle supply;
5. Availability and stability of technology (e.g., charging platforms supported; and
6. Reliability and availability of data.

At a finer-grained level, Javad Bassam's 2023 UBC and Pacific Institute for Climate Solutions (PICS) study looked at non-financial barriers to fleet owners adopting BEV commercial vehicles. Interviewed owners cited four overarching reasons for why they could not adopt EVs, with operational needs and cost as the top two reasons they were saying no.

Figure 6. Survey of fleet owners on non-financial barriers to ZEVs (Javed 2022)



Nevertheless, the technology is already in place for almost every use-case in light-duty and medium-duty vehicles. There is some evidence that barriers perceived by SME fleet operators in operational domains of electrical vehicle could be overcome by demonstrating how these operational needs could be met by electrical vehicles. Moreover, further studies on the availability of (and any potential reconfiguration needs for) maintenance shops should be conducted to demonstrate how perceived operational needs could be addressed.

Table 12. Breakdown of common commercial ownership and procurement strategies (Javed 2022)

		Full ownership	Financing	Lease	Other
Ownership type	Public	97%	3%	0%	0%
	Private	72%	7%	14%	7%
		Dealership	**Purchased direct from automaker**	**Third party procurement firm**	**Other**
Procurement type	Public	73%	11%	8%	8%
	Private	41%	10%	21%	28%

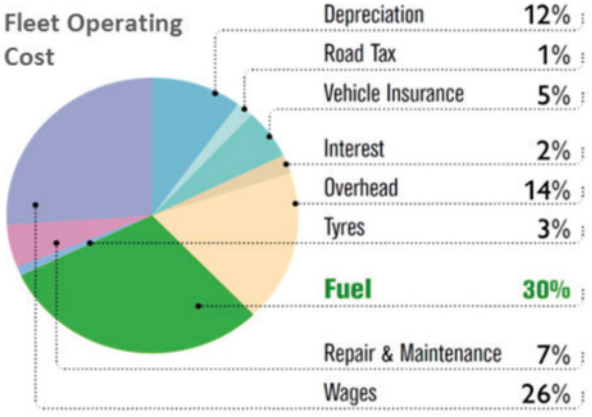
One of the key findings from the Javed and UBC study (as shown in Table 12) is that fleets contain a mixture of mostly owned and some leased and other ownership types. Over two-thirds of owners are purchasing their vehicles outright, but there are still a substantive number of vehicles being leased or financed, in addition to other modes of ownership. This mixture of ownership typologies is the key to understanding how to develop effective programs.

In terms of procurement type, fleets tend to be purchased through dealership for the public sector; meanwhile, third-party procurement is the most common method for private operators. According to this study, third party procurement is the most commonly used method to purchase heavier duty-class vehicles or larger quantities of LDVs.

4.2 Fleet Costs Context

The biggest costs for fleet operators are fuel and driver wages, with related overheads from interest, benefits, and accidents, while other costs are a distant third (Javed 2022). No Vancouver or B.C.-specific data was found within this project's research, but it is estimated that these costs would be reasonably approximate in our context, as well.

Figure 7. Fleet operating costs. Source: (Big Road Marketing 2023)



Although these are U.S.-based numbers, the Transportation Carriers Association (TCA), identifies more specific cost-breakdowns. Due to the heterogenous nature of commercial fleets in Vancouver, these trucking-specific costs are not representative across all of them. However, they do provide some sense of the order of magnitude for at least one-type of fleet operator in North America. These costs may be higher still in B.C. owing to the carbon tax.

Table 13. High and low average costs for trucking operators (Source: Truckload Carriers Association TPP Program for all carriers in the program)

Expense Category	Low Range (CAD/km)	High Range (CAD/km)
Driver Compensation	$0.40	$0.69
Fuel	$0.33	$0.46
Equipment Financing	$0.00	$0.33
Maintenance and Repair	$0.07	$0.33
Insurance	$0.05	$0.15
Variable Driving Expenses	$0.01	$0.07
Non-Driver Compensation	$0.05	$0.25
Fixed Overhead	$0.05	$0.25

Fuel costs

As shown in Figure 7, fuel costs comprise 30% of average total fleet operating costs. It is important to note that commercial trucks may consume as much as 40 times the fuel of a passenger vehicle, and so a fleet comprising different vehicle classes may vary in its total fuel consumption. At the foundational level, fuel will generally be the largest fixed expenditure of a commercial operator, and therefore any technologies (e.g., telematics, programs, or incentives that increase efficiency are highly sought after. If whole-lifecycle costs of BEVs or other ZEVs outweigh current fuel costs and still meet operational needs, they will be a desirable choice for an operator.

Maintenance and Repair Costs

Maintenance and repair costs vary greatly between vehicle classes and styles but always represent a substantial part of fleet costs. Maintenance costs can refer to everything related to regular servicing to prevent damage

or prolong the life of a vehicle, while repairs generally refer to unscheduled work to fix malfunctioning parts that inhibit or prevent the intended uses of a vehicle. As the Argonne National Lab found in their 2021 ICE and ZEV cost comparisons, “Electric and electrified powertrains have lower maintenance and repair costs than ICE powertrains for all vehicle sizes, relative to vehicle price [emphasis added].”

Other Costs

Other fixed costs for operating commercial fleets vary greatly, but are broadly inclusive of driver wages and benefits, insurance, registration, road tolls, mobile costs, administrative supports, workover benefits, and superannuation. While policies and programs can reduce some of these costs to promote ZEV adoption, most are generally fixed. Insurance costs are an area of great variability, where there are not inherently differences in ICE and ZEV insurance costs, but the power of motors in ZEVs and ICE may result in different premiums.

5. ZEV Adoption Scenarios and Financial Modelling

To understand how commercial fleet operators can navigate the costs and challenges of ZEV adoption, this project attempted a conceptual financial modelling to identify gaps in the kinds of incentives and programs already offered in B.C. While this exercise was highly theoretical and did not involve actual use data, it was and is still helpful in understanding some of the order of magnitude in challenges for ZEV adoption. The analysis used two different models as part of this exercise: one from the California Air Resources Board (CARB), and one internally developed for the purposes of this project.

Although the modelling in this report is highly conceptual, it attempts to engage with best practices in costing from all sectors. A useful framework for considering relevant costing information was developed by National Renewable Energy Research Laboratory with regards to battery electric buses (BEBs). They note the following key parameters for undertaking costing studies and financial modelling:

- **BEB purchase price.** It's crucial to procure BEBs at a reasonable price, which depends on factors like time, geography, selected options, and negotiating contract prices.
- **Purchase price of foregone diesel bus.** Fleets facing high prices for diesel buses are more suitable for a BEB investment.
- **Funding amount.** At this early stage of market development, grants are essential to make BEB investments cost-effective. Larger grants lead to more viable projects.
- **Maintenance costs of foregone diesel vehicles.** Fleets facing high maintenance costs on their diesel vehicles find the switch to BEBs more cost-effective.
- **Annual vehicle miles traveled (VMT).** Putting BEBs on high-mileage routes increases operational savings, making the investment more lucrative.
- **Choice of depot or fast charger.** The choice depends on fleet size, charging patterns, and other specific parameters. Fast chargers become more favorable with certain conditions.
- **BEB range.** Determining the range of BEBs through route profiles helps optimize the number of buses and chargers, minimizing project costs.
- **Accuracy of economic analysis.** Collecting fleet-specific inputs and modelling a specific fleet improves the accuracy and actionability of the analysis.

California Air Resources Board (CARB) Transit Fleet Cost Model

CARB developed the Transit Fleet Cost Model in 2017, which enables analyzing of individual fleets for baseline and scenario costs. The model includes two sections: (1) bus and variable infrastructure costs and (2) infrastructure capital costs.

In addition to the Transit Fleet Cost Model, CARB also developed a manual describing how to use the model and key findings of heavy-duty vehicle market segment, using battery electric buses (BEBs) as an example. Using the Transit Fleet Cost Model, a user can estimate net present value and payback period for investment in BEBs and charging infrastructure were determined.

Within the model, four battery electric buses and four depot chargers showed an NPV of $785,000 over the 12-year bus life, considering US$1,500,000 (or US$375,000 per bus with charger) in government subsidies. Baseline analysis included depot charging, where buses were charged overnight, along with a cost comparison with diesel buses.

The example was conducted for buses, as it has been envisioned that transit buses would benefit from electrification sooner – and to a greater degree – than most other heavy-duty vehicles. Moreover, electric buses are available worldwide, as the market is quite mature. NREL reports at least 24 BEB manufacturers of BEBs active in Canada, China, Europe, India and the United States.

The financial analysis provided on BEBs from the National Renewable Energy Laboratory (2020), detemines under which conditions battery electric buses could be a good investment.

The method is a discounted cashflow analysis, which is widely utilised in analysing investment options. Baseline parameters are represented in Table 13.

Table 13. Baseline parameters for the project under Transit Fleet Model

Baseline Parameters				
	Parameter	**Value**	**Unit**	**Source**
General	Number of BEBs obtained (total)	4	Vehicles	Set to put the economics at a sensitive threshold
	Grant amount	$1,500,000	$	Median of FY 2018 Low-No Bus Grant Program (FTA 2018)
	Average life of bus (held same for both bus types to have consistent project period)	12	years	American Public Transit Association (APTA) procurement guidelines (APTA 2013)
	Required rate of return (RRR) or discount rate	3.6%	%	5-year annual returns on Standard & Poor's municipal bond index (S&P Global 2019)
	Average annual vehicle miles traveled (VMT)	32,814	Miles/year	APTA (2018)
	Driver/attendant refueling hours reduction	0	Hours/ week	Assume that maneuvering buses is the same for diesel or electric refueling
Diesel Bus	Cost of new 40-ft diesel bus	$480,000	$	Standard diesel bus price (CARB 2016a)
	Fuel economy diesel buses	22.6	gal/100 mi	Altoona test of Gillig 40-ft bus (Sturaa 2004). 4.4 mpg
	Diesel fuel price	$3.18/gal	$/gallon	U.S. annual 2018 price, (EIA 2019a)
	Diesel price increase	0.7%/year	%/year	Reference case 2018–2050 (EIA 2019b)
	Diesel vehicle maintenance costs	$0.88/mile	$/mi	Utilimarc Fleet Benchmarking database as summarized in the Alternative Fuel Life-Cycle Environmental and Economic Transportation Tool (AFLEET 2018)
	Cost of operating a diesel fuel station	$0/year	$/year	Assume that the retail price of diesel incorporates the amortized cost of running the station
	Number of diesel buses at facility where recharge is to happen	132	buses	Average of 11 facilities surveyed
	Residual value of diesel bus	15.0%	% of purchase price	Hensher (2007)

Battery Electric Bus	Purchase price of BEB	$887,308	$	TCRP (2018)
	BEB efficiency	1.82	kWh/mi	Altoona testing results unweighted average from Proterra, BYD, and Nova 40-ft buses (PTI 2014, 2017, and 2018)
	Battery life	12	years	From cycle-based calculations, preliminary field reports (Eudy and Jeffers 2017), and manufacturer warranties.
	BEB vehicle maintenance costs	$0.64/mile	$/mile	Combined average of scheduled and unscheduled maintenance (TCRP 2018)
	BEB maintenance costs while under warranty	$0.18/mile	$/mile	Average BEB unscheduled cost per mile in year one of evaluation period (Eudy and Jeffers 2017)
	BEB maintenance warranty period	1.00	years	Proterra (2019a)
	Electricity consumption charge	$0.1275/kWh	$/kWh	U.S. average commercial rate (Utility Rate Database [URDB] 2019)
	Electricity price increase	-0.10%	% per year	Reference case, Commercial Electricity Price 2018–2050 (EIA 2019)
	Electricity demand charge	$3.45/kW	$/kW	U.S. average commercial rate (URDB 2019)
	Days driven per year	312	Days/year	6 days/week, 52 weeks/year
	New battery cost-reduction schedule	8%/year	%/year	Nykvist and Nilsson (2015)
	Residual value of BEB	15.0%	Percent of purchase price	Assumed to be the same as diesel bus
	Battery capacity[a]	351/90	kWh	TCRP (2018)
	Number of chargers[a]	4/1	Chargers	One per vehicle (depot) or one for up to eight vehicles (route)
Charger	Charger price (each)[a]	$50,000/$495,636	$ per charger	TCRP (2018)
	Installation cost (each)[a]	$17,050/$202,811	$ per charger	TCRP (2018)
	Charger annual operations and maintenance (O&M) costs[a]	$0/$1,500	$ per month per charger	Eudy and Jeffers 2017
	Peak draw per charger[a]	70/325	kW	Proterra chargers, which are central to the BYD K9 depot chargers and New Flyer route chargers
	Charger efficiency[a]	91.4%	%	Eudy and Jeffers (2017 and 2018)

[a] Items highlighted in yellow have two distinct values for depot charge (left) and fast charge (right) projects.

The CARB model was only developed for BEBs, but by adapting the NREL parameters for other vehicle types, further financial modelling could be done to assist fleet operators in understanding the cost implications (and especially payback periods) for MDVs and HDVs.

Additional research is required in terms of defining maximum–minimum values for the abovementioned parameters, given the market of heavy-duty electric vehicles is being dynamically expanded. Moreover, the auxiliary loads, temperature and driving style impacts should be studied deeper, as well as charge timing, facility electrical load and demand charges. Considering the developing market for batteries, it is advisable to assess the viability and economics of battery leasing.

Original Financial Modelling

An original financial model was developed for the purposes of this project to maximize local understanding. This model aims to compare one archetype each across LDVs, MDVs, and HDVs, with a corresponding model of ICE vehicle.

Purchase costs comprise of total vehicle cost, tax, import tax, provincial sales tax, while operating costs consist of annual registration fee, average insurance, maintenance, annual charging cost, annual depreciation, license fee. Distances were calculated were difficult to calculate, but were averaged using the 2018 US National Transportation Energy Data Booklet and are specific to each class and type of vehicle as a best estimate.

Table 5 demonstrates the total cost of light-duty electric vehicle. The final purchase cost after rebate at provincial and federal level is $41,490 for an electric passenger car.

Please note that all currency labelled $ in this section refers to CAD.

Table 14. LDVs calculation

Light-duty electric vehicles (Passenger car)	 **2023 Chevrolet Bolt EV**
Purchase costs	
Total vehicle purchase cost without rebate	$47,240
Vehicle cost (before taxes)	$40,000
Tax	0
Import tax [23]	$2,440[4]
Provincial Sales tax (PST)	$4,800
Annual Operating costs	
Annual registration fee	0
Average insurance per year	$1,700
Est. Maintenance per year	$2,000
Annual charging cost in B.C.	N/A
Annual depreciation costs	$2,650
Licence fee	$61
Est. Annual Operation Cost*	
Rebate	$9,000
Final purchase cost after rebate (B.C. or federal rebate)	**$38,240**

* Note: does not include financing costs or interest on leases.

Table 6 presents the overall costs of medium-duty electric vehicles, including the cargo van from Class 2 and the cargo van from Class 3.

Table 15. MDVs calculation

Medium-duty vehicles (MDVs)	 **2023 - Ford e-Transit Cargo Van (2023)**	 **2021-2023 Lightning Motors ZEV3 Cargo Van**
	Cargo Van - Class 2B	**Cargo Van - Class 3**
Purchase costs		
Total vehicle purchase cost without rebate	$94,480	$89,106
Vehicle cost (before taxes)	$80,000	$75,450
Provincial Sales tax (PST)	$9,600	$9,054
Annual Operating costs		
Annual registration fee	$579	$865
Insurance per year	$1,700	$1,700
Est. Maintenance per year	$2,000	$4,000
Annual charging cost in B.C.	0	0
Annual depreciation costs	$2,650	$2,650
License fee	$84	$84
Financing costs		
Rebate	$10,000	$55,00
Final purchase cost after rebate (B.C. or federal rebate)	$34,600	$29,504

[2] All vehicles that are non-NAFTA will have a 6.1% import duty. If your vehicle is manufactured or assembled in the U.S, Mexico or Canada with at least 55% content then its NAFTA and exempt from import duty. Transport Canada. (2019). Importing a vehicle from the US and Mexico. https://tc.canada.ca/en/road-transportation/importing-vehicle/importing-vehicle-united-states-mexico

[3] EasyAutoShip. (2023). Cost to import a car to Canada from the US. https://diytransport.com/cost-to-import-a-car-to-canada-from-the-us/#:~:text=Import%20Duty%3A%20All%20vehicles%20that,vehicle%20is%20imported%20to%20Canada.

[4] All vehicles that are non-NAFTA will have a 6.1% import duty. If 55% of the vehicle's components are manufactured and assembled in the U.S, Mexico, or Canada, it is exempt from import duty.

Table 7 displays the comprehensive costs of heavy-duty electric vehicles, encompassing the cargo van, shuttle bus, box truck, and step van.

Table 16. HDVs calculation Part I

Heavy-duty vehicles **Class 4-Class 6**	 **2023 GreenPower EV Star Cargo (22 feet)**	 **2022 – GreenPower – EV Star Min-E Bus MAX**	 **2021-2023 Lightning eMotors ZEV5 Box Truck (no refrig)**	 **2021-2023 Lightning Motors ZEV4 Step Van**
	Cargo Van - Class 2B	**Shuttle Bus - Class 4**	**Box Truck-Class 5**	**Step Van - Class 6**
Purchase costs				
Total vehicle purchase cost without rebate	$167,440	$212,240	$382,679	$318,209
Vehicle cost (before taxes)	$149,500	$189,500	$341,678	$284,115
Provincial Sales tax (PST)	$17,940	$22,740	$41,001	$34,094
Annual Operating costs				
Annual registration fee	0	0	0	0
Insurance per year	$1,700	$3,150	$3,150	$4,600
Est.Maintenance per year	$7,475	$11,370	$17,084	$22,729
Annual charging cost in B.C.	$850	$1,747	$1,278	$1,278
Annual depreciation costs	$2,650	$2,650	$2,650	$2,650
License fee	$122	$122	$142	$142
Rebates				
Rebate (Provincial plus Federal rebate)	$49,784	$59,574	$100,000	$100,000
Final purchase cost after rebate (B.C. or federal rebate)	$117,656	$152,666	$173,970	$156,800

Table 17 displays heavy-duty vehicles (HDVs) categorized into Class 6, Class 7, and Class 8. The results indicate that these classes continue to exhibit higher prices when compared to internal combustion engine (ICE) HDVs.

Table 17. HDVs calculation Part II

	 **2023 Lion All-Electric Class 6**	 **2023 7 Peterbilt 220EV box truck**	 **2023 Lion Electrtic 8**
	Box Truck (Class 6)	**Cargo Truck (Class 7)**	**Straight Truck (Class 8, 350 kW+)**
Purchase costs			
Total vehicle purchase cost **without rebate**	$382,900	$572,050	$758,606
Vehicle cost (before taxes)	$300,000	$450,000	$677,327
Provincial Sales tax (PST)	$36,000	$54,000	$81,279
Annual Operating costs			
Annual registration fee	0	0	0
Insurance per year	$4,600	$4,600	$4,600
Maintenance per year	$24,628	$29,377	$67,733
Annual charging cost in B.C.	$1,789	$2,752	$2,625
Annual depreciation costs	$2,650	$4,600	$4,600
License fee	$142	$142	$142
Rebates			
Rebate (Provincial plus Federal rebate)	$10,0000	$100,0000	$150,000
Final purchase cost after rebate (B.C. or federal rebate)	$244,798	$311,272	$608,606

Formulae

- **CAPEX (without rebate)** = Total vehicle cost (without rebate) + Taxes
- **CAPEX (with rebate)** = [Total vehicle cost (without rebate) + Taxes] - Rebate
- **OPEX** = Maintenance per year + Annual registration fee + Insurance per year + Annual charging cost + Annual depreciation costs + Licence fee

The key findings are summarized below, comparing electric vehicles in all classes with their respective internal combustion engine counterparts. As evident from Table 9, ICE vehicles still exhibit a significant price difference from a capital expenditure perspective. However, the light-duty vehicles fall within a narrower price range of approximately $36,000 to $47,000, attributed to the increasing availability of technology and decreasing battery prices over time. It is clear that ZEVs have strong opportunities to out-compete gasoline and diesel vehicles in the LDV and MDV space, but HDVs, with their high capital costs, still are at a slight disadvantage for general-use trucks. While not compared in this study, the extremely high capital cost differentials for specialty use vehicles, like garbage trucks, mean that this vehicle segment will still be extremely difficult to decarbonize without subsidies for the forseeable future.

Table 18. Total cost of ownership for relevant Vancouver-based Commercial Vehicles, over five-years

Total Cost of Ownership (5-year) - CAP-EX + OP-EX		
	ZEVs	ICE vehicles
LDVs (passenger car)	$65,855	$82,305
MDVs (Cargo Van - Class 2)	$79,667	$125,260
HDVs (Cargo Van - Class 4)	$181,643	$145,950

6. Recommendations and Conclusions

This report has reviewed key policy drivers for commercial ZEV uptake in Canada, as well as relevant programs for Vancouver-based businesses to aid in the purchase of ZEVs; developed case studies from three relevant jurisdictions to B.C. to consider lessons-learned from their ZEV-support programs for businesses; and undertaken high-level modelling on financial costs relevant to commercial fleet owners looking to own and operate ZEVs. On the basis of all of this research, two sets of recommendations are offered, covering programming, research, partnerships, and advocacy opportunities for VEC and others.

6.1 Summary of Key Findings

- **Programs and Policies**
  - Jurisdictions outside of B.C. and Canada are offering a wider, and often more integrated range of incentives than currently offered here.
  - California is a world-leader in vehicle electrification and, with its recent MDV and HDV targets and mandates, is driving strong uptake via regulations, but also offers a range of generous financial incentives (including forgivable loans and grants) as well as other supports, such as letters of credit, tax credits). Importantly, California also often allows for grant funding to be used for a mixture of vehicle purchasing and infrastructure installation.
- **Local Context and Financial Modelling**
  - The commercial vehicle population in Vancouver, as of 2021, is largely comprised of vans (>8,000), crewcabs (<5,000), and pick-up trucks (,>3,900). This mixture of LDVs and MDVs will be critical to target programmatically in supporting faster fleet turnovers to ZEVs.
  - Substantial price differentials between ICE vehicles and ZEVs before incentives are applied and can still present a capital expenditures barrier to transitioning.
  - Including operational expenditures, however, consistently models a lower whole lifecycle cost for LDVs and MDVs, with mixed cases for HDVs.
  - Fully calculating savings related to maintenance and fuels can be challenging, but anecdotally, BEV repair cycles specifically are lower than ICE vehicles and will further enhance cost savings – if they are effectively integrated into the financial model.

6.2 Recommendations for the Vancouver Economic Commission

Further research

This project has uncovered several unanswered questions. VEC may wish to undertake research in partnership with other aligned organizations to answer some of the following:

- When should specific vehicle types be purchased to optimize fleet decarbonization, and what does a conceptual fleet decarbonization strategy entail?
- What is the financial impact of leasing on fleet decarbonization efforts?
- How much additional investment is required to support fleet decarbonization initiatives?
- How many charging stations are needed to facilitate the transition to electric vehicles in the fleet?
- What is the readiness of the local repair and maintenance facilities to service zero emission MDVs and HDVs? Is there any capacity building that is needed in these sectors to support fulsome deployment of ZEVs at scale?
- What are the areas identified by NREL (2020) and Caley et al. (2020) and supported by this research that require further investigation in the context of fleet decarbonization for Vancouver-based businesses?

Programs

This research did not seek to develop specific programs, but based on the initial findings, VEC may aim to further explore some programmatic work in the following areas:

- Continue to catalogue programs that are applicable to SMEs and share this routinely with local operators to help ease access and increase awareness.
- Consider new programs similar to Global Commercial Vehicle: Drive to Zero through becoming pledge partners and signing the global memorandum of understanding,
- Explore leveraging existing financial tools (e.g., US Department of Energy Electric Vehicle Infrastructure Financial Analysis Scenario Tool) to help local SMEs,
- Collaborate with other tool providers, such as Vancity, to explore additional leverage opportunities.
- Working with all levels of government and industry to develop a wrap-around, concierge-like platform with a dedicated focus on facilitating the deployment of medium and heavy-duty electric vehicles for businesses, particularly small and medium enterprises. This could operate in the spirit of what Clean Energy Canada identified in their 2023 Road to Net Zero report.

Partnerships and Advocacy

No organization can solve the vehicle decarbonization challenge alone. Partnerships and coordination between all levels of government will be key. To advance work collaboratively, VEC should consider continuing to advance collaboration in the following ways:

- Work with the City of Vancouver, BC Hydro, other major institutions, and major private landowners, to enhance the placement of private charging stations and, in the longer-term, to explore development of multi-stakeholder charging hubs for commercial vehicles.
- Explore partnerships with capacity-building networks like CALSTART, or the North American Council on Freight Efficiency, which have longstanding experience in this sector and could inform (or help operate) local programs for SMEs.
- Explore ways to pursue intergovernmental partnerships with organizations in Quebec, to further amplify the demand for ZEVs in Canada's two leading markets.

At the policy level, VEC could also help advance action in the ecosystem in the following ways:

- Continue to engage with the Province of British Columbia on their MDV and HDV regulatory target and mandate, broadly in alignment with California’s comparable policy.
- Advocate to the Province of British Columbia to enhance data collection and sharing on fleets, including by opening public sector fleet procurement and operational data to private operators, so they can understand both capital and operational expense implications of ZEV adoption.
- Advocate to the Government of Canada, Province of British Columbia, and other actors to continue to provide more capacity building and technical support to SMEs looking to adopt ZEVs.

7. Conclusion

Decarbonizing transportation stands as one of the most formidable challenges faced by governments seeking climate action. Despite commendable progress in reducing emissions in buildings within Vancouver and British Columbia, efforts to lower vehicle emissions have lagged. Among these challenges, the predominantly commercially operated medium and heavy-duty vehicle (MDV and HDV) sector poses one of the toughest hurdles from a decarbonization standpoint.

Considering the significance of the transportation sector in contributing to greenhouse gas emissions in urban economies, this report focused on exploring how Vancouver could contribute to the global net-zero agenda through the lens of commercial fleets. The primary objective was to analyze the financial barriers that businesses encounter when transitioning from internal combustion engine vehicles to zero-emission vehicles (ZEVs).

The study's key findings revealed that while light-duty electric commercial vehicles showed promise in competing with their ICE counterparts, the adoption of electric MDVs and HDVs faced higher costs, hindering small and medium-sized enterprises from readily decarbonizing their fleets.

To effectively address these financial barriers and drive the decarbonization of commercial fleets, the report put forth several recommendations. Implementing a sales mandate for medium and heavy-duty electric vehicles would spur the market, creating more accessible options for businesses. Establishing an institute similar to CALSTART as a coordinating body among stakeholders would facilitate cohesive efforts towards a greener transportation landscape. Emulating comprehensive programs like those in California could further incentivize fleet electrification across diverse sectors of Vancouver's economy. Additionally, increasing subsidies per project, as opposed to per vehicle, would provide enhanced financial support for larger-scale fleet transitions.

Furthermore, exploring alternative funding mechanisms, such as loans, tax exemptions, and other financial incentives (including, but not limited to loan guarantees, direct agreements, federal cost sharing, competitive solicitation for grants) could encourage businesses to adopt ZEVs and promote a wider adoption of sustainable transportation practices.

Vancouver's journey towards decarbonizing commercial fleets is challenging but vital for the broader net-zero agenda. By addressing financial obstacles through the suggested strategies, Vancouver could emerge as a frontrunner in the race to create cleaner and more sustainable urban mobility, contributing significantly to a greener and healthier future for generations to come.

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Researching Opportunities to Reduce Financial Barriers to

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Contact us

Speak to a member of our team to learn more this research, please contact:

Name Here
George P.R. Benson,
Senior Manager, Economic Transformation,
gbenson@vancouvereconomic.com

VEC respectfully acknowledges that it is located on the traditional, ancestral and unceded territory of the Sḵwx̱wú7mesh (Squamish), Səl̓ílwətaʔ/Selilwitulh (Tsleil-Waututh) and xʷməθkʷəy̓əm (Musqueam) Nations.