Futureproofing Multifamily Buildings for EV Charging

Final Report

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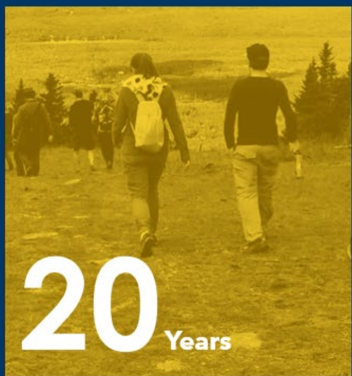
About Dunsky



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List of Abbreviations

AGM	Annual General Meeting
CaaS	Charging as a Service
CE Code	Canadian Electrical Code
CFR	Clean Fuel Regulations
CMS	Charging Management System
CSA Group	Canadian Standards Association Group
CSP	Charging Service Provider
DCFC	Direct Current Fast Charging
DERMS	Distributed Energy Resource Management System
DFI	Development Finance Institution
DSO	Distribution System Operator
EOM	End of Month
EV	Electric Vehicle
EVEMS	Electric Vehicle Energy Management System
EVSE	Electric Vehicle Supply Equipment
GMF	Green Municipal Fund
GTHA	Greater Toronto and Hamilton Area
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
JB	Junction Box
LAN	Local Area Network
LC3	Low Carbon Cities Canada
LCFS	Low Carbon Fuel Standard
MURB	Multiunit Residential Building
NACS	North American Charging Standard
NPV	Net Present Value
NRCan	Natural Resources Canada
OCA	Open Charge Alliance
OCPP	Open Charge Point Protocol
OSCP	Open Smart Charging Protocol
SG	Switchgear
SGM	Special General Meeting
V1G	Vehicle-to-Grid (unidirectional power flow)
V2G	Vehicle-to-Grid (bidirectional power flow)
XFMR	Transformer
ZEVIP	Zero Emission Vehicle Infrastructure Program

Executive Summary

This report provides information, analysis and recommendations to support the Federation of Canadian Municipalities' Green Municipal Fund (GMF), the Low Carbon Cities (LC3) network, and their partners and collaborators **develop strategies to accelerate access to "at home" electric vehicle (EV) charging for the increasing share of Canadians who live in multifamily housing**.

Achieving Federal and Provincial **climate targets** requires that we rapidly switch from fossil fueled vehicles to EVs, as well as switch to efficient electric building systems (e.g. heat pump space heating and hot water). Additionally, the transition to EVs represents a significant economic opportunity - On a life-cycle basis, **EVs are the most cost-effective vehicle technology today**, and **EV costs will continue to decline** as the cost of producing batteries decreases due to learning effects and economies of scale. Accordingly, Canada is bringing forward legislation to ensure that **by 2035, all new passenger vehicles sold will be Zero-Emission Vehicles** (ZEVs), effectively requiring EVs.

Charging EVs at home is generally the lowest cost and most convenient for drivers. However, while implementing EV charging in single family homes with onsite parking is usually relatively straightforward, it is challenging for multifamily buildings that have not been properly futureproofed for EV charging.

About one-third of Canadians live in multifamily buildings; this share reaches **nearly half** in many urban centres and is increasing. The large majority multifamily buildings in Canadian metro areas are **condos**, though a sizeable stock of rental apartments, co-ops and other tenures also exists.

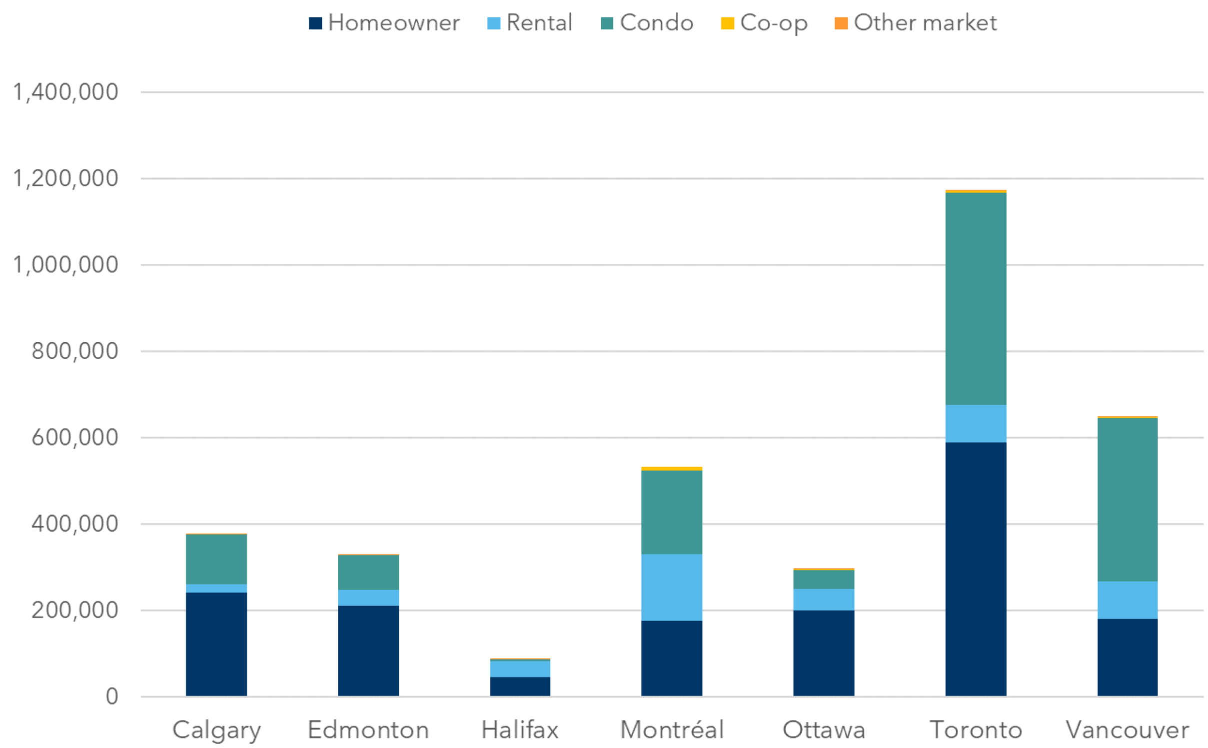

Figure ES-1: Housing Starts by Market Type and Census Metropolitan Area, 1988-2023.

Access to home charging is important for households to feel comfortable choosing an EV as their next vehicle. For building and condo owners, it adds an increasingly sought-after **amenity** that can make the building more valuable. Moreover, access to charging in multifamily buildings is an **equity** issue, given the greater prevalence of low-income and racialized people in multifamily buildings relative to single-family homes. Finally, EV charging infrastructure in multifamily buildings can be used to **support shared mobility services** (e.g. car share).

Unplanned, piecemeal approaches to adding EV chargers are currently the most common way that EV charging infrastructure is implemented in multifamily buildings. Unfortunately, this piecemeal approach is expensive on a life-cycle basis, and has considerable risks of being incompatible with future expansion to accommodate more EV drivers, risking stranded assets. **To avoid excessive costs and delayed EV adoption in multifamily buildings, we need to rapidly transition from piecemeal approaches to comprehensive EV charging infrastructure futureproofing.** With the transition to EVs well underway, we cannot afford to delay comprehensively futureproofing multifamily buildings.

For **new** multifamily buildings, the best solution is **requirements to make all residential parking spaces, and a portion of non-residential parking, "EV Ready" for Level 2 charging**. This greatly lowers life-cycle costs for future installation of chargers.

For the large **existing stock** of multifamily buildings, the optimal solution is usually a **comprehensive futureproofing retrofit that will enable all parking spaces to feature EV charging (or at least one parking space per residence).**[1]

KEY CONCEPTS

Multifamily building refers to buildings featuring more than one residential unit. It includes both condos and rental housing. It includes apartments and townhome style dwellings. For the purposes of this report, it does not include single-detached or duplex housing.

Comprehensive futureproofing means retrofitting electrical systems to enable each residential parking space to easily implement EV charging in the future, as resident adopt EVs. Comprehensive EV futureproofing can occur upon construction (in the case of new buildings) or through a carefully planned retrofit (in the case of existing buildings).

- **EV Ready** is a futureproofing approach where a parking space features an adjacent electrical outlet at which a charging station can be installed in the future.
- **EV Capable** parking is served by an electrical panel with sufficient electrical capacity to later install a branch electrical circuit and EV charging.
- **Load management** refers to using EV Energy Management Systems (EVEMS) to monitor and control EV loads so as not to exceed the capacity of an electrical circuit.

[1] Comprehensive futureproofing further provides an opportunity to consider changes in the tenure and use of multifamily buildings' assigned parking to create more value for residents and owners, as well as advance sustainable transportation and social equity. For example, condo owners could be enabled to lease parking to car-share or e-bike services by allowing non-residents to access buildings' parkades. A detailed exploration of how to enable more sustainable and valuable use of parking was outside the scope of this report, but should be considered by policy-makers and multifamily building owners.

Futureproofing Designs for EV Charging in Multifamily Buildings

A **comprehensive EV charging infrastructure futureproofing approach** should be taken in most multifamily buildings because:

- Comprehensive installations are usually **more cost-effective** on a per-stall basis compared to incremental approaches.
- Comprehensive installations ensure that **any drivers who make the switch** to an EV can access charging.
- Planning comprehensive futureproofing also provides an **opportunity to plan optimal electrical systems to support electrification** of other building systems (e.g. space heat, hot water, etc.) that must decarbonize. Likewise, it provides an opportunity to plan for changes in the use and/or tenure of parking (e.g. enabling car-share, e-bike share, etc.).

A variety of different electrical configurations could be implemented as part of such a comprehensive futureproofing approach.

Firstly, residential EV charging can be **Level 1** (120V), or **Level 2** (208V/240V). Level 2 is much more likely to provide drivers with enough charge for their next days' driving, even if significant load management occurs. Conversely, Level 1 is usually insufficient for large vehicles such as increasingly popular pickup trucks and SUVs, and for those that drive longer than average distances. Likewise, Level 1 futureproofing is usually has higher "Day One" capital cost than Level 2 with reasonable load management, though it can be lower cost on a life cycle basis due to no or low cost EV chargers. For these reasons, Dunsky usually **recommends buildings futureproof for Level 2**. However, some stakeholders (e.g. some rental building owners) appreciate the "low tech" nature of Level 1. The implications of Level 1 versus Level 2 is further described in Section 2 of this report.

Secondly, parking can be either **EV Ready** or **EV Capable** (see definitions above). Finally, there are a wide range of electrical configurations that can be suitable in different circumstances, as described in Section 2 of this report.

Figure ES-2 compares the life cycle costs of several different futureproofing configurations. The key takeaway of this analysis is that **comprehensive futureproofing will outperform an unplanned, piecemeal approach to add EV charging**, even when discounting future cashflows and ignoring the potential for stranded assets that are often associated with piecemeal approaches.

Dunsky's analysis further suggests that Level 1 can realize the lower life cycle costs, though as noted above it will be inadequate for many drivers, and will also entail higher "Day One" infrastructure and installation costs than other futureproofing strategies. 100% EV Ready with load sharing across branch circuits is often the most cost-effective approach, though other configurations (e.g. 100% EV Capable; EV Ready with feeder monitoring of individual residents' panels; etc.) can represent the optimal solution in certain situations. Every building is different, and **the best comprehensive futureproofing strategy for each building should be considered** based on its unique electrical systems, parking tenure (e.g. limited common property; leases; etc.),layout and priorities of owners and drivers.

Figure ES-2: Net present cost of different futureproofing configurations (assumes a 7% discount rate on future cashflows).

The Funding and Financing Landscape today

Table ES-1 below summarizes some prominent Canadian incentive programs supporting EV Ready retrofits. The table reflects that B.C. is a world leader in funding comprehensive EV Ready retrofits of multifamily buildings, with the CleanBC EV Ready Rebate program supporting condominium and rental buildings alike to offer charging to their residents at scale. B.C. municipalities including the District of Saanich and the City of Vancouver provide complementary "top-up" programs. In Quebec, the provincial government also offers rebates for charging installation in multifamily buildings.

Of the limited number of comprehensive futureproofing projects that have occurred to date, we are not aware of any that have been loan financed. Furthermore, while there are products available for condo retrofits in general, those that exist have short repayment terms and high interest rates. Loans and other financing strategies represent an important opportunity to scale up EV futureproofing, as profiled in this report.

Table ES-1: Best-in-class funding programs for EV ready retrofits in multifamily buildings

Program	Administrator	Region	Funding Streams	Offer	Supports Comprehensive Futureproofing
EV Ready Rebate Program	BC Hydro	BC	EV Ready plan rebate	$3,000	Yes
			EV Ready infrastructure rebate	$600 per parking space, maximum $120,000	
			EV charger rebate	$1,400 per charger, maximum $14,000	
Rental Building EV Ready Top-up Program	City of Vancouver	BC	Infrastructure and charger (add-on to BC EV Ready Rebate Program)	Up to $93,000	Yes
EV Charging in Existing Multifamily Buildings Top-Up Rebates	District of Saanich	BC	EV ready plan rebate (add-on to BC EV Ready Rebate Program)	Up to $1,000	Yes
			EV Ready infrastructure rebate	Up to $100 per parking space	
Roulez Vert Program	Gouvernement du Québec	QC	Multiple dwelling building charging station	$5,000 per charger, maximum $20,000 to $49,000 **per year** based on building size	Yes

Action Plan

Based on the research and findings detailed in this report, we present our recommendations to support the widespread deployment of comprehensive futureproofing across Canada. We have selected strategies that are viable, equitable, and support (or at least do not inhibit) whole building electrification.[2]

Table ES-2 presents key roles by lead actor. More details are presented in Section 6 of the main report.

[2] Whole building electrification refers to the transition of all building systems and appliances to run on electricity instead of fossil fuels, aiming to reduce greenhouse gas emissions and improve energy efficiency.

Table ES-2: Action Plan.

Action	Who?
1.0 Policy & Regulation	
1.1 Update the model *National Energy Code for Buildings* (NECB) and the *National Building Code* (NBC) to require EV Ready new construction.	Federal govt., P/Ts
1.2 Adopt best practice EV Ready requirements for new construction.	P/Ts, Munis
1.3 Adopt "Right to Charge 2.0" (as described in this report).	P/Ts
1.4 Update utility policy constructs, regulation, rates and programs to support widespread deployment of EV charging, and broader beneficial electrification.	P/Ts, Utility regulators, Utilities
1.5 Explore legislation, and/or template condo bylaws and associated processes, to enable legally exchanging parking spaces in condos and thereby enable phased retrofits, and to lower approval voting thresholds for futureproofing projects.	P/Ts, Federal govt., DFIs, Non-profits
2.0 Incentive Programs	
2.1 Offer incentives (rebates) for comprehensive EV futureproofing retrofit planning studies and infrastructure upgrades. **In aggregate, we recommend incentives total approximately $3 billion by 2030.**	Federal govt., P/Ts, Utilities
2.2 Offer incentives specifically tailored to low- or moderate-income rental buildings and non-market housing. Offer incentives specifically tailored to low- or moderate-income rental buildings and non-market housing. Consider Charging as a Service and utility "make ready" programs specifically tailored to the rental and affordable housing sectors. Include clauses in funding agreements that restrict rent increases, evictions and exorbitant user fees.	Federal govt., P/Ts, Utilities
3.0 Financing Programs	
3.1 Introduce loan financing products to support comprehensive EV futureproofing.	Development finance institutions (DFIs - e.g., CIB, GMF, LC3s, credit unions, and other public interest lenders)
3.2 Engage with the Canada Infrastructure Bank and consider aggregating EV futureproofing projects as part of the Building Retrofits Initiative.	DFIs
3.3 Explore financing projects to be repaid against future Clean Fuel credit revenues in jurisdictions with high credit values.	DFIs, Federal govt., P/Ts
3.4 Pilot Charging-as-a-Service, and quickly scale up if programs are deemed effective.	DFIs, Utilities, Federal govt., P/Ts, Munis, Charging service providers

Action	Who?
3.5 Pilot "Make Ready" utility investment in EV charging infrastructure, and quickly scale up programs if deemed cost effective.	Utilities, Utility Regulators
4.0 Capacity building, standards & bulk procurement	
4.1 Provide education and training related to comprehensive EV ready retrofits for condominium boards and rental building owners to understand the value proposition.	Federal govt., P/Ts, Munis., Utilities, Non-profits
4.2 Develop a standard specification for networked EV charging services for multifamily buildings (and potentially other applications – e.g. workplaces), and an impartial means of testing and certifying service providers against the specification.	Federal govt., P/Ts, Utilities, DFIs, Non-profits
4.3 Develop specifications and guidance for wholistic electrification planning studies and futureproofing practices.	Federal govt., P/Ts, Utilities, Non-profits & DFIs
4.4 Explore bulk procurement of EV charging services for multifamily buildings (and potentially other applications – e.g. workplaces).	Federal govt., P/Ts, DFIs

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Introduction

1. Introduction

1.1 Purpose of this Report

The Purpose of this Report is to identify how existing multifamily buildings can best be futureproofed with electric vehicle (EV) charging infrastructure, and to recommend actions that different levels of government, utilities and civil society can take to support adoption of comprehensive EV charging infrastructure retrofits. This work will inform the Federation of Canadian Municipalities' Green Municipal Fund (GMF) and the Low Carbon Cities (LC3) network in developing and advocating for strategies to accelerate EV futureproofing.

Governments and communities across Canada have committed to eliminating carbon pollution from our personal travel by 2050. Reaching this goal will require that first, we reduce the travel demand by building more complete communities; second, that we offer compelling and affordable alternatives to automobiles; and finally, that we electrify the remaining vehicles.

Charging EVs at home, as compared to public charging, offers multiple benefits:

- For **EV users**, it is more convenient and affordable;
- For **building and condo owners**, it adds an increasingly sought-after amenity that can make their property more valuable;
- For **cities,** it frees up valuable public space for other uses; and
- For **utilities,** it creates opportunities to harness the flexibility of EV charging loads to build a responsive electrical grid.

Indeed, widespread access to home charging is critical to ensure Canada is on track to achieve its national EV adoption targets and broader emissions reduction targets. Access to EV charging at home makes drivers more comfortable and more likely to choose an EV as their next vehicle.

In Canada, setting up home EV charging is typically a straightforward process for single-family homes with onsite parking. However, the situation is more complex for the approximately one-third of Canadians who reside in multifamily buildings. In many urban centers, this proportion rises to nearly half of the population and is on the rise. **Residents in multifamily buildings face notable financial, technical, and legal hurdles when it comes to installing EV charging solutions in their buildings.**

For **new multifamily buildings**, the best solution is to **require that all residential parking in new developments feature "EV Ready" electrical infrastructure** (as described below). These measures will ensure that residents of new buildings do not face the same barriers that prevail today.

However, there is a large **existing stock** of multifamily buildings that were not designed with EV charging in mind. Wherever possible, these buildings need **comprehensive futureproofing retrofits** to ensure that drivers can access **EV charging in their assigned parking space** when they eventually get an EV, or let other community members or carshare services park EVs in their space. Comprehensive futureproofing approaches, as described in this report, can significantly reduce the lifecycle costs of EV charging and reduce the risks of stranded assets, compared to the piecemeal addition of EV chargers. By implementing such approaches, multifamily buildings can ensure that all parking spaces are equipped to ultimately accommodate EV charging needs.

Compatibility with Electrification of (Nearly) Everything

Electrifying (nearly) everything is the lynchpin of decarbonizing the built environment and personal mobility. **Electrification is the most viable pathway to decarbonize passenger vehicles, as well as most building space and water heating, ventilation, cooking, clothes drying, and other end uses.** Thus, it is important that EV charging infrastructure in multifamily buildings is compatible with the electrification of other building systems.

While this report focuses on strategies to implement EV charging, it notes implications for electrifying other energy end uses. Importantly, buildings have limited electrical capacity; electrical upgrades can be expensive, and it is often preferable to avoid them. Therefore, to a certain extent, **EV charging and building electrification are competing for limited electrical capacity on buildings' existing services**. Nevertheless, there are opportunities to design for **efficient** EV charging and building systems and leverage **energy management systems**. Using these tools, **it can be possible to avoid electrical upgrades even when "electrifying everything"** (though it should be noted that very few buildings to date have implemented comprehensive EV futureproofing *and* electrification of all building systems, and there is thus little empirical data to draw on).

This report notes how efficient design of EV charging, and the associated use of EV energy management systems (EVEMS), can help reduce costs and the likelihood of electrification exceeding buildings' limited electrical capacity. It also highlights opportunities for integrated design and delivery of programs to support both comprehensive futureproofing for EV charging as well as electrification of other building systems. However, this study does not evaluate the proportion of multifamily buildings that can accommodate full electrification; nor the many efficiency and energy management strategies that can free electrical capacity (there are many such opportunities beyond those relating to EV charging noted in this report); nor make recommendations with regards to programs that are focused on building energy uses other than EV charging. Further study, including support for pioneering buildings that are electrifying all building systems along with comprehensively futureproofing for EV charging, is recommended.

1.2 Methodology

The analysis presented in this report was informed by four separate tasks:

1. **Stakeholder interviews.** We conducted 12 stakeholder interviews with EV charging service providers (CSPs), contractors and engineering firms experienced with EV ready retrofits, utilities, federal government employees, rental building owners, financiers, and others. Interview questions covered stakeholders' perspectives on EV retrofit processes, project delivery models, costs of retrofits, key barriers, and what policy and program interventions can enable EV ready retrofits. These findings are integrated throughout the report.
2. **Technical analysis.** We identified and described the range of design options and implementation processes to futureproof multifamily buildings. Drawing from pre-existing studies, stakeholder interviews, and program data, we developed high-level capital and

operating cost ranges for comprehensive EV charging infrastructure futureproofing retrofits for a range of building archetypes.

3. **Legal and procedural analysis.** We characterized futureproofing project approval and implementation processes. We identified risks associated with project implementation and strategies to mitigate those risks.
4. **Business case analysis.** We developed a *pro forma* modeling tool to assess the lifecycle costs of different approaches to EV futureproofing retrofits. The modeling tool was designed to evaluate various unique contexts for EV charging installation in multifamily buildings, informed by the building archetypes and project delivery models identified as part of Task 2. We calculated total lifecycle costs of different approaches to retrofits and compared them according to different assumptions.

Drawing on the four tasks outlined above, we assessed the feasibility of comprehensive EV futureproofing retrofits and the most viable funding and financing structures to implement these retrofits. We compare different approaches to comprehensive futureproofing in existing multifamily buildings to unplanned piecemeal approaches using technical, financial and legal perspectives. Finally, we present recommendations for how the GMF, LC3, cities, governments, and other actors can collaborate to ensure access to home charging for people living in multifamily buildings.

1.3 Outline

This report is structured into the following sections:

- **Technologies, Services & Design Strategies to Futureproof multifamily buildings for EV Charging.** An overview of electrical systems in multifamily buildings, EV charging infrastructure, standards and protocols for EV charging communications, EV Energy Management Systems (EVEMS), performance requirements for EV charging, EV charging service providers, and futureproofing parking for EV charging.
- **Funding, Financing & Project Delivery Mechanisms to Futureproof multifamily buildings.** A description and comparison of different project delivery mechanisms, funding and financing strategies, including utility-led "Make Ready" programs, customer-owned infrastructure, and charging-as-a-service business models.
- **Project Implementation Considerations.** An overview of condominium approvals processes in different jurisdictions, the role and significance of "Right to Charge" legislation, and risk-mitigation strategies associated with project implementation.
- **Business Case Analysis.** A description of the building characteristics with the biggest financial impact on EV futureproofing, estimates of the costs of different futureproofing strategies, and a description of the model and results of the pro forma analysis.
- **Recommended Actions.** A summary of the key recommended actions.

1.4 The Importance and Challenge of Implementing EV Charging in Multifamily Buildings

1.4.1 A growing share of Canadians live in multifamily buildings

Over the last decade, the share of Canadians living in multifamily buildings has continued to increase as the number of new apartments being built across Canada outpaces that of single detached homes. While single-unit homes (e.g., single-or semi-detached houses and movable dwellings) still account for the majority of dwellings at 65.6%, their market share is on a steady decline (Table 1). In contrast, the share of residential units in multifamily buildings has increased by 1.8% on average across Canada since 2011, with more significant growth in urban census metropolitan areas (CMAs) including Halifax, Toronto, Calgary, and Vancouver. Across the CMAs of Vancouver, Halifax, Montreal, Toronto, Hamilton, Edmonton, Calgary, and Ottawa/Gatineau, the share of residential units in multifamily buildings is 46%, higher than the national average of 34%.

What is a multifamily building?

For the purposes of this report, we consider multifamily buildings to encompass apartment-style buildings (including condominiums as well as purpose built rental apartments) and townhomes/rowhouses. Because they feature shared electrical infrastructure and often have common parking garages, these building types face challenges to implement EV charging at scale.

Table 1 summarizes the share of residential units in multifamily buildings for the eight CMAs of interest for this study, showing that across all of these CMAs, the share of units in multifamily buildings relative to single unit dwellings has increased relative to 2011, with the lowest increase in Ottawa/Gatineau (0.05%), and the largest increase in Vancouver (4.9%).

Table 1: Share of Units in Multifamily Buildings[3,4]

	2011	2021	% Increase
Halifax	35.90%	37.90%	2.00%
Montreal	58.60%	59.50%	0.90%
Hamilton	26.50%	27.20%	0.70%
Ottawa	31.20%	31.20%	0.00%
Toronto	42.00%	44.20%	2.20%
Calgary	24.10%	26.40%	2.30%
Edmonton	26.50%	26.80%	0.30%
Vancouver	54.40%	59.50%	4.90%
Canada	32.60%	34.40%	1.80%

1.4.2 Cities have different multifamily building stock compositions

Canadian cities vary widely in the composition of their multifamily building stock. Figure 1 summarizes the total number of individual units in multifamily buildings by building size and census metropolitan area for Vancouver, Halifax, Montreal, Toronto, Hamilton, Edmonton, Calgary, and Ottawa.

[3] Statistics Canada. 2021. *Table 98-10-0138-01 Household type including multigenerational households and structural type of dwelling: Canada, provinces and territories, census metropolitan areas and census agglomerations.*
[4] Statistics Canada. 2011. *Census of Population, Statistics Canada Catalogue no. 98-313-XCB2011022.*

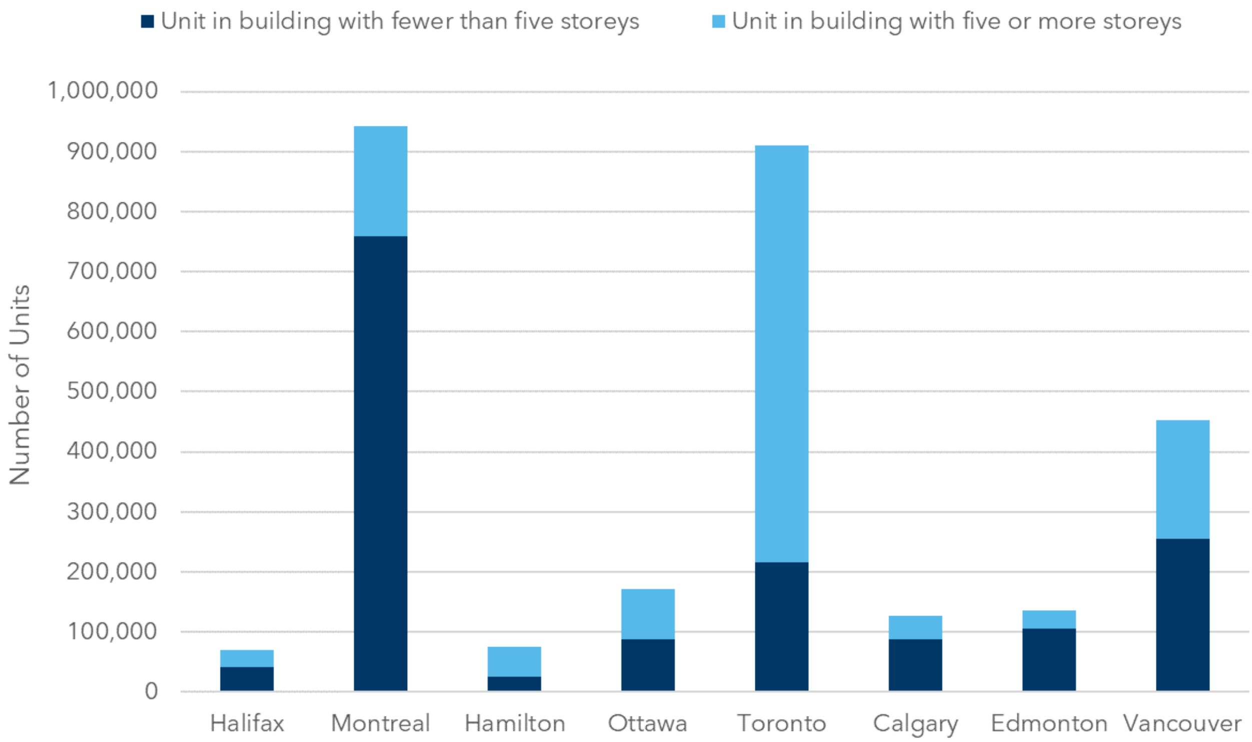

Figure 1: Units in multifamily buildings by Building Type and Census Metropolitan Area.[1]

1.4.3 The rising presence of condominiums

Within the multifamily building segments, the market shares of condos versus rental apartments also varies significantly across CMAs. Since Statistics Canada began tracking housing start data in 1988, the Toronto and Vancouver CMAs have seen the largest increase in condo development (Figure 2). In Toronto, nearly 600,000 units in **condo buildings** have been developed since 1988, representing **42% of all housing starts**. In Vancouver, **58% of all housing starts** since 1988 have been condo development, with only 14% of development being purpose-built rental apartments. Condo development has outpaced rental apartment development in all but two municipalities included in this study, with the exceptions being Halifax and Ottawa.

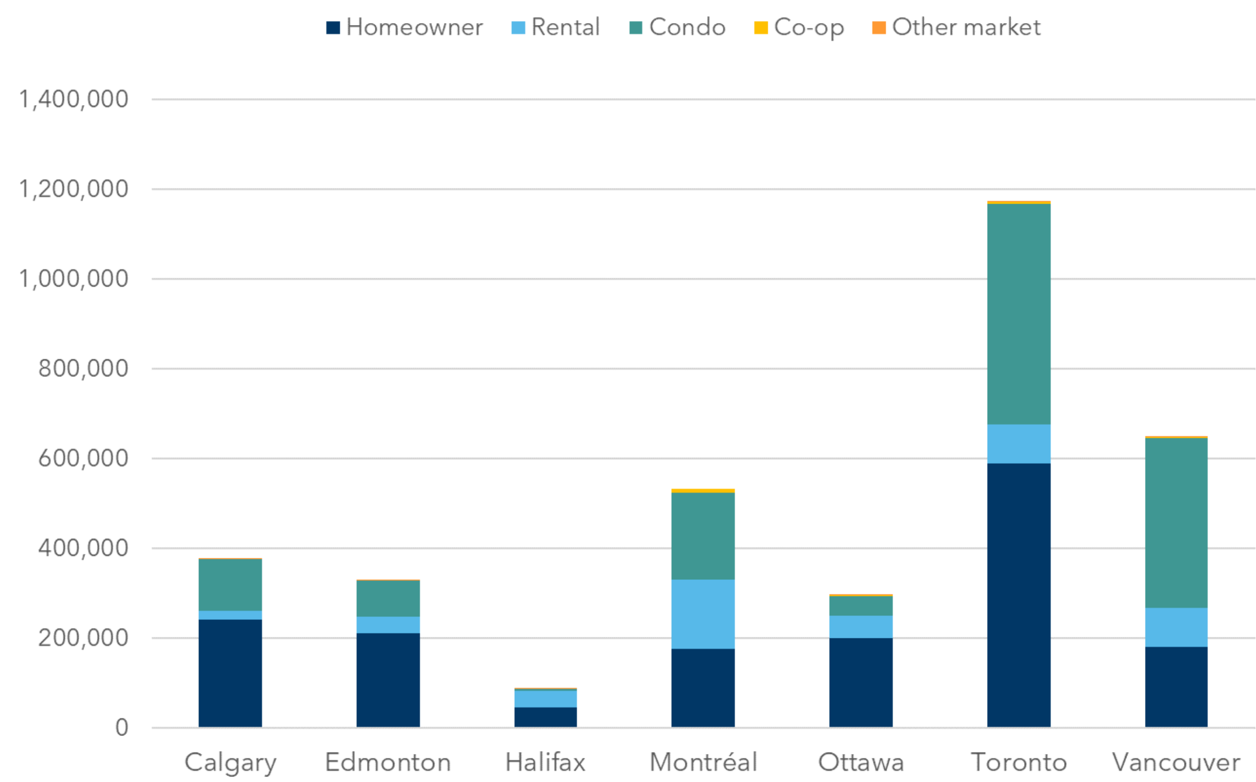

Figure 2: Housing Starts by Market Type and Census Metropolitan Area, 1988-2023.[5]

The increasing share of condos in the existing building stock is relevant for multifamily building futureproofing retrofits, as it affects the decision-making processes required and the appropriate futureproofing strategies. Notably, it condo owners typically cannot readily exchange parking spaces among residents, given the legal designations of parking; thus, all parking in condominiums require futureproofing if all residents are to have access to at home charging. Conversely, in rental apartments, it can be possible to phase retrofits, though these should be planned in such a way as to ensure that all residents ultimately have access to EV charging.

Buildings constructed since 1988 are also likely to be especially strong candidates for comprehensive futureproofing, as they are very likely to remain standing in 20 to 40 years, with EV adoption set to increase significantly over the same time period.

Rental housing broadly falls into two categories: **market rental** (housing about 88% of tenants), which is owned by individuals/private landlords, companies or real estate investment trusts, and **non-market rental** (housing about 12% of tenants), which includes **social (public) housing,** non-profit housing, and cooperatives.

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[5] Canada Mortgage and Housing Corporation. 2023. *Table 34-10-0148-01 Housing starts, by type of dwelling and market type in centres 10,000 and over, Canada, provinces, census metropolitan areas and large census agglomerations*.

1.4.4 Access to EV charging in multifamily buildings is an equity issue

The transition to EVs is crucial to mitigate climate change and improve local air quality. Moreover, given the ongoing decline in EVs' upfront costs, they increasingly entail lower life-cycle costs for drivers, compared to internal combustion engine (ICE) vehicles. Thus, **ensuring access to EVs constitutes an important economic justice issue**.

More affluent people are much more likely to purchase or lease new cars; middle- and lower-income people tend to acquire used cars.[6] Because mass-market EVs have only begun to be available in the last five years, and because they currently have an upfront cost premium, EV adoption is concentrated amongst more affluent people. Indeed, data from studies in the U.S demonstrate that EV ownership is currently skewed towards the affluent, white, male, middle-aged people that reside in detached houses.[7] [8]

However, as EVs enter the used market at scale, they will be increasingly available to low- and middle-income people. EVs stand to save these populations considerable amounts of money – the International Council on Clean Transportation forecast that low-income households acquiring an EV in 2030 will save 7% of their total household expenditures relative to households with internal combustion engine (ICE) vehicles.[9]

Low- and middle-income households, and marginalized and racialized communities, are more likely to live in multifamily buildings. These multifamily residents may rent units in purpose built rental housing or condos; close to 40% of condo units in Canada are rented out.[10] Alternately, low- and middle-income households may own condo units.

Unfortunately, without careful planning and futureproofing investments, it is much more costly and complicated to implement home charging in multifamily buildings. Moreover, unplanned piecemeal retrofits run the risk of using all the limited electrical capacity in the building (as explained further in Section 2.4 below). Exhausting electrical capacity in early deployments will make it much more expensive to add additional EV charging to serve residents adopting EVs in later years, who will disproportionately be lower income.

If they cannot access home charging, these populations must rely on public charging stations, which will be more costly. Additionally, home charging is more convenient, avoiding the time spent traveling to and using public chargers. Without equitable access to home charging, multifamily residents will be slower to adopt EVs, reducing the potential economic benefits and local air quality benefits of transitioning to EVs for lower income communities.

Thus, increasing access to EV charging in multifamily buildings, and ensuring that all residents can ultimately access EV charging in their building, is critical to rectify existing inequalities. Likewise, it is important to ensure that programs and policies supporting deployment of EV charging in existing multifamily buildings do not inadvertently exacerbate socio-economic inequalities by making it harder to scale EV charging in the future.

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[6] Paszkiewicz of the US Bureau of Labor Statistics. 2003. The Cost and Demographics of Vehicle Acquisition.
[7] ICCT (2017). Expanding access to electric mobility in the United States.
[8] National Center for Sustainable Transportation (2018). Understanding the Distributional Impacts of Vehicle Policy: Who Buys New and Used Alternative Vehicles?.
[9] ICCT (2021). When might lower-income drivers benefit from electric vehicles? Quantifying the economic equity implications of electric vehicle adoption.
[10] https://www150.statcan.gc.ca/n1/daily-quotidien/220921/dq220921b-eng.pdf

1.4.5 EV Futureproofing and the broader sustainable mobility transition

Of course, **the most sustainable and affordable option is usually to forgo personal vehicles entirely** – While some households may require vehicles, many can be much better enabled to forgo driving personal vehicles through improved transit; walking and biking infrastructure; and shared mobility services such as access to car-share, e-bike share, etc. Indeed, our societies' investments in such transportation options can collectively save households billions of dollars in personal vehicle costs every year, improve community health, and eliminate the environmental impacts of vehicle travel. As Canadian cities and multifamily neighbourhoods grow in the coming decades, there is a profound opportunity to change land use and transportation networks, and grow shared-mobility services, to realize these outcomes.

In the context of such an opportunity, why should governments and civil society support comprehensive EV futureproofing? If the goal is to significantly reduce car travel in the coming years and decades, why futureproof all (or most) parking? Will such investments in EV futureproofing encourage vehicle use?

In Dunsky's opinion, **comprehensive EV futureproofing will not undermine the transition to non-automotive transportation, and can even enable it**.

Firstly, parking in *existing* multifamily buildings is, by definition, already constructed. The fact is that having access to onsite parking, particularly if it is free, significantly increases households' propensity to own and use a car(s)[11] - What drives personal vehicle adoption is mainly access to convenient, low-cost parking, not EV charging. Therefore, households that *do* have access to onsite parking should at least be enabled to drive EVs through futureproofing retrofits.

Secondly, as more fully documented in Section 2 below, comprehensive futureproofing is much more cost-effective than adding a few chargers at a time in a piecemeal fashion. Furthermore, the **marginal costs** of futureproofing all parking, versus a significant proportion of parking, are **often very small;** electrical costs in EV futureproofing retrofits are not necessarily linear with the proportion of parking implemented. Moreover, if it is anticipated that parking will be used at low intensity (e.g. much parking will be unused, and/or most vehicles will travel short distances) then comprehensive futureproofing can design for more aggressive load-sharing using EV energy management systems (see Section 2 below) – This can result in the same absolute project cost as futureproofing a smaller proportion of parking (e.g. 50%), but allow *all* spaces to eventually feature charging. This is especially important in condo's assigned parking, as it cannot be known ahead of time which condo units will adopt EVs, and parking tenure in most condos makes it very difficult to trade parking spaces between residents.

Finally, as Canadian cities grow in coming years, we must reduce the prevalence of parking,[12] and make better and more efficient use of existing parking. Eliminating municipal minimum parking requirements, and setting maximums, for new construction presents a profound opportunity to make constructing new housing more affordable, improve urban design, and reduce personal vehicle ownership.[13] Likewise, on-street and other publicly accessible parking can be converted to better

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[11] See, e.g. literature summarized by the Oregon Department of Land Conservation & Development. 2022. "Parking Supply, Car Ownership, and Driving Rates". https://www.oregon.gov/lcd/CL/Documents/ParkingCarsDriving.pdf

[12] The vast majority of existing multifamily buildings, as well as single family and non-residential building types, were constructed subject to municipal requirements to construct a minimum number of parking spaces.

[13] See e.g. Donald Shoup. 2011. *The High Cost of Free Parking*.

uses (e.g. bike lanes; wider sidewalks; landscaping and parks; housing in the case of public parkades; etc.).

Conversely, structural parking for residential buildings is less likely to be productively converted to other uses – Structural parking usually is not good for much besides storing cars.[14]

Enabling condo and rental building owners to lease parking spaces to neighbors and shared-mobility services will allow for more intensive use of parking; give residents an economic incentive to forgo vehicle ownership; and better enable a rapid transition to less on-street and off-street parking. **It is lower income households who have the most to gain by decoupling parking from housing.**

When a multifamily building pursues a comprehensive EV futureproofing project, it presents a key opportunity to consider such broader changes in the tenure and use of parking. However, even if such changes in parking use are not considered at that time, EV futureproofing inherently provides charging infrastructure for car-share services, and other forms of electric shared mobility. Additionally, it could be made compatible with renovations of parking to certain other compatible uses (e.g. conditioned storage space; etc.).

It was beyond the scope of this report to consider how best to enable multifamily buildings to repurpose residents' parking for such more intensive, environmentally friendly, and socially equitable uses. Enabling such changes requires careful consideration of several issues, including different business models, how best to ensure positive outcomes for residents (e.g. what security upgrades are necessary to enable public access to parking areas car-share services), legal and policy questions, etc. It is recommended that these issues be further explored by FCM, LC3 and other stakeholders.

[14] Conversely, residential surface parking often presents significant redevelopment opportunity. And some structural parking could be repurposed for e.g. storage, etc.

Technologies, Services & Design Strategies to Futureproof Multifamily Buildings for EV Charging

2. Technologies, Services & Design Strategies to Futureproof Multifamily Buildings for EV Charging

This section provides an overview of the technologies, services and design strategies to futureproof multifamily buildings for EV charging.

KEY CONCEPTS

There are different **electrical configurations** to futureproofing parking for EV charging:

- **EVSE Installed.** A parking space with adjacent hardwired EV Supply Equipment (EVSE - either Level 1, Level 2 or DCFC).
- **EV Ready.** A parking space with an adjacent wired electrical outlet at which Level 1 or Level 2 EVSE can be implemented in the future.
- **EV Capable.** A parking space served by a proximate electrical panel that has spare electrical capacity for EV charging.

EV Energy Management Systems (EVEMS) monitor and control loads so as not to exceed the capacity of an electrical circuit. EVEMS enable **load management,** which is a critical strategy to enable a large proportion of parking spaces to feature EV charging within the limited electrical capacity of an existing building.

Broadly, there are **two ways to implement EV charging infrastructure** in multifamily buildings:

1. **Unplanned piecemeal additions of a few EVSE at a time**, with little or no consideration of futureproofing for subsequent expansion. As of this writing, this represents the most common way for multifamily buildings to add EV charging.
2. **Comprehensive futureproofing,** where building systems are planned from the earliest stages of retrofits to accommodate near-universal adoption of EV charging in most parking spaces. Usually, all parking will be made EV Ready or EV Capable; in some circumstances where residents can exchange parking spaces (for example, in some rental buildings), there may be opportunities for phased retrofits where electrical infrastructure is planned to ultimately serve all residents, but only a proportion of parking spaces are initially made EV Ready or EV Capable.

CENTRAL RECOMMENDATIONS

In this section, we provide an overview of technical issues to help answer the following questions:

What Level of charging should be installed in multifamily buildings?

- In most multifamily buildings, Dunsky recommends installing EV ready infrastructure that supports load-shared Level 2. Broadly, Level 1 charging will not be adequate to meet the needs of all drivers, such as those with larger vehicles, or those who drive farther than average. Level 2 futureproofing will also often be lower capital cost on "day one".
- However, Level 1 infrastructure can have lower lifecycle costs than Level 2, and is appropriate when residents' driving distances are low and vehicles are small. Likewise, some building owners and property managers report appreciating the relative simplicity of Level 1 charging infrastructure. Level 1 without use of EVEMS is generally less dependent on proper commissioning than Level 2 with EVEMS.
- Given that some stakeholders value the attributes of Level 1, programs and policies should support owners of existing buildings to choose either Level 2 or Level 1. However, parking in new construction should be required be Level 2 EV Ready.

How should EV ready charging systems be designed?

- A **comprehensive EV futureproofing** approach is superior to piecemeal installation of EVSE in most existing multifamily buildings. Compared to piecemeal approaches, comprehensive retrofits:
    - Are more cost-effective over the life cycle of the building.
    - Ensure equitable access to EV charging for all residents.
- Comprehensive retrofits can make all parking **EV Ready or EV Capable**. Programs and policies should support building owners' and charging service providers' prerogative to choose either EV Ready or EV Capable approaches.
- Designs should carefully consider the optimal amount of load-sharing using EVEMS, to minimize costs well ensuring drivers have an adequate charging experience.

2.1 Basics of Electrical Systems in Multifamily Buildings

Figure 3 and Figure 4 summarize the basic elements of electrical systems in more simple and complex buildings, respectively. These electrical systems include:

- A **main transformer**, which reduces voltages from utility distribution system voltages (e.g., 25kV, 12.5kV, other voltages) to those used in building systems (e.g., 120/240V in small buildings; 277/480V or 347/600V in larger buildings). Utilities typically own the transformers in small buildings and many larger buildings too. Some large buildings get utility service connection at distribution system voltages and own their own transformers.
- A main **electrical meter**. Additional utility meters, as well as non-utility sub-metering, may be installed in other portions of the building too (e.g., a single utility meter for all EV charging in the building; residential units' meters; etc.).
- **Switchgear**. In larger buildings, the electricity supply is first fed into switchgear comprised of electrical disconnect switches, fuses or circuit breakers used to control, that protect and isolate electrical equipment. Switchgear distributes power to various **feeders** serving different parts of a building.
- Transformers may be located on these feeders to step down voltages to those used to supply equipment such as EV chargers (e.g., from 347/600V to 120/208V).
- Power is then delivered to various **branch panels**. For example, one or more branch panels will provide the source of electricity for EV charging in a multifamily building resident parking area.
- **Branch circuits** are distributed off from branch panels. A branch circuit is the portion of a wiring installation between the final overcurrent device (e.g., a circuit breaker) protecting the circuit and an outlet(s).
- An **outlet** is the point in a wiring installation at which current is taken to supply equipment like an EV charger. An outlet can be a receptacle at which equipment is plugged in. It can also be a junction box or enclosure at which equipment like an EV charger can be hardwired.

When implementing EV charging infrastructure, and any other equipment, all the above electrical systems must be sized appropriately to handle the electrical load. Existing buildings have limited spare electrical capacity; EV charging infrastructure should be designed carefully to ensure that electrical constraints are not unnecessarily exceeded, and to thereby control the costs of new electrical systems. For information on how the electrical capacity for a building is determined see Appendix B.

Small Building

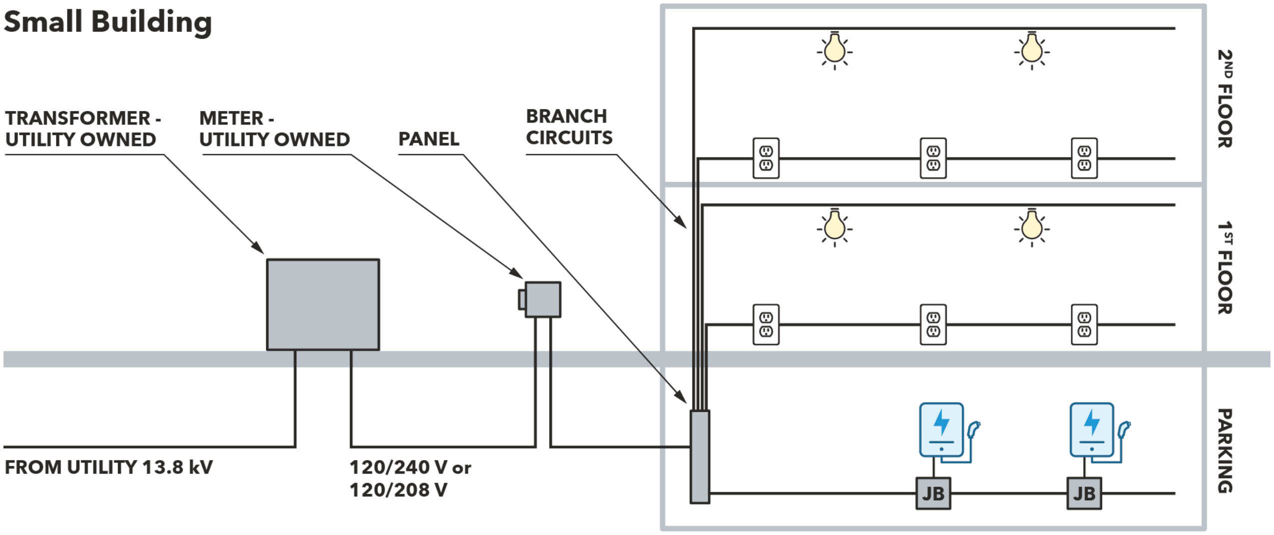

Figure 3: Electrical systems in a smaller building.

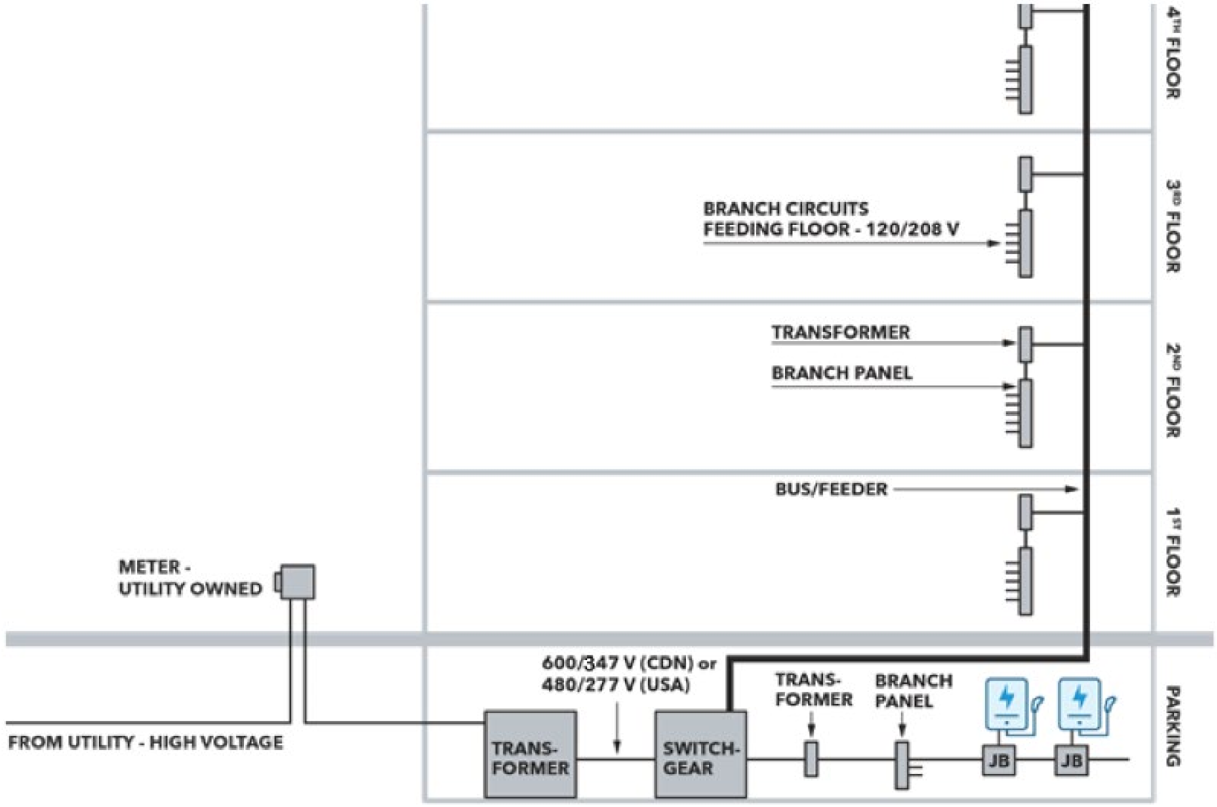

Figure 4: Electrical systems in a larger building.

2.2 Basics of EV Charging Infrastructure in Multifamily Buildings

2.2.1 Levels of EV Charging

Table 2 summarizes the different levels of EV charging applicable to multifamily building charging systems. These charging levels are defined in the SAE J1772 standard. The term EV supply equipment (EVSE) is the technical term for an EV charger.

Table 2: Levels of EV Charging.

Charging Type	Voltage	Circuit Amperage	Charging Power	Approx. charging time for 300 km of range[15]		Charging Contexts for Passenger Vehicles				Type of light-duty EV that can use
				Typical car	Typical SUV/ light truck	Residential	Workplace	Public	Depot	
Level 1	120 V	16A / 20A	1.3-2.4 kW	25-45 h	35-80 h					BEV and PHEV
Level 2	208V / 240V	20A	3.3 kW	20 h	30 h					BEV and PHEV
		40A	6.6 kW	8.5 h	13 h					
		50A	9.6 kW	6 h	9.5 h					
		100A	19.2 kW	3.25 h	4.75 h					
DCFC	200V – 600V	varies	25 kW	2.5 h	3.5 h					BEV
			50 kW	1.25 h	1.75 h					
			100 kW	36 min	54 min					
			150 kW	24 min	36 min					
			350 kW	10 min	15 min					

For performance, cost, and load management reasons, Dunsky generally recommends system designs that use Level 2 charging in multifamily buildings. However, some actors have found success with Level 1 systems and continue to recommend them. Table 3 briefly summarizes the benefits and drawbacks in multifamily buildings of both charging levels. The relative merits of both levels of charging are further compared throughout this report. Broadly, Level 1 charging will not be adequate to meet the needs of all drivers, such as those with larger vehicles, or those who drive farther than average. See Appendix B for a detailed discussion of the performance requirements associated home EV charging, and the performance of Level 1 versus load managed Level 2.

15 Many vehicles do not require a full 300 km charge on a typical day.

Programs and policies supporting implementation of EV charging in existing multifamily buildings can enable both levels of charging to be deployed, allowing the market to determine which approach is preferred.

Legend: Good satisfaction OK satisfaction Sacrifice

Table 3: Benefits and Challenges of Load-shared Level 2 versus Level 1

Benefits	Load-shared Level 2	Dedicated Level 1
Performance level	Greater likelihood of a sufficient charge for the next days' driving. Level 2 is much more resilient to a range of future driving patterns & services (e.g., a transition to higher mileage shared mobility)	Lower likelihood of sufficient charge, particularly for those driving longer distances and larger vehicles
Performance predictability	Charging speed may be faster or slower depending on neighbours' actions	Charging speed is constant
Revenue opportunities	Offers opportunities to capture the value of demand response programs and clean fuel credits	Fewer revenue opportunities from demand response and clean fuel credits
Reliability	There are more systems that can fail if not properly commissioned. Nevertheless, installations are typically successful and reliable.	Lower-tech option with fewer possible failures
Ability to manage loads	Flexible load management is available (for example, responding to time-of-use rates)	Less load flexibility

2.2.2 Networked vs. Non-networked EV Chargers

Networked or "smart" chargers come with built in Wi-Fi, cellular, or other network capabilities that allow them to communicate with a charging service provider's charging management systems (CMS) and/or communicate with an EV Energy Management System (EVEMS) (see Section 2.3.1).[16] Because networked chargers are one of the most common ways to enable load management, they are a key technology to enable well-designed charging in multifamily buildings. As discussed further in Section 2.3, load management can be used to reduce the overall electrical load from EV charging, thereby reducing capital costs and the overall impact on the electrical grid.

Non-networked chargers, on the other hand, are less expensive and do not include any ability to communicate across a network. Some designs use EVEMS to provide on/off control of a branch circuit, and then non-networked chargers (see Section 2.3.1).

[16] CMS are enterprise software systems that support information processing and communications between EVSE, EVs, drivers, DSOs and others. Some CMS are proprietary, while others adhere to the Open Charge Point Protocol (OCPP). The OCPP is a free, open-source, vendor-independent protocol developed by the Open Charge Alliance.

For more information on the system architectures that are enabled by networked chargers, as well as more details on the standards and protocols for EV charging communications, please see Appendix B.

2.2.3 Charging Service Providers (CSPs)

EV charging service providers (CSPs) are key players in multifamily building charging projects whose EVEMS configurations are predicated on networked EV chargers (see section 2.3.1 below). CSPs can act as the **site host**, meaning that they implement and manage EV charging infrastructure at multifamily buildings. CSPs can coordinate with contractors to design and implement installation of compatible electrical infrastructure, and will then **sell EV chargers** to multifamily building occupants or building owners. Services offered by CSPs can include:

- Providing factory-programmed **EVSE** and coordinating **installation**.
- Managing **user access controls** to ensure only registered drivers can use the chargers.
- Providing **apps and dashboards** for drivers and system administrators.
- Facilitating **payment of user fees**, enabling building owners or condominiums to recover the costs of electricity used by vehicles.
- Handling **data management** and ensuring **data security**.
- Offering **helplines and customer assistance**.
- Managing EV energy use through **EVEMS**.
- Conducting **operations and maintenance** of the charging infrastructure.
- Providing **warranties** for the equipment.
- **Generating revenue opportunities** for building owners, whether through utility-led demand response programs, or by validating carbon credits under regulations like the federal Clean Fuel Regulations.

Some examples (non-exhaustive) of CSPs serving the multifamily space include ChargePoint, Flo, SWTCH, Greenlots, Hypercharge, AmpUp and VariableGrid.

For more on CSP business models and revenue streams, see Appendix B.

2.2.4 Vehicle-grid integration

Vehicle-grid integration (VGI) is a general term that includes smart charging (described above) and behavioural responses to varying electricity rates. VGI is important in the context of multifamily building charging because it is an opportunity for users and building owners to save money, and potentially generate revenue, from their charging infrastructure and EVs.

The following definitions are derived from the California Public Utility Commission's Vehicle-Grid Integration Communication Protocol Working Group[1]:

- **Behavioural VGI**: passive solutions such as a customer responding to time-of-use (TOU) rates by choosing to charge when demand for electricity is lowest and the grid is least constrained.
- **Smart Charging (V1G)**: central or customer control of EV charging to provide grid benefits, including ramping up or ramping down charging, or deferring charging to a later time. Unidirectional charging only.
- **Vehicle-to-Grid (V2G)**: uses an EV's onboard energy storage system to provide power back to the electrical grid and/or the building, sometimes also referred to as "bi-directional charging."

V2G is considered the most advanced form of VGI. To use V2G in the context of Level 2 AC charging, a bi-directional inverter/charger must be integrated into the vehicle. Most EVs are not currently equipped with this technology, and it may come at a significant cost. Furthermore, to make V2G a reality, utilities will need to develop programs and/or rates that provide an incentive to share electricity back to the grid.

In the business case analysis, we investigate the potential financial benefits from electricity rates that are favourable to EV charging and designs that incorporate networked/smart charging (V1G). We do not incorporate V2G into our analysis below because there have been very few efforts to document how it could be implemented in multifamily buildings, and we therefore do not have access to sufficient design, system architecture, and costing information to suggest whether and how V2G can be integrated into these buildings. However, multifamily buildings that are supported to implement comprehensive EV futureproofing retrofits will have the opportunity to consider whether and how V2G could be implemented in their buildings. Likewise, utilities will increasingly have reason to explore the value to their systems of V2G in multifamily buildings.

2.3 Load Management: A Key Ingredient

EV charging is a flexible load that offers significant opportunities for managing loads to optimize conditions at the building or grid level. Load management technologies are applicable to both new construction and existing building retrofits. The textbox below provides a high-level summary of why EVs in multifamily buildings are particularly suited for load management.

EXAMPLE OF LOAD MANAGEMENT OPPORTUNITIES FOR RESIDENTIAL CHARGING

- 89% of Canadian EV drivers travel less than 60 km per day.[17]
- Most home charging takes place using a Level 2 port.
- Therefore, for a typical vehicle energy consumption of 20 kWh/100km, the charging time required to top up the battery is approximately **one hour and 45 minutes.**
- Meanwhile, the vehicle is likely parked for **eight** or more hours overnight, illustrating the opportunity to displace or spread out the energy demand to the most beneficial time for a building and/or the electrical grid, with no negative impact on the consumer.
- EV Energy Management Systems (EVEMS) can be programmed to charge when there is sufficient electrical capacity in the building systems, and to meet other criteria (e.g., minimize demand charges).
- Likewise, utility grid operators can provide signals specifying when it is most valuable for an EV to charge (for example, when wholesale power prices are low and the distribution grid is not congested).

2.3.1 EV Energy Management Systems (EVEMS)

EVEMS monitor and control loads so as not to exceed the capacity of an electrical circuit. They can be used to accommodate more EV charging at a facility than could otherwise occur without EVEMS, making it possible to provide up to 100% of parking in multifamily buildings with EV charging at more affordable prices to install and operate.

While the speed of charging slows when load management is occurring, using reasonable amounts of load sharing is perfectly appropriate in situations where vehicles are parked for longer periods of time, such as overnight in residential parking.

Broadly, there are two control schemes by which EVEMS can operate:

- **Algorithms communicating to networked chargers**. The EVSE receive signals to throttle the power usage down or up, based on an EVEMS calculation of how much power is available on a circuit, and/or to achieve some other criteria (e.g., a maximum kW demand limit). To use such a control scheme, networked chargers are required.
- **Switching circuits on or off**. A EVEMS monitors how much power is instantaneously being used at the level of a service, feeder, panel, etc. The EVEMS switches off the breaker to a branch circuit when a certain threshold is reached. Such systems can use unnetworked EVSE.

These two broad categories of EVEMS control schemes enable a variety of different electrical configurations and associated EV energy management strategies. A description of these

[17] Roulez Électrique. 2014. Les distances moyennes de déplacement au Canada : étonnamment courtes!

configurations is provided in Appendix B. Section 2.4 below describes the futureproofing configurations enabled by different EVEMS strategies.

2.4 Futureproofing Configurations

Broadly, there are four different ways to futureproof parking for EV charging.[18] These approaches apply in both new construction and retrofits of existing multifamily buildings. Various jurisdictions require different forms of futureproofed parking for new developments. Likewise, buildings' electrical systems can be retrofitted so that parking can be futureproofed in these ways:

1. **EVSE Installed.** A parking space at which an adjacent EVSE (either Level 1, Level 2 or DCFC) is electrically hardwired. This system is immediately ready for EV charging.
2. **EV Ready.** A parking space with an adjacent wired electrical outlet. An "outlet" may be a junction box at which an EVSE can be hardwired in the future. Alternately, it can be an electrical receptacle on a dedicated branch circuit, at which a Level 1 or Level 2 EVSE with a plug may be plugged in. Electrical codes require that where an outlet is implemented, there is sufficient electrical capacity and all necessary electrical circuitry to support that outlet.
3. **EV Capable.** A parking space served by a proximate branch panel that has spare electrical capacity and space for an overcurrent protection device (e.g., a circuit breaker). Often, electrical conduit will be laid between the panel and the parking space, at least in hard to retrofit locations such as where coring through concrete or trenching underground would be required. The branch circuit wiring is installed at the same time as the EVSE is installed, deferring the cost of the branch circuit wiring from the initial retrofit.
4. **Conduit and Space.** A parking space that is served by electrical conduit between the parking space and an electrical room. Some jurisdictions have required that new construction also allocate space in an electrical room for future installation of electrical equipment (e.g., transformers, switchgear, branch panels, feeders, etc.) that will be needed to provide power to charge EVs. **Providing only conduit and space comprises minimal futureproofing.** It may help reduce the costs of providing charging in surface parking and other circumstances where adding branch circuits can involve expensive civil works. But it provides no actual infrastructure to convey electricity. Additionally, conduit may not necessarily be designed in the most appropriate configurations for subsequent addition of EV charging. Accordingly, **conduit and space is *not* an appropriate way to futureproof parking for EV charging as a part of retrofit projects, nor does Dunsky recommend it for new construction**.

These different parking futureproofing options could each be used in designs featuring a wide array of electrical configurations enabled by different EVEMS schemes – for example, EV Ready parking could be designed on an unmanaged dedicated circuit, or for designs using load management.

The schematic diagrams in Figure 5 illustrate these different futureproofing options.

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[18] The naming conventions that Dunsky has chosen to use for these futureproofing options is largely consistent with various building codes and EV charging infrastructure requirements in North America, notably proposals for inclusion in the 2024 *International Energy Conservation Code* that are under consideration by the International Codes Council. However, different jurisdictions define EV charging infrastructure requirements in different ways and use different naming conventions – The terms "EV Ready" or "EV Capable" do not necessarily mean the same thing from one jurisdiction to the next.

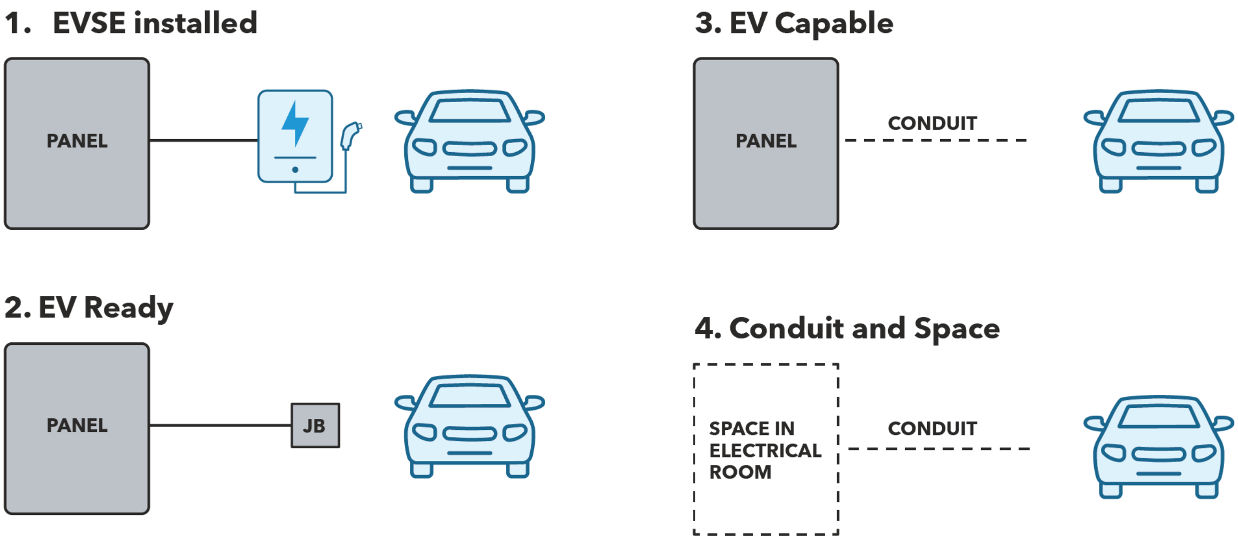

Figure 5: Different ways to futureproof a parking space for EV charging.

2.4.1 Comprehensive Futureproofing vs. Incremental Additions of EV Charging

Broadly, EV charging may be deployed in multifamily buildings in two ways:

1. **Unplanned piecemeal additions of a few EVSE at a time**, with little or no consideration of futureproofing for subsequent expansion. As of this writing, this represents the most common way for multifamily buildings to add EV charging. A multifamily building owner will typically contact an electrical contractor. The electrical contractor will determine how to source power for a few EVSE to be installed. Contractors will rarely consider how best to optimize for subsequent installations without explicit direction to do so.

   Chargers may be located in households' assigned parking spaces; in condominiums, all electrical works in these circumstances will usually be paid by the unit owner. Alternately, they may be in a common parking areas (e.g., visitor parking) and shared between drivers.

2. **Comprehensive futureproofing**, where building systems are planned to accommodate near-universal adoption of EV charging in most parking spaces. EV charging infrastructure will then be implemented as part of one large electrical retrofit to futureproof the building for subsequent addition of EV chargers. For example, buildings might be made 100% EV Ready or 100% EV Capable. In circumstances where parking spaces can be exchanged between drivers (e.g. some rental buildings), it can be possible to plan for how to ultimately accommodate all parking to feature EV charging, but futureproof phased tranches of parking over time. However, in buildings where parking spaces cannot be exchanged between drivers, such phasing is not possible and all parking must usually be futureproofed from the outset.

   Comprehensive futureproofing involves a detailed feasibility assessment, including determining that the building has sufficient electrical capacity; conceptual design; approvals; detailed design; and construction of necessary electrical and civil works. Appendix C includes a process diagram of a comprehensive futureproofing project.

Comprehensive futureproofing retrofits offer multiple benefits over an incremental approach, as shown in Table 4 and Table 5.

Legend: Good satisfaction Sacrifice

Benefits and challenges to building owner or investor

	Comprehensive EV futureproofing (e.g. 100% EV Ready)	Incremental additions of EV chargers
Upfront cost	Higher one-time upfront cost	Lower individual project costs (but significantly more expensive in aggregate)
Project management	One project	Series of smaller projects
Total cost	Lower total cost	Higher total cost
Futureproofing	Avoids stranded assets	Initial installations may not be designed for later expansion; potential for stranded assets when systems are installed that are not compatible with subsequent additions of EV charging.

Table 4: Benefits and Challenges of Comprehensive EV Ready Retrofits versus an Incremental Approach

Benefits and challenges to resident or user

	Comprehensive EV futureproofing (e.g. 100% EV Ready)	Incremental additions of EV chargers
Certainty of access to charging	Typically, can ensure that all drivers get access to charging	Potential to exhaust limited electrical capacity if design for EVEMS not considered, meaning some drivers may not get access
Charger installation experience	Simple process to install chargers (after initial comprehensive electrical renovation)	Process to implement new chargers is frequently lengthy and complicated
User experience	Charging can be conveniently located in drivers' assigned parking space	Often, initially in visitor parking, though sometimes in assigned parking

Table 5: Benefits and Challenges of Comprehensive EV Ready Retrofits versus an Incremental Approach

2.4.2 Some potential configurations for comprehensive futureproofing

A variety of different electrical configurations could be implemented as part of such a comprehensive futureproofing approach. Below, we contemplate four potential infrastructure configurations.

1. **100% Level 1 outlets**. Much Level 1 charging is predicated on unmonitored "dumb" receptacles. However, the vendor Plugzio offers a smart outlet that is capable of user access controls; metering and billing for power; dashboards; etc. These functions entail a monthly networking fee.

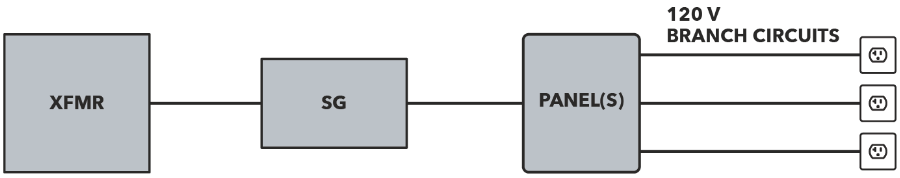

Figure 6: 100% Level 1 Outlets.

2. **100% EV Ready with Level 2 outlets designed for load-sharing on branch circuits.** In addition to branch circuit sharing, this design can further load-manage at the service or feeder level. This design is predicated on use of networked Level 2 chargers. Many services to date involve ongoing networking fees; however, business models not predicated on networking fees are possible.

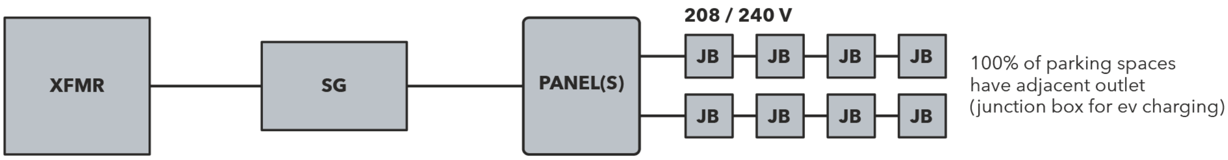

Figure 7: 100% EV Ready with Level 2 outlets designed for load-sharing on branch circuits.

3. **100% EV Ready with Level 2 outlets designed for feeder monitoring of residential unit's electrical panels**. This design allows billing to be associated with each individual household's electrical meter. This forgoes any need for ongoing billing services, and associated fees. Non-networked EVSE are used, reducing EVSE costs. The design allows for the use of a Level 2 receptacle; if vehicles come with an EVSE capable of level 2 charging, this can avoid the cost of an EVSE.

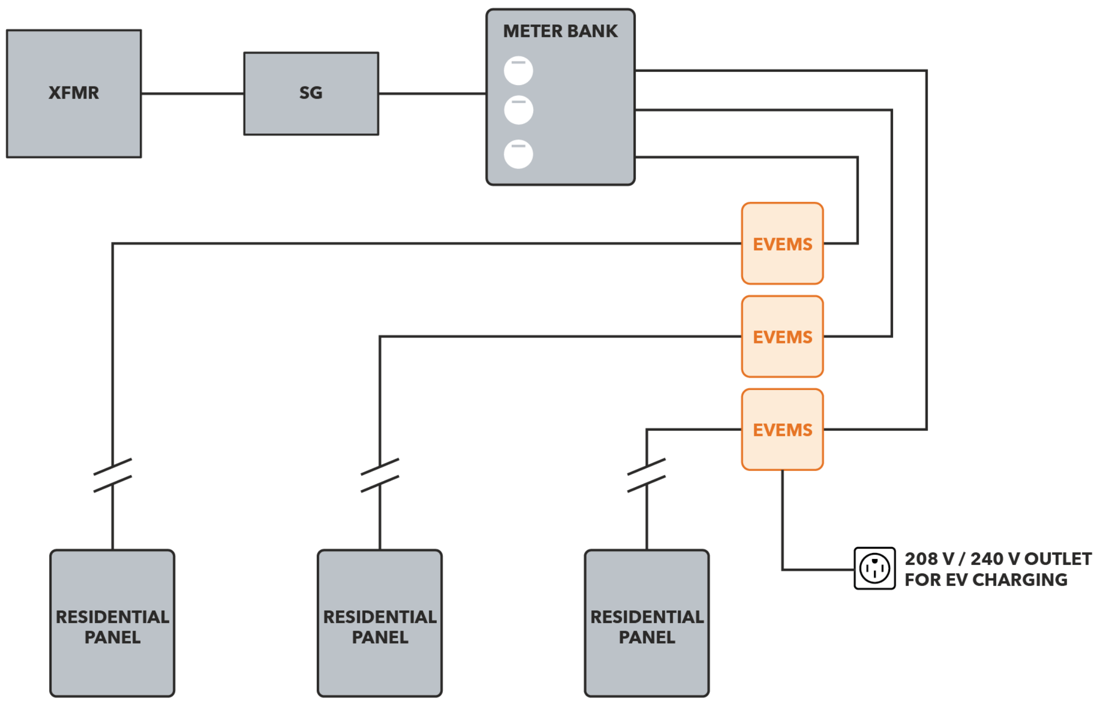

Figure 8: EV Ready with Level 2 outlets designed for feeder monitoring of residential unit's electrical panels.

4. 100% EV Capable with incremental upgrades of branch circuits.

A. **Designed for dedicated branch circuits on smart panels.** The smart panel can switch branch circuits on/off. This can allow for the use an unnetworked "dumb" EVSE, reducing cost.

B. **Designed for load-sharing on branch circuits**. Branch circuits are pulled as drivers adopt EVs. Networked EVSE compatible with an EVEMS manage load-sharing across the branch circuit.

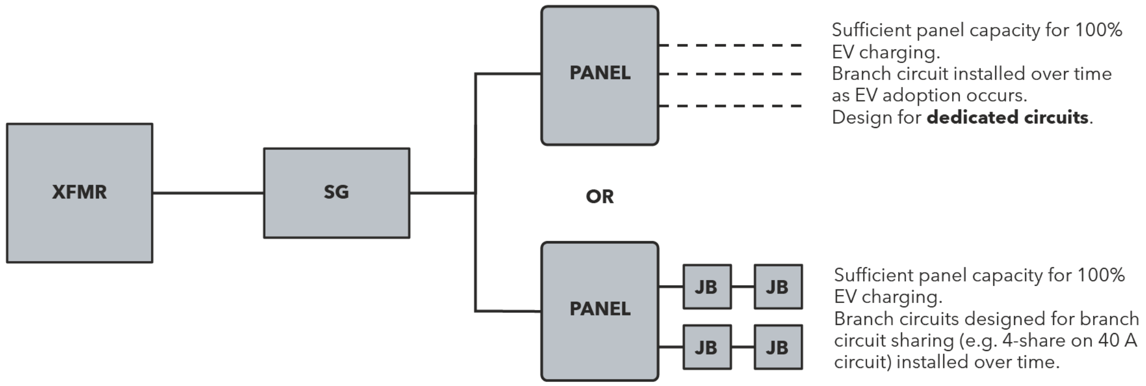

Figure 9: 100% EV Capable with incremental upgrades of branch circuits.

2.4.2.1 Comprehensive planning with phased implementation

Each of the potential infrastructure configurations noted above could theoretically be implemented in phases in a way that is compatible with all parking ultimately featuring EV charging. This would involve a design for all parking to ultimately feature EV charging. Upstream electrical infrastructure (e.g., switchgear) compatible with this design would be implemented on "day one". But some feeders and branch panels would be implemented incrementally. See Figure 10.

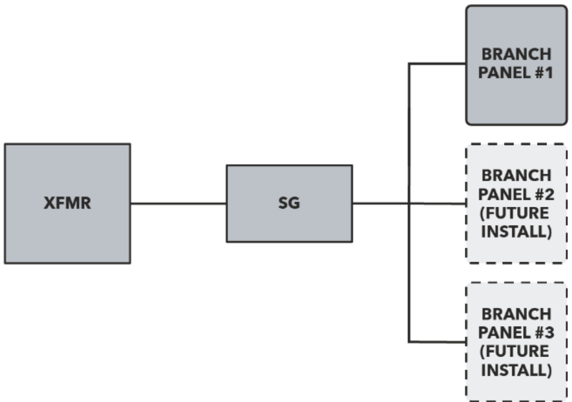

Figure 10: Comprehensive planning approach depicting fully installed upstream electrical infrastructure, with incremental installation of branch panels.

In smaller buildings, there is often not any meaningful opportunity for phased build out of branch panels and feeders. Conversely, in larger buildings that necessitate multiple branch panels and feeders, there may be an opportunity for phasing. This involves planning for sufficient capacity for subsequent expansion, while only building out the feeder(s) and branch panel(s) needed for the first generation of adopters. Subsequent tranches of infrastructure can be implemented as the population of EV drivers expands.

For phased approaches to be viable, all the EV charging in the first phase will typically need to be concentrated in parking closest to the first installed branch panel. However, EV adoption is likely to emerge randomly throughout the parking lot.

Thus, phased futureproofing retrofits are only viable if parking spaces can be exchanged between residents relatively easily and unilaterally. This is the case in many rental buildings. However, in condominiums, most forms of parking tenure are not conducive to trading parking spaces between occupants (see Section 4), and thus not candidates for phased futureproofing retrofits. Typically, in condominiums, it is so procedurally and legally onerous to legally exchange parking spaces that it is not viable, and is more cost-effective to simply futureproof the whole building at one time.

If administratively simple processes could be developed to compel condominium owners to swap parking spaces, it could enable such strategies in condominiums as well. However, we are not aware of any such mechanism. Nevertheless, it is recommended to further explore legislation that can guarantee exchanging parking spaces, as well as template bylaws and processes for condos to update their parking tenure to enable easy swapping.

It should also be noted that implementing panels and feeders incrementally can result in greater costs, as there are greater design and installation complexities; mobilization costs; and lesser economies of scale in procuring the equipment. These cost increases need to be weighed against the time value of money.

2.4.3 Comparison of futureproof options

Table 6 provides an initial comparison of these futureproofing options. The Business Case Analysis in Section 5 provides further insight into the costs of three of these options: 100% Level 1, 100% EV Ready with branch circuit sharing, and EV Capable using networked charging (this study did not evaluate the costs of EV Capable using "smart" panels and non-networked charging; however, this configuration represents a promising approach as well).

Table 6: Comparison of futureproofing options.

Futureproofing option	Initial cost for electrical infrastructure	Subsequent cost to add EV charger	Ongoing network fees	Notes on application in comprehensive multifamily building retrofits
EVSE Installed	High.	None.	Common.	Because households will adopt EVs over time, it is usually unnecessary to install EVSE at all parking spaces at the outset.
1. 100% Level 1*	Medium-High	None (could include cost of branch circuit if initially deferred as part of EV Capable futureproofing).	Yes, if "smart" outlets included.	Level 1 will work for many households. However, those that drive longer distances and/or have larger vehicles (e.g., SUVs and pickups) may have poor experiences with Level 1. There are fewer load management opportunities.
2. 100% EV Ready with Level 2 outlets designed for load-sharing on branch circuits*	Medium.	EVSE.	Common.	Usually the best business case in circumstances where households cannot exchange assigned parking (e.g., most condominiums). Will usually result in lowest overall costs.
3. EV Ready with Level 2 outlets designed for feeder monitoring of residential unit's electrical panels.	Medium-High.	None (could include cost of branch circuit if initially deferred).	Uncommon.	Only viable in circumstances where metering is located proximate to parking (e.g., smaller low-rise apartments). An important option to consider in these circumstances.
4. EV Capable	Medium-Low (usually 50% to 80% of cost of EV Ready).	Branch circuiting. EVSE if design is predicated on networked EVSE.	Common, if predicated on networked EVSE. Uncommon if predicated on a "smart" panel and unnetworked EVSE.	Designs for circuit sharing raise the issue of who will pay for the branch circuit in condos – e.g. the first EV adopter? Or all households sharing that branch circuit? Therefore, designs for branch circuit sharing may only be applicable to rental buildings, and not condos.
Space & conduit	Very low.	Very high. Essentially, all the work.	Common.	Only appropriate in unusual circumstances (e.g., refinishing surface parking provides opportunity to add conduit).

2.4.4 Barriers to Comprehensive Futureproofing

For existing buildings, there are unfortunately complex barriers to pursuing EV ready retrofits. These include:

Cost. Condominium associations and rental building owners often do not have substantial cash reserves. Condominiums particularly often have deferred maintenance and many other capital projects that demand their attention. Even those rental building owners with access to capital may not yet perceive a business case for comprehensive futureproofing.

Lack of demand. Many MURB residents and owners, particularly in parts of Canada with lower EV adoption, do not yet perceive the need to provide EV charging in their building.

Complicated processes and transaction costs. Condominium decision-making dynamics tend to result in long, complicated processes and uncertainty regarding whether a comprehensive futureproofing retrofit will proceed. Different condominium owners will have various perspectives and a range of questions. These transaction costs make it challenging for engineering consultants and contractors to support these services.

Information asymmetries and misaligned incentives. Building owners do not have a good sense of the potential value that comprehensive futureproofing could add to their property. Most condominium residents do not have a good understanding of how EV charging works, and often imagine a "gas station model" for recharging rather than intuitively recognize the convenience and lower cost of charging at home.

Condominium boards typically do not have expertise in electrical systems. They may not realize the risk of stranded assets associated with unplanned incremental additions of EV charging. And they rarely have a good understanding of the costs and economics of comprehensive futureproofing absent strong education and technical assistance.

Electrical contractors have little incentive to encourage building owners to consider much more complicated comprehensive futureproofing retrofits. Comprehensive futureproofing tends to involve further feasibility study, much longer sales cycles, the involvement of engineer consultants, and may jeopardize the sale.

Many building owners are wary of contractors, engineering consultants and CSPs. They are concerned about being bamboozled into a large, poorly designed capital project, and about being locked into charging services with high monthly fees for drivers.

Finally, many engineering consultants and contractors, particularly those in jurisdictions with lesser EV adoption to date, do not fully understand best practices in EV charging infrastructure design. Many have little familiarity with the different ways to comprehensively futureproof buildings.

Lack of standard approaches. Broadly, there is limited understanding and standardization of design approaches for comprehensive futureproofing. While the CleanBC EV Ready Rebate Program (see Section 3) has established some *de facto* standard approaches through its program requirements, these are "first generation" and high level.

Incentive program design. Most provincial incentive programs and the federal Zero Emissions Vehicle Incentive Program (see below) provide incentives per charging station, not per parking space futureproofed for EV charging. This focuses contractors and building owners on deploying chargers, but does not create incentives for careful futureproofing.

2.5 Need for Coordination with Broader Building Electrification

Ideally, multifamily EV charging futureproofing retrofits will be planned and designed in an integrated fashion that wholistically considers how best to accommodate EV charging, building systems electrification (e.g., heat pump space heating & domestic hot water; electric cooking), onsite renewable generation (e.g., solar), and/or onsite storage.

However, there are significant challenges to achieving this coordination. Many multifamily buildings have little understanding of, or demand for, certain building systems electrification measures like electrifying domestic hot water, while they have greater demand for other EV charging. The cost for a building evaluation covering all these options is substantial.

The first step to realizing these outcomes is through incentive programs that reward participants for integrated assessment and design of these systems. Program administrators should seek to map customer journeys and provide additional incentives for considering EV charging infrastructure requirements and deep decarbonization electrification retrofits as part of the same feasibility study.

2.6 Potential Revenue Sources for Building Owners and/or Charging Service Providers

2.6.1 User fees

Condos or building owners can charge residents user fees for the use of EV charging infrastructure. User fees are usually either structured on a time basis (i.e. $X per hour of charging) or a volumetric basis (i.e. $ per kWh or $ per kW). These user fees can be set to vary with time, to reflect dynamic utility rates (e.g. time of use rates; real time pricing; etc.). Likewise, if applying user fees on a per unit of time basis, rates can be pro-rated depending on how much load-sharing is occurring, to ensure that the fees being applied to drivers are proportional to how much power they consume.

2.6.2 EV-favourable electricity rates and demand response programs

The price incentive to respond to the real-time cost of electricity (encompassing both wholesale power prices, as well as the locational marginal value of reducing peak demand on distribution systems to defer grid capacity upgrades) is important for economically efficient electrical systems being deployed in multifamily buildings. There is an excellent opportunity for EV charging to provide flexible demand in multifamily buildings that can lower total system costs for everyone; however, this potential will only be realized when buildings are better exposed to the real-time prices of providing electricity.

Rates (including potential "opt-in" rates) and demand response programs should continue to be deployed to support the alignment of charging behavior with real-time grid conditions. By exposing multifamily buildings to the real-time marginal cost of power, building owners and occupants can be incentivized to shift EV charging to off-peak times, when electricity is often cheaper and more readily available. This not only reduces strain on the grid but also allows residents to take advantage of lower charging costs, thus making EV charging more affordable and accessible. Furthermore, such a utility rate structure can encourage the integration of advanced EV charging management systems within multifamily buildings, enhancing efficiency and flexibility.

2.6.3 Clean Fuel credits

Clean Fuel credits, anticipated to be issued under the federal Clean Fuel Regulation and provincial clean fuel requirements, can significantly improve the business case of EV ready retrofits. These credits, part of broader efforts to reduce carbon emissions, can be earned by parties that provide EV charging, and then sold or traded within regulated markets. By transforming the environmental benefits of electric vehicle adoption into a tangible financial asset, Clean Fuel credits can create an additional revenue stream for building owners who invest in EV ready infrastructure. This, in turn, can offset some of the initial costs of the retrofit and provide ongoing financial incentives that align with broader societal goals for emission reduction.

As policies and markets for low carbon fuels evolve and mature towards 2030, this mechanism could become an increasingly significant factor in the financial viability of EV ready retrofits, making them more attractive to property owners and investors. This is already the case in BC, where the provincial Low Carbon Fuel Standard results is already changing the charging business case, with credits currently trading at about $450/tonne, enough to significantly offset the amortized cost of implement EV futureproofing retrofits. However, there is significant uncertainty regarding the long-term future credit values for the B.C. and federal clean fuel credit programs. Likewise, aggregator services will need to emerge to sell these credits; this may be a natural role for EV charging service providers serving multiple MURBs and other sites.

Funding, Financing & Project Delivery Mechanisms to Futureproof Multifamily Buildings

3. Funding, Financing & Project Delivery Mechanisms

KEY CONCEPTS

EV futureproofing infrastructure can be delivered in different ways:

Customer-owned infrastructure refers to when building owners, condominium associations, condominium unit owners, and/or tenants (or some combination) pay for and own the EV charging infrastructure and equipment. This is the most common way that comprehensive EV charging futureproofing has occurred in Canada. **Incentive programs** and/or **project financing** (e.g. loans) can support such deployment of EV charging infrastructure.

Make Ready programs involve electrical utilities being enabled by regulators to invest in electrical infrastructure to provide EV charging, and rate-basing the investment. This reduces the costs that customers must pay for EV charging infrastructure.

Charging-as-a-Service involves a third party owning and operating EV charging infrastructure. Building owners typically do not need to pay any capital expense. Third party operators apply user fees to drivers for EV charging.

CENTRAL RECOMMENDATIONS

Offer Incentives for Comprehensive EV Futureproofing - The Federal government, provinces and demand side management program administrators should **offer incentive programs for comprehensive (100%) EV Ready and EV Capable retrofits** in existing multifamily buildings.

Introduce Project Financing - Governments, utilities, and non-profit financial organizations should explore opportunities to **support project financing** for comprehensive EV futureproofing. This includes:

- Offering **loan products** for comprehensive EV futureproofing projects.
- Exploring **aggregating** comprehensive EV futureproofing projects for financing under the favourable terms available from the **Canada Infrastructure Bank's Building Retrofits Initiative**.
- Exploring the potential of **credit enhancements** to encourage private sector lenders to offer better financing terms than they would on their own.

Pilot Make Ready Programs - Provinces, utility regulators and utilities should pilot Make Ready Programs, and quickly scale the programs if deemed successful and cost effective.

More detailed recommendations are included in Section 6.

3.1 EV Futureproofing Infrastructure Delivery Mechanisms

This section profiles mechanisms to implement EV charging infrastructure in multifamily buildings, organized according to different EV charging infrastructure project delivery models. In brief, these project delivery models include:

- **Customer-owned infrastructure**: In this model, building owners, condominiums, condominium unit owners, and/or tenants pay for and own the EV charging infrastructure. **Incentives** and **project financing** can support EV ready retrofits using this model.
- **"Make Ready infrastructure"**: A utility pays and rate-bases the cost to make parking EV Ready (or potentially EV Capable) futureproofing configurations, and/or the cost of a new electrical service to the building. Building owners and residents will then pay for the remaining electrical infrastructure costs (e.g. a condo unit owner would pay for the cost of an EV charger, if the parking had been made EV Ready via a Make Ready program).
- **"Charging as a service"**: A third-party service provider owns and operates all the electrical works in the building providing EV charging. To access EV charging, drivers pay a service fee and/or volumetric cost, to cover the service provider's amortized capital and operating expenses, and profit. Third party owner/operators are typically private actors, but can be public entities (for example, the City of Vancouver owns and operates multifamily building charging infrastructure as part of its rental retrofit program).

The sections below further describe the project delivery models and the mechanisms supporting their deployment, summarizing noteworthy precedent programs and key considerations.

3.1.1 Customer-Owned Infrastructure

Of the limited number of comprehensive EV charging multifamily buildings futureproofing projects to date, most have been delivered via a customer-ownership model.

In **existing condominiums**, the condominium association will often pay for the EV Ready or EV Capable infrastructure that comprises part of common property (developers will pay for it in the case of new construction). The condo association may source these funds from their reserves; a special assessment whereby each resident pays a share of the cost of comprehensive EV futureproofing (e.g. $700 – $2,000); or debt. Residential unit owners will then often pay for installation of EV chargers when they adopt an EV, as well as related works such as the completion of branch circuits in the case of EV Capable infrastructure. However, other ways of organizing who pays for what infrastructure are possible – In parkades that are designated as common property with no long-term lease assignments (see Section 4.1 for further discussion of parking tenure), the condominium might also pay for the EV charger; they may then allow units to use this EV charging for a fee. Likewise, it is conceivable that some portion of the units (not the whole condominium) could pay for the common property EV Ready or EV Capable infrastructure. Particularly when implementing EV Ready using feeder monitoring of residential units' electrical panels configurations (as described in Sections 2.4.2 and Appendix B), it is possible for individual units to pay for all the electrical works associated with providing an EV Ready outlet to their parking space. See Figure C-1 in Appendix C for an outline of the basic process to implement customer-owned infrastructure in condos. Section 4 includes further information regarding condominium decision-making processes.

In **existing rental buildings**, the building owner will often pay for the EV Ready or EV Capable infrastructure, as well as the subsequent installation of EV chargers. However, it is possible that a rental tenant could be obliged to pay for some or all these works, depending on their agreement with the landlord. Landlords can recoup costs by charging user fees to drivers using the charging infrastructure.

For designs that are predicated on networked EV chargers, a condominium or rental building owner will typically enter into a service agreement with an EV charging service provider. As noted in Section 0, as drivers adopt EVs over time the charging service provider will implement EV chargers that are programmed to be compatible with the buildings' EVEMS and CMS; they also often provide related services, such as ongoing billing for drivers' electricity consumption, getting revenue from low carbon fuel credits, etc.

As noted in Sections 2.3 and in Appendix B, some designs (e.g., unmanaged dedicated circuits; feeder monitoring of residential units' electrical panels; panel sharing with on/off switching controls) are not predicated on the use of networked EVSE, and do not necessarily require the ongoing involvement of charging service providers.

Two key interventions that can support the deployment of customer-owned EV charging infrastructure in **existing buildings** are **incentive programs** and **project financing**. These interventions are described below.

3.1.1.1 Incentive programs and advisory services

For **existing buildings (condominiums and rental)**, **cash incentives (rebates)** can be used to encourage futureproofing. Incentives can be provided for feasibility studies, the electrical works, and the eventual installation of EV charging ports. There are several EV charging incentive programs available to multifamily buildings in Canada; these are summarized in Table 7.

In addition to cash incentives, **advisory services,** often offered by third party organizations and funded by government, can help multifamily buildings owners and residents better understand their options and plan ahead for implementing EV charging infrastructure at their properties. Table 7 summarizes different incentives and advisory service support options.

Table 7: Incentives and supports for implementing EV charging infrastructure futureproofing.

	EV Advisory Service	Feasibility Study Incentive	EV Ready / EV Capable Infrastructure Incentive	EVSE Incentive
Project Phase supported (See Figure C1 in Appendix C)	Research & understanding options	Feasibility study & evaluating options	Decision to proceed	EVSE installation
What services or infrastructure can be supported	Educational info (e.g., webpage, guide, video, webinars, etc.) In-person advisory services explaining rationale for futureproofing. Refer to firms providing Feasibility Studies; assist multifamily buildings in interpretation	Electrical feasibility study (by an electrical engineer or contractor). This can include additional evaluation of electrical capacity necessary to electrify space heat, hot water, etc. Development & review of bylaws and resolutions. Legal review. Additional property management services.	All electrical works to implement EV Ready or EV Capable infrastructure for 100% of parking (or at least one parking space per residence).	Purchase & Installation of EVSE.
Example values (values are hypothetical for illustrative purposes)	Up to 10 free hours of advising	$4k for EV Feasibility study. $10k bonus for broader electrification assessment. In kind legal assistance.	$800 / Level 2 EV Ready parking space $600 / Level 2 EV Capable parking space $500 / Level 1 outlet	$1000 per EVSE installed.
Precedent Programs	Plug'n Drive Plug-in BC Signature Electric (paid services) MURBLY (online resource)	BC EV Ready Rebate Program Efficiency Nova Scotia EV Ready Plan incentive	BC EV Ready Rebate Program Roulez Vert Program (Quebec)	NRCan ZEVIP BC EVSE Rebate Efficiency Nova Scotia Roulez Vert Program (Quebec) Good Energy rebates (Yukon)

POTENTIAL CHALLENGES OF EV CHARGER INCENTIVES THAT ENCOURAGE INCREMENTAL ADDITIONS

Most of the existing programs, with the important exception of the Clean BC EV Ready program, provide incentives per EV charger installed (typically $2,000 to $5000 per charger). They do not require multifamily buildings to perform any sort of feasibility study assessment or futureproofing to allow for future expansion of electrical systems in their building.

These programs have been valuable in supporting early EV adopters get access to home charging. However, **by only providing funds for the charging equipment, they can encourage unplanned, more costly and piecemeal additions of chargers**. This is problematic, especially as multifamily buildings owners (particularly condominiums) operate with imperfect information about their options and often take their cues from government and utility programs.

It is preferable that programs help educate multifamily building owners and residents about the range of options to implement EV charging infrastructure at their properties, and provide support for comprehensive futureproofing. Programs could still support incremental additions if buildings make an informed decision to pursue such a retrofit.

The case study below summarizes the globe's best in class EV ready retrofit incentive programs: BC's EV Ready Rebate program. Three other important programs, Efficiency Nova Scotia's EV Ready Program, NRCan's ZEVIP, and the Government of Quebec's Roulez Vert program, are profiled in Appendix C.

BC's EV Ready Incentive Program

The CleanBC Go Electric programs provide rebates for home and workplace charging infrastructure. The programs are initiatives of the BC provincial government to support the installation of EV charging infrastructure residential buildings, workplaces, and public locations. Funding for the programs is provided by the Ministry of Energy, Mines and Low Carbon Innovation of the Government of British Columbia, along with contributions from the Government of Canada. The programs are administered collaboratively by BC Hydro and FortisBC.

Two program streams are available for condominiums and rental apartments:

- **The Standalone EV Charger Rebate** provides $2000 per EV charger installed. This program stream is typically used by multifamily buildings implementing piecemeal additions of a few EV chargers at a time.
- **The EV Ready Rebate Program**. This program supports multifamily buildings implementing comprehensive 100% EV Ready retrofits.

The EV Ready Rebate Program consists of the following elements:

- **EV Ready plan rebate**: Eligible building owners can receive a rebate of up to $3,000 (up to maximum of 75% of the costs), for creating an EV Ready plan. The plan outlines strategies to ensure that each residential unit has at least one parking space equipped for EV charging.
- **EV Ready infrastructure rebate:** The program offers a rebate of up to 50% of the costs associated with installing the necessary electrical infrastructure to implement the EV Ready

BC's EV Ready Incentive Program

plan. The maximum rebate is $600 per parking space, with a total project limit of $120,000.[19] To be eligible for the infrastructure rebate, an apartment or condo building must have a completed EV Ready plan.

- **EV charger rebate**: Building owners and other eligible recipients can claim a rebate of up to $1,400 per unit to cover the purchase and installation of L2 networked EV chargers. This rebate supports the implementation of the building's EV Ready plan and has a maximum limit of $14,000.

The total maximum rebate amount from all three funding streams for a single apartment building or condo complex is $137,000. The **EV Ready Rebates and charger rebates can be combined with other incentives and rebates offered by BC Hydro**; however, total incentives granted cannot exceed the overall cost of the equipment and installation.

Property owners or stakeholders interested in applying for the rebate must work with an electrical contractor to complete the installation of the charging infrastructure. The contractor must be a licensed British Columbia certified electrician.

One significant advantage of the Clean BC EV Ready rebates is that they enable BC communities to pursue and implement comprehensive EV ready retrofits, which tend to yield the greatest value over the building's lifetime compared to a more incremental approach. In most circumstances, a comprehensive approach to EV Ready retrofits makes the best use of public and/or utility ratepayer funds, offering an efficient pathway for building owners to embrace EV charging infrastructure and support the growth of electric mobility in the region.

Table 8 provides a high-level comparison of different rebate programs across Canada, what they cover, and whether they support comprehensive or incremental additions.

[19] The $120,000 limit means that larger buildings with more than 200 units will receive less subsidy per-unit than smaller buildings. This has been a criticism of the program, as it is inequitable for residents of larger buildings.

Table 8: Comparison of EV charging infrastructure incentive programs for existing multifamily buildings

Program	Administrator	Region	Funding Streams	Offer	Supports Comprehensive Futureproofing
EV Ready Rebate Program	BC Hydro	British Columbia	EV Ready plan rebate	$3,000	Yes
EV Ready Rebate Program	BC Hydro	British Columbia	EV Ready infrastructure rebate	$600 per parking space, maximum $120,000	Yes
EV Ready Rebate Program	BC Hydro	British Columbia	EV charger rebate	$1,400 per charger, maximum $14,000	
Rental Building EV Ready Top-up Program	City of Vancouver	British Columbia	Infrastructure and charger (add-on to BC EV Ready Rebate Program)	Up to $93,000 City assumes ownership and operations of charging infrastructure Only available to rental buildings	Yes
EV Charging in Existing Multifamily Buildings Top-Up Rebates	District of Saanich & City of North Vancouver	British Columbia	EV Ready plan rebate (add-on to BC EV Ready Rebate Program)	Up to $1,000	Yes
EV Charging in Existing Multifamily Buildings Top-Up Rebates			EV Ready infrastructure rebate	Up to $100 per parking space	Yes
The EV Ready Approach	Efficiency Nova Scotia	Nova Scotia	EV Ready Plan Rebate	$4,000	No
The EV Ready Approach	Efficiency Nova Scotia	Nova Scotia	EV Ready Charger Rebate	$3,000 per charger, maximum $15,000	No
The Standalone EV Charger	Efficiency Nova Scotia	Nova Scotia	EV Charger rebate	$2,500 per charger, maximum $10,000	No
Zero Emission Vehicle Infrastructure Program (ZEVIP)	Natural Resources Canada	Canada	For owners/operators of ZEV infrastructure	$5,000 per charger[20]	No
Roulez Vert Program	Gouvernement du Québec	Quebec	Multiple dwelling building charging station	$5,000 per charger, maximum $20,000 to $49,000 per year based on building size	Yes, particularly for phased retrofits
Good Energy Program	Government of Yukon	Yukon	Level 2 EV charger rebate for Businesses and non-government organizations	$7,500 per charger, maximum $150,000	No

[20] Through ZEVIP, Level 2 connectors are eligible for a rebate of $5,000, but fast chargers can qualify for increased funding limits (up to $100,000 per charger), depending on their capacity.

3.1.1.2 Financing Mechanisms

Like incentives, **loans** can be provided to **existing building owners or condominiums** to support comprehensive EV charging infrastructure futureproofing. Based on interviews conducted for this project, **such lending is currently very uncommon**: None of the parties interviewed identified an instance where lending was used to finance comprehensive futureproofing of EV charging, nor is our team aware of any such example. (Interviewees did report on more piecemeal EV charging infrastructure being financed via loans). This is likely due to the **nascent state** of the market for comprehensive futureproofing.

Lending to the multifamily building retrofit sector is typically managed through banks' and other financial institutions' commercial finance departments. Loans to a rental building owner will be repaid by the owner. Loans to condominiums must be approved by members, and then will be repaid through association fees. Theoretically, a lending product can be envisioned in which the investment in EV futureproofing infrastructure is repaid by drivers over time, and not the condominium or building owner. This is analogous in its financial structure to the Charging as a Service model noted below. In this case, the lender would assume the risk associated with how quickly drivers adopt EVs, and whether and to what extent they will elect to charge at home.

According to interviewees, **few lenders are adept at serving the condominium retrofit sector**. This is largely due to the significant transaction costs that condominium decision-making processes can entail; lenders must have the knowledge, interpersonal skills and systems to efficiently interact with condominium boards when originating deals.

In interviews, financiers experienced with providing loans to condominiums suggested current commercial financing to condominiums for EV charging infrastructure will tend to have repayment terms of no more than five years. **Interest rates reportedly vary considerably** based on the nature of the project and lenders' assessment of the risk profile of applicants. One interviewee suggested **typical interest rates are currently about 10%,** and that these relatively high interest rates can often **cause buildings to lose interest in pursuing upgrades.** It was also suggested that loans must be at least $25,000 to be worth the transaction costs for a lender.

3.1.1.3 Interventions to support access to financing for EV futureproofing

Governments, utilities, and non-profit financial organizations, including the Canadian Infrastructure Bank (CIB), the LC3 network and GMF, can make interventions in financial markets to improve access to capital for desirable energy retrofit projects, including EV charging futureproofing in multifamily buildings. For the purposes of this report, we group government, utilities and non-profit financial organizations under the umbrella term **"development finance institutions" (DFIs).** Broadly, there are two types of interventions that DFIs can make:

1. **Repayment vehicles offering preferential financing terms.** These tools provide the mechanism through which participants repay loans to administrators or third-party capital sources. By accepting a different risk profile for EV multifamily building futureproofing, DFIs can provide finance at preferable terms to the private sector (e.g., lower interest rates, longer repayment terms, different collateral, tying the financing to the property rather than the owner; higher debt to equity ratios; etc.). In turn, this can help build markets for these beneficial retrofit activities.
2. **Credit enhancements to improve the credit risk profile of the transaction.** These tools encourage private sector lenders to offer better financing terms, and more inclusive underwriting standards, than they would be willing to provide on their own. In Dunsky's experience, credit

enhancements typically are unlikely to encourage private sector lenders to significantly reduce interest rates, though they may encourage lenders to offer financing where they would not before.

Table 9 and Table 10 offer a high-level summary of the potential benefits of using different financial interventions. Section 6 includes recommendations for DFIs to enable lending mechanisms that will support multifamily buildings implementing comprehensive EV charging infrastructure futureproofing.

Table 9: Overview of development finance tools - Repayment Vehicles .

Financial Tools	Potential Benefits - Improve terms	Potential Benefits - Enable Loan Transferability
Revolving loan fund	✓	
Loans (securitization to recapitalize)	✓	
Property Assessed Clean Energy (PACE)[21] financing	✓	✓
On-utility-bill repayment	✓	✓

Table 10: Overview of development finance tools - Credit Enhancements.

Financial Tools	Potential Benefits - Improve terms	Potential Benefits - Enable Loan Transferability
Loan loss reserve	✓	
Loan guarantees	✓	
Interest rate buy-downs	✓	
Warehousing	✓	

3.1.1.4 Canada Infrastructure Bank's Building Retrofits Initiative

The Canada Infrastructure Bank's (CIB) Building Retrofits Initiative (BRI) provides financing for energy retrofits projects, including in multifamily rental and condominium buildings. The BRI could potentially support EV charging infrastructure deployment. CIB can offer competitive rates (e.g. near-prime interest rates) for energy upgrades, at relatively long amortization periods and flexible repayment schedules.

Dunsky understands that the CIB is only interested in entertaining lending on the order of $20M+. This is many times the amount of capital that even the largest multifamily buildings require for EV Ready retrofits. However, it is possible to aggregate multiple projects as part of one CIB BRI loan. An aggregator could theoretically organize multiple buildings to undertake EV futureproofing, conditional to financing from the CIB BRI. Further engagement with the CIB on this opportunity is warranted.

[21] The property assessed clean energy (PACE) model allows a residential or commercial property owner to finance the up-front cost of energy improvements on a property and then pay the costs back over time through a voluntary property assessment. Unlike other financing mechanisms, the assessment is attached to the property rather than an individual. For more information, see: https://www.energy.gov/scep/slsc/property-assessed-clean-energy-programs

3.1.2 Utility Make Ready Programs

Several utility jurisdictions in the US have established Make Ready EV charging programs serving the multifamily building market. Under these programs, a utility may pay for either, or both, the cost of:

- **Utility-side make ready infrastructure.** This entails the cost of a new electrical service (i.e., an additional electrical service beyond the one already serving the existing facility) up to and including an electrical meter; and/or
- **Customer-side make ready infrastructure.** This entails the costs on the customer side of the meter, up to an EV Ready outlet. Building owners (in e.g., rental buildings) or unit owners (in e.g., condominiums or co-ops) will then pay for the installation of EV chargers.

Figure 11 illustrates the electrical systems involved in utility-side and customer-side make ready infrastructure. Appendix C includes case studies of California independently operated utilities' utility-side make-ready program, and the Joint Utilities of New York's EV Make Ready Program.

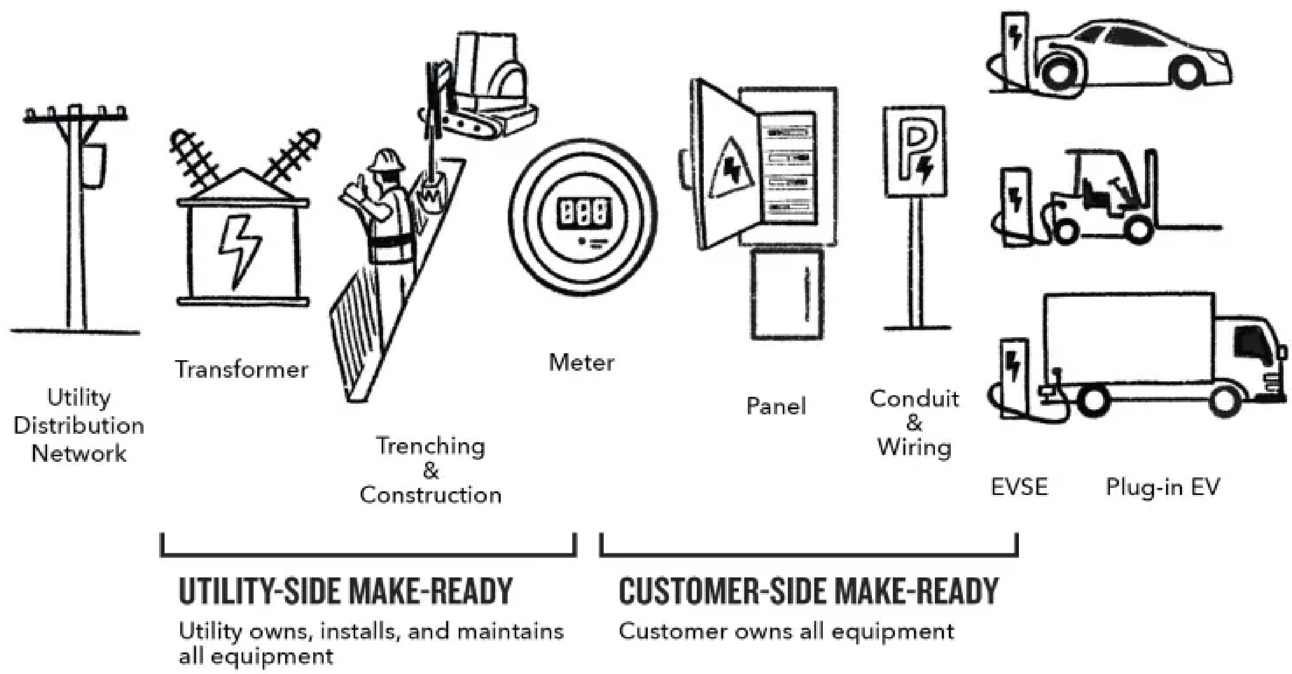

Figure 11: Utility-side and customer-side make ready infrastructure. Source: NRDC. 2021.

3.1.2.1 Utility-side make ready

Utilities can rate-base their costs incurred as part of make ready programs. This means that ratepayers must ultimately cover the cost of the infrastructure implemented. Whether make-ready programs have the effect of increasing or decreasing utility rates depends on whether the additional revenue that is garnered from the provision of EV charging over time more than offsets the investment in infrastructure utilities must make to provide the EV charging.

Providing a new electrical service free of cost to customers through utility-side make ready programs entails different pros and cons. Because the EV charging loads will not be on the original service, one benefit is that the upgrade will not impact the remaining spare electrical capacity in the building. This can **preserve electrical capacity** for electrification of other end uses (e.g., space heating and hot water) in the future.

However, providing a new service to any and all existing multifamily buildings free of charge could be a relatively costly and inefficient means of accommodating EV charging access, even in the context of broader electrification efforts. It is likely optimal for new electrical services to be implemented when they are necessary to avoid overloading pre-existing electrical services, so as to avoid unnecessarily increasing utility system costs and the customers rates that must be paid to pay for this infrastructure. In 100% EV Ready projects implemented to date, there tends to be sufficient electrical capacity to futureproof all parking, with judicious use of load sharing using EVEMS. Indeed, the limited experience in some buildings suggests that (near) universal electrification may be possible using the spare electrical capacity on existing services. However, there is very little experience with such full electrification of existing multifamily buildings and further analysis is required to determine whether and when electrical upgrades will be triggered, as well as what efficiency and energy management technologies can best avoid or defer these upgrades.

3.1.2.2 Customer-side make ready

Some programs to date (e.g., California utilities' previous make ready programs and Joint Utilities of New York) were predicated on utilities implementing both utility-side and customer-side make-ready infrastructure. Additionally, it is conceivable that a utility could commit to paying all the customer-side investment, while not adding a new service to the building. Alternatively, utilities could commit to an investment up to a certain level (e.g., $800 per EV Ready parking space), which would constitute a similar approach as the incentives noted in section 3.1.1.1.

A challenge with utility-funded customer-side infrastructure programs is that, under these programs, customers have few incentives to implement strategic use of load management using EVEMS, or other cost saving measures (e.g., considering where EV charging is located in parking areas that are not fully futureproofed). Indeed, the absence of cost-saving incentive for customers is reportedly part of the rationale for the California Public Utilities Commission' decision to direct utilities to focus on utility-side make-ready programs, while phasing out customer-side make-ready programs.[22] However, the program terms could be designed that ensure that reasonable steps to minimize costs are realized (for example, specifying that to be eligible for funding projects must be designed to limit loads to some amount per kW) or, again, by providing maximum funding amounts.

Two case studies of Make Ready programs are profiled in Appendix C, from California and New York State.

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[22] NRDC. October 2021. *CA Approves New Rules to Support EV Charging Infrastructure.*

3.1.3 Charging as a Service

The charging as a service (CaaS) model refers to a business model in which the provision of EV charging infrastructure and related services is offered as a **turnkey** package to individuals, businesses, or other organizations. Instead of purchasing and owning the charging equipment outright, customers can subscribe or pay for charging services on a usage or subscription basis. This model simplifies the process of installing and managing EV charging infrastructure while providing flexibility and scalability. Examples of businesses offering CaaS include: EVgo, ChargePoint, Greenlots, and Zeplug (see Appendix C for profiles of these firms).

CaaS is nascent, and industry members rarely provide specifics regarding their cost profiles, charges for applicants, and contract details. It has been suggested that service providers may charge $100 to $200 per month for vehicles to access home charging. Other fee structures in addition to monthly charges are likewise possible; for example, including a one-time connection fee to represent the cost of installing EVSE.

A key element of this model Is that the charging service provider assumes the risk of EV adoption emerging in a timely manner. This model is rarely associated with 100% EV Ready or EV Capable futureproofing, though it could be in jurisdictions that offer incentives for comprehensive futureproofing or where buildings provide no significant benefits of phasing. Because of the challenges of exchanging parking between residents in most condos, CaaS may be difficult to implement in the condo sector except for in visitor parking. In rental buildings where changing who uses parking spaces is more practical, CaaS can be implemented at no cost to the owner, and then drivers can access the charging infrastructure as they adopt eVs.

Firms offering CaaS are often sophisticated and understand buildings' electrical systems well; they may anticipate future residents' charging needs as well as current adopters. However, **the structure of CaaS services does not necessarily provide incentive for CaaS providers to implement electrical infrastructure that is futureproofed so that most residents adopt eVs**. For example, it may be in CaaS providers' interests to implement charging infrastructure that is sized to accommodate some first tranche of EV adopters, but cannot readily accommodate later adopters in future years or decades. Providing for these subsequent adopters in the future may be considerably more expensive as a result of the initial investment, due to capacity constraints and/or needing to replace stranded assets. This can create an equity issue, particularly for less affluent households that are likely to be later adopters of eVs. Public purpose entities, including the GMF and LC3 network, should consider and seek to mitigate such issues, if supporting or offering CaaS.

3.2 Comparison of Delivery Mechanisms

Table 11 compares the different project delivery mechanisms. It is unclear whether any mechanism is more likely to achieve widespread adoption of EV charging multifamily building futureproofing, nor which offers the best outcomes for building owners and occupants. As the market evolves, it may become clearer whether any model is superior. Section 6 includes recommendations regarding how GMF, LC3 and other stakeholders should respond to enable widespread multifamily building futureproofing for EV charging.

Table 11: Comparison of EV charging infrastructure project deliver mechanisms.

	Customer owned infrastructure	Make-ready infrastructure	Charging as a Service
Who is responsible for design	Buildings' consultants	Buildings' consultants and utilities	Service provider
Cost of capital	Buildings' implicit "hurdle rate" for cash on hand or special assessments Commercial financing rates for loans	Utilities' weighted average cost of capital used in rate base	Implicit interest rate likely higher than other models to account for service providers' risks and that it will likely be equity financed
Who assumes risk for EV adoption	Condominium association / building owner	Utility rate payers and/or other funders (e.g. govt)	Charging service provider
Who assumes construction & project development risks	Building, its consultants & contractors	Depends on program terms; utilities may assume risks	Depends on contract terms; service providers or building owners may assume risks
Impact on utility services & capacity to support additional electrification	Typically performed within existing service capacity. Could compete with other electrification projects if not coordinated	If utility provides a new service ("utility make ready"), will not use buildings' spare electrical capacity	Typically performed within existing service capacity. Could compete with other electrification projects if not coordinated

Project Implementation Considerations

4. Project Implementation Considerations

This section relates to various considerations associated with implementing EV futureproofing projects in multifamily buildings, including: Condominium approvals processes; how to manage any impacts on rental affordability associated with offering programs that support EV futureproofing; and how to mitigate legal and financial risks associated with implementing EV charging infrastructure in multifamily buildings. Appendix D includes further information relating to these issues.

KEY CONCEPTS

Key concepts developed in this section are:

- **Condominium approval process** are governed by **provincial legislation** (which varies by province) as well as condominium **bylaws;** they determine the process to approve funding for feasibility studies, capital works and services associated with EV charging infrastructure. Only BC and Ontario have rules specific to EV infrastructure.
- **"Right to Charge"** refers to laws that grant individuals residing in multifamily buildings the right to install and use EV charging infrastructure, typically within their assigned parking spaces.
- **"Right to Charge 2.0"** refers to laws that oblige condos and/or rental building owners to plan comprehensively for EV futureproofing, and make it easier for condos to vote in favour of such retrofits.

CENTRAL RECOMMENDATIONS

Provinces should adopt "Right to Charge 2.0" regulations modeled after BC's *Bill 22 –Strata Property Amendment Act, 2023*. This includes:

- Requiring condominiums and rental owners to undertake Electrical Planning Reports.
- Simplifying approval processes for EV Ready studies/plans.
- Reducing voting thresholds to 50% to approve capital investments in comprehensive EV futureproofing.

Policy-makers should mitigate any risks to rental housing affordability associated with EV charging futureproofing by:

- Providing higher incentive funding, and/or priority selection, for rental housing serving low- and moderate-income rental housing as part of programs encouraging EV charging futureproofing of multifamily buildings. Higher incentives should be combined with clauses in funding agreements that restrict rent increases, evictions, and exorbitant user fees, and attention to how to ensure compliance with these clause.
- Consider establishing programs that offer Charging as a Service for the rental sector.

Incentive and financing program administrators should take actions to **mitigate risks** associated with EV charging implementation in multifamily buildings by encouraging buildings to plan for comprehensive for EV futureproofing; ensuring qualified people are involved in design and construction of EV charging systems; requiring appropriate terms for construction insurance; and including indemnity clauses protecting program administrators as part of funding agreements.

4.1 Condominium Approval Processes

Condominium approval processes must be followed when condos approve EV charging infrastructure projects. These decision-making processes are governed by provincial condominium legislation and set out in individual condominium by-laws, which must not be less stringent than the provincial legislation. Most importantly, condominium approval processes determine the **required vote threshold for undertaking capital projects,** including EV futureproofing retrofits. As well, legislation and bylaws influence **whether a condo board has the authority to initiate an""EV Ready Pla""** (feasibility study) without the need for approval from the broader condo association at an Annual General Meeting (AGM) or Special General Meeting (SGM).

Condominium legislation varies by province: B.C. and Ontario have specific legislation related to EV charging infrastructure, while other provincial legislation is less prescriptive, with more of the key pieces left up to individual condominium by-laws (e.g., Alberta).

A high-level summary of condominium voting thresholds for capital projects and relevant legislation is presented in Table 12.

Table 12: Capital Project Voting Thresholds and Legislation for EV Charging Retrofits in Condominiums.

	Ontario	British Columbia	Alberta	Nova Scotia	Quebec
Relevant voting threshold[23]	50%	50%	75%	66.67%	75%
EV-specific condo regulation	✓	✓			
Relevant policy documents	*Condominium Act*; Ontario Regulation 48/01	*Strata Property Act*; Strata Property Regulation	*Condominium Property Act*; Condominium Property Regulation	*Condominium Act*; Condominium Regulations	Civil Code of Québec

In **Ontario**, the *Condominium Regulations* enacted under the *Condominium Act* (1998) include specific guidelines for the installation of an EV charging system by a corporation. Under the regulations, there are two processes by which EV charging infrastructure can be implemented: Condo corporation initiated and unit owner initiated. If **initiated by the condo corporation**, the condo board must conduct a cost assessment of the installation and determine if it is likely to affect the owner'' use or enjoyment of their units. If the installation costs are less than 10% of the annual budget and wo''t negatively impact owners, the board then notifies the owners of the proposal, including cost details and payment methods. After a 60-day period, the installation can proceed. If

[23] Specific voting thresholds and approvals processes may vary in each jurisdiction according to individual condominium corporations' bylaws.

costs exceed 10% of the annual budget or if the installation is likely to have a detrimental impact on residents, owners are informed of their right to request a meeting to vote on the proposal. If (50%) vote in favor or if a quorum (25%) is not present, the installation can go ahead.

If a **unit owner initiates** the project, the owner must submit a written application to the condo board detailing the project. The board can only deny the project if a professional finds that the proposal will pose health and safety risks, or damage property. The unit owner can then pay for the works. This is an example of **"Right to Charge"** legislation (see Section 4.1.1 below).

Since amendments in 2023, **British Columbi''s** *Strata Property Act* is the best-in-class legislation for EV futureproofing retrofits in condominiums (referred to as "strata" in B.C.) in Canada. While the Act previously required a 75% approval for changes to common property, the *Strata Property Amendment Act* of 2023 lowered this to **50% for changes related to installing EV charging stations**. The Act will also make it easier for condo unit owners to independently make changes to common property for their own EV chargers, subject to approval by the condo corporation; the forthcoming regulations will establish the conditions that a condo council may consider when reviewing an owner's request. For example, the strata may consider the capacity of the corporation's electrical system.

Finally, the legislation will require condo corporations to obtain an **electrical planning report** to help understand the building's electrical capacity and plan for the expansion of EV charging stations. The Regulations to specify the required contents of the electrical planning report are in the process of being developed by the BC Ministry of Housing. It is important that the required scope of the report supports the condominium in considering comprehensive futureproofing for EV charging infrastructure, as well as other electrification projects. While there are important details to be determined by the forthcoming regulation, BC's recent legislation is a good example of **"Right to Charge 2.0"** (see Section 4.1.1 below).

Albert''s *Condominium Property Act* stipulates that a special resolution is needed to approve funding for significant capital projects, requiring approval from owners representing at least 75% of the units, although this can vary by condominium. In cases where bylaws conflict with the Alberta Condominium Act and Regulations, the approval threshold is reduced to 50%.

Nova Scotia allows changes to condominium by-laws by owners who own 60% of the common elements (i.e., 60% of condominium unit owners). The *Nova Scotia Condominium Act* specifies that capital expenditures and levies for extraordinary expenses need the consent of a group of owners representing at least two-thirds (66.66%) of the common elements. However, for substantial changes, the voting threshold is increased to 80%. Decisions affecting the lesser of $2,500 or 5% of the corporation's annual budget generally don't require owner approval.

In summary, **the processes for approval of EV infrastructure installation vary across these jurisdictions**, with Ontario adopting a dual-path approach depending on the cost and impact of the project, while BC has sought to streamline the process by reducing voting thresholds. In contrast, Alberta and Nova Scotia have set high voting thresholds, potentially making it more challenging to get approval for such installations in condominiums.

Please see Appendix D for a more detailed description of relevant legislation and guidelines pertaining to condominium approvals processes in Ontario, Alberta, British Columbia, Nova Scotia, and Quebec.

4.1.1 Right to Charge Legislation

Right to Charge legislation refers to laws or regulations that grant individuals residing in multifamily buildings the right to install and use EV charging infrastructure, typically within their assigned parking spaces. These laws aim to address the barriers faced by EV owners living in multifamily buildings who may encounter challenges in accessing charging infrastructure due to restrictions imposed by property owners or condominium associations. With the""Right to Charge"" individuals can install EV chargers in their parking spaces without undue barriers. As noted above, Ontario and BC's condo approvals process provisions relating to unit owners installing EV charging constitute a form of Right to Charge legislation.

One notable example of Right to Charge legislation is in California. In 2022, the state introduced the""Electric Vehicle Charging Stations in Multifamily Housing and Common Interest Development"" law, which grants tenants and residents the right to install EV charging stations in their assigned parking spaces, subject to certain conditions and restrictions.

Right to Charge legislation can allow early EV adopters to implement EV charging in their multifamily buildings. However, this legislation itself is not a comprehensive solution. Notably, without careful planning, implement EV charging in the piecemeal fashion anticipated by Right to Charge legislation can result in capacity constraints that could make future installation of additional EV charging or other electrification projects more difficult.

British Columbia's requirements for Electrical Planning Reports, and reducing voting thresholds for comprehensive EV futureproofing projects, provide a better policy – For lack of a pre-existing term, Dunsky coins this suite of policies **"Right to Charge 2.0"**. Right to Charge 2.0 involves:

- Requiring condominiums and rental owners to undertake Electrical Planning Reports.
- Simplifying approval processes for EV Ready studies/plans.
- Reducing voting thresholds to 50% to approve capital investments in comprehensive EV futureproofing.

4.2 Retrofits and Rental Housing Affordability

EV futureproofing retrofits of existing rental buildings are an important tool **to expand equitable access to home charging to renters**, a population that is disproportionately low- and moderate-income and racialized. As noted in Section 1.4.4, because of eVs' lower life cycle costs, they hold the promise of improving transportation affordability for less affluent households that drive.[24]

However, there is some **risk** that EV futureproofing retrofits could negatively impact tenants. The main two risks are that landlords:

1. **Use capital investments in EV charging infrastructure to justify rent increases**. In many Canadian provinces, landlords may apply to provincial regulators for an additional rent increase beyond standard allowable annual increases, if the landlords have incurred eligible capital expenditures at their rental property. Some regulators may deem EV charging infrastructure an

[24] Of course, the most affordable and low-carbon option is usually forgoing vehicle use, with greater reliance on active transport, transit, and car-share. However, many renters will continue to use cars, and will thus benefit from access to home charging.

eligible expense. While the presence of EV charging would benefit EV driving tenants, the increases could potentially apply to all residents in the building.

2. **Charge exorbitant user fee**s. It is reasonable for EV charging user fees to cover amortized capital and operating costs of charging infrastructure (net of any incentives or other revenues like low carbon fuel credits), and some modest profit margin. However, landlords, and EV charging service providers, could charge more substantial user fees and make windfall profits. For tenants with eVs, the alternatives to charging at home would be public charging; therefore, they would be willing to pay user fees comparable to those for public charging. However, providing home charging at scale is likely to be lower cost to deliver than public charging, particularly if building owners can access incentives for futureproofing retrofits.

   From a social equity perspective, it would be best for tenants to reap these savings, as opposed to their being captured as windfall profits for landlords or charging service providers. Likewise, ensuring modest user fees will speed the transition to eVs and reduced emissions, as drivers will benefit from lower fuel costs.

There are three strategies policy-makers, and entities with a public purpose like development finance institutions, can take to mitigate these risks.

1. **Provide higher incentive funding, and/or priority selection, for rental housing serving low- and moderate-income rental housing**. For example, the recently-launched EV Station Fund, administered by The Atmospheric Fund, will prioritize charger installation in buildings that are home to taxi and ride hailing drivers. This program is expected to help expand charging access to this key population, which is also disproportionately low-income, racialized, and drives relatively large amounts; such targeting can improve both justice and climate (by displacing greater amounts of fossil vehicle kilometers traveled) outcomes. Likewise, EV charging futureproofing programs could layer in similar additional incentives for target populations.

   However, on its own, higher incentive levels for rental buildings housing target populations might not prevent landlords from increasing rents; it would be up to provincial rental authorities to ensure that any allowed rent increase for capital expenses was net of any incentives, and not encompassing the gross project costs. Likewise, higher incentives would not prevent a landlord from charging excessive user fees.

2. **Include clauses in funding agreements that restrict rent increases, evictions, and exorbitant user fees.** For example, the City of Vancouver's EV ready top-up funding (see Section 3.1.3), the City of Ottawa's energy efficiency financing programs, and the City of Toronto's HiRIS program, all include clauses in their funding agreements preventing landlords from increasing rents above the minimums specified by provincial rental regulators. Theoretically, programs could also specify that landlords or condos limit user fees to certain levels.

   However, it is understood that none of the above programs feature ways of tracking and ensuring compliance with these provisions. Evidently, enforcement is only as good as provinces' pre-existing systems for regulating the rental sector.

3. **Operating Charging as a Service (CaaS) for the rental sector.** If governments, utilities, or non-profit public-purpose organizations provided CaaS (as described in Section 3.1.3), they would pay the costs of installing and implementing charging infrastructure. Landlords would thus not have eligible expenses to justify their rent increases to provincial regulators. Likewise, the CaaS operator would typically control user fees. Thus, public-purpose CaaS might afford some protections for rental housing residents.

It is unclear at this time how significantly tenants could be impacted by rent increases to cover EV retrofit expenses and high user fees. In Dunsky's opinion, the risks posed by these issues to affordability and rental housing security are relatively modest, at least when compared to the greater expense that can be incurred through many other capital works, and to the broader issue of "renovictions". Nevertheless, it is appropriate to seek to mitigate these risks using the strategies noted above, as reflected in the recommendations in Section 6.

4.3 Risks and Mitigation Strategies for Building Owners and Program Administrators

Dunsky engaged the law firm McCarthy Tétrault LLP to comment on the potential risks associated with EV charging infrastructure projects in MURBs, and the appropriate risk mitigation measures that should be considered by multifamily building owners and programs supporting deployment of EV charging infrastructure. Table 13 summarizes risks and mitigation strategies. Appendix D includes associated commentary provided by McCarthy Tétrault LLP.

Table 13: Risks and Mitigation Strategies for Building Owners and Program Administrators

Risk	Mitigation Strategy
Stranded Assets – Piecemeal EV charger additions may not be compatible with subsequent expansion. If individual driver(s) originally were allowed to make the piecemeal addition, and the stranded asset must now be removed, they may take action against the condo or building owner, and/or the program that supported the initial implementation.	Encourage buildings to get comprehensive EV charging strategy/plan. Indemnity clauses in funding agreements.
Insurance and Professional Liability – There may be losses to occupants either during construction, or subsequently during operations if electrical upgrades are designed improperly. There is risk that building owners might take action against program administrators.	Ensure qualified professionals are engaged. Develop standard terms for construction insurance policy to be used in programs. Indemnity clauses in funding agreements. Ensure EV charging service providers assume liability in CaaS agreements.

Business Case Analysis

5. Business Case Analysis

KEY CONCLUSIONS

In this section, we assess life cycle costs of EV ready retrofits under a range of scenarios and approaches to determine the most cost-effective approaches. Key conclusions include:

- All buildings will benefit from careful feasibility study of the best means of futureproofing their parking for EV charging.
- On a life-cycle basis, **comprehensively planned futureproofing approaches are more cost-effective than piecemeal, unplanned installations of a few EVSE at a time**.
- Level 1 futureproofing can sometimes be lower cost on a life cycle basis. However, it may not provide adequate charging performance for many residents. Additionally, the "day one" capital costs of 100% Level 1 are often higher than 100% Level 2 EV Ready or EV Capable.
- Phased retrofits, with careful planning at the outset for how to ultimately provide EV charging at all parking spaces, can be appropriate in certain circumstances where exchanging parking stalls between residents is viable (e.g. some rental, but not condos). Phased approaches are likely most valuable in larger buildings.
- Despite the benefits of an EV ready retrofit, it is difficult to get condos and rental building owners to invest in these works. Multifamily buildings often have high hurdle rates. They face a variety of informational barriers, transaction costs and split-incentives.
- **Incentives for comprehensive futureproofing can greatly improve the business case.** Incentives are important to getting multifamily buildings to undertake comprehensive futureproofing.
- Financing mechanisms (e.g. loans) could play an important role in addressing multifamily buildings' lack of access to cash.
- **Charging as a service (CaaS) may present a viable business model** and could be compatible with comprehensive futureproofing in multifamily buildings. However, the success of CaaS depends on various factors, including the level of EV adoption among building occupants and the pricing competitiveness of CaaS in relation to other charging options (workplace or public charging) for all drivers. Comprehensive futureproofing does require additional upfront investment compared to some partial futureproofing strategies. There can be a tension in CaaS models between keeping initial capital expenses low and ultimately enabling all residents to have access to home EV charging through comprehensive retrofits. CaaS may be most appropriate in buildings where parking can be readily exchanged, and where phased implementation is viable.

This section of the report summarizes life cycle cost analysis of different approaches to EV futureproofing.

- Section 5.1 describes several of the most important factors impacting how EV futureproofing can be delivered, and the costs associated with that futureproofing.
- Section 5.2 summarizes high-level, indicative capital and operating costs estimates for different EV futureproofing configurations.

- Section 5.3 then summarizes the structure and inputs of a pro forma life cycle costing analysis model Dunsky developed for this project. The model compares the life cycle economics of different EV futureproofing configurations, and demonstrates the potential impacts of different public policy interventions, including providing incentives, project financing, and offering CaaS.
- Section 5.4 includes results and discussion.

It is important to emphasize the **purpose** and necessary **limitations** of this life cycle cost analysis:

- This analysis is intended to inform **program** and **policy design** to support multifamily building EV futureproofing. Thus, it aims to provide some indication of the relative financial performance of different futureproofing configurations and strategies – Notably, the performance of comprehensive futureproofing versus piecemeal additions of EVSE; Level 2 with networked charging versus Level 1; and EV Ready versus EV Capable predicated on the use of networked chargers.
- The business case of different approaches to futureproofing retrofits will depend on which costs and potential revenues are accounted for, which itself depends on the specific stakeholder perspectives being considered in the analysis (e.g. rental building owner or condo board, condo owners or rental building occupants, or EV charging service providers). While there are many broad societal benefits of EV Ready retrofits (e.g. reducing greenhouse gas emissions, improving equitable access to EV charging, promoting healthier people and communities), as well as direct benefits for drivers (greater convenience, costs savings from using EVs, etc.) only some of these benefits are captured in the analysis presented in this section. Accordingly, **the business case presented in this Section of any particular EV Ready retrofit is not a complete reflection of its true value**. This business case analysis merely demonstrates the rough costs of providing EV futureproofing in different ways. Ultimately, condos, building owners, drivers and policy makers will decide whether such futureproofing is worth the cost.
- The **cost estimates**, and thus the results of this analysis, are **high-level and indicative only**. Capital costs were derived from past costing studies developed for buildings in the Vancouver area, adjusted for construction cost inflation to 2023 dollars. These cost estimates were further validated with input from interviews with charging service providers across Canada, and information received regarding BC's EV Ready Rebate program. In the absence of better empirical data, this analysis provides a reasonable rough indicative estimate of the costs to implement EV charging infrastructure in multifamily buildings, for the purposes of informing program and policy design across Canada.
- There are **major uncertainties** regarding the future operating costs of EV charging infrastructure. Key sources of uncertainty include: How the market for EV charging services will evolve; the prevalence and cost of ongoing networking fees; utility rate design and potential for demand response program revenues (including how different charging infrastructure can impact buildings' ability to respond to these price signals); the ongoing cost to purchase and install EVSE; the value of low carbon fuel credits, including what metering and infrastructure will be required to successfully monetize these credits; and other parameters.

  We have attempted to make reasonable educated guesses about the future costs/revenues associated with these parameters, and included sensitivity analysis. Nevertheless, we openly acknowledge that reasonable cases can be made for different assumptions; the future is not determined.
- **This analysis does not encompass all possible EV futureproofing configurations**. There are a theoretically (nearly) limitless number of electrical configurations that could be deployed in multifamily buildings; we present costing for only four configurations. **This study does not**

encompass several strategies that could provide greater value in some buildings. For example:

  - In many buildings where driving distances are less (e.g. inner city), it is viable to load share to a greater extent than contemplated in the configurations below – The EV Ready and EV Capable configurations in this analysis assume 4-share on 40A branch circuits. However, several 100% EV Ready buildings have successfully deployed higher ratios of EV load sharing (e.g. 6+share on 40A circuits), with proportionally greater savings.
  - EV Capable future-proofing using "smart" panels or feeder monitoring presents a promising opportunity that can avoid the cost of networked Level 2 EVSE and ongoing network fees. While these futureproofing approaches will typically have higher capital costs, they can be cost-effective on a life cycle basis. However, they were not evaluated as part of this analysis.

- **This analysis should not be used to determine the financial performance of EV charging infrastructure for any one particular building. Moreover, this analysis does not conclude that one futureproofing configuration will always outperform others.** Every building is different. Furthermore, different owners and residents of multifamily buildings have different values and preferences – For example, some might prefer non-networked charging solutions, to avoid the need for an ongoing relationship with an EV charging service provider. Others might be happy to use networked solutions to realize lower CAPEX and services such as billing users for utility costs.
- Nothing can replace the value of a considered assessment of a building's unique electrical systems by an appropriate professional, informed by an understanding of building owners' values and of the parking tenure and layout. **A careful feasibility study is necessary to determine the best approach to EV futureproofing in any given building**.

5.1 Building Characteristics Impacting EV Futureproofing

The project team was directed by FCM and LC3 to identify the building characteristics that most impact the business case for futureproofing multifamily buildings. Based on our collective experience, key variables include:

1. **Whether phasing of retrofits is viable because residents can exchange parking spaces, and/or sufficient common parking is available for shared charging facilities**. In some circumstances, phased additions of charging infrastructure may allow for some costs to be deferred. The ability to exchange parking spaces exists in many rental apartments, but not in most condos where parking tenure makes swapping parking impractical (as described in Section 2.4). The potential for deferring electrical infrastructure is likely greatest in very large buildings that may ultimately require multiple electrical feeders to parkades, or those buildings that elect to use feeder monitoring of each residential unit's electrical panels (see point 4 below). However, depending on electrical systems, there may be limited benefits to phasing, as often electrical works are "lumpy"; most of the costs of a project may be associated with the "upstream" electrical works (e.g. transformers; switchgear; feeders; etc.) that would need to be sized appropriately to ensure that all drivers can ultimately access EV charging. Section 5.4.3 below illustrates a case where phasing can improve the life cycle economics of a project.
2. **Whether an electrical service upgrade will be necessary**. In our experience, appropriate use of EV load management can usually avoid utility upgrades when making all parking "EV Ready". However, some buildings do face unavoidable capacity constraints. Furthermore, electrification of other building loads (space heat, hot water, cooking, etc.) will increase the prevalence of such constraints (though full electrification without service upgrades is still possible in many facilities). The impact of electrical service upgrades is illustrated in the sensitivity analysis in section 5.4.4.
3. **Whether the building has structural parking (underground or in-building) or surface parking**. EV charging retrofits of surface parking tends to be more expensive due to trenching to accommodate branch circuiting, feeders and/or other electrical infrastructure. Additionally, surface parking may require civil works such as pedestal-mounted chargers and curb stops, which can add to the costs of implementing EV chargers.
4. **Whether electrical meters are located proximate to parking.** This can enable designs for feeder monitoring of residential units' electrical panels, which as noted in Section 2.4 can be an option for some parking areas. However, this option was not evaluated in this analysis.

5.2 Approximate Costs of Different Futureproofing Strategies

Table 14 summarizes estimated costs and revenues used in the model, expressed per parking space. Colour coding illustrates what capital costs are incurred "day 1", versus what costs are deferred until drivers adopt EVs. All costs are in 2023 dollars. Notes on performance and implementation are included, to provide relevant context about the different configurations.

The configuration options in Table 14 were chosen to represent common approaches in multifamily buildings being implemented today. Please note that the futureproofing configuration options do not encompass all possible potential configurations nor technologies that could be used. Indeed, there are hundreds of potential configurations, including some that could potentially offer even greater value. To provide one example, more aggressive load sharing on higher amperage circuits (e.g. 10+ share on 80A) *might* achieve lower life cycle costs and comparable performance compared to the "100% EV Ready Level 2" (with 4-share on 40A) configuration chosen, contingent on favorable evolutions in charger offerings and electrical codes.

Table 14: Approximate Costs and Revenues of Different Futureproofing Strategies

CAPEX Colour Coding: **Red = day 1 costs / revenues** | **Yellow = Costs / revenues begin on EV adoption.**

Futureproofing configurations options	Notes on performance & implementation	CAPEX (Equipment & Installation)							OPEX (Annual)		Revenues	
		Design Services	Legal & Admin Services	Service Upgrade	Electrical Infrastructure[25]	Branch circuiting	EVEMS & ICT networks	EVSE	Charging Network User Fees	Electricity Costs	Clean Fuel Credits	Utility Demand Response
Piecemeal additions of a few EVSE at a time	Unplanned addition of a few EVSE at a time.	N/A	N/A	After 35% of stalls made EVSE	Included in EVSE estimate	Included in EVSE estimate	Included in EVSE estimate	$8,000 per EVSE[26]	$250, plus no-cost sensitivity	Based on utility rates	None	Eligible
100% Level 1 outlets	Dedicated Level 1 circuits. Will provide less performance than other options (i.e. less likelihood of adequate charge for the next days' driving, particularly for larger vehicles and longer VKT).	10% of total CAPEX	5% of total CAPEX	Average $1,000, plus two sensitivities: $0 (no upgrade), $500 (minor upgrades)	$902	$838	$0; or $100 for networked L1 $100 (e.g. Plugzio)	$0; or $450 for networked L1 outlet	$0; or $250 for networked L1	Based on utility rates	Not eligible	Not eligible
100% EV Ready Level 2	Assumed 4-share on 40A. More aggressive load-sharing (e.g. 6+ share on 40A) can achieve lower costs, though with slower average charging speeds.	10% of total CAPEX	5% of total CAPEX	Average $1,000, plus two sensitivities: $0 (no upgrade), $500 (minor upgrades)	Average $1300 in existing programs.[27] $600 - $1000 may be achievable via more aggressive load-sharing.[28]	$244	$100	$2,000	$250, plus no-cost sensitivity	Based on utility rates	Eligible	Eligible
100% EV Capable with incremental upgrades of branch circuits	Dedicated branch circuits. Panel is 4X overloaded.	10% of total CAPEX	5% of total CAPEX	Average $1,000, plus two sensitivities: $0 (no upgrade), $500 (minor upgrades)	$1,255	$961	$100	$2,000	$250, plus no-cost sensitivity	Based on utility rates	Eligible	Eligible

[25] All infrastructure between service entrance and branch panel breaker. Excludes branch circuiting.
[26] The approximate average program cost reported for incremental retrofits for one Canadian program.
[27] Average program costs from EV Ready retrofits.
[28] Based on authors' experience.

5.3 *Pro Forma* Life Cycle Costing Analysis Model

5.3.1 Model Description

Dunsky developed a *pro forma* life cycle costing analysis model to assess the life cycle economics of different EV futureproofing configurations. Inputs in the model can be adjusted to account for variations in building characteristics and other circumstances.

The model allows the user to change inputs and assumptions related to futureproofing configuration, EV adoption rates, incentives, charging network user fees, whether a utility service upgrade is required, cost of EVSE, cost of EVEMS and ICT networks, number of building units, efficiency of EV, and annual cost savings that can be realized through dynamic utility rates (for example, time of use rates). Futureproofing configurations include 100% Level 1 outlets, 100% EV Ready Level 2, and 100% EV Capable with incremental upgrades of branch circuits. The model could readily accommodate other futureproofing configurations as well.

Table 15 outlines the set of user-specified model inputs, to reflect different building characteristics (Section 5.1); regional differences in utility costs, pace of EV adoption, policy landscape; and different futureproofing configurations. The "Central Assumption" values were assumed in the results below, unless otherwise stated.

Table 15: Model Inputs and Outputs

Input / Assumption	Possible Inputs	Central Assumption	Explanatory Notes	Outputs Impacted
Utility Extension ($)	Zero; Low; High	Zero (no utility extension)	To reflect one of the most important building characteristics outlined in Section 5.1 – whether or not an electrical service upgrade is required.	Capital Costs
EVEMS & ICT Networks ($)	Zero; Standard; Networked L1	Standard	Costs for EVEMS and ICT implemented as part of capital works.	
Phased retrofits	Yes; No	No	Depends on whether phasing is possible. If Y, phasing depends on manual phased capital schedule reflecting unique opportunities in the building.	
Design, Legal, and Admin Costs (%)	1 to 15%	10% design; 5% legal	Calculated as a % of year 1 CAPEX to reflect design, legal, and administrative costs of EV ready installation.	
Parking Type	Structural; Surface	Structural	Reflects whether the building has structural or surface parking. Surface parking increases CAPEX by a user-input percentage.	
Loan Amount (% of CAPEX)	0.0% to 100%	No Financing	Loan amount can be specified as a % of CAPEX or as an absolute value.	
Loan Term (years)	2 to 27		To represent different loan terms and interest rates.	
Interest Rate (%)	0.0% to 20.0%			
Utility rates ($/kWh)	Energy and demand charges	$0.06 to $0.12 per kWh and $0 to $12 per kW	Structured to accommodate energy charges ($/kWh) and demand charges ($/kW), presuming a general service rate structure. Other utility rates can be readily inputted.	Operating Costs

Input / Assumption	Possible Inputs	Central Assumption	Explanatory Notes	Outputs Impacted
EVSE lifetime	5-20 years	15 years	Impacts costs of maintenance and repair.	
Savings Associated with Dynamic Utility Rates (%)	Zero; Medium; High	High for networked Level 2 chargers; otherwise Zero	A percent savings on annual utility bills associated with the ability to take advantage of dynamic utility rates (e.g. Time of Use; Critical Peak; Real Time Pricing; etc.). We anticipate that being able to respond to dynamic price signals will be advantageous and result in savings in future years; however, the structure of rates and associated savings potential is difficult to forecast, and thus modeled coarsely.	
Charging Network User Fees ($/user)	Cost; No Cost	Cost	Monthly cost for users to pay EV charging service providers' network fees. Typically paid by EV driver.	
EV Efficiency (km/kWh)	4.5 to 7.0	6.4	Average EV efficiency impacts utility consumption.	Operating Costs and Revenues
EV Adoption Rate (%)	Low; Medium; High	Medium, reaching 100% by 2050	Accounts for variations in pace of EV adoption, which can vary by building and by region.	All output categories
EVSE Incentives ($ per EVSE)	None; Medium; High	None	Reflects rebates for the purchase of an EVSE.	Installation Revenues
EV Ready Incentives ($ per EV Ready Parking Space)	Yes; No	No	To act as proxy for a program similar to BC's EV Ready Rebate program, which provides funding for EV charging infrastructure. Varies by region.	
LCFS/CFR Credits ($/T)	Yes; No	No	Revenues from clean fuel credits.	Operating Revenues
Demand Response Program	Yes; No	No	To account for revenues from participating in demand response programs.	
Gasoline Savings ($)	Yes; No	No	Gasoline savings can be disabled (i.e., not accounted for), depending on the objectives of the costing analysis (for example, gasoline savings may be less relevant for assessing the business case from a building owner or utility's perspective).	

5.4 Results and Discussion

5.4.1 Comparing Costs of EV Ready Approaches

Figure 12 summarizes the **net present cost (including operational and capital costs) per parking stall** of five different EV charging retrofit approaches:

- 100% EV Ready networked Level 1,
- 100% EV Ready non-networked Level 1,
- 100% EV Ready networked Level 2, with 4-share on 40A branch circuit sharing,
- 100% EV Capable Level 2 with incremental upgrades of branch circuits, and
- Piecemeal unplanned installation of a few EVSE at a time.

In each case, the costs include the installation of EV chargers over a project lifetime of 2023 to 2035, as well as their operational costs to the user over this period. Note that costs incurred in future years are subject to a 7% discount rate, to reflect the time value of money from decisionmakers' perspective in the present day; this accounts for the differences in the nominal costs noted in tables above. Figure 12 only represents the net present costs associated with each futureproofing configuration, and does not account for any potential revenues (for example, low carbon fuel credits, EVs' fuel and maintenance savings, etc.).

As noted in Table 15 above, networked Level 2 chargers are assumed to be Wi-Fi enabled chargers with the capacity for sophisticated load management. For networked chargers, we assume that favourable electricity rate structures, and/or demand response programs, are available in future years; this enables networked load-shared Level 2 chargers to experience lower electricity (utility) costs.

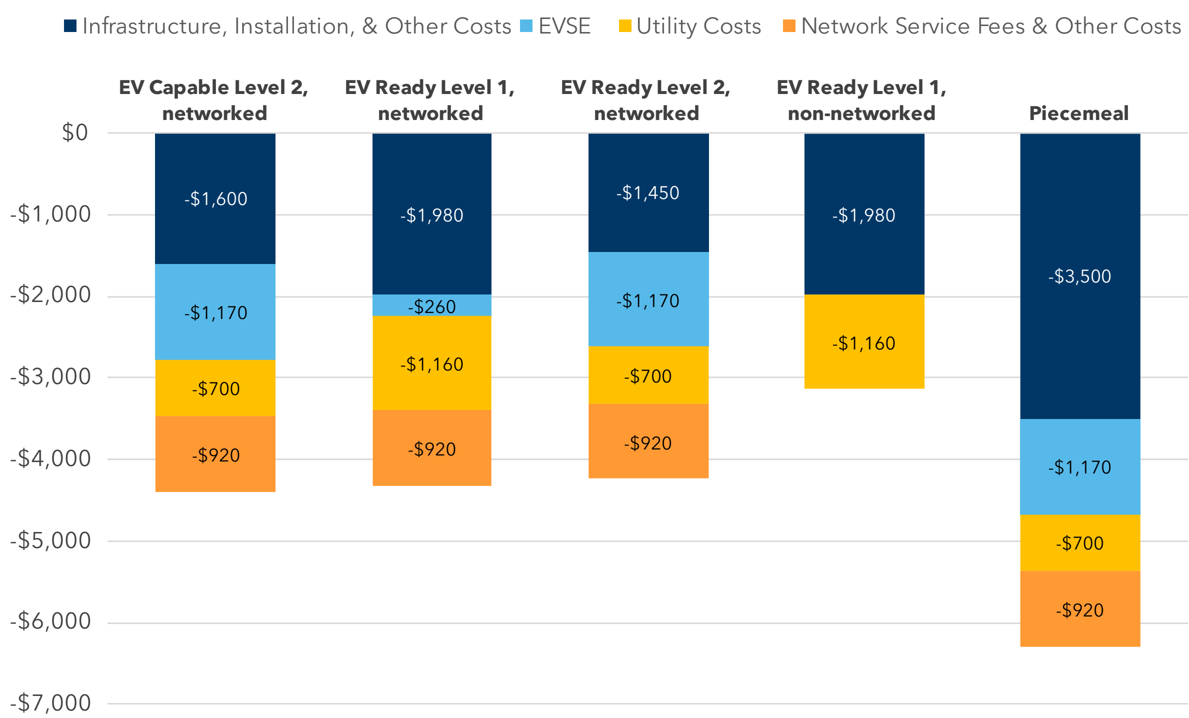

Figure 12: Net present cost of different futureproofing configurations (7% discount rate on future cashflows).

The key conclusion from Figure 12, is that **unplanned, piecemeal installation of a few EVSE at a time is the most expensive approach on a per parking stall basis**, even with significantly discounted cashflows for the costs of implemented EV charging in future years and ignoring the significant potential for stranded assets. In a piecemeal approach, each installation comes with its own set of fixed costs, such as labor for installation, electrical work, permitting, and inspections, which do not scale linearly. A comprehensive approach allows for economies of scale, optimizing labor and materials and reducing per-unit costs.

The 100% EV Ready non-networked Level 1 scenario yields the lowest net present cost over the project's lifetime. However, it should be noted that Level 1 will provide considerably lower charging performance than configurations using Level 2, which is not captured as a financial benefit here. See Section 2.2.1 and Appendix B for further discussion of charging Levels and performance.

The financial implications of different futureproofing configurations for building owners, condo board, condo owners, and tenants will depend on the specific costs assumed by each in different retrofit scenario. Figure 13 shows the net present costs of different futureproofing configurations for the building owner or condo board, and building occupants, assuming that the building owner or condo board pays the cost of the electrical infrastructure and installation, along with the cost of the EVSE. This situation is common in rentals, and may prevail in condos where parking is common property with no long-term leases. Building occupants are assumed to pay for utility costs related to the operation of their EV charger, along with any incurred network service fees.

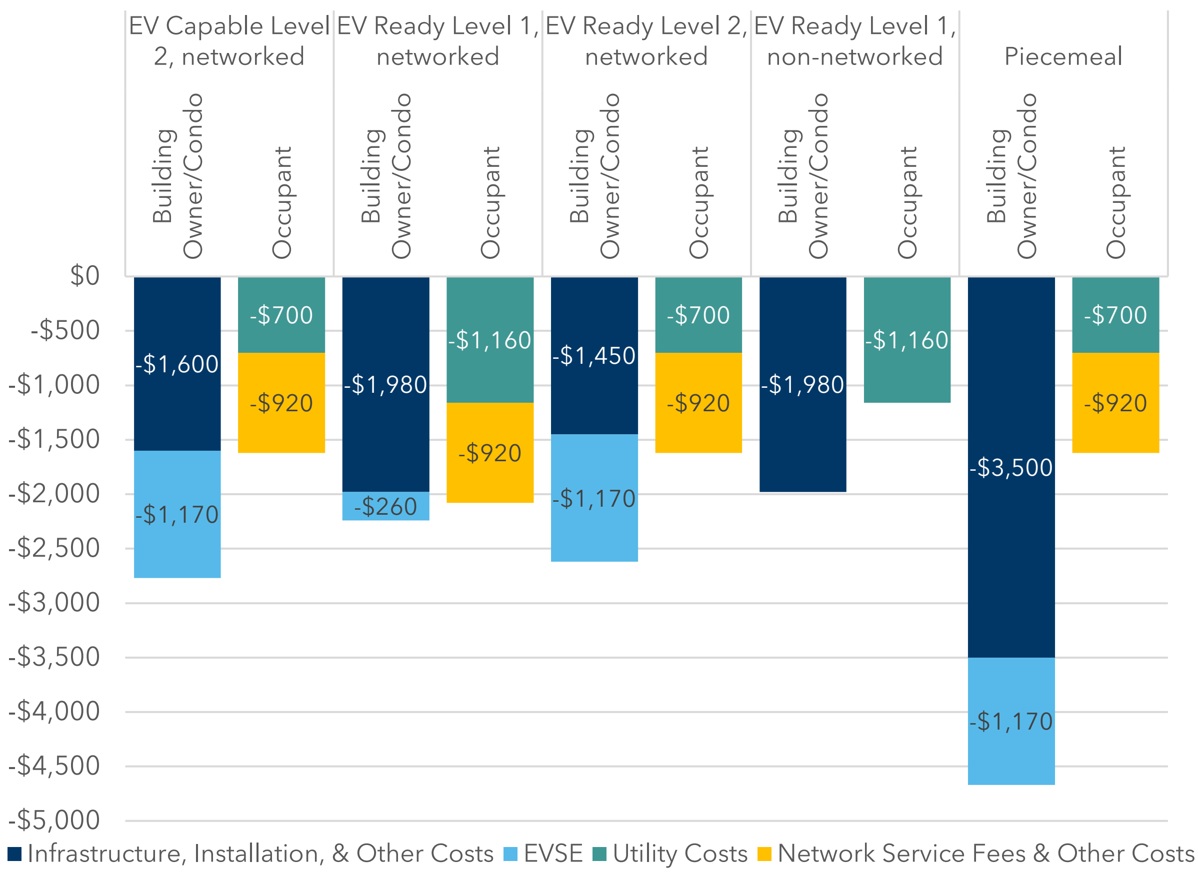

Figure 13: Net present cost of different futureproofing strategies, building pays for EVSE and electrical infrastructure and installation

Figure 14 shows the net present costs of different futureproofing configurations for building owner or condo board, and building occupants, assuming that the building owner or condo board **only** pays the cost of the electrical infrastructure and installation, while building occupants pay for the EVSE, along with utility costs and network service fees. This situation is common in most condos. However, for the piecemeal, unplanned installation of a few EVSE at a time, we assume that the building occupant also pays for the electrical infrastructure and installation costs.

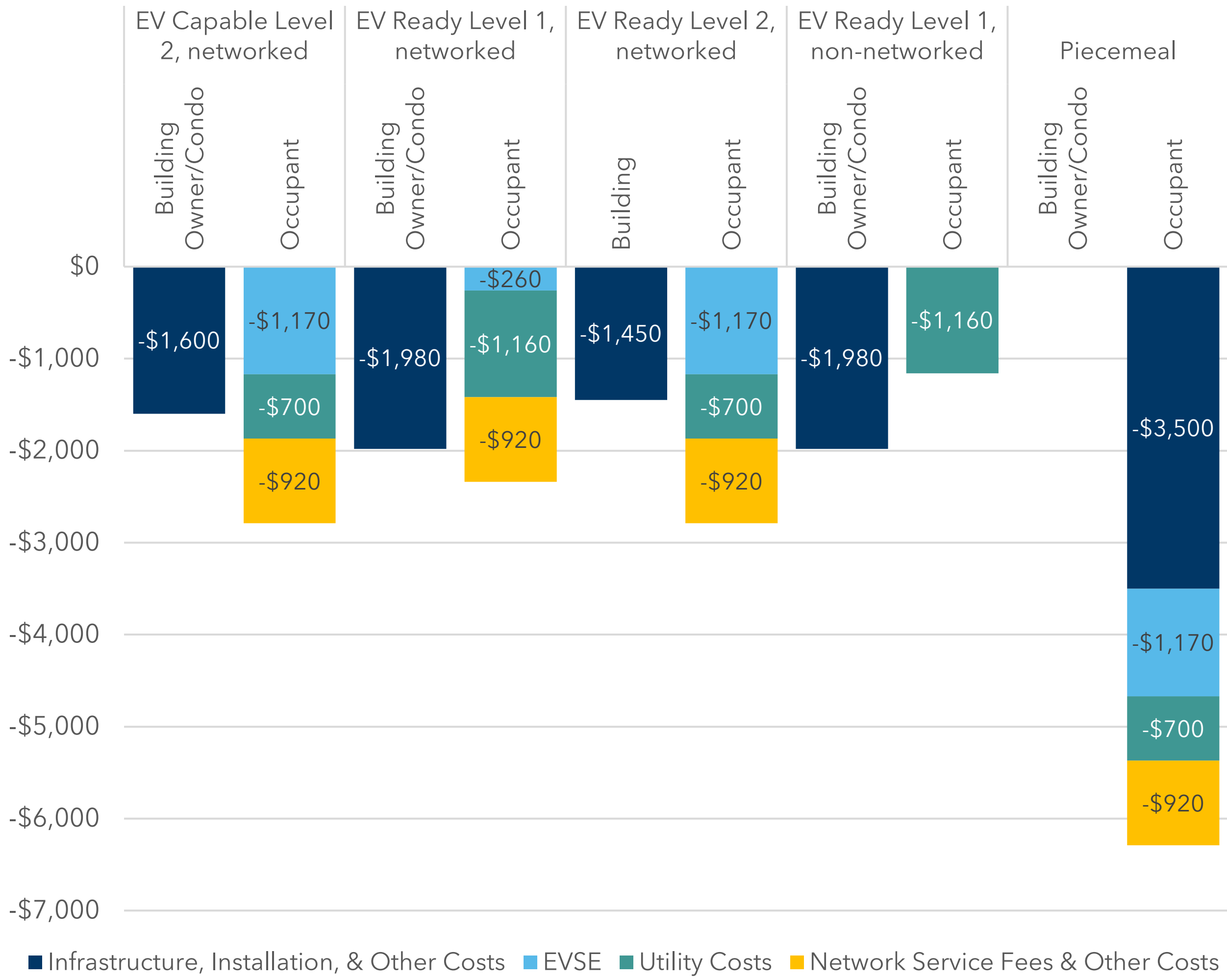

Figure 14: Net present cost of different futureproofing strategies, building owner only pays electrical infrastructure and installation costs.

In this scenario, the configuration with the lowest net present cost for the building owner or condo board is the unplanned, piecemeal installation of a few EVSE at a time, as the cost to the building would be zero. However, this unplanned installation scenario is also by far the most expensive from the perspective of building occupants, who would bear all the costs related to the installation. From the perspective of the building owner or condo board, the least expensive comprehensive futureproofing approach is the networked EV Ready Level 2 configuration, at only $1,450 per parking stall, while the most expensive approaches are the EV Ready Level 1 installations at $1,980 per stall.

5.4.2 Incentives and Financing

This section explores the impact of incentives and financing on the business case for a 100% Level 2 EV Ready retrofit in a **100-unit multifamily building**. Table 16 outlines the assumptions relating to the various incentives and financing options. The scenarios include an "LC3 Loan", consisting of a theoretical lending product offered by LC3s with market rate interest rates, but longer amortization periods. The "Low Interest Loan" scenario contemplates a lending product that has below-market interest and long amortization.

Table 16: Incentive and Financing Scenario Assumptions

Scenario	Assumptions
No Support	No financing or incentives
Incentives	$800 per EV Ready parking space plus $1400 per EVSE installed
Market Financing	Loan covering 80% of CAPEX at 10% fixed interest rate, 5-year amortization
LC3 Loan	Loan covering 80% of CAPEX at 10% fixed interest rate, 15-year amortization
Low Interest Loan	Loan covering 80% of CAPEX at 6% fixed interest rate, 15-year amortization
LC3 Loan and Incentives	Loan covering 80% of CAPEX at 10% fixed interest rate, 15-year amortization plus $800 per EV Ready parking space

Figure 15 shows the nominal annual costs of the project, subject to the different scenarios. Table 17 describes the different costs that comprise the total cashflow in Figure 15.

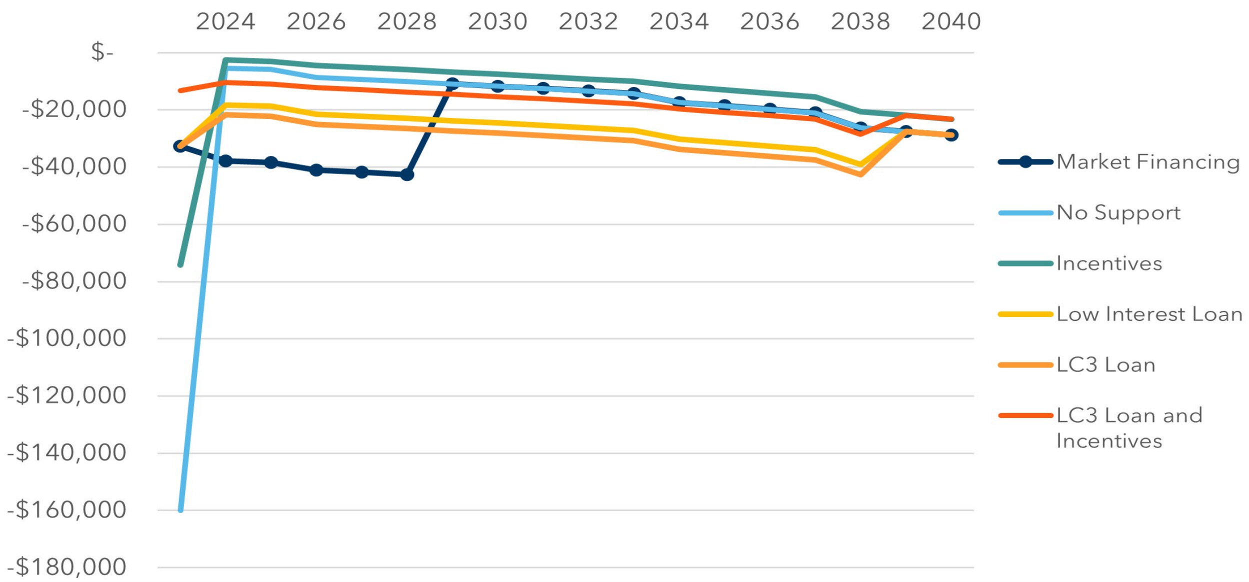

Figure 15: Net annual cost for building owner or condo board of 100% Level 2 EV Ready Retrofit. Interpretive note: where lines converge, they continue into future years with the same cashflow.

Table 17: Distribution of costs under different scenarios, 100% Level 2 EV Ready Retrofit

	Costs per building Year 1 Cash Investment - Paid by condo / building owner	**Costs per building** Loan Repayment - Paid by condo / building owner	**Costs per stall** EVSE - Typically paid by unit owner in condo; building owner in rental	**Costs per stall** Utility, network fees & other costs - Typically paid by driver
No Support	$155,000	N/A	$2,000 one time on EV adoption	$750 per year
Incentives	$72,000	N/A		
Market Financing	$28,000	$32,400 for 5 years		
LC3 Loan	$28,000	$16,400 for 15 years		
Low Interest Loan	$28,000	$12,900 for 15 years		
LC3 Loan & Incentives	$11,000	$7,800 for 15 years		

As shown in Figure 15 and Table 15, a Level 2 100% EV Ready retrofit requires a significant capital investment in year 1 in the absence of financing options and/or incentives. Loan financing can help buildings that do not have access to cash, a significant proportion of multifamily buildings.

Market financing, modeled as a loan covering 80% of CAPEX at a 10% fixed interest rate with 5-year amortization, alleviates some of the initial financial burden of the EV Ready retrofit. However, the relatively high interest rate and short amortization period results in significant ongoing annual loan repayments of more than $30,000 per year through 2028.

Similar to market financing, an LC3 loan covering 80% of CAPEX at a 10% fixed interest rate with a longer, 15-year amortization period reduces the initial capital investment required for an EV ready retrofit. The longer amortization results in lower annual loan repayment costs compared to the market financing option, thereby easing cash flow concerns. However, the cost paid in interest over the loan's lifetime is higher due to the longer repayment period.

A low interest loan, modeled as a loan covering 80% of CAPEX at a 6% fixed interest rate and 15-year amortization, offers a lower interest burden and long-term repayment schedule. This option is the most favorable in terms of monthly cash flow and total interest paid over the life of the loan, contributing to the financial viability of the EV ready retrofit. Options to achieve below market interest rates are explored in section 3.1.1.

Combining a loan with incentives provides both initial capital relief and reduced total capital expense, resulting in the most economically viable scenario for the building owner or condo board.

5.4.3 Phased Approach with Comprehensive Planning

The results shared in this section are based on a comprehensively planned, phased implementation Level 2 EV Ready retrofit in a **400-unit multifamily building** with structural parking, where exchanging parking spaces can occur (more likely in rental housing). Phased implementation of EV Ready retrofits may be possible in larger buildings, where swapping of parking is viable (See Section 2.4.2.1). Where possible, a phased approach can improve the business case of an EV ready retrofit by deferring some of the costs to future years.

The scenario depicted in Figure 16 assumes that each phase of the EV ready installation occurs when each additional 16% of building occupants adopt an EV. The analysis assumes a 4% construction cost inflation.

Through 2040, the net present cost of the phased approach EV ready retrofit is $930,000, compared to a net present cost of $1.15 million for the 100% in year one installation, assuming a 7% discount rate. Accordingly, **deferring costs can improve the business case for EV ready retrofits.** However, as noted above, phasing is probably not viable in most condos, and the benefits may be more modest in smaller buildings.

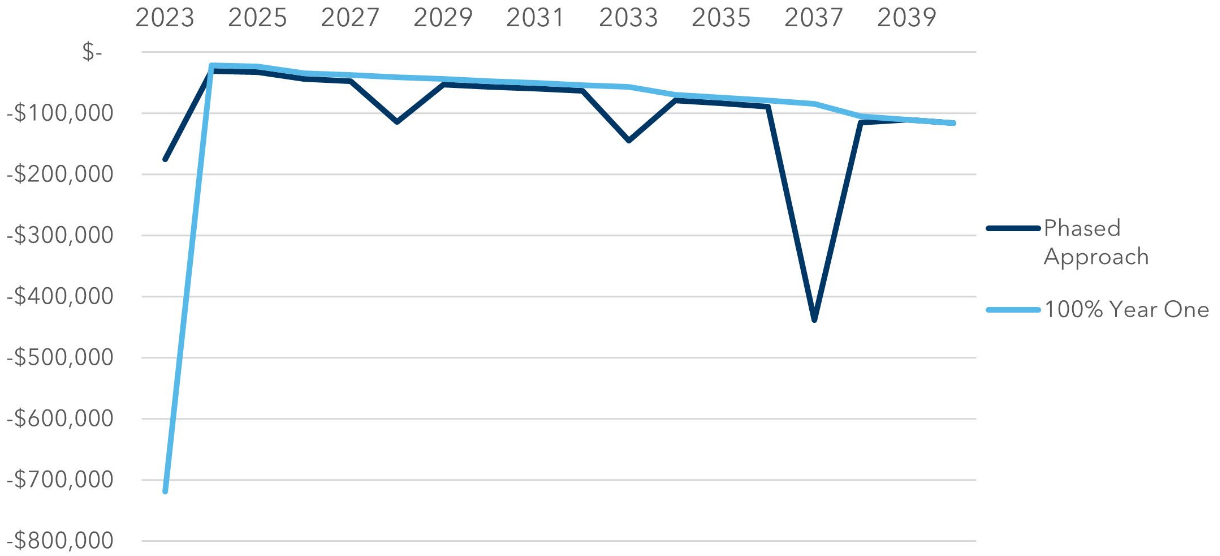

Figure 16: Net annual cost for building owner or condo board of Phased vs. Year One Approach Level 2 EV Ready Retrofit.

5.4.4 Charging-as-a-Service

Another option for EV ready retrofit financing is charging-as-a-service. Figure 17 shows the cash flow of an illustrative CaaS example in a 100-unit building, in which the charging service provider is assumed to pay for all CAPEX and OPEX of the Level 2 100% EV Ready retrofit, and accrues the benefits of all non-driver revenues. Debt financing is assumed to cover 30% of the total capital cost of the project, at 10% interest with a 15-year amortization period. The remaining CAPEX is equity financed, with a targeted 20% return on investment. The analysis determines monthly user fees, which are paid by drivers, that can achieve the targeted return on equity.

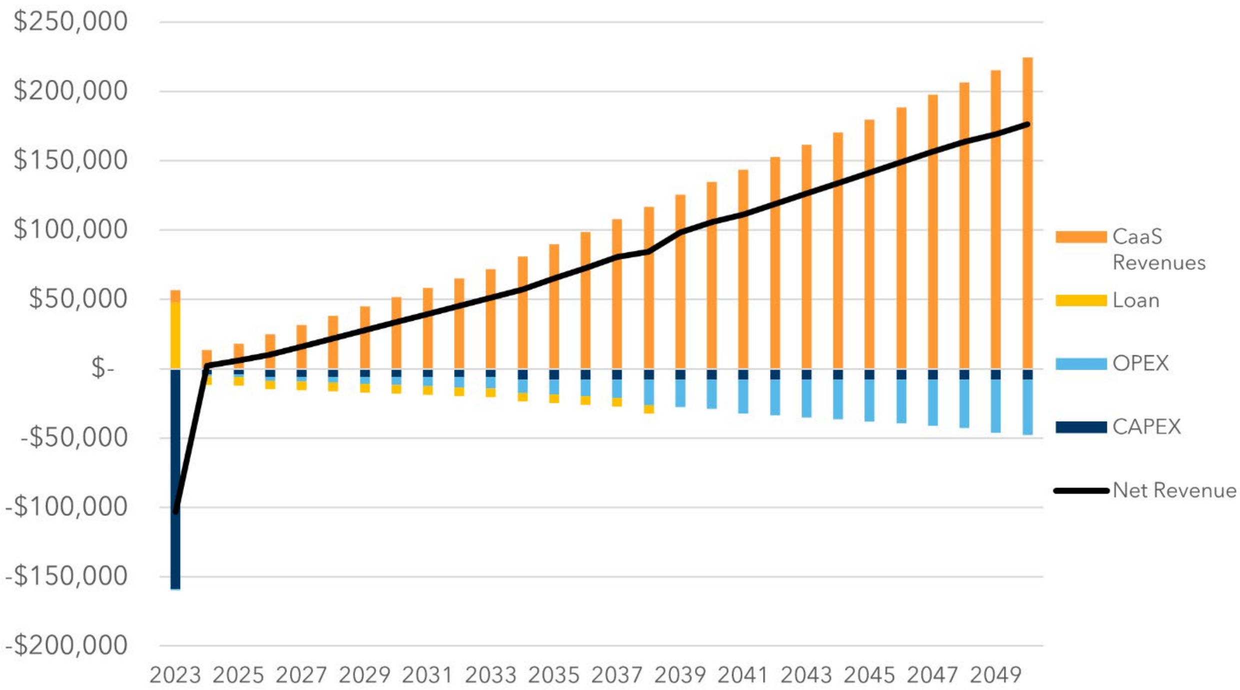

Figure 17: Charging-as-a-Service Cash Flows for Charging Service Provider, 100% Level 2 EV Ready Retrofit

In the scenario shown in Figure 17, there are no financing options (beyond CaaS) or rebates/incentives, and the pace of EV adoption is assumed to be moderate, reaching 60% of drivers by 2040 and 100% by 2050.

To achieve a 20% return on investment over the 2023-2040 period, the monthly user fee that must be charged to each driver is $187, assuming that there are no EVSE or EV Ready incentives, no demand response program, and no revenues from clean fuel credits.

CaaS may also present a viable business model for phased EV ready retrofits, where viable (i.e., in larger buildings where exchanging parking spots is possible). Figure 18 represents an illustrative charging-as-a-service example for a comprehensively planned, phased implementation EV Ready retrofit in a 400-unit building with structural parking.

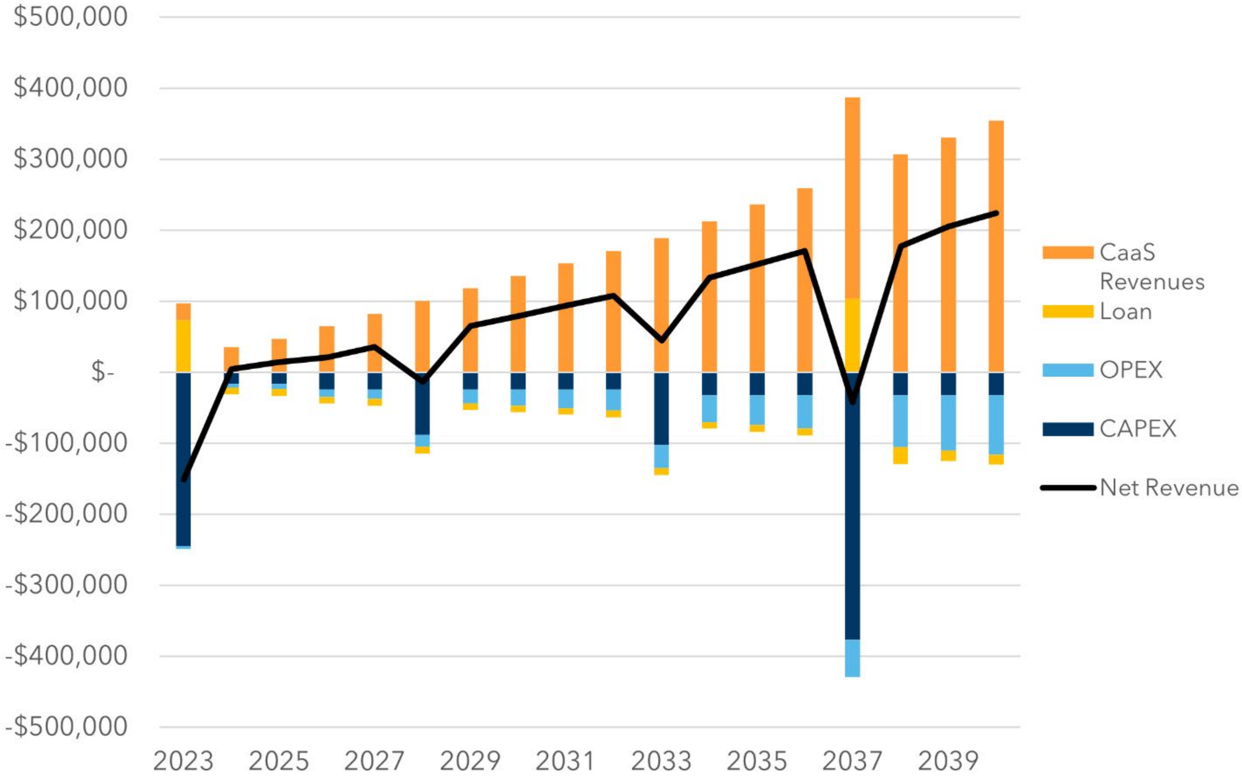

Figure 18: Charging-as-a-Service Cash Flows for Charging Service Provider, Phased Approach Level 2 EV Ready Retrofit

The above example achieves a 20% return on investment with an assumed $123/month for CaaS fees, while assuming that there are no EVSE or EV Ready incentives, no demand response revenues, and no revenues from clean fuel credits.

Monthly charging as a service fees required for the EVCSP to generate a 20% return on investment varies significantly according to several factors. Table 16 below outlines the changes in monthly fees required according to different sets of assumptions.

Table 18: Monthly CaaS fee required to generate 20% ROI under different scenarios, 2023-2040

Scenario	Description	**Monthly fee -** 100-unit building, 100% year one	**Monthly fee -** 400-unit building, phased
Baseline	No incentives, moderate pace EV adoption, high TOU cost savings	$187	$123
High EV Adoption	EV adoption in the building reaches 100% by 2040.	$130	$104
Low EV Adoption	EV adoption in the building reaches 30% by 2040.	$388	$192
EV Ready Rebate	CaaS provider receives EV Ready rebate of $800 per parking stall	$130	$107
Clean Fuel Credits	CaaS provider accrues revenues from clean fuel credits	$115	$51
High Adoption, EV Ready Rebate & Credits	EV adoption in the building reaches 100% by 2040; CaaS provider receives EV Ready rebate of $800 per parking stall plus revenues from clean fuel credits.	$25	$17

As illustrated in Table 18, **the viability of CaaS as a business model for comprehensive EV ready retrofits in multifamily buildings varies significantly based on several factors**. Overall, the results of the business case analysis indicate that CaaS may be most viable where phasing can be achieved (or where designs are never intended to provide access to home charging for all residents).

It should be noted that costs of around $123 to $187 per month may be too high to avoid attrition of drivers to rely on public chargers. Very roughly, public charging in Canadian urban areas costs approximately $0.25/kWh to $0.50/kWh.[29] Assuming the same annual average distance driven as modeled for this analysis, this equates to monthly costs of approximately $53 to $106 per month. Driver attrition will reduce return on investment, or necessitate higher monthly fees, which of course may cause additional attrition.

Given these dynamics, in the absence of incentives and other revenue streams, **it may not always be possible to cost-effectively implement CaaS while designing projects for comprehensive futureproofing** (for example, by being 100% EV Ready). CaaS could be used in appropriate in circumstances where a portion of a parking area can cost-effectively feature EV charging infrastructure, provided that parking spaces can be exchanged to allow any household that adopts an EV to have access to that parking; this would serve the first generation of adopters, but again may not be able to cost-effectively support all residents to ultimately have access to EV charging.

[29] In Dunsky's opinion, these costs will probably increase above the rate of inflation in the future. This is due to a variety of factors including prime public charging locations being exhausted, changes in incentive regimes, propensity towards faster charging, and other factors. However, EV drivers in the next few years to decade *will* have recourse to public charging at closer to current costs. If at home charging via CaaS is too costly, drivers could forgo it for public charging. This would significantly impact CaaS's business case.

Under the best case scenario presented in Table 18, CaaS fees could be as low as $17 to $25 even with comprehensive EV Ready futureproofing. In contrast, the most challenging scenario—low EV adoption with no incentives—requires a monthly fee of $388 for a 100-unit building and $192 for a 400-unit building to achieve the same return on investment. The **cost sensitivities to EV adoption rates and available incentives highlight the critical importance of these factors in making the CaaS model financially viable when implementing comprehensive futureproofing**.

The results presented in Table 19 also indicate that EV Ready rebates could mitigate some of the financial risks associated with the CaaS business model, particularly in the case of moderate or slow EV adoption. By providing an upfront financial incentive, these rebates lower the initial capital expenditure required to set up the charging infrastructure, thereby reducing the monthly fees needed to achieve a target return on investment, making the service more affordable for residents and potentially accelerating the adoption of EV charging services within the building.

5.4.5 Sensitivity Analysis

To assess which variables have the most significant impact on the business case for EV ready retrofits in multifamily buildings, we modeled a baseline scenario assuming no policy support (no rebates, incentives, or clean fuel credits) nor financing is available. Additional baseline scenario assumptions are highlighted in Table 19 (shaded in grey).

Table 19 summarizes the impacts of different model assumptions over the short (year 1 net revenues), medium (NPV through 2030), and long term (NPV to 2050). For the first year, impacts were categorized as low if less than $5,000, medium if between $5,000 and $20,000, and high if greater than $20,000. In the medium term, impacts were considered low if the total change in net present value was less than $50,000, medium if between $50,000 and $100,000, and high if exceeding $100,000. Long term, impacts were deemed significant (high) if greater than $500,000, and less significant (low impact) if less than $100,000.

Table 19: Impacts of Key Variables on Net Present Value of Level 2 EV Ready Retrofit

Colour Coding:

Grey cells = Baseline	**White cells = Sensitivity**

Variable	Sensitivity	Year 1 Net Revenue	NPV 2023-2030	NPV 2023-2050	Impact - Year 1	Impact - Medium Term	Impact - Long Term
Clean Fuel Credits	Without	-$161K	-$216K	-$487K	Medium	**High**	Medium
	With	-$153K	-$112K	-$356K			
Utility Extension	Not Required	-$161K	-$216K	-$487K	**High**	**High**	Medium
	Required	-$277K	-$324K	-$595K			
EVSE Rebates	None	-$161K	-$216K	-$487K	Low	Low	Low
	Med	-160K	-$206K	-$460K			
	High	-$158K	-$195K	-$433K			
EV Ready Rebate	No	-$161K	-$216K	-$487K	**High**	Medium	Low
	Yes	-$78K	-$139K	-$410K			
Loans	None	-$161K	-$216K	-$487K	**High**	Medium	Low
	Low Interest	-$34K	-$162K	-$478K			
	LC3	-$34K	-$180K	-$508K			
	Market	-$34K	-$222K	-$493K			
Time-of-Use Cost Savings	High	-$161K	-$210K	-$450K	None	Low	Low
	Med	-$161K	-$216K	-$487K			
	None	-$161K	-$222K	-$524K			
Gasoline Savings	No	-$161K	-$216K	-$487K	Medium	**High**	**High**
	Yes	-$151K	-$25K	$578K			
EV Adoption Rate	Low	-$158K	-$171K	-$312K	Medium	**High**	**High**
	Med	-$161K	-$216K	-$487K			
	High	-$164K	-$275K	-$665K			
Charging Network User Fees	Cost	-$161K	-$216K	-$487K	Low	Low	Medium
	No Cost	-$160K	-$198K	-$387K			
Demand Response Program	None	-$161K	-$216K	-$487K	None	Low	Low
	Yes	-$161K	-$207K	-$422K			

Based on the results of the sensitivity analysis, one of the most important factors impacting the business case for EV Ready Retrofits in the short term is whether a utility extension is required. **The necessity of an electrical capacity upgrade can significantly impact the business case for an EV ready retrofit in a multifamily building**. An upgrade to the existing electrical system may be required to accommodate the increased load from EV charging stations, and this can be a costly and complex undertaking. These upfront costs may deter building owners from pursuing EV-ready retrofits. Additionally, in some cases it can take up to several years for a building to receive a requested utility service upgrade.

Another important factor impacting the business case in the short term is the **availability of EV ready rebates** aimed at supporting the installation of the electrical infrastructure required for EV charging. In the short term, EV ready rebates can play a crucial role in bridging the gap between the high upfront costs and the longer-term benefits of EV ready retrofits.

In the medium term, Clean Fuel credits can significantly improve the business case of EV ready retrofits. As policies and markets for low carbon fuels evolve and mature towards 2030, this mechanism could become an increasingly significant factor in the financial viability of EV ready retrofits, making them more attractive to property owners and investors. However, there is significant uncertainty regarding the long-term future credit values for the BC and federal clean fuel credit programs. Our model assumes that LCFS and federal Clean Fuel Regulations (CFR) credits will diminish in value over time.

In the medium and long term, the pace of EV adoption has a substantial impact on the net financial benefits and costs conferred by EV futureproofing retrofits, with **faster EV adoption significantly enhancing the economic case for such works**. In the sensitivity analysis presented in Table 19, increased EV adoption rate translates to increased costs and a lower NPV, resulting from increased capital costs for the purchase of EVSE along with increased operating costs for electricity required to charge EVs in the building. However, the **baseline sensitivity scenario does not account for any potential revenues of EV ready retrofits**, which could include demand response revenues, gasoline savings, low carbon fuel credits, and charging-as-a-service revenues. Accordingly, in a scenario where potential revenues are accounted for, **faster rates of EV adoption tends to improve the business case of EV Ready retrofits**, whether through demand response revenues, low carbon fuel credits, or fuel and maintenance savings associated with EVs. Indeed, the most significant consideration when evaluating the economics of EV ready retrofits is **whether the gasoline and maintenance savings are attributed to the project** and/or included in the NPV and cash flow calculations. Most fundamentally, the more people that have an EV, or anticipate acquiring an EV for their next vehicle, the more people will demand EV charging.

5.4.6 Other Considerations

The *pro forma* model developed for this project accounts for the costs of providing EV charging infrastructure, as well as various potential revenue streams including: Electricity demand response payments; the potential sale of carbon credits through low carbon fuel requirements; and gasoline savings, which are treated as a source of net revenue from EV driving households' perspectives.

There are several potential value streams that this analysis did not attempt to quantify:

- **Increasing resale and rental values.** EV charging infrastructure can positively impact both rentability and resale value, potentially enhancing the business case for retrofits. As EV adoption grows, prospective tenants and buyers may increasingly seek properties with convenient charging infrastructure, making buildings with EV futureproofing more attractive in the rental and sales markets. Eventually, EV charging infrastructure may be considered as an essential feature by many households. This added appeal can translate into higher rental rates and resale prices, offering a financial incentive for property owners to invest in the retrofit. Indeed, stakeholders from the condominium sector interviewed for this study cited the promise of increased property value as one of the key reasons they were able to garner support for a large-scale EV ready retrofit in a condo building. Unfortunately, we are not aware of any publicly available data on the average premiums fetched for units with EV Ready parking or access to EV charging; further study could be warranted, though given the nascent state of the market and many other variables that have much greater impact on housing costs, we suspect definitive conclusions would be challenging to achieve.

- **Vehicle-to-Grid (V2G) and Vehicle-to-Building (V2B).** As noted in Section 2.2.4, V2G involves a discharge of a vehicles' battery to export to the electric grid; it provides opportunities for energy arbitrage, and a range of grid services (e.g. capacity; frequency regulation; and other ancillary services). V2B uses an EV to provide supplementary power to a building; it can save customers money by reducing consumption during times when power is more expensive under dynamic utility rates, and/or to provide backup power during blackouts.

  Despite the potential benefits of V2G and V2B, implementing such systems will result in considerable cost premiums compared to the EV futureproofing configurations profiled in this report. There is considerable uncertainty regarding the most appropriate design strategies in a multifamily context. Moreover, potential savings and revenue from V2G are heavily dependent on regulatory frameworks, energy market dynamics, and the availability of EVs equipped with V2G capability within the building. Additionally, concerns about potential impacts on the battery lifespan and warranty issues for the EVs involved might further complicate the decision to incorporate V2G into an EV ready retrofit. Finally, there are a wide range of factors and value judgements inherent in ascribing a value to V2B in multifamily buildings. Given the limited state of development of V2G and V2B strategies in multifamily buildings, it was not considered in this analysis.
- **Reduced GHG emissions and air pollution.** Facilitating the use of electric vehicles helps reduce GHG emissions and dependence on fossil fuels, contributing to broader climate goals. Health benefits are also significant, as increased use of electric vehicles leads to improved air quality by reducing air pollutants associated with gasoline and diesel combustion, lowering respiratory issues and other health problems within the community. These costs could be accounted for by assigning a social cost of GHG and air contaminant pollution, over and above the price paid for low carbon fuel credits. Of course, these avoided costs benefit society as a whole, with a vanishingly small proportion of those benefits accruing to the building owners or residents.
- **Complementing other projects that repurpose parking in multifamily buildings.** Parking in multifamily buildings can be underutilized. Furthermore, building residents' demand for parking will hopefully diminish in the future, as household shift away from personal vehicle ownership towards more sustainable transportation modes. Underutilized parking could be repurposed in a variety of ways to provide greater value. For example:[30]
  - Parkades could be made accessible to community members outside of the building, allowing building or unit owners to rent out parking to other drivers, car-share, micro-mobility docking stations, etc.
  - Parking could be repurposed for storage; perhaps containerized commercial applications (e.g. data centres; hydroponic agriculture; etc.); or other non-vehicular uses.

  Electrical futureproofing can complement many such ways of changing parking use, particularly if the ultimate application is considered at the outset of the project. While a detailed analysis of how such opportunities could be implemented is beyond the scope of this report, it is worth

[30] It is worth noting that there are a range of barriers to repurposing parking, including municipal regulations; the organization of parking tenure in condominiums; and the challenges of facilitating public access to buildings' parkades in a safe and secure manner.

noting that providing a source of electricity to the parking space for car-share EV charging, or potentially other electrical loads, could realize benefits.

The *pro forma* model Dunsky developed could be augmented to account for these value streams. However, as noted in the description of these benefits, there is limited data on the appropriate dollar value to assign; and/or the value does not accrue only to the building owner or residents, but rather society as a whole. Thus, they were not included.

6. Recommended Actions

This section of the report provides recommendations for the GMF, LC3, and their partners and collaborators to accelerate access to EV charging at home for the increasing share of Canadians who live in multifamily housing.

Based on the research and findings detailed in the preceding sections, we have selected strategies that:

- Maximize **emissions reductions** by maximizing access to home charging.
- Support the **equitable** distribution of benefits stemming from EV charging infrastructure.
- Are compatible with **whole building electrification.**
- Align with tools at GMF and LC3's disposal: **Funding programs, impact investment, policy advocacy, and stakeholder/public education**.

Table 20 includes recommended actions.

6.1 Action Plan

Table 20: Recommended Actions

Action	Who?	Applies to	Considerations
1.0 Policy & Regulation			
1.1 Update the model **National Energy Code for Buildings** (NECB) and the **National Building Code** (NBC) to require EV Ready new construction.	Federal govt. P/Ts	New buildings	Several Canadian cities, including the Cities of Vancouver and Toronto, have adopted EV Ready requirements for new construction that represent the global best practice. These jurisdictions require that 100% of residential parking in new construction, and 20%-50% of non-residential parking, be EV Ready. EV Ready new construction avoids the challenges of futureproofing existing buildings. The NECB and the NBC are model codes on which provincial and municipal codes are based. The Canadian Commission on Building and Fire Codes (CCBFC), established by the National Research Council of Canada, develops the NECB, NBC and other Codes Canada publications. The CCBFC receives policy guidance from the Provincial/Territorial Policy Advisory Committee on Codes, which is made up of representatives from the provinces and territories. The NECB and NBC should be updated with requirements reflecting the best practices already adopted by leading Canadian cities. Advocates for these updates should engage both federal and provincial code authorities, including the CCBFC.
1.2 Adopt best practice EV Ready requirements for new construction.	P/Ts Munis.	New buildings	Provinces should adopt best practice requirements that 100% of residential parking in new construction, and 20%-50% of non-residential parking, be EV Ready. Such requirements could be made in building codes and/or other regulations. If provinces are unwilling to adopt provincial requirements that reflect best practice, they should clarify local governments' authority to do so, amending relevant legislation and regulations if required.
1.3 Adopt "Right to Charge 2.0".	P/Ts	Existing buildings, especially condos	As noted in Section 4.1.1, "Right to Charge 2.0" make it easier for condominiums and other multifamily buildings to assess and implement comprehensive futureproofing. These laws: • Require condominiums and rental owners to undertake electrical planning for EV charging and buildings systems electrification. • Simplify approval processes for feasibility studies. • Reduce voting thresholds (e.g. to 50%) to approve capital investments in comprehensive EV futureproofing. • Specify that comprehensive futureproofing can be funded from condo reserve funds. Provinces should adopt "Right to Charge 2.0" laws.

Action	Who?	Applies to	Considerations
1.4 Update utility regulation, rates and programs to support widespread deployment of EV charging, and broader beneficial electrification.	P/Ts Utility regulators Utilities	All	Implementing EV charging infrastructure in cost effective ways is one example of the broader trend towards electrification of energy uses that previously used fossil fuels. "Beneficial electrification" involves electrification strategies that 1) provide consumer and ratepayer value; 2) enable better grid management; and 3) reduce negative environmental impacts.[31] Provinces, utilities and their regulators should seek to update their policies and regulatory constructs to support beneficial electrification. Key opportunities relating to EV charging in multifamily buildings include: • Updating utility tariffs to make utility service upgrades costs more affordable and predictable. • Updating utility rates to best encourage multifamily buildings to implement EV charging strategies that result in the lowest system costs. Special EV charging rates, demand charges, and dynamic pricing systems should all be carefully considered. This includes comparing rate designs' ability to realize low-cost power demand profiles and incent demand response; fairness; and other benefits and attributes. • Establishing transparent, expedient, low/no-cost processes for buildings to access historic electric utility load data. Such data is a critical element of feasibility studies for comprehensive EV futureproofing, and other electrification initiatives. Processes should provide buildings' historic peak demand loads, including aggregating and anonymizing residential units' meters as well as loads serving common spaces. • Introduce utility programs that support comprehensive EV futureproofing. Provide incentives for feasibility studies and subsequent electrical renovations (see Action 2.1 below). • Enable and direct utilities to implement Make-Ready investments in EV charging infrastructure, as described in Section 3.1.2 (above) and Action 3.4 (below).
1.5 Explore legislation, and/or template condo bylaws and associated processes, to enable legally exchanging parking spaces in condos and thereby enable phased retrofits, and to lower approval voting thresholds for futureproofing projects.	P/Ts Federal govt. DFIs Non-profits	Condos	As discussed in Section 2.4, while phased approaches to comprehensive futureproofing can defer some capital expenses, implementing such phasing is dependent on residents being able to exchange parking spaces. However, in most condos, current parking tenure (e.g. Limited Common Property designation; long-term leases; etc.) make exchanging parking spaces utterly impractical. Provincial legislation should be explored to compel parking tenure to be changed to enable exchanging parking as part of phased retrofits. Likewise, there could be value in developing template condo bylaws, resolutions and associated processes to update parking tenure to enable compulsory exchange of parking spaces; once templates are available, condos could be assisted in adopting them. Dunsky is not convinced that either of these options present a viable pathway to enable phased retrofitting of condos. However, given the potential for considerable value to be created by enabling phasing of comprehensive futureproofing retrofits, such mechanisms should nevertheless be carefully explored.

[31] For a primer on regulating utilities in the public interest for beneficial electrification, see The Regulatory Assistance Project's *Beneficial Electrification*. https://www.raponline.org/be/

Action	Who?	Applies to	Considerations
2.0 Incentive Programs			
2.1 Offer incentives (rebates) for comprehensive EV futureproofing retrofit planning studies and infrastructure upgrades. In aggregate, we recommend incentives total approximately $3 billion by 2030.	Federal govt. P/Ts Utilities	Existing buildings	As discussed in Sections 3.1 and 5, monetary incentives are key to driving demand for comprehensive EV futureproofing of multifamily buildings. Without incentives, comprehensive futureproofing is unlikely to occur at appropriate scale because of: • **Information barriers.** Condo and rental building owners do not have a good understanding of their options. Many electrical engineers and contractors likewise do not yet have a strong understanding of the design strategies to cost effectively futureproof parking. • **Process barriers, principal-agent problems and transaction costs**. Condo decision-making processes are convoluted, making it difficult for complicated retrofit projects to be developed and approved; electrical professionals are often reticent to serve condos for this reason. Condo owners often are not confident future buyers will recognize the value of EV charging. Landlords are often not be responsive to tenants' demands for charging. Moreover, there are significant financial costs to not implementing carefully designed EV futureproofing – Notably the risk of stranded assets from piecemeal additions of EV charging that do not consider capacity for future expansion. Accordingly, **significant incentives are appropriate.** Multiple levels of government and utilities should support EV futureproofing: • The **Federal government** should update the Zero-Emission Vehicle Infrastructure Program (ZEVIP) to include incentives for EV futureproofing plans and subsequent comprehensive (100%) upgrades. It should also offer a refundable tax credit for such works. • **Provincial governments** and/or **utilities** demand side management programs should also offer incentives for EV futureproofing plans and subsequent comprehensive upgrades. Incentives should support EV Ready, EV Capable, and Level 1 infrastructure. While the authors believe that Level 2 EV Ready parking (with judicious use of load management) represents the most sensible futureproofing configuration in most buildings, flexibility should be allowed to let condos and building owners choose the approach they believe offers the most value to their building. Accordingly, we recommend incentive programs offer: • $3000 to $10k+ for feasibility assessments / "EV Ready Plans". Consider scaling incentives to building size, and offering significantly more funds if buildings consider electrical futureproofing for electrification of other building systems (e.g. space heating, hot water, ventilation; etc.). • $800 per Level 2 EV Ready parking space. • $600 per Level 2 EV Capable space.

Action	Who?	Applies to	Considerations
			• $500 per Level 1 parking space. Incentives should only be provided if at least one parking space per residential unit (or all parking, whichever is less) is futureproofed, or if a plan for phasing retrofits is adequately demonstrated (criteria for evaluating the adequacy of such phasing will need to be carefully considered from both an engineering and legal/governance perspective). Incentive programs should provide the same support per parking space in large and small buildings; there should be no funding limit on the number of parking spaces that can be futureproofed. To **futureproof 4 million multifamily parking** spaces across the country at an average incentive of $750 each would equate to **$3 billion in total incentives,** covering about half the total initial capital investment in EV futureproofing retrofits; EV drivers would assume most of the total cost of the EV charging infrastructure over its lifetime. The Federal government committing to $1 billion to this effort over 2024-28, and an additional $1 billion from 2029-30, would be a strong step in the right direction. Likewise, provinces, utilities and local governments could provide incentive funds.
2.2 Offer supports specifically tailored to low- or moderate-income (LMI) rental buildings and non-market housing	Federal govt. P/Ts Utilities DFIs	Rental Existing	As noted in Section 4.2, policy-makers and program administrators should provide special support EV futureproofing in LMI rental housing and non-market housing, including: • Additional incentives for priority areas. Because it is too logistically difficult to get income/wealth data from all residents, priority areas should be designated – The City of Toronto's Neighbourhood Improvement Area Profiles represent a useful precedent for how programs can identify priority areas for additional funding.[32] Include clauses in funding agreements that restrict rent increases, evictions and exorbitant user fees. • Consideration of Charging as a Service and utility make-ready programs specifically for these sectors.
3.0 Financing Programs			
3.1 Introduce loan financing products to support comprehensive EV futureproofing	Development finance institutions (DFIs - e.g., CIB, GMF, LC3s, credit unions,	Condos	Condos and rental building owners often do not have significant cash reserves. Accordingly, they often have high hurdle rates. Condos are usually hesitant to implement one-time special assessment for non-emergency projects. Loan financing can be used to overcome condo and building owners' limited access to cash. Currently, there are few commercial lenders serving the EV charging infrastructure space, and none offering loans dedicated to comprehensive EV retrofit futureproofing. Those commercial lenders that will lend to condos for EV

[32] City of Toronto. Neighbourhood Improvement Area Profiles. https://www.toronto.ca/city-government/data-research-maps/neighbourhoods-communities/neighbourhood-profiles/nia-profiles/

Action	Who?	Applies to	Considerations
	and other public interest lenders)		charging infrastructure will often do so for relatively short amortization periods (e.g. maximum five years), and may allow a variety of technical approaches including those that present risks of stranded assets. Accordingly, DFIs could play an important role in loan financing of EV futureproofing projects. It is recommended DFIs develop loan financing products, and that they consider: • Offering longer amortization periods (e.g. 10-15 years). • Offering floating interest rates (i.e. a set premium above the prime rate), ideally with caps on the high end. • Assuming the risk of low utilization in early years (e.g. by integrating clauses to defer payments if utilization of the infrastructure does not occur according to certain schedules, or if EV adoption in a Metro area is below a certain rate). • Opportunities to aggregate projects to access low-cost pools of capital, particularly the Canada Infrastructure Bank's Building Retrofits Initiative (see Action 3.2 below). LC3s could pilot such approaches. Likewise, GMF could potentially capitalize a fund allowing local governments to offer loan programs to multifamily buildings, analogous to GMF's Community Efficiency Financing initiative.
3.2 Engage with **the Canada Infrastructure Bank** and consider aggregating EV futureproofing projects as part of the **Building Retrofits Initiative**	Federal govt., DFIs	All	As noted in Section 3.1.1.4, the Canada Infrastructure Bank's (CIB) Building Retrofits Initiative provides financing for energy retrofits projects at below market interest rates and flexible terms. The CIB funds large initiatives, far exceeding even EV futureproofing projects in even the largest multifamily buildings. DFIs and/or EV futureproofing service providers (e.g. engineering firms, contractors, charging service providers, etc.), potentially in partnership, could aggregate loans for multiple buildings. It is recommended the Federal government and interested DFIs engage with CIB regarding the potential for such a structure.
3.3 Explore financing projects to be repaid against future Clean Fuel credit revenues in jurisdictions with high credit values	DFIs Federal govt. P/Ts	All buildings	As noted in Section 2.6.3, the federal Clean Fuel Regulation and provincial low carbon fuel requirements can realize revenues to multifamily buildings where charging is occurring. These credits could be quite lucrative in certain circumstances – in BC, credits are currently trading at $450 per tonne CO_2e. At such a price, this could equate to $1000+ in revenue per EV *each year*. Entities could pay for (some portion of) the cost of EV futureproofing, in exchange for rights to these future revenues. Governments and DFIs may be particularly suited to finance in this manner because they operate for a public purpose; can better manage the risk of credit markets being eliminated or volatile prices; could potentially more readily achieve sufficient scale to sell to off-takers; and because they may be perceived as more trustworthy than conventional lenders offering such unusual financing arrangements.

Action	Who?	Applies to	Considerations
3.4 Pilot Charging-as-a-Service, and quickly scale up if programs are deemed effective	DFIs Utilities Federal govt. P/Ts Munis Charging service providers	Some rental Potentially, some condos	Development finance institutions, utilities, and government agencies may be well positioned to partner with charging service providers to offer CaaS in ways that best serve buildings' interests, as well as the interests of the broader public. Notably, public purpose entities may be more concerned with ensuring the preservation of electrical capacity for all future generations of EV drivers, as well as for electrification of other building systems. Likewise, they may be more willing to ensure reasonable, but not usurious, rates of return, providing the best deal for multifamily building occupants. CaaS providers may value such partnership as an opportunity to access lower cost capital, higher leverage, and association with trusted institutions. There is considerable financial risk associated with CaaS, as well reputational risk. Consider the opportunity to secure revenues beyond driver fees, including demand response and access to clean fuel credits. CaaS is probably most desirable in buildings where parking can be readily exchanged between residents, encompassing many rentals but few condos.
3.5 Pilot "Make Ready" utility investment in EV charging infrastructure, and quickly scale up programs if deemed cost effective.	Utilities Utility Regulators	All buildings	As described in Section 3.1.2, utilities should design and pilot Make Ready programs. Programs offering both "Utility-Side" and "Customer-Side" Make Ready should be considered, including evaluation of the costs of providing both these forms of infrastructure. Program design and evaluation should especially consider whether using "Utility-Side" Make-Ready (i.e. typically a new electrical service) can be valuable to broader building electrification by saving limited electrical capacity for electrification of other building end uses (e.g. space heat, hot water, etc.). "Customer-Side" programs should be structured to encourage design strategies that minimize life-cycle costs while providing adequate charging performance (e.g. encourage load-sharing using EVEMS; comprehensive future-proofing; etc.).
4.0 Capacity building, standards & bulk procurement			
4.1 Provide education and training related to comprehensive EV ready retrofits for condominium boards and rental building owners to understand the value proposition	Federal govt. P/Ts Munis. Utilities Non-profits		Key actors should fund, coordinate and provide education and training for building owners and condo corporations on comprehensive EV ready retrofits, including on the importance of comprehensive planning (i.e., outlining risks associated with incremental, unplanned installation). Such training could be provided via a free or subsidized advisory service based on buildings' unique circumstances, point them to available resources, incentives, lawyers, and electricians. At a minimum, a government webpage outlining steps and considerations for EV ready retrofits would help to increase awareness of the importance of comprehensive EV ready retrofits in multifamily buildings and dispel some common myths.

Action	Who?	Applies to	Considerations
4.2 Consider developing a standard specification for networked EV charging services, and an impartial means of testing and certifying service providers against the standard	Federal govt. P/Ts Utilities DFIs Non-profits		A "gold standard" specification could provide multifamily building owners and other stakeholders with better insight into what services offer good value, without needing to build extensive expertise in charging services independently. Many multifamily buildings, particularly condominiums, are in an information asymmetry with EV charging service providers. Public purpose entities can help define the conditions of service that will realize the most value. Considerations include (but are not limited to): - Use of open protocols (e.g., OCPP certification) - Reasonable price for user fees - EVSE price - Reliability & servicing capacity - Utility demand response capability - Clean fuel credit valorization Specifications should be developed in close coordination with industry. Care will be required to ensure appropriate criteria, that evolves with technology, is attainable for market actors (including new entrants), and truly unbiased administration of the specification. The standard can also form the basis of training to increase the knowledge of tradespeople related to EV ready and load sharing designs.
4.3 Develop specifications and guidance for wholistic electrification planning studies and futureproofing practices	Federal govt. P/Ts Utilities Non-profits & DFIs	All existing buildings	The market for comprehensive EV futureproofing is in its infancy. There is a great divergence in professionals' and contractors' understanding of technologies, design strategies, and governance and decision-making processes to implement EV futureproofing retrofits. There are many ways that projects can be implemented improperly, and mistakes are possible. Accordingly, to support incentive and financing programs, it is important that acceptable project practices be more standardized. Training to these standards should subsequently occur. This specification will encompass the electrical and mechanical feasibility study components to wholistically assess a building's capacity to futureproof parking for EV charging, as well as electrify other building systems (space heat, hot water, etc.). The scope should include assessment of spare capacity; determining EV charging performance requirements; developing conceptual designs for EV charging; conceptual design options for efficiently electrifying space heat, hot water, cooking, and other end uses; potentially, conceptual designs for solar; associated cost estimates sufficient for budgeting purposes; and the appropriate phasing of building upgrades, reflecting their unique capital assets. The specification should be accompanied by detailed training for electrical engineers, contractors, and associated consultants.

Action	Who?	Applies to	Considerations
4.4 Explore bulk procurement of EV charging services for buildings	Federal govt. P/Ts DFIs	All buildings	There are a range of prices for EV chargers and associated EV charging services (e.g. customer billing; etc.) that are appropriate to multifamily buildings. For example, some EV chargers that could be used in these applications currently retail for $500; however, many used by charging service providers are closer to $2000+ installed. Likewise, charging services fees are often $15-$25 per month, though some charging service providers offer similar services for $0-$2 per month. It is possible that aggregation and bulk procurement of services meeting the Gold Standard noted above could help drive down prices. Similar bulk procurement initiatives have been used effectively in nascent markets around the world. Governments or well-resourced DFIs might be best equipped to lead such bulk procurement. An appropriate next step would be to commission a detailed evaluation of the potential for such bulk procurement, potentially in concert with scoping the Gold Standard networked charging service noted in Action 4.2 above.

6.2 Communications Framework

A narrative framework for communicating about comprehensive futureproofing to is included in Appendix A.

APPENDICES

Appendix A: Communications Framework

The following key messages should be communicated to building owners, condo associations, property managers and residents.

- **EV charging at home is the most convenient and cost-effective.**
    - Recharging an EV is different than refueling gas vehicles – Most people charge their vehicles like a cell phone (a low-cost top up every night) than a gas vehicle (a trip to a gas station). Charging at home is usually much more convenient than the gas station model or public charging.
    - Charging at home can realize much lower energy costs than public charging. Depending on electricity rates, home charging can cost the equivalent of $0.05 to $0.40 per L of gasoline. Public EV charging tends to be more expensive, though still compares favourably to gasoline and diesel costs.
- **The number of EVs will grow exponentially in coming years.** Based on market forces, and federal and provincial policies, it is likely that by the late 2030s or 2040s (depending on geography) the large majority of vehicles in your parkade will be EVs. It's useful to implement a **comprehensive solution** to EV charging in your building, so you won't need to manage requests for charging every few months.
- **Charging at home requires investments in charging infrastructure**.
    - Different strategies can entail significantly different **costs**.
    - Different strategies can be **overkill, adequate** or **inadequate** to meet peoples charging needs. For example:
        - Your building probably doesn't have enough capacity for dedicated 50A "Level 2" (208V/240V) circuits to each parking space. And it would be very expensive to do so.
        - Level 1 (120V – the same as a wall outlet) "trickle charging" can serve some households adequately. Conversely, households that regularly drive long distances and/or have larger vehicles (SUVs & pickups) will find it inadequate.
        - Level 2 with "load-sharing"/"EV energy management" can usually meet everyone's needs at a much lower cost than Level 2 without load-sharing.
    - Charging stations are often hardwired. It can also be possible to use solutions that entail a receptacle into which you can directly plug the charger that often comes with a car – The best solution will depend on circumstances in your building.
    - Buildings can **futureproof parking**, installing some electrical infrastructure on "Day 1", deferring other costs until people adopt EVs. Common futureproofing strategies include (note, these are not standardized terms):
        - **"EV Ready"** – The parking space features a wired junction box at which an EV charger can be hardwired in the future. EV charger is installed when a household adopts an EV.
        - **"EV Capable"** – The parking space is served by electrical panel space and capacity. The electrical branch circuit and EV charger is installed when households adopt an EV.

- Over the life cycle of your building, it will usually be much more cost-effective to implement comprehensive futureproofing of all parking (or one per residential unit), compared to an unplanned piecemeal approach to EV charging.
    - Unplanned, piecemeal approaches can serve early adopters OK. However, they sometimes result in stranded assets by making inefficient use of buildings' limited electrical capacity.
    - Comprehensive futureproofing will usually be much more cost-effective over the life-cycle of the building.
    - However, comprehensive retrofits are complicated, and will entail a substantial upfront expense. It is important to get it right - Get expert assistance (an experience electrical engineer's involvement in feasibility study and design); consider options carefully; and carefully plan the management and financing of the project.
    - Because it is usually difficult to exchange parking spaces between residents in condos, it is often best to futureproof all parking. Conversely, phased retrofits may be possible in some condos and rental apartments, depending on the tenure of parking spaces.
    - Are the upfront costs too great? Contact your elected officials! Leading jurisdictions (BC and QC) offer programs that support comprehensive EV futureproofing.
- Considering options should be informed by a **careful feasibility study** (i.e. an "EV Ready Plan") performed by an experience professional. At minimum, this should include:
    - An assessment of available electrical capacity.
    - Evaluation of different charging strategies and how performance requirements for residents needs.
    - Schematic design
    - Cost estimates, suitable for budgeting purposes.
- **The most optimal solution will depend** on the unique electrical infrastructure in your building, and the way that parking is organized (e.g. can parking spaces be exchanged between residents? Is parking limited common property; leased; etc.?) **Every building is different.**
- **Several resources exist** to help building owners, condo associations, property managers and residents better understand options and navigate decisions.[33] They include:
    - https://pluginbc.ca/ev-advisor-service/
    - https://electricvehicles.bchydro.com/incentives/charger-rebates
    - https://www.efficiencyns.ca/evcharging/#EVReady
    - https://www.plugndrive.ca/condo-charging/
    - https://www.hydroquebec.com/data/electrification-transport/pdf/electric-vehicle-charging-for-multi-unit-residential-buildings.pdf
    - https://murbly.com/en/

[33] **Note:** Dunsky does not assume responsibility for all the content currently listed in these resources, nor what may be added in the future.

Appendix B: Supporting Information on Technologies, Services & Design Strategies

This Appendix B provides supplemental information to what is presented in Section 2 of this report.

Determining the electrical capacity available for EV charging

The Canadian Electrical Code CSA C22.1 (CE Code) is a standard published by CSA Group. The object of the CE Code is to establish safety standards for the installation and maintenance of electrical equipment. Provinces, and in some cases cities, adopt the CE Code by reference, sometimes with amendments. Electrical safety authorities having jurisdiction (AHJs - e.g., usually provincial agencies or cities) are responsible for interpreting electrical codes and administering compliance systems, such as project permitting and contractor licensing.

When adding new electrical loads like EV charging to an existing building, a qualified person must determine that there is available spare capacity to serve that load, in accordance with the relevant electrical code. For apartments and similar buildings, the load calculation is required to be in conformance with Rule 8-202, and/or as permitted by Rules 8-106(8) – 8-106(11). These rules can be summarized as follows (see the CE Code for precise language):

- Rule 8-202: Designates load allowance values for various components of the electrical system of an apartment (or similar) building.
- Rule 8-106(8): Permits use of metered data in lieu of a load calculation where the most recent 12-month period is available.
- Rule 8-106(9): Permits use of data for similar building types and conditions, termed as demonstrated load. The rule was introduced in the 2015 edition, is rarely used, and is subject to approval from the AHJ.
- Rule 8-106(10): Permits limitation of the calculated demand load for EV charging to the maximum load established by an EV energy management system (EVEMS).
- Rule 8-106(11): Permits the demand load for EV charging to be disregarded, where an EMS with service monitoring capability is used (see section 0).

Many load calculations are performed according to Rule 8-202 alone. However, the load calculation method in Rule 8-202 is inherently conservative and will tend to significantly underestimate how much power is available in a building. Where appropriate metering data is available for an existing building, Rule 8-106(8) is often used instead, as the actual metering history will tend to show a greater amount of power is available; however, metering data is often not available for residential buildings from utilities.[34]

[34] It is pertinent to note that if utilities can consolidate all tenant and common/house metering data for a building, or implement a master meter, it can be useful for those wishing to install EV charging and electrify other loads in existing buildings. Ideally, information would be in the form of peak demand (kW) values for the most recent 12-month period and be available to electrical designers upon request. No specific tenant information would be necessary, thereby avoiding privacy of information issues.

Rules 8-106(10) and 8-106(11) allow for EMS to be used to significantly reduce, or even eliminate, loads associated with EV charging from load calculations.[35] For this reason, use of electric vehicle energy management systems (EVEMS) is often important to comprehensively futureproofing buildings for EV charging without expensive electrical upgrades. EVEMS is explored further in Section 0.

System Architectures for EV Charging Systems

There are two broad system architectures enabled by networked chargers:

- **Internet connected EVSE**. EVSE communicate across some network (e.g., cellular, Wi-Fi, etc.) via a communications gateway to an internet cloud-based CMS.
- **Local Area Network connected EVSE with facility-scale EVEMS**. In this system architecture, the EVEMS application is hosted on a dedicated hardware situated within the building itself. Its purpose is to oversee and control the EV charging loads specifically within the building's parking stalls. Under this model, EVSE communicates with the EVEMS via a Local Area Network (LAN). This LAN can employ diverse network technologies, such as ZigBee, Wi-Fi, Ethernet cable, or power line communications, to facilitate this communication.

Standards and Protocols for EV Charging Communications

This section summarizes the landscape of communications standards and protocols that relate to EV charging. Figure B-1 summarizes several relevant applications protocols and standards (dashed lines) used in managing EV charging in multifamily buildings, and the entities, systems and equipment (black boxes) between which they communicate information. Below, we summarize the entities and systems involved, then summarize protocols and standards.

[35] The CE Code also has some allowances for management of non-EV loads to limit load calculations; however, management of non-EV loads is much less comprehensively enabled in the CE Code. There is an opportunity to update electrical codes to better enable management of equipment other than EV charging as an option to reduce calculated loads.

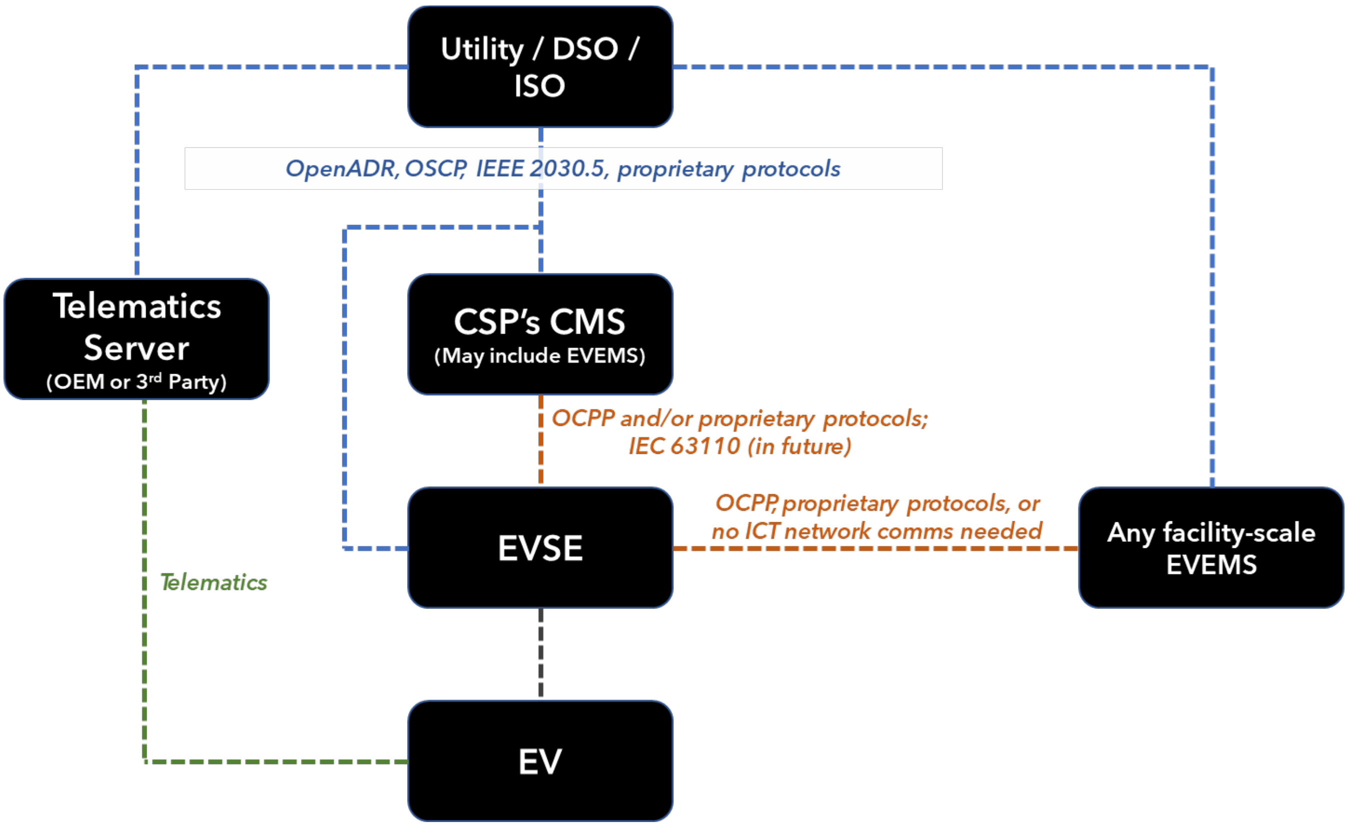

Figure B-1: Relevant application communications protocols and standards for EV charging in multifamily buildings.

The entities and systems reflected in Figure B-1 include:

Distribution System Operators (DSOs – i.e., electrical utilities) and Independent System Operators (ISOs)

DSOs are responsible for managing the electricity distribution system and providing electricity to their final customers. ISOs are organizations which coordinate the operation of the wholesale electrical power system. To provide reliable electricity at affordable costs, DSOs increasingly seek to influence the timing and load profile of EV charging. Likewise, ISOs may enable aggregators of EV demand response resources (and in the future vehicle to grid, V2G, resources) to bid into wholesale capacity and energy markets.

DSOs' influence on EV loads can be done *passively* through dynamic utility rates (e.g., time of use rates) and/or other prices signals. Another way of passively influencing EV loads is through incentive program requirements that encourage electrical system configurations designs that inherently shape facilities' load profiles in advantageous ways – for example, designs using significant load-sharing (see Section 2.3) have inherently less potential for high peak electrical consumption than designs that do not include significant load-sharing.

Additionally, DSOs may establish *active* managed charging initiatives (i.e., "V1G"), sending real-time price signals or directly controlling EV loads at facilities. As noted in Figure B-1 and explored further below, these signals can be communicated through a range of different standards and protocols. Utilities' systems to support active management of various end uses are often called distributed energy resource management systems (DERMS). As EVs make up an increasing proportion of vehicles and EVs become significant loads, it is likely that the opportunity for DSOs to actively manage charging will be increasingly valuable.

Charging Service Providers (CSPs)

CSPs help "site host" (e.g., multifamily buildings) implement and manage EV charging infrastructure at their facilities. CSPs will coordinate with electrical engineers and contractors to design and implement electrical systems that are compatible with CSPs' EV charging systems. For example, they will ensure that designs' electrical configurations and information and communication technology (ICT) equipment are compatible with the EVEMS control strategies used by their hardware and software. CSPs will then **sell EV chargers** to multifamily building occupants or building owners. CSPs will ensure that properly programmed EV chargers (in the case of networked chargers) are installed by electrical contractors.

Many CSPs charge monthly networking fees. These fees pay for services including electricity metering and billing, customer assistance such as remote troubleshooting, etc. Where chargers are installed at assigned parking spaces and/or are owned by individual condominium units, these fees are usually charged to individual residential units (e.g., $10-$20 per month). For rental buildings, workplaces, and public charging, monthly fees are often charged to site hosts and not individual drivers. Likewise, CSPs may structure fees as a percentage of transactions, rather than a flat fee.

There are business models that are not predicated on ongoing fees. Some CSPs with a system architecture consisting of EVSE connecting via a LAN to facility-scale EVEMS will just sell networked chargers, the LAN infrastructure, and the EVEMS to the building on a one-time basis. The software can allow a system administrator to track units' consumption and perform billing for electricity cost reconciliation. VariableGrid is a Canadian firm noted for this approach.

Some CSPs will help **valorize carbon credits** under Low Carbon Fuel Requirements (e.g., Canada's Clean Fuel Regulations; BC's Low Carbon Fuel Requirements; etc.). CSPs may serve as an aggregator and coordinate with brokers on behalf of site hosts to sell credits to entities (e.g., fossil fuel wholesalers) that need to procure credits for compliance. CSPs may agree with site hosts to keep a **percentage of credit revenues**, or they may **reduce prices if they are entitled to these revenues** (who is entitled to these revenues varies under different programs). Likewise, CSPs will coordinate with utilities to access revenues associated with utility demand response programs.

Some CSPs offer **charging as a service** (CaaS) models, whereby they will pay the cost of infrastructure upgrades on behalf of site hosts. They may also assume energy costs. Site hosts and/or drivers must then pay monthly fees, covering the capital and ongoing operating costs associated with the project.

Charging management systems (CMS)

CSPs deliver many of the services noted above via charging management systems (CMS). CMS are enterprise software systems that support information processing and communications between EVSE, EVs, drivers, DSOs and others. Some CMS are proprietary, while others adhere to the Open Charge Point Protocol (OCPP), summarized further below.

EV energy management systems (EVEMS)

The CE Code defines EVEMS as "a means used to control electric vehicle supply equipment loads through the process of connecting, disconnecting, increasing, or reducing electric power to the loads and consisting of any of the following: a monitor(s), communications equipment, a controller(s), a timer(s), and other applicable device(s)." EVEMS can be a component of CSP's CMSs. Alternately, they may operate independently of a CSP's CMS; operating independently of a CMS entails controlling EVSE loads at the scale of a facility, either through communications with EVSE to reduce their loads, or through equipment that monitors electrical conditions at a facility and switches circuits to EVSE on and off accordingly. Further details about EVEMS are provided in Section 2.3.1.

Communications Standards and Protocols

The communications standards and protocols noted in Figure B-1 include:

OpenADR

OpenADR is an open protocol intended to enable interoperable information exchange between DSOs and control systems to facilitate automated demand response. OpenADR provides an open and standardized way for Virtual Top Nodes (e.g., DSOs and ISOs) to communicate with various Virtual End Nodes (e.g., aggregators, EV charging network operators, EVSE, etc.) using a common language over the internet. OpenADR was created to automate and simplify demand response with dynamic price and reliability signals that allow end users to modify their usage patterns. OpenADR provides a consistent way for DSOs to communicate with various entities that aggregate loads or communicate directly to end use equipment. Messaging protocols such as OpenADR can be used in combination with other protocols, such as those used to communicate between a charging station and a network operator (e.g., OCPP; see below). The OpenADR Alliance was formed 2010 by industry stakeholders including electronics OEMs, EV CSPs, utilities and others, to support development and testing of applications enabled by OpenADR.

OSCP

The Open Smart Charging Protocol facilitates communication between a DSO and a CMS or EVSE. It can also be used to communicate between facilities' energy management systems and the CMS. OSCP is administered by the Open Charge Alliance (OCA), an industry stakeholder-based non-profit that administers several open protocols relating to EV charging.

IEEE 2030.5

The IEEE 2030.5 Standard for Smart Energy Profile Application Protocol is a standard to facilitate management of the end user energy environment, including demand response, direct load control, and price communication. Like OpenADR and OSCP, IEEE 2030.5 is a software application protocol that establishes a standardized means of communicating information over the internet.

OCPP

The Open Charge Point Protocol (OCPP) is a free, open-source, vendor-independent protocol developed by OCA. It is an application protocol for communication between EVSE and a CMS. The intent of OCPP is to minimize the risk of networked EV charging infrastructure investments, by allowing interoperability with various EVSE models/manufacturers and different CSPs' CMS. Likewise, it can allow CSPs to be agnostic to the EVSE they support. Many EVSE vendors and CSPs have adopted OCPP.

There are multiple versions of OCPP. OCPP 1.6 is commonly used for many EVSE and systems available today. OCPP 2.0.1 contains more functions; some networks (e.g., ChargePoint) have committed to their EVSE and/or CMS to use OCPP 2.0.1 in the future.

Messaging in OCPP is grouped into several "Profiles". OCPP 1.6 includes the following profiles:

- **Core Profile** includes all the messages required to make use of the basic functionality of the OCPP.

- **Firmware Management Profile** relates to updating the firmware and diagnostics.
- **Local Authorization List Management Profile** includes configurations and features to reduce the message traffic between the CMS and EVSE, and allow the EVSE to operate when its network connection is lost.
- **Reservation** is responsible for reserving a connector on the .
- **Smart Charging** supports control of the power consumption of the EVSE. It can facilitate facility-scale load management using various electrical configurations, as well as utility-scale managed charging and demand response.

The OCA offers a certification program for EVSE and CMS, confirming that the OCPP implementation has been validated on conformance to the OCPP specifications by an approved independent test laboratory. This better ensures that OCPP EVSE and CMSs are interoperable. Table B-2 summarizes available certifications.

Table B-2: OCPP Certifications for EVSE and CMS. Source: OCA.

Functionality	Full Certificate OCPP 1.6 (For EVSE & CMS)	Subset Certificate OCPP 1.6 (For EVSE)
Core	Mandatory	Mandatory
Firmware Management	Mandatory	Optional
Smart Charging	Mandatory	Optional
Reservation	Mandatory	Optional
Local Authorization List Management	Mandatory	Optional
Remote Trigger	Mandatory	Optional

The certification process is reportedly lengthy. Many CSPs and equipment vendors, particularly in North America, note that their EVSE and/or CMS are OCPP compliant, but have not been certified. Some equipment systems only partially implement OCPP for certain functions/profiles. Additionally, it is possible for OCPP implementation to be insufficient for interoperability, but for vendors to still claim their CMS or EVSE as "compliant". Finally, OCPP is only the application layer – Fully open systems require interoperable transport and hardware integration, and compatible commands.

Nevertheless, despite the potential issues and shortcomings noted above, it is generally acknowledged that OCPP EVSE and CMS can significantly reduce the risks of stranded assets.

IEC 63110

IEC 63110 Protocol for management of EV charging and discharging infrastructure is currently in development, with publication expected in 2025.[36] IEC 63110 covers much of the same functions as OCPP, and is being informed by the OCA. IEC 63110 will also allow bidirectional charging (V2G) and fast frequency response services, and is intended to entail other improvements in functionality on OCPP.

As an international standard, as opposed to OCPP which is fundamentally a voluntary protocol, it is hoped IEC 63110 can better ensure interoperability. It is unclear whether IEC 63110 will be

[36] **Report**: Environmental Coalition on Standards and Regulatory Assistance Project. December 2022. *Standards for EV smart charging: A guide for local authorities.*

backwards compatible with any version of OCPP, but there are efforts to enable coexistence between the two.

Telematics

In the context of EV charging, telematics refers to the communication of data and commands between some remote platform (a telematics server) and an EV. Vehicle OEMs may offer telematics services, as may third party service providers that develop telematics controls for either individual or multiple vehicle brands.[37] These entities can aggregate demand response resources for DSOs.

While telematics may be able to provide utilities with the opportunity to perform active managed charging provide grid-scale demand response, telematics typically cannot be relied on to perform facility-scale EV energy management. There are not standards for facility-scale energy management using telematics, and the specific individual EVs that will park at a given multifamily building or workplace will almost always be in flux and unpredictable.

[37] It should be noted that functionality and safety issues have arisen when third parties develop telematic controls with insufficient coordination with the vehicle OEMs.

Additional information about EVEMS Configurations

Below, several different electrical configurations are summarized, including:

- Unmanaged dedicated circuits.
- Branch circuit sharing.
- Panel sharing.
- Feeder monitoring of residential units' electrical panels.
- Service monitoring.

Unmanaged dedicated circuits

If no EV energy management systems are used, electrical codes require that EVSE loads are calculated at (close to) 100% of the total nominal electrical loads. For example, on a 200A panel, there would be a limit of five unmanaged (i.e., "dumb") EVSE on 40A circuits (see Figure B-2); each EVSE requires its own dedicated branch circuit (i.e., multiple unmanaged EVSE sharing the same branch circuit is *not* allowed). Likewise, a 200A panel could accommodate ten Level 1 receptacles with 20A breakers.

Unmanaged Dedicated Circuit NO EVEMS USED

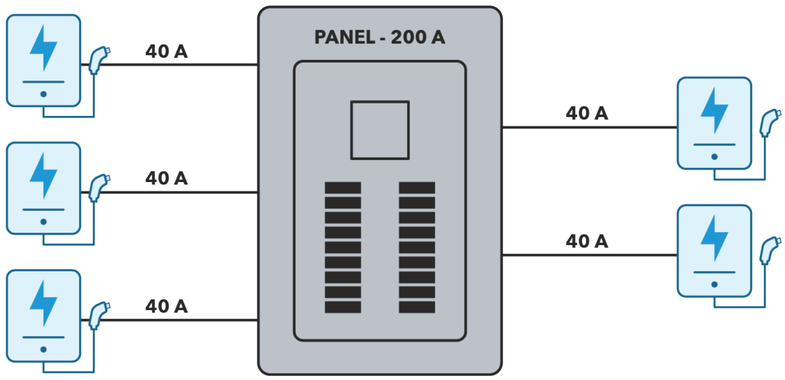

Figure B-2: Unmanaged Dedicated Circuit with no EVEMS.

Branch circuit sharing

Branch circuit sharing involves sharing one branch circuit between multiple EVSE, with an EVEMS that controls each EVSE such that the total circuit capacity is not exceeded, as depicted in Figure B-3. Load calculations to size the feeder and service use the "maximum load allowed by the [EVEMS]" (CSA C22.1-18 Rule 8-106(10)). This configuration requires the use of networked EVSE that are capable of communications with an EVEMS according to algorithm communication. Many vendors offer EVEMS systems that support load sharing across a branch circuit.

Branch Circuit Sharing USING EVEMS

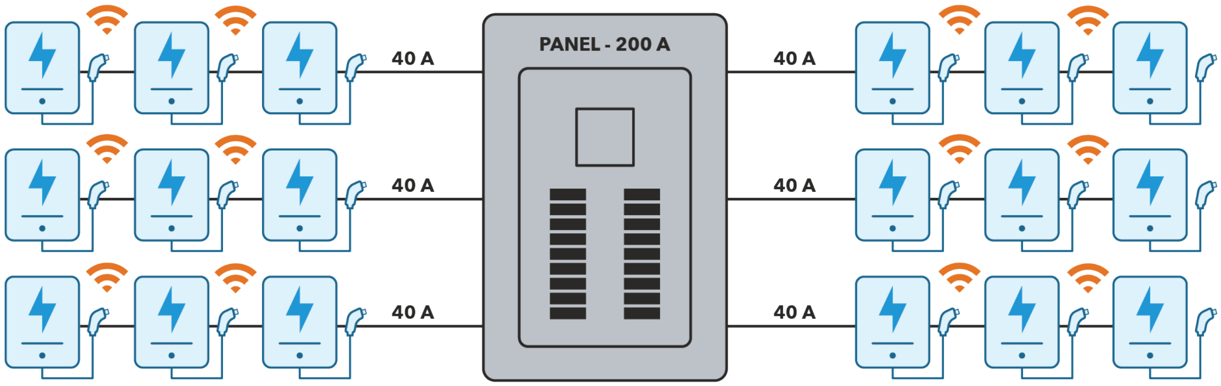

Figure B-3: Branch Circuit Sharing Using EVEMS.

Panel sharing

In a panel sharing configuration, the EVEMS manages the EV charging loads to ensure that the capacity of a branch panel and the feeder serving it is not exceeded. Panel sharing can be performed using hardwired networked EVSE that communicate with an EVEMS; in this case, it can be combined with branch circuit sharing. See Figure B-4.

Panel Sharing USING EVEMS

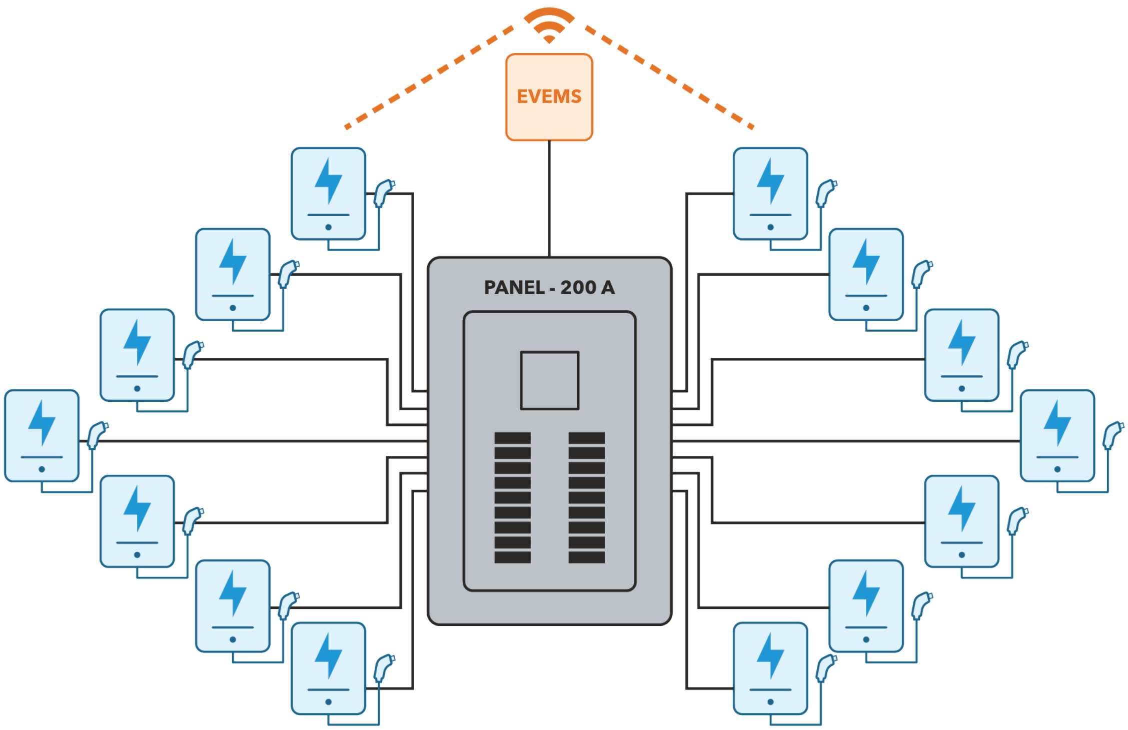

Figure B-4: Panel Sharing Using EVEMS.

Alternately, panel sharing can be performed through monitoring the power flowing through the panel and switching breakers to branch circuits on and off according to the actual energy consumed by each circuit or alternatively, in a "round robin" fashion, so as not to exceed the capacity of the panel (Figure B-5). This control scheme will typically use dedicated branch circuits to individual EVSE, while overloading the panel. This control scheme can use unnetworked ("dumb") EVSE.

Panel with Integrated EVEMS SMART SWITCHING

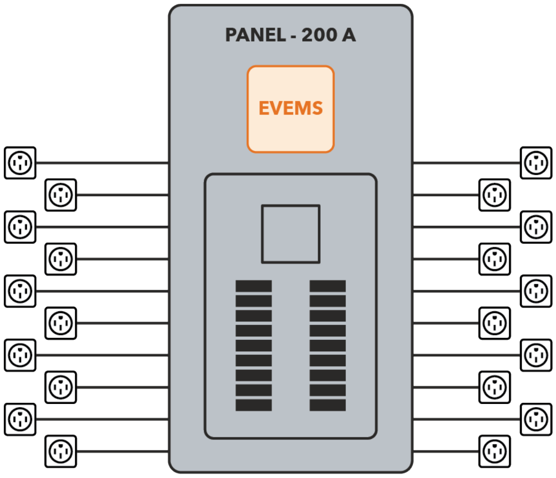

Figure B-5: Panel with Integrated EVEMS Smart Switching.

Feeder monitoring of residential unit's electrical panels

Feeder monitoring manages EV charging loads through monitoring the real time electrical load in feeders to the individual electrical panels for individual units in a multifamily building. A monitoring device is located on the feeder between a unit's meter and electrical panel. This EVEMS device then measures the incoming power on the feeder, and switches off the circuit to the EVSE when the feeder is at or approaching its capacity, or reduces consumption incrementally by communicating to the EV charger if the charger is networked. Because this configuration involves wiring between units' electrical meters and these units' parking space, it requires that the meters be located close to the parking space (e.g., both the meter and the parking space in the basement of the building). Particularly in larger multifamily buildings, meters are often located on upper floors, making this configuration difficult to apply in those circumstances. As a result, this solution typically works best in small and midsized multifamily buildings and townhomes.

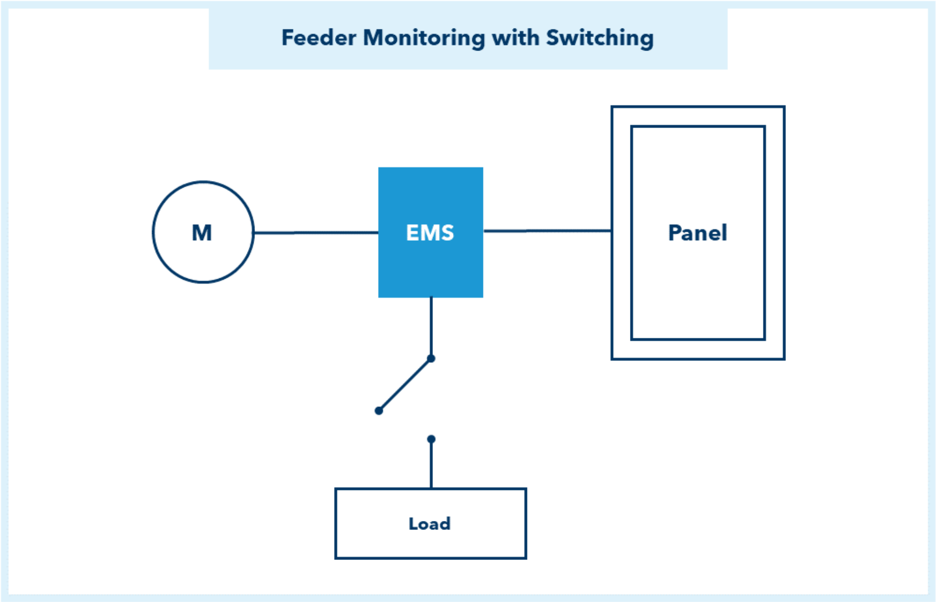

Figure B-6: Feeder Monitoring with Switching.

Figure B-7: Example of multiple feeder monitoring devices installed on a meter stack serving a parking garage. Source: MURBLY / RVE.

Service monitoring

Service monitoring involves an EVEMS that monitors the load on the service or feeder supplying the EVSE and other loads (Figure B-8). The EVEMS controls the EVSE such that the maximum capacity of the service or feeder is not exceeded. When using service monitoring, the CE Code dictates that the load for the EVSE "shall not be required to be considered in the determination of the calculated load" (CSA C22.1-21 Rule 8-106(11)) to size the service or feeder. This can enable EV loads that would not otherwise be able to be added to an existing multifamily building without getting an electrical service upgrade. It is still relatively rare for service monitoring to be deployed in multifamily buildings; however, a growing number of EV charging service vendors provide EVEMS that can perform service monitoring, and service monitoring technology may be more common in the future.

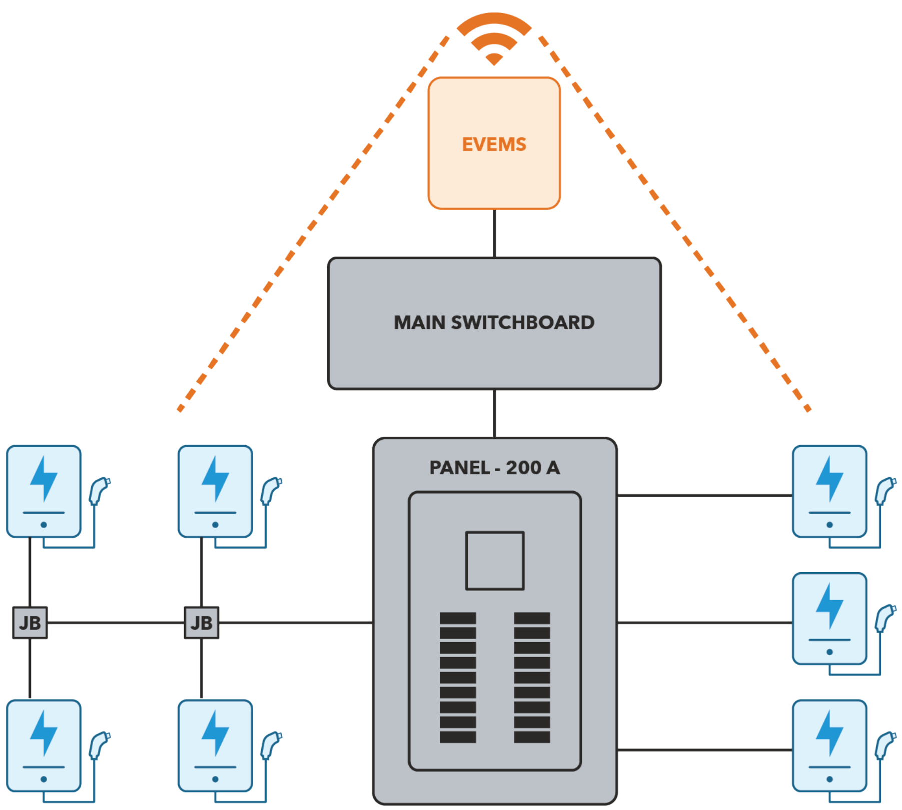

Figure B-8: Service Monitoring with an EVEMS.

Feeder monitoring of residential unit's electrical panels with service and/or transformer monitoring

Service monitoring can be combined with feeder monitoring of units' electrical panels. As feeder monitoring manages EV charging loads through monitoring the real time electrical load in feeders to the individual electrical panels for individual units, it is also possible to add main service and/or building transformers monitoring with an additional main monitoring device placed at that point. The main monitoring device will communicate to the individual charge controllers that control each EV charging station to keep the service or transformer load under the set-point. This constitutes a form of "multi-tier" monitoring. CE Code rule 8-106(11) permits to omit the EV charging station load at load calculation on the service and/or transformer upstream.

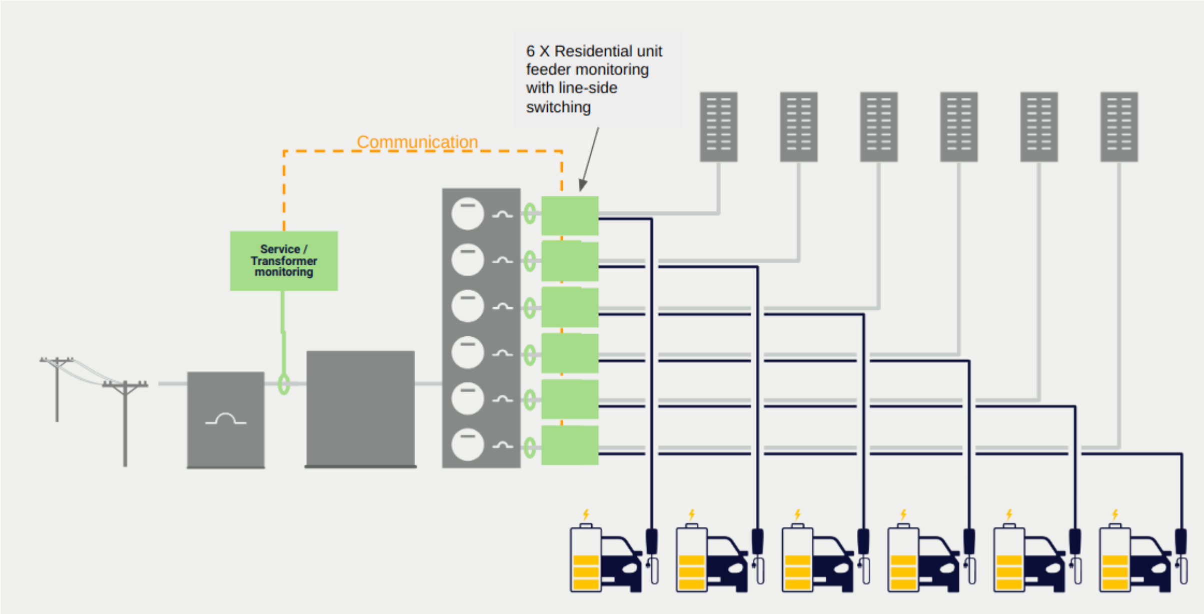

Figure B-9: Service Monitoring with monitoring of units' electrical panels (a form of multi-tier monitoring). Source: RVE.

Performance Requirements for EV Charging

Greater amounts of load-sharing across branch circuits will result in reduced costs. However, there are limits on how much load-sharing can occur before the quality of EV charging experience diminishes for drivers. Metrics for the "quality" of home charging experience include the likelihood of starting the next day fully charged, as well as the likelihood of being able to achieve the next day's driving distance with the previous night's charge.[38]

The likelihood of getting a full overnight charge, or at least enough power for the next day's driving, is a product of:

- The distribution of **daily driving distances** amongst drivers in the building.
- The **efficiency of the vehicle fleet**. A preponderance of larger, less-efficient vehicles will mean that less aggressive load sharing is viable.
- **Climate**. The coldest and warmest temperatures should be considered as vehicles operate least efficiently at these times.
- Typical **arrival and departure times**.
- The **capacity of circuits and of the EV chargers**.
- **Battery capacities**.
- The **efficiency of the charging system and EVEMS**.[39]
- The **number of EV ports between which load-sharing is occurring**. Sharing between a larger number of ports allows for higher average performance due to the statistical "law of large numbers." For example, it is more likely that all four vehicles sharing a 40A branch circuit will all return home with an abnormally low state of charge, than it is that all eight vehicles sharing an 80A circuit will do so. Therefore, even though in both scenarios each vehicle is allocated 10A (2kW capacity), sharing across a larger branch circuit will achieve greater performance.

We recommend using a performance requirement as follows to determine the appropriate load sharing configuration in a given building or neighbourhood:

Multifamily building EV charging systems should be designed to ensure that EVs are fully charged 90% of nights, and enough power for the next day's driving is provided 99% of nights.

As an illustrative example, using this performance requirement, modelling was conducted to determine the maximum appropriate load sharing configurations for the Greater Toronto Hamilton Area (GTHA). Based on this modelling, Table B-3 summarizes the maximum number of EVs that can share a circuit of a given capacity according to the average mean vehicle kilometers traveled (VKT) for different neighbourhoods in the region.

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[38] Additionally, EV manufacturers often note that customers want as fast charging at home as possible, perhaps as a status symbol, to deal with "edge cases", or because they are not yet very familiar with EV charging. However, especially in the multifamily building context, fast charging speeds will be costly to achieve at scale. Thus, encouraging households and building owners to consider the minimum charging performance they will require for a good quality home charging experience is important.

[39] Some EVEMS algorithms can make inefficient use of capacity. For example, EVEMS that switch between vehicles can make less efficient use of capacity compared to EVEMS that dynamically throttle charging up and down, as sometimes vehicles request fewer amps, allowing dynamic throttling to allocate the remainder to other vehicles. On/off switching controls cannot take advantage of this dynamic to the same extent.

Figure B-10 shows the distribution of average VKT in the GTHA, for reference.[40] This modeling suggests that **in the parts of the GTHA with the lowest average VKT of about 30 km per day (downtown Toronto), it is possible to implement systems with high levels of load-sharing** (e.g., 6-share on 40A branch circuits or 10-share on 80A branch circuits) while meeting the performance requirement. These areas are illustrated in green in the Table. Since downtowns are the densest part of Canadian urban regions, **this approach will be ideal for many multifamily buildings across the country.** Conversely, more suburban locations where the average VKT is greater than 50 km per day are better served by 4-share or 3-share on 40A, or even less aggressive load sharing. These areas are illustrated in yellow in the Table.

This analysis assumed that all vehicles are EVs, and all charging occurs at home. In two to three decades when most vehicles are EVs, home charging could be more regularly augmented by workplace charging and/or public charging, further improving performance.

Table B-3: Maximum number of EVs that can share a circuit of a given capacity, by the average daily VKT. Source: AES Engineering. 2021.

Circuit Breaker Size (A)	30 VKT	35 VKT	40 VKT	45 VKT	50 VKT	55 VKT	60 VKT	65 VKT	70 VKT
20 A	2	1	1	1					
30 A	4	3	3	2	2	1	1	1	1
40 A	6	5	4	4	3	3	2	2	2
80 A	15	12	10	9	8	7	6	6	5

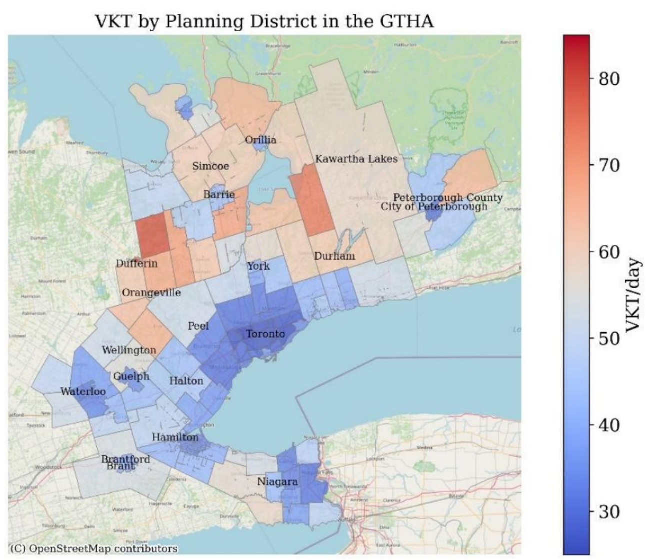

Figure B-10: Average vehicle kilometers traveled in different planning districts in the GTHA. Source: AES Engineering. 2021.

[40] AES Engineering. 2021. *EV Charging Performance Requirements*. Prepared for Clean Air Partnership.

Comparing the performance of load-shared Level 2 charging to Level 1 charging

Because Level 1 charging occurs on dedicated Level 1 circuits and is typically unmanaged, it cannot take advantage of the "law of large numbers" noted above. As a result, users of Level 1 systems will experience a lower service level, tending to experience more days where a full charge is not achieved overnight, where they will need to supplement with midday public charging. This dynamic was demonstrated in a 2020 study and illustrated in the Figures below.[41] It shows that high levels of load sharing with Level 2 chargers (i.e. 10-share per 40A circuit) have similar performance characteristics as dedicated Level 1 circuits. Sharing a 40A branch circuit to this extent will typically result in much lower upfront costs for the electrical wiring (though may also entail greater costs for the networked Level 2 EVSE).

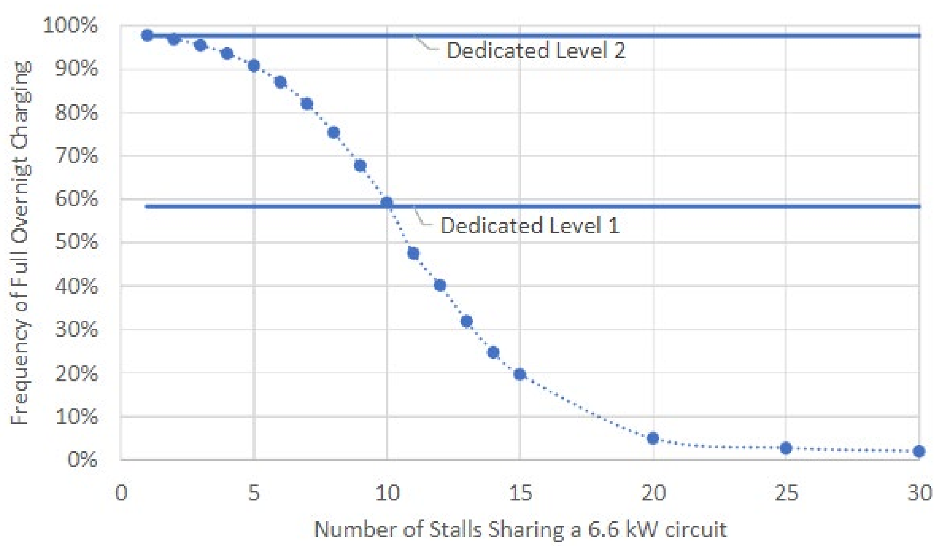

Figure B-11: The frequency of full overnight charging for different EV charging systems. The dashed line shows the frequency for a 6.6kW (208V 40A) branch circuit sharing increasing numbers of parking stalls. The solid lines show a dedicated Level 2 and Level 1, for reference. Source: Chandler 2020.

[41] Doug Chandler, in coordination with AES Engineering, published a paper modeling these effects. Chandler's model assumes that vehicles will require an average of 13.3kWh per day, equivalent to an average daily VKT of 53km assuming an average fleet efficiency of 250Wh/km. The model suggests that Level 1 charging is equivalent to approximately 10-share on 40A circuits Level 2 charging, in terms of frequency of full overnight charging and probability of requiring a midday charge. Results will vary somewhat depending on assumptions. Source: Chandler, D. 2020. "*Statistical Modelling of Load-Managed Charging for Electric Vehicles in Multi-Unit Residential Parking*."

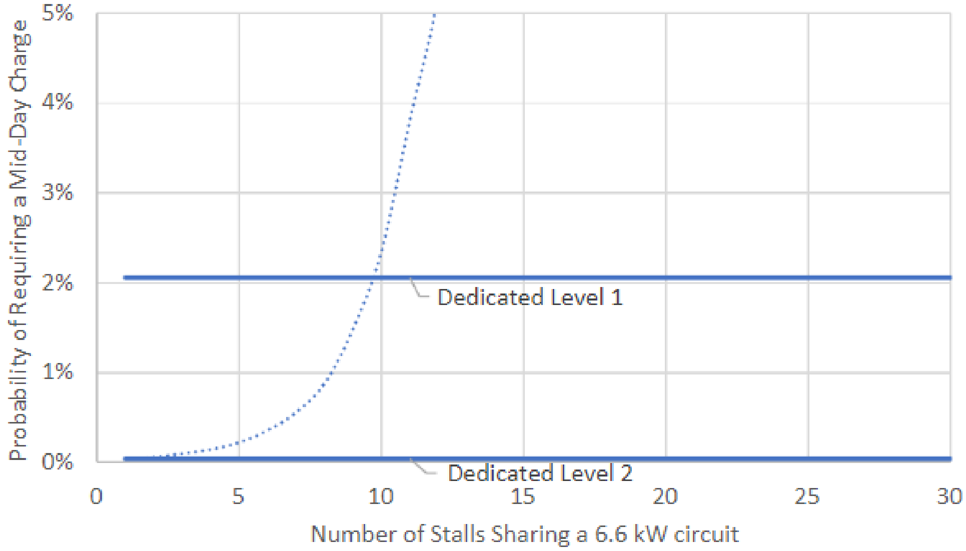

Figure B-12: The probability of requiring a mid-day charge. The dashed line shows the probability for a 6.6kW (208V 40A) branch circuit sharing increasing numbers of parking stalls. Source: Chandler 2020.

It should also be noted that the 2% likelihood that a driver would require a midday charge when relying on dedicated Level 1 charging at home (as shown in Figure B-12) does not apply equally to all drivers; rather, it is an average across the whole population of drivers. While Level 1 may be generally sufficient on average across the entire population of drivers, this average masks the significant variance among individual users. Some, like the commuter with an electric smart car, may find Level 1 charging adequate for their needs most of the time, whereas others with higher driving needs or larger vehicles are likely to be chronically underserved by Level 1 charging. In contrast, Level 2 charging with load-sharing capabilities offers a more robust solution that is likely to serve a broader range of users effectively. It allows for faster charging and greater flexibility, making it less likely that users with high consumption needs will be underserved.

Appendix C: Supporting Information on Funding, Financing & Project Delivery Mechanisms

Process to install customer-owned infrastructure

Figure C-1 below outlines the basic process to implement customer-owned infrastructure. The figure illustrates an idealized process; other processes are possible, and the experience of deciding to implement EV charging futureproofing is often less linear and more iterative. Some decision-making processes specific to condominiums and cooperatives are summarized in Figure C-1; these do not apply to rental buildings.

Researching & Understanding Options

- Engagement with owners/tenants to determine attitudes regarding comprehensive EV charging futureproofing.
- Research futureproofing options & charging services.
- In condos, review of how parking tenure is organized (e.g. common property, limited common property, leases, etc.) to inform who should pay for & own chargers.

Feasibility Study

- Feasibilty study typically performed by electrical engineer or contractor.
- Includes review of building electrical systems; load capacity analysis; consideration of buildings' EV charging performance requirements; conceptual design (e.g. electrical single line diagram and wiring layout); description of what EV charging service providers are compatible with conceptual design; cost estimates sufficient for budgeting and decision-making purposes.

Evaluating Options & Negotiations

- Consideration of funding options (e.g. incentives; project financing; special assessments; etc.).
- Negotiating Service Agreement terms with EV charging service providers.
- Engagement with condominium owners about options.
- Preparation of condo resolutions & bylaws (regarding how EV charging infrastructure will be managed; funding for project; any loans; etc.).

Decision to Proceed

- Building owners elect to pursue project. In condominiums, this will entail owners voting to approve the capital project. Condos may also neeed to vote to update bylaws/rules regarding: Entering into contract with a charging service provider; who is responsible for charger installation, maintenance, etc. (e.g. unit owners vs. condominium); user fees to cover electricity costs and any other condominium operating costs; access rights; bylaws to assume loans or special assessments to fund the project; etc.

Detailed design, permitting & construction administration

- Finalize detailed electrical design.
- Construction tendering (if project is being competitively tendered - Projects originated by electrical engineers will often be competively tendered. Those originated by contractors may be "sole source").
- Permitting, including any operating permits required by electrical AHJs.
- Applying for incentive funds.

Construction, commissioning & EVSE installation

- Construction of EV Ready / EV Capable retrofit.
- Installation of the first tranche of EV chargers.
- Commissioning of systems (e.g. EVEMS; etc.).
- Additional EV chargers added over time as households adopt EVs.

Figure C-1: Process to implement comprehensive futureproofing of EV charging infrastructure.

Supplemental Case Studies

Municipal EV ready rental building top-up programs

City of Vancouver, BC: Rental Building EV-Ready Top-up Program

The City of Vancouver launched an incentive program to accelerate EV ready retrofits of existing rental buildings in 2021. Ensuring access to EV charging in rental buildings is an important element of an equitable EV charging strategy, especially because low income, racialized, and other disadvantaged groups are more likely to be renters.

Layering on to the CleanBC Go Electric Rebate Program for apartment buildings, the program invites rental building owners to apply to have City-owned EV chargers installed in existing rental buildings for tenant use. The City will contribute up to $93,000 in addition to up to $137,000 from the CleanBC program which covers an EV ready plan, infrastructure and charging equipment. Additional eligibility criteria for the City top-up incentive includes that the applicant must:

- Be the landlord or building manager of a rental building with three or more parking stalls;
- Meet BC Hydro building eligibility requirements, including that the building must not be constructed after municipal EV-ready requirements came into effect;
- Agree to provide the required financial contribution of $2,000;
- Agree to re-assign parking as needed so that EV drivers have access to charging stations;
- Agree that the City of Vancouver will own and operate the chargers on the property. The decision to have the City own and operate the charging equipment was made because under the Vancouver Charter, the City is not able to grant money to private entities such as rental property owners;
- Agree to cover any costs related to damage from misuse or negligence;
- Agree that rental rates in the building will not increase as a result of this program. While the City does not have a mechanism to track this, landlords are legally not allowed to raise rents in cases like this under the Residential Tenancy Act.

The program took City staff approximately a year to plan and launch. The City issued a competitive bid to select an organization to install and manage charging; Shell Recharge won the contract. In addition to day-to-day tasks performed by Shell Recharge, two City staff work part-time on program implementation. The City is also accessing federal funding to support the program.

No EV charging infrastructure has been built to date, but as of August 2023, approximately 30 buildings have applied, according to City staff. Staff are working to electrify over 1200 parking stalls, of which approximately 1,000 will become EV ready and 200 will be outfitted with chargers. The first round of construction is expected to be completed in Fall 2023.

Other funding programs for EV charging infrastructure in existing multifamily buildings

Efficiency Nova Scotia's EV Ready and Standalone EV Charger Programs

Efficiency Nova Scotia administers two programs aimed at providing rebates for EV chargers to owners of multifamily buildings: the EV Ready Approach program, and the Standalone EV Charger program.

- **EV Ready Approach:** The EV Ready Approach program offers two rebates to support the installation of EV charging stations in existing multifamily buildings. The first rebate, the EV Ready Plan Rebate, provides $4,000, or up to 75% of eligible costs, to conduct a detailed study to develop a customized EV Ready Plan for their building. Once the EV Ready Plan is completed, participants can access the second rebate, the EV Ready Charger Rebate, which provides $3,000 per charger, up to a maximum of five chargers ($15,000 per building), to help cover the costs of installing charging stations in accordance with their EV Ready Plan.
- **Standalone EV Charger.** The Standalone EV Charger program provides rebates for smaller, straightforward charging projects in existing multifamily buildings. The program offers up to $2,500 per Level 2, networked smart charging stations, up to a maximum of $10,000 per building, or 50% of eligible costs.

NRCan Zero Emissions Vehicle Incentive Program

Launched in 2019, the Zero Emission Vehicle Infrastructure Program (ZEVIP) is a $680 million initiative administered by Natural Resources Canada (NRCan) to enable increased availability of EV charging across Canada.

Under ZEVIP, there are three principal funding streams to improve access to EV charging and hydrogen refuelling opportunities: For owners and operators of ZEV infrastructure, for delivery organizations, and for Indigenous organizations. Multifamily buildings can receive funding for EV charging installations from any of the three streams. Funding for the program will be available through 2027.

Through ZEVIP, NRCan offers funding through a cost-sharing model to help cover the costs of EV charging infrastructure. Each funding stream's cost-sharing is subject to different limitations, specified both as a maximum total funding amount, and as a maximum share of total project costs. The three funding streams are as follows:

- **Owners and Operators of ZEV Infrastructure:** Through this funding steam, NRCan provides funding for owners and operators of ZEV infrastructure aimed at supporting charging deployment in public places, on-street, in multifamily building, at workplaces, and for vehicle fleets. Funding delivered via this funding stream is capped at 50% of total project costs, up to a maximum of $10 million per project.
- **Delivery Organizations:** ZEVIP funding for delivery organizations is designed to further distribute funds from the "Initial Recipients" (delivery organizations) to "Ultimate Recipients". Initial recipients of funds distributed via this funding stream may include provincial, territorial, regional, or municipals governments, governmental institutions and agencies, not-for-profit

organizations, and public utilities. Ultimate recipients include condo boards and private companies, including residential rental property owners. Funding delivered via this funding stream is capped at 50% of total project costs, up to a maximum of $5 million per project.

- **Indigenous Organizations:** Funding delivered via this funding stream is capped at 75% of total project costs, up to a maximum of $2 million per project.

NRCan's ZEVIP is structured to distribute funds on a per EVSE basis. Each Level 2 connector is eligible for a rebate of $5,000, while fast chargers can qualify for increased funding limits (up to $100,000 per charger), depending on their capacity. However, while NRCan's ZEVIP encourages some EVSE deployment, the program is not designed to incentivize building owners to implement comprehensive EV Ready futureproofing.

Quebec Roulez Vert Program

The Quebec Roulez Vert program aims offers financial assistance for the installation of EV charging stations in multiple dwelling buildings. This program is open to a range of applicants, including residents of such buildings who own an EV, property owners, developers, managers, and syndicates of co-owners (i.e., condos). To qualify, the building must have at least five dwelling units, or three to four if constructed before October 1, 2018. The building can be for residential or mixed use and must be located in Quebec, with parking spaces grouped in a common area.

The program stipulates that the installed charging stations should offer Level 2 charging, operating at either 208 or 240 volts in alternating current (AC). Importantly, residents do not need to currently own an electric vehicle for a building to be eligible; **charging stations can be installed in anticipation of future use.** Once installed, these stations must be maintained for at least three years.

Eligible expenses under this program include the cost of purchasing or leasing the charging stations, installation costs, and the **oversizing of electrical infrastructure to meet future needs.** As of April 18, 2023, additional eligible expenses have been added, such as professional design fees, energy management software or devices, and the required permits for installation work. To qualify, the stations must be purchased and installed after January 1, 2020, and the work must be performed by an electrical contractor in compliance with the Quebec Construction Code.

Financial assistance can cover up to 50% of eligible expenses, with a cap of $5,000 per connector or wireless charging station. Specific assistance is also provided for the long-term leasing and installation of charging stations. Furthermore, there are **annual maximum amounts for financial assistance based on the number of dwelling units in the building, ranging from $20,000 for buildings with 3-9 units to $49,000 for buildings with 20 or more units**. Applicants must choose one of two approaches for cost-sharing: either a single entity assumes all costs and submits one reimbursement request, or costs are divided among co-owners or tenants, who then each submit their own reimbursement requests.

Utility Make Ready Programs

Case Study: California Make Ready Programs

In 2021, the California Public Utilities Commission approved rules to support "utility-side make-ready" infrastructure for electric vehicle (EV) charging at no cost to the typical customer. This initiative is aimed at reducing the costs of installing charging stations by about 25%, thus improving the overall economics of transportation electrification. Prior to this change, support for such infrastructure varied depending on customer participation in utility EV programs, leading to inconsistencies in the level of support. The newly approved tariffs remove these inconsistencies, making the provision of infrastructure a part of normal utility business, and saving hundreds of thousands of dollars in charging station installation at typical sites. Furthermore, these rules provide long-term, predictable support for customers investing in EVs, leveling the playing field for all customers.

Assembly Bill 841, signed by Governor Newsom, was the catalyst for these new tariffs, directing utilities like Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric to propose new tariffs to allow them to design, install, and maintain the required infrastructure and all associated work on the utility side of the meter. Despite the tariffs covering the utility side of the infrastructure, customers will still bear a significant portion (70-80%) of the total cost of installing EV charging infrastructure at their site in the absence of state or utility incentives, since the tariffs do not cover customer-side distribution infrastructure. The Commission has also laid out extensive reporting requirements to track the costs and effectiveness of these tariffs.

The tariffs also include provisions to take service on time-varying rates, encouraging off-peak charging, and requiring utilities to propose an average energization timeline to expedite deployment.

Case Study: Joint Utilities of New York EV Make-Ready Program

Launched in 2020, the Joint Utilities of New York EV Make-Ready Program aims to facilitate the expansion of EV infrastructure in New York State by reducing the upfront costs of building EV charging stations. The program offers incentives for the installation of Level 2 and/or Direct Current Fast Charging (DCFC) chargers, offsetting most if not all the infrastructure costs associated with preparing a site for EV charger installation.

Under the EV Make-Ready Program, incentives are available for two distinct categories of equipment or infrastructure needed for electric vehicle charging:

1. **Utility-side Make-Ready Infrastructure**: This category encompasses the utility's electric infrastructure required to connect and serve EV charging sites, up to the point of the utility service entrance. The utility-side make ready infrastructure covers these utility costs that would otherwise result in a utility service extension fee for customers. Utilities own and operate this infrastructure.
2. **Customer-side Make-Ready Infrastructure**: This involves the equipment or infrastructure needed to accommodate an EV charger owned by the charging station Developer, Equipment Owner, or Site Host. Typical elements include conductors, trenching, and panels necessary for the EV charging station. Different utilities structure their customer-side

programs differently; the utility National Grid offers up to $6,700 USD per EV charging port, for example.

The total program budget is $701 million USD, of which $601 million is allocated by the New York Joint Utilities to support Make-Ready programs. From the program's budget, $206 million must directly benefit disadvantaged communities, defined as communities that bear burdens of negative public health effects, environmental pollution, impacts of climate change, and possess certain socioeconomic criteria, or comprise high concentrations of low- and moderate-income households.

Charging-as-a-service provider profiles

- **EVgo** – EVgo, one of the largest public fast-charging networks in the U.S, offers CaaS to businesses, fleet operators, and property owners. EVgo's charging as a service offering presents a tailored solution for multifamily buildings by providing a complete end-to-end package that includes design, installation, maintenance, and customer support for electric vehicle charging infrastructure (L2 or DCFC). This model can significantly reduce upfront costs and management complexities for building owners, thereby facilitating the integration of EV charging stations within residential communities and enhancing the accessibility of charging options for occupants. Customers pay for the charging services through various pricing models, including pay-as-you-go, membership plans, or utility partnerships.
- **ChargePoint** - ChargePoint also offers CaaS in addition to their other revenue streams. Through their commercial CaaS program, ChargePoint provides businesses and property owners with solutions for installing and managing charging infrastructure, including the provision of charging stations, software platform, maintenance, and support services. ChargePoint offers solutions for assigned charging (suitable for condo buildings), community charging (best suited for rental buildings), and mixed-use charging.
- **Zeplug** – Zeplug is a provider of electric vehicle (EV) charging solutions that aims to simplify the adoption of EVs for individuals and businesses. Zeplug provides charging infrastructure, installation services, and support for EV owners and property owners.

Appendix D: Supporting Information on Project Implementation Considerations

Detailed Condominium Approvals Processes by Province

British Columbia

In British Columbia, any changes to the common property typically require approval from the strata corporation, which consists of all the owners in the strata development. Generally, the voting threshold for approving expenditures and changes to common property in British Columbia is 75%, according to the Strata Property Act. However, the Government of British Columbia recently adopted Bill 22, "Strata Property Amendment Act, 2023", lowering the necessary threshold from 75% to 50% approval for expenditures and changes to common and personal property that are needed to install EV charging stations.[42]

In addition to lowering the votes required for expenditures and changes to common property required for EV charging installation, BC also recently introduced amendments requiring strata corporations to obtain an electrical planning report to help understand the building's electrical capacity and plan for the expansion of EV charging stations; as well as requiring strata corporations to approve owners' requests to install EV charging stations at the owners' expense. The Regulations to specify the required contents of the electrical planning report are in the process of being developed by the BC Ministry of Housing. The details of what will be required in the electrical planning report will be critical to determining whether the report appropriately supports the condominium in considering comprehensive futureproofing for EV charging infrastructure, and other electrification projects.

The recent amendments to the Strata Property Act also include provisions similar to Ontario's that allow individual units certain rights to make changes to common property to support implementation of EV charging. These are noted in Section 4.

Regarding unapproved expenditures, a strata council can make expenditures from the operating fund without owner approval if the total unapproved expenditures for the year does not exceed the lesser of $2,000 or 5% of total contributions to the operating fund for the current fiscal year.[43] However, individual condo corporations may choose to implement different unapproved expenditure limits in their bylaws. $2000 could conceivably cover the cost of feasibility assessment of futureproofing options, but more is almost always required particularly for an impartial assessment.

Ontario

Ontario's Condominium Regulations enacted under the Condominium Act (1998) include specific guidelines for the installation of an EV charging system by a corporation.

Per Ontario's Condominium Regulations, there are two processes by which a corporation can install electric vehicle charging systems. The specific process **depends on 1) the cost of the proposed installation, and 2) whether the installation is deemed by the condo board as causing a**

[42] **Bill**: Legislative Assembly of British Columbia. 2023. Bill 22: Strata Property Amendment Act, 2023.
[43] **Website:** Government of British Columbia. "Budget and strata fees". Accessed May 23, 2023.

material reduction or elimination of owners' use or enjoyment of their units or the common elements or assets. Accordingly, in Ontario, the first step for the installation of an electric vehicle charging system by a corporation is for the board to conduct a cost assessment to the corporation of the proposed installation. Second, the board must determine whether the owners would regard the proposed installation as causing a material reduction or elimination of their use or enjoyment of the units that they own or the common elements or assets.

If the proposed installation is less than 10% of the annual budgeted common expenses for the current fiscal year, **and** if the board decides the installation will not have a negative impact on owners, then the board can simply notify owners of the installation, including specifying the assessed costs and how the board proposes to pay. After a 60-day waiting period, the corporation can go through with the installation.

If the assessed cost of the proposed installation is more than 10% of the annual budgeted common expenses for the current fiscal year, **and/or** if the board deems the installation likely to have a material detrimental impact on the owners, then the board must send a notice to the owners that not only outlines the cost of the installation and how the board proposes to pay the cost, but also notifies the owners of their right to requisition a meeting to vote on the proposed installation. If a meeting is not requisitioned, or if a meeting is requisitioned and quorum (25% of owners) is not present, the corporation can go through with the installation. If quorum is present at the requisitioned meeting, the board can only go through with the installation if a majority of all owners (50%) vote in favour of it.

In the vast majority of cases, comprehensive EV ready retrofits will cost more than 10% of the annual budgeted common expenses in a given year for a condo building. As a result, for most EV ready retrofits, owners in Ontario would need to be notified of their right to requisition a meeting, regardless of the assessment of whether the installation is likely to impact owners' enjoyment of their units or the common elements. One barrier that arises if a meeting is called is that the vote threshold of 50% is based on all owners (i.e., not only those present at the meeting). As a result, getting approval for a large-scale EV charging installation by a corporation can be challenging due to owner absenteeism.

Alberta

In Alberta, the rules governing changes to common property in condo buildings are outlined in the Condominium Property Act. According to the Act, a special resolution is generally required to approve funding for major capital projects in condominiums. A special resolution typically requires approval from owners representing at least 75% of the unit factors in the condominium corporation; however, specific thresholds may vary according to individual condominium corporations' bylaws. In the case that a resolution amends bylaws that currently conflict with the Alberta Condominium Act and Regulations (ordinary resolution), the threshold is reduced to 50%.

A condo corporation may make capital expenses to upgrade existing common property if owners pass a special resolution in favour of the expense. A corporation may only withdraw money from its reserve fund for a capital expense if it is authorized to do so via special resolution. According to Alberta condo legislation, all condominiums must have a capital replacement reserve fund. The minimum amount for an individual condo building's capital replacement reserve fund is determined based on a capital reserve fund study, which must be conducted every five years.

Alberta's condominium regulations are relatively sparse on guidance relating to common property with most of the key pieces apparently left up to individual condo corporation by-laws.

Nova Scotia

In Nova Scotia, condominium by-laws can be changed by owners who own 60% of the common elements. Common elements are defined as any property beyond individual unit boundaries (hallways, elevators, lawn, swimming pool).[44] Limited common elements, or "exclusive use common elements", are a subset of the common property designated for the sole use of one or more unit owners (i.e., parking).
The Nova Scotia Condominium Act specifies that a corporation may, among other things, make capital expenditures and levy special assessments for extraordinary common-element expenses with the consent of a group of owners representing at least two-thirds (66.66%) of the common elements (p. 15). However, in the case that a corporation is seeking to make substantial changes (addition, alteration, improvement, or renovation) to common elements or assets, the voting threshold is increased to 80% of condo owners. The Act defines a substantial change as one in which its value is equal to 25% or more of the appraised value of the property (p. 39); however, EV ready retrofits are unlikely to fall within this scope.

For the decisions described above, it is unclear whether the affirmative vote percentage threshold is intended to be based on all condo owners, including those that did not vote, or simply a percentage of votes cast.[45] Per the Act, quorum for the transaction of business at a meeting is defined as at least 30% of condo owners.

Condo corporations in Nova Scotia are generally not required to seek owner approval for decisions affecting the lesser of $2,500 or 5% of the corporation's annual budget.

Quebec

In Quebec, the rules governing changes to common portions of condo buildings are outlined in the Civil Code of Quebec (Book Four, Title Three, Chapter III – "Divided Co-ownership of Immovables") and the co-ownership declaration and bylaws specific to each condominium corporation. Specific regulations governing changes to common portions can vary between different condo corporations in Quebec.

In the Quebec legislation, common areas are referred to as common portions. Parking, storage areas, foundations and main walls, and common equipment (i.e., wiring) are all designated as common portions according to that legislation.

In Quebec, any alteration, enlargement, or improvement to common portions of a condo building requires approval from the co-owners. The specific voting threshold and approval process may vary depending on the condo corporation's bylaws. Proposals for changes to common portions typically need to be presented at a general meeting of the co-owners, convened in accordance with the requirements outlined in the co-ownership declaration and bylaws.

In many cases, a special resolution is required to approve changes to common portions. A special resolution typically requires approval from co-owners representing at least three-quarters (75%) of the votes of the co-owners present at the meeting. Prior to the general meeting, a notice must be sent to all co-owners, providing details about the proposed changes to the common portions. The required notice period varies according to individual condo corporations' bylaws.

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[44] Government of Nova Scotia. "Condominium owners: your rights and responsibilities". Accessed May 18, 2023.
[45] Canadian Condominium Institute. 2022. "Condominium Act Amendments Passed". Accessed May 17, 2023.

The number of co-owners votes required to make decisions depends on the subject matter according to the Civil Code of Quebec.

Decisions concerning the following matters are made by co-owners representing three-quarters of the votes (75%) of the co-owners present or represented:

- Acts of acquisition or alienation of immovables by the syndicate;
- Work for the **alteration, enlargement or improvement of the common portions**, the apportionment of the cost of the work and the granting of a movable hypothec to finance it;
- The construction of buildings to create new fractions;
- The amendment of the act constituting the co-ownership or of the description of the fractions;
- The amendment of the description of the private portions;

Decisions on the following matters require a "double supermajority": at least three quarters of the co-owners present or represented, also representing 90% of the votes of all the co-owners:

- to change the destination of the immovable;
- to authorize the alienation of common portions, the retention of which is necessary to maintain the destination of the immovable;
- to amend the declaration of co-ownership to permit the holding of a fraction by several persons having a periodic and successive right of enjoyment.

In most cases, an EV ready retrofit would require a 75% vote, as EV charging infrastructure installation constitutes the "alteration, enlargement or improvement of the common portions". However, voting thresholds may be higher in some cases according to individual condominium by-laws.

The co-owners must have access to the plans, specifications, and estimated costs associated with the proposed changes. This information must be provided in advance to allow co-owners to make informed decisions during the approval process.

In some cases, the co-ownership declaration and bylaws may include specific restrictions or guidelines for changes to common portions. These restrictions may relate to architectural conformity, preservation of common elements, or the need for approval from other relevant authorities. Further, depending on the nature and complexity of the proposed changes, it is sometimes necessary to involve professionals such as architects or engineers to ensure compliance with building codes and regulations.

Risks and Mitigation Strategies

Dunsky engaged the law firm McCarthy Tétrault LLP to comment on the potential risks associated with EV charging infrastructure projects in MURBs, and the appropriate risk mitigation measures that should be considered by multifamily building owners and programs supporting deployment of EV charging infrastructure.

Stranded Assets

Condominiums typically have common property and limited common. Much less commonly, portions of a commonly accessible parking area may be designated as stratified private property, or the parking may be an air-rights parcel owned by a separate legal entity that will manage the parking.

Common property intended for the use of all the condominium units, while limited common property refers to common property intended for the exclusive use of one or more specified condominium units. Sometimes parking spaces are limited common property, but more typically they are common property that is allocated among units through a separate parking lease scheme. It is not typical for a residential parking facility to be common property with no option for a condominium lot owner to have exclusive use of a parking stall.

Depending on the condominium by-laws, a situation could arise where a resident with an EV has, in the past, obtained approval to alter a parking space to install an EV charging unit, thus "altering" common property or limited common property; often, this will occur as part of an unplanned incremental addition of EV charging. The EV charger itself could be limited common property but could also simply be the personal property of the resident. If, at a later time, the condo board wishes to install additional EV charging infrastructure (whether as common property or limited common property), for instance as part of comprehensive futureproofing serving multiple residents, it is possible that the already-existing EV infrastructure is incompatible with the project envisioned by the board.[46] In such cases, there is nothing in the relevant legislation or in typical condo by-laws that would empower the board to unilaterally reverse its decision and to force the resident to remove an existing charger, nor does the legislation empower the board to effectively expropriate a resident's personal property. However, it is possible that the condo could remove the electrical supply to the parking – electrical works are likely to be designated as common property. However, it is plausible a court would be sympathetic to an argument from an early EV adopter that they had a reasonable expectation they would be able to continue using the charger and preventing their ability to do so would be unfair and counter to the relevant condo legislation, requiring redress.

This type of issue must be dealt with on a case-by-case basis, whether through incentivizing recalcitrant residents to allow the removal of their existing infrastructure; adopting special resolutions by supermajority (as described above at section 4.1) to make compliance with the new project (subject to reimbursement of any losses) an obligation for all residents; confidential settlement of disputes; or all three. If none of the above mitigation strategies was effective and the condominium board or management removed a resident's existing EV infrastructure in order to impose its own solution, a condominium board could be held liable for the damages suffered by such resident.

Similar issues may arise in respect of rental properties, but in such case any disputes over the removal of existing infrastructure would be governed first by the lease or other agreement that enabled the tenant to install such infrastructure in the first place, and then by the statutes and tribunals governing residential leases in the applicable jurisdiction.

The key takeaway is that unplanned piecemeal approaches to EV charging infrastructure is likely opening condominiums, condominium owners, rental owners, and rental lessees to financial and legal risk, to the extent that the original unplanned incremental upgrade impedes subsequent efforts to implement EV charging infrastructure. As noted in previous sections, it is Dunsky's understanding that such unplanned incremental upgrades can indeed sometimes make subsequent electrical retrofits significantly more costly. Accordingly, to mitigate the risk of stranded assets, if possible, **multifamily buildings should be encouraged to complete comprehensive EV Ready feasibility studies and electrical planning reports for electrification**.

[46] For example, the existing infrastructure may use too much of the finite electrical capacity in an existing building, or it may make inefficient use of spare space for circuit protection equipment, electrical switch gear, or branch panels.

Insurance policies

One question that arises in the context of EV infrastructure implementation is whether the insurance policies held by the condominium board or management company or building owner or manager (in the case of rental properties) will automatically cover any losses that occur during the installation of EV charging.

Insurance held by a condominium may respond to damage caused to parking facilities, but that insurance would very likely have exclusions for damage arising from construction that has not been specifically reported and agreed to in advance with the insurer, with necessary revisions to policy language.

Project-specific insurance is often obtained for construction projects, and it would likely be prudent to proceed that way for these projects instead of relying on existing policies that may have problematic exclusions. Typically, project-specific insurance requirements are addressed within the contract between the owner and the contractor. It would be prudent for the insurance requirements to include procurement of a project-specific course of construction policy, including a wrap-up liability policy, either by the owner or the contractor (the contractor may have access to better premium rates). Those policies are meant to address damage and liability arising from construction projects, although the scope of coverage can vary considerably, and the owners would be well-advised to seek advice from counsel and an insurance broker when stipulating the required coverage. It would also be prudent for the contract to require the contractor to have other insurance in place (in addition to a course of construction and wrap-up policy) including a commercial general liability policy and professional liability policy and to require the contractor to ensure its subcontractors and consultants have the requisite insurance as well.

On the assumption that EV charging infrastructure is incorporated into the parking facilities and not in individual rental units, we would not expect insurance held by individual owners or renters to cover damage caused to parking facilities. Those policies may provide coverage to the extent damage is caused to individual units themselves, or to the extent that individual owners or renters are sued, although coverage will turn on the specific terms of the policies at play.

Issues such as the above are best addressed in the context of a specific contract and project, and legal counsel and an insurance broker can and should review existing policies and advise on best practices both from a coverage perspective and in respect of limits.

Professional liability

An EV ready retrofit generally involves major electrical work – specifically, the installation of 208-volt or 240-volt wiring to each parking space. In such circumstances, multifamily building owners (condominium associations, management companies or actual owners) should generally obtain the approval of a licensed electrician or engineer. Whether a project requires the sign-off of a licensed electrician or an electrical engineer depends on the nature of the project as well as the relevant regional legislation governing the licensing of electrical contractors. Larger-scale projects are more likely to require the involvement of electrical engineers; however, requirements vary on a project-by-project basis.

Obtaining approval from a licensed electrician or electrical engineer mitigates risk because it can allow for liability for any incidents/losses to be shifted from the owner or contractor to the professional in question in certain cases (for example, if the infrastructure is unfit for the system implemented, or if the professional's plans deviate from accepted standards). Since insurance coverage follows risk, the professional liability insurance of the professional in question may also cover such losses, but owners will typically only have "recourse" to a professional liability policy if they make a demand of, and usually, sue, the professional that caused the loss. As set out above, it would be most prudent to have insurance requirements addressed within the contractual structure that is ultimately used for a specific project, and to do so with legal advice and support from an insurance broker.

Personal/movable and real/immovable property matters

In real estate law, generally, a chattel (in Quebec, "movable property") is property that is not permanently attached to the land or building, and can be moved. Conversely, a fixture is fixed to the property. So, in the case of a condo, a sale of a property will result in fixture in that unit and in its designated limited common property being transferred to a new owner; chattels can be removed.

Broadly, it not otherwise specified in a condos bylaws, an EV charger is likely to be considered a chattel if it can be readily unplugged from a unit's assigned parking (e.g. designated as limited common property for use of the unit, or common property or an air source parcel subject to a long-term lease). If hardwired and attached to the wall, it is likely to be considered a fixture.

Incentive or Financing Programs

It is also possible for a claimant to allege (validly or not) that an entity providing incentives or financing for EV infrastructure should be held responsible for such claimant's losses associated with EV charging. Generally, any incentive or project financing program can seek to minimize such risk through the funding or loan agreement, including by ensuring that borrowers provide indemnities to, and agree to "save harmless", the financiers in respect of direct and third-party claims. Expansion of projects can be anticipated and provided for in finance documentation.

Financiers can also seek to mitigate risks associated with financed projects by conducting due diligence and ensuring that risks are appropriately allocated to those parties best positioned to bear such risk.

Charging as a Service

Some Charging as a Service (CaaS) project delivery models involve an agreement with a multifamily building owner or condominium board to pay for and implement EV charging infrastructure in their building, and to operate this infrastructure and the parking space on behalf of the building. Fees are charged to drivers for access. These are long-term agreements (10+ years) that typically give the service providers the exclusive right to provide EV charging in the building.

Although each project has its own circumstances, the following agreements should generally be considered as part of a CaaS model:

- Licence from the owner or condo board to the service provider, granting the **exclusive right to use the parking stall and/or the EV charger** (this can be included in the parking lease or on a standalone basis);
- Service agreement between the owner or condo board and the service provider, according to which **the service provider that will perform certain monitoring, management, maintenance, activation (enabling), deactivation (disabling), reactivation (re-enabling), support** and other services in respect of the EV chargers installed;
- Service agreement between the service provider and the EV charger users providing for a **monthly invoice** for user fees.

- Provisions within (including any required modifications to) the relevant condominium by-laws or apartment leases, according to which **the condominium lot owner or tenant agrees to hold harmless the building owner** (and importantly any third-party funding entity or financier) in respect of losses occurring in connection with the charging-as-a-service provided by the third-party service provider.

One benefit of the charging-as-a-service model is that to the extent the above agreements, leases and licences are in place, certain legal liability risks for owners are passed on to service providers. These risks include the following examples, which underscore the importance of crafting appropriate commercial agreements:

- **Events of Default.** Depending on the service agreement negotiated, if the service provider is not able to provide the services set out in the service agreement, or not able to provide the services in a way that is compliant with the Canadian Electrical Code and provincial electrical safety standards and codes, it could be liable for damages and/or the service agreement could be terminated.
- **Damages**. The service provider could be held liable if a malfunctioning EV charger causes damages to a car, an individual, the electrical grid, the building, etc. (due to a technical issue or not).

“NO DISCLAIMERS” POLICY

This report was prepared by Dunsky Energy + Climate Advisors, an independent firm focused on the clean energy transition and committed to quality, integrity and unbiased analysis and counsel. Our findings and recommendations are based on the best information available at the time the work was conducted as well as our experts' professional judgment.
Dunsky is proud to stand by our work.