EV CHARGER RETROFIT STRATEGY OPTIONS FOR MULTI-USE RESIDENTIAL BUILDINGS IN NEW WESTMINSTER

Prepared by: Drew Séguin, UBC Sustainability Scholar
Prepared for: Penny Page-Brittin, Community Energy and Emissions Specialist, City of New Westminster

August 15th, 2023

1 DISCLAIMER

This report was produced as part of the UBC Sustainability Scholars Program, a partnership between the University of British Columbia and various local governments and organisations in support of providing graduate students with opportunities to do applied research on projects that advance sustainability and climate action across the region.

This project was conducted under the mentorship of City of New Westminster staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of the City of New Westminster or the University of British Columbia.

NEW WESTMINSTER

UBC sustainability

2 ACKNOWLEDGEMENTS

The author recognises and respects that New Westminster is on the unceded and unsurrendered land of the Halkomelem speaking peoples and acknowledges that colonialism has made invisible their histories and connections to the land.

The author also acknowledges that they operate on the traditional, ancestral and unceded territory of the kʷikʷəƛəm (Kwikwetlem First Nation). The author thanks the kʷikʷəƛəm who continue to live on these lands and care for them, along with the waters and all that is above and below.

The author thanks the UBC Sustainability Scholar Program, Faculty of Applied Science, and City of New Westminster for all their support and guidance throughout the creation of this project. The author would also like to thank the following individuals for their contributions, support and insights that made this project successful: Leya Behra, Ryan Coleman, Brendan McEwen, Reid Arkinstall, and Kate Lewis. Finally, the author would like to thank Penny Page-Brittin from the City of New Westminster Planning Dept. for her continual support, guidance, and know-how, without which this project would not have been possible.

Cover image by CHUTTERSNAP on Unsplash

3 TABLE OF CONTENTS

4 LIST OF FIGURES

5 LIST OF TABLES

1 EXECUTIVE SUMMARY

In an effort to curb local greenhouse gas emission (GHG) production, many cities have begun implementing strategies to facilitate the transition to zero-tailpipe-emission electric vehicles (EV). In New Westminster, B.C., a goal of 50% of kilometres driven by light-duty vehicles must be completed by EV's by 2030. As more EVs become commercially available, providing adequate access to at-home charging has become a major hurdle to widespread adoption. In New Westminster, nearly 70% of residents live in multi-use residential buildings (MURBs), most of which require retrofits to implement EV charging. MURB retrofits present several unique challenges to charger installation due to their technical complexity and management structure.

This report examines the current landscape of Canadian electric vehicle charging incentivization and policy in the context of retrofitting MURBs, and summarizes findings from a literature review, case study analysis, and interviews with local stakeholders. Six Canadian jurisdictions were reviewed to inform current best-practices, and a review of existing incentives available to New Westminster's residents was completed. Findings suggest that there are several barriers to a successful EVSE MURB retrofit program – especially given the brevity required to meet New Westminster's 2030 timeline projections.

The analysis concludes that several key challenges exist for New Westminster to meet their MURB EVSE retrofit goals. A list of barriers has been determined, summarized into four distinct categories: technical challenges, financial challenges, challenges pertaining to strata corporations, and equity considerations. Findings suggest that all barriers are addressable and makes a series of recommendations to solve each challenge.

The report makes the following recommendations for New Westminster as they develop their MURB EVSE retrofit strategy:

1. Consider procuring a detailed electrical inventory for MURBs
2. Consider developing a city-approved, standardized list of EVSE & EVEMS technology
3. Consider limiting strategy to 100% EV-Ready options
4. Consider providing online informational resources
5. Consider providing holistic energy assessments to MURBs
6. Consider providing a "future-proof" retrofit advisor service for MURBs
7. Consider providing an independent financial benefit to MURBs

2 GLOSSARY OF TERMS

DCFC – (Direct Current Fast Charging) an electric vehicle charger that typically provides a charging power of 20 kW to 49 kW, equating to roughly 400 km of range per hour [1]

DCFC+ – (Direct Current Fast Charging Plus) an electric vehicle charger that typically provides a charging power of 50 kW to 350 kW, equating to roughly 400 km of range per hour [2]

DSM – (Demand Side Management) refers to technology that utilities can communicate with on the 'demand side' of electrical distribution, in this case to manage electricity usage according to a plan or algorithm that typically is used to minimize grid impacts

EV – (Electric Vehicle) in the case of this report EV will be used to describe Battery Electric Vehicles (BEVs), excluding plug-in hybrid electric vehicles (PHEVs)

EVEMS – (Electric Vehicle Energy Management System) refers to a variety of technologies that distributes and controls the amount of electricity going to multiple EVs connected to the same energized outlet [2]

EVSE – (Electric Vehicle Supply Equipment) includes physical charger as well as necessary infrastructure/wiring to electric panel

EV-Ready – A term used to describe a parking spot or garage that has all the necessary infrastructure for EVSE implementation, minus the charger itself

GHG – (Greenhouse Gas Emissions) generally measured in metric tonnes of CO_2 or $CO_{2,equivalent}$ emitted

Level 2 (L2) Charging – An electric vehicle charger that typically provides a charging power of 3.3 kW to 7.2 kW, equating to roughly 40 km of range per hour [3]

MURB – (Multi-Unit Residential Building) considered as low-, mid-, or high-rise apartment buildings with shared underground or above-ground parking

ZEV – (Zero Emission Vehicle) used to describe vehicles that produce no tailpipe emissions, such as BEVs and hydrogen-propelled vehicles

NRCan – (National Resource Council of Canada), provider of the federal Zero Emission Vehicle Infrastructure Programs

3 INTRODUCTION

In British Columbia, light-duty transportation is one of the main sources of CO_2 and other GHG emissions [4]. As the climate crisis intensifies and the profound effects of increasing atmospheric GHG emissions begin to unfold in British Columbia, municipalities have begun to identify and explore ways to enable reductions in local transportation emissions to comply with provincial and federal climate targets for 2030 and 2050 [5].The City of New Westminster has identified 7 Bold Steps for Climate Action [6] that serve as the framework to reduce the city's emissions by 45% by 2030 from 2010 levels, which is further supported by the Community Energy and Emissions Plan 2050 (CEEP) [7]. Step #4, Pollution Free Vehicles, prescribes 50% of kilometres driven by 2030 by light-duty vehicles be completed by zero emission vehicles (ZEVs).

The City of New Westminster developed an eMobility strategy [3] in part to support this Bold Step, which provides an in-depth analysis on how to feasibly accomplish these goals. The strategy suggests a focus should be placed on maximizing the sales of EVs, whereby 2030 93% of new cars purchased must be ZEVs. The widespread adoption of EVs will need to be supported largely by at-home charging, as it was found to be unfeasible to support this level of EV ownership by public charging [3]. Nearly 70% of New Westminster residents live in multi-unit residential buildings (MURBs) [8]. Most MURBs have not been designed to account for the large electric demand increase brought on by EV charging, thus understanding the technical, financial, and policy-induced barriers to retrofitting MURBs with electric vehicle supply equipment (EVSE) must be understood if the City is to meet their 2030 goals.

3.1 Objective

The purpose of this research project is to develop a strategic EV charger retrofit Strategy for MURBs in New Westminster. The research identifies barriers in MURB EV charger retrofits and recommends solutions, by exploring best policy and incentive practices in Canadian jurisdictions, case studies of successful MURB EVSE retrofits in the Lower Mainland, and interviews with local consultants and stratas. Recommendations are contextualized to the City of New Westminster's specific needs for MURB EVSE retrofits and support New Westminster's climate goals.

3.2 Research Methodology

Research was conducted in the form of a literature review using resources available in the public domain, as well as a series of interviews with industry subject matter experts and other stakeholders. The two main phases are summarized as:

a) **Phase 1:** Background review of New Westminster policy and goals & literature review of:
    a. Multiple Canadian jurisdictions best practices
    b. Case study identification and analysis
    c. Interviews with local consulting firm, BCHydro, and strata council members
b) **Phase 2:** Identification of challenges, barriers, and potential solutions

4 BACKGROUND

As with most sustainable energy solutions, the implementation of an EV charging strategy depends highly on the socio-economic & environmental factors of the area in which it is situated. To maintain cost- and resource efficiency and technical efficacy, a large portion of completed research focused heavily on the local contexts in which the City of New Westminster sits.

4.1 Contextualizing New Westminster

The City of New Westminster is located in the Lower Mainland of British Columbia, bordering the Fraser River in the middle of Greater Vancouver. 2021 census data [8] reports a population of 78,916 residents, with a five-year growth of 11.2%, over double the national average and one of the fastest growing urban areas in the Lower Mainland.

Figure 1: City of New Westminster, from [9]

Due to the population rapid growth combined with a relatively high urban density, MURBs are extremely common with over 69.5% of the city's residents living in apartments [10] . With such a significant portion of residents living in rental or strata-managed buildings with shared parking, they are a central focus of the city's Bold Step goal of pollution-free vehicles. While the city did introduce policy that stated all MURBs built after April 1st, 2019, are required to be 100% EV ready (supply level 2 charger capability to each residential parking stall in a MURB), the average age of buildings with 4 or more residential units is 43 years old. Therefore, the majority of building managers/stratas will need to conduct building retrofits if they are to supply L2 EV chargers for their residents. The City's eMobility strategy found that the ability to charge at home is the most effective way to support the ZEV transition, and that 95% of all parking stalls in MURBs must be retrofitted by 2030 in order to accomplish this goal. Furthermore, an effective solution is only achieved by implementing L2 or higher, as Level 1 may not provide adequate charge overnight after daily use [3]. This requirement

introduces a host of electrical capacity-related challenges at the building level, which will be discussed later on.

Over 50% of MURBs in New Westminster are managed by stratas and should be considered an integral component of the city's strategy; Much of the complexity and unique challenges introduced by MURBs stem from the fact that they are managed by stratas. Recent amendments to Bill 22, BC's Strata Property Amendment Act, has introduced several changes that are intended to facilitate the implementation of EVSE retrofits in MURBs. As of May 11th, 2023, strata corporations may now approve key EV charging decisions by majority vote as opposed to the usual ¾ vote [11], including decisions regarding contingency reserve expenditure on electrical reports regarding EVSE installation, the management of EVSE infrastructure, and alterations of common property in regard to EVSE infrastructure. It has been indicated that later this year, strata corporations will also be required to obtain an electrical planning report to understand their capacity needs for electrification of large systems such as EVSE, heat pumps, etc. The significance of this change cannot be overstated, as this is a key step to achieving multiple of New Westminster's climate action goals. Bill 22 changes have played a significant role in the recommendations made in this report.

New Westminster is set apart from most cities in British Columbia by the fact that it has its own electric utility; New Westminster Electrical Utility operates independently and is not regulated by the British Columbia Utilities Commission, rather by a local utilities commission. This places New Westminster in a unique position where residents can make use of certain provincial programs but can act in a more agile fashion to provide additional electrical connection support to its citizens. Combining the advanced analysis of New Westminster's eMobility strategy with the agility of full control over the City's electrical utility may allow for unique solutions to be taken in a timeframe that is conducive to meeting a goal that is less than 7 years away.

4.2 MURB Age in New Westminster

As mentioned in the Background section, a building inventory analysis showed that the average age of a residential building in New Westminster with more than 4 units is 43 years old. However, this data is somewhat skewed by several older buildings, and it can be seen below that over 35% of buildings were built after 1997, with only a small portion of these buildings being built after April 1st, 2019, when the mandatory EV-ready bylaw was put in place.

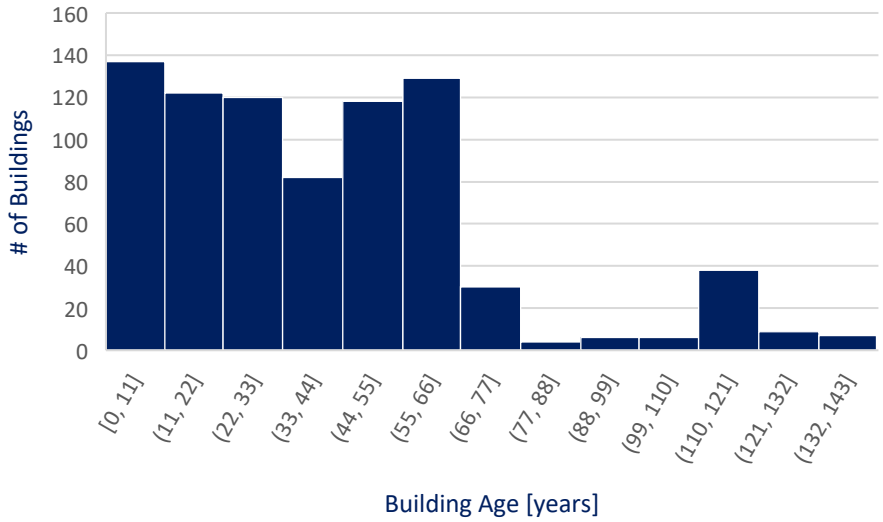

Figure 2: New Westminster Building Age Distribution w/ Greater than 4 Residential Units

When analyzing for buildings with 4 or greater floors, over 75% of buildings were built after 1990. These buildings, considered mid- to high-rise buildings, are more likely to have underground parking which increases complexity i.e., service room limitations, cellular/internet communication reception. Note the heavy presence of strata vs. rental buildings from 1980 onward; This data will factor heavily in both the barriers that New Westminster face and recommendations given.

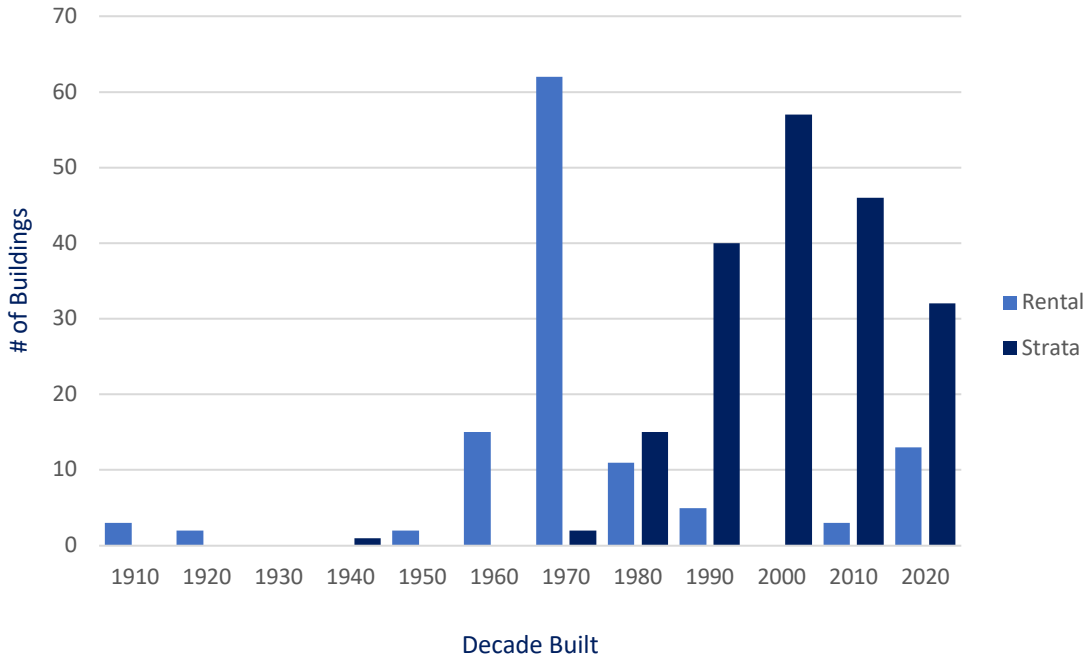

Figure 3: New Westminster Building Age Distribution with Greater than 3 Floors

5 MURB RETROFITS – TECHNICAL CONSIDERATIONS

The following section is a short summary of the basic technical considerations and processes for charger installation & configuration. There is no one-size-fits-all solution for any building retrofit, and EVSE installation is no exception. The installation process of providing large-scale EV charging to a MURB can vary drastically depending on the buildings pre-existing electrical infrastructure, parking lot construction and layout, parking tenure agreements, and more. All of these considerations are highly unique to a specific building, and thus each building requires consultation from an engineering firm and an electrician, and even charging product vendors if specific smart solutions are chosen by the strata or building management council. There are usually several different setups a strata or property manager may choose from, depending on cost, complexity, and availability preferences.

5.1 Classification of EVSE Retrofits

There are three main levels of EVSE infrastructure that can be installed, each with a degree of 'readiness' a building may choose to pursue, each providing a different level of service to residents; They have been summarized below. It should be noted that partial EV-readiness is not recommended in MURBs as studies have shown [12] that in the long-term, it is not nearly as cost-effective as fully EV-ready and can cause financial inequity to residents, as those with the financial means to immediately buy EVSE equipment and support the retrofits will receive the majority of the benefits of provincial or local incentives.

Infrastructure Installation Type	*Potential Capacity Upgrades*	*Conduit & Dedicated Circuit*	*Wiring + Outlets*	*Charger Install*
Partial EV-Ready	Yes	Yes (Partial)	Yes (Partial)	No
100% EV-Ready	Yes	Yes	Yes	No
Fully Installed EVSE	Yes	Yes	Yes	Yes

Table 1: Different EVSE Infrastructure Installation Options for a MURB

In 2021, the BCIT Smart Microgrid Applied Research Team (SMART), in partnership with AES Engineering, conducted several demonstration EVSE retrofit projects in MURBs in the Lower Mainland. The objective of the study was to reduce apparent barriers to large-scale EV charger retrofits in strata-owned MURBs, and demonstrate EV

infrastructure solutions that are "interoperable, minimize grid-impacts, and improve the customer's charging experience" [12]. A summary of the benefits of 100% EV-Ready retrofits has been adapted from their work and shown below; this is why government recommendations tend to neglect partial retrofits. Electric Vehicle Energy Management Systems (EVEMS) technologies are discussed in more depth in the following section. A full review of this case study is provided in Appendix 2.

Consideration	*Comprehensive 100% EV-Ready Retrofits*	*Incremental Additions of EVSE*
Life-Cycle Cost per Parking Space	Less expensive, when designed with appropriate levels of load sharing and EVEMS.	More expensive over time, assuming that most vehicles in multifamily buildings will ultimately be EVs.
Process	One-time significant electrical renovation.	Repeated electrical renovations.
Location of Charging Stations	In drivers' assigned parking space.	Often initially in commonly accessible parking (e.g. visitor parking). Sometimes in assigned parking.
Process for Drivers to Install Chargers	Simple (after initial comprehensive electrical renovation). An EVSE compatible with the buildings' EVEMS will be installed.	Typically lengthy and complicated.
Convenience	Highly convenient for drivers, EV charging in regular assigned parking spot.	When chargers are located in commonly accessible parking (e.g. visitor parking), scheduling can be less convenient
Futureproofing	With EVEMS, frequently can ensure sufficient electrical capacity for all parking spaces to have EV charging.	Initial installations are sometimes not compatible with later expansion (e.g. may not leave electrical capacity or physical space). Potential for stranded assets. Potential to exhaust limited electrical capacity if design for EVEMS not considered.
Market Adoption	Where incentives are available (e.g. BC's EV Ready Rebate program) 100% EV Ready retrofits are growing more common, but still nascent.	Typical approach to adding EV charging in existing multifamily buildings.
Electrical Permit	Typically, only a single electrical permit is required.	New electrical permits will be required for each electrical renovation.

Table 2: Partial vs.100% EV-Ready MURB Retrofit Comparison, adapted from [12]

5.2 EVSE Configurations in MURBs

Much of this section is based off information found in *Electric Vehicle Charging Infrastructure in Shared Parking Areas: Resources to Support Implementation & Charging Infrastructure Requirements,* a publicly available document made available by the City of Richmond. Readers are encouraged to consult this document for more information.

There are several different configurations a building may choose from depending on the individual needs of the parking garage/lot, capacity available, and the mandate from the local utility. While there are technical nuances that lead to many technically different configurations, basic EVSE implementations may be summarized as following:

5.2.1 Dedicated Circuit EVSE

The most basic layout, where each stall that is being supplied with power for a charger has its own dedicated branch circuit. This configuration offers the highest level of performance, allows each resident to use their own brand of charger, requires no additional hardware, and does not require intervention control from a service or utility.

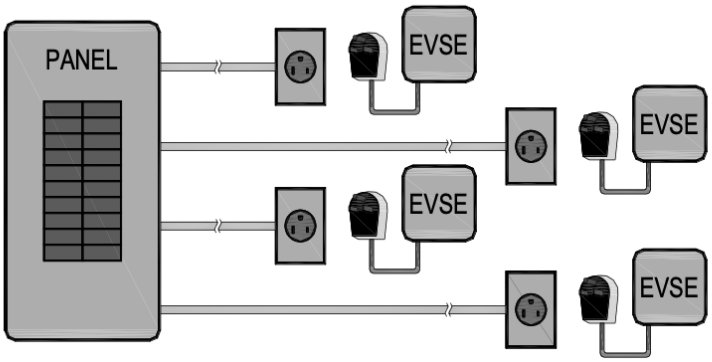

Figure 4: Dedicated Circuit Diagram, from [13]

This configuration also maximizes the amount of power used at any given time, and does not have any sort of load limiting, making it the most likely to exceed a building's available capacity.

5.2.2 Static Load Management EVSE

This layout employs a very basic form of load-sharing in which stalls are paired up between one or two residents, each stall having its own EVSE, connected by a junction box. There are only two possible charging configurations: one stall receives 100% of available capacity, or each stall receives 50% of available capacity.

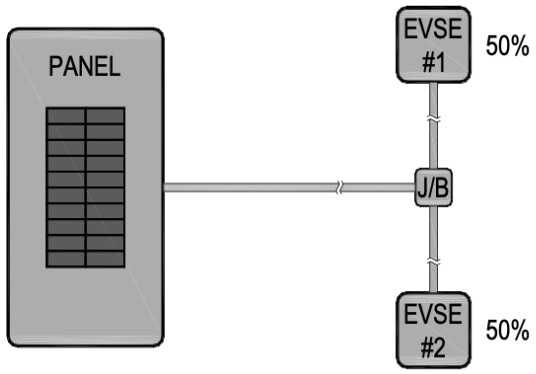

Figure 5: Static Load Management Diagram, from [13]

This is a very cost-effective method to share load between EVSE's as it requires no additional hardware, however this configuration is limited by the lack of EVEMS and is not encouraged for MURB residential charging due to the reduction in available power compared to other solutions.

5.2.3 Dynamic/Panel Load Management EVSE

Dynamic and panel load management EVSE are increasingly becoming the preferred configurations for MURBs for their balance of moderate cost and performance. Both systems leverage available capacity with the charging demands of each EV and are very effective at managing charging when building capacity is limited. While each EV may have poorer charging service overall, this configuration ensures effective use of 100% of the building's pre-determined capacity and more advanced scheduling algorithms may be used.

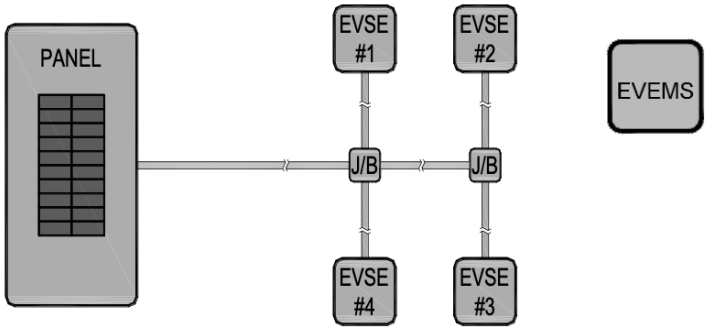

Figure 6: Dynamic Load Management Diagram, from [13]

This configuration is what most 100% EV-Ready MURB retrofits employ. Despite the popularity, these systems also have drawbacks, requiring additional EVEMS that need

cellular connectivity to communicate with off-site servers and may have associated server fees. This reliance on proprietary software and systems can limit versatility and lifespan, a major issue discussed in the *Barriers* section.

5.2.4 Building Demand Load Management EVSE

The following configuration, while very rare, offers the greatest optimization of electrical infrastructure and maximizes charging by using circuit sharing combined with maximizing the available capacity to the EVSE panels by monitoring the entire building's electricity use, and allocating as much capacity as possible. While this configuration is CSA approved, it is still considered advanced and is not a viable solution for retrofits that need to start happening as soon as possible. These systems can also send communications with the electric utility that monitor the entire distribution grid's demand and optimize or shift power delivery to the MURB, known as demand response.

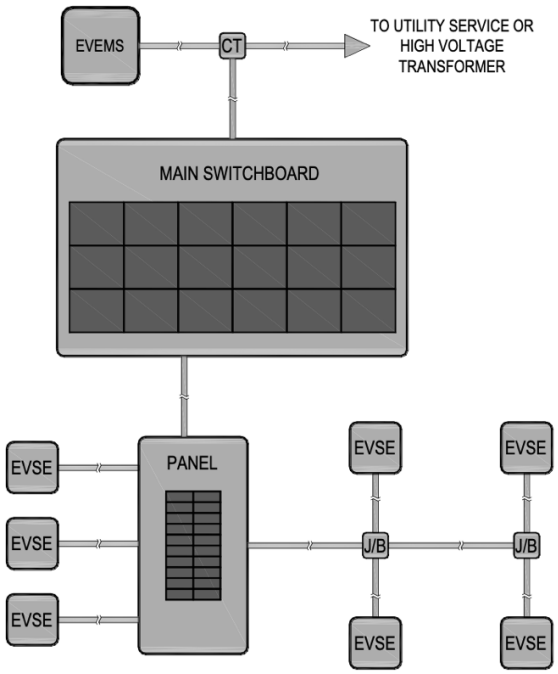

Figure 7: Building Demand Load Management Diagram, from [13]

6 RESEARCH SUMMARY

The following section is a short summary of the research conducted to inform this report. The detailed results and findings from the research portion of the project are presented in Appendices A and B.

6.1 Best Practices Findings

A total of 6 jurisdictions were reviewed for this report, with each city or area employing a different method of incentivization for EVSE MURB retrofits. For a full findings report, see *Appendix A*. A brief report of each is listed below:

6.1.1 City of North Vancouver

In a complement to the CleanBC Go Electric program the city offers additional top-up's totalling to a maximum of $158,000 for eligible buildings, requiring no additional paperwork or applications [14]. The city also places a large emphasis on community engagement with events, surveys, and input on the city's Climate and Environment Strategy.

6.1.2 City of Vancouver

The City of Vancouver has an equivalent goal to New Westminster's *Bold Step* on kilometres driven by EV's but takes the unique approach of incentivizing EVSE MURB retrofits by offering a co-operative program where the city installs its' own charger infrastructure in MURBs and operates them independently [15]. It is likely that the city is using current Low Carbon Fuel Standard regulations [16] to recuperate costs and eventually make a profit from charging EV's.

6.1.3 City of Richmond

While no extra incentive program has been introduced, the city is promoting the CleanBC program and contributing to MURB EVSE retrofit knowledge for municipal governments; much of the background information contained in this report was based on information from their reports created with AES Engineering.

6.1.4 Greater Toronto & Hamilton Area

The GTHA supports EVSE MURB retrofits through a non-profit called *The Atmospheric Fund*, providing a similar rebate program to British Columbia with different rates, and allowing investment in DCFC(+) EVSE as well as L2. There is also a focus on supplying lower-income regions with more support as a part of their application progress.

6.1.5 City of Toronto

While the city's main focus is on increasing public charger access to citizens, they do offer a MURB EVSE loan program for building owners which offers low-interest loans based on property value. The city also offers an online retrofit informational resource[1] to building owners, similar to BC's plug-in BC service.

6.1.6 Québec

The province of Québec has introduced a MURB retrofit program for EVSE as a part of their 2030 Green Economy Plan [17], supporting L2 installations in MURBs with rebate amounts varying with the number of dwellings in the building. This initiative is unique in Canada, as it resets every fiscal year, so the same building may take advantage of rebates multiple times.

6.2 Incentives for MURB Retrofits in New Westminster

In British Columbia, there is a large push toward mass EV adoption to meet provincial GHG reduction goals for 2030 [18]. The electrification of transportation is especially effective in B.C. in reducing overall emissions, as over 98% [5] of electricity delivered in the province is done so without emitting CO2 or other greenhouse gases. As a result, the B.C. government has implemented the CleanBC Go Electric EV charger rebate program, which supports individuals, stratas, businesses, and indigenous communities.

The goal of the Provincial program is to reduce the high financial barrier of entry to EV charging by partnering with the two main electricity supplies, BC Hydro and FortisBC and supplying various forms of rebates for the aforementioned groups, not only for charger installation but also associated planning and infrastructure costs. These rebates,

[1] pointA.ca

shown in the figure below, can help subsidize L2 charger retrofits in MURBs dramatically and thus is the backbone of most municipalities' current strategies in Metro Vancouver. Additionally, Plug-in BC currently offers strata advising resources[2] and Metro Vancouver offers basic online instructional resources[3] to EV owners, strata councils, and property managers to help guide them through the process. Though the City of New Westminster has its own utility, through the development of agreements with BC Hydro, all residents qualify for the incentives administered through BC Hydro:

EV Ready Rebates	***Standalone EV Charger Rebates***
• Up to $3,000 for EV Ready Plan • Up to $120,000 for EV Ready Infrastructure • Up to $14,000 for chargers	• Up to $14,000 for chargers
TOTAL : $137,000 per apartment/condo complex	TOTAL : $14,000 per apartment/condo complex

Table 3: Maximum Rebate Amounts for Clean BC's Go Electric Rebate program from BC Hydro

It should be noted that the program is currently on standby, and no new applications are currently being accepted. There is no information as of the writing of this report suggesting whether the program will continue shortly or has ended permanently. Naturally, as a provincially mandated incentive, limited budgets combined with a lack of publicly available updates can create confusion and uncertainty, something a municipality should ideally avoid if they are to implement a local incentive program.

Municipalities may also apply for the federal Zero-Emissions Vehicle Infrastructure Program (ZEVIP). The federal ZEVIP program is a nationally funded program put forth by NRCan and is intended for large-scale EV infrastructure projects across the country. While condo boards may apply for this fund, it is largely intended for municipal and provincial groups to use and distribute for EV charger projects. An example of a successful ZEVIP application is presented in the Findings section of this report.

[2] https://pluginbc.ca/ev-advisor-service/
[3] http://www.metrovancouver.org/services/air-quality/climate-action/climate-solutions/ev-strata-condo/Pages/default.aspx

7 CHALLENGES & BARRIERS

The following section is a culmination of barriers identified for the city of New Westminster from a best practice review, interviews, and strata consultation.

7.1 Technical Barriers

The following section describes the main challenges and barriers that New Westminster faces regarding the technical implementation of widespread retrofits. While these challenges largely are induced by cost constraints and not a lack of technology, it is pertinent to describe best practices that will allow for a substantial amount of buildings in New Westminster to be retrofitted before 2030. As noted in New Westminster's eMobility Strategy, a significant portion of stalls in MURBs need to be retrofitted annually, so there is an emphasis on solutions that can be implemented as soon as possible and adhere to the trajectory below.

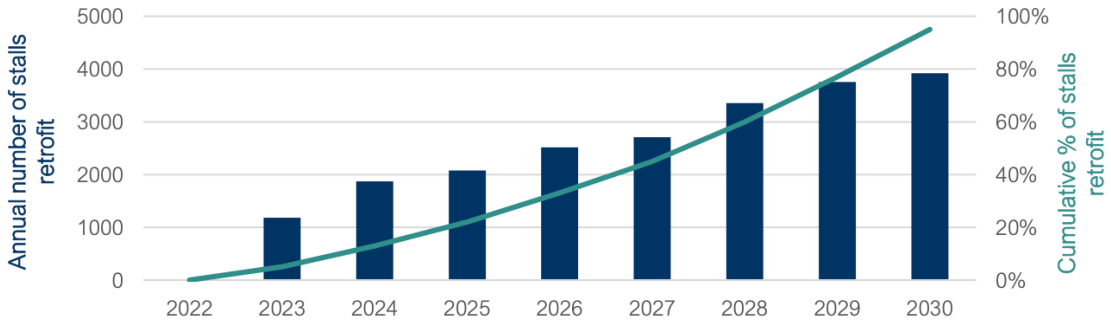

Figure 8: Trajectory to Reach EV Ready in 95% of stalls in MURBs with annual number of stalls retrofit, from [3]

7.1.1 MURB Electrical Capacity

The challenge of capacity constraints is already well-understood & documented in the eMobility strategy; however it is worth reiterating. Many MURBs are already 20 years old so it is unlikely that buildings have been designed with enough spare capacity to accommodate the increased load brought on by EV charging. Compounding this effect, buildings may soon be investing in other technologies that may raise electricity consumption, such as heat pump retrofits. A typical residential unit tends to consume the most electricity in the evening, presumably after the workday, shown in the graph on the following page.

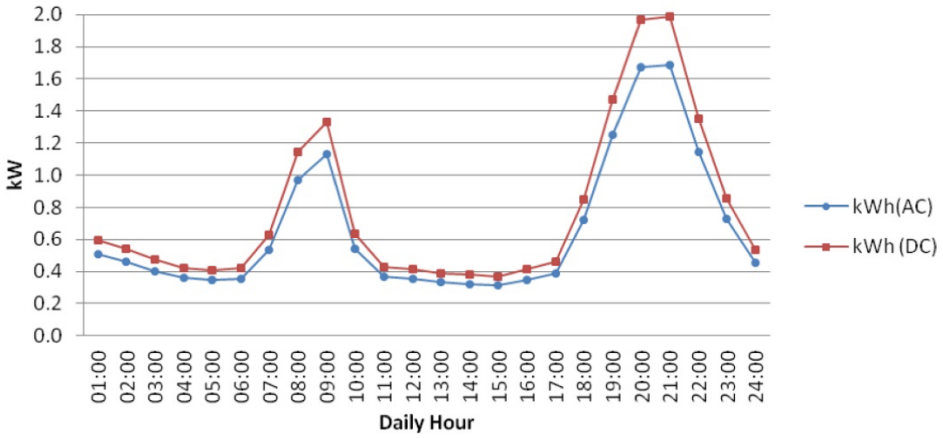

Figure 9: Illustration of Typical time-of-day Electricity Consumption, from [19]

This presents a risk of many residents at a building all charging at the same time, at peak consumption hours. If charging time is not managed properly, it is much more likely that a MURB would require increased electrical capacity. Capacity upgrades may require additional service to the building or an entirely new distribution transformer.

7.1.2 EVSE Technical Lifespan

When employing even a modest estimate of a modern building having a 50-year lifespan, it is clear that any solution for EVSE retrofits will require at least a 20-year lifespan without major upgrades/overhauls needed. The EVSE technology space is commercially quite new, with many new companies coming into the space. The longevity of many of these suppliers may not be guaranteed, introducing an increased risk that a building could invest heavily in a system that may not have technical support, spare parts, or new chargers in 10-15 years. This effect is magnified by the heavy reliance on EVEMS communication with off-site servers. Not only would this be a significant barrier to adoption for a strata or building management team; from a utility's perspective, this would heavily hinder any attempt at city-wide load management systems.

7.1.3 EVSE Technical Complexity

There is currently a lack of industry experience in performing these retrofits, as the process is still in its infancy. Factors such as parking garage/lot layout, service room location, parking tenure restraints, communication/networking solutions, etc., all impede implementation and increase project time due to an overall lack of industry standardization. A streamlined technical process is not yet available, and this effect is compounded by the different requirements needed by different EVEMS and EVSE vendors, as well as the needs of the utility.

7.2 Strata Corporations

The following section describes the main challenges and barriers that New Westminster faces regarding supporting stratas who wish to complete a retrofit. One of the most challenging aspects of supporting a successful EVSE retrofit in New Westminster is providing adequate support for MURB strata councils. Much of the focus of all interviews/consultations with experts and stratas focused on the barriers that exist between stratas and other stakeholders. Strata-owned MURBs were given a major focus due to their ubiquity in New Westminster.

7.2.1 Limited Council Bandwidth

A major complaint concerning EVSE MURB retrofits using current provincial and federal incentives in British Columbia is the amount of research and hours needed in order to complete a retrofit. As strata councils are volunteer positions, it can be challenging for councils to amass necessary information, communicate with the body providing the incentive, assess their property's needs and consult with unit owners to understand their wishes. Major decisions are usually decided upon at an annual general meeting, which can also force stratas to wait for key decisions to be made for a retrofit; the reliance of 50% resolutions by the strata members require strata councils to inform all residence owners to the benefits of EV charging as well. In talking with a president of a strata in New Westminster that successfully completed an EVSE retrofit, it was found that their research team spent over 100 hours researching, compiling & analyzing data, informing residents, and consulting with professional services in order to complete the retrofit. They went on to say that for a strata, this can mean upward of a year of dedicated work by individuals who may already have full-time employment and other council-related engagements.

7.2.2 Limited Technical Know-How

In [20], as well as when conducting interviews for this project, limited technical knowledge was a barrier both BC Hydro & Dunsky heavily emphasised as well as by the strata president who volunteered. In British Columbia, there is limited technical information readily available to stratas on the process of assess building infrastructure, understanding EV readiness and associated solutions, selecting appropriate EVSE for the proposal, planning cost recovery and more. In the interview, it was noted that one member of the research team was formerly an electrician, and the team believes this experience was the only way they managed to successfully complete the retrofit. It is unreasonable to expect stratas to have the level of knowledge currently required for a

retrofit, especially as the landscape of EVSE and EVEMS products are developing at an accelerated rate.

7.2.3 Parking Tenure

There are many ownership configurations a shared parking lot may take in a strata owned MURB, each of which requires different strategies for charging layouts, especially if 100% EV-ready is not the chosen retrofit solution. This is especially true depending on metering locations and lot configurations in proximity to services rooms. This contributes heavily to the length of the decision-making process for stratas. The main types of stall ownership are:

Common Property: The strata may usually reassign parking stalls to suit the needs of resident who need access to specific stalls for EVSE access. Note: there are cases where stalls are assigned in leases and may require more attention.

Limited-Common Property: The strata may have limited capability to swap parking stalls, it depends on specific agreements made within the strata plan and may require voting or resolution at a general meeting.

Strata Lot: The strata corporation does not have authority to swap stalls, usually the stalls are property of the owners.

In an interview with a strata president, it was estimated that identifying parking stall ownership and determining an EVSE implementation plan based on a 1-per-resident strategy took over two months.

7.3 Financial Barriers

The following section describes the main financial challenges and barriers that New Westminster faces in achieving 95% of MURB stalls successfully retrofitted by 2030. Undoubtedly cost constraints are the largest barrier identified, so this section will focus largely on secondary constraints and barriers related to cost-saving solutions that are presently being used elsewhere. These barriers have been identified largely from the best practice review and interviews. Depending on the strategy, the city may be looking at considerable investment, but largely costs are identified as they relate to a strata corporation looking to complete a retrofit.

7.3.1 High-Cost Aspects of an EVSE MURB Retrofit

This section describes the processes and requirements of an EVSE retrofit that are associated with high cost:

1. Technical complexity introduces the need for heavy third-party involvement (EVEMS communications, EVSE management, etc.,)
2. Buildings may require an increase in electrical service to the building to account for increased capacity
3. Buildings may require an upgraded distribution transformer for the building to account for increased capacity
4. 100% EV-Ready retrofit requires significant initial investment upfront
5. Partial EV-Ready retrofit requires multiple permits, electrical analyses, and labour that increases overall cost

7.3.2 Timeframe for Incentives

Strata corporations employ contingency reserve funds (CRFs) for major building upgrades that happen on less than an annual basis. This fund is essential to have in case of major repairs that may require immediate attention. Stratas can use CRFs to pay for EVSE retrofits due to their high upfront costs that usually go beyond the funds held in the operating fund. In British Columbia, the CleanBC Go Electric EV Charger incentives may extend periods before repayment to strata corporations in a reasonable amount of time. In some cases, rebate providers have taken over 12 months to repay stratas that qualified through their program after having completed their retrofit.

In talking with a strata corporation president in New Westminster who completed a retrofit, they highlighted that limited-time incentive programs such as the Provincial incentives administered through BC Hydro encourage stratas to work as fast as possible to qualify for the rebate before time runs out while the incentive refund in the case study completed 14 months ago, is still waiting to receive the funding. It is challenging for Stratas to plan when it is unclear when incentive funding will be received. This may place stratas at considerable risk if a significant mechanical issue arises within the building and the CRF has been depleted, having relied on cost-recovery from the rebate. MURBs that are at an advanced age are especially vulnerable.

7.3.3 Provincial Incentive Uncertainty

The EVSE landscape is changing dramatically, both in policy and technology. Not only are the life spans of the technology and the companies' who supply them uncertain,

but so are the support structures that supply British Columbians. Currently, there are no provincial incentive programs in B.C. that are intended to last past 2024, and BCHydro recently announced that they are pausing new applications for the CleanBC Go Electric program. Additionally, there is no publicly available information regarding the state of these incentive programs, or their timelines. Devising a retrofit strategy that relies on supplementing provincial incentives is therefore not a robust method of supporting retrofits in the long term.

7.4 Equity

The following section describes the main challenges and barriers that New Westminster faces regarding the equitable implementation of EVSE retrofits. These challenges are the direct result of previous barriers mentioned and depend on the methodology of city-given support and technical details of the specific MURB where the retrofit is taking place. Any city program that supports EVSE retrofits should do so equitably, as nearly all stalls need to be retrofitted. Creating an inclusive, all-encompassing strategy that gives all residents access to the benefits of a program is essential for city-wide adoption.

Most EVSE retrofit support programs available in Canada do not reinforce financially equitable distribution, favouring early adopters who have the financial means to assist their strata or rental building in performing an EVSE MURB retrofit. Nearly all retrofit incentive programs reviewed in Canada are not structured to provide annual or periodic support – each building may only qualify for a one-time retrofit rebate, even if they do not maximize the receivable amount. Thus, a building's initial savings tend to go to those who have extra income at the ready when a temporary incentive program comes online, and those who must wait to invest often miss out on receiving any savings when investing in EVSE. This effect can be quite disparate, especially when late-stage adopters in a MURB require EVSE and the building's capacity is already fully in use by others using EVSE, or if a subsequent retrofit has been completed, such as a heat pump upgrade.

According to the interviews conducted, strata councils/building managers in British Columbia do not receive adequate technical support from provincial programs, and therefore many must pay out-of-pocket for technical and vendor-related advice. This funding gap between buildings creates another problem for equitable distribution, especially true as retrofitting EVSE in a MURB tends to raise property values.

7.5 Summary

A summary of all identified challenges and barriers to a successful MURB EVSE retrofit is shown on the following page. As this project was conducted on an accelerated schedule, a risk and probability analysis of the challenges was not completed. However, it may be of great value for city staff to identify which of these barriers are most likely to occur, and which hinder widespread EVSE retrofits the most. For the sake of this report, all barriers are considered to be equally inhibitory to a successful EVSE MURB retrofit and a solution will be proposed to eliminate each barrier presented.

Challenge Category	***Barrier #***	***Associated Barriers***
Technical	1	MURB Electrical Capacity
	2	Lifespan Requirements
	3	Inherent Complexity
Strata Corporation	4	Lack of Council Bandwidth
	5	Lack of Technical Know-How
	6	Parking Tenure
Financial	7	High Upfront Cost
	8	Incentive Timeframe
	9	Provincial Incentive Uncertainty
Equity	10	Risk for Late Adopters (MURBs or Individuals)

Table 4: Summary of Challenges & Barriers to MURB EVSE Retrofit

8 RECOMMENDATIONS

The following section contains a list of recommendations intended to inform the City of New Westminster of potential avenues or considerations to be taken in supporting EVSE MURB retrofits within the city. To accomplish their Climate Action *Bold Step*, it is estimated that 95% of existing stalls will need to be retrofitted in 6.5 years, a goal that requires solutions to be inclusive, immediately available, and well-informed. The goal of these recommendations is to foster an understanding of potential solutions where other Canadian retrofit programs have encountered issues. See *APPENDIX C*: FULL BARRIER-RECOMMENDATION MATRIX for the full labeled matrix of recommendations and their associated solved barriers.

8.1 Technical & Strata Preliminary Recommendations

In consideration of the technical & strata-specific barriers highlighted in the previous section, the following recommendations are presented. These recommendations will inform the strategy's recommended program structure, providing reasoning to the subsequent recommendations.

8.1.1 Recommendation #1: Consider procuring a detailed electrical inventory for MURBs

Developing a repository of MURB electrical information would allow for an understanding of the prevalence and subsequent risk-level of capacity overloads in MURBs in New Westminster. Acquiring meter data, total building capacity, and associated transformer capacity for each MURB would allow the city to perform an inventory capacity analysis. This data is crucial for understanding to what extent advanced EVEMS technology, smart grid upgrades, and infrastructure upgrades could be implemented across the city. Ideally, it should also contain a list of buildings who have already completed a retrofit in New Westminster.

Barriers Addressed									
1	2	3	4	5	6	7	8	9	10

8.1.2 Recommendation #2: Consider developing a city-approved, standardized list of EVSE & EVEMS technology

Developing city approved EVSE and EVEMS is vital in addressing several barriers listed above. In order to reduce technical complexity, it is crucial to select vendors that:

- Invest in compatibility technologies such as Open Charge Point Protocol (OCPP) (see Appendix B)
- Limit excessive proprietary tools
- Provide solutions for long-term product use
- Implement effective dynamic or building load sharing
- Create avenues for future smart load management capabilities by utility

Not only does this increase compatibility and reduce complexity, but it will also increase the lifespan of the retrofit. This would also greatly limit the required level of research strata councils must do in selecting EVSE and EVEMS that suit their needs, eliminating significant barriers to stratas with limited time and resources for research.

Barriers Addressed									
1	2	3	4	5	6	7	8	9	10

8.1.3 Recommendation #3: Consider limiting strategy to 100% EV-Ready options

While there are some specific cases where partial retrofits may make sense, the vast majority of retrofits should only be considering 100% EV-Ready options in New Westminster. This will accelerate retrofit timeframes significantly by:

- Reducing the number of electrical permits required
- Reducing overall labour costs (Though incurring higher upfront costs)
- Minimizing strata decision-making required

Decreasing the required time to complete a retrofit is crucial in reaching the goal of 95% of stalls retrofitted by 2030. It also stands to eliminate much of the inequitable early-adopter benefits discussed in the Barriers section, as well as parking tenure challenges brought on by stall-swapping. This is especially true if an initial retrofit qualifies for a provincial incentive, and later additions do not.

Barriers Addressed									
1	2	3	4	5	6	7	8	9	10

8.1.4 Recommendation #4: Consider providing online informational resources

A major hurdle for MURB stratas looking to begin an EVSE retrofit is understanding the basics, with basic questions such as:

- What the general process & cost of a retrofit
- What are the main components of EVSE
- What are the main components of the underlying electrical infrastructure
- What sort of considerations need to be made based on the parking layout
- What are the benefits of at-home EVSE
- What are the differences between partial vs. 100% retrofits, etc.

Presently, no online resource provides the answers to these basic questions in a succinct, easy to understand format. Stratas in New Westminster with limited bandwidth & background technical knowledge would stand to benefit greatly from an easily locatable webpage that answers these questions.

Barriers Addressed									
1	2	3	4	5	6	7	8	9	10

8.2 Strategy Recommendations

In consideration of the technical & strata-specific recommendations, the following section provides recommendations regarding potential support strategies that the City of New Westminster could pursue to provide MURBs with retrofit support.

8.2.1 Recommendation #5: Consider providing holistic energy assessments to MURBs

Given the extended time frame required for a MURB to complete an EVSE retrofit, it is essential to maintain a comprehensive view of a buildings needs in New Westminster in the next 10 years. Beyond the need for city-wide at-home charging for MURBs, there are also several sustainable initiatives such as heat-pump retrofits that are being prioritized in New Westminster. These retrofits also dramatically increase a MURB's energy consumption; It would be inhibitive to New Westminster's emissions reduction goals to require multiple energy assessments within a five- or ten-year span for each MURB.

The city is in a unique position where it can plan all major load increases for MURBs based on load forecasting predictions, growth projections, and demand increases due

to adherence to all relevant *Bold Steps.* If energy assessments provided an all-encompassing approach to energy management, this would save both city staff and New Westminster residents time & money, increasing the likelihood of successfully accomplishing the city's 2030 goals.

Barriers Addressed									
1	2	3	4	5	6	7	8	9	10

8.2.2 Recommendation #6: Consider providing an "future-proof" retrofit advisor service for MURBs

Akin to the recently completed Strata Energy Advisor (SEA) pilot program, supplying stratas & rental buildings with an advisory service will ultimately help New Westminster accomplish its climate action goals. This service should support stratas by combining comprehensive energy assessments with advisors also providing the necessary technical background knowledge during a project to inform and ultimately accelerate strata decision-making; Based off of the results of the SEA pilot program [20], these services stand to significantly increase the likelihood of successful GHG emission-reducing project completion in MURBs.

Barriers Addressed									
1	2	3	4	5	6	7	8	9	10

8.2.3 Recommendation #7: Consider providing an independent financial benefit to MURBs

Considering the recent pausing of the CleanBC Go Electric rebate program by BCHydro, it is uncertain what the future of provincial incentivization will be for New Westminster residents. Given this uncertainty, the City of New Westminster should structure an independent financial benefit for residents that does not rely on provincial support, i.e., top-ups that are given in addition to provincial incentives will not be effective for a long-term retrofit strategy. There are multiple avenues that a city may take given its' financial assets and current provincial and federal laws; an independent economic analysis of each suggested option is highly recommended. Based on all available research and interviews conducted, the following strategies are most likely to be feasible and effective for the coming years.

8.2.3.1 CaaS in New Westminster

While there are few companies offering CaaS in Canada, a city like New Westminster is in an excellent position to employ and benefit from offering CaaS to MURBs. By the city providing the infrastructure upgrades and EVSE, this eliminates the heavy burden on stratas from large upfront costs from 100% EV-ready infrastructure needs, thus not depleting CRFs and eliminating the need to wait until other major building upgrade costs have been recovered. If a MURB only has to contribute 5%-10% of a normal retrofit to the city, like in the case of the City of Vancouver, this is far more attainable for city residents, and therefore more equitable (See Appendix A for details).

There are several benefits to providing CaaS for the city, especially for the utility. This strategy would allow for near total control over which EVSE is implemented, eliminating overall technical complexity, and increasing the ability for smart grid planning as 2030 approaches and beyond. Also, the utility would be consistently aware of exactly what sort of load increases may be expected.

There is uncertainty in the financial feasibility for the author due to the accelerated project deadline & lack of data. However, it is likely that the city may find success similar to the City of Vancouver using this approach. Notably, if the City owns and operates the EVSE within the MURBs, they become a part 3 fuel supplier in the B.C. Low Carbon Fuel Standard [21]. Being a Part 3 allows the city to receive credits for supplying alternative fuel below the specified carbon intensity, which presently is at over $500 per tonne of $CO_{2,e}$ offset. While the credit amount per tonne is variable, the LCFS is intended to last well beyond 2030 [21], securing a certain level of certainty in the feasibility of aiding fund this strategy.

8.2.3.2 EVSE Loan Program in New Westminster

Providing a loan program similar to the City of Toronto is another avenue that avoids most pitfalls present in most other Canadian retrofit support programs, while likely presenting a faster cost recovery than CaaS. For stratas, the process may require slightly more research and decision-making as they are given more control over the EVSE implemented and infrastructure requirements, though much of this could be supplemented by the EVSE retrofit advisory service. If sized appropriately, a short-to-moderate payback period loan can still effectively remove the risk of severe CRF depletion. If strict EVSE standardization is determined beforehand, this still gives the utility moderate levels of information in terms of forecasting & planning capabilities.

9 FUTURE AREAS OF RESEARCH

Due to the immaturity of the EVSE industry, the landscape is changing quickly from both a technical and regulatory perspective. The following short section is intended to highlight fast-accelerating areas that should be watched closely as a formal strategy is developed and implemented in New Westminster.

9.1.1 EVSE & EVEMS Compatibility

Figure 10: OCPP Logo, from [22]

To maintain the recommended lifespan of 20+ years for EVSE retrofits, it is essential to understand the dynamic relationship between EVSE vendors. While some have begun to adopt the Open Charge Point Protocol, many vendors have been criticized for poor implementation resulting in a lack of actual compatibility with other EVEMS & EVSE. Developing a deeper understanding of the landscape of the interplay between vendors and software will be crucial for maximizing lifespan.

9.1.2 Smart Grid Advancements

Another area that is changing constantly is the development of new standards for things like end-to-end Vehicle-to-Grid (V2G), a concept that has been discussed immensely in the scientific literature but is only starting to break through in real grids. V2G would allow for immense flexibility MURB charging and allow for an unprecedented level of demand control for New Westminster's utility. As more standards for things like demand response, other DSM techniques, and V2G come online, it is crucial that they are examined and implemented as soon as possible to maximize the city's ability to charge the city's EVs simultaneously.

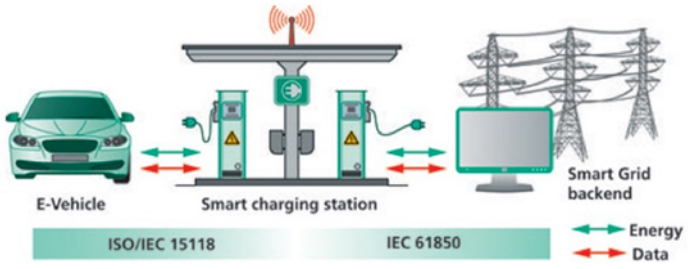

Figure 11 : Basic Smart Grid Diagram, [22]

10 REFERENCES

[1] J. Susser, "How DC Fast Charging Works," 2023. [Online]. Available: https://www.advancedenergy.org/2022/01/24/how-dc-fast-charging-works/. [Accessed 29 May 2023].

[2] "Greater Toronto Hamilton Area EV Revolution," TAF, 2022. [Online]. Available: https://ev.taf.ca/prequalification/glossary/#. [Accessed 29 May 2023].

[3] City of New Westminster, *eMobility Strategy: Supporting New Westminster's Bold Steps for Climate Action,* 2022.

[4] Government of British Columbia, "Trends in Greenhouse Gas Emissions in B.C. (1990-2020)," January 2023. [Online]. Available: https://www.env.gov.bc.ca/soe/indicators/sustainability/ghg-emissions.html. [Accessed May 2023].

[5] Government of British Columbia, "CleanBC: Roadmap to 2030," Victoria, 2018.

[6] City of New Westminster, "Climate Action Budgeting Framework & Seven Bold Steps," November 2019. [Online]. Available: https://www.newwestcity.ca/database/files/library/CNW_DOCS_1514691_v1_Climate_Action_Budgeting_Framework___Nov__4_PPT.pdf. [Accessed 25 May 2023].

[7] City of New Westminster, *Community Energy and Emissions Plan 2050,* 2022.

[8] Statistics Canada, "Focus on Geography Series, 2021 Census of Population New Westminster, City," 2022. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?topic=3&lang=E&dguid=2021A00055915029.

[9] "City of New Westminster," [Online]. Available: https://www.newwestcity.ca.

[10] "Focus on Geography Series, 2021 Census of Population New Westminster, City," December 2022. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?topic=1&lang=E&dguid=2021A00055915029.

[11] Government of British Columbia, "Bill 22 – supporting electric vehicle charging in strata corporations," May 2023. [Online]. Available:https://www2.gov.bc.ca/gov/content/housing-tenancy/strata-housing/operating-a-strata/the-environment/electric-vehicle-charging. [Accessed June 2023].

[12] BCIT, "EV Charging Demonstrations in MURBs," 2021. [Online]. Available: https://www.bcit.ca/files/appliedresearch/pdf/bcit-evid-project-public-report-murb-guidelines-final.pdf. [Accessed May 2023].

[13] City of Richmond, *Electric Vehicle Charging Infrastructure in Shared Parking Areas: Resources to Support Implementation & Charging Infrastructure Requirements,* British Columbia.

[14] City of North Vancouver, "Climate & Environment Strategy," [Online]. Available: https://www.cnv.org/Community-Environment/Climate-Action/Climate Environment-Strategy . [Accessed 19 May 2023].

[15] City of Vancouver, "Climate Emergency Action Plan," [Online]. Available: https://vancouver.ca/green-vancouver/vancouvers-climate-emergency.aspx . [Accessed 23 May 2023].

[16] Government of British Columbia, "Renewable & Low Carbon Fuel Requirements Regulation," [Online]. Available: https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels. [Accessed 2017 July 2023].

[17] Government of Quebec, "Financial assistance for a multiple dwelling building charging station," [Online]. Available: https://www.quebec.ca/en/transports/electric-transportation/financial-assistance-electric-vehicle/charging/multiple-dwelling buildingchargingstation/msg/3?cHash=c5f2fd5f6bc2988eb47df6bb5fa4b8cb#c3 4503. [Accessed 25 May 2023].

[18] Ministry of Transportation & Infrastructure, "Climate Action and Transportation, Province of British Columbia," [Online]. Available: https://www2.gov.bc.ca/gov/content/transportation/transportation-environment/climate-action . [Accessed 22 May 2023].

[19] M. Taufiqul Arif, A. M. T. Oo and A. B. M. Shawkat Ali, "Estimation of Energy Storage and Its Feasibility Analysis," *Energy Storage,* pp. 41-78, 2023.

[20] Metro Vancouver/SES Consulting, *Strata Energy Advisor Pilot Program: Final Report,* 2020.

[21] Government of British Columbia, "Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act," 1 January 2023. [Online]. Available: https://www.bclaws.gov.bc.ca/civix/document/ id/complete/statreg /394_2008#section4.1.

[22] "Bringing EVs into the Smart Grid for Stability and Security," [Online]. Available: https://www.digikey.com/en/articles/bringing-evs- into-the-smart-grid-for-stability-and-security. [Accessed 10 July 2023].

[23] City of North Vancouver, "EV charging in Condo Apartment Buildings," [Online]. Available: https://www.cnv.org/Streets-Transportation/Traffic/Electric-Vehicles/EV-Charging-in-Existing-Buildings. [Accessed 23 May 2023].

[24] City of Vancouver, "Vancouver's EV Ecosystem Strategy," 2022. [Online]. Available: https://vancouver.ca/files/cov/EV-Ecosystem-Strategy.pdf. [Accessed 25 May 2023]

[25] City of Vancouver, "Electric Vehicle for Rental Buildings," [Online]. Available: https://vancouver.ca/streets-transportation/electric-vehicle-charging-for-rental-buildings.aspx . [Accessed 25 May 2023].

[26] Province of Ontario, "Building Code Updates," [Online]. Available: https://www.ontario.ca/page/building-code- updates. [Accessed 29 May 2023].

[27] TAF, "Join the Greater Toronto Hamilton Area EV revolution," [Online]. Available: https://ev.taf.ca/. [Accessed 7 June 2023].

[28] City of Toronto, "City of Toronto electric vehicle strategy," [Online]. Available: https://www.toronto.ca/wp- content/uploads/2020/02/8c46-City-of-Toronto-Electric-Vehicle-Strategy.pdf. [Accessed 25 May 2023].

[29] TAF, "Toronto EV Charging Survey," [Online]. Available: https://taf.ca/custom/uploads/2022/05/Toronto_chargingsurvey_results.. [Accessed 23 May 2023].

[30] City of Toronto, "High-rise retrofit improvement support program (hi-RIS)," [Online]. Available: https://www.toronto.ca/community-people/community-partners/apartment-building-operators/hi-ris/. [Accessed 23 May 2023].

[31] "100% EV ready multifamily building retrofit - case study - Saanich," [Online]. Available:https://www.saanich.ca/assets/Community/Documents/Planning/sustainability/EV-MURB-Case-Study.pdf. [Accessed 21 May 2023].

[32] "Open Charge Alliance," [Online]. Available: https://www.openchargealliance.org. [Accessed 3 July 2023].

11 APPENDIX A: COMPLETE JURISDICTION REVIEW

The following section is a full summary of significant research findings for the review of jurisdictions' policy and incentive programs. This section is intended to inform readers of the current state of these Canadian regions' MURB EVSE retrofit strategies and motivate questions and insights for further investigation for the *Strategy*. The following jurisdictions below were chosen using the following research criteria:

1. Potential contextualization/adaptability to the context of New Westminster
2. Age of policy/incentive implementation to allow for objective evaluation
3. Overall level of support/benefit to respective community

11.1 Metro Vancouver

In British Columbia, there is a large push toward mass EV adoption to meet provincial GHG reduction goals for 2030 [18]. The electrification of transportation in B.C. is especially effective in reducing overall emissions, as over 98% [5] of electricity delivered in the province is done so without emitting CO_2 or other greenhouse gases. As a result, the B.C. government has implemented the CleanBC Go Electric EV charger rebate program, which supports individuals, stratas, businesses, and indigenous communities. The goal of the program is to reduce the high financial barrier of entry to EV charging by partnering with the two main electricity supplies, BC Hydro and FortisBC and supplying various forms of rebates for the aforementioned groups, not only for charger installation but also associated planning and infrastructure costs. These rebates, shown in the figure below, can help subsidize level 2 EVSE retrofits in MURBs dramatically and thus is the backbone of most municipalities' strategies in Metro Vancouver and in British Columbia as a whole. Additionally, Plug in BC offers substantial strata advising resources and Metro Vancouver offers online instructional resources to EV owners, strata councils, and property managers to help guide them through this process.

EV Ready Rebates	***Standalone EV Charger Rebates***
• Up to $3,000 for EV Ready Plan • Up to $120,000 for EV Ready Infrastructure • Up to $14,000 for chargers	• Up to $14,000 for chargers per apartment/condo complex
TOTAL : $137,000 per apartment/condo complex	TOTAL : $14,000 for chargers per apartment/condo complex

Table 5: Maximum Rebate Amounts for Clean BC's Go Electric Rebate program from BC Hydro

A selection of jurisdictions from around Metro Vancouver have been explored to provide a holistic view of best practices in policy and incentives programs. These jurisdictions have been selected as they have the potential to inform strategies, programs, or policies for the City of New Westminster due to geographic and legislative proximity. This is a condensed collection of the most significant practices or policies and is by no means exhaustive. An in-depth description of the resources mentioned for each jurisdiction and their associated scope can be supplied upon request.

11.1.1 City of North Vancouver

The City of North Vancouver is currently developing a strategy for EV charger retrofits in existing MURBs as a part of their Climate and Environment Strategy (CES) [14] which is currently in its second of three phases. The CES is currently in a review period after hosting a public engagement event where citizens gave their input on which strategies, goals and climate change areas that should be focused on by the city. Their approach is based on a heavily on community education and subsequent input, with each phase of their strategy relying on educational events and a follow-up engagement period, such as their pop-up events, ride and drive events, and strategy survey. This will culminate in a formal strategy draft later this year for further community review.

Due to their extended development periods, no formal short or long-term strategy for MURB EVSE retrofits has been defined for the city, and subsequently no policy changes have been made in the area. However, presently they heavily promote the CleanBC Go Electric rebates and offer a top-up incentive on implementing EV-Ready infrastructure in MURBs. Presently, the city offers an extra $1000 rebate to obtain an EV Ready plan (a 20% increase), and an extra $100 per parking stall for EV Ready infrastructure (a 12.5% increase) [23]. This totals to a potential $158,000 for an existing MURB to be retrofitted, and the extra rebate is applied directly to an application to BC Hydro, with no extra forms to be completed by the applicant.

Little has been mentioned regarding the city's considerations on equity in their current EV strategy. It may be worth re-evaluating this jurisdiction's practices after their Climate and Environment Strategy has been formally approved after final consultation.

11.1.2 City of Vancouver

The City of Vancouver has highlighted EVSE retrofits in MURBs as a key factor in their Climate Emergency Action Plan [15]. As a part of their *Big Move* plan, similar to New Westminster's *Bold Step* plan, which summarizes their plan: 50% of kilometres driven in Vancouver must be driven by ZEV's. This goal is expanded upon by the city's

EV Ecosystem Strategy [24]. The city intends on implementing a long-term EV charging retrofit strategy, but this is slated for 2024. An action to identify key factors in equity-induced barriers for EV charging MURB retrofits will also be done, however this has also not been completed as of May 2023.

Presently, the city's main mechanism in implementing EVSE retrofits in existing MURBs is a cooperative program with building managers and stratas, with no direct-to-consumer top-up or incentive program available. Instead, the city has developed a limited-availability charger installation program, where the city charges a small fee to building owners and managers and operates the chargers independently in MURBs. The city offers to pay a maximum value of $93,000 [25] for EV chargers, necessary infrastructure, & installation and works directly with BC Hydro or FortisBC to receive CleanBC provincial rebates. The process is operating as a competitive, application-based program, and the city has not divulged how many MURBs will ultimately be retrofitted through this program. The City of Vancouver stipulates that as a part of this ownership agreement, the advent of EV charging infrastructure in a building may not be used to justify increased unit rental rates. This requirement is unique in the landscape of Canadian EVSE retrofit programs and is worth noting as an equitable provision to a community if the amount of potential building retrofits is limited.

11.1.3 City of Richmond

The City of Richmond has put a large focus on practical technical information and guidelines for municipalities to use, producing documents with BC Hydro. An emphasis has been put on policy for new buildings being EV Ready and supplying communities with resources regarding EVSE installation in residential areas. According to the city's Community Energy & Emissions Plan and associated Climate Action Program Report, they intend on supporting provincial incentive programs and increasing public charging access. However, there is no official strategy or plan to retrofit existing buildings in the city aside from providing a retrofit advisor to citizens.

The report provided by the City of Richmond and BC Hydro entitled Electric Vehicle Charging Infrastructure in Shared Parking Areas: Resources to Support Implementation & Charging Infrastructure Requirements is a guide to understand the basics of EVEMS and EVSE from a technical standpoint in MURBS, as well as economic considerations and pertinent strata bylaws. Another report, Residential Electric Vehicle Charging: A Guide for Local Governments, offers municipalities considerations of potential cost and socio-economic concerns stemming from MURB EVSE retrofits, and high-level suggestions to combat issues relating to inequity for early adopters. This report also has

a full section regarding strata rule recommendations and cost reconciliation; these pages may be somewhat out of date, given the recent amendments to the Strata Property Act.

11.1.4 Summary

The three cities reviewed in Metro Vancouver have all taken different approaches to strategizing and incentivizing EV charger retrofits in MURBs. Because all of these initiatives have been introduced within that past two years, it is challenging to draw objective conclusions on the efficacy of any particular strategy, especially as North Vancouver has not finalized their strategy. It is worth highlighting that no municipality that was reviewed in Metro Vancouver has published or made mention of necessary projections needed for annual MURB retrofits to meet these goals; New Westminster's e-Mobility strategy is the exception. These projections are not only crucial to meeting a target that is <7 years out but could also form the basis for objective evaluation in strategy success that other cities in the Lower Mainland may wish to replicate.

While the goals of the City of Vancouver and North Vancouver parallel that of New Westminster (50% of kilometres driven by 2030 be zero emissions), the goal of the City of Richmond is to reduce overall emissions from the transportation sector by 50% for light-duty vehicles, and 33% for heavy-duty vehicles. It is challenging to evaluate which goal leads to a greater overall reduction in GHG emissions. All cities have acknowledged the necessity of ZEV's in reducing transportation emissions, and all have programs to inform citizens of the benefits of EV's, including the use of emotiveBC events. The percentage of residents who live in MURBs in these municipalities differ slightly, with the City of Vancouver being the lowest at 58% [8], and the City of North Vancouver being the highest with 70% [23]. With New Westminster having 68% of residents living in MURBs, these variances will likely not have a significant impact compared to the economic, social, and infrastructural differences between these cities and New Westminster.

Overall, no municipality in Metro Vancouver has provided strong equity considerations for retrofit access within their respective strategies, though some strategies allow for frequent community consultation which may allow for some level of equitable decision-making. This is surprising, as this problem has received significantly higher emphasis in the other jurisdictions.

11.2 Greater Toronto & Hamilton Area

In Ontario, there is no official provincial incentive program for EV charging infrastructure. In fact, current provincial policymakers have recently amended to *no*

longer support 100% EV Ready building requirements for new MURBs [26]. Additionally, Ontario does not have a ZEV adoption requirement. This leaves municipalities to rely on the federal Zero-Emissions Vehicle Infrastructure Program ZEVIP program, or municipal programs for funding. The federal ZEVIP program is a nationally funded program put forth by NRCan and is intended for large-scale EV infrastructure projects across the country. While condo boards can apply for this fund, it is largely intended for municipal and provincial groups to use and distribute for EV charger projects.

The Atmospheric Fund (TAF), a not-for-profit based in the Greater Toronto & Hamilton Area (GTHA), is a recipient of ZEVIP funding. They have developed the EV Station Fund, a rebate program for residents and condo-boards that allow MURBs, workplaces, and public lots in the GTHA to receive rebates for EVSE equipment and necessary technical advisory support [27]. The incentives, listed below, reflect what is listed on the website. Upon further inspection, the 'per station' costs do include necessary infrastructure and professional services required to make stalls EV-ready. A $1000 per site (maximum of 3 sites) bursary for technical advisory services is available as a part of the program.

TAF EV Station Fund Rebates		
Level 2 Charge Port	**DCFC Charge Port**	**DCFC+ Charge Port**
Up to $5,000 per L2 station	Up to $15,000 per DCFC station	Up to $50,000 per DCFC+ station
TOTAL : 50% of costs, or $100,000 for a maximum of 20 stations across all apartment/condo complexes	TOTAL : 50% of costs, or $100,000 for a maximum of 6 stations across all apartment/condo complexes	TOTAL : 50% of costs, or $100,000 for a maximum of 6 stations across all apartment/condo complexes

Table 6: Maximum Rebate Amounts for TAF EV Station Fund in GTHA

Most notably, the TAF EV Station Fund gives priority to MURBs, specifically in municipalities that have a lower-than-average number of charging stations per capita [3]. This is a higher standard of equity-based eligibility than seen in B.C. programs. However, it is likely that they are working with a much smaller budget than B.C. programs, which may heighten the need for equity-based need assessments.

11.2.1 City of Toronto

The City of Toronto has put forward an EV Strategy to complement their TransformTO Net Zero Strategy transportation goals. While the city's 2030 climate goals do not include a private charger installation milestone, they do list a goal of 20% of vehicles on the road be EVs and include a public charger goal of 10,000 Level 2 ports and 650 DCFC ports available by 2030 [28]. The city suggests that a higher focus on public charging is a more equitable approach, as they will avoid the imbalance of charger density in higher-income areas. This approach was supported by a large survey completed by Toronto residents [29] and the TAF EV Station Fund program, which focuses on individuals in MURBs and garage orphans.

The main MURB EVSE retrofit benefit Toronto offers is a loan program for condo (MURB only) building owners called the High-Rise Retrofit Support Program (Hi-RIS). Aimed at owners of buildings with three storeys or more, the Hi-RIS program supports a variety of building energy and efficiency upgrades offering low-interest loans [30]. EV charger upgrades are eligible, but criteria needed for a successful EVSE upgrade application is sparse without placing a formal expression of interest. The maximum amount offered is either 10% of the property's Current Value Assessment, or $2 million.

City of Toronto Hi-RIS Financing Rates	
Term	**Fixed Interest Rate**
5 years	3.39%
10 years	3.74%
15 years	4.19%
20 years	4.24%

Table 7: Interest Rates for City of Toronto Hi-RIS Program

Several rounds of community consultation were offered to inform the TransformTO strategy and held several in-person outreach events in different regions of Toronto during the making of the strategy. Additionally, much like plug-in BC, Torontonian condo owners may refer to pointA.ca for information regarding the processes and resources necessary for converting a MURB to be EV-ready or install chargers.

11.3 Québec

The province of Québec has also put forward a strategy for sustainable actions within the province, called the 2030 Plan for a Green Economy. The incentivization of EV purchasing and charging are focused on heavily, as decarbonization of transportation would result in a 42.8% reduction in the province's GHGs [17], with light vehicles comprising 63% of these emissions. According to their Plan de Mise en Œuvre 2023-2028 (Implementation Plan) for their Plan for a Green Economy, no official goal has been set for EV chargers in MURBs/private dwellings, but a strategy is currently being created to accelerate EVSE availability to citizens. A $500 million budget was given for the strategy, and it is intended to give direction to their provincial utility Hydro-Québec, as well as policies, and the responsibilities of municipalities within the province.

Québec has introduced an incentive program for the installation of EVSE in MURBs much like those seen in British Columbia, available for tenants, owners, building managers, and co-ownership syndicates. The program supports level 2 charging, with a pre-determined list of charging station equipment. The program includes expenses that would be considered as EV-ready support in British Columbia. A summary of the rebate amounts is shown below. It should be noted that these are *annual* amounts, and a building may be eligible multiple times given criteria set here. Nothing could be found regarding equitable distribution of the rebates; however given the scope of the budget and imminence of a formal charging strategy this may change in the coming months/years.

Québec Financial Assistance for EV Chargers in MURBs		
Building w/ 3 to 9 Dwelling Units	**Building w/ 10 to 19 Dwelling Units**	**Building w/ 20+ Dwelling Units**
Purchasing: Lesser of $5,000 per connector/wireless charging station OR 50% of expenses Leasing: $500 per connector/wireless charging station AND 50% of installation expenses	Purchasing: Lesser of $5,000 per connector/wireless charging station OR 50% of expenses Leasing: $500 per connector/wireless charging station AND 50% of installation expenses	Purchasing: Lesser of $5,000 per connector/wireless charging station OR 50% of expenses Leasing: $500 per connector/wireless charging station AND 50% of installation expenses
TOTAL: Lesser of 50% of costs, or $20,000 total per fiscal year	TOTAL: Lesser of 50% of costs, or $40,000 total per fiscal year	TOTAL: Lesser of 50% of costs, or $49,000 total per fiscal year

Table 8: Maximum Rebate Amounts for Québec Financial Assistance Program

12 APPENDIX B: COMPLETE CASE STUDY REVIEW

12.1 Study 1: BCIT SMART MURB EVSE Retrofit Demonstration

In 2021, the BCIT Smart Microgrid Applied Research Team (SMART) led by Dr. Vidya Vankala, in partnership with AES Engineering, conducted several demonstration EVSE retrofit projects in MURBs in the Lower Mainland. This was a part of BCIT's Electric Vehicle Infrastructure Development R&D initiatives, which focuses on EVs, solar PV integration, energy storage, and other sustainable EV infrastructure technologies. The SMART team provided a summary [12] describing 3 MURB retrofits that were used as demonstration to "de-risk and validate" the use of EVEMS and open protocols in Canadian MURB retrofits as per the 2021 Canadian Electrical code. The objective of the study was to reduce apparent barriers to large-scale EV charger retrofits in strata-owned MURBs, and demonstrate EV infrastructure solutions that are "interoperable, minimize grid-impacts, and improve the customer's charging experience" [12].

The three MURBs that were chosen are shown below, as well as the number of units in the buildings, number of parking stalls, capacity upgrades and number of chargers installed.

BCIT MURB EVSE Retrofits						
Location	**Year Built**	**Housing Units**	**Parking Stalls**	**#L2 EVSEs Installed**	**100% EV Ready**	**Infrastructure Upgrades**
Riverbend Housing Co-op, New Westminster	1985-1986	72	96	6	No (Plans are available)	600A distribution board, 225A panel board, load meters
Anchor Pointe, New Westminster	1990	110	162	8	No (Plans are available)	1200A distribution board, 225A panel board, load meters
Siena of Portico, Vancouver	2003	92	129	6	No (Plans are available)	Unspecified

Table 9: Case Study #1 Retrofit Summary

The case study discusses the methods explored and those chosen to facilitate EV charging in these MURBs with limited funding, with a major focus on providing charging

access to as many residents as possible, and the resiliency of the services over time. As two of the three MURBs were in New Westminster and the other in Vancouver, the policies, strata consultation, and technical implementation make this potentially the most applicable case study publicly available for the City of New Westminster (An attempt was made to reach out to the SMART team and discuss this project further, however as of now no response has been received.) Each retrofit used a multitude of EVSE equipment from different suppliers and using different software. The document highlights several EVEMS strategies that currently exist within the confines of the Canadian Electrical code, which are listed below. The use of somewhat novel EVEMS techniques was one of the main components used in all three MURBS that allowed for resilience and reduced cost.

1. Time and/or power allocation
2. Load switching
3. Load sharing
4. Load management without monitoring
5. Load management with EVSE monitoring

The demonstration used load management with EVSE monitoring, citing optimized efficiency for a moderate cost. The case study suggests the use of the Open Charge Point Protocol (OCPP) is a driver for charger network resilience in MURBs by extending their lifespan by avoiding reliance on a single vendor or service to manage chargers from different suppliers. The OCPP, developed and managed by the Open Charge Alliance, is a free to use protocol that allows EVSE from different vendors to communicate with one another and implement load balancing and charge profiles, as well as a host of other features. BCIT uses OCPP as a part of their charge station management system software which implements EVSE control using OCPP, as well as: code for new EVSE vendor integration, administration and management tools, payment services and more. This software is available as a free download from BCIT. All 3 retrofits used this software, controlling level 2 EVSE from a mix of vendors, such as Sun Country Highway, SWTCH (Lite-On), Phihong, and Flo.

The authors conclude that load management EVEMS is extremely beneficial in facilitating 100% EV Ready requirements as it not only allows for reduced capacity requirements but can also help with incremental upgrades as residents adopt EV's over time. This is especially true in stratas where tenants legally own parking spots and new control configurations with existing circuits may have to be made. However, managing load management EVEMS is currently a large challenge. The use of proprietary and complex software will currently be a barrier to ease of adoption, potentially increasing cost, and time for project completion. It would be a worthwhile study to perform a market

review on current charge station management system software products available and ready to use in Canada, especially those that use OCPP.

The study conducted 100% EV Ready planning, however SMART did not implement the full infrastructure in any of the 3 buildings due to funding constraints. This led to challenges due to unique parking lot allocation rules. In the Siena of Portico building, they implemented a special busway that allowed EVSE to be easily moved from spot to spot using tap-offs above all stalls. Parking tenure can introduce significant challenges if a 100% EV Ready upgrade is not chosen for a retrofit. A summary comparing the benefits of 100% EV Ready retrofits vs. incremental has been adapted from the demonstration and shown below.

Consideration	*Comprehensive 100% EV-Ready Retrofits*	*Incremental Additions of EVSE*
Life-Cycle Cost per Parking Space	Less expensive, when designed with appropriate levels of load sharing and EVEMS.	More expensive over time, assuming that most vehicles in multifamily buildings will ultimately be EVs.
Process	One-time significant electrical renovation.	Repeated electrical renovations.
Location of Charging Stations	In drivers' assigned parking space.	Often initially in commonly accessible parking (e.g. visitor parking). Sometimes in assigned parking.
Process for Drivers to Install Chargers	Simple (after initial comprehensive electrical renovation). An EVSE compatible with the buildings' EVEMS will be installed.	Typically lengthy and complicated.
Convenience	Highly convenient for drivers, EV charging in regular assigned parking spot.	When chargers are located in commonly accessible parking (e.g. visitor parking), scheduling can be less convenient
Futureproofing	With EVEMS, frequently can ensure sufficient electrical capacity for all parking spaces to have EV charging.	Initial installations are sometimes not compatible with later expansion (e.g. may not leave electrical capacity or physical space). Potential for stranded assets. Potential to exhaust limited electrical capacity if design for EVEMS not considered.
Market Adoption	Currently very uncommon. Where incentives are available (e.g. BC's EV Ready Rebate program) 100% EV Ready retrofits are growing more common, but still nascent.	Typical approach to adding EV charging in existing multifamily buildings.
Electrical Permit	Typically, only a single electrical permit is required.	New electrical permits will be required for each electrical renovation.

Table 10: Case Study #1 Retrofit Comparison, from [12]

BCIT also provided a list of recommendations, which can be seen in the main case study document. These retrofits may inform the city with what obstacles older high-rise

MURBs present in New Westminster, and whom to contact regarding services or data. It should be noted that while all test cases ran successfully in the study, no follow-up data has been presented on BCIT's website, and may also be worthwhile in following up with a representative from the SMART team.

12.2 Study 2: AES Engineering MURB Retrofit

This case study is a short review of a MURB retrofit in West Vancouver that was completed in 2020. A 23-unit MURB elected to work with AES Engineering to produce an EV-ready assessment and opted to complete a 100% EV-Ready infrastructure upgrade (1 junction box for each resident's 2 stalls), and 10 units subsequently elected to have L2 EVSE installed. The case study [31] provides a brief technical overview summarising the entire process of the retrofit, associated costs, and outcomes. Because this was not a pilot project, plans were made and carried out in full to produce a 100% EV Ready MURB and offers realistic costs for a small MURB retrofit. The figure shown below provides a summary of the building and the upgrades produced.

The case study presents the assessment process as three distinct steps: capacity assessment, equipment identification, and cost assessment. Each of these steps were broken down to provide more information, which has been briefly summarized.

AES MURB EVSE Retrofit						
Location	**Year Built**	**Housing Units**	**Parking Stalls**	**# L2 EVSEs Installed**	**100% EV Ready**	**Infrastructure Upgrades**
West Vancouver B.C.	Unknown	23	46 (2 per unit, 1 visitor stall)	10	Yes	400A panel board, BC Hydro meter, communication gateway and receiver

Table 11: Case Study #2 Retrofit Summary

12.2.1 Capacity Assessment

The MURB was rated to have a capacity of 461 kVA at 80%-rated, and load calculations completed using BC Hydro meters showed that just over 50% of this capacity was not being used. 23 L2 EVSEs requires up 80 kVA, thus no capacity upgrade was needed. As little is known regarding the building's archetype, there is no way of knowing how common this capacity surplus would be for a MURB of similar size.

12.2.2 Equipment Identification

A summary of the equipment installed for the EV-Ready upgrade and charger installation can be seen in the table above, which only neglected to mention the wiring, conduit and junction boxes required for the retrofit. Because residents elected for 2-way load sharing, EVSE and EVEMS form ChargePoint were used to accomplish the desired functionality. The study notes that this has limited future adopters in the other 13 units to installing hardware only from ChargePoint. This may no longer be the case with the advent of OCP Protocols, as ChargePoint has since adopted OCPP into their charging stations.

12.2.3 Cost Assessment

Residents elected for a 2 way-load sharing on each 40A circuit (two units share one 40A connection), which increased cost but also increased capacity for each resident. This allows for increased charging speed for each EVSE. A financial breakdown was included in the study:

1. Electrical engineering feasibility assessment: $6,000
2. Detailed electrical design: $8,000
3. Electrical contractor materials and labor (excluding EVSE): $57,200
4. BC Hydro and other misc. costs: $2,600
5. Materials and labor to install 10 EVSE: $23,000 (paid by individual unit owners)

As this project was completed in 2020, the project received the full $14,000 sum for EVSE installations from the CleanBC EV Charger rebate program, but no EV-Ready rebates were available. The author estimates that incentives could have totalled $27,800 if current rebates were available at the time. Also, this project may be considered “old” in terms of hardware cost due to industry advancements, though electrical feasibility, design, and contractor costs may be relatively indicative of the cost of a 23-unit MURB retrofit.

12.2.4 Conclusion

The author concluded that units that owned EVs increased from 3 to 7 after the project was completed, and remaining units that had not installed EVSE may easily do so because of the EV-Ready stalls. While this is true, new adopters are not eligible to partake in the CleanBC rebate incentives, one major limitation of British Columbia’s provincial incentive program.

13 APPENDIX C: FULL BARRIER-RECOMMENDATION MATRIX

Barrier #	Associated Barriers
1	MURB Electrical Capacity
2	Lifespan Requirements
3	Inherent Complexity
4	Lack of Council Bandwidth
5	Lack of Technical Know-How
6	Parking Tenure
7	High Upfront Cost
8	Incentive Timeframe
9	Provincial Incentive Uncertainty
10	Risk for Late Adopters (MURBs or Individuals)

	Barrier									
Recommendation	1	2	3	4	5	6	7	8	9	10
Consider procuring a detailed electrical inventory for MURBs	■									
Consider developing a city-approved, standardized list of EVSE & EVEMS technology	■	■	■	■	■					■
Consider limiting strategy to 100% EV-Ready options			■			■	■			■
Consider providing online informational resources				■	■	■				
Consider providing holistic energy assessments to MURBs	■	■	■	■	■		■	■	■	
Consider providing an “future-proof” retrofit advisor service for MURBs	■	■	■	■	■		■	■	■	
Consider providing an independent financial benefit to MURBs				■	■	■	■	■	■	■

Table 13: Full Barrier vs. Recommendation List