Fleet Strategy Report

City of Port Moody

By: Innotech Fleet Strategies

September 26, 2023

EXECUTIVE SUMMARY

The City of Port Moody's *Climate Action Plan* outlines targets to reduce its emissions by 40% by 2030 and achieve carbon neutrality by 2050. Fleet-specific goals include electrification of 40% of passenger vehicles and 25% of commercial vehicles by 2030. In addition, the Government of Canada has set a mandatory target for all new light-duty cars and passenger trucks sold to be zero-emission vehicles by 2035. A target has also been set for 35% of all new medium-and heavy-duty vehicles to be zero-emissions by 2030[1]. The Province of British Columbia has developed targets, that are largely in alignment with the Government of Canada. To assist organizations with meeting these targets, there are several incentives available. The federal incentive provides up to $200,000 per vehicle and the provincial incentives are up to $100,000 per vehicle.

Analysis

This report examines operational best practices and policies from across Canada, alternative fuel options for vehicles and electrification using three scenarios: business-as-usual, cost-optimized and technology leadership. This analysis is intended to provide the City with a roadmap to meet it's emissions targets.

Under the ***business-as-usual*** (BAU) scenario, the lowest total cost of ownership (TCO) vehicle example is procured. Procurement of EVs is excluded in this scenario regardless of TCO outcome to outline a consistent baseline from which the transition scenarios can be compared. The intention of BAU is to serve as a baseline, and is reflective of how the City would continue to procure vehicles if there were no mandates or initiatives related to emissions reduction or fleet electrification. In the BAU, hybrid and plug-in hybrid examples might be procured where lowest TCO is demonstrated.

The ***cost-optimized*** scenario seeks to meet the City's emission and fleet-electrification targets in the most cost-optimized manner. In this scenario, the lowest TCO vehicle example is generally procured. However, EVs may be selected even if the TCO is not the lowest if they are required to meet City's climate objectives and policies. This scenario generally results in higher costs than the BAU as a result of the 'green premium' of purchasing EVs.

The ***technology leadership*** scenario seeks to position the City as an industry leader in fleet electrification. This generally means no more internal combustion engine (ICE) vehicles are purchased, provided there are suitable EV alternatives. This results in a faster transition of the fleet to electric but also results in the highest TCO.

Renewable diesel has also been added where specific scenarios to electrify the fleet do not meet the City's strategic goals for a 40% reduction in emissions by 2030.

[1] "2030 Emissions Reduction Plan – Transportation," Government of Canada, accessed at https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/erp/factsheet-06-transportation.pdf

Electrical and charging infrastructure requirements have also been assessed and recommendations made. The service would be sized appropriately for 2032 EV power requirements and charging infrastructure costs have been provided to meet 2027 BC Hydro EV Fleet Strategy Incentive requirements.

Risks

The EV industry is growing rapidly and has significant government support including several initiatives to implement these technologies. Despite the pressure that organizations may feel to purchase all new vehicles as electric, there are risks and limitations that need awareness and planning. The City has several high-level risks to consider, including the ability to provide reliable emergency services, as well as the responsible use of taxpayer dollars. A thorough review of risks and mitigations are listed in **Section 5.3: Risks.**

Recommendations

Based on the analysis of the City's current fleet, targets and available EVs, our recommended scenarios are a combination of the cost-optimized light-duty, technology leadership heavy-duty scenarios and installation of electrical and charging infrastructure. While this is not the lowest cost option, with an incremental $2.759M required between now and 2030, it is the only combination of scenarios that meets the City's strategic goals and is shown below.

Recommended Scenario	**Emissions (t/yr)**	**Emissions Reduction**	**Incremental Costs***	**Renewable Diesel (L)**	**Charging Infrastructure****	**Renewable Diesel Cost**	**Total Incremental Costs**	**LD Fleet EV**	**HD Fleet EV**
Cost Optimized LD + Tech Leadership HD	439,397	41%	$1,831,000	N/A	$928,885	N/A	$2,759,885	48%	29%

Costs and emissions reductions associated with other scenarios can be found in **Table 8: Summary of emission reductions and costs in 2030**. Additional recommendations include actions such as the implementation of a pool fleet for office staff use. A full analysis was completed comparing the implementation of a three-vehicle pool fleet vs the continued use of personal vehicles. Over 10 years there is projected to be a cost savings of $40,992 with the implementation of a pool fleet.

The full list of recommendations is shown below.

	Recommendation	Rationale
Operational	1. Improve fleet data consistency	Consistent data will assist fleet in making decisions about specific vehicles, such as whether they should be replaced early.
	2. Develop a single source for fleet data	A single data source is important for fleet to be able to make quick assessments and decisions about vehicles.
	3. Timely data entry	Timely data entry ensures accuracy and current information for any viewer.
	4. Develop a stakeholder input process for vehicle replacements	This is outlined in the **Behaviour & Policies** section and allows additional input for the replacement of a small number of vehicles that meet pre-determined criteria.
	5. Train maintenance staff	Maintenance staff should be trained on EV maintenance, diagnostics and high-voltage safety.
	6. Procure industry recommended PPE for high-voltage vehicle safety	This is required as part of a complete EV safety and maintenance program.
	7. Develop a safe work practice	A safe work practice should be developed for safely de-energizing an EV when required.
	8. Trial or demo medium-and heavy-duty electric vehicles	While EVs have a similar form factor to gasoline or diesel, the driver experience and maintenance requirements are quite different. Exposing drivers and maintenance staff to vehicles early will help ensure a successful change management plan and help inform vehicle specifications for future procurement processes.
	9. Continue annual review of vehicle replacement plans	This fleet strategy report does not replace the need to continue with annual updates to fleet replacement plans and the review of suitable replacement vehicles for operational use.
Financial	10. Budget for increased capital	EVs have a different lifecycle cost profile than internal combustion vehicles. The capital cost is typical higher, significantly higher in the case of medium-and heavy-duty vehicles, and maintenance and operating costs are lower.
	11. Research and apply for incentives	There are many incentives available for vehicles, charging stations and electrical infrastructure, which have the ability to offset the costs by a significant amount.
Strategic	12. Implement the cost-optimized LD & technology leadership HD scenarios	To meet the City's strategic goals for: a 40% reduction in emissions, 40% electrification of light-duty (LD) fleet and 25% electrification of heavy-duty (HD) fleet by 2030, the cost optimized LD and technology leadership HD scenarios should be implemented.

13. Conduct future fleet assessments	As the City moves forward on its electrification plans, additional fleet assessments should be conducted every 3-5 years to ensure it continues to implement vehicle electrification in the most cost-effective and operationally efficient manner. Future fleet assessments are expected to be significantly smaller scope than this initial project.
14. Consider the purchase of renewable diesel for more immediate and aggressive emission reductions	While renewable diesel is not required to meet strategic goals, it should be considered should the City want immediate emission reductions. Renewable diesel is available today and can be implemented with **no changes** to vehicles, maintenance practices, or fueling infrastructure currently supporting standard diesel. Costs are approximately 1.5 to 2 times that of regular diesel and dependant on volume and suppler.
15. The future of the Public Works site would benefit from additional clarity and a roadmap.	Significant infrastructure is required to support a growing and changing fleet. Significant electrical upgrades are required and a new or upgraded fleet maintenance facility should also be considered to support the fleet into the future. Additional clarity on the roadmap for this facility's replacement or upgrades would be beneficial. This clarity would aid in making recommendations and decisions on fleet strategies.
16. Implement a pool fleet for office staff use.	The pool fleet analysis shows numerous benefits, including financial, for the implementation of a pool fleet for office staff use.

In developing these recommendations every effort was made to anticipate industry trends, available vehicles, technology progression and estimated costs. Moving forward, there is still a need for the City to complete annual reviews of vehicle replacements, industry progression, changing operational needs and suitability of any EVs for their fleet and adjust the plan accordingly. In addition, and considering the current significant and rapid changes in technology in the fleet industry, another fleet assessment is recommended in approximately 5 years to align the plan with new standards and to ensure a resilient and sustainable fleet transition.

CONTENTS

1. INTRODUCTION

In the Summer of 2022, the City of Port Moody (City) released a Request for Qualifications (RFQ) for a Fleet Assessment and Strategy. The intent of this RFQ was to solicit bids from qualified consulting firms to provide guidance and recommendations to assist the City in reducing its carbon emissions from fleet vehicles. Innotech Fleet Strategies was selected and has teamed up with BetterFleet and PBX Engineering to provide recommendations that allow the City to understand the industry, set realistic emission reduction targets, balance risk, and provide a roadmap for a cost-effective and successful implementation. This report outlines the project, findings, and recommendations.

2. BACKGROUND

The City of Port Moody (the City) is located within Metro Vancouver. It's spread over a small region of just over 25 square kilometres and has a population of approximately 35,000 residents. In alignment with many other municipalities in the region and the Province of British Columbia, the City has developed a *Climate Action Plan* to help reduce its emissions by 40% by 2030 and achieve carbon neutrality by 2050. Fleet-specific goals included electrification of 40% of passenger vehicles and 25% of commercial vehicles by 2030.

The City's fleet consists of approximately 152 pieces of equipment for the Police, Fire, Engineering & Operations, Community Services, and Administration departments. It accounts for approximately 35% of the City's greenhouse gas emissions (GHGs) with heavy-duty vehicles alone contributing 65% of the fleet's total emissions. The scope of the fleet assessment was to identify and develop strategies to reduce these emissions. As such, this fleet strategy forms an important piece of the City's carbon-reduction plan. Specifically, the assessment focused on the following:

- Fleet optimization and utilization;
- Opportunities for technology to help reduce emissions;
- Opportunities to replace internal combustion vehicles with zero-emission vehicles;
- Infrastructure requirements to support zero-emission vehicles;
- Identification of viable low-carbon fuels;
- Prioritization of the purchase of zero-emission vehicles when replacements are needed;
- Assessment of a small pool of zero-emission vehicles for staff use.

In addition, this assessment and strategy required that this next evolution of the City's fleet can operate effectively and efficiently while optimizing value for taxpayer dollars. Optimizing fleet operations is particularly valuable in an electric vehicle (EV) study, as it can identify opportunities for significant cost savings that can be implemented immediately following the assessment. These cost savings can then be realized to help offset the higher capital costs of EV implementation and allow the City to reach its electrification goals more quickly and while reducing the financial impact on taxpayers and budgets.

2.1 ALIGNMENT WITH FEDERAL AND PROVINCIAL GOVERNMENTS

Aligning with market sentiment and government policies, many fleets are setting aggressive carbon-reduction targets. The Government of Canada has set a mandatory target for all new light-duty cars and passenger trucks sold to be zero-emission vehicles by 2035 with interim targets of 20% by 2026 and 60% by 2030. In addition, the Canadian government has set a target for 35% of all new medium-and heavy-duty vehicles to be zero-emission by 2030[2] and will develop zero emission regulations for 100% by 2040. However, some vehicles and operations are expected to be exempt.

The Province of British Columbia has developed a similar target, with some key differences, to advance zero-emission adoption in the interim. Notably, a zero-emission first policy will be developed for public sector fleets setting the target that 100% of light-duty vehicles purchased be zero-emission by 2027[3]. While this target does not include municipalities, it is notable as it includes some peer organizations. These targets have resulted in increased funding for numerous carbon-reduction initiatives across Canada in the zero-emission vehicle industry. Zero-emission vehicles are typically defined as "battery electric" or "hydrogen fuel cell". However, in order to meet mandated zero-emission targets, the industry needs time to, not only develop feasible technology solutions, but allow for fleets to adopt them.

To support these ambitious targets, the federal and provincial governments are providing significant support for organizations to reduce the carbon emissions of their fleets. These include offering sizable incentives, intended to offset the incremental capital costs associated with the purchase, for the adoption of electric vehicles. The federal incentive program, introduced in July 2022, provides incentives for up to $200,000 per vehicle. In British Columbia, the provincial government has a similar program with incentives of up to $100,000 per vehicle. These incentives can be combined for eligible vehicles to offset the costs up to 75% of the MSRP. Funding for these incentives is topped up annually and is expected to only be offered for a few years; however, no end date is currently identified. The timing of these incentives is also aligned with increases in the carbon tax as the cost of carbon is forecast to increase from $50 CAD/tonne in 2022 to $170 CAD/tonne in 2030. The time-limited government

[2] "2030 Emissions Reduction Plan – Transportation," Government of Canada, accessed at https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/erp/factsheet-06-transportation.pdf

[3] "Clean BC Roadmap to 2030," Province of British Columbia, accessed at https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf

incentives and projected increases to the carbon tax represent just a few of the financial justifications for organizations to convert their fleets to electric.

2.2 PROJECT APPROACH

The project was divided into four distinct phases to allow for a broad approach. The phases and their deliverables are shown in **Table 1** below.

Phases	**Phase 1 Data Gathering and Analysis**	**Phase 2 City Staff Engagement**	**Phase 3 Fleet Recommendations**	**Phase 4 Draft Fleet Assessment and Strategy Report**
Activities	✓ Project kick-off ✓ Data gathering and understanding of City operations ✓ Review of industry best practices and technology	✓ Develop staff engagement plan ✓ Conduct workshops with stakeholder groups	✓ Develop recommended actions and corresponding business case including: ▪ decarbonization ▪ low-carbon fuels ▪ optimization and behaviour change	✓ Compile draft report including results and recommendations ✓ Assist City staff in presentation to council
Deliverables	✓ Project Plan ✓ Summary of City data ✓ Summary of industry best practices	✓ Summary of stakeholder engagement	✓ Business case ✓ Roadmap to implementation	✓ Draft report ✓ Slide deck for council presentation

Table 1: Project phases

The project team used a robust and multi-disciplinary approach to ensure the City is provided with an accurate and representative strategy. This approach relied on leveraging industry experience managing similar fleets combined with world-class software for fleet analysis. The data, current practices and policies provided by the City were reviewed for anomalies and general accuracy. This information was then compared against industry standards, municipal peers and available technologies. Finally, the project team worked with City staff on recommended scenarios. The remainder of the report focuses on policies, technology and behaviour and provides an in-depth review of findings, analysis of various scenarios and recommendations.

3. CURRENT STATE

In order to set future targets as well as identify gaps and opportunities in the City's processes and infrastructure, it's critical to understand the current state. For this project, understanding the current state consisted of reviewing the City's fleet, how it's used and completing a gap analysis to compare it to industry peers. This was completed by gathering a complete fleet listing, usage profile, fuel consumption data, maintenance costs and other relevant data collected from several sources including: the fleet management and financial systems as well as stakeholder feedback. While the data was largely complete using these sources, it did require a notable level of manual analysis, correction, and interpretation. The importance of fleet data is increasing with the higher complexity associated with today's vehicles and the fleet industry as a whole. Strong data is a major driver informing decision-making for fleet maintenance, vehicle replacement, staffing levels and costs.

3.1 FLEET PLAN

The fleet plan typically consists of all the gathered vehicle data including: a complete vehicle listing, capital replacement plans, utilization data, fuel usage and maintenance data. For the purposes of this project, the data has been vastly expanded to include home location, additional operational use data, and numerous other pieces of data that allow for an in depth analysis to create a realistic EV transition plan. This information is compiled in a large database and a pdf version can be found in **Appendix A: Fleet Plan & Database**.

3.2 FACILITIES AND ELECTRICAL INFRASTRUCTURE

With a focus on fleet electrification, it's critical for the City to understand the electrical infrastructure at the facilities where vehicles will be parked, charged and maintained. There are six locations that have been identified for electrical capacity analysis. These locations are:

- Civic Centre (City Hall)
- Public Works Yard
- Recreation Complex
- Inlet Fire Hall
- Public Safety Building
- 3016 Murray St. (Parks Operations)

The Public Works facility is where most of the vehicles are stored and once transitioned to EV, it is also where they would be charged. This is also the location that will be the focus for the completion of BC

Hydro's EV Fleet Ready Plan and workbook. A full analysis of all of these facilities can be found in 4.4 Electrical Capacity Assessment.

3.3 EXPERIENCE WITH ELECTRIC VEHICLES

At this time, the City has limited exposure and experience with electric vehicles (EVs). There are only four in the fleet: two are Zambonis; one is a small, low-speed service vehicle used by the Parks Department, and the other is a Ford Focus used by office staff. While these vehicles have provided the City with some insight into EV use in operation, it's a very small sample size with three of them being niche usage cases.

While the general shape and intended function of an EV is the same as a gasoline or diesel model, there are many operating nuances. EVs present a different driving experience with different controls, braking performance, lack of engine noise and the need for operators to plan their route when the battery is low. There are also differing maintenance requirements for the City's fleet maintenance staff to become familiar with including high-voltage safety, components and general system design. Finally, there are limitations to the technology, which may mean changes to an operational activity are required for an electric vehicle to be used or that an electric vehicle would not be suitable for certain activities based on current technology.

Figure 1 below shows a simplified diagram of the components that make up an electric car.

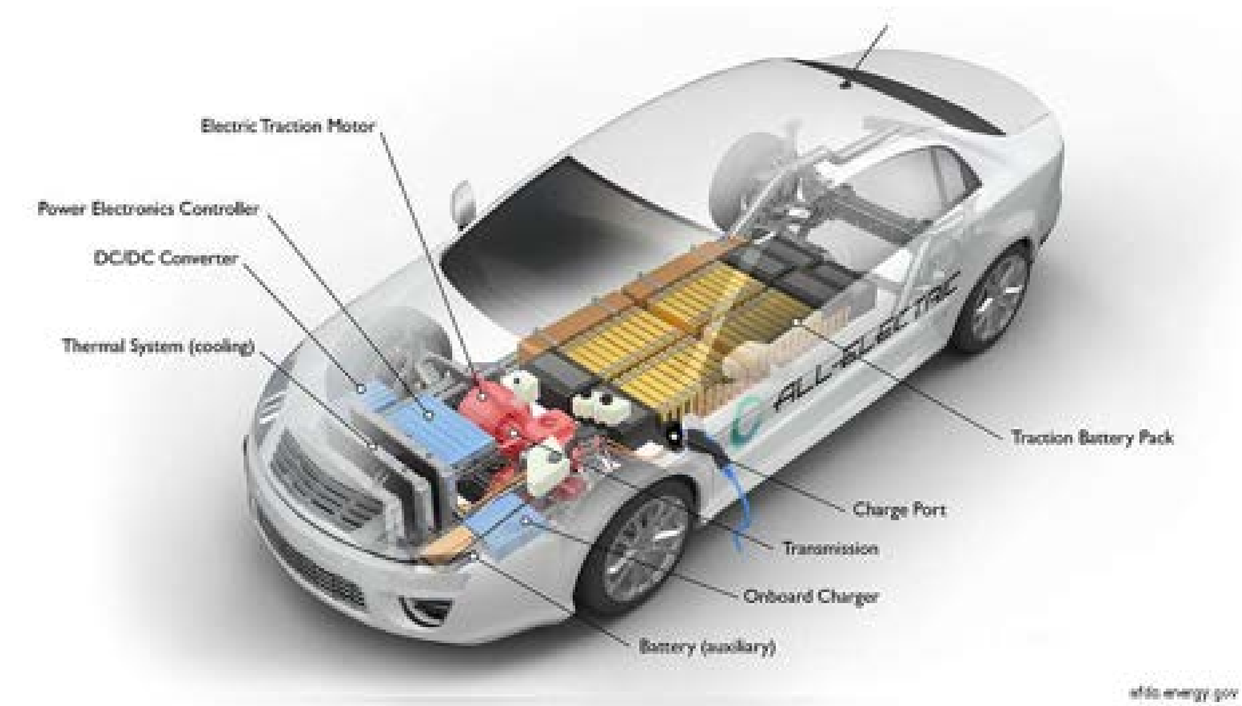

Figure 1: Base components of an electric vehicle (EV)

4. RESEARCH & ANALYSIS

Our research and analysis focused on the transition to electric vehicles (EVs), including a review of the vehicles themselves, development of transition plans, and collection of information on supporting infrastructure. In addition to electrification, this report focuses on: operational best practices, alternative fuels that may provide interim emission reductions, and an analysis to determine the feasibility of implementing a small pool fleet of EVs for office staff use. All of this information is outlined in detail throughout **Section 4: Research & Analysis**.

4.1 OVERVIEW OF ELECTRIFICATION

As we shift towards broader adoption of electric vehicles, more types have come on the market including plug in hybrid and full electric. . In Canada, governments at all levels are providing significant incentives and programs to assist individuals and businesses replace their fossil fuel-powered vehicles with EVs. While the vehicle technology is not yet advanced enough for all duty cycles and market segments, return-to-base fleets, such as those operated by municipalities, provide the optimal operation and duty cycles for EVs. Light-duty vehicles, including Class 1 and 2, which include: cars, SUVs and small pickup trucks, such as the Ford F150, are the most advanced with numerous models available from all manufacturers. These vehicles have been proving lower maintenance costs, good performance in mild climates, and longer battery life than expected. Light-duty vehicles have been successfully used in operational business for many years.

Heavy-duty vehicles represent vehicle classes 6-8 and typically consist of dump trucks, garbage trucks, sewer combination trucks, hydro excavators and other large vehicles. These vehicles are lagging behind light-duty vehicles in terms of technological readiness and number of years in the market. Many heavy-duty vehicle manufacturers only offer a single electric option with production vehicles just being introduced in 2021 and 2022. They are generally well-suited to predictable regular operational use, such as delivery services. Unpredictable uses, such as municipal operations where vehicles are used 24/7 for snow clearing and emergency infrastructure repairs, and the requirement for complex truck bodies present some real challenges and risks. While this technology is progressing rapidly, organizations need to consider the risks to their service levels before introducing these vehicles in their fleet. However, these risks should not prevent organizations from assessing the suitability of this technology and beginning to develop a plan for implementation.

Medium-duty vehicles, include Classes 3-5 and typically consist of service trucks and construction vehicles, such as Ford F350-550, Isuzu cab overs, etc. This market segment is lagging behind both light- and heavy-duty vehicles in terms of electric options. Very limited options are available from any manufacturers and those that are available are generally from new vehicle manufacturers that have recently entered the vehicle manufacturing space in North America. Similar to heavy-duty vehicles, this market segment is expected to progress quickly and businesses should begin assessing the technology and begin planning for implementation.

Charging infrastructure is readily available with numerous level 2 and 3 (also known as DC fast charging) options from many manufacturers on the market. Utility providers are investing heavily in planning and implementing infrastructure upgrades to support charging networks and the transition of businesses to EVs. BC Hydro is offering incentives and encouraging business to develop EV fleet strategies so it can better understand future power needs and plan for infrastructure to support anticipated power requirements[4].

Finally, all levels of government are offering significant rebates and incentives for both vehicles and charging infrastructure. In British Columbia, the provincial and federal vehicle rebates can be as high as $200,000 per vehicle. These incentives drastically help to offset the increased capital cost of EVs and charging infrastructure when compared to traditional gasoline or diesel vehicles.

The carbon reduction potential for electrification is high, especially in British Columbia where most electricity generated is hydroelectric. Many other provinces and states still use coal and natural gas for

[4] "Electric Fleets", BC Hydro, accessed at: https://www.bchydro.com/powersmart/electric-vehicles/industry/fleets.html

electricity generation, which means higher carbon emissions when used as a power source for EVs. Another environmental consideration for battery electric vehicles is battery recycling. Recycling has seen significant technological advancement over the past few years. Companies, such as Li-Cycle, have developed safe battery recycling technology that can recover up to 95% of the raw materials[5]. The Province of British Columbia has also added EV batteries to its recycling regulations, which is expected to help increase investment in recycling technology and facilities within British Columbia.

4.2 BETTERFLEET ANALYSIS

BetterFleet is a global brand with proprietary software that provides an in depth analysis of fleets. This analysis is focused on providing zero emission vehicle transition plans. For the purposes of this project, it is used to determine when the City's vehicles are technically and commercially suitable for electrification. The methodology applied herein is presented below:

1. Map replacement schedule and emissions for business-as-usual and like-for-like replacements (lowest total cost of ownership (TCO)).
2. Understand if there are like-for-like EV replacements based on duty requirements in the market at each replacement date, and the expected market timing for alternatives.
3. Map vehicle replacement schedules for the forecast period under the devised scenarios, selecting the most appropriate replacement vehicle according to the preferences of given scenarios, delivering economic budgets, and evaluating emissions outcomes.
4. Assemble preliminary emissions and costing information for the forecast period, excluding out-of-scope considerations such as infrastructure deployment.

In order for this approach to be successful, a few notable factors are used in the analysis. Heavy-duty vehicles do not have a fuel efficiency rating like light-duty vehicles do; because of this, gross vehicle mass (GVM) and payload considerations must be used to identify comparable EVs. The analysis focuses on understanding the energy consumed in the normal operation of current diesel fleet vehicles. It correlates energy consumption to the electrical energy equivalent and provides each vehicle use-case with an energy consumption rating. This rating accounts for duty-cycle and driving style factors and negates the need to measure and track vehicle payload and overall mass.

A derating factor is applied to the energy consumption rating to account for variability of battery performance in cold and warm weather conditions, and the added relative drain of heating and air-conditioning systems. Modeling the peak energy consumed by heavy-duty EV replacements to existing fleet assets therefore presents worst-case energy consumption scenarios.

[5] "Services", Li-Cycle, accessed at: https://li-cycle.com/services/

Master data is applied to the total cost of ownership (TCO) and asset replacement modelling tools, and is built on a number of assumptions based on a combination of empirical data from other jurisdictions, professional judgement, and data provided by the City. This is notable as it provides relatively accurate results for the early years of modelling. However, as heavy-duty electric vehicles are still so new, with limited real-world usage data, longer-term accuracy is limited and ideally the analysis would be updated annually as the market matures.

The following scenarios have been used as the core framework for analysis of the City's fleet.

Scenario Name	**Description**
Business-as-usual (BAU)	The lowest total cost of ownership (TCO) vehicle example is procured. Procurement of EVs is excluded under this scenario regardless of TCO outcome to outline a consistent baseline from which the transition scenarios can be compared. The intention of BAU is that it is the baseline scenario, and is reflective of how the City would continue to procure vehicles if there were no mandates or initiatives related to emissions reduction or fleet electrification. In the BAU, hybrid and plug-in hybrid examples might be procured where lowest TCO is demonstrated.
Cost-optimized	The cost-optimized scenario seeks to meet the City's emission and fleet-electrification targets in the most cost-optimized manner. In this scenario, the lowest TCO vehicle example is generally procured. However, EVs may be selected even if the TCO is not the lowest if they are required to meet City's climate objectives and policies. This scenario generally results in higher costs than the BAU as a result of the 'green premium' of purchasing EVs.
Technology leadership	The technology leadership scenario seeks to position the City as an industry leader in fleet electrification. This generally means no more internal combustion engine (ICE) vehicles are purchased, provided there are suitable EV alternatives. This results in a faster transition of the fleet to electric but also results in the highest TCO.

Table 2: Description of scenarios

The results of the analysis are presented below. It's important to note that there are two categories for the analysis: light-duty vehicles and medium/heavy-duty. The figures below outline the vehicle replacements where an EV alternative can be purchased. They are categorized based on light-duty or heavy-duty fleet as well as cost-optimized and technology leadership scenarios. A full overview of the software analysis and all results are shown in **Appendix C: BetterFleet Analysis**. The recommended scenario, associated carbon emission reduction and financial implications are outlined in **Section 5: Results** and Recommendations.

The addition of light-duty EVs under the cost-optimized scenario is shown below. The vehicles entering the fleet first are large SUVs, followed by medium SUVs, which have higher utilization, as well as upper-large SUVs, light commercial utility vehicles, and light commercial vans.

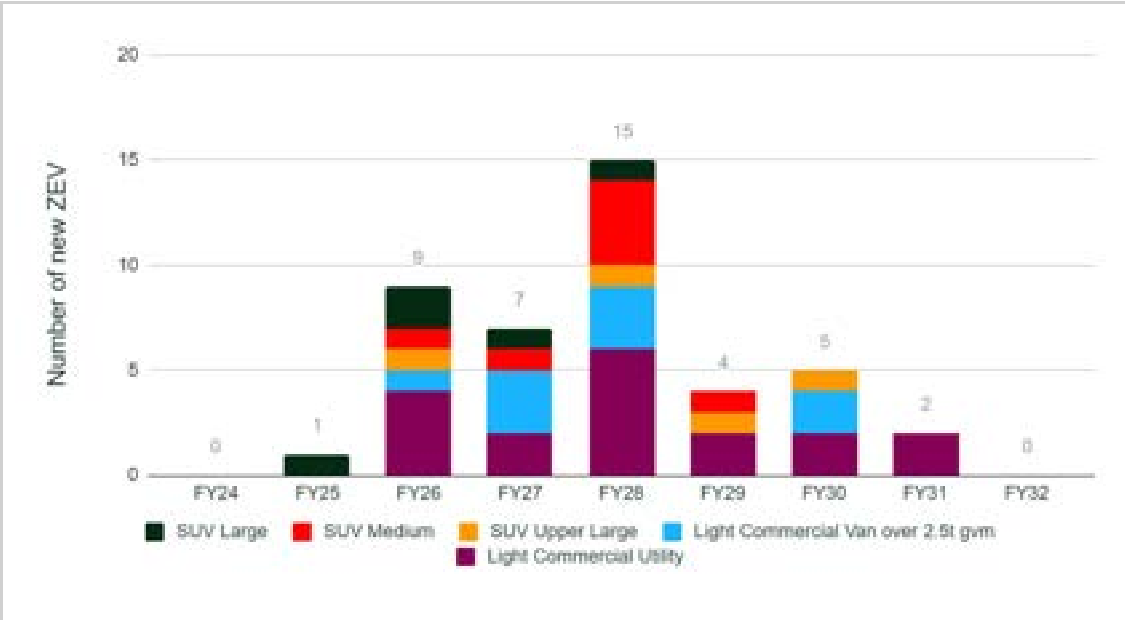

Figure 2: Light-duty vehicle transition results - cost-optimized transition by type

Under the light-duty technology leadership scenario, a similar trend as in the cost-optimized scenario is followed with respect to vehicle transitioning with a few additional vehicles identified for transitioning in fiscal years (FY)27 and 28.

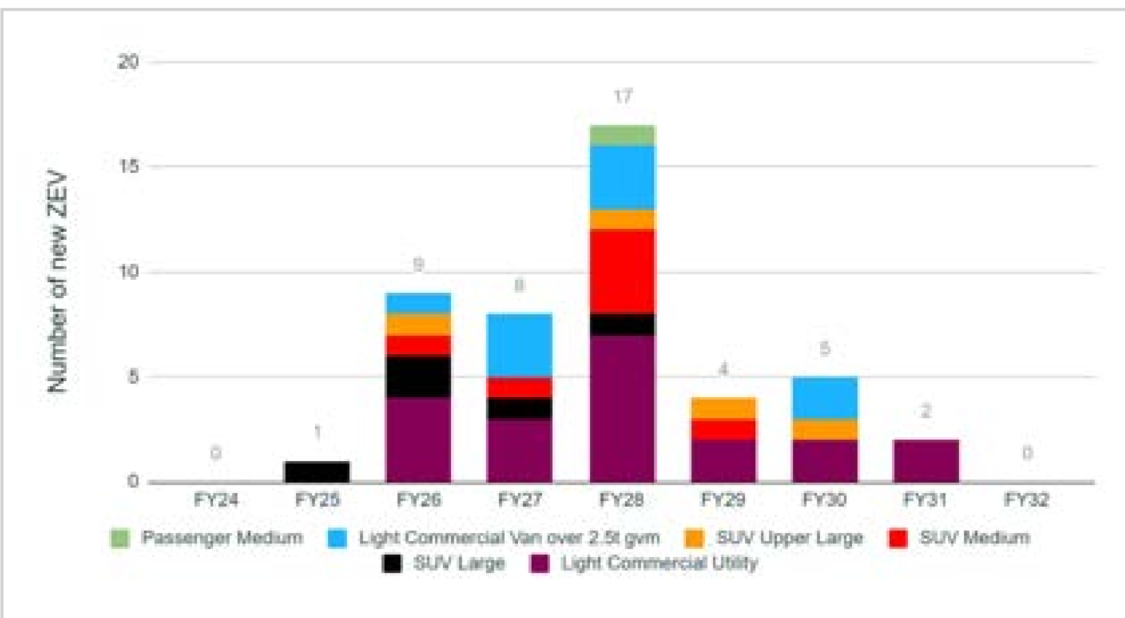

Figure 3: Light vehicle transition results - technology leadership transition by type

In the heavy-duty cost-optimized scenario, no heavy-duty EVs are envisioned to be added to the fleet during the study horizon. Due to more challenging EV transitions, it is recommended that the cost-optimized scenario focus electrification efforts on the light-duty vehicle fleet.

Under the heavy-duty technology leadership scenario, several heavy-duty EVs are envisioned, beginning with an EV dump truck and an EV garbage truck in FY25. The year with the most heavy-duty EVs being added to the fleet is FY29, with five heavy-duty EVs added.

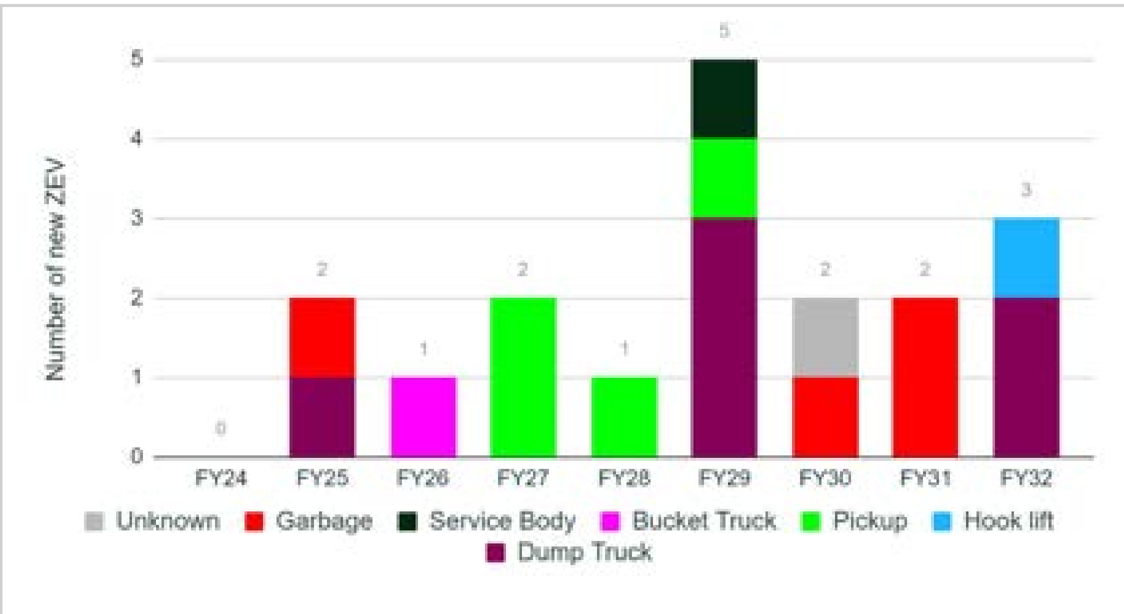

Figure 4: Heavy vehicle transition results - technology leadership transition by type

The results from these EV transition scenarios must be combined with emission reduction profiles and cost profiles before recommendations can be made. All of this information is presented in **Section 5: Results** and Recommendations.

4.3 OVERVIEW OF CHARGING INFRASTRUCTURE

Charging infrastructure, also known as electric vehicle supply equipment (EVSE) is designed to numerous different charging standards and power levels. As a result, a range of charging options exist and not all charging infrastructure is compatible with all vehicles. In general, EVSE conforms to the standard system described below and shown in Figure 5.

The EV battery is located onboard the vehicle. Power is delivered to the vehicle battery through an inlet, which is considered a part of the vehicle. A connector with a cord makes an electrical connection between the vehicle and the utility (or the power source) for the purposes of charging and exchanging information. The utility is known as the energy portal. The connector, cord, and associated components that make the connection are collectively known as the EVSE. The interface between the EVSE and energy portal can be as simple as a plug and receptacle interface. Charging configurations vary based on type of connector and charging levels.

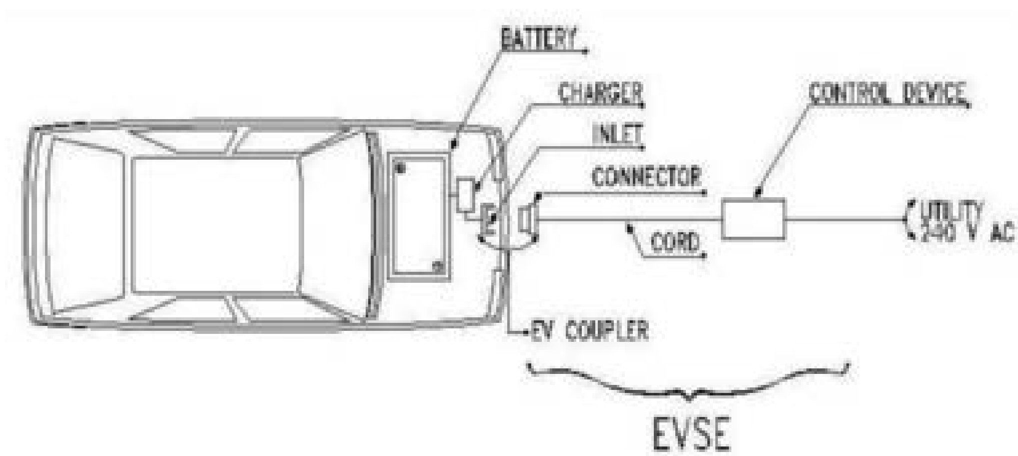

Figure 5: Standard AC Level 2 charging station configuration

Charging stations for commercial applications or public use on private or public property provide three levels of charging:

- AC Level 1 Charging
- AC Level 2 Charging
- DC Fast Charging (DCFC) (formerly Level 3)

The amount of time needed to charge an EV battery is a function of the charge level, battery size, battery age, EV Battery Management System (BMS), and onboard charger specifications. The onboard battery charger communicates with the EVSE to identify the circuit rating and adjust the charge to the battery accordingly. The battery to be considered when estimating charging times is a 65kWh battery, typical of most consumer electric cars currently on the road (e.g. Chevy Bolt). The onboard charger specifications determine the amount of charge a battery can receive. For example, the Chevy Bolt can accept up to 7.7kW of charging on an AC level 2 charging station. For a level 2 station of greater power output, the Chevy Bolt will still only accept up to 7.7kW. Furthermore, charging speed slows via the BMS as the battery gets closer to full to prevent battery damage. It can take about as long to charge the last 10% of the battery as the first 90%.

Appendix D: Charging Infrastructure Overview offers more in-depth descriptions of charging system design, infrastructure costs, networking and charging station specifications.

The products selected for the basis of review are the ChargePoint CPF50 for the Level 2 EVSE and the ChargePoint Express 250 for the DCFC EVSE. The ChargePoint offerings are designed for applications where several stations are required, such as workplaces and commercial fleets. The charging stations offer standalone models or power sharing models, which allows multiple charging ports on the same electrical infrastructure.

Technical specifications for the charging stations are summarized in the table below.

Specification	**ChargePoint CPF50**	**ChargePoint Express 250**
Voltage	208VAC, Single-Phase	480V, Three-Phase
Current	50A (power shared between up to two ports)	80A
Power	10.4kW	66.5kVA / 62.5kW
Wiring	3-wire	4-wire
Enclosure Rating	Type 3R per UL 50E	Type 3R, IP54
Connector	SAE J1772 (up to 2)	CHAdeMO, CCS1 (SAE J1772™ Combo), CCS2 (IEC 61851-23). Up to two (2) per station.
Cable Length	5.4m (optional 7.0m)	4.27m
Networking	Cellular 4G LTE	Cellular 4G LTE
Certification	CSA	CSA
Operating Temperature	-40°C to 50°C	-40°C to 50°C
Installation	Pad-mount Pedestal or Wall-mounted	Pad-mount Pedestal

Table 3 - Tabulated Charging Station Specifications

4.4 ELECTRICAL CAPACITY ASSESSMENT

The six (6) locations to be considered are the Civic Centre, Public Works Yard, Recreation Complex, Inlet Fire Hall, Public Safety Building, and 3016 Murray St. The following is a summary of the review of the electrical record information and an electrical capacity assessment of the existing services at the sites.

The existing peak demand load was ascertained using 1-Year BC Hydro provided load consumption history. The existing peak demand was determined by taking the maximum value of all the demand load data that was provided. Load consumption history provided by BC Hydro was provided as metering data and captured in 5-minute intervals. This is a risk that the peak demand may have occurred within the 5-min interval and was not captured. A Demand Load Study performed by a licensed electrician is recommended to confirm results at each of the locations prior to performing any work.

	Civic Center	Public Works	Recreation Complex	Inlet Fire Hall	Public Safety Building	3016 Murray St.
Electrical Service Capacity[1]	499 kVA	115 kVA	1,995 kVA	173 kVA	461 kVA	58 kVA
Maximum Electrical Demand[1]	232 kVA	70 kVA	741 kVA	70 kVA	88 kVA	13 kVA
Remaining Capacity[1]	267 kVA	45 kVA	1,254 kVA	103 kVA	374 kVA	44 kVA
Projected EV Peak Demand[2,3]	5 kW	358 kW	10 kW	10 kW	48 kW	16 kW
Upgrades Required[2]		Yes				

1. Data retrieved from BC Hydro provided 1-year historical load information. Data should be confirmed via demand load study. See **Appendix D: Electrical Capacity Assessment** for additional details.
2. Based on the energy analysis of vehicles transitioned to EV by 2032. This does not include all vehicles in Port Moody's fleet and peak demand may be higher when all vehicles are included.
3. Assumes charging infrastructure is networked and uses load balancing to charge vehicles over approximately 13 hours.

Table 4: Summary of Electrical Capacity Assessment

Based on the electrical capacity assessment and required energy by vehicles transitioned to EV, electrical service upgrades are required at Public Works. The City has indicated that the future of Public Works is unknown as the facility is aging and requires replacement in the near future. In addition, the BC Hydro EV Fleet Ready Plan requires a three year outlook for transition to EVs. Combining the shorter BC Hydro timeframe and uncertainty of the Public Works facility, an interim dedicated service for electric vehicles supply equipment (EVSE) is recommended. The proposed electrical infrastructure plan provides sufficient capacity for all vehicles transitioned by 2027, plus a few extra. Based on the fleet assessment and proposed transition of 8 vehicles to electric by 2027 the Public Works facility will require five (5) level 2 and three (3) DCFC by 2027 to support the electrification of the fleet vehicles. The total demand load of the proposed EVSE was determined to be 252kVA. The existing service capacity has a deficiency of 206kVA and a service upgrade will be required to support the potential EVSE load.

There are two options presented for electrical infrastructure upgrades:

1. To support the fleet EVSE expansion through 2027, a new 1200A, 3-phase, 120/208V dedicated secondary service would be required. In this configuration, the conceptual design allows for an additional 94 kVA of electrical capacity at the end of 2027. There would be electrical capacity for an additional one (1) dedicated DCFC EVSE or nine (9) dedicated level 2 EVSE; however, networked chargers would allow for additional spare capacity.

   The total estimated order of magnitude opinion of electrical construction cost for Option 1 is $897,783.49.

2. To support the fleet EVSE expansion through 2032, a new 1600A, 3-phase, 120/208V dedicated secondary service would be required. This is the largest service size allowed by BC Hydro for 208V rating. In this configuration, the conceptual design allows for an additional 210 kVA of electrical capacity at the end of 2027. There would be electrical capacity for an additional three (3) dedicated DCFC EVSE or twenty (20) dedicated level 2 EVSE; however, networked chargers would allow for additional spare capacity.

   The total estimated order of magnitude opinion of electrical construction cost for Option 2 is $928,885.38. Construction costs are order of magnitude and based on a preliminary location for charging infrastructure as shown in Figure 6. In order to refine the costs, the quantity and type of chargers and their confirmed locations are required. This work typically occurs during Engineering design and was not part of the scope of this project.

For the Public Works location, option 2 is recommended. The electrical infrastructure should be sized for the future build-out of Option 2. However, only the stations in Option 1 shall be energized. The recommended plan will allow for installation of five (5) level 2 ChargePoint CPF50 and three (3) DCFC ChargePoint Express 250 to support the eight vehicles identified for transition to electric by 2027 an additional 210 kVA of spare capacity for additional future charger installs. The proposed location for these chargers is shown in Figure 6 below. This location was selected for its simplicity for electrical infrastructure. However, this location may not be optimal for Public Works operations and the City should review the location when undertaking detailed design. This recommended solution would provide the City with the most flexible option considering the uncertainty of the Public Works site.

A detailed electrical capacity assessment and breakdown of projected costs for the Public Works infrastructure upgrades can be found in **Appendix D: Electrical Capacity Assessment**.

Figure 6: Public Works proposed electrical infrastructure site plan

Evolving charging technology such as Megawatt Charging standards (MCS), equipment and procedures are still in development. This future charging standard will allow for rapid charging of commercial vehicles that require 24/7 use and cannot be down for extended charging sessions. When commercially viable it is expected to provide solutions for EVs that are used for snow clearing, emergency events, fire trucks or any other critical vehicle that requires a quick charge. This charging standard will allow for up to 1,250V and 3,000A DC. This project has not considered MCS in the electrical infrastructure upgrades or charging plan as the technology is still about 5-10 years from commercial production. The City may want to consider it at the time of redevelopment of their Public Works facility.

4.5 BEHAVIOUR & POLICIES

Overall, the City has excellent fleet policies that align with those of its peers and that allow it significant flexibility to implement behaviour-based carbon-reduction initiatives. Most municipalities contacted during our research had lengthy policies outlining each specific initiative. Many of these policies required significant administrative effort to regularly update and ensure staff were familiar with them. All municipalities contacted were much larger than Port Moody and as such had more resources, which allowed them to develop these lengthy policies. What's notable about Port Moody's current approach is that its policies have been kept relatively short and few in number while still outlining the same principles that govern best practices. As these principles are broad, they give a lot of flexibility while still sufficiently outlining expectations for staff and vehicle use. This approach aligns well with the smaller size of Port Moody and available resources.

One of the best practices outlined during the review that the City has not yet adopted is a formal stakeholder engagement process like the fleet procurement committee that Metro Vancouver uses. Metro-Vancouver's fleet procurement committee consists of a small group of stakeholders that collectively discuss key vehicle replacements. Traditionally, the City's decisions about vehicle specifications, fuel type and need have been driven by Fleet Services. However, as the vehicle industry has become more complex and has demonstrated an ability to substantially reduce carbon emissions, reduce costs and improve operational productivity, it's recommended that additional stakeholders are included in decision-making for select vehicles. These stakeholders provide valuable input that allows fleet to make more informed decisions that align with any changing strategic priorities or industry trends. For a smaller municipality, like Port Moody, this stakeholder input could be provided through an electronic form, committee, or other similar method. The key is to ensure the input is documented, not administratively burdensome and only used for select vehicles. The City already has a policy that outlines the replacement of vehicles with alternative or innovative technologies, which is sufficient to govern the majority of vehicle purchases using Fleet's sole authority. However, cases where additional stakeholder input would provide value, include the replacement of high-fuel-use and low-utilization vehicles.

A full list of best practices for behavioural approaches to carbon reduction can be found in **Appendix E: Industry Best Practices.** When reviewing these, it should be noted that implementing behaviour-based best practices generally takes a significant amount of effort and results in small gains.

4.6 ALTERNATIVE FUELS

While the City has a preference for EVs, the scope for this project also included a review of alternative fuel use and associated technologies. This review consisted of investigating the use of several different fuel types and their applicability to the City's operations, infrastructure, and carbon-reduction goals. Fuels are generally classified as zero-emission and low-carbon. Zero-emission fuels include electric and hydrogen, while low-carbon fuels include propane, compressed natural gas (CNG), renewable natural gas (RNG), biodiesel and renewable diesel (also known as RHD or R100). A summary of fuels and their alignment with the City's fleet and carbon reduction goals is shown in the table below. A detailed description of these fuels, overview of infrastructure requirements and compatible vehicle availability is also included in **Appendix B: Low-Carbon Fuels.**

Technology	**High CO2 Emission Reduction Potential**	**Compatible Vehicle Availability**	**Fueling Infrastructure Availability**	**Same or Reduced Vehicle Maintenance Impact**	**Financial Incentives**
Propane					
Biodiesel		✓	✓		
Renewable Diesel	✓	✓	✓	✓	
CNG					
RNG	✓				
Electric	✓	✓*	✓	✓	✓
Hydrogen	✓				

*Electric vehicle availability for medium-and heavy-duty fleet is low, but growing at a rapid pace

Table 5: Fuel technology matrix

In an effort to quantify the Canadian targets and provide insight into the broader industry, a review of the American (US) market was also conducted. The State of Sustainable Fleets is an initiative by several industry-leading companies to produce a technology-neutral report with information from over 250 fleets across the US. The 2022 report outlines the carbon reduction potential across several fuel types and zero-emission vehicle technologies.

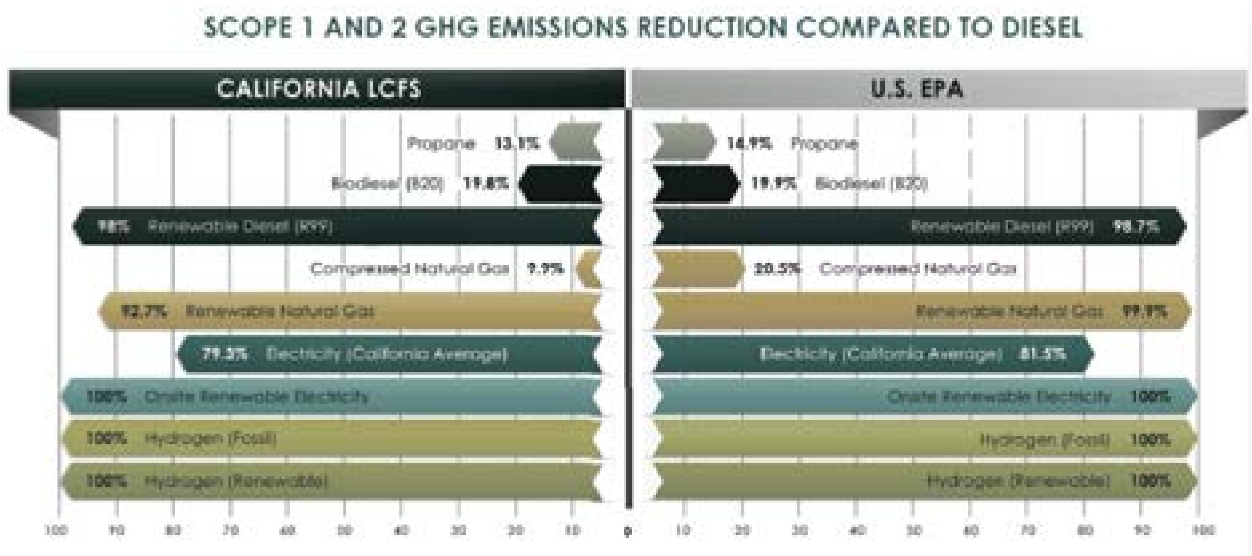

Figure 7: Carbon reduction potential by fuel and technology type compared to diesel.[6]

The reduction potentials align well with the Province of British Columbia's Methodology for Quantifying Greenhouse Gas Emissions and British Columbia's Low Carbon Fuel Standard. While there are minor differences between British Columbian carbon methodologies, the US Environmental Protection Agency (EPA) and California greenhouse gas (GHG) methodologies, the only notable difference is that British Columbia's methodology considers electricity to be a zero-emission technology, whereas California's electricity is only considered a low carbon fuel with only an 80% reduction as shown in Figure 7. Despite Figure 7 being from a US study, it was chosen for this report as it provides a nice visual summarizing the reduction potentials of each fuel type.

Renewable diesel is also known as Renewable Hydrogenated Diesel (RHD) or R100. It uses similar feedstock to biodiesel, but differs in two key areas: its ability to meet standard diesel fuel quality standards, and its refining process. This fuel has been in commercial production since 2007 with the number of refining facilities across the world slowly increasing, and a few refining facilities now located in North America. These facilities use manufacturers' proprietary refining processes to develop renewable diesel that meets ASTM D975, EN 590 and CGSB 3.517. These are the relevant fuel quality standards in Canada, the US and Europe for #2 diesel fuel.[7] As a result of renewable diesel's ability to

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[6] Gladstein, Neandross & Associates (GNA), "State of Sustainable Fleets 2022 Market Brief", May 2022, Santa Monica, CA. Accessed at: www.StateofSustainableFleets.com

[7] "Study of Hydrogenation Derived Renewable Diesel as a Renewable Fuel Option in North America", Natural Resources Canada, March 2012, accessed at https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/files/pdf/transportation/alternative-fuels/resources/pdf/HDRD_Final_Report_eng.pdf

meet these standards, it's compatible with all current diesel fueling infrastructure including: storage tanks, dispensers and vehicle engines. For this reason it's considered a drop in replacement fuel and can be mixed with #2 diesel. This means it can be supplied regularly as a diluted percentage such as R20 (20 percent RHD) or periodically in it's full strength. Discussions with the City's fuel supplier would be required to determine the optimal supply method and frequency.

Hydrogen is a gaseous fuel similar to CNG and propane. Leading sectors and vehicle segments for hydrogen use include transit and long-haul trucking[8]. As these are the primary markets, there are insufficient suitable vehicle options for municipal operations in addition to very limited hydrogen fueling stations and fuel supply. Despite its carbon emission reduction potential, the fueling infrastructure and vehicle industry have not advanced in a manner where this technology would be considered a feasible option for a small municipality such as Port Moody. However, there are plans for a possible hydrogen fueling station to be built within Port Moody at the Suncor site near the Glenayre neighbourhood. It would be worthwhile for Port Moody to follow this project as it may change the feasibility for hydrogen in the future.

4.7 POOL FLEET

City office staff currently rely on the use of their personal vehicles to conduct City business. Many Municipalities are beginning to provide staff with alternatives that demonstrate numerous benefits to both staff and the Municipality. As part of this project, the implementation of a small number of City owned vehicles (pool fleet) has been explored. The concept of a pool fleet would allow staff to reserve a vehicle and use it for transportation to offsite meetings, site assessments, and for any other work purposes.

The City currently has a service contract with Modo and a program for mileage reimbursement for staff use of personal vehicles. Data shows that the Modo service is rarely used and that personal vehicles seem to be the mode of choice for staff. Three years worth of data collected and analysed. This data shows that staff rely heavily on their own vehicles for work use. From 2017 to 2019, 84,000 km were accumulated on staff vehicles and the City reimbursed just over $47,000 over this three-year period. There were also 510 unique accounting transactions for the reimbursements.

The 84,000km accumulated over three years represents 28,000km per year. A pool fleet of approximately 2-5 vehicles would normally be suitable for that level of mileage, however, time of use data is also required to further refine the exact number of vehicles. For the purposes of this analysis three vehicles were selected as the appropriate pool fleet size with a defined life of 10 years. A phased

[8] Gladstein, Neandross & Associates (GNA), "State of Sustainable Fleets 2022 Market Brief", May 2022, Santa Monica, CA. Accessed at: www.StateofSustainableFleets.com

approach was modelled and reflects the purchase of two cars in the first year and the third car a year later. This approach allows for staff adoption and time of use data to be collected before investing in the third car. For the analysis it was also assumed that there would still be a requirement for staff to use their own personal vehicles on occasion. As a result, only 60% of the $47,000 mileage reimbursement costs have been included in the net present value (NPV) analysis below. The results of the NPV over ten years is shown in the table below. This analysis indicates a savings of $40,992 over ten years and favours the implementation of a 3 vehicle pool fleet.

	Net Present Value
Pool Fleet (3 vehicles)	$119,224
Staff vehicle reimbursement	$160,216
Savings	**$40,992**

Table 6: Pool fleet 10 year NPV

In addition to the anticipated costs savings, there are also numerous other benefits associated with use of a pool fleet:

1. All trips are zero emissions;
2. Noise reduction;
3. Vehicles are branded with Port Moody logos;
4. Staff have more options to use active transportation to get to work;
5. Improved safety and security;
6. Reduced financial resource use for mileage reimbursement.

Additional analysis and description of benefits are provided in **Appendix F: Pool Fleet Analysis**.

5. RESULTS AND RECOMMENDATIONS

Based on the data and analysis, there are a number of key results and recommendations for the City. Key results for carbon emissions, financial strategy and risk are outlined in the next three sub sections. Final recommendations are then described in **Section 5.4: Recommendations**.

5.1 CARBON REDUCTION TARGETS

The City's target of a 40% reduction in emissions by 2030 is baselined against 2021 fleet emissions data. In 2021, the City fleet consumed approximately 150,000 litres of gasoline and 160,000 litres of diesel. Using the province's 2021 Best Practices Methodology for Quantifying Greenhouse Gas Emissions[9], the baseline emissions for 2021 are calculated as 740,510 tonnes.

The emissions profiles for light vehicles below, shows the impact the transition to EVs would have on emissions. Under both the cost-optimized transition and the technology leadership transition, emissions fall to under 100 tonnes per year by FY29.

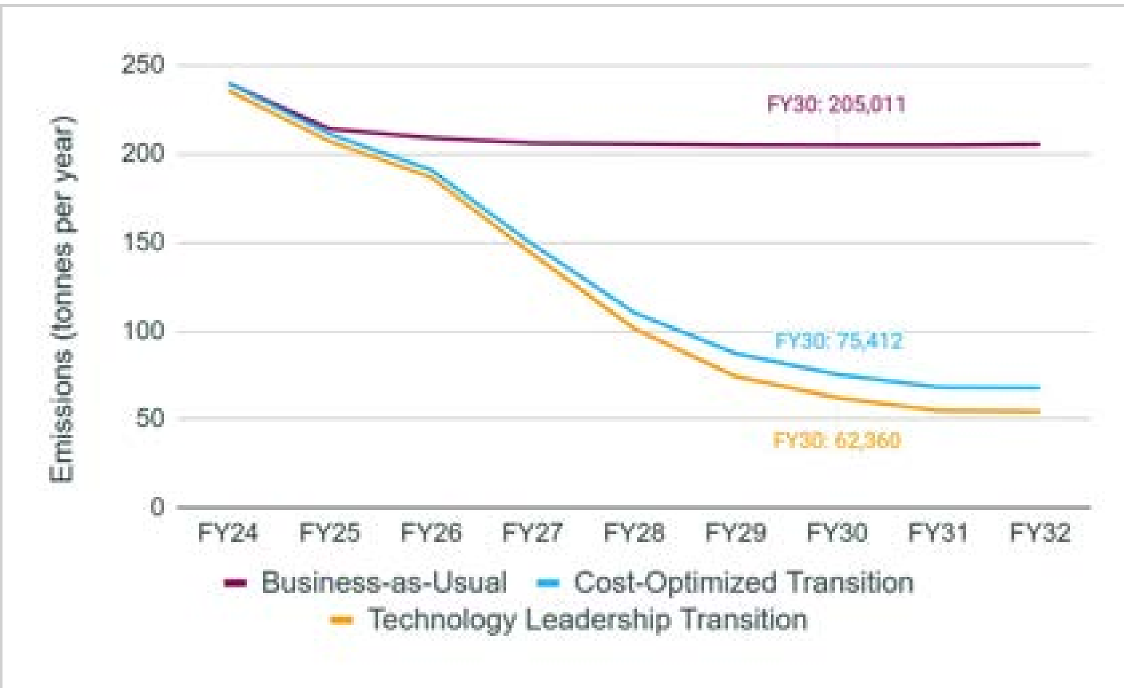


Figure 8: Transition emissions profile

The emissions profile for heavy-duty vehicles below, shows the impact that the transition to EVs would have on emissions. The line for the cost-optimized scenario is identical to the line for business-as-usual as no heavy-duty EV replacements are projected to be cost-optimized before 2030. In the leadership

[9] Ministry of Environment and Climate Change Strategy, Province of British Columbia, "2021 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions", May 2022, Victoria, BC. Accessed at: https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/guidance-documents/2021-best-practices-methodology_for_archive.pdf

scenario, emissions begin to drop significantly starting in FY29, and fall to under 400 tonnes per year by FY30.

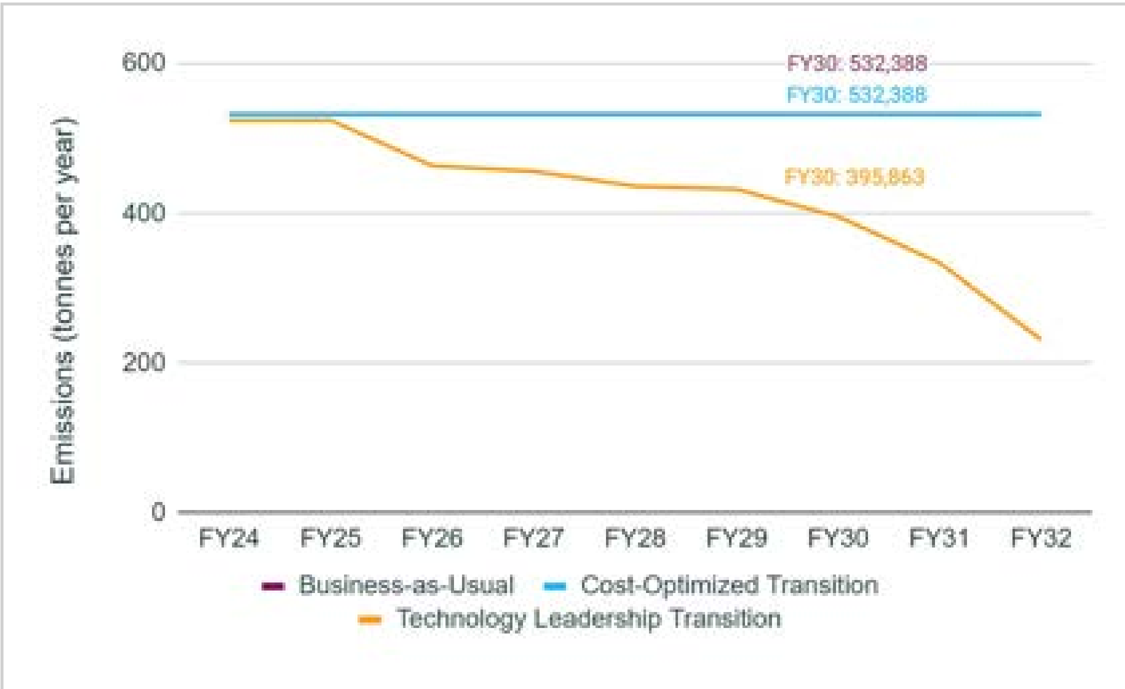


Figure 9: Transition emissions profile – transition

The emissions reductions for each combination of scenarios ranges from a 5% reduction with business-as-usual for both light-duty and heavy-duty vehicles to a 42% reduction with technology leadership for both light-duty and heavy-duty. A full decision matrix outlining scenarios, emissions reductions and costs is shown in **Section 5.4: Recommendation**.

5.2 FINANCIAL IMPACTS

There are several figures below showing the projected difference in cash flow between business-as-usual and each of the light-duty and heavy-duty cost-optimized and technology leadership scenarios. These figures show the vehicle analysis only. For the purposes of this analysis, federal and provincial incentives have not been included, as they are not guaranteed. Not including these represents the worst-case cash flows and any incentives the City receives will greatly offset the capital costs.

For the light-duty cost-optimized transition, shown in **Figure 10** below, slightly greater capital spending occurs in FY26-FY28 when the greatest number of new EVs are added to the fleet. Small savings in operating and maintenance costs are realized beginning in FY25. It's estimated that there will be a net increase in spending of $109k over the next five years (through FY27), and a net decrease of $475k over the following five years (FY28-FY32).

Figure 10: Light vehicle transition cost profile - cost-optimized

In the technology leadership transition, shown in **Figure 11** below, the years of greatest capital expenditure remain FY26-FY28, but are slightly higher than the cost-optimized scenario. In addition, more substantial savings in operating costs and maintenance costs are also observed. A net increase in spending (compared to BAU) of $138k over the next five years (through FY27) is estimated, and a net decrease of $468k over the following five years (FY28-FY32).

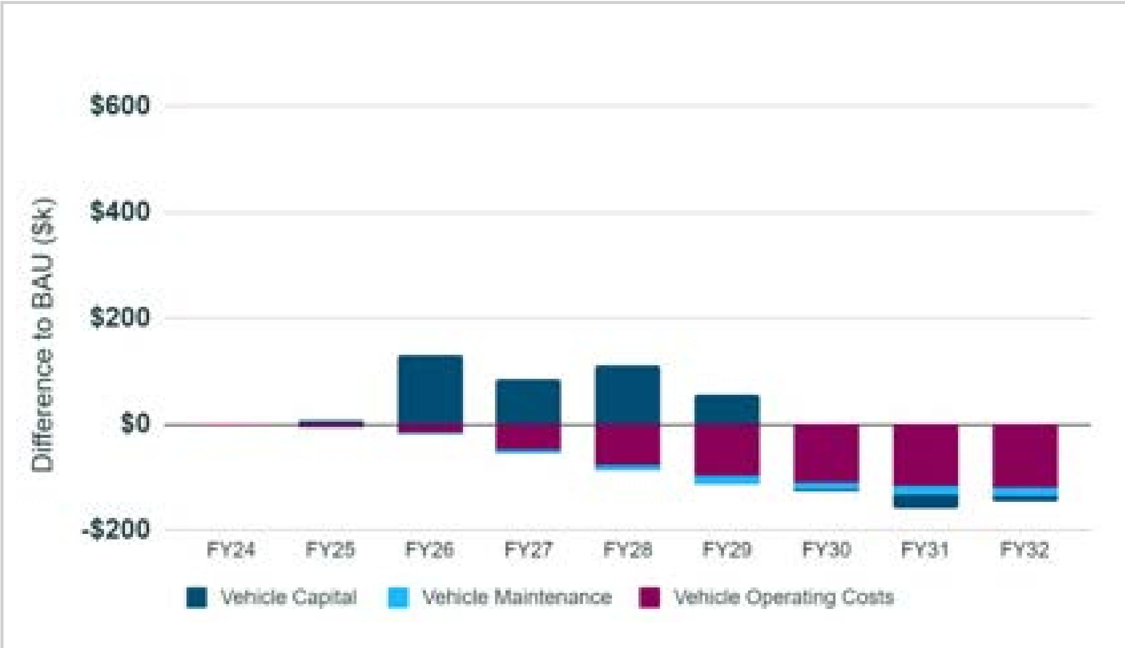


Figure 11: Light vehicle transition cost profile - technology leadership

In the heavy-duty vehicle technology leadership transition, shown in **Figure 12** below, greater capital spending begins in FY25 when the first heavy-duty EV? vehicle is added to the fleet. As heavy-duty EVs are still an emerging technology and new to the market, costs are significantly higher than their internal combustion counterparts. Small cost savings in operating and maintenance costs are expected beginning in FY25, but are small in proportion to the capital requirements and are not expected to result in a lower total cost of ownership over the life of the vehicle. A net increase in spending of $1,272k over the next five years (through FY27), and a net increase of $1,311k over the following five years (FY28-FY32) is estimated.

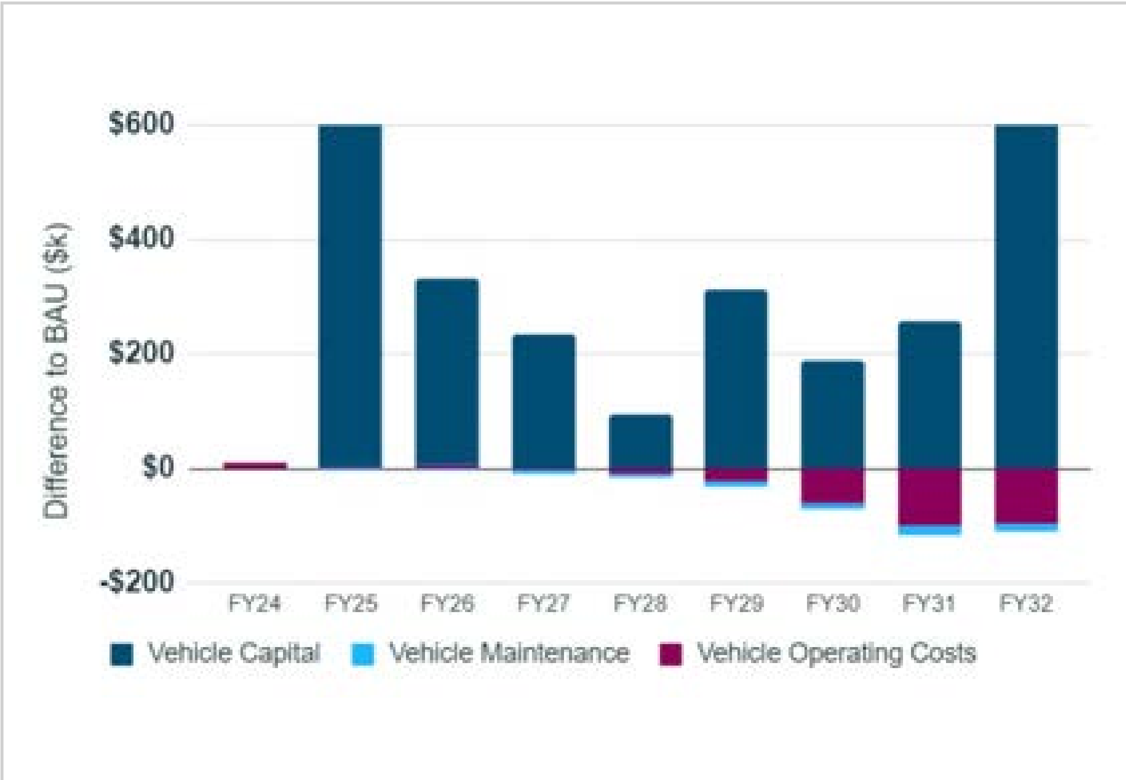


Figure 12: Heavy vehicle transition cost profile - technology leadership

The total financial impacts for each combination of scenarios ranges from an expected increase of $225k to $1.83M (not including charging infrastructure). These increases include both vehicle capital and operating expenses and are the cumulative increase from today until 2030. A full decision matrix outlining scenarios, emissions reductions and costs is shown in **Section 5.4: Recommendations**.

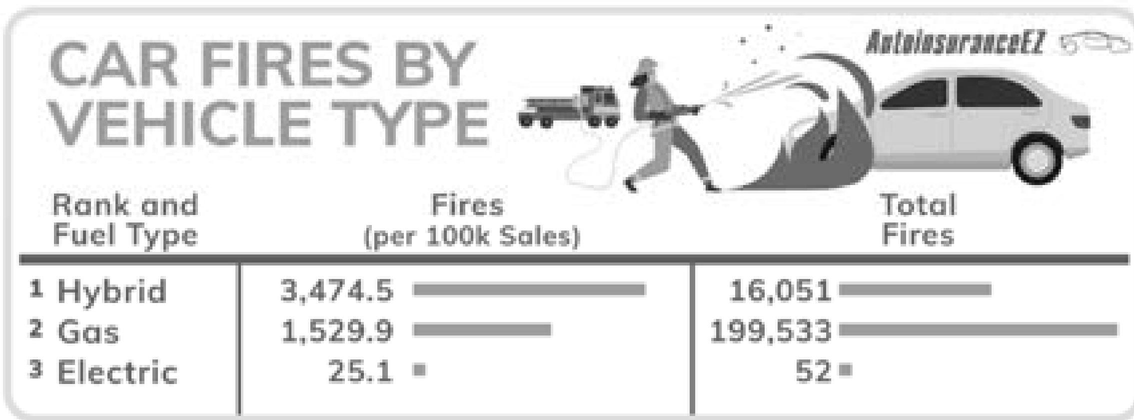
The costs for charging infrastructure to support the implementation of the EVs includes costs for the initial install to support vehicles to 2027. This cost is projected at $928,885 and would need to occur within the next 2 years to meet 2027 transition goals. Beyond 2027 additional chargers and supporting electrical infrastructure would need to be purchased and installed. However, the service from BC Hydro is expected to be sufficient to meet 2032 power needs with appropriately networked chargers that utilize load balancing.

5.3 RISKS AND LIMITATIONS

The EV industry is growing rapidly, and has significant government support, including several initiatives to implement these technologies, as well as ample media coverage and public support. Despite the pressure that an organization may feel to purchase all new vehicles as electric, there are risks an organization needs to be aware of and plan for. Each organization will have a different risk profile. The City has several high-level risks to consider, including the ability to provide reliable emergency services as well as the responsible use of taxpayer dollars. While these are two highly notable risks, they are not the only ones. A list of all identified risks are listed below along with options on how to eliminate or minimize them.

1. **High downtime for medium-and heavy-duty fleet** – The light-duty EV industry is relatively mature from a technology development perspective. Most of the major original equipment manufacturers (OEMs) offer several light-duty models that have already been in production for up to 10 years. However, medium-and heavy-duty EVs are relatively new with most major OEMs beginning production of their first vehicles in 2022. Many of these vehicles have limited mileage with unknown reliability and performance over the course of a standard 8 to 15-year life. Implementation of these vehicles presents a risk to daily operations.
   Mitigation – Monitor other larger fleets that are already operating medium-and heavy-duty EVs. When comfortable with vehicle performance in other fleets, begin to purchase in small quantities.
2. **Financial incentives not guaranteed** – the federal and provincial governments are providing significant financial incentives for EVs. While these incentives are projected to be available for several years and there is no defined end date, they are time-limited. The industry is also expecting the capital cost of EVs to decrease. However, this timeline is largely an unknown and the costs continue to increase year over year despite expectations that they will decrease.
   Mitigation – plan for increased capital costs for vehicle purchases. Maintenance and fuel savings on EVs can be used to offset the increased capital budget requirements. Also, review total cost of ownership of electric vs gasoline or diesel prior to vehicle purchase.
3. **Charging infrastructure** – vehicles and charging infrastructure need to be compatible to work correctly. There are several charging standards, plug styles, charging levels and voltage architectures.
   Mitigation – ensure vehicle voltage architecture is compatible with charging infrastructure. Also, check if the vehicle has an onboard charger, which allows for level 2 charging or if only DCFC can be used.
4. **Power outages** – power outages are commonly outlined as a risk for fleets. However, it's a complex risk. Generally, fleets will implement EVs in their low-risk vehicle operations, which means power outages aren't really a risk during the first few years of implementation. Also, with vehicle-to-grid technology, EVs can actually be used as a portable generator to power buildings or other equipment during a power outage.
   Mitigation – monitor technology advancements and the possible effect on critical EV use during power outages. This risk is a future risk. Back up battery bank options exist, but are costly and real estate intensive. It's expected that other options will be available in five to ten years when the City electrifies some of it's critical vehicles.

5. **Unknown future capital costs** – EV manufacturers are projecting vehicle price decreases as the volume of vehicles sold increases. However, the raw materials for current battery technology are at an all-time high. Manufacturers are also facing significant and costly recalls and there are still many unknowns as EVs are a relatively new technology. Prices may increase.
   Mitigation – follow the same mitigation strategy as "Financial Incentives" risk.
6. **Fires** – While EV fires are reported in the media, they are actually uncommon. A 2022 study conducted by AutoinsuranceEZ[10] demonstrated that EV fires are infrequent compared with gasoline and hybrid vehicles. The danger with EV fires is the difficulty in extinguishing them.
   Mitigation – Ensure the City Fire Department is trained to extinguish EV fires.



7. **Technology obsolescence –** technology for the EV industry is advancing extremely quickly. Some vehicle manufacturers are implementing updated batteries within a year of the previous generation. Charging infrastructure is also advancing rapidly with the need for higher power for medium-and heavy-duty vehicles.
   Mitigation – when specifying and purchasing vehicles, ensure that the specifications meet the operational needs and plan for a maximum use of 80% of the battery. This will provide a buffer for battery degradation over the vehicle's life. Additionally, ensure vehicles are purchased from reputable manufacturers with robust support systems. Manufacturers are required to support their vehicles for a minimum of 10 years.
8. **Operational risk –** some EVs are still not capable of working in the same conditions and duty cycles as internal combustion vehicles. Typically, the vehicles do not have the ability to integrate some of the more complex service bodies (e.g. aerial trucks, snow plows, hydro excavators, etc.) and vehicles do not have the battery range or speed of charging for continuous 24/7 operational use.

[10] Auto Insurance EZ, "Gas vs. Electric Car Fires", November 2022. Accessed at: https://www.autoinsuranceez.com/gas-vs-electric-car-fires/

Mitigation – plan to implement EVs in lower-risk operations. This will allow the City to still meet strategic goals, while allowing for operations to understand EV limitations and ensuring internal combustion vehicles continue to be used in high-risk operations until EV technology is advanced enough to replace them.

9. **Emergency services –** emergency services such as fire, police, snow plows, etc. use frontline vehicles that need to perform consistently and reliably. While EV technology has advanced significantly over the past decade, it's still not necessarily suitable for these operational uses.
   Mitigation – when implementing EVs as frontline vehicles for use in these emergency services, develop a risk-mitigation plan specific to the operational use of that vehicle. Examples might include: increasing the vehicle spare ratio for that subset of the fleet, planning operations around the limitations of EVs, making a conscious decision understanding that service levels may be reduced, etc.
10. **Fleet Maintenance Facility** – the current facility is failing to meet typical minimum standards of what is required to support a fleet of this size. Vehicles do not fit into bays; there is minimal space for storage of spare parts, tools, portable hoists, or even working on large vehicles; based on initial viewing it likely does not meet current seismic requirements; and layout is quite inefficient for operations.
    Mitigation – subject to the plan for Public Works, this facility would benefit from some immediate improvements.

5.4 RECOMMENDATIONS

Recommendations are outlined below in two tables. **Table 7: Recommendations** is a summary of all recommendations, categorized by Operational, Financial, and Strategic recommendations. The second table, Error! Reference source not found. **Table 8: Summary of emission reductions and costs in 2030** outlines the resulting emissions and financial impact of the analyzed scenarios.

	Recommendation	Rationale
Operational	1. Improve fleet data consistency	Consistent data will assist fleet in making decisions about specific vehicles, such as whether they should be replaced early.
	2. Develop a single source for fleet data	A single data source is important for fleet to be able to make quick assessments and decisions about vehicles.
	3. Timely data entry	Timely data entry ensures accuracy and current information for any viewer.
	4. Develop a stakeholder input process for vehicle replacements	This is outlined in the **Behaviour & Policies** section and allows additional input for the replacement of a small number of vehicles that meet pre-determined criteria.
	5. Train maintenance staff	Maintenance staff should be trained on EV maintenance, diagnostics and high-voltage safety.

	6. Procure industry recommended PPE for high-voltage vehicle safety	This is required as part of a complete EV safety and maintenance program.
	7. Develop a safe work practice	A safe work practice should be developed for safely de-energizing an EV when required.
	8. Trial or demo medium-and heavy-duty electric vehicles	While EVs have a similar form factor to gasoline or diesel, the driver experience and maintenance requirements are quite different. Exposing drivers and maintenance staff to vehicles early will help ensure a successful change management plan and help inform vehicle specifications for future procurement processes.
	9. Continue annual review of vehicle replacement plans	This fleet strategy report does not replace the need to continue with annual updates to fleet replacement plans and the review of suitable replacement vehicles for operational use.
Financial	10. Budget for increased capital	EVs have a different lifecycle cost profile than internal combustion vehicles. The capital cost is typical higher, significantly higher in the case of medium-and heavy-duty vehicles, and maintenance and operating costs are lower.
	11. Research and apply for incentives	There are many incentives available for vehicles, charging stations and electrical infrastructure, which have the ability to offset the costs by a significant amount.
Strategic	12. Implement the cost-optimized LD & technology leadership HD scenarios	To meet the City's strategic goals for: a 40% reduction in emissions, 40% electrification of light-duty (LD) fleet and 25% electrification of heavy-duty (HD) fleet by 2030, the cost optimized LD and technology leadership HD scenarios should be implemented.
	13. Conduct future fleet assessments	As the City moves forward on its electrification plans, additional fleet assessments should be conducted every 3-5 years to ensure it continues to implement vehicle electrification in the most cost-effective and operationally efficient manner. Future fleet assessments are expected to be significantly smaller scope than this initial project.
	14. Consider the purchase of renewable diesel for more immediate and aggressive emission reductions	While renewable diesel is not required to meet strategic goals, it should be considered should the City want immediate emission reductions. Renewable diesel is available today and can be implemented with **no changes** to vehicles, maintenance practices, or fueling infrastructure currently supporting standard diesel. Costs are approximately 1.5 to 2 times that of regular diesel and dependant on volume and suppler.

15. The future of the Public Works site would benefit from additional clarity and a roadmap.	Significant infrastructure is required to support a growing and changing fleet. Significant electrical upgrades are required and a new or upgraded fleet maintenance facility should also be considered to support the fleet into the future. Additional clarity on the roadmap for this facility's replacement or upgrades would be beneficial. This clarity would aid in making recommendations and decisions on fleet strategies.
16. Implement a pool fleet for office staff use.	The pool fleet analysis shows numerous benefits, including financial, for the implementation of a pool fleet for office staff use.

Table 7: Recommendations

Table 8 below outlines the results of each scenario in 2030. Renewable diesel has also been added where specific scenarios to electrify the fleet do not meet the City's strategic goals for a 40% reduction in emissions by 2030. The recommended scenarios are a combination of the cost optimized light duty, technology leadership heavy duty scenarios and charging infrastructure. While this is not the lowest cost option, with an incremental $2.759M ($1.831M for vehicles and $0.928M for electrical infrastructure) required between now and 2030, it is the only combination of scenarios that meets the City's strategic goals.

Scenario	Emissions (t/yr)	Emissions Reduction	Incremental Costs*	Renewable Diesel (L)	Charging Infrastructure**	Renewable Diesel Cost	Total Incremental Costs	LD Fleet EV	HD Fleet EV
2021 Baseline	740,510	0%	-	-		-	-		
BAU LD + BAU HD	705,521	5%	-	112,789		$527,698	$527,698		
Cost Optimized LD + BAU HD	575,922	22%	$(16,000)	56,830	$632,248	$265,886	$882,134	48%	
Tech Leadership LD + BAU HD	562,870	24%	$(12,000)	51,194	$632,248	$239,519	$859,767	50%	
BAU LD + Tech Leadership HD	568,996	23%	$1,847,000	53,840	$902,518	$251,895	$3,001,413		29%
Cost Optimized LD + Tech Leadership HD	439,397	41%	$1,831,000	N/A	$928,885	N/A	$2,759,885	48%	29%
Tech Leadership LD + Tech Leadership HD	426,345	42%	$1,835,000	N/A	$928,885	N/A	$2,763,885	50%	29%

*Costs represent a combination of vehicle capital and operation and do not include any incentives.

**Includes costs of service upgrade (sized to 2032 needs) and install of charging infrastructure to support fleet to 2027.

Table 8: Summary of emission reductions and costs in 2030

As a final note about this project, every effort was made to anticipate industry trends, available vehicles, technology progression and estimated costs. However, there is still a need for the City to complete an annual review of vehicle replacements, industry progression, changing operational needs and suitability of any EVs for their fleet.

6. ROADMAP

The development of this EV transition roadmap is has been completed in a manner that factors in the City's infrastructure, training, and current adoption of EVs. In order for this to be a successful transition, the City will require implementation of the recommendations in this report including infrastructure upgrades. There are several charts below outlining the roadmap to 2030. **Figure 13** outlines the EV transition roadmap in a simple and easy to follow format. The first EV is not introduced until 2025 which gives the City time to implement initial recommendations and develop the foundations for a successful rollout. This also allows for time to install electrical infrastructure to support the EVs for 2025. Subsequently, **Table 9** and **Table 10** provide the detailed transition of vehicles on a year by year basis. These tables are based on the recommended scenarios of cost optimized light duty and technology leadership heavy duty.

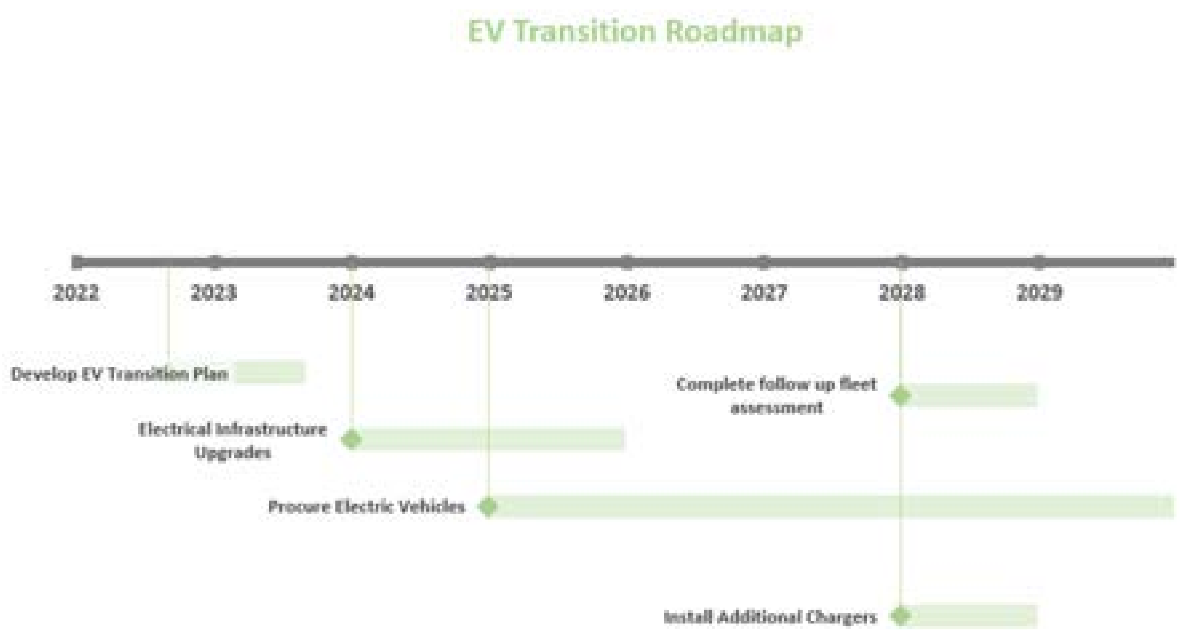


Figure13: EV Transition Overview Roadmap

ASSET#	MAKE	MODEL	TYPE	ANNUAL DISTANCE	COST-OPTIMIZED TRANSITION								
					2024	2025	2026	2027	2028	2029	2030	2031	2032
CU001	DODGE	GRAND CARAVAN	CU	2,000	ICE								
EN001	FORD	ESCAPE	EN	7,000					BEV				
FC072	FORD	TRANSIT	FC	3,000							BEV		
FC074	FORD	ESCAPE	FC	10,000				BEV					BEV
FC066	FORD	F150	FC	14,000					BEV				
FC063	FORD	F150	FC	7,000				BEV					
FC067	FORD	TRANSIT CONNECT	FC	10,000				BEV					
FC064	FORD	TRANSIT CONNECT	FC	7,000				BEV					
FC073	FORD	RANGER	FC	6,000						BEV			
FR011A	CHEVROLET	COLORADO	FR	2,500									HEV
FR023	FORD	EXPLORER	FR	30,000					BEV				
FR028	FORD	EXPEDITION	FR	5,000							ICE		
FR024	FORD	EXPLORER	FR	10,000						BEV			
OP081	FORD	ESCAPE	OP	5,000					BEV				
OP068	FORD	F150	OP	5,000			BEV						
OP087	FORD	F150	OP	11,000					BEV				
OP113	FORD	F150	OP	7,200					BEV				
OP059	FORD	F150	OP	9,000			BEV						
OP073	FORD	F150	OP	18,000			BEV						
OP060	FORD	TRANSIT	OP	10,000			BEV						
OP066	MERCEDES-BENZ	SPRINTER	OP	9,000					BEV				
OP067	MERCEDES-BENZ	SPRINTER	OP	7,000					BEV				
OP112	FORD	TRANSIT	OP	5,000							BEV		
PK071D	FORD	F250	PK	3,000								BEV	
PK085A	FORD	F250	PK	1,000								BEV	
PK103	FORD	F150	PK	10,000				BEV					BEV
PK073	FORD	F150	PK	11,000					BEV				
PK074	FORD	F150	PK	6,000					BEV				
PK076	FORD	F150	PK	6,000					BEV				
PK041A	FORD	F150	PK	7,000									
PK053B	FORD	F150	PK	7,000									
PK065A	FORD	F150	PK	15,000			BEV						
PK070B	FORD	RANGER	PK	5,000						BEV			
PK083	FORD	RANGER	PK	5,000							BEV		
PK101A	NISSAN	FRONTIER	PK	10,000				HEV					HEV
PL004	FORD	TRANSIT CONNECT	PL	18,000				BEV					
PO100A	DODGE	CHARGER	PO	6,000	ICE								ICE
PO103C	DODGE	CHARGER	PO	15,000			ICE					ICE	
PO103B	DODGE	CHARGER	PO	25,000					ICE				ICE
PO089B	DODGE	CHARGER	PO	30,000	ICE					ICE			
PO092C	DODGE	CHARGER	PO	47,000	ICE			ICE			ICE		
PO093C	DODGE	CHARGER	PO	47,000		ICE			ICE			ICE	
PO105B	DODGE	CHARGER	PO	47,000	ICE			ICE			ICE		
PO086B	DODGE	DURANGO	PO	15,000			BEV						
PO088B	DODGE	DURANGO	PO	20,000				BEV					
PO114	DODGE	GRAND CARAVAN	PO	1,000						ICE			
PO098	DODGE	GRAND CARAVAN	PO	1,000				ICE					
PO101B	DODGE	RAM 1500	PO	10,000							BEV		
PO084A	FORD	ESCAPE	PO	5,000					BEV				
PO091C	FORD	EXPLORER	PO	50,000			BEV			BEV			BEV
PO087C	FORD	EXPLORER	PO	25,000		ICE					BEV		
PO082A	GMC	SAVANA 3500	PO	1,500					BEV				
PO094B	HONDA	ACCORD	PO	4,000					HEV				
PO112	HONDA	ACCORD	PO	4,000			HEV						
PO110E	KIA	SPORTAGE	PO	10,000			BEV					BEV	
PO108A	MAZDA	CX-5	PO	20,000					BEV				
PO085B	TOYOTA	4RUNNER	PO	22,500		BEV					BEV		
PO109B	TOYOTA	HIGHLANDER	PO	10,000			PHEV					BEV	
PO115	TOYOTA	HIGHLANDER	PO	5,000					BEV				
PO083B	VOLKSWAGEN	PASSAT	PO	6,000					HEV				
PO097B	TOYOTA	RAV4	PO	2,000						BEV			
RS056A	FORD	ECONOVAN	RS	5,000									ICE
RS062	FORD	RANGER	RS	20,000					HEV				

Table 9: Cost optimized scenario for light duty vehicle transition

					TECHNOLOGY LEADERSHIP TRANSITION								
ASSET#	MAKE	MODEL	TYPE	ANNUAL DISTANCE	2024	2025	2026	2027	2028	2029	2030	2031	2032
FR010	FORD	F550	FR	10,000									
FR022	FORD	F550	FR	6,000	ICE								BEV
FR027	FORD	F350	FR	3,000							BEV		
FR009	FREIGHTLINER	TBD	FR	10,000									
OP078	FORD	F350	OP	10,000				BEV					
OP057	FORD	F550	OP	8,500	ICE								BEV
OP100	FORD	F550	OP	6,000			BEV						BEV
OP070	FORD	F550	OP	11,000		ICE							
OP072	FORD	F550	OP	4,000						BEV			
OP102	FORD	F600	OP	10,000						BEV			
OP033A	FORD	F350	OP	10,000									
OP091	FORD	F350	OP	10,000				BEV					
OP086	FREIGHTLINER	TBD	OP	12,000				ICE					
OP080	FREIGHTLINER	108 SD	OP	7,000			ICE						
OP075	MACK	LR	OP	18,000							BEV		
OP076	MACK	LR	OP	18,000		BEV							BEV
OP077	MACK	LR	OP	14,000	ICE							BEV	
OP083	MACK	LR	OP	17,000	ICE							BEV	
OP088	MACK	LR	OP	17,000			ICE						
OP090	MACK	Granite	OP	4,000						BEV			
OP089	MACK	Granite	OP	3,000						BEV			
OP079	ELGIN	CROSSWIND	OP	5,000			ICE						
PK071E	FORD	F350	PK	10,000						BEV			
PK062A	FORD	F450	PK	7,000									
PK064A	FORD	F550	PK	9,000	ICE								BEV
PK072	FORD	F550	PK	6,000		ICE							
PK069	FORD	F550	PK	6,000		BEV							
PK101	GMC	SIERRA 3500	PK	6,000					BEV				

Table 10: Technology leadership scenario for heavy duty vehicle transition

As a final note, the intent of this report is to provide the City with a plan on how to reach 2030 emissions targets. The City is encouraged to use this plan to help guide decisions in the coming years, with the understanding that unforeseen operational changes, industry trends, and technological advancements may require the City to deviate from this plan. The City should continue their best practices of vehicle and operational reviews annually throughout the implementation of their EV transition. The fleet industry is in a time of significant and rapid changes in technology that has not been experienced in decades and the City is commended for undertaking this project as a way to increase chances of success on their journey to reduce harmful GHG emissions.

APPENDIX A: FLEET PLAN & DATABASE

2022 Vehicle/Equipment/Trailer List

Date Updated: 19-Oct-22

cells highlighted - need additional info/confirmation

Columns highlighted - need Port Moody to Provide Data (if available)

Vehicle Unit #	Insured Y/N	NERO GPS Unit	Division	Use	Vehicle Status	Vehicle Owner	Year	Purchase Price	Upfitting or equipment cost	Make	Model	4x4
CU001	Y		Cultural Services	Passenger/inspections	Active	Owned	2007	$23,948		DODGE/RAM TRUCK/VAN	GRAND CARAVAN	
EN001	Y		Engineering	Passenger/inspections	Active	Owned	2018	$14,856		FORD TRUCK/VAN	ESCAPE SE 4DR 4WD	x
FC063	Y		Rec Services	Maintenance - Vehicle	Active	Owned	2017	$39,663		FORD TRUCK/VAN	F150 XLT SUPERCAB 4WD	x
FC064	Y		Rec Services	Maintenance - Vehicle	Active	Owned	2017	$44,197		FORD TRUCK/VAN	TRANSIT CONNECT XL CARGO VAN	
FC065	Y		Rec Services	Maintenance - Vehicle	Active	Owned	2017	$191,380		ZAMBONI	All Models	
FC066	Y		Rec Services	Civil Supervisor	Active	Lease	2018	$48,646		FORD TRUCK/VAN	F150 LARIAT SUPERCREW 4WD	x
FC067	Y		Rec Services	Maintenance - Vehicle	Active	Owned	2017	$35,810		FORD TRUCK/VAN	TRANSIT 350 WB 148 CARGO VAN	
FC069	Y		Facilities	Maintenance - Equipment	Active	Owned	2019	$201,252		ZAMBONI	All Models	
FC070	Y		Facilities	Maintenance - Equipment	Active	Owned	2019	$126,942		ZAMBONI	All Models	
FC072	Y		Facilities	Maintenance - Vehicle	Active	Owned	2020	$60,109		FORD TRUCK/VAN	TRANSIT 350 WB 148 CARGO VAN	
FC073	Y		Rec Services	Maintenance - Vehicle	Active	Owned	2019	$46,195		FORD TRUCK/VAN	RANGER XLT SUPERCREW 4WD	x
FC074			Rec Services	Maintenance - Vehicle			2022			FORD TRUCK/VAN	FORD ESCAPE HYBRID	
FR001	Y-vintage		Fire	Fire Vintage truck	Active	Owned	1950			FORD/MERCURY	Bickle Seagrave	
FR007	Y		Fire	Fire Equipment	Active	Owned	1999			FREIGHTLIN	Freightliner	
FR009	Y		Fire	Fire Equipment	Active	Owned	1997			FREIGHTLIN	Freightliner	
FR010	Y		Fire	Fire Equipment	Active	Owned	2003			FORD	Ford	
FR011A	Y		Fire	Fire Vehicle	Active	Owned	2011	$33,962		CHEVROLET TRUCK/VAN	COLORADO LT EXT CAB 2WD	
FR018	Y		Fire	Fire Equipment	Active	Owned	2007	$733,153		SPARTAN	Spartan	
FR020	Y		Fire	Fire Equipment	Active	Owned	2008	$566,903		SPARTAN	Spartan	
FR021	Y		Fire	Fire Equipment	Active	Owned	2013	$745,727		SPARTAN	Spartan	
FR022	Y		Fire	Fire Vehicle	Active	Owned	2016	$91,499		FORD	Ford F550 Hooklift	
FR023	Y		Fire	Fire Vehicle	Active	Owned	2017	$59,838		FORD TRUCK/VAN	EXPLORER XLT 4DR 4WD	x
FR024	Y		Fire	Fire Vehicle	Active	Owned	2019	$59,631		FORD TRUCK/VAN	EXPLORER 4DR 4WD	x
FR025	Y		Fire	Fire Equipment	Active	Owned	2019	$1,596,148		SPARTAN	Spartan	
FR026	Y		Fire	Fire Equipment	Active	Owned	2019	$2,006,733		SPARTAN	Spartan	
FR027	Y		Fire	Fire Vehicle	Active	Owned	2020	$66,321		FORD TRUCK/VAN	F350 SD LARIAT CREW CAB 4WD	x
FR028	Y		Fire	Fire Vehicle	Active	Owned	2020	$72,836		FORD TRUCK/VAN	EXPEDITION SSV 4DR 4WD	x
FR029	Y		Fire	Fire Equipment	Active	Owned	2021	$27,870		POLARIS	Polaris	
FR031	N/A		Fire	Fire Equipment	Active	Owned	2020			MERCURY	INFLATABLE BOAT	
OP031	Y			Maintenance - Equipment	Active	Owned	2002	$29,235		INGERSOL	Ingersol Roller	
OP033A	Y		Utilities	Maintenance - Vehicle	Active	Owned	2013	$32,586		FORD TRUCK/VAN	F350 SD LARIAT SUPERCAB 4WD	x
OP057	Y		Operations	Maintenance - Vehicle	Active	Owned	2016	$79,574		FORD	F550 4x4 supercab dump	
OP059	Y		Operations	Maintenance - Vehicle	Active	Owned	2016	$35,000		FORD TRUCK/VAN	F150 XLT SUPERCAB 4WD	x
OP060	Y	Y	Operations	Maintenance - Vehicle	Active	Owned	2016	$39,359		FORD TRUCK/VAN	TRANSIT 350 WB 148 CARGO VAN	
OP062	N/A			Maintenance - Equipment	Active	Owned		$34,517		CLARK	Forklift	
OP066	Y		Utilities	Maintenance - Vehicle	Active	Owned	2016	$98,635		MERCEDES-BENZ TRUCK	SPRINTER 2500 WB 144 CARGO VAN DIESEL	
OP067	Y		Operations	Maintenance - Vehicle	Active	Owned	2016	$98,060		MERCEDES-BENZ TRUCK	SPRINTER 2500 WB 144 CARGO VAN DIESEL	
OP068	Y		Operations	Maintenance - Vehicle	Active	Owned	2016	$35,000		FORD TRUCK/VAN	F150 LARIAT SUPERCAB 4WD	x
OP070	Y		Operations	Maintenance - Vehicle	Active	Owned	2017	$76,865		FORD	F550 crewcap dump	
OP072	Y		Operations	Maintenance - Vehicle	Active	Owned	2017	$99,947		FORD	F550 service truck	
OP073	Y		Operations	Maintenance - Vehicle	Active	Owned	2017	$39,840		FORD TRUCK/VAN	F150 XLT SUPERCREW 4WD	x
OP074	Y	Y	Operations	Maintenance - Equipment	Active	Owned	2017	$174,942		CATERPILAR	Caterpillar	
OP075	Y	Y	Solid Waste	SW - Curbside Collection	Active	Owned	2017	$421,000		MACK	Mack	
OP076	Y	Y	Solid Waste	SW - Curbside Collection	Active	Owned	2017	$420,920		MACK	Mack	
OP077	Y	Y	Solid Waste	SW - Curbside Collection	Active	Owned	2017	$421,039		MACK	Mack	
OP078	Y		Operations	Maintenance - Vehicle	Active	Owned	2017	$59,730		FORD	F350 supercab 4x4	x
OP079	Y		Operations	Maintenance - Equipment	Active	Owned	2018	$323,478		PETERBILT	Elgin street sweeper	
OP080	Y		Operations	Maintenance - Equipment	Active	Owned	2018	$173,193		FREIGHTLIN	Freightliner 108 SD dump	
OP081	Y		Operations	Passenger/Inspections	Active	Owned	2018	$41,533		FORD TRUCK/VAN	ESCAPE SE 4DR 4WD	x
OP082	Y		Operations	Maintenance - Equipment	Active	Owned	2018	$152,699		CATERPILAR	Caterpillar	
OP083	Y	Y	Solid Waste	SW - Curbside Collection	Active	Owned	2018	$420,878		MACK	Mack	
OP084	Y		Operations	Maintenance - Equipment	Active	Owned	2016	$110,638		NEW HOLLAN	New Holland	
OP086	Y		Utilities	Maintenance - Equipment	Active	Owned	2020	$558,749		FREIGHTLIN	Freightliner	
OP087	Y		Solid Waste	Maintenance	Active	Owned	2018	$39,398		FORD TRUCK/VAN	F150 LARIAT SUPERCAB 4WD	x
OP088	Y	Y	Solid Waste	SW - Curbside Collection	Active	Owned	2020	$449,777		MACK	Mack	
OP089	Y	Y	Operations	Maintenance - Equipment	Active	Owned	2022	$383,547		MACK	Mack tandem dump	
OP090	Y	Y	Operations	Maintenance - Equipment	Active	Owned	2022	$305,781		MACK	Mack single dump	
OP091	Y		Solid Waste	SW - Glass collection	Active	Owned	2017	$46,463		FORD TRUCK/VAN	F350 SD LARIAT SUPERCAB 4WD	x
OP100	Y		Operations	Maintenance - Vehicle	Active	Owned	2020	$64,582		FORD	F550 bucket truck	
OP101	Y			Maintenance - Vehicle	Active	Owned	2021	$52,965		FORD	F150 supercab	
OP102	Y			Maintenance - Vehicle	Active	Owned	2021	$1,851		FORD	F600 reg cab 4x4 dump	x
OP103	Y		Operations	Maintenance - Equipment	Active	Owned	2021	$210,103		CATERPILAR	Caterpillar	
OP105	Y			Maintenance - Equipment	Active	Owned	2021	$54,881		JOHN DEERE	John Deere 1575 terrain cut	
OP106	N/A			Maintenance - Equipment	Active	Owned	2021	$12,012		JOHN DEERE	W61R mower	
OP112	Y		Utilities	Utilities	Active	Lease	2020	$28,120		FORD TRUCK/VAN	TRANSIT 250 WB 148 EL CARGO VAN AWD	
OP113	Y		Operations	Maintenance - Vehicle	Active	Owned	2018	$22,042		FORD TRUCK/VAN	F150 LARIAT SUPERCAB 4WD	x
PK017	Y			Maintenance - Equipment	Active	Owned	2008	$22,501		AGRI METAL	Tuff vac sweeper	
PK041A	Y		Parks	Maintenance - Vehicle	Active	Owned	2013	$41,740		FORD TRUCK/VAN	F150 XLT SUPERCAB 4WD	x
PK046A	Y		Parks	Maintenance - Equipment	Active	Owned	2010	$57,897		JOHN DEERE	John Deere	
PK053B	Y		Parks	Maintenance - Vehicle	Active	Owned	2013	$28,172		FORD TRUCK/VAN	F150 XLT SUPERCAB 4WD	x
PK062A	Y		Parks	Maintenance - Vehicle	Active	Owned	2012	$47,863		FORD	F450 reg cab dump	
PK064A	Y	Y	Parks	Maintenance - Vehicle	Active	Owned	2016	$79,220		FORD	F550 supercab dump	
PK065A	Y		Parks	Maintenance - Vehicle	Active	Owned	2016	$35,337		FORD TRUCK/VAN	F150 XLT SUPERCAB 4WD	x
PK066A	N/A		Parks	Maintenance - Equipment	Active	Owned	2016	$15,043		John Deere	950R Zero Turn	
PK069							2017	$80,192		FORD TRUCK/VAN	F550 Dump	
PK104	Y		Parks	Grass crew truck	Active	Lease	2019	$16,564		FORD TRUCK/VAN	RANGER LARIAT SUPERCREW 4WD	x
PK071E	Y			Maintenance - Vehicle	Active	Lease	2021			FORD	F350	
PK072	Y		Parks	Maintenance - Vehicle	Active	Owned	2017	$89,178		FORD	F550 supercab dump	
PK073	Y		Parks	Maintenance - Vehicle	Active	Owned	2018	$39,568		FORD TRUCK/VAN	F150 LARIAT SUPERCAB 4WD	x
PK074	Y		Parks	Maintenance - Vehicle	Active	Owned	2018	$44,899		FORD TRUCK/VAN	F150 LARIAT SUPERCAB 4WD	x
PK076	Y		Parks	Maintenance - Vehicle	Active	Owned	2018	$42,871		FORD TRUCK/VAN	F150 XL SUPERCAB 4WD	x
PK077	Y		Parks	Maintenance - Vehicle	Active	Owned	2018	$30,676		KUBOTA	Kubota	
PK080	Y		Parks	Maintenance - Equipment	Active	Owned	2019	$85,537		NEW HOLLAN	New Holland	
PK082	Y			Maintenance - Vehicle	Active	Owned	2020	$49,852		CANEV	MIGHT-E	
PK083	Y		Parks	Maintenance - Vehicle	Active	Owned	2020	$44,159		FORD TRUCK/VAN	RANGER LARIAT SUPERCREW 4WD	x
PK084	N/A		Parks	Maintenance - Equipment	Active	Owned	2019			FERRIS	FB2000	
PK086	Y		Parks	Maintenance - Equipment	Active	Owned	2021	$84,964		BANDIT	12XP	
PK087	Y		Parks	Maintenance - Equipment	Active	Owned	2021	$54,881		JOHN DEERE	John Deere 1575 terrain cut	
PK089	Y			Water truck	Active	Lease	2021	$66,742		FORD	F350 with dump box insert	
PK101A	Y		Parks	Parks	Active	Lease	2022			NISSAN	FRONTIER	
PK103			Parks				2022			FORD TRUCK/VAN	F150 hybrid	
PL003	Y		Building Bylaw Licensi	Passenger/Inspections	Active	Owned	2016	$20,937		FORD	FOCUS ELECTRIC 5DR	
PL004	Y		Planning &	Passenger/Inspections	Active	Owned	2018	$25,980		FORD TRUCK/VAN	TRANSIT CONNECT XL CARGO VAN	
PO082A	Y		Police	Prisoner Transport Van	Active	Owned	2016	$35,000	$28,000	GMC TRUCK/VAN	SAVANA 3500 CARGO VAN	
PO083B	Y		Police	Detectives	Active	Lease	2018			VOLKSWAGEN	PASSAT 2.0 TSI 4DR	
PO084A	Y		Police	Detectives	Active	Lease	2018			FORD TRUCK/VAN	ESCAPE SEL 4DR 4WD	x
PO085B	Y		Police	Chief Constable	Active	Lease	2020			TOYOTA TRUCK/VAN	4RUNNER V6 4DR 4WD	x
PO086B	Y		Police	Mental Health Liaison	Active	Owned	2016	$40,000	$11,000	DODGE/RAM TRUCK/VAN	DURANGO LIMITED 4DR 4WD	x
PO087C	Y		Police	Patrol - marked	Active	Owned	2020	$49,900	$18,100	FORD TRUCK/VAN	EXPLORER LIMITED 4DR AWD	x
PO088B	Y		Police	Duty Officer	Active	Owned	2019	$60,277		DODGE/RAM TRUCK/VAN	DURANGO SXT 4DR AWD	x
PO089B	Y		Police	Patrol - marked	Active	Owned	2019	$42,200	$14,000	DODGE	CHARGER SXT 4DR AWD	x
PO090A	Y		Police	Community Services - marked	Active	Owned	2021	$55,333		DODGE/RAM TRUCK/VAN	DURANGO SXT 4DR AWD	x
PO091C	Y		Police	Patrol - marked	Active	Owned	2020	$49,900	$19,900	FORD TRUCK/VAN	EXPLORER LIMITED 4DR 4WD	x
PO092C	Y		Police	Patrol - marked	Active	Owned	2019	$42,200	$14,200	DODGE	CHARGER SXT 4DR AWD	x
PO093C	Y		Police	Patrol - marked	Active	Owned	2019	$42,200	$13,900	DODGE	CHARGER SXT 4DR AWD	x
PO094B	Y		Police	Detectives	Active	Lease	2018			HONDA	ACCORD SPORT 2.0 4DR	
PO095B	Y		Police	Patrol supervisor - marked	Active	Owned	2021	$75,676		CHEVROLET TRUCK/VAN	TAHOE LS 4DR 4WD	x
PO097B	Y		Police	Detectives	Active	Owned	2019	$32,300	$5,400	TOYOTA TRUCK/VAN	RAV4 LE 4DR AWD	x
PO098	Y		Police	Community Services - school l	Active	Owned	2015			DODGE/RAM TRUCK/VAN	GRAND CARAVAN SE	
PO100A	Y		Police	Community Services - school l	Active	Owned	2015	$52,766		DODGE	CHARGER SE 4DR	
PO101B	Y		Police	Traffic - unmarked	Active	Owned	2014	$39,207		DODGE/RAM TRUCK/VAN	RAM 1500 SLT CREW CAB 4WD	x
PO102A	Y			Traffic - marked	Active	Owned	2012	$24,588		KAWASAKI		
PO103C	Y		Police	Patrol - marked	Active	Owned	2021	$54,504		DODGE	CHARGER GT 4DR	
PO105B	Y		Police	Patrol - marked	Active	Owned	2019	$42,000	$13,100	DODGE	CHARGER SXT 4DR AWD	x
PO106A	Y		Police	Detectives	Active	Lease	2021			TOYOTA	CAMRY SE HYBRID 4DR	
PO108B			Police	Deputy Chief	Active	Lease	2022			TOYOTA TRUCK/VAN	RAV4 4DR AWD	x
PO109B	Y		Police	Detectives	Active	Lease	2021			TOYOTA TRUCK/VAN	HIGHLANDER LE V6 4DR AWD	x
PO110E	Y		Police	Passenger Vehicle	Active	Lease	2021			KIA TRUCK/VAN	SPORTAGE LX 4DR AWD	x
PO112	Y		Police	Admin	Active	Owned	2015	$35,471		HONDA	ACCORD TOURING HYBRID 4DR	
PO115A			Police	Detectives	Active	Lease	2022			TOYOTA TRUCK/VAN	Highlander	
PO116	Y		Police	Passenger Vehicle	Active	Owned	2013			BMW	328i xDrive 4DR AWD	x
RS062	Y		Operations	Maintenance - Vehicle	Active	Owned	2020	$64,945		FORD TRUCK/VAN	RANGER XL SUPERCAB 4WD	x
	Y			Maintenance - Vehicle	Active	Owned	2017			FORD TRUCK/VAN	F350 SD LARIAT SUPERCAB 4WD	x
OP112							2020	$28,120		FORD TRUCK/VAN	Ford Transit Van (PWR Vehicle)	
OP113							2018	$22,042		FORD TRUCK/VAN	Ford F150 Crew Cab	
ILS-001				Maintenance - Trailer						Ioco Cleansing Station-GEN	Generator trailer	
OP050D							2021			FORD TRUCK/VAN	Ford F350 Crew Cab	
OP99F				Maintenance - Trailer			1990			1990 Sullair 009 Compressor	Compressor Trailer	
PK071D							2021			FORD TRUCK/VAN	Ford F250 Pickkup	
PK085A							2021			FORD TRUCK/VAN	Ford F250 PIckup	

vehicle charges spreadsheet - $700k to $1M /year not allocated to vehicle - why?

Location:	Address:
City Hall	100 Newport Drive
Recreation Center	300 Ioco Rd
Works Yard: Operations	3250 Murray St
Works Yard: Parks	3016 Murray St
Carpenter Shop	2904 Murray St
Public Safety Buiding	3051 St Johns St
Inlet Firehall	150 Newport Dr
Fire Hall #2	955 Glenayre Dr

APPENDIX B: LOW-CARBON FUELS

Port Moody Fleet Assessment

Low Carbon Fuels

Completed By: Steven Wiebe

Date: November 14, 2022

Aligning with market sentiment and Government policies, many fleets are setting aggressive carbon reduction targets. The Government of Canada has set a mandatory target of all new light-duty cars and passenger trucks sales to be zero-emissions by 2035. In addition, they have also set a target for 35% of all new medium and heavy-duty vehicles to be zero-emissions by 2030[1]. The Province of British Columbia has developed a similar target with some key differences to advance zero-emission adoption in the interim. Notably, a zero-emission first policy will be developed for public sector fleets with 100% of light duty vehicles purchased to be zero-emissions by 2027[2]. These targets have resulted in increased funding for numerous carbon reduction initiatives across Canada in the zero-Emission vehicle industry. Zero-emission vehicles are typically defined as battery electric or hydrogen, however, in order to meet mandated zero-emission targets the industry needs time to not only develop feasible technology solutions, but also for fleets to adopt them. The good news, is that in addition to zero-emission vehicles there are also numerous low carbon fuels that are available today. These fuels are propane, compressed natural gas (CNG), renewable natural gas (RNG), biodiesel, and renewable diesel.

In an effort to quantify the Canadian targets, and provide insight into that broader industry, a review of the market in the United States was also conducted. The State of Sustainable Fleets is an initiative by several industry leading companies to produce a technology neutral report with information from over 250 fleets across the US. The 2022 report outlines the carbon reduction potential across several fuel types and zero-emission vehicle technologies.

[1] "2030 Emissions Reduction Plan – Transportation," Government of Canada, accessed at https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/erp/factsheet-06-transportation.pdf
[2] "Clean BC Roadmap to 2030," Province of British Columbia, accessed at https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf

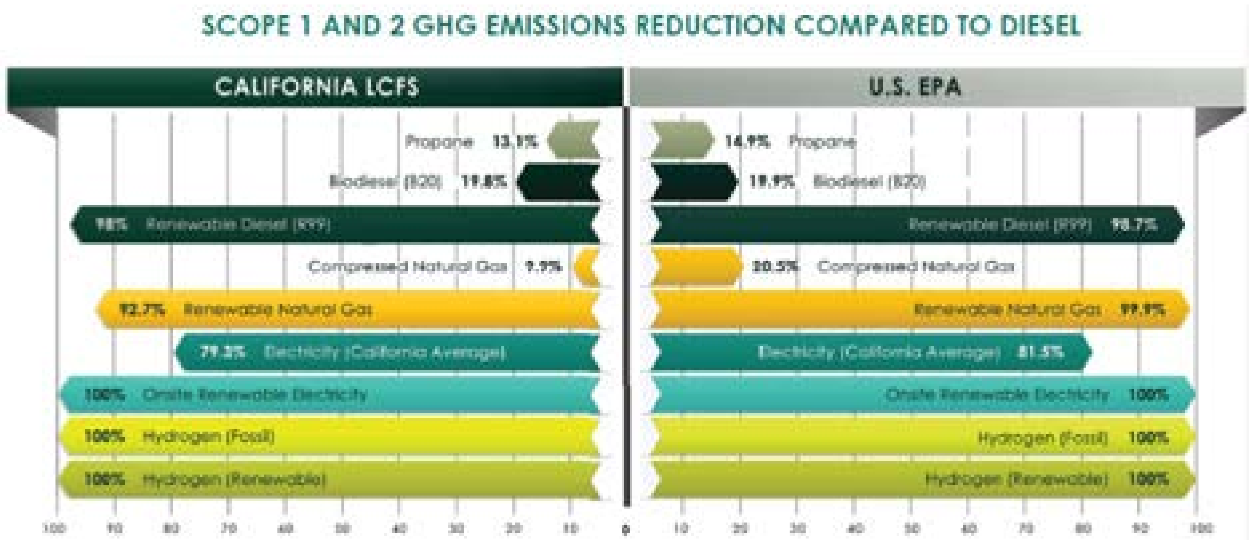


Figure 1: Carbon reduction potential by fuel and technology type compared to diesel.[3]

The reduction potentials align well with the Province of British Columbia's Methodology for Quantifying Greenhouse Gas Emissions and British Columbia's Low Carbon Fuel Standard. While there are minor differences between British Columbia carbon methodologies, the US EPA and California greenhouse gas (GHG) methodologies, the only notable difference is that British Columbia's methodology considers electricity to be a zero-emission technology whereas California's electricity is only considered a low carbon fuel with only an 80% reduction as shown in Figure 1. Despite Figure 1 being from a United States study, it was chosen for this report as it provides a nice visual summarizing the reduction potentials of each fuel type.

A summary of each low carbon fuel and it's suitability for use in Port Moody's fleet.

Technology Assessment Summary

Each of the technologies listed above have been summarized in *Electric vehicle availability for medium and heavy fleet is low, but growing at a rapid pace
Table 1 below. In addition to the carbon emission reduction potential, vehicle availability and fueling infrastructure, two more categories have been added: vehicle maintenance and financial incentives. These five categories have then been assessed to determine which ones provide significant benefit and industry readiness for Port Moody's fleet. From this perspective, electric vehicles and renewable diesel are the optimal technologies for further assessment and financial analysis.

[3] Gladstein, Neandross & Associates (GNA), "State of Sustainable Fleets 2022 Market Brief", May 2022, Santa Monica, CA. Accessed at: www.StateofSustainableFleets.com

Technology	CO2 Emission Reduction	Vehicle Availability	Fueling Infrastructure Availability	Vehicle Maintenance Requirements	Financial Incentives
Propane					
Biodiesel		✓	✓		
Renewable Diesel	✓	✓	✓	✓	
CNG					
RNG	✓				
Electric	✓	✓*	✓	✓	✓
Hydrogen	✓				

*Electric vehicle availability for medium and heavy fleet is low, but growing at a rapid pace

Table 1: Summary of alternative fuel options and their alignment to Port Moody's fleet goals

Propane

Propane has been a small-scale alternative fuel for vehicles for decades. It requires a third party to convert vehicles. This conversion means additional complexity and risk for vehicle failures, denied warranty and complex repairs. The Alternative Fuels Data Center lists only a few medium duty vehicles with propane prep packages and no light duty or heavy-duty vehicles[4]. Propane as a fuel has less energy density than diesel or gasoline which means that vehicles using propane burn larger volumes of fuel. Combining the larger volume that is burned with the carbon emission factor in the BC Methodology for Quantifying Greenhouse Gas Emissions reveals minimal carbon emission reduction potential.

Vehicle Availability: *Low*
Fueling Infrastructure Simplicity: *Medium*
Carbon Reduction Potential: *Low*

[4] "Propane Vehicle Availability", Alternative Fuels Data Center, accessed at https://afdc.energy.gov/vehicles/propane_availability.html

Biodiesel

Biodiesel is another fuel that has been around for decades. It is typically refined from vegetable oils, animal fats, rapeseed oil, sunflower oil and palm oil.[5] As a matter of fact, biodiesel is already part of the diesel fuel supplied to all customers in British Columbia. The BC Low Carbon Fuel Standard mandates a minimum of 4% renewable content in diesel fuel.[6] While the renewable content is not defined, it's typically biodiesel. Where biodiesel is limited is with its ability to meet fuel quality standards for engine manufacturers and low temperature performance. Diesel engine manufacturers have designed engines to be compatible with a 20% mix of biodiesel which means engine reliability and warranty is not impacted with up to 20% biodiesel mix. However, because of the refining process for biodiesel, it has solids that begin to form above the cloud point temperature. This is despite the fact that the cloud point is supposed to be the temperature at which the fuel solidifies. These solids result in what is typically called "gelling" which means the fuel will no longer flow.

Vehicle Availability: *High (maximum 20% blend only)*
Fueling Infrastructure Simplicity: *High*
Carbon Reduction Potential: *Low*

Renewable Diesel

Renewable diesel is also known as Renewable Hydrogenated Diesel (RHD) or R100. It uses similar feedstock to biodiesel, but differs in two key areas: its ability to meet standard diesel fuel quality standards, and it's refining process. This fuel has been in commercial production since 2007 with the number of refining facilities across the world slowly increasing, and a few refining facilities now located in North America. These facilities use manufacturer's proprietary refining processes develop renewable diesel that meets ASTM D975, EN 590 and CGSB 3.517. These are the relevant fuel quality standards in the United States, Europe and Canada for number 2 diesel fuel.[7] As a result of the renewable diesel's ability to meet these standards, it's compatible with all current diesel fueling infrastructure including storage tanks, dispensers and vehicle engines.

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[5] "Biofuels explained", US Energy Information Administration, accessed at https://www.eia.gov/energyexplained/biofuels/biodiesel-rd-other-basics.php#:~:text=Vegetable%20oils%20(mainly%20soybean%20oil,and%20yellow%20grease%20from%20restaurants.

[6] "Low Carbon Fuel Standard", Province of British Columbia, accessed at https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels/requirements

[7] "Study of Hydrogenation Derived Renewable Diesel as a Renewable Fuel Option in North America", Natural Resources Canada, March 2012, accessed at https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/files/pdf/transportation/alternative-fuels/resources/pdf/HDRD_Final_Report_eng.pdf

Because there are limited worldwide refining facilities and limited volume there may be logistical challenges depending on the location of the customer. As there is already supply to the Greater Vancouver region, it should be readily available to Port Moody.

Vehicle Availability: *High*
Fueling Infrastructure Simplicity: *High*
Carbon Reduction Potential: *High*

Compressed Natural Gas

Modern reliable, engine technology has made compressed natural gas (CNG) quite viable for certain applications including refuse, long haul trucking and transit. While the fuel is typically more stable than diesel fuel, total cost of ownership prices are typically only lower with economy of scale. To implement a CNG fleet a fueling station is required (either private or public) along with maintenance facility upgrades for air handling and leak detection. These fueling station costs, facility upgrade costs and increased vehicle costs (when compared to a diesel equivalent) can be upwards of several million dollars to implement for small fleets such as Port Moody. Vehicles available with CNG options include medium and heavy vehicles only and based on Port Moody's fleet duty cycles the only vehicles where the duty cycle and available vehicles would likely be a good match are it's refuse truck fleet.

Fueling stations require a significant footprint of space and based on Port Moody's lack of available land at it's works Yard, either a different piece of land would be required for the fueling station or a partnership with another agency who already has a fueling station would need to be established. Considering the fueling station costs, facility upgrades, low number of vehicles with suitable duty cycles and relatively low carbon emission reduction a business case for CNG is not likely to show CNG as a feasible solution.

Vehicle Availability: *Medium*
Fueling Infrastructure Simplicity: *Low*
Carbon Reduction Potential: *Low*

Renewable Natural Gas

Renewable natural gas has the same considerations as compressed natural gas with the exception that it's made from a renewable source. Local renewable sources that are integrated with Fortis BC infrastructure include landfill gas, agriculture, and waste water[8]. Depending on the source that is used, RNG can actually have a negative carbon emission[9].

Vehicle Availability: *Medium*
Fueling Infrastructure Simplicity: *Low*
Carbon Reduction Potential: *High (only for a small subset of fleet)*

Electricity

Various forms of battery electric vehicles, including hybrid and plug in hybrid, are some of the most popular and prevalent forms of future vehicle propulsion and investment in the industry today. Governments at all levels are providing significant incentives and programs to assist individuals and businesses convert their vehicles to electric. While the vehicle technology is not yet advanced enough for all duty cycles and market segments, return to based fleets, such as Municipalities, provide the optimal operation and duty cycles for electric vehicles. Light duty vehicles, including class 1 and 2, are the most advanced with numerous options from all manufacturers. These vehicles have been proving lower maintenance costs, good performance in mild climates, and longer battery life than expected. Light duty vehicles have been successfully used in operational business for many years.

Heavy duty, including class 6-8, vehicles are lagging light duty in terms of technology readiness and number of years in the market. Many heavy-duty vehicle manufacturers only offer a single electric option with production vehicles just being introduced in 2021 and 2022. They are generally well suited to predictable regular operational use such delivery services. Unpredictable operations such as municipal where vehicles are used 24/7 for snow clearing, emergency infrastructure repairs, and the requirement for complex bodies present some real challenges and risks. While this technology is progressing rapidly, organizations need to consider the risks to their service levels before introducing these vehicles in their fleet. However, these risks should not prevent organizations from assessing the suitability of this technology and beginning to develop a plan for implementation.

Medium duty vehicles, including class 3-5, are lagging both light duty and heavy duty for electric options. There are very limited options available from any manufacturers and those that are available are generally from new vehicle manufacturers that have recently entered the vehicle manufacturing space in North America. Similar to heavy duty vehicles, this market segment is expected to progress quickly and businesses should begin assessing the technology and begin planning for implementation.

Charging infrastructure is readily available with numerous level 2 and 3 (also known as DC fast charging) options from many manufacturers. Utility providers are investing heavily in planning and

[8] "Meet Our Renewable Gas Suppliers", Fortis BC, accessed at: https://www.fortisbc.com/services/sustainable-energy-options/renewable-natural-gas/meet-our-renewable-natural-gas-suppliers
[9] "BC Renewable and Low Carbon Study", Fortis BC, January 2022, accessed at https://www.cdn.fortisbc.com/libraries/docs/default-source/news-events/bc-renewable-and-low-carbon-gas-supply-potential-study-2022-03-11.pdf

implementation of infrastructure to support charging networks and business' transitions to electric vehicles. BC Hydro is offering incentives and encouraging business to develop EV Fleet Strategies that will assist BC Hydro to understand power needs and plan for infrastructure to support the power requirements[10].

Finally, all levels of government are offering significant rebates and incentives for both vehicles and charging infrastructure. In British Columbia the provincial and federal vehicle rebates can be as high as $200,000 per vehicle. These incentives drastically help to offset the increased capital cost of electric vehicles and charging infrastructure when compared to traditional gasoline or diesel vehicles.

The carbon reduction potential for electric is high, especially in British Columbia where most of the electricity is hydro electric. Many other provinces and states still use coal and natural gas for electricity generation which means higher carbon emissions when used as a power source for electric vehicles. Another environmental consideration for battery electric vehicles is battery recycling. Recycling has seen significant technological advancement over the past few years. Companies, such as Li-Cycle, have developed safe battery recycling technology that can recover up to 95% of the raw materials[11]. The Province of British Columbia has also added electric vehicle batteries to it's recycling regulations which is expected to help increase investment in recycling technology and facilities within British Columbia.

Vehicle Availability: *Medium*
Fueling Infrastructure Simplicity: *Medium*
Carbon Reduction Potential: *High*

Hydrogen

Hydrogen is a gaseous fuel similar to CNG and propane. Leading sectors and vehicle segments for hydrogen use include transit and long-haul trucking[12]. As a result, there are next to no suitable vehicle options for municipal operations and very limited hydrogen fueling stations and supply. Despite its carbon emission reduction potential, the fueling infrastructure and vehicle industry have not advanced in a manner where this technology would be considered a feasible option for a small municipality such as Port Moody. However, there are plans for a possible hydrogen fueling station to be built within Port Moody at the Suncor site near Glenayre neighbourhood. It would be worthwhile for Port Moody to follow this project as it may change the feasibility for hydrogen in the future.

Vehicle Availability: *Low*
Fueling Infrastructure Simplicity: *Low*
Carbon Reduction Potential: *High*

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[10] "Electric Fleets", BC Hydro, accessed at: https://www.bchydro.com/powersmart/electric-vehicles/industry/fleets.html
[11] "Services", Li-Cycle, accessed at: https://li-cycle.com/services/
[12] Gladstein, Neandross & Associates (GNA), "State of Sustainable Fleets 2022 Market Brief", May 2022, Santa Monica, CA. Accessed at: www.StateofSustainableFleets.com

APPENDIX C: BETTERFLEET ANALYSIS

1 Introduction to BetterFleet™ Modeling

The Fleet Assessment and Strategy seeks to map the best pathway to a zero emissions fleet considering the demands and operational context of the City of Port Moody. Through undertaking BetterFleet™ modelling, a fleet transition plan has been developed to guide zero-emission vehicle (ZEV) investments over the next five years. Complementing the BetterFleet analyses are strategic-level recommendations to guide ZEV investments across the full Port Moody fleet and in consideration of the longer-term mandates outlined in the Climate Action Plan.

The BetterFleet analysis defines and quantifies opportunities and challenges arising from the transition to zero-emission vehicles, articulates pathways towards meeting City climate goals, and provides context to support other related strategic initiatives (such as EV infrastructure development).

1.1 Methodology underpinning analysis

The aim of the BetterFleet analysis is to help the City understand when assets are technically and commercially suitable for electrification. The methodology applied herein is presented below:

1. Map replacement schedule and emissions for business-as-usual like-for-like replacements (lowest total cost of ownership (TCO)).
2. Understand if there are like-for-like ZEV replacements based on duty requirements in the market at each replacement date, and the expected market timing for alternatives.
3. Map asset replacement schedules for the forecast period under the devised scenarios, selecting the most appropriate replacement vehicle according to the preferences of given scenarios, delivering economic budgets, and evaluating emissions outcomes.
4. Assemble preliminary emissions and costing information for the forecast period, excluding out-of-scope considerations such as infrastructure deployment.

A like-for-like analysis assumes the functional attributes of the existing vehicles in the fleet are optimized for the role, and the need for the function is certain and cannot be replaced. Like-for-like light vehicle replacements are determined by matching existing fleet assets against all options within the same peak-body designated vehicle segment and sub-segment.

For heavy vehicles, this analysis uses gross vehicle mass (GVM) and payload considerations to identify matching vehicles with a zero emissions drivetrain. The analysis focuses on understanding the energy consumed in operation of the heavy vehicles in the City fleet. It adapts energy consumption to the electrical energy equivalent and provides each vehicle use-case with an energy consumption rating. This rating accounts for duty-cycle and driving style factors and negates the need to measure and track vehicle payload and overall mass.

A derating factor is applied to the energy consumption rating to account for variability of battery performance in cold and hot conditions, and the added relative drain of heating and air conditioning systems. Modeling the peak energy consumed by heavy electric vehicle replacements to existing fleet assets therefore presents worst case energy consumption.

Master data is applied to TCO and asset replacement modelling tools, set up to compute results for scenarios according to the assumptions underpinning each scenario. We note that this analysis is built on a number of assumptions based on a combination of empirical data from other jurisdictions, professional judgement, and data provided by the City. As such, while the early years of the analysis can be expected to be relatively accurate, the future years provide a framework for analysis and will need to be updated annually as the market matures.

1.2 Fleet transition scenarios

The following pathways have been used as the core framework for analysis of future scenarios for the City's fleet.

Table X: Description of modeled scenarios

Scenario name	Scenario description
Business-as-usual (BAU)	The lowest total cost of ownership vehicle example is procured. Procurement of ZEVs is excluded under this scenario regardless of TCO outcome to outline a consistent baseline from which the ZEV transition scenarios can be compared. The intention of BAU is that it is the "do nothing" scenario, i.e. it is reflective of how the City would continue to procure vehicles if there were no mandates or initiatives related to emissions reduction or fleet electrification. In the BAU, hybrid and plug-in hybrid examples might be procured where lowest TCO is demonstrated.
Cost-optimized scenario	The cost-optimized scenario seeks to meet your emissions and fleet electrification targets in the most cost-optimized manner. In this scenario, generally the lowest total cost of ownership vehicle example is procured, however, ZEVs may be selected even if the TCO is not the lowest if they are required to meet your climate objectives and policies, so long as there is a viable alternative that can meet the needs of the City. This scenario generally results in higher costs than for BAU as a result of the 'green premium' of purchasing ZEVs.
Technology leadership scenario	The technology leadership scenario seeks to position Port Moody as an industry leader in fleet electrification. Whereas in the cost-optimized scenario, we are only electrifying the fleet as much as necessary to meet your objectives, in the technology leadership scenario we are generally halting all purchases of internal combustion engine (ICE) vehicles provided there is a suitable ZEV alternative. This results in a faster transition of your fleet to ZEVs but also results in the highest TCO out of the scenarios.

2 Five-year Fleet Transition Plan

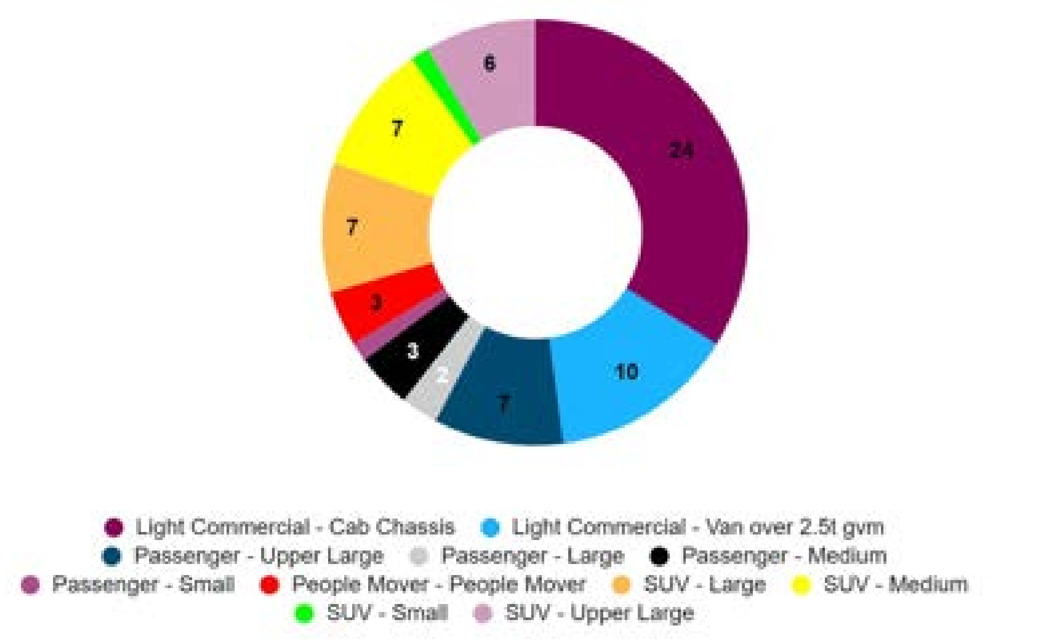
To begin the BetterFleet modeling, the Port Moody fleet was divided into light-duty vehicles and heavy-duty vehicles, and the analyses were run separately for each. Light-duty vehicles were defined as any vehicle under 3.5T, with heavy-duty vehicles referring to those that are over 3.5T.

2.1 Light vehicle fleet

2.1.1 Fleet Composition

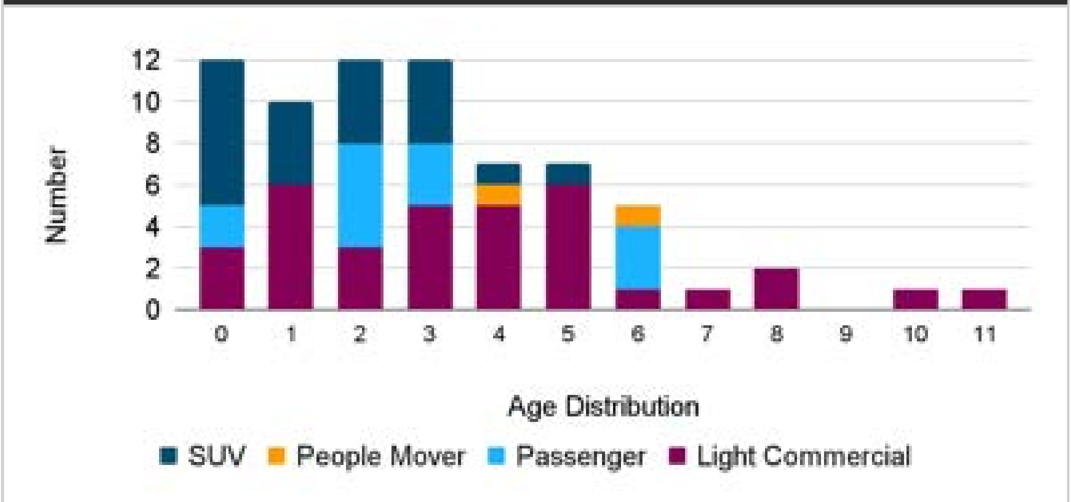
Pickup trucks strongly represented by Ford F-150 and Ford Ranger are the largest components of the light vehicle fleet at Port Moody. Other larger segments include the Vans over 2.5T which are strongly represented by Ford Transit and Ford Transit connect. An assortment of passenger vehicle size and types exists with larger passenger cars including the Dodge Charger and Honda Accords. There are relatively few small vehicles in either passenger or SUV types.

Figure X: Light vehicle fleet composition



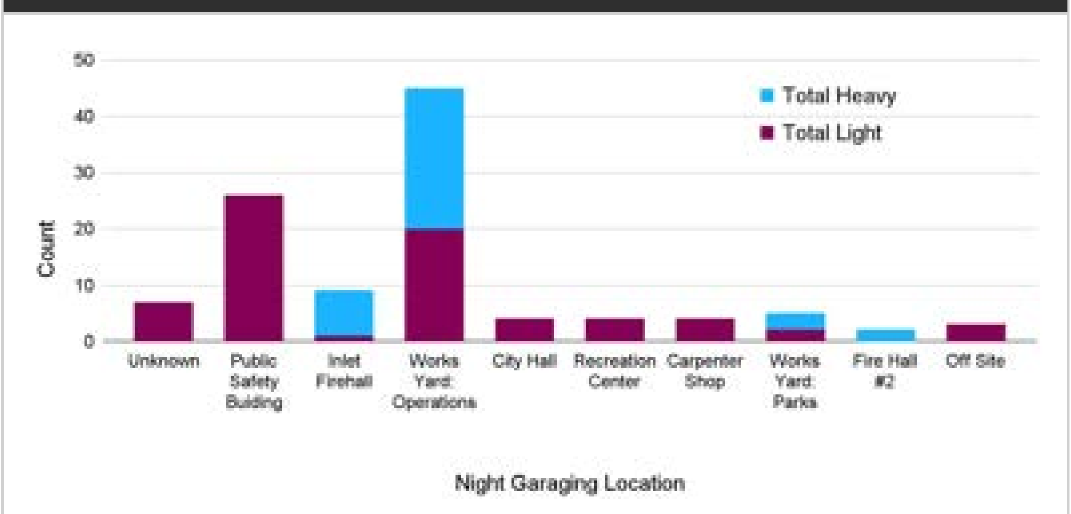
The age profile is important for determining which vehicles are coming up for replacement in the next few years. The majority of the older vehicles are the light commercial vehicles and a number of the larger passenger vehicles are aged at 6 years.

Figure X: Light vehicle age profile



The light vehicle fleet is spread across a number of sites with the works yard and public safety building with more light vehicles than many of the other locations which have less than 5 vehicles each.

Figure X: Light vehicle location analysis

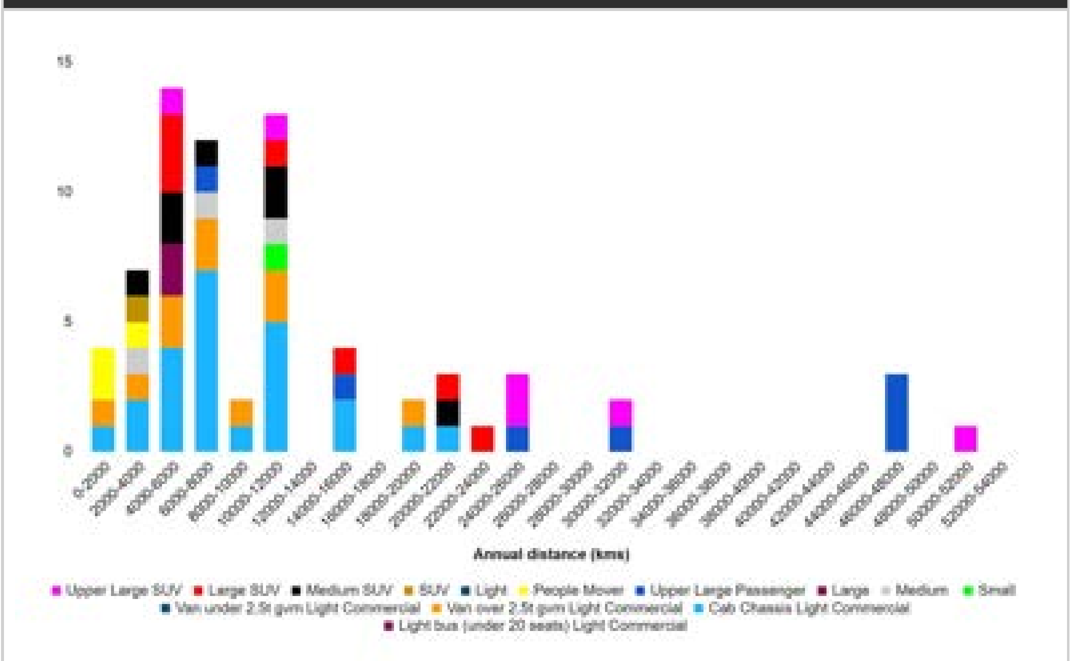


2.1.2 Fleet Utilization

About 70% of Port Moody vehicles have an annual utilization under 12,000 kilometres suggesting that the fleet is relatively lightly utilized and comparable to other similar municipal fleets. This may reflect the relatively small geographical area and footprint of operations in Port Moody. Lower utilization can present a challenge when economically transitioning to EVs. While lower utilization benefits the operational feasibility of an EV transition by limiting range anxiety, it can also make it more challenging to meet climate targets (less greenhouse gas (GHG) savings realized) and detracts from the financial business case as operations and maintenance (O&M) cost savings are less pronounced.

The highest utilized vehicles are some of the Upper Large SUVs (Ford Explorers) and Upper Large Passenger vehicles (Dodge Chargers) and Large SUVs (Dodge Durangos and Toyota Highlanders). These vehicles have better economic prospects for transition however the challenge with large and upper large vehicles at the moment is the availability of suitable EVs in the value part of the market. Small and medium sized cars have greater options for transition. The small and medium sized vehicles at Port Moody currently have lower utilization and therefore are less likely to be economically beneficial in the near term.

Figure X: Light vehicle fleet utilization



2.1.3 Market Capability and Transition Feasibility

The challenge with large and upper large vehicles at the moment is the availability of suitable EVs in the value part of the market. Small and medium sized cars have greater options currently but have lower utilization.

A number of light vehicles were excluded from the BetterFleet analysis given the period of interest is the next 5 years. Out of the 71 light-duty vehicles, 63 of them were included in the analysis. All of the vehicles included had transitions prior to 2030. Vehicles were excluded if their next transition was in 2030 or after. A leased Ford Focus was also excluded from the analysis which is already an EV. The full list of vehicle IDs excluded based on the above criteria is as follows: OP101, PK100, PL003, PO090A, PO095B, PO106A, PO115A, and PO116.

While similar markets overseas provide many times more vehicle choices per segment, and the technology is now well and truly validated, the electric vehicle market is only slowly increasing in competitiveness. More options are becoming available at lower price points, with growing access to fleet-centric options. There is growing diversity in battery size options trending in the market, with vehicles now available described as ‘standard range’ and ‘extended range’ or similar.

The table below describes the existing and anticipated battery capacities in different market segments. This becomes a key consideration in assessing technical feasibility.

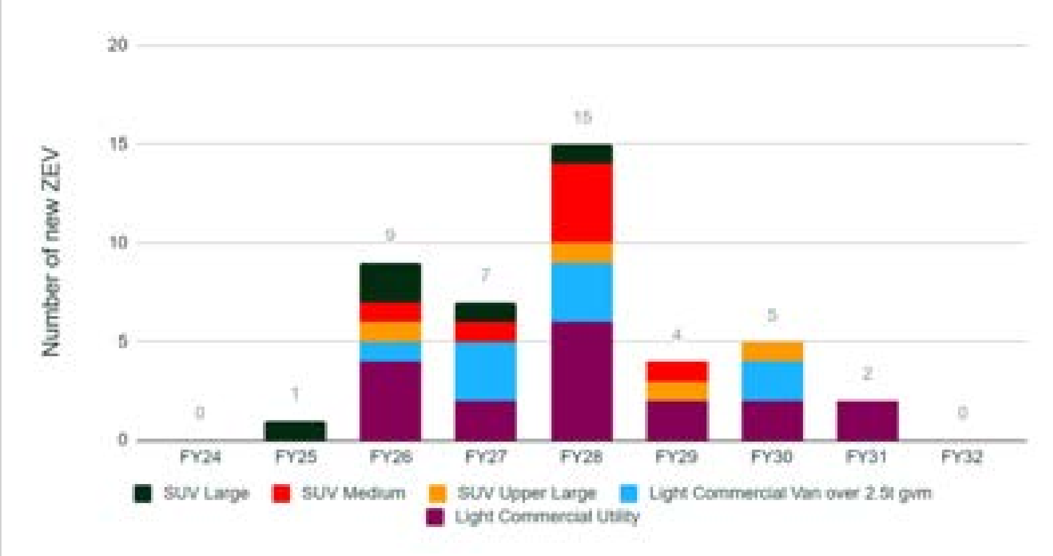
Figure X: Light vehicle class and typical maximum battery sizes

Light Vehicle Class	Sub Class	Largest Battery Size in Market
SUV	Large and Upper Large	87 kWh
SUV	Medium	76 kWh
SUV	Small	64 kWh
Passenger	Large	70 kWh
Passenger	Medium	60 kWh
Passenger	Small	52 kWh
Passenger	Light	45 kWh
Light Commercial	Small Truck	200 kWh
Light Commercial	Van over 2.5t	125 kWh
Light Commercial	Light bus (under 20 seats)	125 kWh

2.1.4 Transition Results

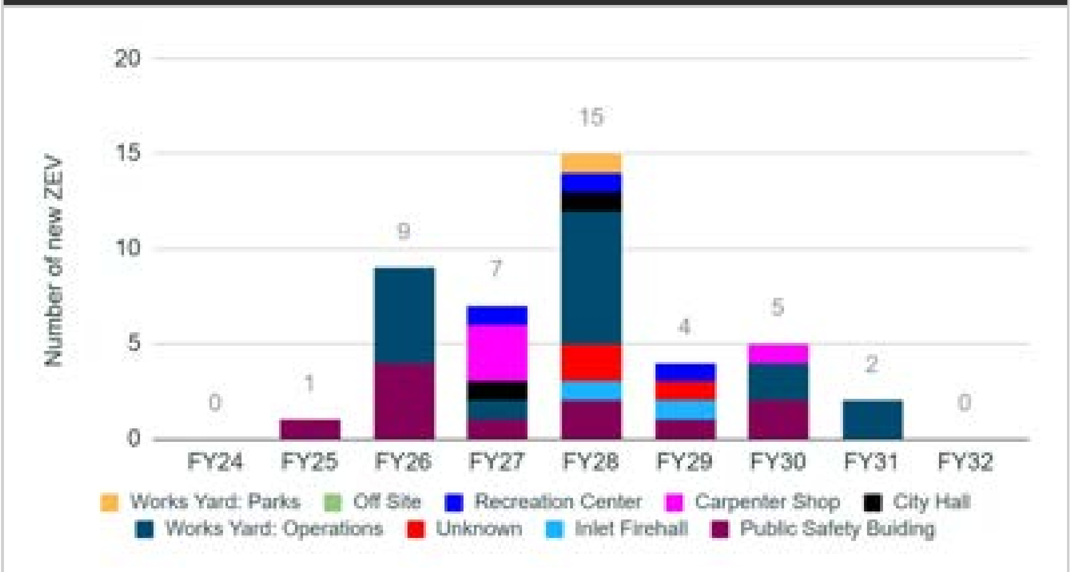
The addition of EVs under the cost-optimized scenario is shown below. The vehicles entering the fleet first are large SUVs, followed by medium SUVs, which have higher utilization, as well as upper-large SUVs, light commercial utility vehicles, and light commercial vans over 2.5T.

Figure X: Light vehicle transition results - cost-optimized transition by type



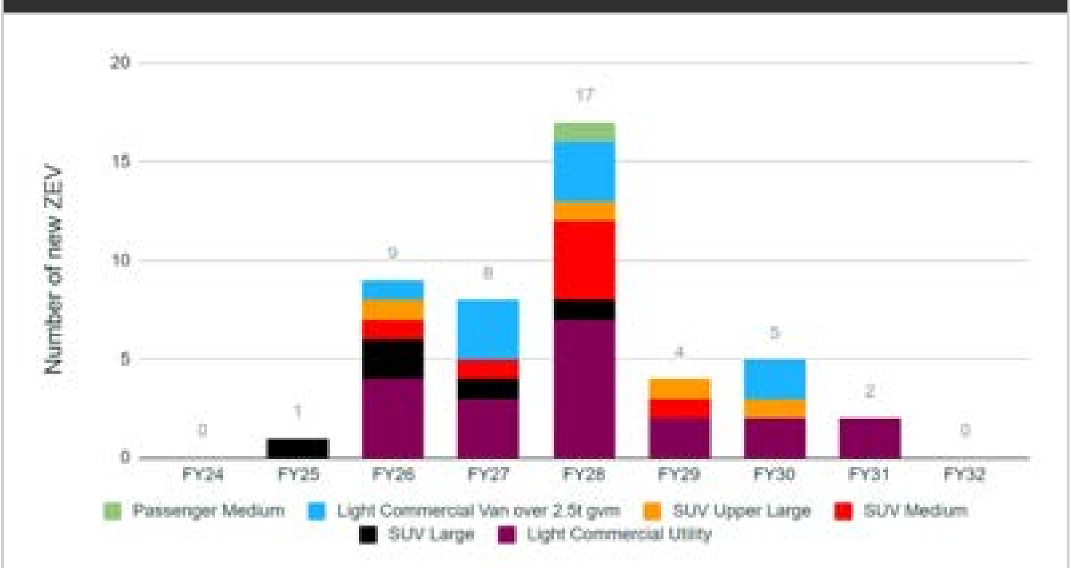
Notwithstanding the cost-optimized transition approach, Port Moody's vehicle sites are very quickly expected to be impacted by the transition. The first two sites to be impacted are the Public Safety Building and the Works Yard: Operations, but the Recreation Centre, Carpenter Shop, City Hall, Inlet Firehall, and Works Yard: Parks quickly follow. Vehicles with a site not clearly defined in the fleet datasets are also involved in the transition in FY28 and FY29; in the graph below these are labelled as "unknown".

Figure X: Light vehicle transition results - cost-optimized transition by location



Under the technology leadership scenario, a similar trend is followed with respect to vehicle transitioning as in the cost-optimized scenario, but with a few additional vehicles identified for transitioning in FY27 and FY28.

Figure X: Light vehicle transition results - technology leadership transition by type



In this scenario, the same sites are involved in the transition as in the cost-optimized scenario.

Figure X: Light vehicle transition results - leadership transition by location

Notably, the figures above refer to the number of *new* ZEV vehicles to be added to the fleet. In other words, the figures refer to an ICE-ZEV transition. Going forward, will be important to monitor developments in the ZEV industry alongside the City's operating needs on an ongoing basis, which may uncover in the coming years additional fleet transitioning opportunities.

It is important to also appreciate that additional ZEV purchases associated with fleet replacements, or in other words a ZEV vehicle replacing a ZEV vehicle, are not considered in the above figures. However, the ZEVs procured through FY28 will begin to reach the end of their useful life, and their replacement vehicles must be considered appropriately. But as these replacement vehicles are not technically a part of the fleet transition, they correspondingly are not highlighted in the graphs above.

The individual light-duty vehicle transition timeline for the cost-optimized and technology leadership scenarios is illustrated in the following tables. The vehicles included in the BetterFleet analysis but not identified to transition to a ZEV alternative were not identified for transitioning as the economic case is not strong and/or because there are no suitable fit-for-purpose EV alternatives at present.

Notably, there are several Dodge Charger police vehicles that were not identified for an EV transition, but theoretically could have strong candidacy for transitioning in the next five years due to their relatively high utilization, with several vehicles logging approximately 47,000 kilometres per year. These vehicles were not identified for an EV transition because they are rather unique in their specifications as large passenger cars, and there is no suitable like-for-like EV replacement at present. However, if the City of Port Moody is open to a shift in vehicle type, for example to a slightly smaller Tesla Model 3, that could help accelerate the transition. However, we are cognizant that police cars have unique operating requirements, and did not want to make assumptions of the suitability of different vehicle types; therefore these are recommended to remain as ICE vehicles in the BetterFleet analysis.

					COST-OPTIMIZED TRANSITION								
ASSET#	MAKE	MODEL	TYPE	ANNUAL DISTANCE	2024	2025	2026	2027	2028	2029	2030	2031	2032
CU001	DODGE	GRAND CARAVAN	CU	2,000	ICE								
EN001	FORD	ESCAPE	EN	7,000					BEV				
FC072	FORD	TRANSIT	FC	3,000							BEV		
FC074	FORD	ESCAPE	FC	10,000				BEV					BEV
FC066	FORD	F150	FC	14,000					BEV				
FC063	FORD	F150	FC	7,000				BEV					
FC067	FORD	TRANSIT CONNECT	FC	10,000				BEV					
FC064	FORD	TRANSIT CONNECT	FC	7,000				BEV					
FC073	FORD	RANGER	FC	6,000						BEV			
FR011A	CHEVROLET	COLORADO	FR	2,500									HEV
FR023	FORD	EXPLORER	FR	30,000					BEV				
FR028	FORD	EXPEDITION	FR	5,000							ICE		
FR024	FORD	EXPLORER	FR	10,000						BEV			
OP081	FORD	ESCAPE	OP	5,000					BEV				
OP068	FORD	F150	OP	5,000			BEV						
OP087	FORD	F150	OP	11,000					BEV				
OP113	FORD	F150	OP	7,200					BEV				
OP059	FORD	F150	OP	9,000			BEV						
OP073	FORD	F150	OP	18,000			BEV						
OP060	FORD	TRANSIT	OP	10,000			BEV						
OP066	MERCEDES-BENZ	SPRINTER	OP	9,000					BEV				
OP067	MERCEDES-BENZ	SPRINTER	OP	7,000					BEV				
OP112	FORD	TRANSIT	OP	5,000							BEV		
PK071D	FORD	F250	PK	3,000								BEV	
PK085A	FORD	F250	PK	1,000								BEV	
PK103	FORD	F150	PK	10,000				BEV					BEV
PK073	FORD	F150	PK	11,000					BEV				
PK074	FORD	F150	PK	6,000					BEV				
PK076	FORD	F150	PK	6,000					BEV				
PK041A	FORD	F150	PK	7,000									
PK053B	FORD	F150	PK	7,000									
PK065A	FORD	F150	PK	15,000			BEV						
PK070B	FORD	RANGER	PK	5,000						BEV			
PK083	FORD	RANGER	PK	5,000							BEV		
PK101A	NISSAN	FRONTIER	PK	10,000				HEV					HEV
PL004	FORD	TRANSIT CONNECT	PL	18,000				BEV					
PO100A	DODGE	CHARGER	PO	6,000	ICE								ICE
PO103C	DODGE	CHARGER	PO	15,000			ICE					ICE	
PO103B	DODGE	CHARGER	PO	25,000					ICE				ICE
PO089B	DODGE	CHARGER	PO	30,000	ICE					ICE			
PO092C	DODGE	CHARGER	PO	47,000	ICE			ICE			ICE		
PO093C	DODGE	CHARGER	PO	47,000		ICE			ICE			ICE	
PO105B	DODGE	CHARGER	PO	47,000	ICE			ICE			ICE		
PO086B	DODGE	DURANGO	PO	15,000			BEV						
PO088B	DODGE	DURANGO	PO	20,000				BEV					
PO114	DODGE	GRAND CARAVAN	PO	1,000						ICE			
PO098	DODGE	GRAND CARAVAN	PO	1,000				ICE					
PO101B	DODGE	RAM 1500	PO	10,000							BEV		
PO084A	FORD	ESCAPE	PO	5,000					BEV				
PO091C	FORD	EXPLORER	PO	50,000			BEV			BEV			BEV
PO087C	FORD	EXPLORER	PO	25,000		ICE					BEV		
PO082A	GMC	SAVANA 3500	PO	1,500					BEV				
PO094B	HONDA	ACCORD	PO	4,000					HEV				
PO112	HONDA	ACCORD	PO	4,000			HEV						
PO110E	KIA	SPORTAGE	PO	10,000			BEV					BEV	
PO108A	MAZDA	CX-5	PO	20,000					BEV				
PO085B	TOYOTA	4RUNNER	PO	22,500		BEV					BEV		
PO109B	TOYOTA	HIGHLANDER	PO	10,000			PHEV					BEV	
PO115	TOYOTA	HIGHLANDER	PO	5,000					BEV				
PO083B	VOLKSWAGEN	PASSAT	PO	6,000					HEV				
PO097B	TOYOTA	RAV4	PO	2,000						BEV			
RS056A	FORD	ECONOVAN	RS	5,000									ICE
RS062	FORD	RANGER	RS	20,000					HEV				

Note: PK041A and PK053B do not show a transition in the above table as these vehicles are scheduled for replacement in 2023.

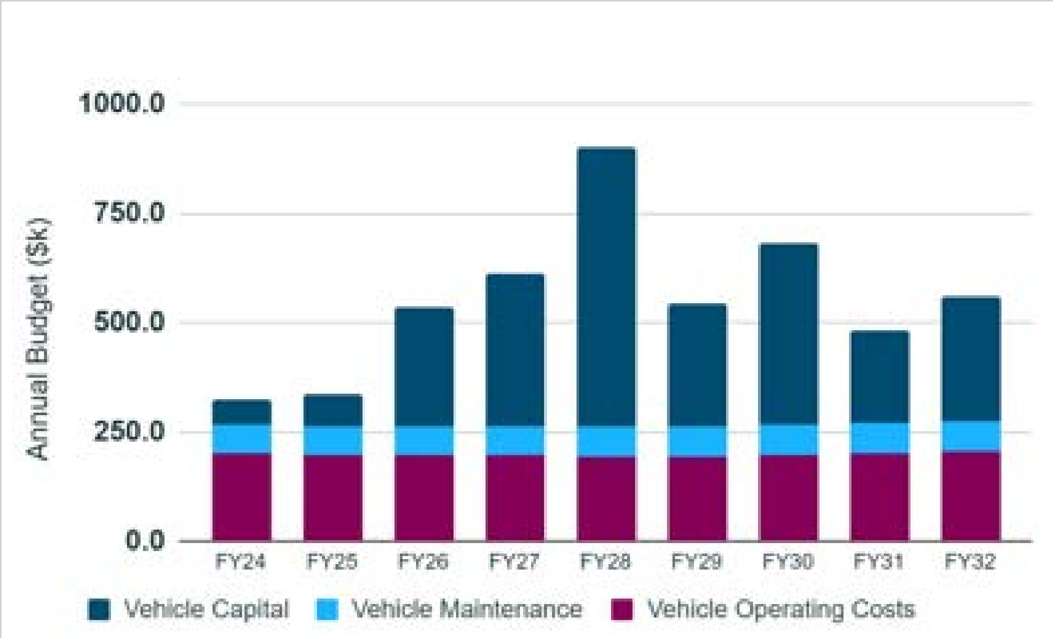
					TECHNOLOGY LEADERSHIP TRANSITION								
ASSET#	MAKE	MODEL	TYPE	ANNUAL DISTANCE	2024	2025	2026	2027	2028	2029	2030	2031	2032
CU001	DODGE	GRAND CARAVAN	CU	2,000	ICE								
EN001	FORD	ESCAPE	EN	7,000					BEV				
FC072	FORD	TRANSIT	FC	3,000							BEV		
FC074	FORD	ESCAPE	FC	10,000				BEV					BEV
FC066	FORD	F150	FC	14,000					BEV				
FC063	FORD	F150	FC	7,000				BEV					
FC067	FORD	TRANSIT CONNECT	FC	10,000				BEV					
FC064	FORD	TRANSIT CONNECT	FC	7,000				BEV					
FC073	FORD	RANGER	FC	6,000						BEV			
FR011A	CHEVROLET	COLORADO	FR	2,500									BEV
FR023	FORD	EXPLORER	FR	30,000					BEV				
FR028	FORD	EXPEDITION	FR	5,000							ICE		
FR024	FORD	EXPLORER	FR	10,000						BEV			
OP081	FORD	ESCAPE	OP	5,000					BEV				
OP068	FORD	F150	OP	5,000			BEV						
OP087	FORD	F150	OP	11,000					BEV				
OP113	FORD	F150	OP	7,200					BEV				
OP059	FORD	F150	OP	9,000			BEV						
OP073	FORD	F150	OP	18,000			BEV						
OP060	FORD	TRANSIT	OP	10,000			BEV						
OP066	MERCEDES-BENZ	SPRINTER	OP	9,000					BEV				
OP067	MERCEDES-BENZ	SPRINTER	OP	7,000					BEV				
OP112	FORD	TRANSIT	OP	5,000							BEV		
PK071D	FORD	F250	PK	3,000								BEV	
PK085A	FORD	F250	PK	1,000								BEV	
PK103	FORD	F150	PK	10,000				BEV					BEV
PK073	FORD	F150	PK	11,000					BEV				
PK074	FORD	F150	PK	6,000					BEV				
PK076	FORD	F150	PK	6,000					BEV				
PK041A	FORD	F150	PK	7,000									
PK053B	FORD	F150	PK	7,000									
PK065A	FORD	F150	PK	15,000			BEV						
PK070B	FORD	RANGER	PK	5,000						BEV			
PK083	FORD	RANGER	PK	5,000							BEV		
PK101A	NISSAN	FRONTIER	PK	10,000				BEV					BEV
PL004	FORD	TRANSIT CONNECT	PL	18,000				BEV					
PO100A	DODGE	CHARGER	PO	6,000	ICE								ICE
PO103C	DODGE	CHARGER	PO	15,000			ICE					ICE	
PO103B	DODGE	CHARGER	PO	25,000					ICE				ICE
PO089B	DODGE	CHARGER	PO	30,000	ICE					ICE			
PO092C	DODGE	CHARGER	PO	47,000	ICE			ICE			ICE		
PO093C	DODGE	CHARGER	PO	47,000		ICE			ICE			ICE	
PO105B	DODGE	CHARGER	PO	47,000	ICE			ICE			ICE		
PO086B	DODGE	DURANGO	PO	15,000			BEV						
PO088B	DODGE	DURANGO	PO	20,000				BEV					
PO114	DODGE	GRAND CARAVAN	PO	1,000						ICE			
PO098	DODGE	GRAND CARAVAN	PO	1,000				ICE					
PO101B	DODGE	RAM 1500	PO	10,000							BEV		
PO084A	FORD	ESCAPE	PO	5,000					BEV				
PO091C	FORD	EXPLORER	PO	50,000			BEV			BEV			BEV
PO087C	FORD	EXPLORER	PO	25,000		ICE					BEV		
PO082A	GMC	SAVANA 3500	PO	1,500					BEV				
PO094B	HONDA	ACCORD	PO	4,000					HEV				
PO112	HONDA	ACCORD	PO	4,000			HEV						
PO110E	KIA	SPORTAGE	PO	10,000			BEV					BEV	
PO108A	MAZDA	CX-5	PO	20,000					BEV				
PO085B	TOYOTA	4RUNNER	PO	22,500		BEV					BEV		
PO109B	TOYOTA	HIGHLANDER	PO	10,000			PHEV					BEV	
PO115	TOYOTA	HIGHLANDER	PO	5,000					BEV				
PO083B	VOLKSWAGEN	PASSAT	PO	6,000					BEV				
PO097B	TOYOTA	RAV4	PO	2,000						BEV			
RS056A	FORD	ECONOVAN	RS	5,000									ICE
RS062	FORD	RANGER	RS	20,000					BEV				

Note: PK041A and PK053B do not show a transition in the above table as these vehicles are scheduled for replacement in 2023.

2.1.5 Preliminary Economic Analysis

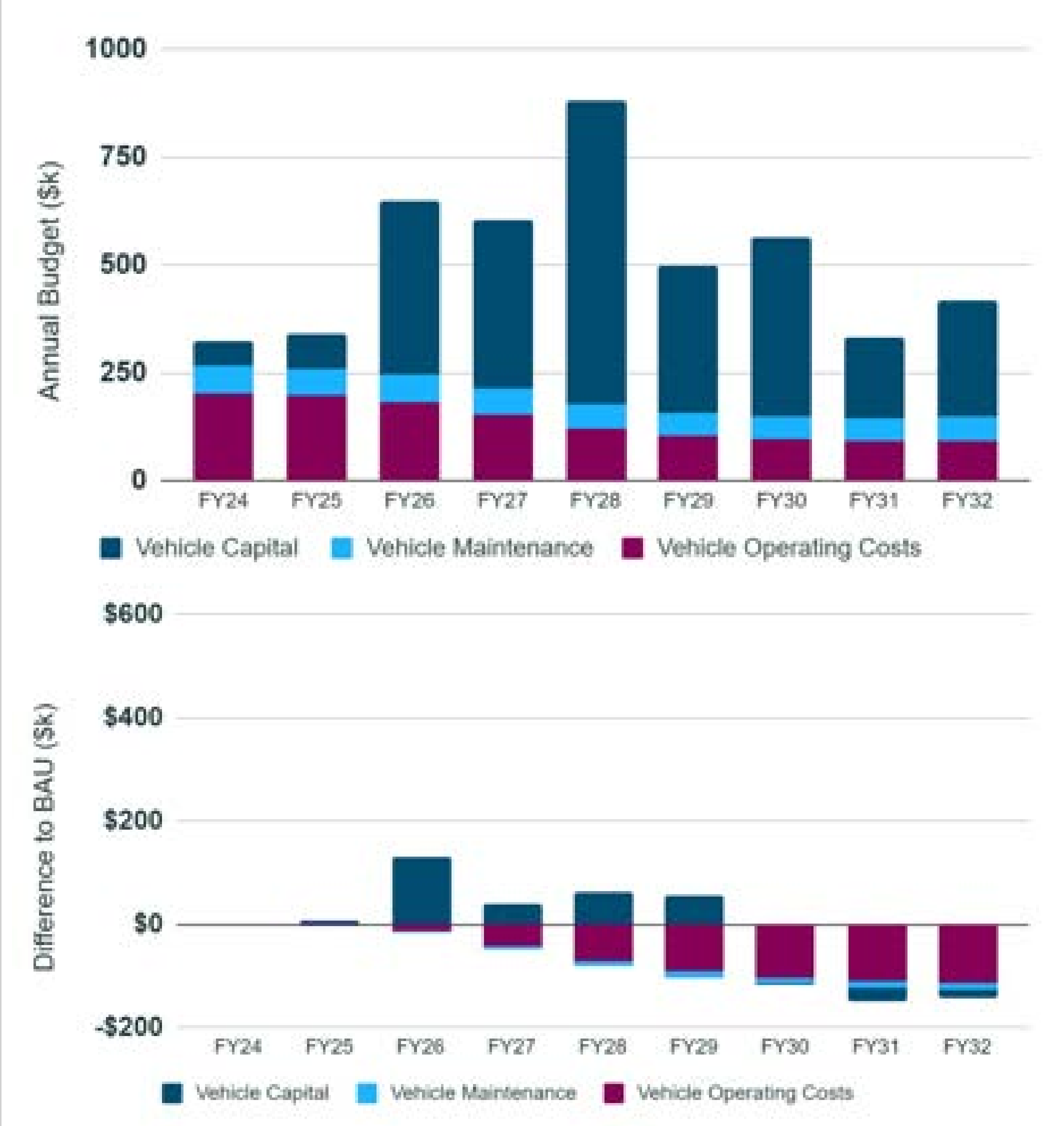
Under the BAU scenario, the spending is generally between $250k and $750k per year, with an exception being FY28 with a higher spend due to the number of vehicles due for replacement. In general, the variable part of the spend is the capital expenditure for vehicles which varies in line with peaks and troughs in replacements. The operating costs and maintenance costs remain relatively constant over the period. This scenario forms the baseline against which the cost-optimized and technology leadership scenarios will be compared.

Figure X: Light vehicle transition cost profile - BAU (63-vehicle subset only)



In the economic transition, slightly greater capital spending occurs in FY26-FY28 when the greatest number of new EVs are added to the fleet. In addition a number of hybrids are added in other years which also leads to slightly higher capital spending than the BAU. Small gains in operating costs and maintenance costs are seen beginning in FY25. From FY30 some vehicles may be cheaper to acquire as EVs than ICE.

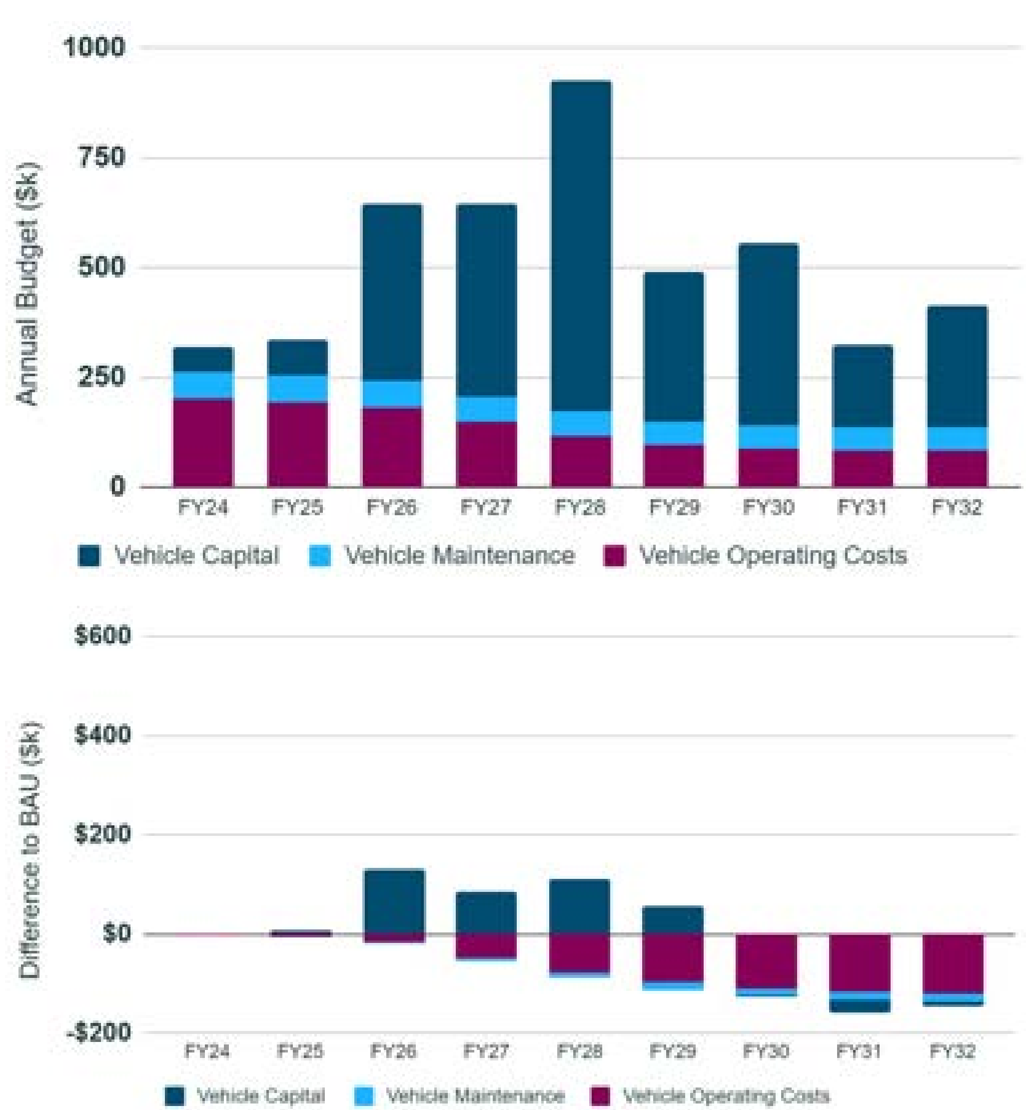
Figure X: Light vehicle transition cost profile - cost-optimized transition (63-vehicle subset only)



In total we are estimating a net increase in spending in the cost-optimized transition (compared to BAU) of $109k over the next five years (through FY27), and a net decrease of $475k over the following five years (FY28-FY32). Note that these amounts are exclusive of other infrastructure-related costs.

In the leadership transition, the years of greatest capital remain FY26-FY28, however, capital requirements are slightly higher, commensurate with the more aggressive fleet transition seen in this scenario. More substantial gains in operating costs and maintenance costs are also seen.

Figure X: Light vehicle transition cost profile - technology leadership transition (63-vehicle subset only)

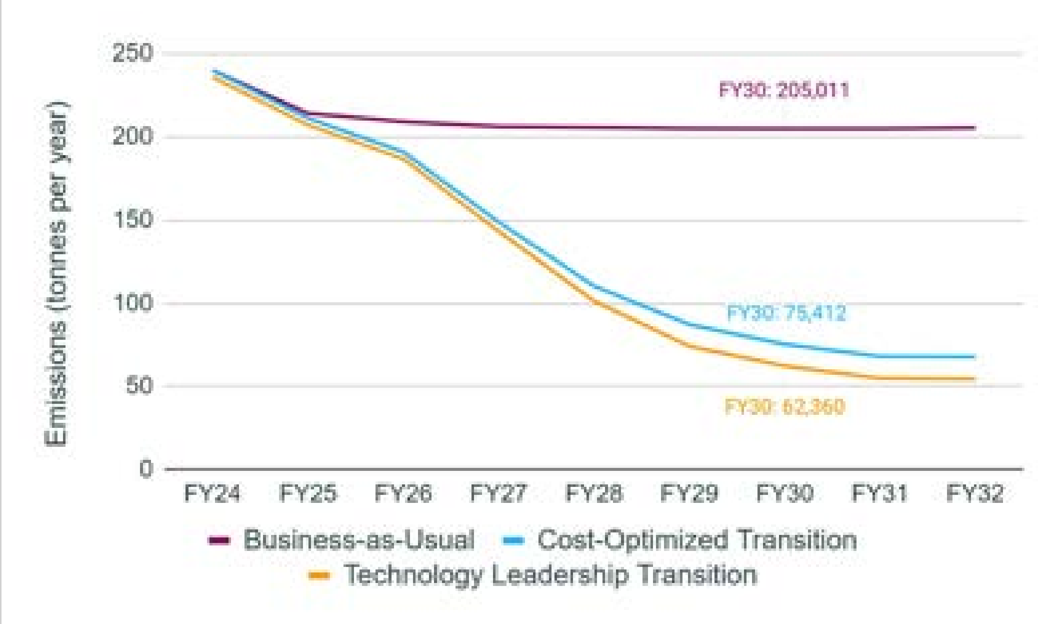


In total, we are estimating a net increase in spending in the technology leadership transition (compared to BAU) of $138k over the next five years (through FY27), and a net decrease of $468k over the following five years (FY28-FY32).

2.1.6 Preliminary CO2 Emissions Analysis

The emissions profiles for light vehicles, shown below, show the impact the transition to EVs has on CO2 emissions. Under both the cost-optimized transition and the technology leadership transition, emissions fall to under 100 tonnes per year by FY29.

Figure X: Transition emissions profile - (63-vehicle subset only)

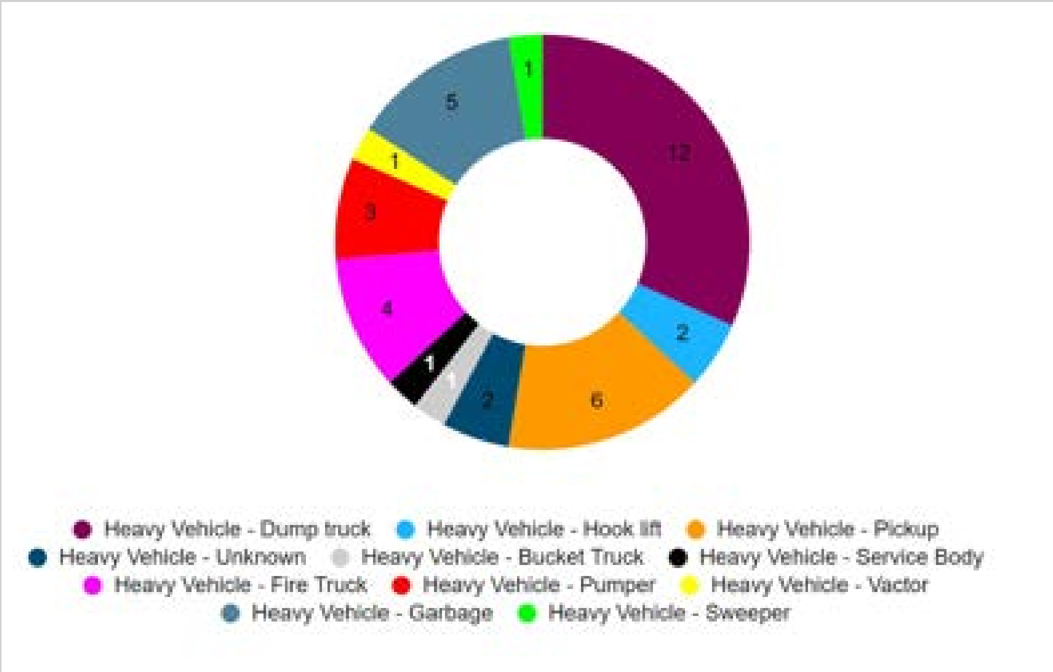


2.2 Heavy vehicle fleet

2.2.1 Fleet Composition

The heavy vehicle fleet has a diverse range of applications. Major groups are the dump trucks, pickup trucks and garbage trucks. There are also a number of pumpers and fire trucks.

Figure X: Heavy vehicle fleet composition

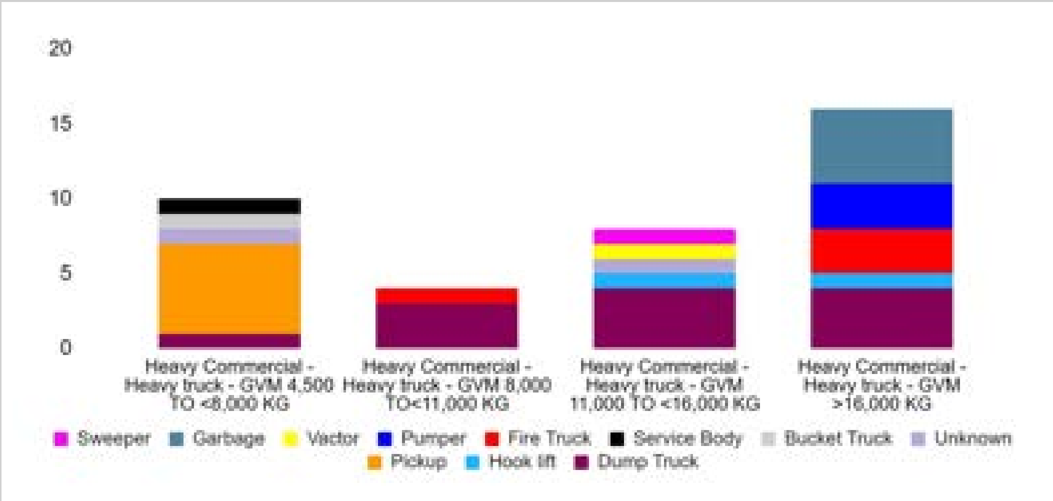


For heavy vehicles, it is also useful to consider the distribution of vehicles with weight. There are 10 trucks in the GVM range 4.5 T to 8 T consisting of mainly Ford F-Series F350, 450 and 550 with body fit-outs of pickup truck, service body and dump truck.

Dump trucks make up most of the vehicles in the middle weight bands.

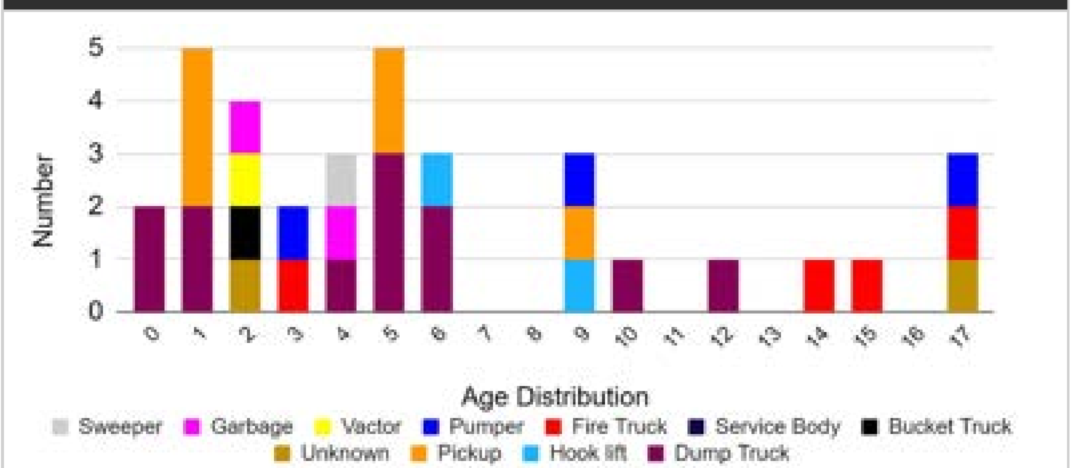
At the heavier GVM end, in the range >16T GVM are the Mack LR garbage trucks, a handful of dump trucks and the fire appliances (pumpers and fire trucks).

Figure X: Heavy vehicle fleet composition by weight



The age profile is important for looking at what vehicles are coming up for replacement in the next few years. The majority of the older vehicles are the fire appliances and a couple of dump trucks.

Figure X: Heavy vehicle age profile



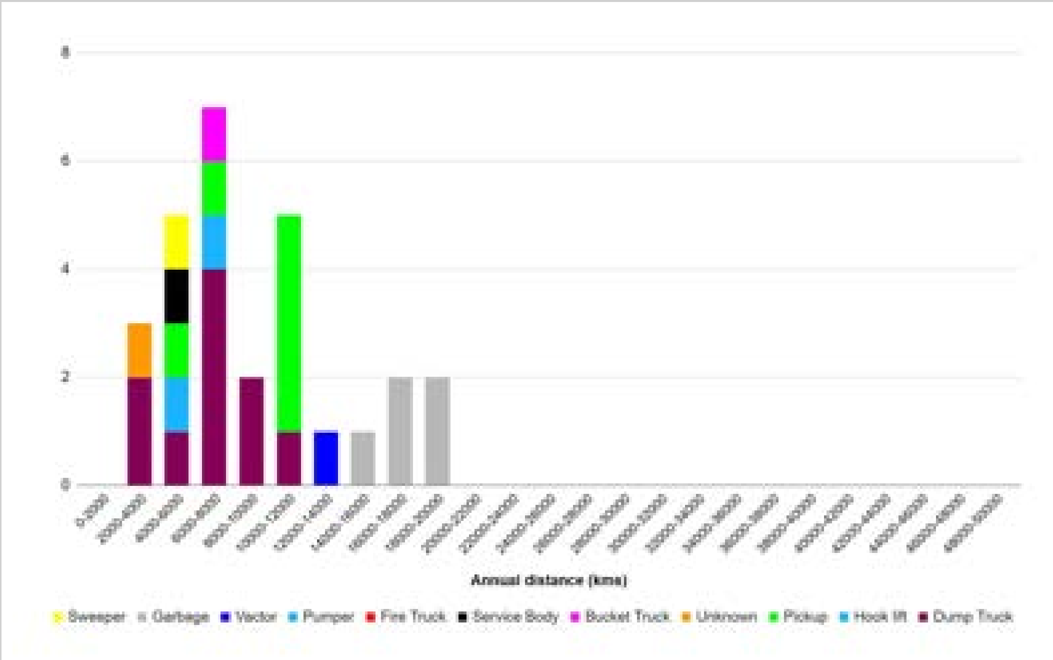
The heavy vehicle fleet is spread across a fewer number of sites compared to the light vehicle fleet with the Works Yard: Operations and Inlet Firehall housing most of the heavy fleet. Only a handful of heavy vehicles are found at other locations including Works Yard: Parks and Fire Hall #2.

Figure X: Heavy vehicle location analysis

2.2.2 Fleet Utilization

About 80% of Port Moody heavy vehicles have utilization under 12,000 kilometres suggesting that the fleet may have average-to-light utilization across the different vehicle classes and use cases. One also needs to consider that emergency response vehicles aren't typically vehicles that you would expect to be highly utilized. The utilization profile likely reflects the geographical area and footprint of operations. As in the case with light-duty vehicles, lower utilization can present a challenge economically with respect to the transition to EVs, however, available vehicles and battery sizes should be compatible with this usage.

Figure X: Heavy vehicle fleet utilization

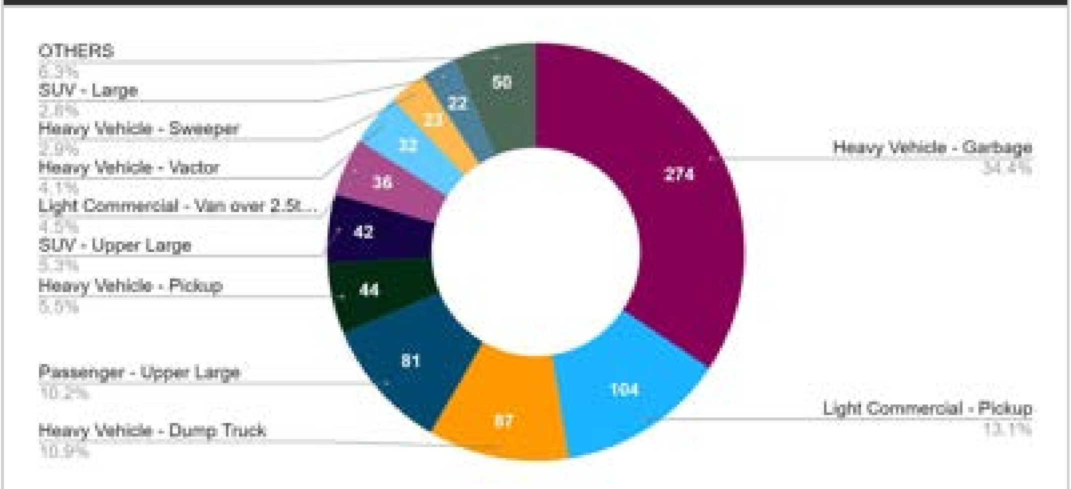


Garbage trucks have some of the highest utilization followed by the pickup trucks. These will be the vehicles most economically suited for transition in the medium term.

2.2.3 Combined fleet emissions

The combined fleet emissions for all vehicles is shown below. Carbon emissions are estimated at 846 tonnes annually with major contributions from the garbage trucks, which given their mass, fuel economy and duty have a disproportionate impact on emissions, when compared to the small number of these vehicles in the fleet. Heavy fleet vehicles contribute almost 60% of CO_2 emissions mostly coming from the dump trucks and garbage trucks.

Figure X: Combined fleet emissions (CO2 tonnes)



2.2.4 Market Capability and Transition Feasibility

A number of heavy vehicles were excluded from the BetterFleet analysis given the period of interest is the next 5 years. Out of the 38 heavy-duty vehicles, 28 of them were included in the analysis. All of the vehicles included are up for replacement prior to or in 2030. Vehicles were excluded if their next replacement is expected to be after 2030. Vehicles included consist of the majority of smaller trucks at the lower GVM bands including dump trucks, pickups and larger garbage trucks given their higher utilization.

The full list of vehicle IDs excluded based on the above criteria is as follows: FR007, FR018, FR020, FR021, FR025, FR026, OP012A, OP015A, OP050D, and PK089.

Compared to light-duty vehicles, electric propulsion in heavy-duty vehicles is not as mature. Heavy-duty EV models that are available today currently have significant capital price premiums over ICE equivalents and have not been deployed to the extent that light-duty EVs have been, and have less empirical operating data accordingly. High utilization cases may already be close to achieving TCO parity, but for lower utilization cases (as in Port Moody), TCO parity can be expected to occur closer to 2030.

Other considerations for heavy-duty EVs include the need for the vehicle to operate auxiliary equipment, which requires power but is not reflected in the odometer reading, and the need for some vehicles to be deployed on short notice, as is the case for fire trucks and other emergency vehicles. This can bring implications with respect to charging strategies as well as operations during power outages, which must be considered.

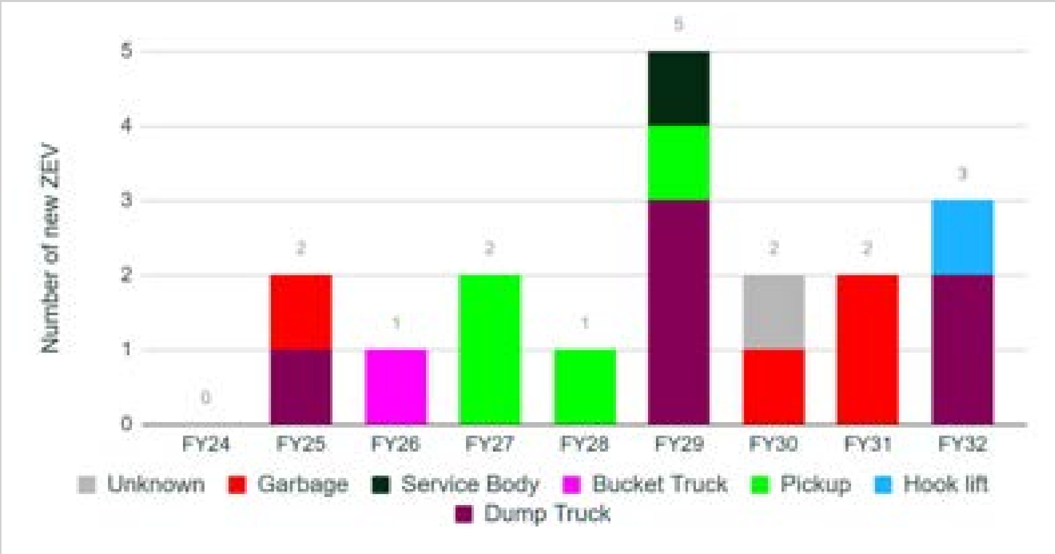
Notably, the federal government is increasingly developing programs to help address some of the barriers to heavy-vehicle EV adoption. For example, National Resource Canada recently developed two funding streams aimed at accelerating the adoption of medium and heavy-duty EVs: the Green Freight Program and the Zero-Emission Vehicle Awareness Initiative. Programs such as these could be of benefit to Port Moody on your electrification journey.

2.2.5 Transition Results

In the cost-optimized scenario, no heavy-duty EVs are envisioned to be added to the fleet in the study horizon. Due to more challenging EV transitions, it is recommended that the cost-optimized scenario focus electrification efforts on the light-duty vehicle fleet.

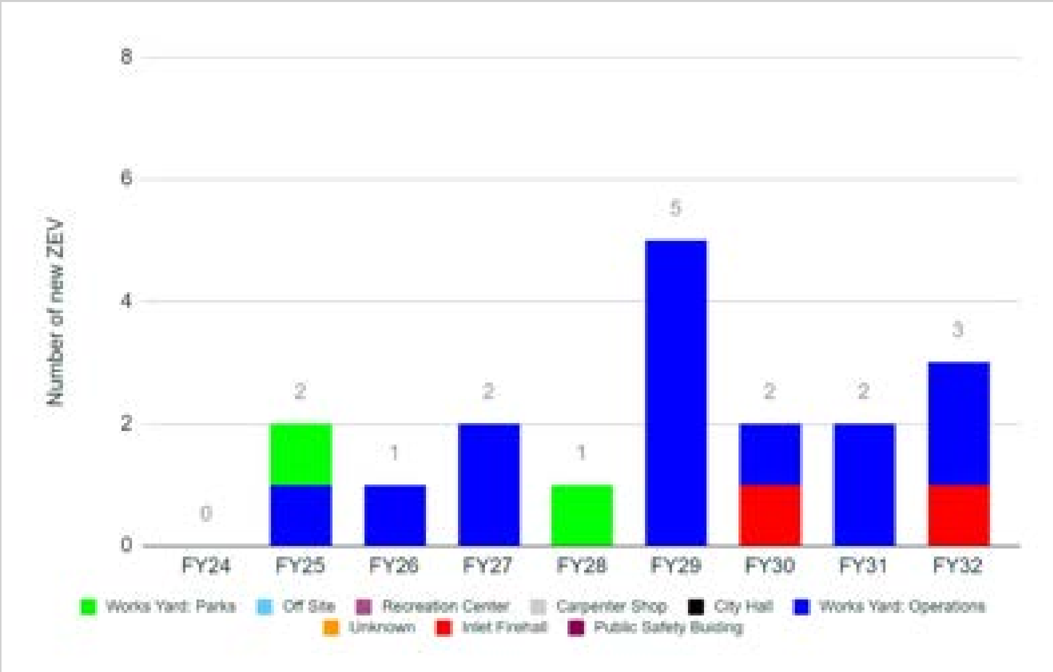
Under the technology leadership scenario, several heavy-duty EVs are envisioned, beginning with an EV dump truck and an EV garbage truck in FY25. The year with the most heavy-duty EVs being added to the fleet is FY29, with five heavy-duty EVs added.

Figure X: Heavy vehicle transition results - technology leadership transition by type



All the vehicles transitioning are based at the Works Yard: Parks, Works Yard: Operations, or Inlet Firehall sites.

Figure X: Heavy vehicle transition results - technology leadership transition by location



The individual heavy-duty vehicle transition timeline for the cost-optimized and technology leadership scenarios is illustrated in the following tables. The vehicles included in the BetterFleet analysis but not identified to transition to a ZEV alternative, was for the reason that the economic case is not strong and/or because there are no suitable fit-for-purpose EV alternatives at present.

					COST-OPTIMIZED TRANSITION								
ASSET#	MAKE	MODEL	TYPE	ANNUAL DISTANCE	2024	2025	2026	2027	2028	2029	2030	2031	2032
FR010	FORD	F550	FR	10,000									
FR022	FORD	F550	FR	6,000	ICE								ICE
FR027	FORD	F350	FR	3,000							ICE		
FR009	FREIGHTLINER	TBD	FR	10,000									
OP078	FORD	F350	OP	10,000				ICE					
OP057	FORD	F550	OP	8,500	ICE								ICE
OP100	FORD	F550	OP	6,000			ICE						ICE
OP070	FORD	F550	OP	11,000		ICE							
OP072	FORD	F550	OP	4,000						ICE			
OP102	FORD	F600	OP	10,000						ICE			
OP033A	FORD	F350	OP	10,000									
OP091	FORD	F350	OP	10,000				ICE					
OP086	FREIGHTLINER	TBD	OP	12,000				ICE					
OP080	FREIGHTLINER	108 SD	OP	7,000			ICE						
OP075	MACK	LR	OP	18,000							ICE		
OP076	MACK	LR	OP	18,000		ICE							ICE
OP077	MACK	LR	OP	14,000	ICE							ICE	
OP083	MACK	LR	OP	17,000	ICE							ICE	
OP088	MACK	LR	OP	17,000			ICE						
OP090	MACK	Granite	OP	4,000						ICE			
OP089	MACK	Granite	OP	3,000						ICE			
OP079	ELGIN	CROSSWIND	OP	5,000			ICE						
PK071E	FORD	F350	PK	10,000						ICE			
PK062A	FORD	F450	PK	7,000									
PK064A	FORD	F550	PK	9,000	ICE								ICE
PK072	FORD	F550	PK	6,000		ICE							
PK069	FORD	F550	PK	6,000		ICE							
PK101	GMC	SIERRA 3500	PK	6,000					ICE				

Note: FR010, FR009, OP033A, and PK062A do not show a transition in the above table as these vehicles are scheduled for replacement in 2023.

					TECHNOLOGY LEADERSHIP TRANSITION								
ASSET#	**MAKE**	**MODEL**	**TYPE**	**ANNUAL DISTANCE**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
FR010	FORD	F550	FR	10,000									
FR022	FORD	F550	FR	6,000	ICE								BEV
FR027	FORD	F350	FR	3,000							BEV		
FR009	FREIGHTLINER	TBD	FR	10,000									
OP078	FORD	F350	OP	10,000				BEV					
OP057	FORD	F550	OP	8,500	ICE								BEV
OP100	FORD	F550	OP	6,000			BEV						BEV
OP070	FORD	F550	OP	11,000		ICE							
OP072	FORD	F550	OP	4,000						BEV			
OP102	FORD	F600	OP	10,000						BEV			
OP033A	FORD	F350	OP	10,000									
OP091	FORD	F350	OP	10,000				BEV					
OP086	FREIGHTLINER	TBD	OP	12,000				ICE					
OP080	FREIGHTLINER	108 SD	OP	7,000			ICE						
OP075	MACK	LR	OP	18,000							BEV		
OP076	MACK	LR	OP	18,000		BEV							BEV
OP077	MACK	LR	OP	14,000	ICE							BEV	
OP083	MACK	LR	OP	17,000	ICE							BEV	
OP088	MACK	LR	OP	17,000			ICE						
OP090	MACK	Granite	OP	4,000						BEV			
OP089	MACK	Granite	OP	3,000						BEV			
OP079	ELGIN	CROSSWIND	OP	5,000			ICE						
PK071E	FORD	F350	PK	10,000						BEV			
PK062A	FORD	F450	PK	7,000									
PK064A	FORD	F550	PK	9,000	ICE								BEV
PK072	FORD	F550	PK	6,000		ICE							
PK069	FORD	F550	PK	6,000		BEV							
PK101	GMC	SIERRA 3500	PK	6,000					BEV				

Note: FR010, FR009, OP033A, and PK062A do not show a transition in the above table as these vehicles are scheduled for replacement in 2023.

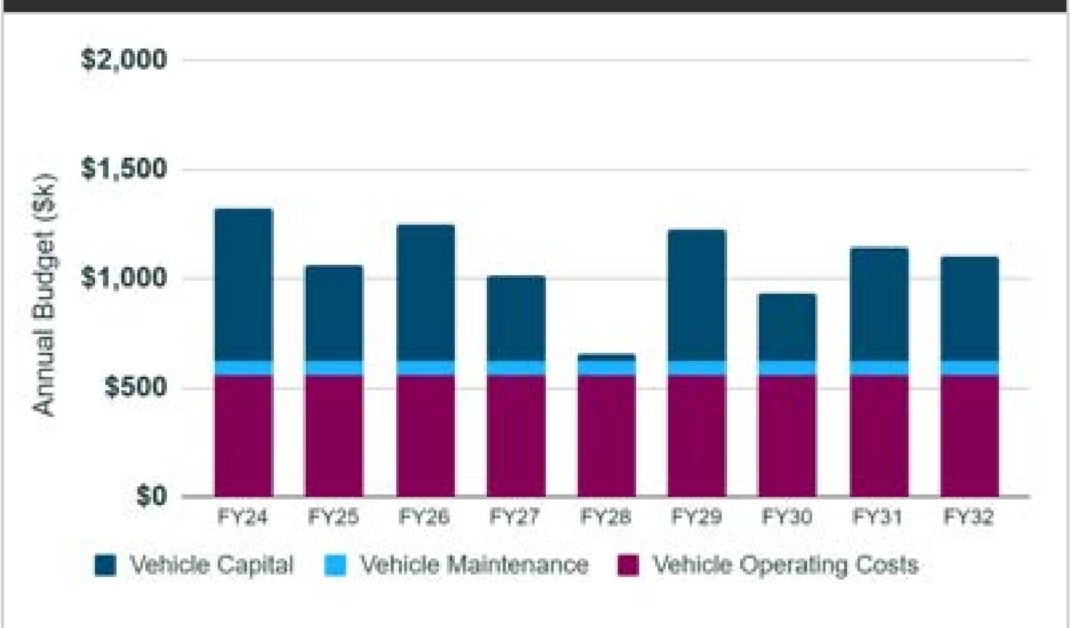
2.2.6 Preliminary Economic Analysis

Under the BAU scenario, the spending is generally a little over $1,000k per year with higher amounts in some years and lower amounts in other years depending on the number of vehicles procured in a given year. That is, similar to the case for light-duty vehicles, the variable part of the spend is the capital expenditure for vehicles which varies in line with peaks and troughs in replacements. The operating costs and maintenance costs remain relatively constant over the period. This scenario forms the baseline against which the cost-optimized and technology leadership scenarios are compared.

Figure X: Heavy vehicle transition cost profile - BAU (28-vehicle subset only)

In the cost-optimized transition, because no new heavy-duty EVs are anticipated to be added to the fleet, the cost profile is identical to the BAU cost profile.

Figure X: Heavy vehicle transition cost profile - cost-optimized transition (28-vehicle subset only)



In the leadership transition, greater capital spending occurs in the years in which heavy-duty EVs are envisioned to be added to the fleet, due to the additional upfront capital expenditures associated with procuring these vehicles. Small cost savings in operating costs and maintenance costs are seen beginning in FY25, but over the period will only contribute and pay back a small portion of the additional capital requirements.

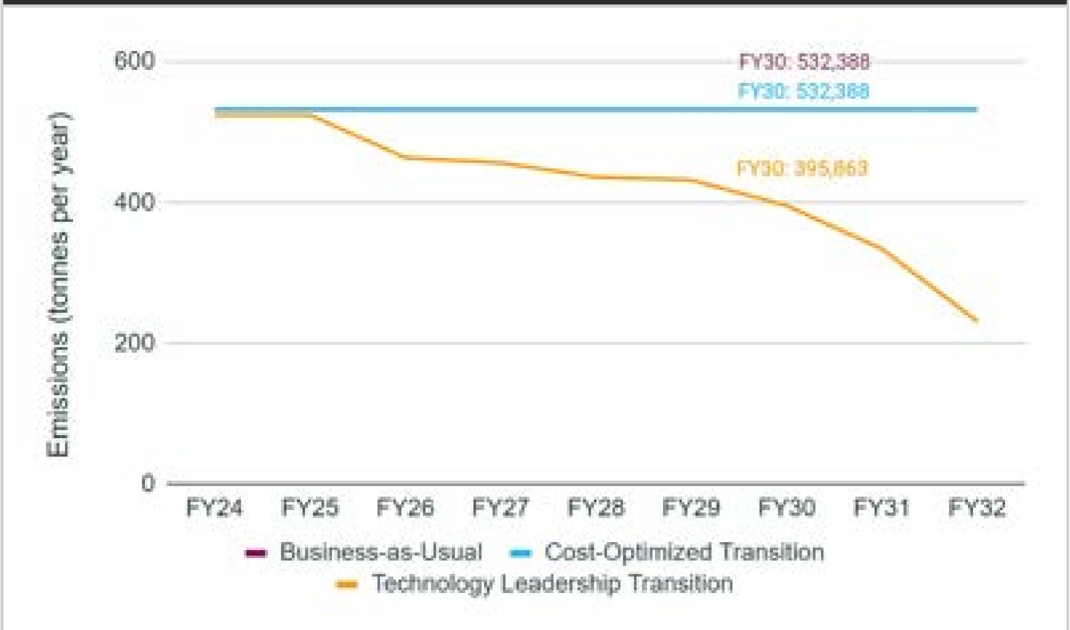
Figure X: Heavy vehicle transition cost profile - technology leadership transition (28-vehicle subset only)

In total, we are estimating a net increase in spending in the technology leadership transition (compared to BAU) of $1,272k over the next five years (through FY27), and a net increase of $1,311k over the following five years (FY28-FY32).

2.2.7 Preliminary CO2 Emissions Analysis

The emissions profiles for heavy vehicles, shown below, show the impact the transition to EVs has on CO2 emissions. The line for the cost-optimized scenario is identical to the line for business-as-usual as no heavy-duty EV replacements are envisioned. In the leadership scenario emissions begin to drop significant starting in FY29, and fall to under 400 tonnes per year by FY30.

Figure X: Transition emissions profile - transition (28-vehicle subset only)



3 Beyond the Five-Year Horizon

3.1 Considerations for the rest of the Port Moody fleet

As noted in the sections above, several light- and heavy-duty fleet vehicles were not considered in the BetterFleet analysis as we do not envision them to be candidates for transition in the short-to-medium term, the scope of this assignment. However, over the next five years, and especially as these vehicles begin to reach the end of their lifecycle, we recommend that Port Moody revisit their electrification potential, especially as technologies and economies are expected to continue to evolve over the same horizon.

It is important to also appreciate that this Fleet Assessment and Strategy is intended to highlight the early action items that Port Moody might take to prepare for a ZEV transition; it is not intended to be a comprehensive ZEV Master Plan. Rather than consider each vehicle individually for its electrification potential, it is important to understand how each vehicle fits within the City's larger fleet electrification program. A more fulsome master plan would be useful not only for planning electrification across the entire City fleet, but also for considering strategies related to infrastructure rollout, engagement with BC Hydro and other stakeholders, human resources planning, and funding strategies. Each of these initiatives have implications with respect to the actions that Port Moody intends to take with respect to EV rollout.

3.2 The case for a ZEV Master Plan

Zero-emission vehicle technology more tightly binds master planning activities with day-to-day fleet management activities, accelerating the need for a higher level master plan to bring all the pieces together.

Fleet electrification must be considered alongside the amount of flexibility desired in the City fleet, recognizing that fluidity of staff and asset allocation to sites required for proper operational functionality must be couched in long-term policies and planning. The lens of fleet electrification adds another layer of consideration in that step changes in technology are bringing interruption to standard rollover budget processes. Electric charging infrastructure becomes an inflexible asset and staff/vehicle flexibility cannot be considered as operationally flexible in the event of extreme circumstances.

Without effective long-term master planning, fleet electrification will begin to drive the suitability of City sites, locking in either inflexibility or inefficient investment.

A ZEV Master Plan affords leadership the opportunity to confirm what needs to be delivered and consider how it can be delivered outside of established system constraints. A master plan should define future service levels expected to be delivered by the City and how technology and staff can enable these services.

The master planning process would remove entrenched inflexibility around opaquely defined fit for purpose criteria and redefines performance in a technology agnostic way, and it would allow ZEV rollout to be planned in a stepwise fashion in tandem with the planning and rollout of the appropriate EV charging infrastructure.

3.3 Hydrogen as a future fuel for heavy vehicles

Many industry voices propose hydrogen fuel cells as a fast approaching technology able to solve the zero emissions range dilemma with higher energy consuming electric vehicles. Hydrogen fuel cell vehicles are already capable of performing many duties, including light passenger and commercial vehicle duties and those of heavy vehicles. A hydrogen fuel cell vehicle, depending on specification, can indeed give zero-emission vehicles a similar range to existing diesel powered vehicles.

The core issue for hydrogen fuelled technologies is that processing and refuelling infrastructure is complex and expensive, with a very large demand for the fuel in one suitable location needed for a sensible business case.

The hydrogen refuelling industry in Canada is still in its infancy. Refuelling stations are only just beginning to appear in the Canadian landscape, and although there are a few in the Greater Vancouver area, there are none yet in Port Moody. Although it is anticipated that more will appear in the near future as trials and more vehicles enter the market.

A heavy truck over 16 tonnes driven over the course of a day may consume over 20kg[1] of hydrogen, especially when considering Port Moody's hilly terrain and, in some cases, the need to operate auxiliary equipment. To consider hydrogen as a potential propulsion technology, a project that can identify 15,000kg of demand from the same refuelling site throughout the year provides an idea of the scale required to make the business case work. Further, it is important to appreciate that hydrogen fueling infrastructure is costly, and therefore is best suited to larger fleets where capital costs for infrastructure are less significant on a per-vehicle basis. It is likely that hydrogen powered vehicles are more than ten years from cost-effective fleet operation, and once the technology has matured it would be important to collaborate on shared hydrogen fueling infrastructure with Port Moody's neighbouring jurisdictions. For these reasons, this analysis did not further consider the technology.

4 Conclusions and recommendations

The core focus of the BetterFleet analysis was to evaluate the City of Port Moody's fleet, identify suitable EV replacements that meet key operational fit-for-purpose requirements, and outline a preliminary strategy to help guide initial fleet transitioning action in the short to medium term.

Some of the key conclusions from the analysis include:

1. The City will need to evaluate how large its appetite is for fleet electrification

1.1. The cost-optimized scenario and the technology leadership scenario illustrate two possible pathways to electrification, but they are not the only two possibilities.

1.2. Regardless of the scenario selected, there are short term opportunities for the City to demonstrate 'quick wins' in electrification, with battery-electric vehicles identified as early as FY25 in both the cost-optimized scenario and technology leadership scenarios.

1.3. Appropriate budgets should be established, and appropriate funding sources identified, to help guide the approach. Essential infrastructure to support the EV transition will also need to be considered.

1.4. Fleet transitioning is best approached with a mind of efficiency, where charging infrastructure is phased in over time and not unnecessarily front-end loaded. The City should take a pragmatic approach to phasing in infrastructure at garaging locations

[1] https://www.sustainable-bus.com/news/hydrogen-at-scale-for-transit-what-does-it-mean-to-operate-fuel-cell-buses/

accordingly. At the same time, in order to maximize the City's electrification potential, charging infrastructure considerations are required throughout the full cross-section of the City's vehicle sites.

2. Emphasizing light-duty vehicles in the transition is a prudent approach for the short-term.

2.1. Light-duty vehicles generally have stronger feasibility for electrification in the short-term as the technology is more established and the TCO gap is more manageable. However, strategizing early for heavy-duty vehicle transition planning will be important as well.

2.2. If a shift in vehicle type is permissible given operational requirements (for example, where the Dodge Charger police vehicles are concerned), this may uncover additional short-term electrification opportunities.

2.3. Transitioning of light-duty vehicles is expected to begin as early as FY25 for the cost-optimized and technology leadership scenarios. While the technology leadership scenario also sees heavy-duty vehicle transitioning beginning in FY25, no heavy-duty vehicles are envisioned to be transitioned in the cost-optimized scenario.

2.4. Through FY27, the City of Port Moody can expect to transition anywhere from 17 to 22 of its vehicles to EV alternatives, 17 to 18 of which are light duty. Through FY32, the City of Port Moody can expect to transition anywhere from 43 to 64 of its vehicles to EV alternatives, 43 to 46 of which are light-duty.

2.5. Prioritize learnings through early electrification projects targeting the lowest TCO gap. Take advantage of new and existing sources of data to build a deeper understanding of the duty cycle demands on assets at relatively low cost.

APPENDIX D: CHARGING INFRASTRUCTURE OVERVIEW & ELECTRICAL CAPACITY ASSESSMENTS

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Technical Memorandum No. 02 v1.0 - FINAL

PROJECT NAME:	**PORT MOODY FLEET ASSESSMENT**		
OWNER:	City of Port Moody		
PRIME CONSULTANT:	Innotech Fleet Strategies	**DATE:**	September 22, 2023
CONTRACTOR:	N/A	**MEMO NO.:**	02 v1.0
ATTENTION:	**Steven Wiebe P.Eng, PMP**		
SUBJECT:	**Preliminary Assessment and Conceptual Design**		

1 Introduction

The City of Port Moody is interested in increasing efficiency and reducing greenhouse gas (GHG) emissions of their fleet operations. The City of Port Moody retained Innotech Fleet Strategies to provide recommendations that allow the City to understand the industry, set realistic emission reduction targets, balance risk, and provide a roadmap for a cost-effective and successful implementation. Innotech Fleet Strategies retained PBX Engineering Ltd to:

- Present Electric Vehicle Supply Equipment (EVSE) options,
- Perform a detailed review of the electrical record information for six (6) locations,
- Perform electrical capacity assessments of the existing services at six (6) locations,
- Prepare and submit conceptual design drawings based on the charging plan for the Public Works Yard location,
- Determine approximate cost of electrical-specific recommendations for the Public Works Yard location, and
- Prepare the electrical-specific requirements for the BC Hydro EV Ready fleet plan workbook.

The City of Port Mopdy is considering electrifying their fleet at the following six (6) locations:

- Civic Centre
- Public Works Yard
- Recreation Complex
- Inlet Fire Hall
- Public Safety Building
- 3016 Murray St

The purpose of this Technical Memorandum is to:

- Review proposed equipment and determine requirements,
- Summarize the findings from the electrical record information,
- Summarize the findings from the electrical capacity assessments, and
- Determine options for providing power to the EVSE infrastructure.

2 Codes and Standards

This Technical Memorandum has been prepared in accordance with all authoritative / legislated codes and standards adopted at the time of design by the Authorities Having Jurisdiction (AHJ), including the following:

- BC Hydro Electric Vehicle Charging Guidelines
- Canadian Electrical Code Part 1: CSA C22.1 – 2021
- Canadian Electric Vehicle Infrastructure Deployment Guidelines – 2014

3 Record Information / Information Provided By Others

The following information has been used as reference information in the preparation of this technical memorandum:

- Equipment Power Distribution Assessment Report, Facility Department Buildings, May 17, 2021, Integral Group
- Electrical Condition Assessment, 3016 Murray St, September 13, 2021, O'M Engineering Electrical & Electronic Consulting Engineers
- Arc Flash and Short Circuit Coordination Study, Civic Centre, February 01, 2023, Introba
- Arc Flash and Short Circuit Coordination Study, Public Safety Building, February 01, 2023, Introba
- Arc Flash and Short Circuit Coordination Study, Inlet Fire Hall, February 14, 2023, Introba
- Arc Flash and Short Circuit Coordination Study, Recreation Centre, February 21, 2023, Introba
- 1-Year Historical Load Consumption Data, March 2022-2023, BC Hydro

4 Definitions

Refer to *PBX Engineering Lt. Technical Memorandum No. 01* for definitions and details of industry accepted EVSE standards, system configurations, and product options.

4.1 Abbreviations

A	Amp
AC	Alternating Current
BMS	Battery Management System
BCH	British Columbia Hydro and Power Authority
DC	Direct Current
DCFC	Direct Current Fast Charging
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GHG	Greenhouse Gas
kW	Kilowatt
PH	Phase
V	Volts

5 Requirements

The following section summarizes the requirements of the proposed EVSE, industry standards, and the electrical code requirements.

5.1 Product Specifications

The products selected for the basis of review are the ChargePoint CPF50 for the Level 2 EVSE and the ChargePoint Express 250 for the DCFC EVSE. The ChargePoint offerings are designed for applications where several stations are required, such as workplaces and commercial fleets. The charging stations offer standalone model or a power sharing models, which allows multiple charging ports on the same electrical infrastructure.

Technical specifications for the charging stations are summarized in the table below.

Specification	ChargePoint CPF50	ChargePoint Express 250
Voltage	208VAC, Single-Phase	480V, Three-Phase
Current	50A (power shared between up to two ports)	80A
Power	10.4kW	66.5kVA / 62.5kW
Wiring	3-wire	4-wire
Enclosure Rating	Type 3R per UL 50E	Type 3R, IP54
Connector	SAE J1772 (up to 2)	CHAdeMO, CCS1 (SAE J1772™ Combo), CCS2 (IEC 61851-23). Up to two (2) per station.
Cable Length	5.4m (optional 7.0m)	4.27m
Networking	Cellular 4G LTE	Cellular 4G LTE
Certification	CSA	CSA
Operating Temperature	-40°C to 50°C	-40°C to 50°C
Installation	Pad-mount Pedestal or Wall-mounted	Pad-mount Pedestal

Figure 1 - Tabulated Charging Station Specifications

Refer to *Appendix A: ChargePoint Technical Specifications* for more details.

5.2 Canadian Electrical Code Requirements

According to the Canadian Electrical Code (CEC) the following requirements must be met:

- Permanent warning sign installed at the connection of the EVSE to the branch circuit warning against operation of the equipment without sufficient ventilation.
- Separate branch circuit protected by appropriately sized breaker, disconnect, and conductors. Located on the supply side of the point of connection for the EVSE, within sight of and accessible to the EVSE, and capable of being locked in the open position.

- Outdoor charging sites shall be permitted to include curbsides, open parking structures, parking lots and similar locations.
- Requires certification from an accredited test agency such as CSA group (or accepted equivalent).

5.3 Canadian EV Infrastructure Deployment Guidelines

The Canadian EV Infrastructure Deployment Guidelines provide essential information and resources to implement EV charging infrastructure. This information includes location selection and lighting recommendations.

The location selected should be such to avoid tripping hazards and allow vehicles to park forwards or backwards in parking space. If EVSE is mounted in front of vehicle, wheel-stops or bollards may be recommended. See the following Figure 1 for a typical EVSE middle placement pedestal mounting in row parking.

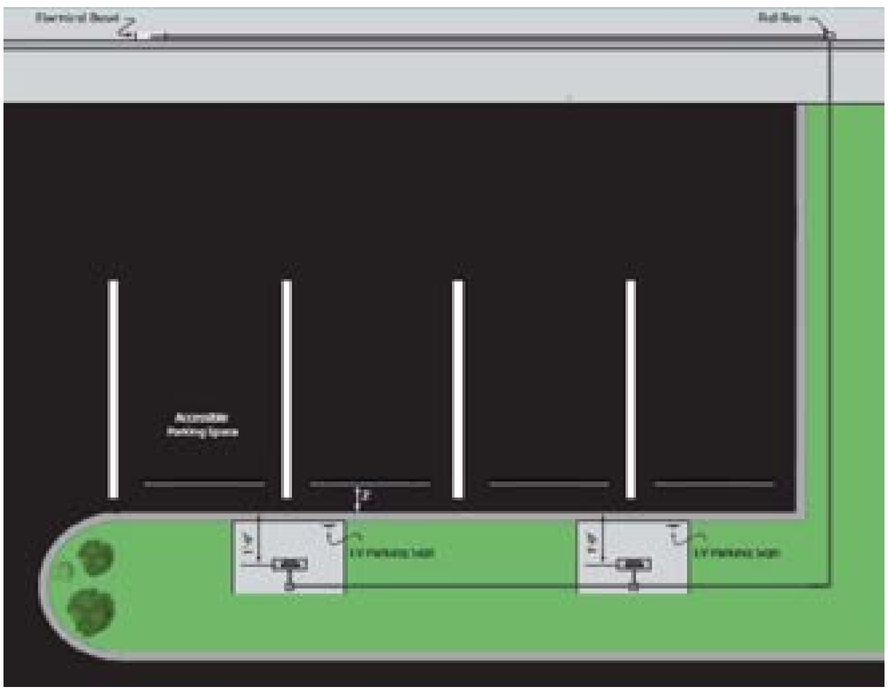

Figure 2 - Typical EVSE Middle Placement Pedestal Mounting in Row Parking

Lighting should be sufficient to read associated signs, instructions, or controls on EVSE and provide visibility around the vehicle for all possible EV inlet locations.

6 Assessment and Findings

The six (6) locations to be considered are the Civic Centre, Public Works Yard, Recreation Complex, Inlet Fire Hall, Public Safety Building, and 3016 Murray St. The following is a summary of the review of the electrical record information and an electrical capacity assessment of the existing services at the sites.

Refer to *Appendix B: Load Analysis Summary*

6.1 Methodology

The existing peak demand load was ascertained using 1-Year BC Hydro provided load consumption history. The existing peak demand was determined by taking the maximum value of all the demand load data that was provided. Load consumption history provided by BC Hydro was provided as metering data and captured in 5-minute intervals. This is a risk that the peak demand may have occurred within the 5-min interval and was not captured. A Demand Load Study performed by a licensed electrician is recommended to confirm results at each of the locations prior to performing any work.

Refer to *Appendix C: BC Hydro 1-Year Historical Consumption Summary*

6.2 Civic Centre

6.2.1 Location

The Civic Centre is located at 100 Newport Drive, Port Moody, BC and comprises a Galleria, City Hall, Library, and Inlet Theatre. The electrical service entrance is located in the main electrical room on the second floor.

6.2.2 Existing Electrical Infrastructure

The existing incoming electrical utility service to the building is 600A (80% Rated), 347/600V, 3-phase, and is supplied from BC Hydro. The service feeds a 1200A, 347/600V, 3-phase, 4-wire, service entrance rated fused switch section and switchboard. Refer to the Partial Single Line Diagram in Figure 3.

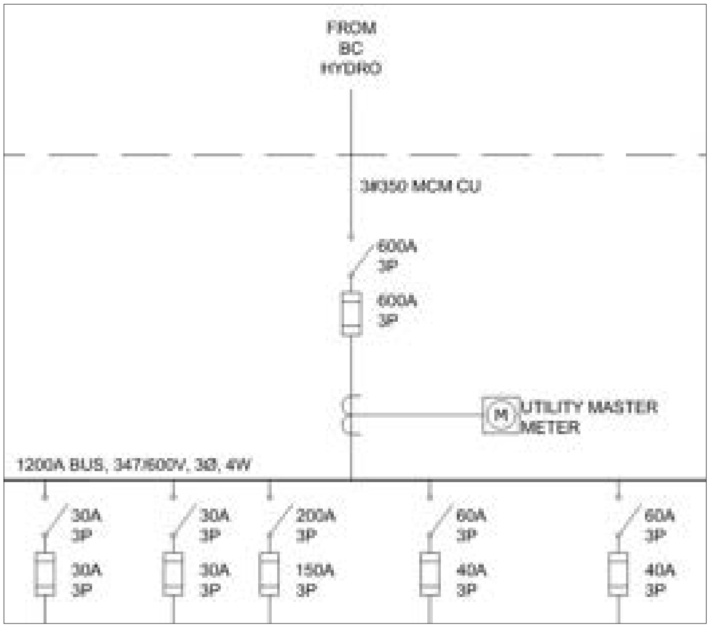

Figure 3 - Civic Centre Service Entrance Partial Single Line Diagram

6.2.3 Electrical Capacity Assessment

The existing 600A, 347/600V, 3-phase service base electrical capacity was calculated at 499kVA. The maximum electrical demand load was determined to be 232kVA. The existing service is underloaded at 47% of the base service size and there is a remaining capacity of 267kVA for new loads. Based on site photos provided by others, there appears to be physical capacity in the switchboard for additional fusible switches.

6.3 Public Works Yard

6.3.1 Location

The Public Works Yard is located at 3250 Murray Street, Port Moody, BC and comprises offices, meeting rooms, a vehicle service garage, and various outdoor buildings. The electrical service entrance is located in the main electrical room in the main office building. In discussions with the Manager of Facilities at the time of the writing of this report, it was indicated that the future of the facility is uncertain and the municipal council of Port Moody has put a hold on any potential building upgrades.

6.3.2 Existing Electrical Infrastructure

The existing incoming electrical utility service to the building is 400A (80% Rated), 120/208V, 3-phase, and is supplied from a roadside BC Hydro kiosk (75kVA, Asset # 16230). The service enters a service entrance rated 400A fused disconnect and feeds a 120/208V, 3-phase, 4-wire splitter bus. Refer to the Partial Single Line Diagram in Figure 4.

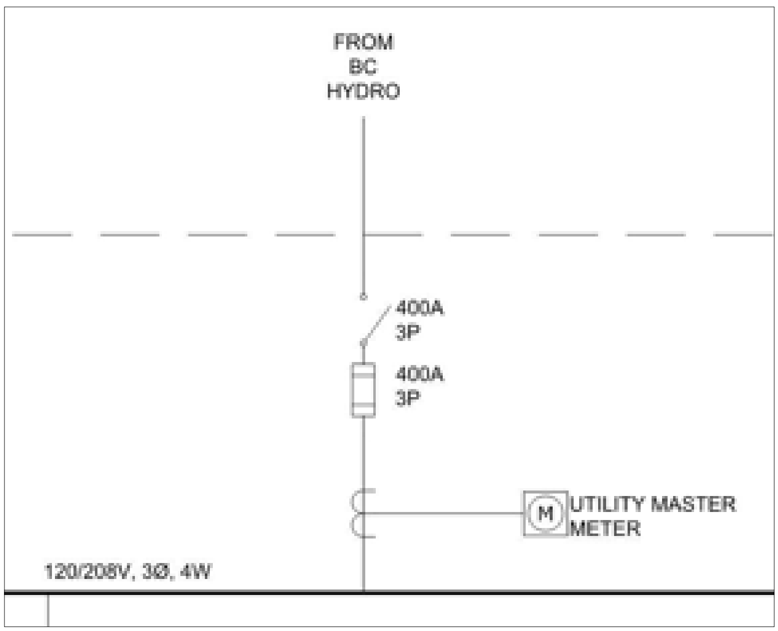

Figure 4 – Public Works Yard Service Entrance Partial Single Line Diagram

6.3.3 Electrical Capacity Assessment

The existing 400A, 120/208V, 3-phase service base electrical capacity was calculated at 115kVA. The maximum electrical demand load was determined to be 70kVA. The existing service is loaded at 61% of the base service size and there is a remaining capacity of 45kVA for new loads. Based on discussions with the Manager of Facilities, there is no significant physical capacity in the splitter bus for additional equipment.

6.3.4 Proposed Equipment & Load Analysis

Based on the fleet assessment performed by Innotech, the facility will require five (5) level 2 ChargePoint CPF50 and three (3) DCFC ChargePoint Express 250 by 2027 to support the electrification of the fleet vehicles. The total demand load of the proposed EVSE for 2027 was determined to be 252kVA.

Furthermore, the plan produced for the facility models a transition of 38 vehicles to electric by 2032. Per the Innotech analysis, the peak demand load is estimated to be 358kW and assumes chargers are networked with load balancing.

The existing service capacity is deficient to support the potential EVSE loads and a service upgrade will be required .

6.4 Recreation Complex

6.4.1 Location

The Recreation Complex is located at 300 Ioco Road, Port Moody, BC and comprises two (2) ice arenas, a curling rink, a cultural centre, and a gymnasium. The electrical service entrance is located in the main electrical room A137 on the main floor at the north of the facility.

6.4.2 Existing Electrical Infrastructure

The existing incoming electrical utility service to the building is 3000A (80% Rated), 277/480V, 3-phase, and is fed via a 1750kVA, 25kV-277/480V, stepdown transformer in a sub station supplied by BC Hydro. The service feeds a 3000A, 277/480V, 3-phase, 4-wire main breaker and switchboard. Refer to the Partial Single Line Diagram in Figure 5

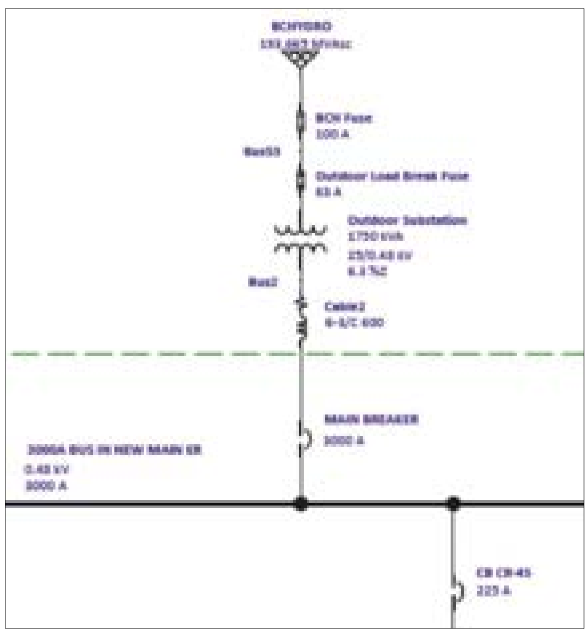

Figure 5 - Recreation Complex Service Entrance Partial Single Line Diagram

6.4.3 Electrical Capacity Assessment

The existing 3000A, 277/480V, 3-phase service base electrical capacity was calculated at 1995kVA. The maximum electrical demand load was determined to be 741kVA. The existing service is underloaded at 37% of the base service size and there is a remaining capacity of 1254kVA for new loads. Based on site photos provided by others, there appears to be physical capacity in the switchboard for additional breakers.

6.5 Inlet Fire Hall

6.5.1 Location

The Inlet Fire Hall is located at 150 Newport Drive, Port Moody, BC and comprises storage spaces, truck bays, and a command room. The electrical service entrance is located at the mezzanine level in electrical room M-3.

6.5.2 Existing Electrical Infrastructure

The existing incoming electrical utility service to the building is 600A (80% Rated), 120/208V, 3-phase, and is supplied from BC Hydro. The service feeds a 600A (80% Rated), 120/208V, 3-phase, 4-wire main breaker and switchboard. The service is partially provided backup power via generator. Refer to the Partial Single Line Diagram in Figure 6.

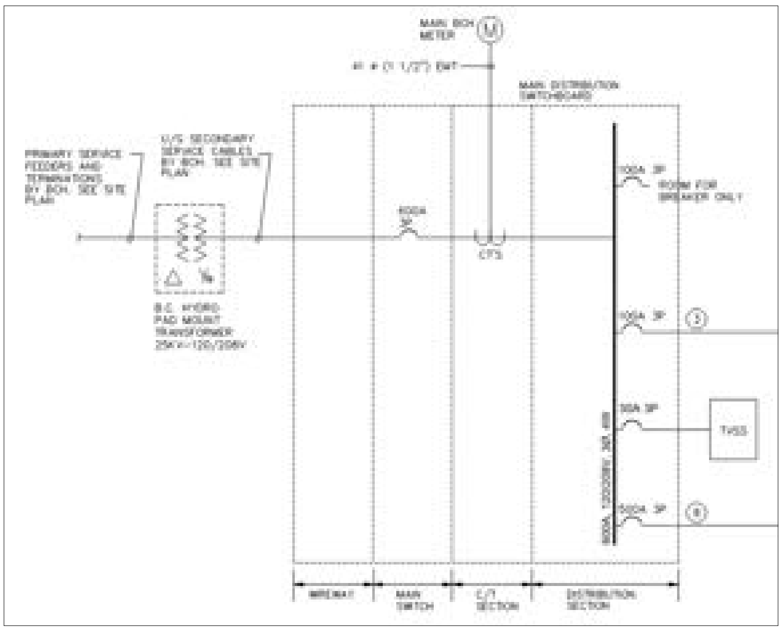

Figure 6 - Inlet Fire Hall Service Entrance Partial Single Line Diagram

6.5.3 Electrical Capacity Assessment

The existing 600A, 120/208V, 3-phase service base electrical capacity was calculated at 173kVA. The maximum electrical demand load was determined to be 70kVA. The existing service is underloaded at 41% of the base service size and there is a remaining capacity of 103kVA for new loads. Based on site photos provided by others, there appears to be physical capacity in the switchboard for additional breakers.

6.6 Public Safety Building

6.6.1 Location

The Public Safety Building is located at 3051 St. John's Street, Port Moody, BC and comprises offices, a communications centre, a fitness gym, and a holding building. The electrical service entrance is located in main electrical room 133 on the main floor. In discussions with the Manager of Facilities, it was indicated that there is an existing expansion project on the third floor.

6.6.2 Existing Electrical Infrastructure

The existing incoming electrical utility service to the building is 1600A (80% Rated), 120/208V, 3-phase, and is supplied from BC Hydro. The service feeds a 1600A, 120/208V, 3-phase, 4-wire main breaker and switchboard. The entire service is provided backup power via generator. Refer to the Partial Single Line Diagram in Figure 7

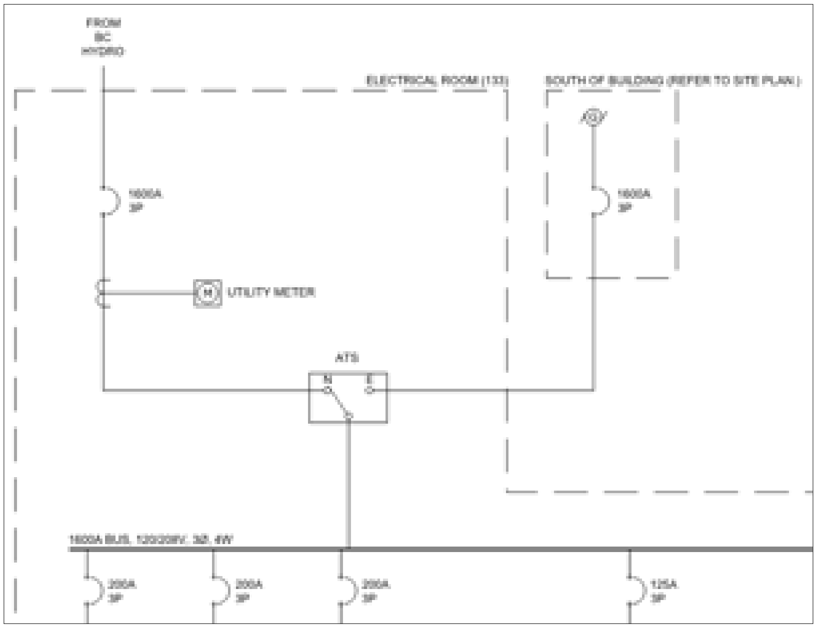

Figure 7 - Public Safety Building Service Entrance Partial Single Line Diagram

6.6.3 Electrical Capacity Assessment

The existing 1600A, 120/208V, 3-phase service base electrical capacity was calculated at 461kVA. The maximum electrical demand load was determined to be 88kVA. The existing service is underloaded at 19% of the base service size and there is a remaining capacity of 374kVA for new loads. Based on site photos provided by others, there appears to be physical capacity in the switchboard for additional breakers.

6.7 3016 Murray Street

6.7.1 Location

The Public Works facility is located at 3016 Murray Street, Port Moody, BC and comprises the Ironhorse Building and the Quonset Hut. The electrical service entrance is located in a closet the Ironhorse Building.

6.7.2 Existing Electrical Infrastructure

The existing incoming electrical utility service to the building is 400A (80% Rated), 120/240V, single-phase, and is supplied from BC Hydro. The service feeds a 400A service entrance rated disconnect fused at 300A and 400A, 120/240V, single-phase, 3-wire, splitter bus. Refer to the Partial Single Line Diagram in Figure 8.

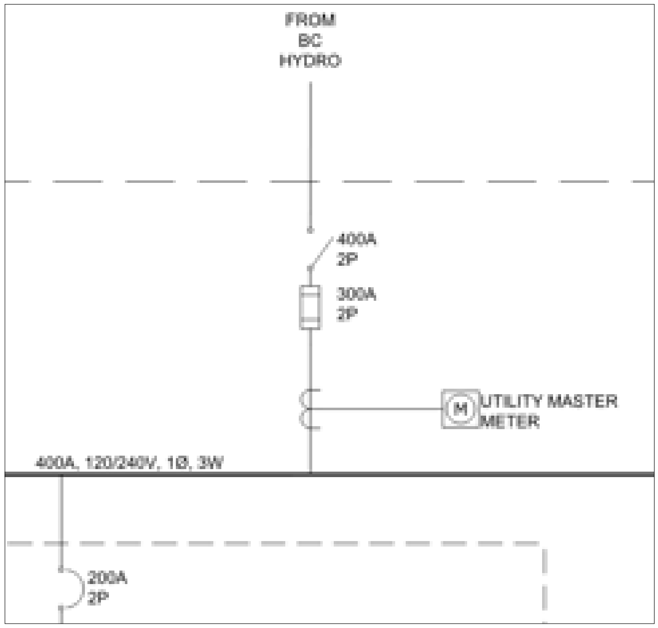

Figure 8 - 3016 Murray St Service Entrance Partial Single Line Diagram

6.7.3 Electrical Capacity Assessment

The existing 400A, 120/208V, single-phase service base electrical capacity was calculated at 58kVA. The maximum electrical demand load was determined to be 13kVA. The existing service is underloaded at 23% of the base service size and there is a remaining capacity of 44kVA for new loads. Based on site photos provided by others, there does not appear to be significant physical capacity in the splitter bus for additional equipment.

7 Conceptual Design & Options Analysis

7.1 Public Works Yard

In discussions with the Manager of Facilities, the preference is to bring a new dedicated service to an electrical kiosk to serve the electrical requirements of the proposed fleet EVSE expansion. The separate service will allow for the fleet EVSE expansion to proceed without being impacted by any proposed building replacement as determined by municipal council. The service entrance, meter base, and EVSE distribution would be contained in a customer-owned electrical kiosk.

Refer to *Appendix B: Load Analysis Summary*.

Refer to *Appendix D: Conceptual Design Public Works Yard Site Plan and Single Line Diagram*

7.1.1 Option 1 – EVSE Infrastructure to 2027

To support the fleet EVSE expansion through 2027, a new 1200A, 3-phase, 120/208V dedicated secondary service would be required. In this configuration, the conceptual design allows for an additional 94 kVA of electrical capacity at the end of 2027. There would be electrical capacity for an additional one (1) dedicated DCFC EVSE or nine (9) dedicated level 2 EVSE; however, networked chargers would allow for additional spare capacity.

The total estimated order of magnitude opinion of electrical construction cost for Option 1 is **$ 897,783.49**. The breakdown of costs is as follows:

1. Civil Infrastructure - $53,867.71
2. Conduit and Wiring - $35,853.48
3. Kiosk and Distribution - $207,172.45
4. EVSE - $323,006.75
5. Project Wide - $66,927.76
6. Construction Contingency (25% not including EVSE) - $90,955.35
7. Service Upgrade - $65,000.00
8. Engineering Design and Construction Administration - $55,0000

7.1.2 Option 2 – EVSE Infrastructure to 2032

To support the fleet EVSE expansion through 2032, a new 1600A, 3-phase, 120/208V dedicated secondary service would be required. In this configuration, the conceptual design allows for an additional 210 kVA of electrical capacity at the end of 2027. There would be electrical capacity for an additional three (3) dedicated DCFC EVSE or twenty (20) dedicated level 2 EVSE; however, networked chargers would allow for additional spare capacity.

The total estimated order of magnitude opinion of electrical construction cost for Option 2 is to be determined. More information about the proposed number and type of EVSE is required.

The total estimated order of magnitude opinion of electrical construction cost for Option 2 is **$ 928,885.38**; however, to more accurately determine the cost, more information is required about the total proposed number and types of EVSE. The breakdown of costs is as follows:

1. Civil Infrastructure - $53,867.71
2. Conduit and Wiring - $35,853.48
3. Kiosk and Distribution - $223,722.95
4. EVSE - $323,006.75
5. Project Wide - $67,258.77
6. Construction Contingency (25% not including EVSE) - $95,175.73
7. Service Upgrade - $75,000.00
8. Engineering Design and Construction Administration - $55,0000

8 Conclusion and Recommendation

PBX recommends the following:

1. For the Public Works Building, the electrical infrastructure shall be sized for the future build-out of Option 2. However, only the stations in Option 1 shall be energized.

9 Closure

This document has been prepared based upon the information referenced herein. It has been prepared in a manner consistent with good engineering judgement. Should new information come to light, PBX Engineering Ltd. requests the opportunity to review this information and our conclusions contained in this report. This document has been prepared for the exclusive use of the City of Port Moody, and there are no representations made by PBX Engineering Ltd. to any other party. Any use that a third party makes of this document, or any reliance on or decisions made based on it, are the responsibility of such third parties.

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Attachments:

- Appendix A: ChargePoint Technical Specifications
- Appendix B: Load Analysis Summary
- Appendix C: BC Hydro 1-Year Historical Consumption Summary
- Appendix D: Conceptual Design Public Works Yard Site Plan and Single Line Diagram

Appendix A: ChargePoint Technical Specifications

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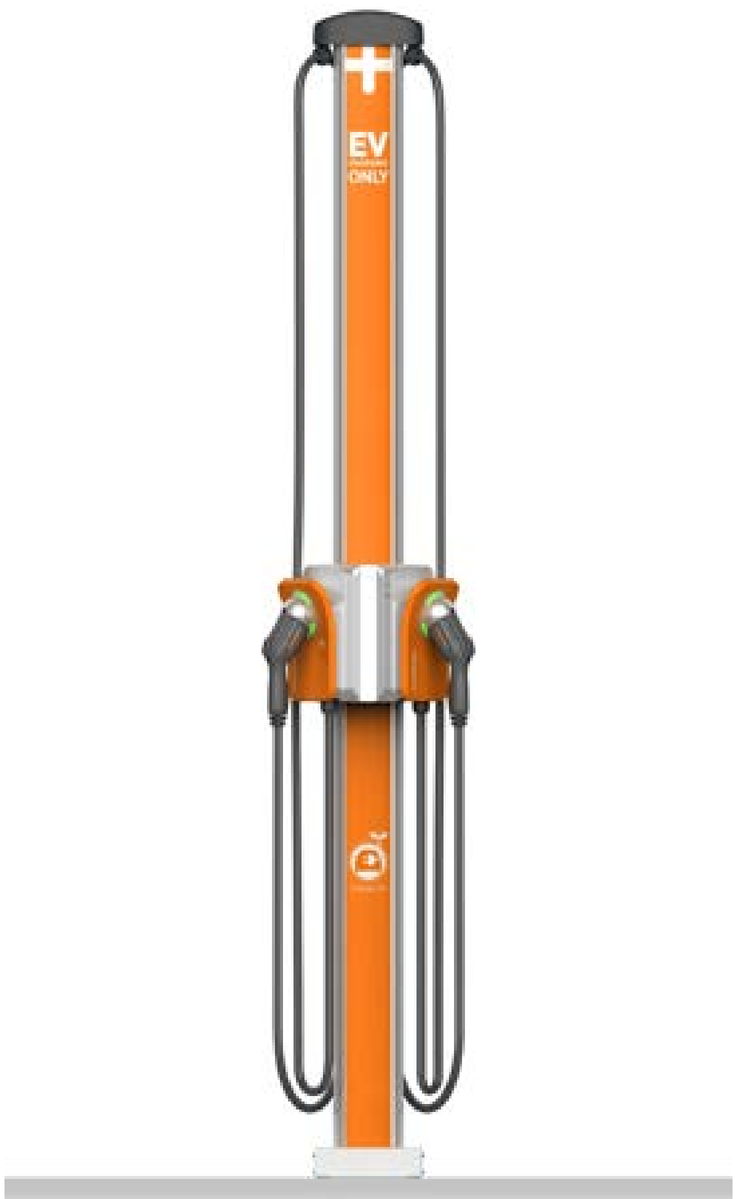
ChargePoint® CPF50 Level 2 Charging Stations for Fleet

Specifications and Ordering Information



Ordering Information

The order codes below represent specific product configurations. Other product options are available. Please contact ChargePoint Sales for information and order codes.

Hardware

Description		Order Code
Model	Single Port, Pedestal 5.4m (18') Cable with 6' Cable Management Kit	CPF50-L18-PEDMNT-CMK6
	Dual Port, Pedestal, 5.4m (18') Cable with 6' Cable Management Kit	CPF50-L18-PEDMNT-CMK-Dual
	Single Port, Wall, 5.4m (18') Cable with 6' Cable Management Kit	CPF50-L18-WALLMNT-CMK6
	Single Port, Pedestal, 7.0m (23') Cable with 8' Cable Management Kit	CPF50-L23-PEDMNT-CMK8
	Dual Port, Pedestal, 7.0m (23') Cable with 8' Cable Management Kit	CPF50-L23-PEDMNT-CMK8-Dual
	Single Port, Wall, 7.0m (23') Cable with 8' Cable Management Kit	CPF50-L23-WALLMNT-CMK8
Replacement Cable	5.4m (18'). 50A, Charging Cable, CMK version 7.0m (23'), 50A, Charging Cable, CMK version	CPFCABLE-T1-50A-L18-CMK-F CPFCABLE-T1-50A-L23-CMK-F

Required Companion Products

Description	Order Code
ChargePoint Cloud Plan	Please contact ChargePoint sales
ChargePoint Gateway* (1 required for every 9 stations)	CPGW1-LTE

* The ChargePoint Gateway is required for all CPF50 installations. ChargePoint certified installers will do a site validation and order the ChargePoint Gateway as needed. In addition, the site host is responsible for providing power to the gateway. The ChargePoint Gateway is owned and maintained by ChargePoint.

The Gateway should be located where cellular signal levels are optimal for LTE. Each Gateway must be located within 150 feet line-of-sight to as many as nine (9) CPF50 charging stations. Each CPF50 charging station has built-in WiFi capability to communicate via the Gateway for ChargePoint network services.

The Gateway is a UL Class 2 device and requires less than four watts power (33 mA@120 V or 19 mA@208 V). ChargePoint recommends hardwire electrical termination to the power source for the Gateway. The Gateway dimensions are 280 mm (11 in) wide by 340 mm (13 3/8 in) long by 137 mm (5 3/8 in) deep.

Recommended Companion Products for Fleet Applications

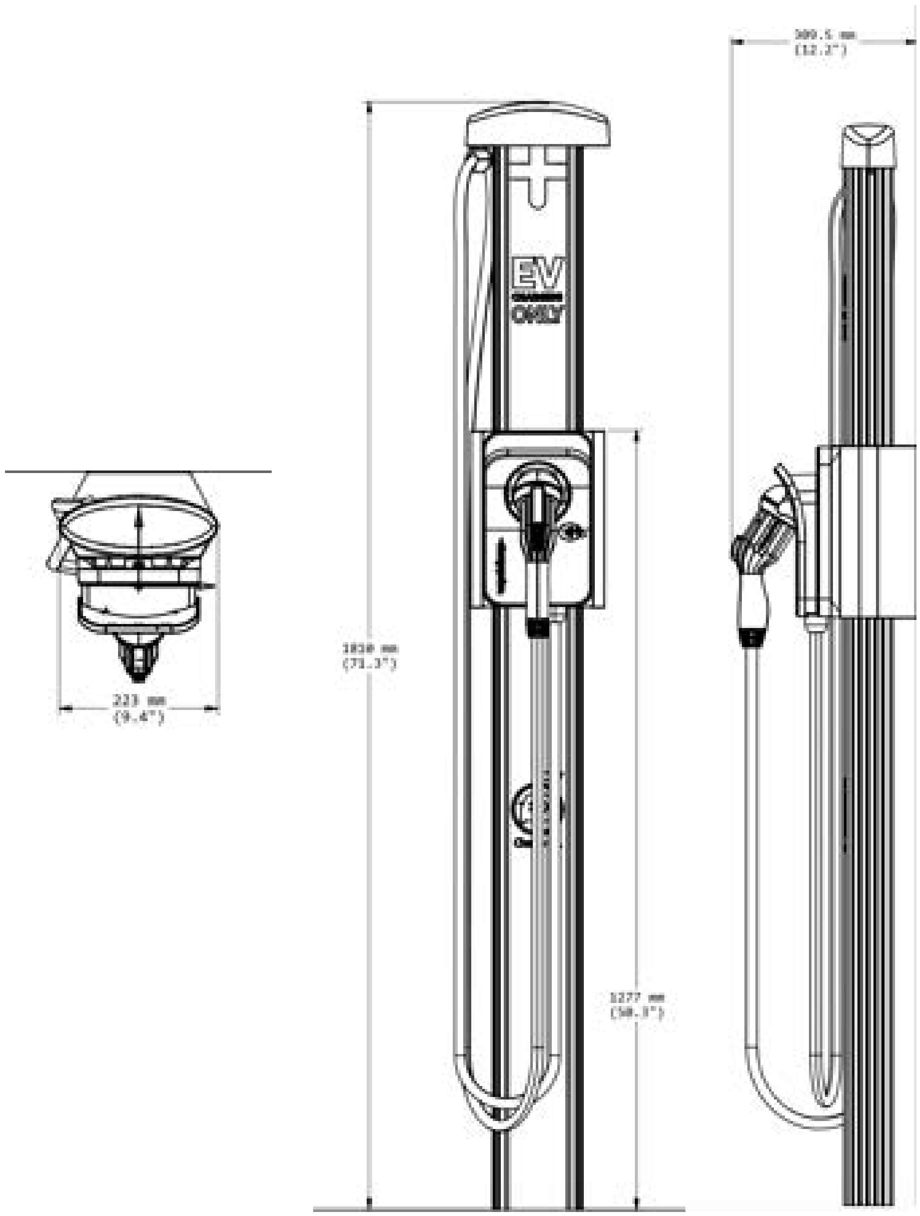
Description	Order Code
Station Initial Activation	CPSUPPORT-ACTIVE
ChargePoint Assure	CPF-ASSURE-*n*[*]

[*]Substitute *n* for desired years of service (1, 2, 3, 4 or 5)

Architectural Drawings (Dimensions)

Single Wall Mount with Cable Management Kit

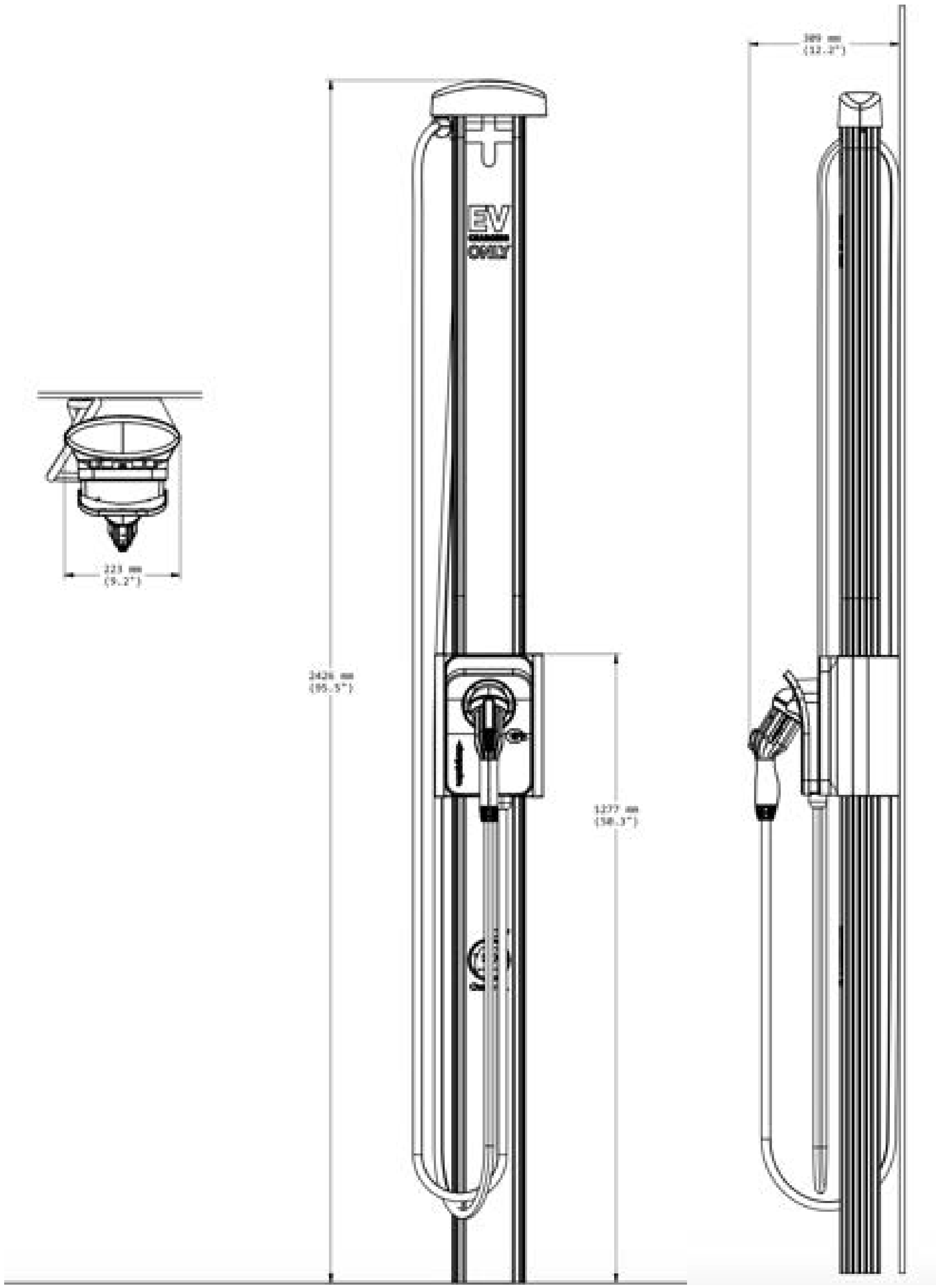
CPF50-L18-WALLMNT-CMK6ft (6 ft)



ChargePoint CPF50 Datasheet

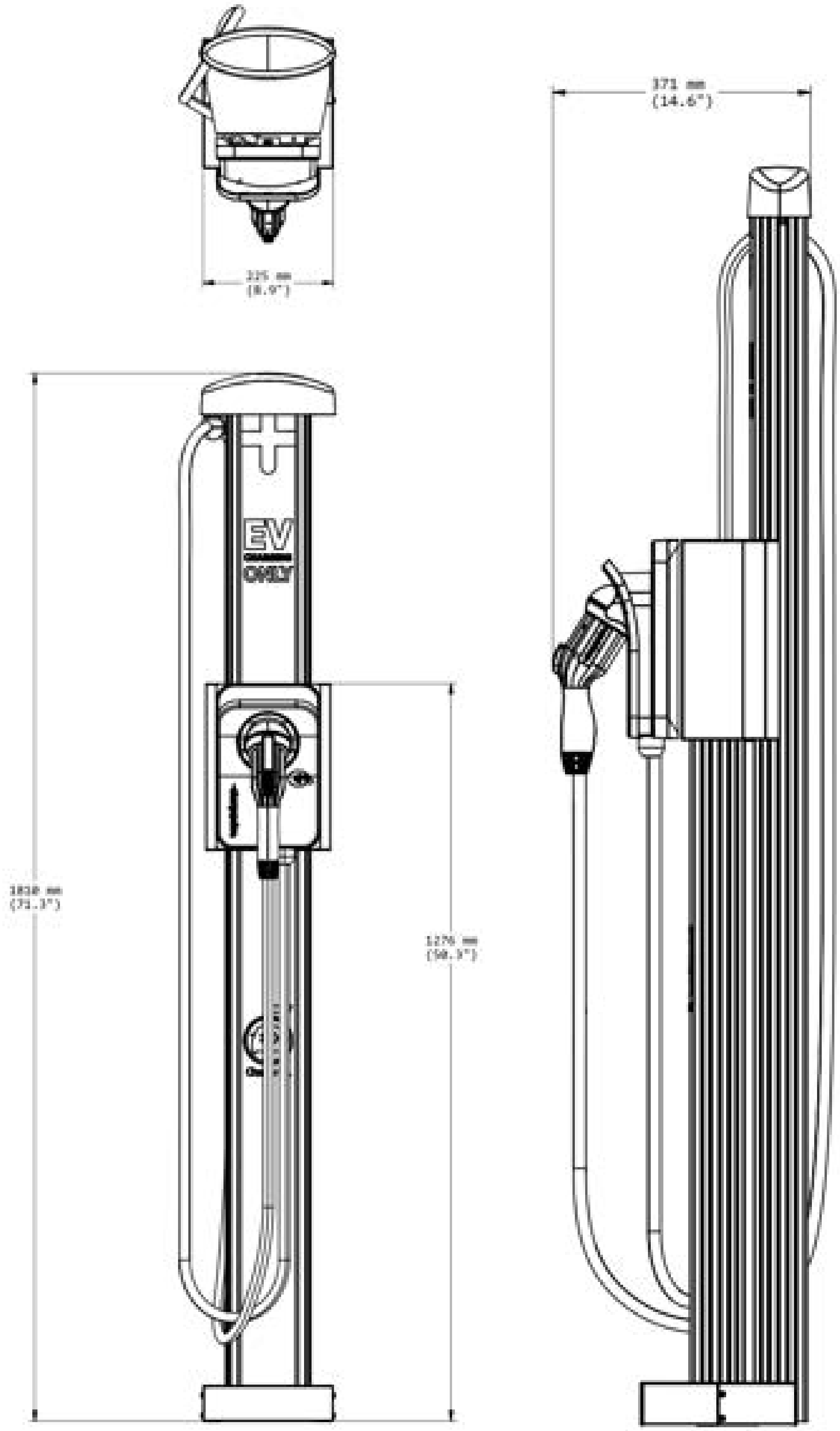
Single Wall Mount with Cable Management Kit

CPF50-L23-WALLMNT-CMK8ft (8 ft)



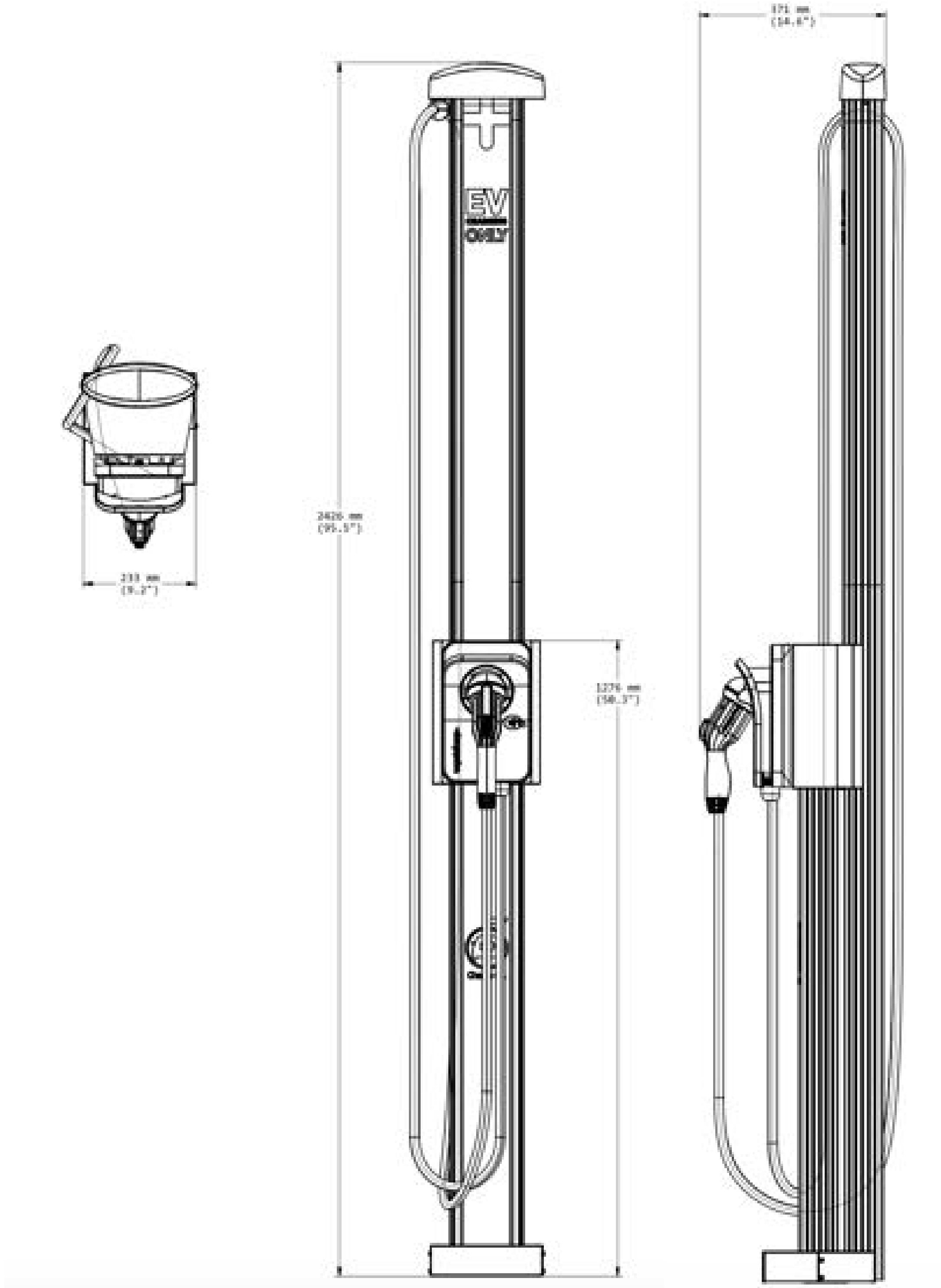
Single Pedestal Mount with Cable Management Kit

CPF50-L18-PEDMNT-CMK6 (6 ft)



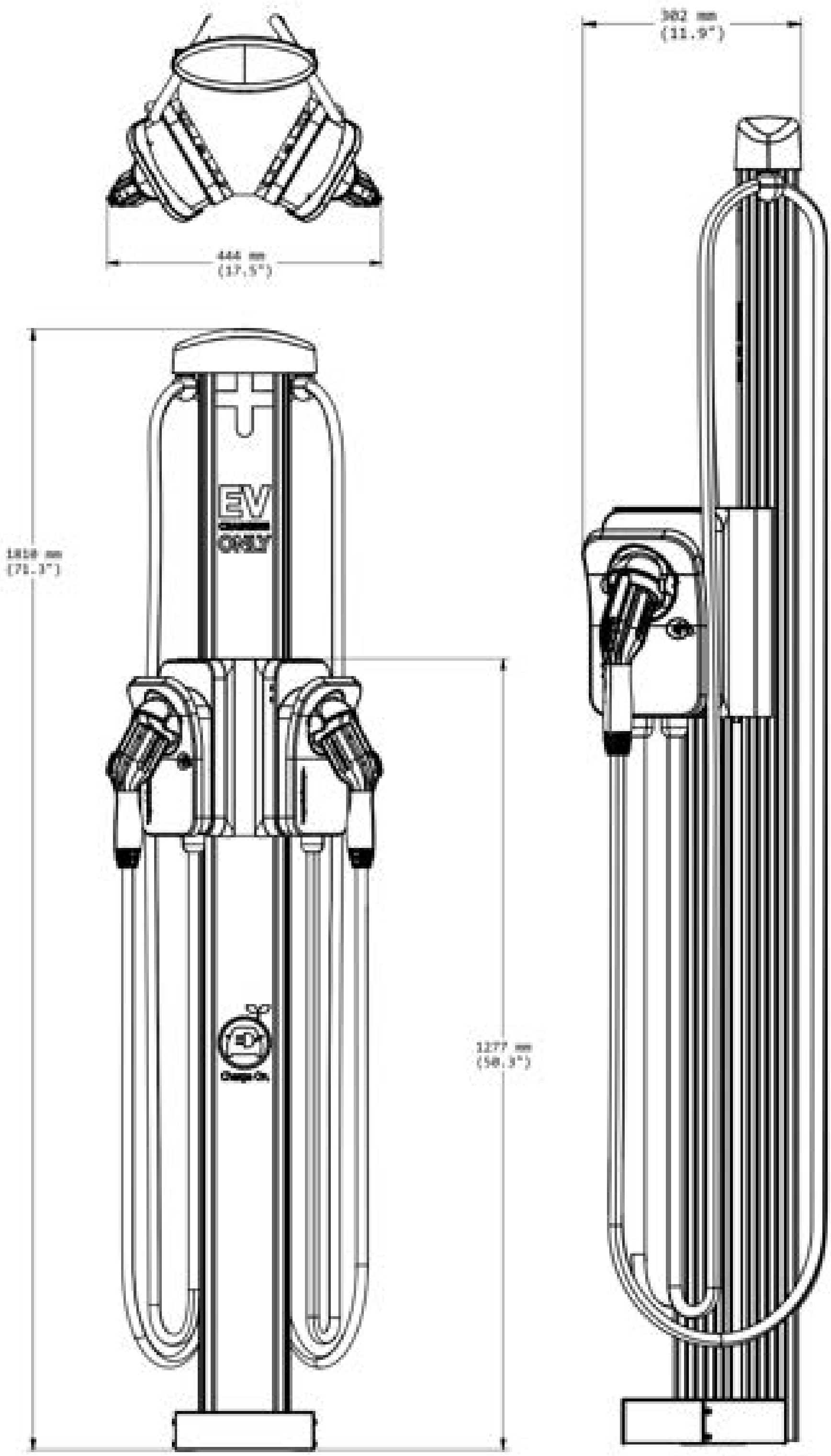
Single Pedestal Mount with Cable Management Kit

CPF50-L23-PEDMNT-CMK8 (8 ft)



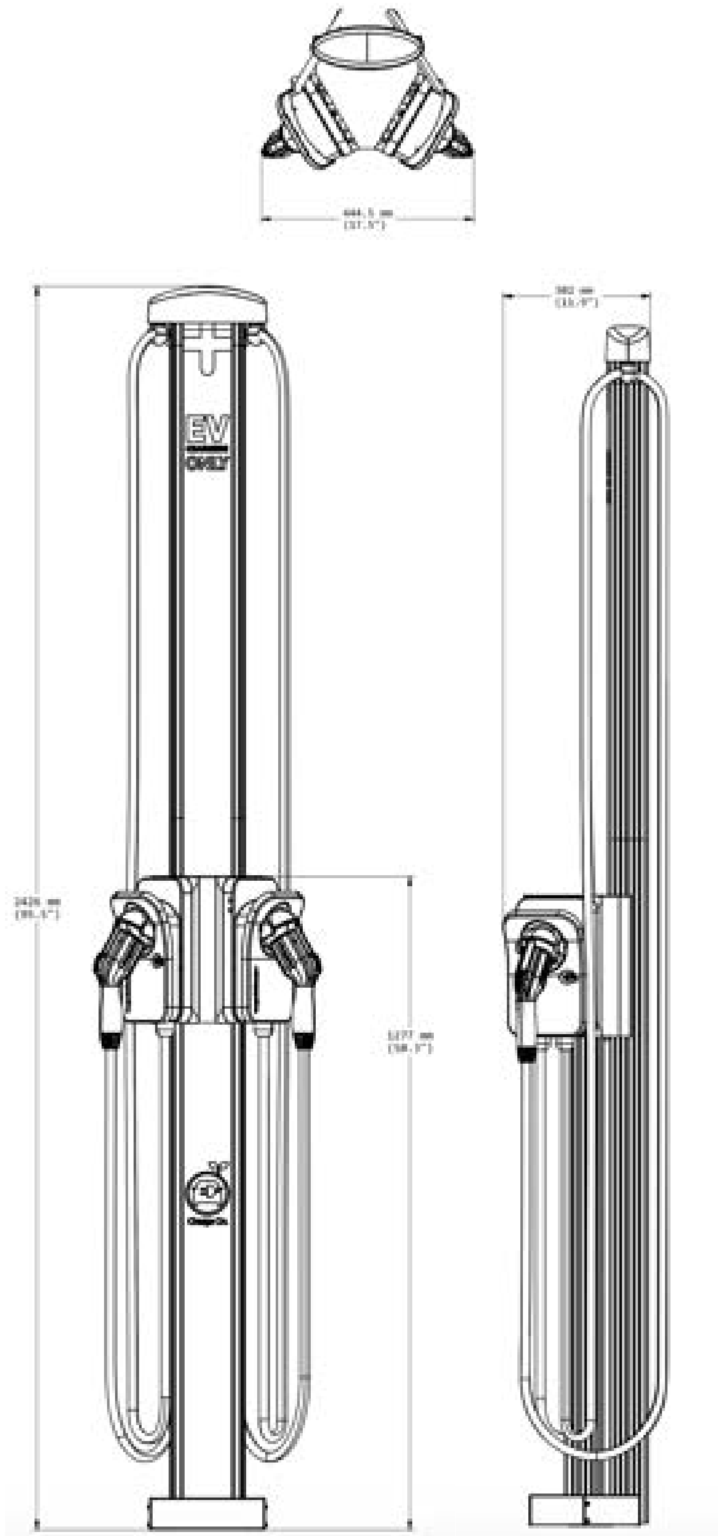
Dual Pedestal Mount with Cable Management Kit

CPF50-L18-PEDMNT-CMK6-Dual (6 ft)



Dual Pedestal Mount with Cable Management Kit

CPF50-L23-PEDMNT-CMK8-Dual (8 ft)



ChargePoint CPF50 Datasheet

General Specifications

Electrical Input

CPF50 supports flexible current settings up to 50A to fit your needs.

Power Select allows CPF50 stations to be installed and software-configured for current input/output lower than the maximum 50A rating depending on your electrical and charging requirements. CPF50 Power Select current input/output options include 16A, 24A, 32A, 40A, and 48A.

Power Share allows two stations to share power from a single circuit dynamically across the stations, adjusting each station's power output depending on whether one or both are actively charging. Standard wiring uses an independent circuit for each station. Power Share can be used in combination with Power Select.

Electrical Input	One Station (AC Voltage 208 / 240V AC)			Two Stations (AC Voltage 208 / 240V AC)		
	Input Current	Input Power Connection	Required Service Panel Breaker	Input Current	Input Power Connection	Required Service Panel Breaker
Maximum 50A (Standard)	50A	One 70A/80A branch circuit	70A/80A dual pole (non-GFCI)	50A x 2	Two independent 70A/80A branch circuits	70A/80A dual pole (non GFCI) x 2
Maximum 50A (Power Share)	N/A	N/A	N/A	50A	One 70A/80A branch circuit split to two	70A/80A dual pole (non GFCI)
Power Select 16A - 48A (Standard)	16A - 48A	One branch circuit rated 125% of input current (20A - 60A)	Dual pole (non-GFCI) rated 125% of input current (20A-60A)	16A - 48A x 2	Two independent branch circuits rated 125% of input current (20A - 60A)	Dual pole (non-GFCI) rated 125% of input current x 2
Power Select 16A - 48A (Power Share)	N/A	N/A	N/A	16A - 48A	One branch circuit rated 125% of input current (20A to 60A) split to two	Dual pole (non-GFCI) rated 125% of input current (20A- 60A)

ChargePoint CPF50 Datasheet

Service Panel/Breaker GFCI	Do not provide external GFCI as it may conflict with internal GFCI (CCID)	
Wiring – Standard	3-wire (L1, L2, Earth) No neutral	3-wire (L1, L2, Earth) x 2 No neutral
Wiring – Power Share	N/A	3-wire (L1, L2, Earth) split to 3-wire (L1, L2, Earth) x 2
Station Power	2.5W typical (standby), 4W maximum (operation)	5W typical (standby), 8W maximum (operation)
Line to Ground Voltage	120V +/- 10%	

Electrical Output

Electrical Output	Single Port (AC Voltage 208 / 240V AC)	Dual Port (AC Voltage 208 / 240V AC)
Maximum 50A (Standard)	12 kW (240V AC @ 50A)	12 kW (240V AC @ 50A)
Maximum 50A (Power Share)	N/A	12 kW (240V AC @ 50A) x 1 or 6 kW (240V AC @ 25A) x 2
Power Select 16A - 48A (Standard)	3.8 kW – 11.5 kW (240V AC @ 16A - 48A)	3.8 kW – 11.5 kW (240V AC @ 16A - 48A) x 2
Power Select 16A - 48A (Power Share)	N/A	3.8 kW – 11.5 kW (240V AC @ 16A - 48A) x 1 or 1.9 kW – 5.8 kW (240V AC @ 8A - 24A) x 2

Functional Interfaces

Connector Types	SAE J1772™
Cable Length – 1.8 m (6') Cable Management	5.4 m (18')

ChargePoint CPF50 Datasheet

Cable Length – 2.4 m (8’) Cable Management	7.0 m (23’)
Overhead Cable Management System	Yes
Card Reader	ISO 15693 and ISO 14443

Indicators

WiFi LED	Yes
Fault Indicator per UL	Yes
Status LED	Yes

Safety and Connectivity Features

Ground Fault Detection	20mA CCID with auto retry
Open Safety Ground Detection	Continuously monitors presence of safety (green wire) ground connection
Plug-Out Detection	Power terminated per SAE J1772™ specifications
Power Measurement Accuracy	+/- 2% from 2% to full scale (50A)
Power Report/Store Interval	15 minute, aligned to hour
Local Area Network	2.4/5 GHz Wi-Fi (802.11 a/b/g/n)
Wide Area Network	4G LTE provided by the ChargePoint Gateway CPGWx

Safety and Operational Ratings

Station Enclosure Rating	Type 3R per UL 50E
Safety and Compliance	UL and C-UL listed; complies with UL2594, UL2231-1, UL 2231-2. NEC Article 625 compliant. For Canada CSA C22.2, No. 280, 281.1, 281.2, CED UL and C-UL listed per UL916 Energy Management Equipment

ChargePoint CPF50 Datasheet

Station Surge Protection	6 kV @ 3000A. In geographic areas subject to frequent thunder storms, supplemental surge protection at the service panel is recommended
EMC Compliance	FCC Part 15 Class B
Storage Temperature	-40ºC to +60ºC (-40ºF to 140ºF)
Operating Temperature	-40ºC to +50ºC (-40ºF to 122ºF)
Operating Humidity	Up to 95% @+50ºC (122ºF) non-condensing
Non-Operating Humidity	Up to 95% @+50ºC (122ºF) non-condensing
Maximum Charging Stations per 802.11 Radio Group	9 maximum. Each station must be located within 46 m (150’) “line of sight” of a CPGW gateway

ChargePoint, Inc. reserves the right to alter product offerings and specifications at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document

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Email sales@chargepoint.com

ENERGY STAR certified. Listed by Underwriters Laboratories Inc.

Express 250

Specifications and Ordering Information

High Power in a Small Footprint

Ordering Information

The order codes below represent specific product configurations. Other product options are available. Please contact ChargePoint Sales for information and order codes.

Hardware

Description		Order Code
Model	Express 250 Station includes 2x Power Modules, 1x CCS1 cable, 1x CHAdeMO cable (NA)	CPE250C-625-CCS1-CHD
	Express 250 Station includes 2x Power Modules, 1x CCS2 cable, 1x CHAdeMO cable (EU)	CPE250C-625-CCS2-CHD
Connector Options	Cable connectors available include CCS1, CCS2, and/or CHAdeMO. Cables can be ordered with a single connector or a combination.	Please contact ChargePoint Sales
Buy America	The Express 250 is compliant with the Federal Transportation Authority (FTA) and Federal Highway Administration (FHWA) Buy America Options.	Please contact ChargePoint Sales

Software & Services

Description	Order Code
ChargePoint Enterprise Cloud Plan *Note: Station activation is included in this plan.*	CPCLD-ENTERPRISE-DC-n*
ChargePoint Assure® — Prepaid Assure Plan for one Express 250 station. Includes Parts and Labor Warranty, Remote Technical Support, On-Site Repairs when needed, Unlimited Configuration Changes, and Reporting.	CPE250-ASSURE-n*
ChargePoint Assure® — Assure Plan for one Express 250 and invoiced annually. Includes Parts and Labor Warranty, Remote Technical Support, On-Site Repairs when needed, Unlimited Configuration Changes, and Reporting.	CPE250-ASSURE-n-COMMIT*

Commissioning Service: includes on-site validation and inspection of electrical, mechanical, installation, wiring and civil parameters for the Express 250 station.	CPE250-COMMISSIONING
Commissioning Service: includes both the installation and commissioning of the Express 250 station.	CPE250-INSTALL-COMMISSIONING

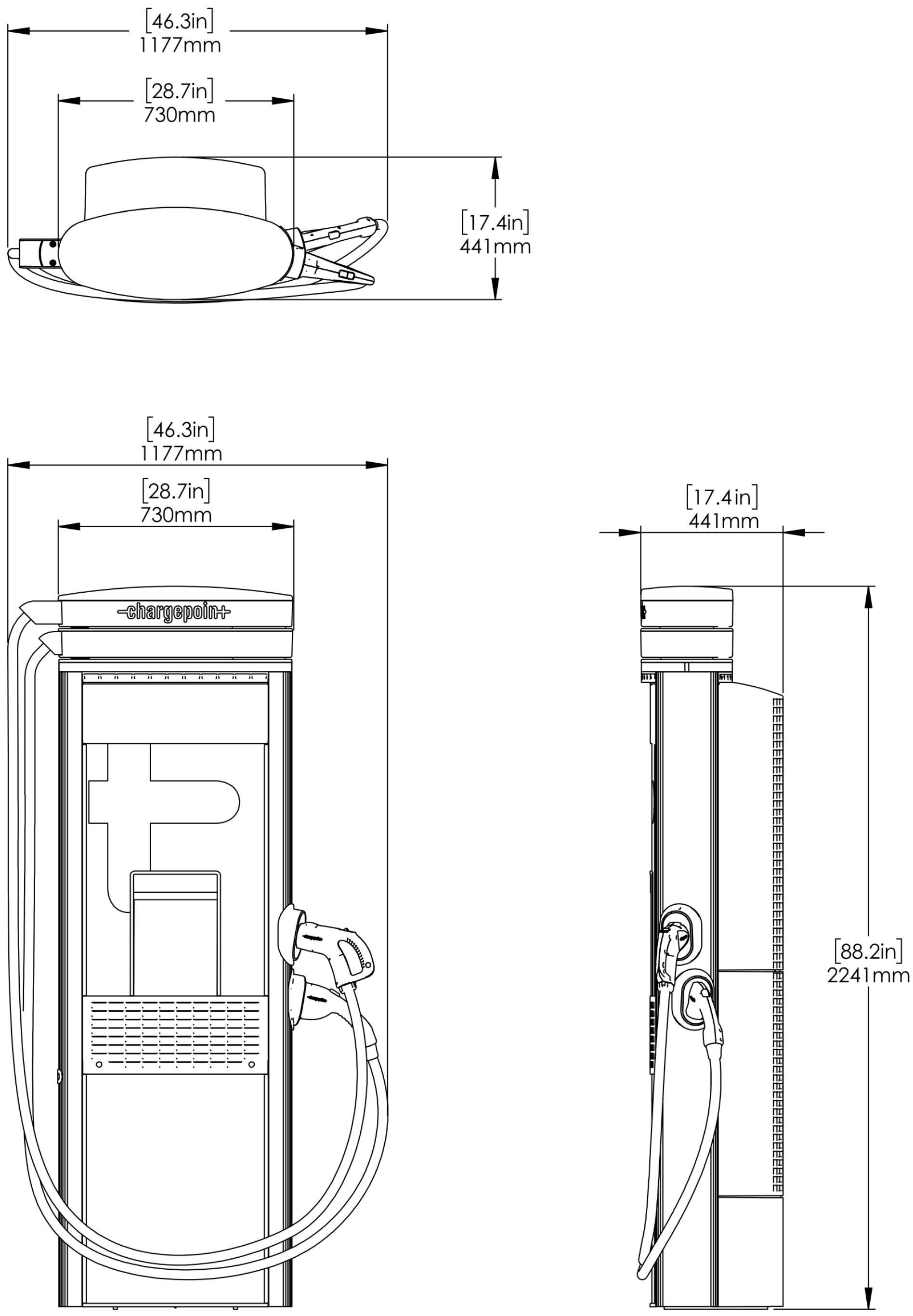
Note: All Express 250 stations require a cloud plan.

*Substitute *n* for desired years of service (1, 2, 3, 4 or 5 years).

Order Code Information

If ordering this…	…the order code is
Express 250 Station includes 2x Power Modules, 1x CCS1 cable, 1x CHAdeMO cable (NA)	CPE250C-625-CCS1-CHD

Architectural Drawings (Dimensions)



General Specifications

Station Electrical Input

Input Rating	400V AC, 3-phase, 96A, 50 Hz 480Y/277V AC, 3-phase, 80A, 60 Hz
Wiring	L1, L2, L3, Neutral & Earth

Station Electrical Output

Max Output Power	62.5 kW
Output Voltage, Charging	200–1,000V DC
Max Output Current	156A
Max Modules per Station	2

Paired Station Electrical Output

Paired Max Output Power	125 kW
Paired Max Output Current	CCS1: 174A or 200A CCS2: 200A CHAdeMO; US: 140A, EU: 125A

Power Module

Max Output Power	31.25 kW
Max Output Current	78 A
Power Conversion Efficiency	> 95%
Power Factor	0.99 at full load
Harmonics	iTHD < 5% (Complies with IEEE 519 Requirements)
Power Module Cooling	Liquid Cooling Technology

Functional Interfaces

Max Connector Types per Station	Up to two different connector types per station
Supported Connector Types	CHAdeMO, CCS1 (SAE J1772™ Combo), CCS2 (IEC 61851-23)
Cable Length with Swing Arm*	Full Horizontal Reach: 4.27m (14')
LCD Display	Full-color 254 mm (10 in) display for driver interaction
Top Display	Full-color 508 mm (20 in) LED display for notifications
Authentication	RFID: ISO 15693, ISO 14443, NEMA EVSE 1.2-2015 (UR) Tap to Charge (NFC on Apple & Android): 15118-2 (EIM) Remote: Mobile and in vehicle (if supported by vehicle)

*Horizontal reach to typical vehicle charging port: 3.76 (12'4")

Connectivity Features

Vehicle Safety Communication	CHAdeMO – JEVS G104 over CAN, CCS1 – SAE J1772 over PLC and CCS2 — IEC 61851-23
Plug-Out Detection	Power terminated per JEVS G104 (CHAdeMO), SAE J2931 (CCS1) and IEC 61851-23 (CCS2)
Local Area Network	2.4 GHz and 5 GHz WiFi (802.11 b/g/n)
Wide Area Network	4G LTE (fall back to 3G GSM)
Supported Communication Protocols	OCPP
Service and Maintenance	Remote system monitoring, diagnostic, and proactive maintenance

Safety and Operational Ratings

Station Enclosure Rating	Type 3R, IP54
Station Impact Rating	IK10
Safety and Compliance	UL and cUL listed: complies with UL 2202, UL 2231-1, UL 2231-2, CSA 107.1 CE marking: complies with IEC 62196, IEC 61851

ChargePoint Express 250 Datasheet

Station Surge Protection	Tested to IEC 6100-4-5, Level 5 (6 kV @ 3,000A). In geographic areas subject to frequent thunder storms, supplemental surge protection at the service panel is recommended.
EMC Compliance	U.S.: FCC part 15 Class A; EU: EN55011, EN55022 and IEC61000-4
Storage Temperature	-40°C to 50°C (-40°F to 122°F)
Operating Temperature	-40°C to 50°C (-40°F to 122°F)
Operational Altitude	<3,000 m (<9,800 ft)
Operating Humidity	Up to 95% @ 50°C (122°F) non-condensing

Generic Specifications

Station Enclosure Dimensions	2,241 mm H x 730 mm W x 441 mm D (7'4" x 2'5" x 1'5")
Power Module Dimensions	760 mm H x 430 mm W x 130 mm D (2'6" x 1'5" x 5")
Station Weight (without Power Modules)	250 kg (551 lb)
Power Module Weight	45 kg (98.5 lb)

Energy Management Features

Dynamic Power Management	Allows a fixed maximum power output per station or lets the system dynamically manage the power distribution per station
Remote Energy Management	Manage output power via the ChargePoint Admin Portal, API, and Open ADR 2.0b VEN

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* Listed by Underwriters Laboratories Inc.

Appendix B: Load Analysis Summary

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ELECTRICAL LOAD SUMMARY

Description	Connected Load [W]	Demand Factor[1] [%]	Load [kW]
ChargePoint CT4000 PowerShare Level 2 Charger (208V, 1Ø)	6,656	100%	6.66
ChargePoint CT4000 Dedicated Level 2 Charger (208V, 1Ø)	6,240	100%	6.24

Civic Centre - Existing Electrical Service Capacity Analysis

Electrical service (600V, 3Ø)	600 A
Electrical service 80% rated (600V, 3Ø)	480 A
Electrical service capacity	499 kVA
Maximum electrical demand load[2]	232 kVA
Electrical service load percentage	47%
Remaining Capacity for new loads	267 kVA
4x Dedicated Level 2 Chargers load	25 kVA
2x PowerShare Level 2 Charger load	13 kVA

Therefore, Electrical service has capacity for the Level 2 chargers

Notes:

1. Demand factor as per CEC Rule 8-210
2. Data retrieved from BC Hydro provided 1-year historical load information. Metering data provided at 5-min intervals. This is a risk that the maximum demand load was not captured (within 5-mins). All metering data shall be confirmed via demand load study.

ELECTRICAL LOAD SUMMARY

Description	Connected Load [W]	Demand Factor[1] [%]	Demand Load [kVA]
EVSE DCFC Dedicated (ChargePoint Express 250 66.5kVA, 80A, 480V, 3Ø)	199,532	100%	199.53
EVSE Level 2 Dedicated (ChargePoint CPF50, 10.4kW, 50A, 208V, 1Ø)	52,000	100%	52.00

Public Works Yard - Existing Electrical Service Capacity Analysis

Electrical service size (208V, 3Ø)	400 A
80% of electrical service (208V, 3Ø)	320 A
Electrical service capacity	115 kVA
Maximum electrical demand load[2]	70 kVA
Electrical service load percentage	61%
Remaining capacity for new loads	45 kVA
Total potential EVSE load	252 kVA
Main service spare capacity after EVSE installation	-206 kVA

Therefore, an electrical service upgrade is required.

Public Works Yard - Proposed EVSE Dedicated Electrical Service Analysis

Total potential EVSE load (2027 EVSE Expansion)	252 kVA
Total potential EVSE amps (208V, 3Ø)	698 A
Min. electrical service 80% rated (208V, 3Ø)	873 A
Recommended electrical service 80% rated (208V, 3Ø)	1,200 A
Main service spare capacity after EVSE installation	94 kVA
Total potential EVSE load (2032 EVSE Expansion)	358 kVA
Recommended electrical service 80% rated (208V, 3Ø)	1,600 A
Main service spare capacity after EVSE installation (2027 EVSE Expansion)	210 kVA

Notes:
1. Demand factor as per CEC Rule 8-210
2. Data retrieved from BC Hydro provided 1-year historical load information. Metering data provided at 5-min intervals. This is a risk that the maximum demand load was not captured (within 5-mins). All metering data shall be confirmed via demand load study.

ELECTRICAL LOAD SUMMARY

Recreation Complex - Existing Electrical Service Capacity Analysis

Electrical service (480V, 3Ø)	3,000 A
Electrical service 80% rated (480V, 3Ø)	2,400 A
Electrical service capacity	1,995 kVA
Maximum electrical demand load[2]	741 kVA
Electrical service load percentage	37%
Remaining Capacity for new loads	1,254 kVA

Notes:

1. Demand factor as per CEC Rule 8-210
2. Data retrieved from BC Hydro provided 1-year historical load information. Metering data provided at 5-min intervals. This is a risk that the maximum demand load was not captured (within 5-mins). All metering data shall be confirmed via demand load study.

ELECTRICAL LOAD SUMMARY

Inlet Centre Fire Hall - Existing Electrical Service Capacity Analysis

Electrical service (208V, 3Ø)	600 A
Electrical service 80% rated (208V, 3Ø)	480 A
Electrical service capacity	173 kVA
Maximum electrical demand load[2]	70 kVA
Electrical service load percentage	41%
Remaining Capacity for new loads	103 kVA

Notes:

1. Demand factor as per CEC Rule 8-210
2. Data retrieved from BC Hydro provided 1-year historical load information. Metering data provided at 5-min intervals. This is a risk that the maximum demand load was not captured (within 5-mins). All metering data shall be confirmed via demand load study.

ELECTRICAL LOAD SUMMARY

Public Safety Building - Existing Electrical Service Capacity Analysis

Electrical service (208V, 3Ø)	1,600 A
Electrical service 80% rated (208V, 3Ø)	1,280 A
Electrical service capacity	461 kVA
Maximum electrical demand load[2]	88 kVA
Electrical service load percentage	19%
Remaining Capacity for new loads	374 kVA

Notes:

1. Demand factor as per CEC Rule 8-210
2. Data retrieved from BC Hydro provided 1-year historical load information. Metering data provided at 5-min intervals. This is a risk that the maximum demand load was not captured (within 5-mins). All metering data shall be confirmed via demand load study.

ELECTRICAL LOAD SUMMARY

3016 Murray St - Existing Electrical Service Capacity Analysis

Electrical service (240V, 1Ø)	300 A
Electrical service 80% rated (240V, 1Ø)	240 A
Electrical service capacity	58 kVA
Maximum electrical demand load[2]	13 kVA
Electrical service load percentage	23%
Remaining Capacity for new loads	44 kVA

Notes:
1. Demand factor as per CEC Rule 8-210
2. Data retrieved from BC Hydro provided 1-year historical load information. Metering data provided at 1-hr intervals. This is a risk that the maximum demand load was not captured (within 5-mins). All metering data shall be confirmed via demand load study.

Appendix C: BC Hydro 1-Year Historical Consumption Summary

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Load Analysis Summary - Maximum Electrical Demand Load

Location	1-Year Net Consumption (kWh)	Max of Demand (kW)	Average of Power Factor (%)	Sum of Net Consumption (kVah)	Max of Demand (kVA)
Civic Centre	819714	206	92.7	882858	231.7
Public Works Yard	287321	69.7	95.8	297398	70.0
Recreation Complex	2788906	693	91.5	3023170	741.2
Inlet Centre Fire Hall	265291	67	96.1	276342	70.1
Public Safety Building	739110	84	96.0	768670	87.5
3016 Murray St	34892	13	Unknown[1]	Unknown[1]	Unknown[1]

Notes:

1. Data was not made avaialble by BC Hydro.

Appendix D: Conceptual Design Public Works Yard Site Plan and Single Line Diagram

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ISSUED FOR CLIENT REVIEW
NOT FOR CONSTRUCTION

LINE TYPE LEGEND	
———	ABOVE GROUND CONDUIT/CABLE
— —	BELOW GROUND CONDUIT/CABLE
SINGLE LINE DIAGRAM	
(M)	ELECTRICAL METER
SPD	SURGE PROTECTION DEVICE
	FUSE
	DISCONNECT SWITCH
DMS	DIGITAL METERING SYSTEM
	CURRENT TRANSFORMER
	BREAKER
	DELTA-WYE TRANSFORMER
	GROUNDING

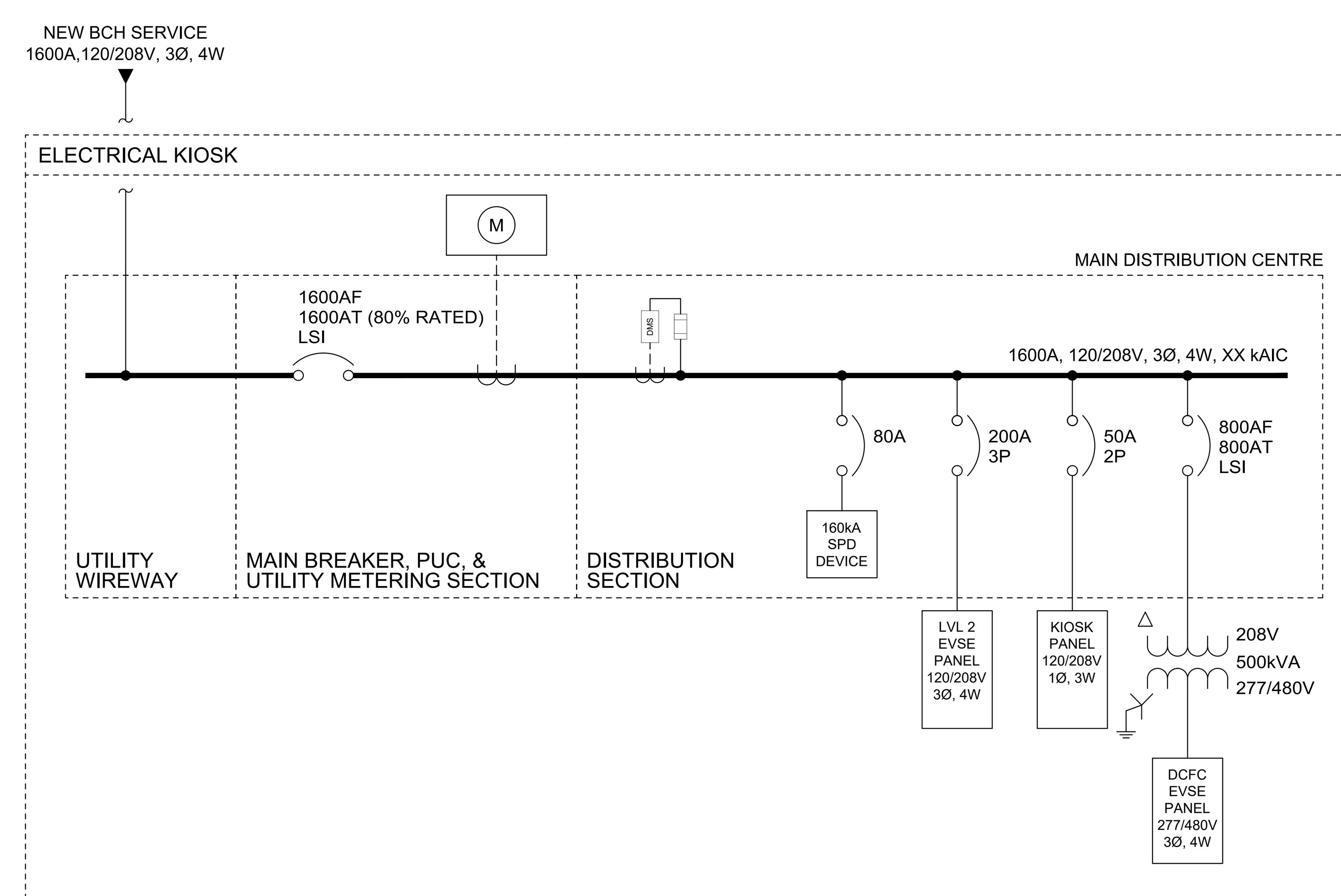
PBX ENGINEERING
PBX ENGINEERING Ltd.
Suite 201 - 2612 Bridge St.
Victoria BC, V8T 4S9
Tel 250.388.7222

CLIENT

PORT MOODY City of the Arts

DETAIL 1 - SITE PLAN PUBLIC WORKS YARD
1:400

0 1:400 20



DETAIL 2 - SINGLE LINE DIAGRAM
N.T.S.

PBX ENGINEERING LTD.
PERMIT TO PRACTICE NUMBER:
1000208

Rev.	DATE	ISSUE / REVISION
PA	23/09/22	CONCEPTUAL DESIGN

DRAWN BY	DESIGNED BY	APPROVED BY
DGH	DGH	RA

PROJECT NUMBER	SCALE
220496	AS SHOWN

PROJECT

PORT MOODY
FLEET ASSESSMENT

TITLE

CONCEPTUAL DESIGN -
SITE PLAN &
SINGLE LINE DIAGRAM

DRAWING NUMBER	REV.
E101	PA

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APPENDIX E: INDUSTRY BEST PRACTICES

Port Moody Fleet Assessment

Best Practices Review

Completed By: Steven Wiebe

Date: November 14, 2022

To assist the City of Port Moody in its goals to reduce fleet emissions and develop a fleet strategy, Innotech Fleet Strategies has contacted numerous municipalities of various sizes across Canada. It's anticipated that this will give a broad understanding of what other municipalities have implemented and where they have observed success. During this best practices review it was apparent that a matrix or table style comparison was not suitable to accurately convey which best practices are successful, nor would it be useful in completing an "apples to apples" comparison. The approach used is to list each municipality that was contacted and outline as program they have found successful. Specific carbon emission reductions from each program have also been difficult to quantify as the municipalities do not have data systems where they can directly track and correlate each initiative and the associated carbon reduction. However, where feasible, qualitative reduction targets have been provided. The population of each municipality is also provided for references. This information is then aligned to what is considered feasible for the City of Port Moody considering its size, resources and cost benefit for each best practice.

Green Procurement Policy – City of Burlington
Public Works Fleet size - 250
Population – 183,000

The City of Burlington has implemented a Green Procurement Policy as well as Green Procurement Guidelines. These documents outline the practices of all departments and sections within the city who wish to procure goods and services. The Policy outlines the objectives to ensure the City acquires sustainable products and services and references several standards by which the sustainability of a product or service can be measured. The Guidelines provide information to employees to educate them on what Green Procurement means, why it's important and misleading or false information that respondents may provide as part of their bids.

Impact: *Low*
Cost/Resources: *Low*

Ease of Implementation: *Moderate*

Anti - Idle Policy and Practices – City of Saskatoon
Public Works Fleet size - 850
Population – 273,000

The City of Saskatoon, like many other municipalities, has an antiquated anti-idle policy that is not monitored or enforced. Considering some of the additional challenges with their winter climates and the zero emission vehicles or renewable fuels, they have decided to invest in anti-idle as a way to reduce their carbon emissions. In an effort to resurrect the anti-idle policy they have implemented GPS systems on their fleet and developed an idle report for Operational Managers. This will allow Managers to create awareness with staff, understand their department idling behaviours and work one on one with staff who may not be following the policy. At this point in time, they are in the initial stages of rolling out the reporting. Despite the fact there is no emission reduction data or organizational feedback, a good anti-idling program can reduce emissions by 5-10%.

Impact: *Low*
Cost/Resources: *High*
Ease of Implementation: *Moderate*

Green Fleet Plan – City of Victoria
Public Works Fleet size - 216
Population – 92,000

The City of Victoria's Green Fleet Plan was completed in 2021. This Plan outlines their roadmap to electrification, City wide charging infrastructure requirements, funding requirements, and other fleet focused carbon reduction strategies. This report outlined recommended actions throughout 2022 and 2023 to help the City meet it's emission targets. The actions are smart goals based on industry best practices that have been aligned with the City's current state. The fleet electrification plans are very aggressive and target a 707 tonne reduction in carbon emissions by 2030. This Plan is still in its infancy so long-term success is difficult to measure, but it gives clear objectives that have been adopted into work plans.

Impact: *High*
Cost/Resources: *High*
Ease of Implementation: *High*

Sustainable Fleet Reserve Analysis – District of Saanich
Public Works Fleet Size - 204
Population – 119,000

The District of Saanich recognized the need to change fleet replacement reserve funding models in anticipation of the incumbent fleet being replaced with electric vehicles. The replacement reserve fund is used for the capital cost of replacement vehicles which for EV's can be anywhere from 1.5-3x the capital cost of a comparable vehicle with an internal combustion engine. The analysis identified shortfalls in funding for the replacement reserve and resulted in operational groups who use vehicles to be paying the full cost of ownership for that vehicle plus a technology inflationary amount that will help to offset the incremental cost of EV's. While this was a controversial project, it did outline the true cost of operating a fleet. When this cost was highlighted and accurately billed to operational departments, some departments requested disposal of assets that were underutilized as they could no longer justify the cost. This reduced the size of the fleet by approximately 5%.

Impact: *Moderate*
Cost/Resources: *Moderate*
Ease of Implementation: *Moderate*

Fleet Procurement Committee – Metro Vancouver
Public Works Fleet size - 500
Population – 2.5 million

Metro Vancouver has taken steps to implement a Fleet Procurement Committee. This is a widely popular approach by a number of other municipalities that generally includes representatives from Fleet, Sustainability, Operations and Finance. This Committee makes recommendations on vehicle, fuel type, specifications, and others when a municipality is either replacing one of its vehicles or purchasing additional vehicles. Historically, Operations and Fleet defined the vehicles to be purchased and the decisions had a very operational centric focus, however, this Committee approach ensures that corporate priorities and good business cases are considered as part of the decisions.

Impact: *Moderate*
Cost/Resources: *Low*
Ease of Implementation: *Low*

Employee Carpool Program – City of Richmond
Public Works Fleet size - TBD
Population – 216,000

The City of Richmond established an employee carpool program in 1997. The program uses 17 City vehicles and allows carpool program applicants to use a City vehicle to commute to and from work. There must be a minimum of three employees per vehicle to be considered. The program has 80 participants and 70 additional on a wait list. While this does not directly reduce corporate carbon emissions it does reduce community emissions and reduces the number of nighttime parking spaces required for fleet vehicles at municipal facilities.

Impact: *Low*
Cost/Resources: *Moderate*
Ease of Implementation: *Moderate*

Telematics – City of Vancouver
Public Works Fleet size – 1,400
Population – 675,000

The City of Vancouver has had telematics installed on their municipal vehicles for over 5 years. The telematics system has allowed them to gain insight and data on the use of the fleet and idling behaviour. With this data they have been able to develop targeted behaviour-based programs such as anti-idling and driver training with a focus on fuel efficient driving practices. While the data allows them insight into driver behaviour, changing driver behaviour requires significant and consistent effort and management. One of the more effective uses for telematics from a carbon reduction perspective is it's use for route optimization. Route optimization can easily result in ten percent or greater fuel savings. It also has the added benefit of reducing vehicle mileage which reduces maintenance, reducing the time operators spend driving which leads to higher productivity, and more consistent service times for customers. In the City of Vancouver, the management of driver behaviour data and route optimization is managed by departments responsible for the service, not the Fleet department. While the installation and use of telematics requires joint effort from many departments, including fleet, the key to successful use for carbon reduction initiatives is that the departments responsible for the services must take an active role in reviewing and managing both the data and their operators.

Impact: *High*
Cost/Resources: *Medium*
Ease of Implementation: *Low*

The best practices and behaviour-based programs showcased above demonstrate what other municipalities have implemented. In conducting this research, it was apparent that municipalities on the west coast are much more progressive in the carbon reduction initiatives they undertake. Some of these initiatives are a result of the mild climate, but much of it seems to be a result of provincial government policies as well as the progressive nature of the population. The City of Port Moody already has an excellent foundation that will allow it to implement any of the listed best practices. Corporate Policy EDMS#452201 for Vehicles and Equipment is a great document for a city the size of Port Moody. All of the other municipalities contacted as part of the best practices review are much larger than Port Moody. The larger size doesn't necessarily mean the initiatives they undertake are superior, it usually only means the effort required for the initiative is much higher as they have more vehicles, more staff and more customers to manage.

APPENDIX F: POOL FLEET ANALYSIS

Port Moody Fleet Assessment

Pool Fleet Analysis

Completed By: Steven Wiebe

Date: January 2, 2023

As part of City of Port Moody's Fleet Assessment project an analysis for a small pool fleet of vehicles has been completed. This analysis explores the option of implementing a small number of electric vehicles that would be open for all staff to use. Staff would be able to reserve one of these vehicles and use it for transportation to meetings, site assessments, or for any other work purposes. For the scope of this analysis only cars have been considered as the intent is for the vehicles to be for office-based staff. They are not recommended for spare vehicles for use by labourers, trades people or other similar outside workers as they will not be suitable for transporting construction tools or appropriate for dirty clothing.

The City currently has a service with Modo and a program for mileage reimbursement for the use of personal vehicles. Data shows that he Modo service is rarely used and personal vehicles seem to be the mode of choice for staff. Data from 2017 to 2019 was used as it's believed to be more reflective of vehicle use moving forward. 2020 and 2021 data was not used as the COVID 19 had severely impacted normal office staff habits and transportation.

A total cost of ownership model was developed to compare the use of City owned pool cars and use of staff vehicles. A Chevrolet Bolt is used as the sample City owned vehicle as it is an economical, roomy, and has sufficient range for most staff trips. An average of 5,000km per year was used as it is a suitable mileage to use for pool vehicles in a municipality with a small geographical area. The below cash flow and total cost of ownership (TCO) shows the cost of the vehicles, maintenance, electricity (both power and demand) and end of life salvage value. Two vehicles have been modeled as purchased in 2023 with an additional one in 2024. This allows the City to review the use of the initial 2 vehicles before purchasing a third. It is also assumed that the vehicles will use the charging stations that are already installed at City hall or other City owned facilities.

Use of staff vehicles shows that staff rely heavily on their own vehicles for work use. From 2017-2019 there was a total of 84,000 km accumulated on staff vehicles, and the City reimbursed just over $47,000 for this use. There were also 510 unique accounting transaction for this use. These transactions can have a notable impact on staff use of resources and time for completing mileage reimbursement forms, approval of these forms and processing. To represent this resource impact, a value of $50 per transaction has been used for the TCO. It's also recognized there will still be some cases where staff need to use their own vehicle even with the availability of a pool fleet. Pool vehicles may not be available, or staff may have unique circumstances where they need to use their own vehicle. It was assumed the providing pool cars would result in a 60% reduction of staff vehicle use.

In the table below it can be seen how costly staff vehicle use is to the City. This is represented by the last row in the table and it's important to note again, that the cost show below is only 60% of the average annual cost to the City.

Vehicle	**TCO**	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1	**39,348**	35,108	1,141	1,175	1,210	1,247	1,284	1,323	1,362	1,403	(2,991)	
2	**39,348**	35,108	1,141	1,175	1,210	1,247	1,284	1,323	1,362	1,403	(2,991)	
3	**40,528**		36,161	1,175	1,210	1,247	1,284	1,323	1,362	1,403	1,445	(3,081)
Pool Total	**119,224**	**70,216**	**38,443**	**3,526**	**3,631**	**3,740**	**3,853**	**3,968**	**4,087**	**4,210**	**(4,536)**	**(3,081)**
Staff Veh	**160,216**	18,315	18,865	19,431	20,014	21,233	21,870	22,526	23,201	23,898		

The benefits associated with use of a pool fleet instead of personal vehicles or Modo include the following:

1. All trips are zero emissions – as the vehicles are electric, all trips with them will be zero emissions. Modo and personal vehicles are not necessarily electric which means vehicles used under the current model may range from a large diesel pickup truck to a small electric car. By developing a pool fleet the carbon emissions from the vehicle can be controlled and with the use of an electric vehicle the emissions are zero.
2. Noise reduction – Similar to the zero emissions point above, by providing an electric vehicle for staff use, it reduces reliance on personal vehicles that can range from loud to quiet. Every trip with the electric vehicle is now almost silent. This reduces noise emissions in the community.
3. Vehicles are branded with Port Moody logos – when staff are representing the City at meetings, events or various other sites, they can be identified as City staff. This has the benefit of the City's presence being more visible at important events, whether it be from the staff member arriving in a branded vehicle or the vehicle simply parked outside of the event. Branded vehicles can be particularly important for any meetings where staff have to enforce any sort of policy, bylaw, common practice, etc. The branded vehicle provides an immediate image of City presence when a staff arrives which can be helpful when delivering information that may be unpopular.

4. Staff have more options to use active transportation to get to work – by providing staff with a vehicle to use for work purposes, this may reduce their need to drive their own personal vehicle to work. For staff who are committed to a healthy lifestyle and reducing their carbon footprint, this may allow them to use alternative methods of transportation to get to work. Alternative methods could be walking, cycling, taking the bus, or any other method that doesn't require a personal vehicle.
5. Improved safety and security – when staff use their own personal vehicle, the vehicle may be an older vehicle with limited safety features. An electric vehicle would have the latest in safety features such as emergency braking, lane departure assistance, stability control, energy absorbing crumple zones, etc. A pool vehicle will also eliminate the possibility for a staff members identity or home address to be determined based on their personal vehicle or license plate. For staff such as bylaw enforcement this provides additional piece of mind during potentially tense bylaw meetings.
6. Reduced resource use for mileage reimbursement – By providing a company vehicle for staff use, it reduces the resources needed to process mileage reimbursement forms. Time saved includes the time a staff member uses to fill out the form, processing by Accounts Payable, any approvals required and payment.

APPENDIX G: STAKEHOLDER MINUTES

Meeting Minutes

Port Moody Fleet Assessment
Kickoff Meeting
Date: September 13, 2022
Time: 1pm to 3 pm

Attendees	Department	Position	Email Contact
Jeff Little	Engineering & Operations	Manager, Operations	jlittle@portmoody.ca
Val Tepes	Community Services	Manager, Facilities	vtepes@portmoody.ca
Michael Blackstock	Port Moody Police	Fleet Coordinator	mblackstock@portmoodypolice.com
Travis Carrol	Port Moody Police	Inspector, Administration Services	travis.carroll@portmoodypolice.com
Laura Sampliner	Community Development	Senior Sustainability & Energy Coordinator	lsampliner@portmoody.ca
Arzan Balsara	Community Development	Sustainability & Energy Coordinator	ABalsara@portmoody.ca
Kelly McMillan	Engineering & Operations	Supervisor, Fleet Services	kmcmillan@portmoody.ca
Paul LeBlanc	Engineering & Operations	Manager, Solid Waste, Fleet, & Shared Services	pleblanc@portmoody.ca
Steven Wiebe	Innotech Fleet Strategies	Managing Director	swiebe@innotechfleet.com
Sasha Pejcic	EVENERGI / Better Fleet	Managing Partner, North America	spejcic@evenergi.com
Brian Putre	EVENERGI / Better Fleet	Director – Zero Emissions Transportation	bputre@evenergi.com
Darren Gervais-Harrison	PBX Engineering	Design Engineer	darren.gervais-harrison@pbxeng.com
Absent			
Jeff Moi	Engineering & Operations	GM	jmoi@portmoody.ca
Jason Harper	Port Moody Fire Rescue	Deputy Fire Chief, Operations & Technical Services	jharper@portmoody.ca
Raj Atwal	PBX Engineering	Principal & Senior Design Engineer	raj.atwal@pbxeng.com

1 Introductions

All attendees introduced themselves as per the attendee list above.

2 Strategic Link and Goals

Paul spoke about the importance of the carbon reduction goals set out by the federal and provincial governments. These goals are reflected by the Port Moody Sustainability targets and the positive impact these will have on operations. There is a lot of support by City Executives and council on these goals.

3 Review of Project Scope & Schedule

Steve reviewed the project scope including the following:

- Scope includes the following vehicles/equipment: Police, Fire, Works Yard and Administrative vehicles.
- Goals include 40% of passenger vehicles and 25% of commercial vehicle electrified by 2030; 40% reduction of 2007 carbon emissions by 2030.
- Project should review all vehicle technology options including electric, hydrogen, CNG, propane, gasoline, diesel and other alternative fuels.
- Scope for charging infrastructure only includes the charging station selection, maintenance and cost modeling. Power assessments, engineering design, installation costs, etc are out of scope.
- Any recommended technology changes that results from the review should not put emergency vehicles or their operations at risk of not being able to perform at least as well as gasoline/diesel equivalents.

Paul added that the scope also needs to include:

- Review of behaviour change initiatives, such as anti-idling
- Identification of gaps in the fleet or policies
- Review of overall vehicle quantities and recommendations on any reduction or increase to vehicle levels.
- Review of the possibility for a small shared pool fleet of vehicles. They currently use car share for this type of service.

Steve reviewed the 4 phases of the project and the schedule. The schedule is attached at the end of the meeting minutes.

4 Overview of Port Moody Operations

Paul provided a high-level overview of operations. All vehicle are operational vehicles and therefore there is very little redundancy for breakdowns or maintenance. Vehicle maintenance takes place at the Works Yard where there is a 3 bay maintenance shop. The Works Yard is already challenged for space therefore any recommendations for additional infrastructure at the Works Yard will need to consider this constraint.

Port Moody is geographically small therefore vehicles generally have low mileage. Because of this the main factor for replacement is age, not mileage. Despite the flow mileage the majority of these vehicles are critical for operations and maintaining city infrastructure.

Solid Waste - Paul

- 5 fully automated curbside collection refuse trucks
- 4 routes with 1 spare truck
- 10 hour shifts, 4 days per week
- Trucks are used from approx. 7 am to 4 pm daily
- Average daily mileage is 100-120 km
- These are the most maintenance intensive vehicles
- Employ approximately 1-2 mechanics full time
- There are also Ford F150 and F350 trucks for public waste including bus shelter litter bins
- Occasionally these vehicles are used for special event support

Public Works Operations– Jeff Little

- Approx 20 vehicles assigned to PW Operations
- The majority of vehicles include tandems, backhoes, ½ and ¾ tonne pickups
- There are 2 x 8 hour shifts. First shift starts at 6:15 am; Second shift starts at 7 am.
- All tandems and F550 trucks have setups for hydraulic tools.
- There is one sweeper
- There is one response vehicle which is a Ford Transit Van
- New vehicles/equipment generally sits too long before it is used. Operators seem to like the old equipment better.

Police – Travis and Michael

- Fleet consists of 30 vehicles
- 8 leased vehicles used for major crimes. These vehicles are rotated regularly and generally replaced after 4 years.

- 9 front line vehicles. These are used 24/7 and some accumulate approx. 3,500km per month. They are outfitted with lights, sirens, rumblers, prisoner partitions, etc. These are replaced approx. every 5 years.
- 1 motor cycle that is not used very often as it has no prisoner partition.
- 1 trailer
- 3 community vehicles
- 1 unmarked traffic vehicle
- Various other vehicles including Chief, Deputy Chief, and admin
- Police vehicles are maintained out of the Works Yard. They also fuel there, but can fuel at gas stations if required.

Fire – Kelly

- There are 2 fire halls and vehicles are split among them. Each hall has 2 pumper trucks.
- Pumper trucks have a 25 year life
- Fire also has pickups and F550s
- Fire Chief has a vehicle that is taken home
- There is a command unit that is generally low mileage
- One of the F550 trucks is outfitted as a hook lift. The hook lift options include a wildfire setup, generator, etc.
- They have one inflatable zodiac with jet
- 2 enclosed trailers. One is for hazmat; the other is for wildland fires.
- 1 UTV

Parks – Paul

- Lots of F series trucks
- 1 small EV. This is the CANEV Mighty Truck and it is used heavily.
- Tractors for grass cutting, including a John Deere 1575 for multi-use
- Commercial grade battery hand tools. While tools are out of scope it would be beneficial if they could be charged on the vehicle.
- 2 leased F150s.
- Slow season is Nov – Mar, however, Parks is working to be a full year operation.

Bylaw – Paul

- They use a transit connect and Ford Focus EV

Community Services – Paul

- They have a single van that is low mileage

5 Facilities Discussion

Val is responsible for all facilities including parking and electrical infrastructure. He indicated they currently have a few City owned charging stations located at City Hall, Works Yard, Rocky Point Park and Rec Centers. One of these stations is DC fast charge. Chargepoint is the provider and all chargers are networked, however, they are open to exploring other charging infrastructure suppliers. The maintenance model on these chargers has simply been a fix on fail model to date. Chargers are purchased with a 5 year warranty and most costs to date have been under warranty. However, some charging stations are already 10 years old.

Val indicated that all facilities are close to their maximum electrical capacity. They are also all limited on space and would not have room for installing fueling infrastructure for CNG or hydrogen.

Darren gave an overview of the 3 levels of charging stations currently available including level 1 which is 120 volt and charges a passenger vehicle in 12-20 hours; level 2 which is 240 volt and chargers a passenger vehicle in 6-14 hours; and level 3 (also known as DC fast charge).

6 Experience with Alternative Fuel Vehicles to Date

Port Moody staff discussed their experience and biases with various fuel types.

- Hydrogen – this is a large investment for fueling station, there is no third party fueling station near by and there are limited vehicles available.
- CNG – There is limited space to install a fueling station, CNG is seen as an interim solution and does not get them to zero Carbon.
- Renewable diesel – the City of Vancouver is using this and has numerous Engineers monitoring the program. There are concerns around Port Moody's lack of resources to monitor and collect data for trends and possible fuel related vehicle issues.
- Biodiesel – Port Moody sees this as a favourable option as B5 is already in use. There is a possibility to increase to B10 or B20.
- Electric – Port Moody is comfortable with passenger cars and ½ tonne pickups. There are concerns about being first adopters for other vehicles. The vehicles must work and they can't afford the downtime often associated with new, unproven technologies. These vehicles are also often needed for responding to disasters which are unpredictable and the vehicle must be ready to go.
- Hybrids – this is seen as a positive technology as the technology is mature. With the slow speed and low mileage of vehicles this can also provide a significant opportunity for fuel savings.

7 Key Stakeholders

A discussion was had about who the key stakeholders for this project are. In addition to the people invited to the meeting we also discussed, union representation, BC Hydro, neighbouring communities (PoCo and Burnaby), Metro Van, and Finance. The union is already represented through some of the attendees and BC Hydro will be engaged by Port Moody at the end of the project. The project team will compile a stakeholder chart showing the involvement of all stakeholders discussed.

8 Better Fleet Software Overview

Brian provided an overview of the Better Fleet system. This included detailed vehicle analysis as well as a summary of entire fleet changes and the impact on Carbon emissions and costs.

9 Next Steps

Steve spoke about the project next steps which include a project plan and stakeholder meetings. While there was a lot detailed information provided in this meeting, there will be a few more small group stakeholder meetings required for additional info (such as with Fire). Outside of these few small group stakeholder meetings, the next large group meeting is expected to be after completion of the Better Fleet analysis and draft options.

Meeting Minutes

Port Moody Fleet Assessment
Finance – stakeholder engagement
Date: November 9, 2022
Time: 1:30 pm to 2 pm

Attendees	Department	Position	Email Contact
Tyson Ganske	Finance	Manager, Financial Systems	tganske@portmoody.ca
Jack Mai	Finance	Business Analyst	jmai@portmoody.ca
Paul LeBlanc	Engineering & Operations	Manager, Solid Waste, Fleet, & Shared Services	pleblanc@portmoody.ca
Steven Wiebe	Innotech Fleet Strategies	Managing Director	swiebe@innotechfleet.com
Brian Putre	EVENERGI / Better Fleet	Director – Zero Emissions Transportation	bputre@evenergi.com

1 Introductions

All attendees introduced themselves as per the attendee list above. Steve shared the scope of the project and outlined the desire to understand Port Moody's vehicle replacement funding model, constraints and any planning that has already been done for conversion to electric and its higher CAPEX.

2 Financial Replacement Model Discussion

The following points were outlined and discussed by all attendees:

- Can be compared to an amortized layaway plan with replacement provisions in department budgets that are transferred to the replacement reserve.
- Most of the reserve is funded through tax with the exception of Solid Waste vehicles which are funded through utilities.
- Replacement plan assumes like for like replacement of vehicles and accounts for general inflation, but not the increased CAPEX associated with electric vehicles.
- Significant increases to reserve contributions will require Council approval.
- The capital replacement plan consists of a relatively detailed vehicle by vehicle replacement for the immediate five years. A long-range plan with less accuracy and detail is also completed to model reserve health for 25 years.

- Generally, the model has a smooth contribution that minimizes impacts to property taxes. Annual vehicle replacement spending can have spikes as requires based on operational need.
- Vehicle replacements can be delayed or accelerated with relative ease as long as annual budget is managed. Significant changes in annual budget, such as the need to replace an expensive vehicle due to a catastrophic failure, require one-off council approval.
- The Solid Waste fleet is funded through the utility which allows for some additional flexibility for budgeting. The high capital cost of electric and the expected lower operational costs can be considered independently for this fleet if council approves the recommendations that will result from completion of this project.

Meeting Minutes

Port Moody Draft Fleet Recommendations and Scenarios
Progress Meeting
Date: November 29, 2022
Time: 1pm to 2:30 pm

Attendees	Department	Position	Email Contact
Jeff Little	Engineering & Operations	Manager, Operations	jlittle@portmoody.ca
Jeff Moi	Engineering & Operations	GM	jmoi@portmoody.ca
Jason Harper	Port Moody Fire Rescue	Deputy Fire Chief, Operations & Technical Services	jharper@portmoody.ca
Michael Blackstock	Port Moody Police	Fleet Coordinator	mblackstock@portmoodypolice.com
Travis Carrol	Port Moody Police	Inspector, Administration Services	travis.carroll@portmoodypolice.com
Laura Sampliner	Community Development	Senior Sustainability & Energy Coordinator	lsampliner@portmoody.ca
Arzan Balsara	Community Development	Sustainability & Energy Coordinator	ABalsara@portmoody.ca
Kelly McMillan	Engineering & Operations	Supervisor, Fleet Services	kmcmillan@portmoody.ca
Paul LeBlanc	Engineering & Operations	Manager, Solid Waste, Fleet, & Shared Services	pleblanc@portmoody.ca
Steven Wiebe	Innotech Fleet Strategies	Managing Director	swiebe@innotechfleet.com
Sasha Pejcic	EVENERGI / Better Fleet	Managing Partner, North America	spejcic@evenergi.com
Absent			
Val Tepes	Community Services	Manager, Facilities	vtepes@portmoody.ca
Brian Putre	EVENERGI / Better Fleet	Director – Zero Emissions Transportation	bputre@evenergi.com
Darren Gervais-Harrison	PBX Engineering	Design Engineer	darren.gervais-harrison@pbxeng.com
Raj Atwal	PBX Engineering	Principal & Senior Design Engineer	raj.atwal@pbxeng.com

1 Introductions

Attendees who hadn't previously met introduced themselves.

2 Review of Project to Date

Steve spoke about the work completed on the project to date. This included the following tasks:

- Fleet data collection and review – fuel use, mileage, vehicle numbers, maintenance costs, vehicles used in emergency scenarios, home parking locations, etc.
- Best practices review from across Canada. Port Moody already has a very progressive policy with its vehicle and equipment policy.
    - Green fleet purchasing policy – Burlington
    - Anti-idle policy – Saskatoon
    - Green Fleet Plan – Victoria
    - Fleet reserve replacement analysis – Saanich
    - Procurement committee – Metro Van
    - Employee carpool – Richmond
    - Telematics use – Vancouver
- Low carbon fuels review
    - Hydrogren
    - CNG/RNG
    - Propane
    - Biodiesel
    - Electric
    - Renewable diesel
- Charging station overview

Based on this background information the project team has agreed to move forward with analysis of vehicle electrification supplemented by renewable diesel for additional carbon reduction.

3 Better Fleet – Overview of analysis and draft electrification plan scenarios

Sasha presented the Better Fleet model and scenario planning. The model baselines current fleet for carbon emissions, outlines 3 scenario options and will provide replacement recommendations by year as well as annual cash flow and annual carbon emissions reduction. At this point the analysis was only about 50% complete. Completion of analysis and summary of results is expected mid December.

4 Next Steps

Steve indicated that planned next steps are as follows:

- Finalize Better Fleet analysis and summary of results
- Develop pool fleet implementation analysis
- Review and develop GHG targets
- Develop risk matrix and mitigation strategies for EV and renewable diesel
- Set up meeting with Fire and separate meeting with Fleet to review detailed plan
- Develop final draft report with all project findings and recommendations – estimated completion end of December
- Develop presentation for Council and attend Council meeting – date TBD.

5 Roundtable

Comments and discussions were as follows:

- Jeff Little – question about ?
- Travis Carrol and Michael Blackstock – Brought up the different requirements for police vehicles including fast charging. The EVs that are Michigan State tested (Tesla and Ford Mustang) are too small for prisoner compartment for front line vehicles. Would like to see larger vehicles such as SUV used for frontline, when available as EV options.

  Open to testing EV for some Admin or detective vehicles if TCO is beneficial. These vehicles are used less frequently and can accommodate the time required for charging.

- Jason Harper – Fire light duty fleet shouldn't be an issue to electrify. For heavy fleet there are only a few production units in North America so they are likely years away from being proven.
- Jeff Moi – brought up a few questions about charging infrastructure and the BC Hydro EV fleet incentive. These were out of scope, and proposed as an optional task under the contract. Port Moody staff were going to discuss internally. Jeff mentioned that if the Fleet Assessment is going to Council, Council will likely want to see a more comprehensive plan that includes the ability to charge vehicles and infrastructure requirements. Paul and Laura mentioned that Facilities is working on a separate project as well. Steve mentioned that it would also be prudent to develop a charging strategy such as single charger per vehicle (networked), use a staff member to transfer charging port to other vehicles, etc. Laura and Paul talked about consideration for return on investment with charging infrastructure of the works site is moved.
- Kelly McMillan – discussed concerns around warranty and training for EVs. Current warranty repairs at dealerships are generally several weeks before the vehicles can even be looked at. If

EVs move towards requiring all vehicle services and repairs be completed at a dealer then there may be impacts to vehicle availability. Mack is requiring their EV truck to return to the dealer for all services and repairs. Steve mentioned there are several EV training options coming to market including BCIT, UAPNAPA, and another mobile training provider. These concerns will be added to the risk assessment for the project.
A question about recycling of lithium batteries was also asked. There are several options including Li-cycle, but no awareness of any large scale local Vancouver options. The recycling industry is expected to continue to grow and be able to meet demand in the coming years. Laura mentioned they had created a EV recycling guide a few years ago for light vehicles.

- Laura Sampliner – asked about the methodology for carbon emissions calculations. Better Fleet was provided with the following https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/methodology/2020-pso-methodology.pdf.
- Arzan Balsara – asked about what carbon pricing model was used and whether it will be considered in the renewable diesel calculations. Carbon pricing is based on Canadian carbon pricing models increasing from $50/tonne to $170/tonne in 2030. It will be considered in the renewable diesel calculations.

APPENDIX H: CITY POLICIES

Corporate Policy

100 Newport Drive, Port Moody, BC, V3H 5C3, Canada
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Section:	Engineering, Operations, and Public Works	11
Sub-Section:	Fleet	5230
Title:	Vehicles and Equipment	2021-01

Related Policies

Number	Title
05-2020-01	Tangible Capital Assets
03-1200-01	Purchasing
EDMS#452201	Vehicle and Mobile Equipment Program

Approvals

Approval Date: April 6, 2021	Resolution #: *CW21/036*
Amended:	Resolution #:
Amended:	Resolution #:
Amended:	Resolution #:

Policy Statement

The City of Port Moody is committed to providing a safe, practical, cost effective, and sustainable vehicle and equipment fleet that meets the City's requirements. The size of the fleet and the cost to operate it represents a level of service to the community that is set by Council. This policy provides the framework for meeting this commitment and the foundation for the City's Administrative Policy for Fleet Services operations, with the aim of providing excellent service to User Departments.

Definitions

Vehicle and Equipment Fleet (Fleet) means all vehicles and powered equipment utilized by User Departments that require ongoing support via a centralized service. This may include, but is not limited to, the following equipment: heavy trucks, construction equipment, passenger vehicles, mobile generators, and ride-on or hand-held construction and maintenance equipment (e.g. lawnmowers and emergency water pumps).

User Departments means City departments using City-owned vehicles and equipment that are administered through Fleet Services, plus other City departments (Police, Fire) whose self-procured units are maintained through Fleet Services.

Telematic Devices (TD) means wireless devices, including global positioning systems (GPS), that track information on vehicle and equipment fleet use, location, and activity, and transmit data to a central application.

Scope

This policy includes principles that guide the procurement, operation, maintenance, repair, and disposition/replacement of the City's vehicle and equipment units. Overall fleet management and maintenance operations are detailed in Administrative Policies.

Policies

The following policies guide the overall management and maintenance of the City's Vehicle and Equipment Fleet.

1. Working Towards a Green Fleet
   The City shall pursue Green Fleet principles (reduced fleet size, reduced emissions, greater fleet-sharing, alternative technologies, etc.), supported by business-case and life-cycle analysis. Use of new technologies, such as electric, hybrid, and alternative fuel vehicles, will be considered for each purchase, taking functional and economic constraints into account. In cases where alternative equipment may provide a lower environmental impact at a higher capital cost, the City shall consider funding a portion of the purchase from other relevant sources (e.g. via a carbon offset reserve fund).

2. <u>Right Sizing the Fleet</u>
The City shall optimize fleet size by eliminating or redeploying under-utilized vehicles and encouraging shared vehicle use across User Departments.

3. <u>Continuously Reviewing the Functionality of Individual Units</u>
The City shall ensure that the size and functionality of individual vehicle and equipment units is aligned with the required uses, and shall review this each time equipment is renewed to ensure it continues to efficiently meet the needs of the User Department. The City shall consider future service areas or emergency needs and technologies that may be required by the User Department within the next vehicle or equipment life cycle.

4. <u>Strategically Planning Vehicle Ownership (ownership vs. lease)</u>
The City shall procure units in the most cost-effective manner, with the aim of minimizing life-cycle costs and risks. The City shall generally consider leasing equipment that is required on a temporary basis or has associated uncertainty, and outright purchasing equipment that will be required on an ongoing basis.

5. <u>Maintaining Equipment to Ensure Safety and Reliability, and to Extend Life Cycles</u>
As Equipment requires scheduled preventative maintenance and reactionary maintenance to ensure ongoing service, the City shall perform most vehicle and equipment maintenance and repairs internally via the Fleet Services Division, with external providers used for some specialty and overflow work and while manufacturer warranty provisions are in effect.

6. <u>Establishing and Following Service Priorities</u>
The City shall schedule and provide vehicle service and repairs according to priorities and service levels agreed upon between User Departments, taking into account the criticality of Fleet vehicles and equipment such as emergency units (police, fire, and urgent-use units such as those used for snow response).

7. <u>Ensuring Safe Vehicle and Equipment Operations</u>
The City shall operate units safely, in accordance with the City's existing policies, equipment training and sign-off procedures, and vehicle operating guidelines. The City shall monitor for irregular safety patterns or trends and adjust programs or Fleet units as appropriate.

8. <u>Replacing Vehicles and Equipment at the Right Time</u>
The City shall extend individual unit life cycles through appropriate initial outfitting, regular maintenance and repair, and responsible operating practices. The City shall consider industry recommended standard useful lives to budget for Fleet unit replacements, but consider multiple factors prior to initiating replacement, including:

    - current mechanical condition and reliability – amount of use, severity of conditions, and other factors that may allow extending the equipment life or could require accelerating replacement;

- functional suitability – over time, the needs and services provided by the User Department can change; consider whether equipment is no longer serving its current need or if it overserves the need, and consider a more efficient or practical option; and
- regulatory environment – new government regulations, such as environmental or safety requirements, that may necessitate early replacement of equipment.

9. <u>Monitoring Fleet Use, including Use of Telematic Devices</u>
Collection, monitoring, and analysis of related data is required to support the principles as outlined above. Telematic Devices shall be installed in all new and replaced fleet vehicles and equipment, where such devices are practical to install (small equipment such as lawnmowers and pumps may not warrant the cost or complexity), to provide utilization and other real-time and historical information. The City shall also monitor data sources, including historical maintenance costs, City safety and accident data, and ICBC claim data.

10. <u>Self-Insuring with the Vehicle Collision Reserve</u>
The City shall maintain the Vehicle Collision Reserve, which can be used to self-insure against minor vehicle collisions or vehicle damage in an effort to reduce overall insurance claims and maintain the lowest possible rates/premiums. This reserve will be used based on discussion between the Fleet manager and the Finance Division on a case-by-case basis to achieve the best overall long-term value for the City. This reserve will continue to be funded through the Fleet Premium Adjustment Agreement through the Insurance Corporation of British Columbia (ICBC).

Monitoring/Authority

Monitoring of this policy is delegated to the General Manager of Engineering and Operations and the General Manager of Finance and Technology. Changes to this policy require approval of Council.