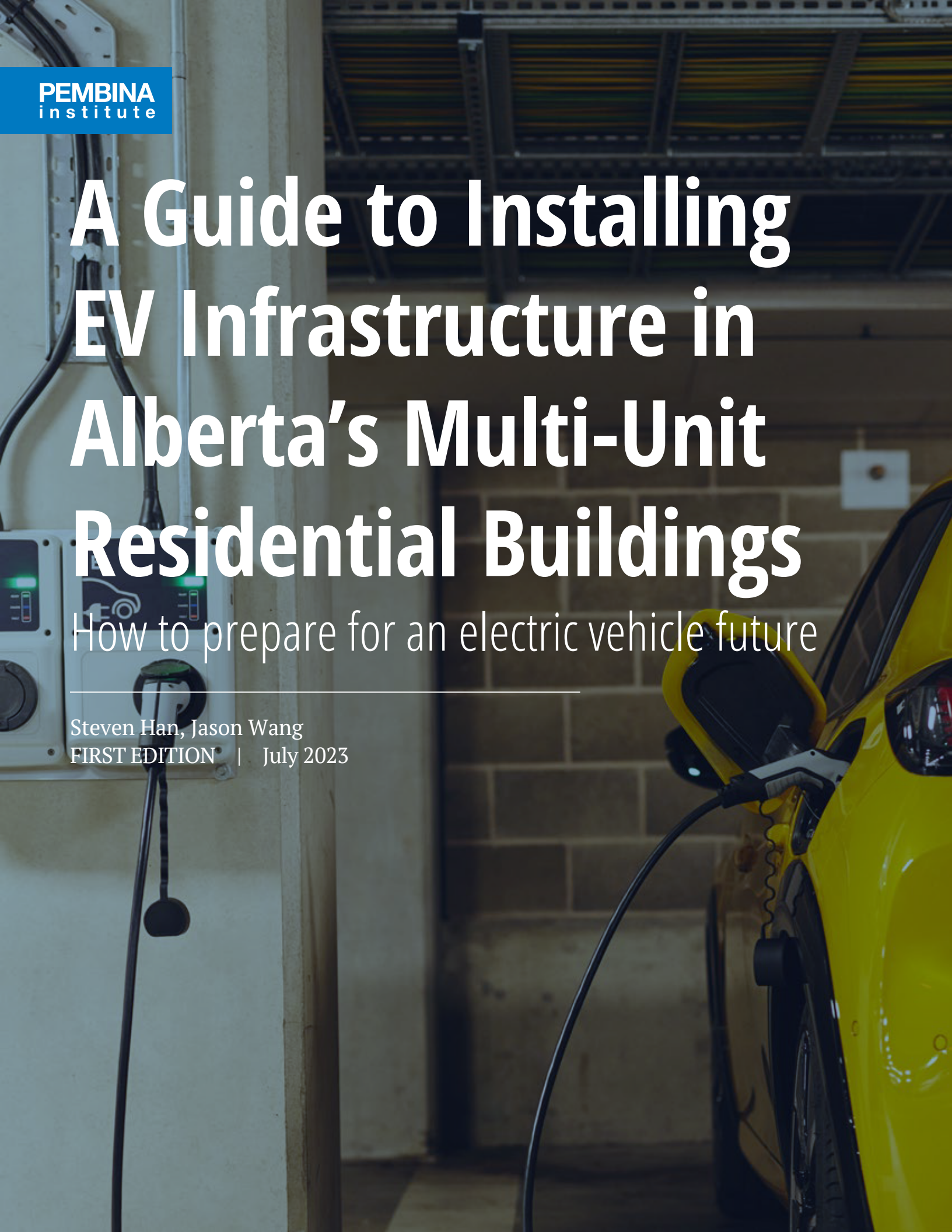

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A Guide to Installing EV Infrastructure in Alberta's Multi-Unit Residential Buildings

How to prepare for an electric vehicle future

Steven Han, Jason Wang

FIRST EDITION | July 2023

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The Pembina Institute is a national non-partisan think tank that advocates for strong, effective policies to support Canada's clean energy transition. We employ multi-faceted and highly collaborative approaches to change. Producing credible, evidence-based research and analysis, we consult directly with organizations to design and implement clean energy solutions, and convene diverse sets of stakeholders to identify and move toward common solutions.

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The Pembina Institute acknowledges that the work we steward and those we serve span across many Nations. We respectfully acknowledge the space our organization is headquartered in as the traditional and ancestral territories of the Blackfoot Confederacy, comprised of the bands Siksika, Piikani, and Kainai, the Îyârhe Nakoda Nations, including the bands of Goodstoney, Chiniki, and Bearspaw, and the Tsuut'ina Dené. These Lands are also home to the Métis Nation of Alberta — Region 3 whose Peoples have deep relationships with the Land.

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

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Executive summary

There has been significant growth in electric vehicle (EVs) purchases in Alberta, as consumers capitalize on the benefits of an EV's lower fuel and maintenance costs. Consumers are increasingly eager to reduce carbon emissions and contribute to the community-wide health benefits of cleaner air that result from lower tailpipe emissions. Since 2017, sales of EVs in the province have increased almost ninefold, and they are predicted to grow even faster in the coming years. With EVs likely to reach price parity with conventional vehicles by the mid- to late-2020s — and the federal government set to introduce sales targets to increase domestic EV supply — zero-emission vehicles are poised to dominate Canadian automobile sales over the next decade.

Access to EV charging will need to expand significantly to keep pace with growing demand. Residential EV chargers are the most common and convenient option for drivers and allow vehicles to be charged overnight. Currently, most people living multi-unit residential buildings (MURBs), such as condos and apartments, don't have EV charging access at home. Installing chargers often entails extensive renovations to connect to electrical infrastructure and can be costly and complex; projects frequently require approval from multiple stakeholders. However, adding charging infrastructure increases the value of the building to residents as well as market value, which in turn contributes to the uptake in EV purchases — an increasingly desirable choice for Albertans and the skilled workers that the province is trying to attract.

This guide presents expedient ways to install chargers for electric vehicles and find efficiencies to help make the process smoother in both existing residential buildings and new builds. With the rapid transition from gas-fueled to hybrids and all-electric cars, property owners and managers will need resources and advice on how to prepare for an EV future.

Key takeaways

1. **Start preparing for the future now**. With the federal government set to require that 20% of new passenger vehicle sales be zero-emission by 2026, followed by 60% of sales by 2030, and 100% by 2035, an all-electric passenger vehicle future is fast approaching. Because electrical renovations can take considerable time to plan and implement, charging plans for new builds need to be in place at the beginning of the project. Similarly, plans must be drafted to retrofit existing MURBs to accommodate EV charging.

2. **Make parking spaces "EV-ready."** EV chargers do not need to be the first step in making a building EV-friendly. Installing outlets or junction boxes adjacent to parking spaces allows residents to easily connect to a charger at some point in the future. With the electrical infrastructure behind the outlet or junction box being the most complicated and expensive part of installing chargers, developers, condo boards, and apartment owners can save themselves — and their residents — significant time in the future by planning ahead for EV charger installation during a new build or retrofit.
3. **Use EV energy management systems (EVEMS) to reduce costs.** EVEMS are a type of technology that controls the rate and timing of chargers, allowing multiple chargers to share the same branch circuit (the wire from the electrical panel breaker to the outlet connecting the charger). By using EVEMS, you avoid needing a dedicated circuit for each charger, significantly cutting down on wiring costs and the potential expense of electrical panel upgrades.
4. **Consider the long-term benefits of a comprehensive 100% EV-ready approach.** When EV adoption is low it may be tempting to electrify only a few parking spaces at a time, installing a handful of chargers for drivers to share in common parking areas. As demand for charging grows, however, and more drivers want to access chargers in their dedicated parking spot, a piecemeal approach can quickly become unsustainable and expensive. If only a handful of parking spaces are electrified with little forward planning, those first few chargers could end up exhausting electrical capacity. Consequently, the electrical infrastructure that was installed will need to be replaced resulting in higher costs and delays. Planning for all parking spaces to be EV-ready from the start and undertaking a single large-scale retrofit — all at once or in stages — will save money in the long term and avoid inconveniencing residents.
5. **Policymakers can lead the way.** While this guide is focused on the practical steps in installing EV infrastructure, decision-makers at all levels of government need to present policies and programs that support the installation of charging infrastructure in MURBs. The upfront cost is the most daunting obstacle. Overcoming this obstacle will entail:
    - requiring that EV-ready parking be a mandatory part of new construction
    - introducing rebate programs to cover a portion of costs
    - exploring financing mechanisms, rate structures and other options to enable MURB owners and utilities to invest in charging infrastructure.

    Appendix D of this guide describes some of the important policies and programs in more detail.

1. Introduction

Multi-unit residential buildings (MURBs) make up more than 30% of dwellings in Canada and 20% in Alberta. For developers of new MURBs, the easiest approach is to make parking spaces EV-ready from the outset, and many municipalities have made this a requirement. EV-ready retrofits in existing MURBs are more costly and challenging by comparison, as buildings must plan how to tie EV chargers into existing electrical infrastructure and, in the case of condominiums, seek out approval from multiple stakeholders.

Given these hurdles, this guide focuses on EV-ready retrofits in existing MURBs and seeks to make the process easier. It provides an overview of EV chargers and EV energy management systems; lists considerations that owners and boards should take into account as they plan retrofits for their building; and gives a step-by-step walkthrough of the retrofit process.

With EVs poised to become the dominant passenger vehicle in Canada by the end of this decade, apartments and condominiums need to be outfitted sooner rather than later by installing convenient charging options for current and prospective residents. Although this guide is focused on the multi-unit residential sector in Alberta, it may also prove informative for MURBs in other provinces.

1.1 About electric vehicles (EVs)

There are two primary types of vehicles with electric motors that are commonly referred to in the market as electric vehicles or EVs (Figure 1):

- **Battery electric vehicles (BEVs)** are driven by an electric motor instead of an internal combustion engine. The motor is powered by a battery pack in the vehicle, which must be plugged into an outlet or charger to recharge.
- **Plug-in hybrid electric vehicles (PHEVs)** have both an electric motor, powered by a battery pack, and an internal combustion engine. The battery pack can be recharged by plugging into an outlet or charger or through regenerative braking. Typically, when the battery is depleted, the vehicle switches to the internal combustion engine.

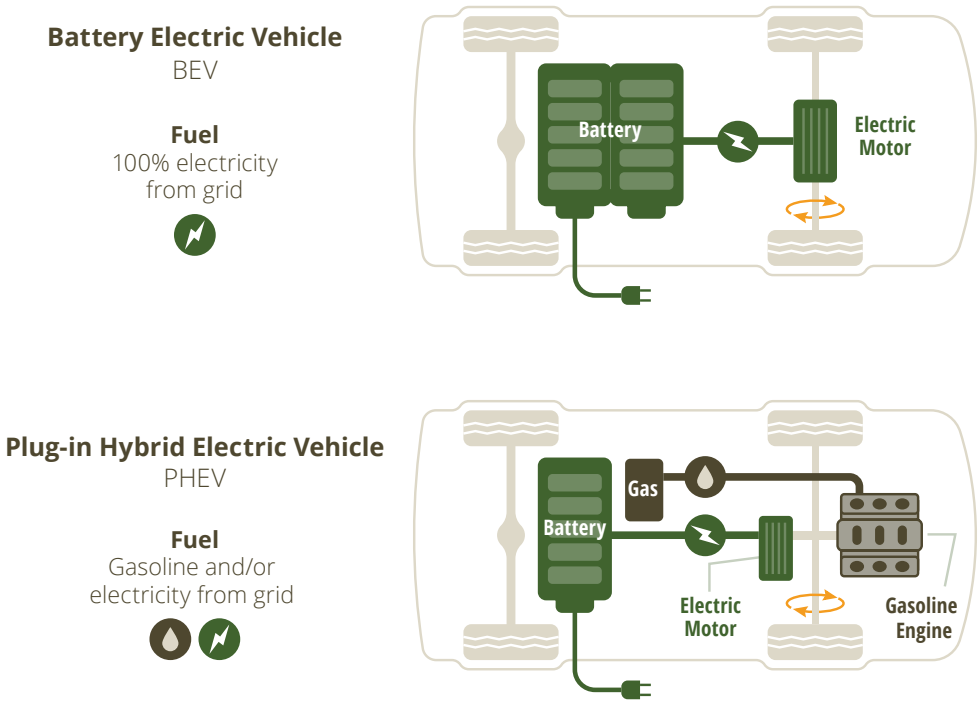

Figure 1. Battery electric and plug-in hybrid electric vehicles

1.2 Demand for EVs is rapidly increasing

Automakers around the world are shifting from internal combustion to electric fleets, and have identified EVs as a means of gaining market share and boosting competitiveness:[1]

- **Ford** plans to increase annual production of EVs to 2 million vehicles by 2026, expecting that one-third of sales will be fully electric, increasing to 50% by 2030.
- **Volkswagen** announced that all-electric vehicles will make up more than 70% of its European sales and more than 50% of its Chinese and U.S. sales by 2030.
- **Toyota**, the world's largest automaker, set plans to introduce 30 all-electric models and reach 3.5 million EV sales annually by 2030.

Automakers are pivoting from the production of internal-combustion passenger vehicles to EVs and hybrids, offering a greater variety of models at competitive pricing. In 2022, battery electric and plug-in hybrid vehicles made up 14% of global car sales, and the International Energy Agency predicts that figure will rise to 18% in 2023.[2]

EV adoption is quickly rising in Canada as well, as consumers capitalize on the benefits of going electric. In 2022, one in 15 new vehicles registered in Canada were all-electric, a sizable increase from 1 in 100 just four years earlier (Figure 2).[3] Over the same period,

the number of registered EVs increased almost ninefold in Alberta, with 5,680 registered EVs in the province in 2022.[4]

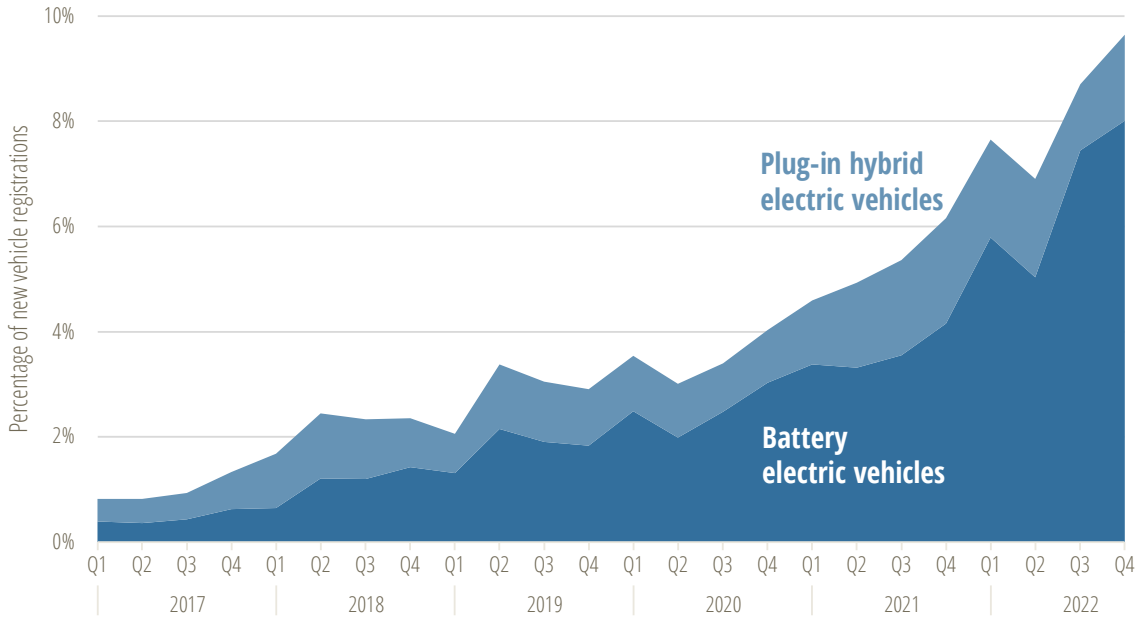

Figure 2. Electric vehicles as a percentage of new vehicle registrations in Canada

EV purchases are projected to accelerate even further, resulting in more than 12 million EVs on Canadian roads by 2035.[5] In Alberta, a 2021 poll showed that 54% of consumers are likely or very likely to buy an EV as their next vehicle.[6] The Alberta Electrical System Operator has estimated that by 2035, there could be 1.5 million EVs in the province.[7] Driving these trends are policy and market forces, which include:

- **The federal government's mandated EV sales targets**, which will require suppliers to meet a sales quota by 2026 where 20% of all new light-duty vehicles (e.g., cars, SUVs, vans, light trucks) sold are electric (BEV or PHEV). That quota increases to 100% of sales in 2035 (Figure 3).[8,9]

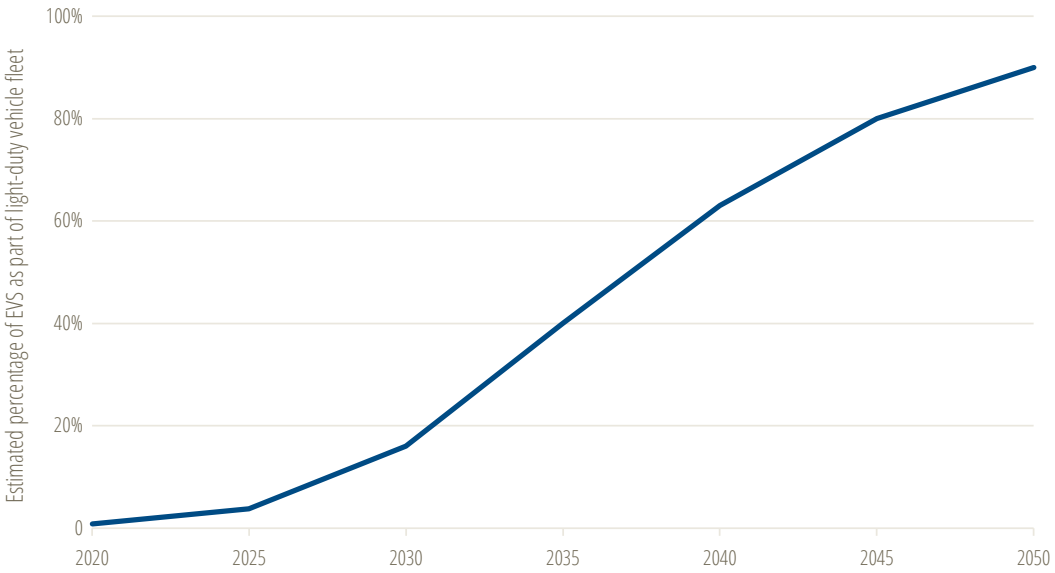

Figure 3. EVs as estimated share of light-duty vehicles on the road in Canada (with federal EV sales targets)

- **The federal government's purchase incentives and charging network —** In 2022, the federal government renewed funding for the Incentives for Zero Emission Vehicles (iZEV) Program, which provides up to $5,000 for Canadians to purchase or lease an EV, and the Zero Emission Vehicle Infrastructure Program (ZEVIP), which will help build 50,000 more charging stations across the country.[10]
- **The increasing affordability of EVs —** Although EVs have higher upfront costs than conventional vehicles, sticker prices are set to drop over the next few years as the cost of batteries decline. EVs are expected to reach price parity with conventional vehicles by the mid- to late-2020s, even without rebates.[11] With the life-cycle cost of many EVs already below that of traditional gas-powered vehicles, the economic appeal of EVs is becoming increasingly attractive to consumers.[12]
- **Public awareness of environmental impacts —** Climate change is increasingly top of mind for consumers. Significantly, 38% of Canadians cite the environment as the number one motivating factor for buying an EV, and 80% of consumers overall expressed a willingness to pay a premium.[13] As costs continue to drop, EVs will become even more popular.

1.3 Where do we charge EVs?

With EV adoption expected to undergo considerable growth over the next decade, EV charging infrastructure will need to likewise increase. Charging mostly takes place:[14]

- **At home —** More than 70% of EV charging in Canada occurs at the driver's home; home charging is generally the most convenient and cost-effective option.[15]
- **At work —** Roughly 15% of charging occurs at workplaces.
- **At public charging stations —** A smaller proportion of charging occurs at public charging stations.

While work and public charging are important, convenient home charging options are critical to supporting the switch to EVs.

1.4 Benefits of EV charging in MURBs

Multi-unit residential buildings that include EV charging offer multiple benefits to owners, managers, and residents:

Attracting and retaining occupants

Residents increasingly value charging options when deciding where to live, as EVs become their vehicle of choice. By providing charging, MURBs address the needs of residents and remain competitive in the housing market.

Preparing for an electric future

In the next decade, all passenger vehicles sold and almost half of all light-duty vehicles on Canadian roads will be EVs.[16] Renovations to install EV charging infrastructure can take considerable time to plan and implement. By being proactive and installing EV charging infrastructure now, owners and property managers will not be caught unaware when demand for EV charging rises suddenly.

Providing convenience and affordability

Providing charging options in MURBs allows residents to determine when to charge their EVs and makes EV ownership much more viable. Some estimates show that Alberta households with EVs could save an average of $3,000 annually on fuel and maintenance.[17]

Advancing equity

Lower-income households live disproportionately in multi-unit residences.[18] By expanding the availability of charging, MURBs can lower barriers for residents looking to acquire an EV and ensure that people of all socioeconomic backgrounds can enjoy the benefits of going electric. Some MURBs even provide public access to EV chargers. As EV prices fall and more used models become available, EVs will become an option for households in a broad range of income levels.

"We expect to see EV charging stations become a staple for new tenant interest in our properties and it will help us secure deals with new clients, residents, tenants, etc. It will provide access to a wider audience of parkers in our parkades which in turn is revenue generation." — Jarret Young, ONE Properties

ONE Properties has installed EV chargers in their Edmonton ICE District parkade, serving hotel, commercial, and residential users. They are now planning to install more chargers in their Edmonton and Calgary multi-unit buildings.

2. About EV charging

2.1 EV charging types

Electrical vehicle supply equipment, commonly referred to as EV chargers, are the assembly of cables, connectors, and apparatus that transfer power and exchange information between the electrical circuit and the vehicle. There are three types of EV chargers: Level 1, Level 2, and Level 3 (which are also referred to as direct current (DC) fast chargers (Figure 4).

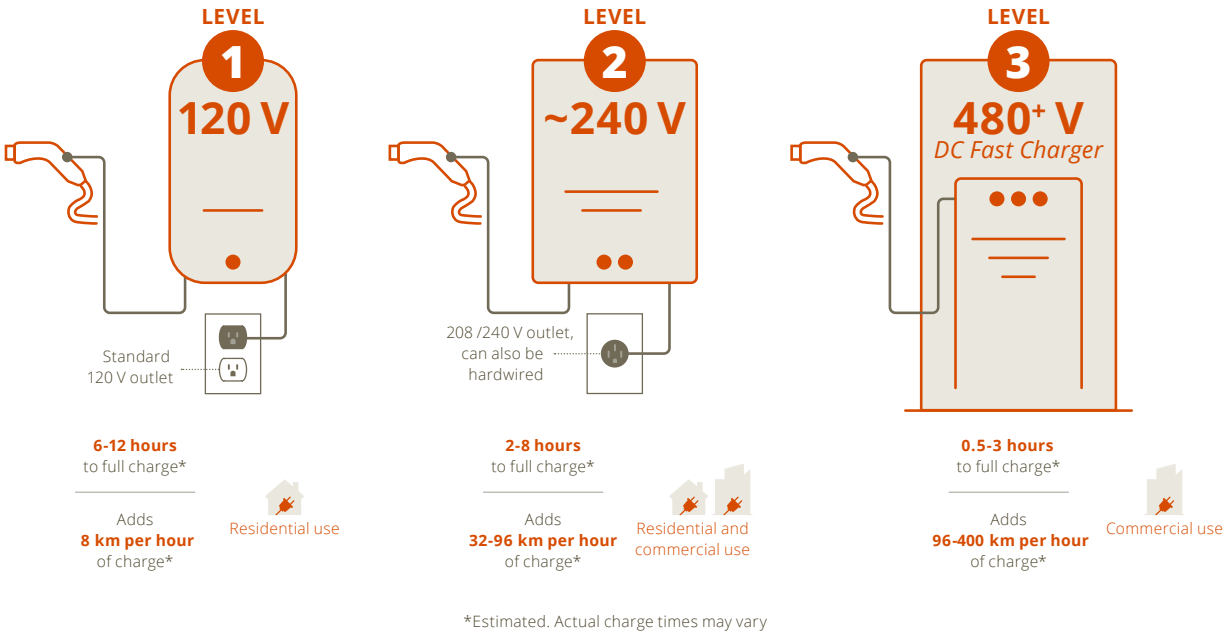

Figure 4. Types of EV chargers

Level 2 chargers are the most common in MURBs. Level 2 chargers are currently better suited than Level 1 chargers to meet the charging needs of residents, especially for people who travel long distances or drive larger vehicles like pickup trucks and SUVs. A Level 2 charger can fully charge most vehicles overnight, more easily preparing residents for long-distance trips at home. They also provide better performance for cold weather charging than Level 1 chargers. DC fast chargers, in contrast, are more frequently installed near high traffic corridors for quick charging en route.

Installing Level 2 chargers in MURBs is also more affordable than DC fast chargers. Purchasing and installing a Level 2 charger costs around $1,000 to $3,000, while a single DC fast charger ranges from $100,000 to $400,000.

The use of Level 2 chargers in combination with electric vehicle energy management systems (EVEMS) can also offer significant savings. EVEMS allow multiple EV chargers to share the same circuit by managing the rate and timing of charging, thus removing the need to build dedicated circuits to each charger (see section 2.2 on EV energy management systems). As an added benefit, installing an energy management system may avoid the need to expand electrical capacity in the future, or reduce the size of such an upgrade.

Networked vs. non-networked chargers

Level 2 EV chargers can either be networked or non-networked:

Networked chargers or "smart" chargers come with built-in Wi-Fi, cellular, or other network capabilities that allow them to connect to a larger charging network and communicate with other chargers. Networked chargers can enable a variety of functions that are valuable for MURBs, such as: tracking individual energy consumption; billing users (see section 3.3 on user fees); remote maintenance and troubleshooting; online reservation systems; and mobile app integration. Furthermore, networked chargers can enable load-sharing across chargers (see section 2.2 on EV energy management systems).

Networked chargers are typically operated by charging service providers (see section 2.4) that charge a subscription/networking fee. Charging service providers' expertise and management can make EV charging easier for your building and more accessible for users.

Non-networked chargers are standalone units that charge EVs. They are typically cheaper than networked chargers but also mean that the benefits of networked chargers, such as online reservation systems, remote maintenance etc., must be done as separate steps which can be time consuming and inconvenient.

2.2 EV energy management systems

EV energy management systems (EVEMS) are a class of technologies that monitor and control the electrical loads of EV chargers. By controlling when during the 24-hour

period a vehicle is being charged and how quickly, an EVEMS can ensure that the electricity needed for charging vehicles is used in the most efficient way possible.

These efficiencies translate into cost reductions when installing and using multiple EV chargers in a building, through efficient ways of configuring the electrical system. The system can also be programmed to concentrate charging when power is less expensive (e.g., in jurisdictions with time-of-use utility rates that charge lower rates for power consumed at certain times of the day) and/or cleaner (e.g., when more of the electricity in the system is being generated from renewable sources).

In the future, networked chargers may be able to contribute to a net-zero grid through vehicle-to-grid technologies that allow a charged vehicle to feed electricity back into the grid, increasing grid flexibility (e.g., reliability services) and helping grids use more renewable electricity.

How EVEMS work

Many EVEMS use automatic electronic communications between chargers (and/or between a charger and an external server that also controls other chargers). This can be done through cellular service, Wi-Fi, ethernet, or other wired networks.

An EVEMS can control how quickly (or slowly) a vehicle is charged, which is determined by the activity of other chargers on the same circuit and the available electrical capacity. For example, imagine a single electrical circuit shared by four chargers, each serving one parking space. If only one vehicle is plugged in and drawing charge, it can use the full capacity of that circuit at a relatively fast rate (approximately 40 km worth of vehicle range per hour of charging). However, if all four EVs are charging at the same time, the rate of charging is slower (in this case 10 km of range per hour), so as not to exceed the capacity of the circuit. For some installations, however, there is enough capacity that the charging rate won't be any slower.

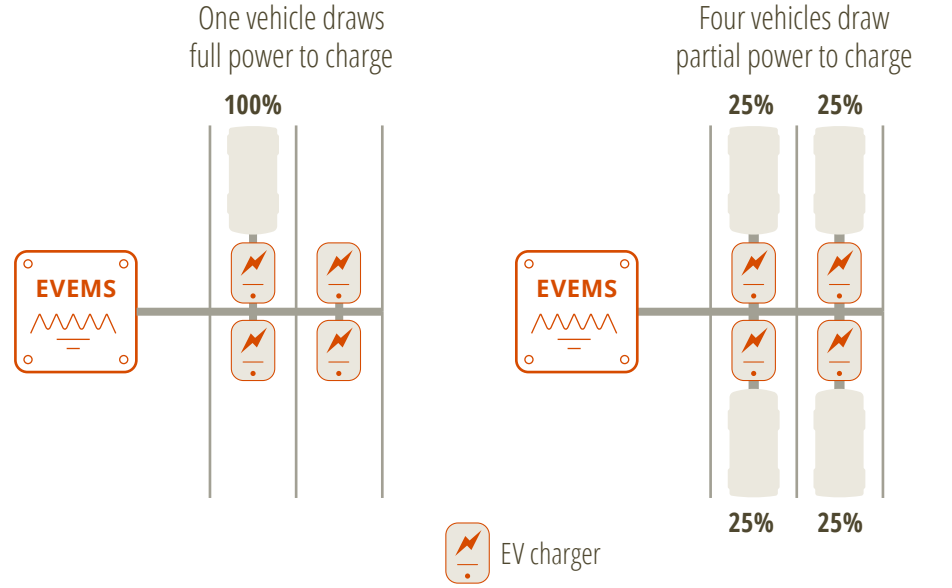

Figure 5. Example of EV energy management system when four cars are charging at once

For residential charging applications, a certain amount of load-sharing will serve drivers perfectly well; because vehicles typically charge overnight there is plenty of time to charge. In the example above, if three vehicles drove 40 km in a day using 10% of their battery (a typical amount for Edmonton and Calgary drivers), and the fourth vehicle drove 400 km (100% of its battery), they would all receive approximately 40 km worth of range in the first four hours. Once other vehicles were completed charging, the remaining vehicle would charge at a faster rate, getting 360 km of range over approximately nine hours.

An EVEMS can accommodate multiple chargers on an electrical panel of finite capacity. By monitoring the amount of electricity used at any given time and how quickly or slowly it is used, more chargers can be installed per electrical panel. Electrical panels and circuits can be configured in a number of ways to support EV charging (note that a "branch circuit" is a term for the wiring between an electrical panel breaker and an electrical outlet):

- **Unmanaged (i.e. no EVEMS is used) dedicated circuits —** In this case, a 200 A panel can serve only five EV chargers, each on a dedicated 40 A branch circuit.
- **Panel sharing using EVEMS —** By controlling EV loads at the panel level, this configuration supports 20 EV chargers on 20 branch circuits.
- **Branch circuit sharing using EVEMS —** By sharing four EV chargers per 40 A branch circuit, 20 EV chargers can be served by a 200 A panel with only five branch circuits.

Branch circuit sharing is the most cost-effective approach in a situation where every parking space has a charger, because it limits the electrical capacity needed and reduces the number of branch circuits (made from expensive copper) that must be installed. Using only panel sharing requires approximately four times as many branch circuits, increasing costs.

Another configuration for EVEMS is "service monitoring." Service monitoring ensures that the maximum electrical capacity at the building level is not exceeded. This provides the ability to install more EV charging loads in a building that would otherwise not have sufficient electrical capacity. Service monitoring through EVEMS is relatively uncommon but can provide options in buildings that are near their electrical capacity.

For visual examples of these EVEMS configurations, see Appendix C.

We recommend designs that use load-sharing enabled by EVEMS, as this will **significantly reduce the costs** of providing EV charging to large numbers of residents. Dedicated circuits can cost three to four times more than a load-share approach using EVEMS or more.

Charging performance requirements

Charging performance requirements vary. In areas where residents typically drive longer distances, load-sharing may need to be reduced to adequately meet drivers' charging needs. An electrical contractor or engineer can assess your building's minimum charging performance requirements and appropriate load-sharing configuration (see Appendix B).

In a study for the cities of Calgary and Edmonton, AES Engineering Ltd. determined that, because the average distance travelled by a passenger vehicle is less than 35 km per day, four Level 2 chargers load-sharing a 40 A circuit is sufficient to meet the charging needs of most drivers.

2.3 Making parking spaces EV-ready and EV-capable

There are several ways to prepare parking spaces for EV charging when building or renovating a building. Three common configurations are:

- **EV charger installed —** The EV charger is installed providing all the infrastructure necessary to charge an EV.

- **EV-ready —** The infrastructure required for charging, except for the charger itself, is installed. This means there is an electrical outlet adjacent to the parking space where an EV charger can be hardwired or plugged in at some point in the future. EV-ready parking is much more cost effective than retrofitting later, when installing a Level 2 charger.
- **EV-capable —** An electrical panel with spare space and electrical capacity allocated to support installation of a branch circuit and EV chargers is installed. It may also include some electrical conduit.

Most building owners will not want to proceed with the full cost of installing all infrastructure including chargers and will instead install EV-ready or EV-capable configurations. These two options are described in more detail in the graphics and table below.

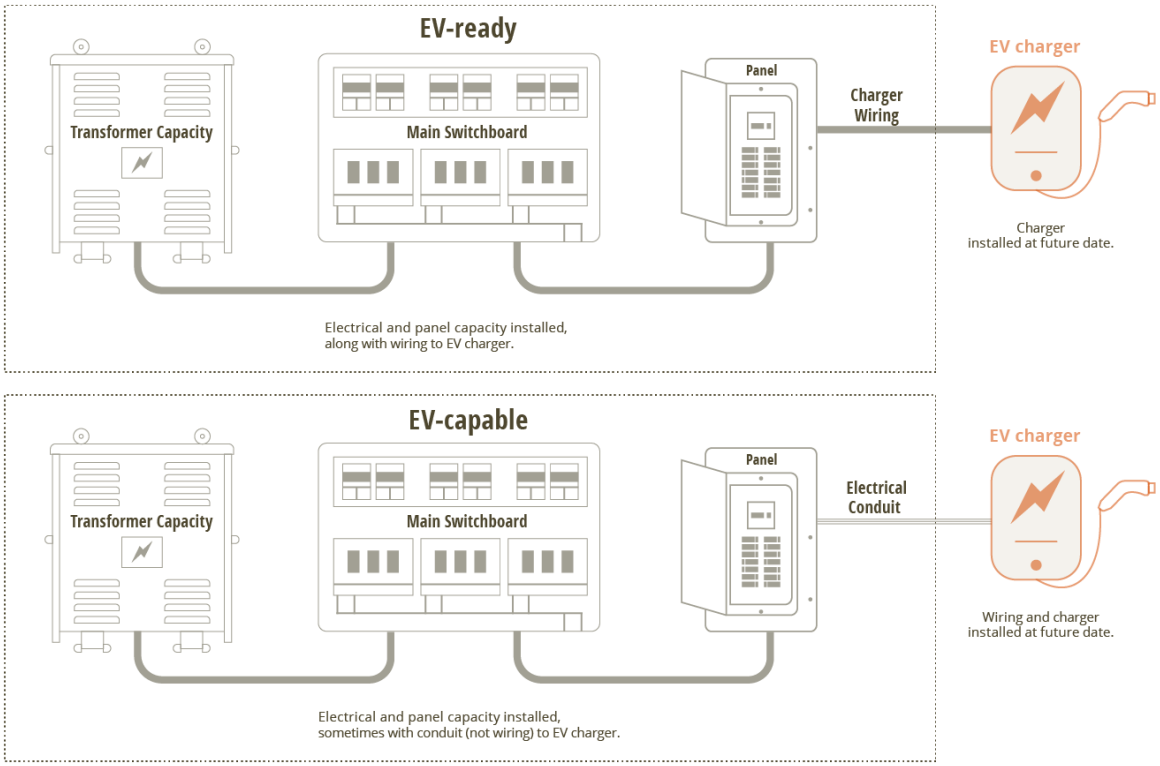

Figure 6. Electrical infrastructure for EV-ready and EV-capable parking

Source: Adapted from Electric Mobility Canada[19]

Table 1. Comparing EV-ready and EV-capable parking infrastructure

EV-ready	EV-capable
Higher upfront costs	Approximately 20% to 30% less expensive upfront than EV-ready
Often designed for load-sharing across branch circuits, resulting in lower life-cycle costs.	Often designed for dedicated branch circuits and management at the panel level, resulting in higher life-cycle costs (can be approximately 50% more than EV-ready).
One, or few, electrical installations.	Multiple electrical installations with inefficient overlap (e.g., conduit configurations).
Lower cost when EV charger is finally installed — cost for charger only.	Higher cost when EV charger is finally installed — cost for both EV charger and branch circuit.
In condominiums, the condo corporation usually pays for the EV-ready infrastructure. EV owners usually pay for the EV charger when they acquire an EV.	In condominiums, the condo corporation usually pays for the EV-capable infrastructure. EV owners usually pay for EV charger and branch circuit. If the design is for load-sharing on branch circuits, it is not clear who pays for a branch circuit — for example, the first unit to get an EV might pay for the branch circuit, which is subsequently used by their neighbours.
Required by many cities in Canada and the U.S. for new construction.	Required by some cities in the U.S.

Condominiums and apartments should consider EV-ready infrastructure designed for significant branch circuit load-sharing (such as 4-share per 40 A or 50 A circuit). This way tenants and owners realize cost savings through branch-circuit sharing, and bypass the challenge of determining which unit pays for shared branch circuits once it is time to install the first charger. Section 3 discusses in more depth how preparing many parking spots to be EV-ready is more cost-effective in the long run.

> *"We used our engineering partners to determine what capacity we had available in our system with the goal of using existing capacity to support initial projects and allow for 4-5x expansion in the future without major upgrades. It's best to do the upgrading up front so you have ease of expansion down the road when demand increases."* — Jarret Young, ONE Properties

2.4 EV charging service providers

EV charging service providers sell EV chargers and the associated software and services. The relationship with the EV charging service provider is an important one. Service providers can offer significant value. On the other hand, if there is a mismatch between an EV charging service provider and the services required by your building and/or budget, there is a risk of spiraling costs and potentially stranded assets.

Condominium and apartment owners should work with electrical professionals experienced in EV charging installations to select an appropriate EV charging service provider for their building. A good practice is to solicit several proposals from charging service providers that include detailed descriptions of services and prices. Some key considerations when selecting a service provider include:

- Cost, including EV charger purchase costs, financing, and ongoing network fees.
- Quality of service/vendor reputation.
- Financial stability of provider (try to gauge how likely it is that a service provider will be in business in the future).
- Whether the EV chargers and charging management system use open or proprietary networking protocols (see below).

See below for a more complete list of services to consider from your EV charging service provider.

2.4.1 Open versus proprietary systems

For networked chargers to communicate with one another, the IT communications systems must be compatible.

Open Charge Point Protocol (OCPP) systems allow different EV chargers and different EV charging service providers to be inter-operable thus avoiding “lock-in” to an EV charging service provider and EV charger models. This means you can switch to a different service provider if you need to.

It should be noted that not all EV charging service providers use OCPP for all communications functions; some of the established providers still use proprietary systems (though some have committed to implementing future versions of OCPP).

2.4.2 Services to consider from your EV charging service provider

When discussing services with an EV charging service provider, consider the following:

- Ability to coordinate charger procurement and installations
- EV charger features, including whether they have OCPP or proprietary protocols
- EV energy management (see section 2.2)
- Operations and maintenance
- Warranties
- Data management and data security
- Helplines and customer assistance
- Apps and dashboards available for drivers and system administrators, including accessibility and services (e.g., user friendliness, cellular or wireless internet connectivity requirements for users, flexibility in payment options)
- How building owners or condominiums will be able to recoup the costs of electricity used by vehicles
- How to ensure only registered drivers may use the chargers
- The possibility of receiving carbon credits (e.g., under the Federal Clean Fuels Regulation), which could allow building owners to generate revenue from EV charging on their property
- Coordinating with utilities to provide "demand response" services (i.e., controlling the timing of charging), again providing revenue opportunities for the building

Many of these services are coordinated through vendors' EV charging management systems. Networked EV chargers that are compatible with the charging management system must be installed.

3. Optimizing charging infrastructure and minimizing costs

Condominium boards and apartment owners need to think carefully about how they can optimize the value of EV charging infrastructure. For existing buildings, the simplest and most cost-effective means is to install an EV-ready retrofit for all residents' parking spaces. Building owners, however, may prefer a more phased approach. These approaches are explored in detail here, while Section 4 outlines the overall process.

3.1 Assessing charger locations

Chargers and EV-ready infrastructure can be installed in either assigned parking or commonly accessible parking (Figure 7). Condo boards and apartment owners should consider the following when making their decision:

- **Assigned parking spaces** are designated parking spots assigned to individual units. This is the most convenient for drivers, allowing them to charge their EVs whenever they want in the space where they park.
- **Commonly accessible parking spaces** are spaces that are shared among residents, such as streetside or visitor parking. Chargers are often installed in these locations and more chargers are added over time. This way the upfront costs are reduced. The downside of this approach as demand for EV charging grows is the following:
    - **Inconvenience —** Residents rotating through a parking spot to use a shared charger can quickly become unsustainable as the number of EV drivers increases. Drivers may have to swap out vehicles at inconvenient hours.
    - **Limits on common parking areas —** Apartment and condo residents are unlikely to agree to changing their assigned parking space, even if it would create more commonly accessible charging sites.
    - **Municipal bylaws —** Some Canadian municipalities have bylaws that prevent residents from using visitor parking spaces, in which case installing chargers for resident use in these areas is not an option.
    - **Stranded assets and long-term costs —** The first few chargers installed in common parking areas may prove a barrier to future retrofits, when

additional charging infrastructure needs to be installed in dedicated parking spaces. If these first chargers were installed without planning for future expansion and they exhaust the building's electrical capacity, charging infrastructure will need to be altered, adding costs and delays to subsequent retrofits.

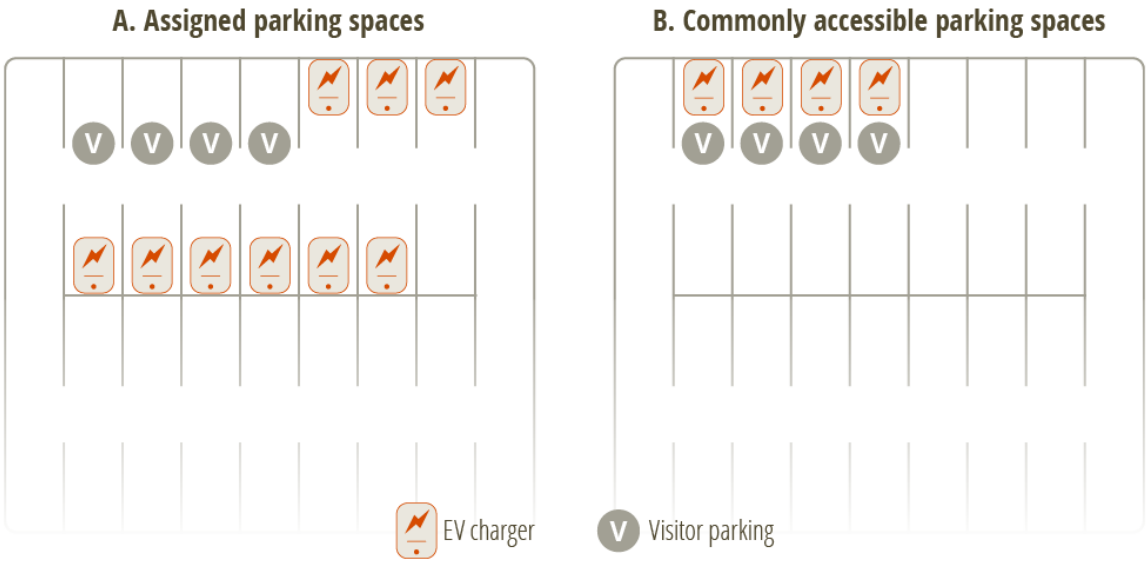

Figure 7. Implementing chargers in assigned vs. commonly accessible parking areas

3.2 Piecemeal additions vs comprehensive retrofits

There are two options for retrofitting MURBs with EV charging infrastructure:

1. **Piecemeal additions —** One option is to install a few chargers and associated electrical infrastructure and add more over time as the number of EVs increase. Often these chargers are initially located in common parking areas.
2. **Comprehensive EV-ready retrofits —** A second option is to undertake an electrical renovation to make all parking spots EV-ready (or alternately EV-capable).

A comprehensive EV-ready retrofit is a large upfront capital investment. But in our research, we have found this approach will also be much more cost-effective over the lifetime of the building.

Planning for 100% of parking spaces to be EV-ready from the beginning will ensure there will be enough electrical capacity to support all residents' charging needs, avoid stranded assets, and significantly reduce the cost of wiring and electrical upgrades.

Adding chargers piecemeal can lead to inefficiencies and rising costs. Each additional project may not account for future electrical demand. As a result, subsequent charger installations may require electrical upgrades that could have been avoided. Table 2 compares the two options.

Table 2. Comparing piecemeal additions of EV chargers vs comprehensive EV-ready retrofits

	Piecemeal additions of EV chargers	Comprehensive EV-ready retrofits
Description	A few chargers are installed. Repeated series of electrical projects, as EVs are purchased. Designs typically place chargers on dedicated electrical circuits.	A holistic electrical renovation to make each parking space (or one per residence) EV-ready or EV-capable. Typically designed for extensive branch circuit load-sharing. Can be installed all at once or in large stages (e.g., one floor at a time in an apartment parkade).
Location of EV chargers	In commonly accessible parking (e.g., visitor parking), or in units' assigned parking.	In units' assigned parking.
Who pays for electrical work & EV charger installation?	In condominiums, condo corporations or in some cases individual units — often the first EV owner — may pay for EV charger installation. The same procedure occurs in rental buildings.	In condominiums, the condo corporation usually pays for the electrical infrastructure to make parking EV-ready. Unit owners usually pay to install EV chargers and pay any monthly fee to the charging service provider. In rental buildings, the owner typically pays for everything and rents out parking space.
Who pays for operating costs?	If the charger is commonly accessible, condo corporation / building owner pays the service fees. User fees may cover electricity costs.	Drivers typically pay a monthly service fee directly to an EV charging service provider, or indirectly through a premium on their parking fee. User fees typically cover electricity costs.

Upgrade cost per parking space	Average cost per parking space is approximately $8,000. This includes $4,000-12,000+ for electrical infrastructure, and $1,500-3,000 for the charging equipment.	Average cost in 2022 was approximately $1,300 per EV-ready parking space (individual project costs range significantly).* Unit owners pay charger installation costs over time. Current average costs of $2,000-3,000; opportunities exist for industry to reduce costs.
Convenience to install chargers	Typically, lengthy and uncertain process for unit owners to install new chargers.	Relatively simple process. Unit owner contacts EV charging service provider to install charger. Often charger installations will be grouped together (e.g., bi-annually) to achieve economies of scale.
Potential for expansion & impacts on electrical capacity	Piecemeal additions tend to not be designed for subsequent expansion. Can lead to stranded assets in future years. Lack of design for load-sharing can result in insufficient electrical capacity for subsequent expansion, requiring multiple service upgrades.	Typically, with use of load-sharing EVEMS, sufficient electrical capacity is available to provide EV charging to all residents without an electrical service upgrade (or with only one upgrade).

* Data from British Columbia; EV-ready installations used load-sharing with EVEMS. Costs were derived from buildings with structural parking; EV installations on surface parking is likely to be more costly, due to civic infrastructure.

Piecemeal additions of EV chargers have been by far the most common approach in jurisdictions without EV-ready incentives given the significant upfront costs of a comprehensive retrofit. Because EV uptake is rapidly increasing, however, comprehensive EV-ready retrofits will provide the most value to most MURBs — especially those that will be in use for 20 or more years.

The case study below summarizes an EV-ready retrofit in a large multi-unit condominium in Saanich, British Columbia.

Case study: Saanich strata complex now 100% EV-ready

In fall 2021 Saanich District introduced a municipal top-up rebate program for multifamily buildings looking to install EV chargers. In 2022, Saanich's largest strata (condo) complex completed an upgrade to provide EV charging to residents, wiring 255 parking stalls to accept an EV charging station (becoming becoming "EV-ready"). The strata consists of 5 condo buildings, has 245 residential units, and includes 337 (+66 visitor) underground parking spots.

An EV-Ready Plan that outlined electrical design options was developed by a local contractor, at a cost of $3,700. The building owners approved a special levy to fund the project and decided on a load-sharing strategy: each 40 Amp circuit is shared by six chargers using smart energy management technology. This approach was done to balance keeping costs low and still meeting residents' charging needs with overnight charging. The total cost of the project was $381,000 before rebates ($1,490 per stall) or $144,500 after rebates. Residents are charged $1 per charging hour at 6.6 kW (pro-rated for load-sharing).

Source: District of Saanich[20]

3.2.1 A phased approach to comprehensive retrofits

Some building owners may decide to take a comprehensive approach to retrofits with the goal of making 100% of parking spaces EV-ready, but elect not to install charging infrastructure all at once. Instead, buildings may adopt a phased approach, installing EV-ready infrastructure in a few stages. For instance, a building might prepare one floor of a parkade of the parking spaces to be EV-ready in the first stage, with plans to make the remaining parking spaces EV-ready in the second stage of retrofits.

When carefully planned with future expansion in mind, a phased approach distributes upfront costs over time, without adding too excessively to life-cycle costs. The cost-effectiveness of such an approach, however, depends largely on the type of building. Phased retrofits such as floor-by-floor in a parkade may be feasible in rental apartments, where tenants do not legally own their parking spaces. Owners of these buildings may be able to re-assign parking, or there may be sufficient turnover in residents so that residents in early need of charging have their parking spaces grouped together, making phased retrofits more cost-effective. In many condos, however, where residents often own their parking space, phased retrofits may be challenging and costly, making a 100% one-time comprehensive approach more appropriate.

Building owners should carefully consider which approach makes sense for them, taking into account parking configurations, demand for charging among residents, service capacity, and upfront and life-cycle costs. By consulting an electrical engineer and making an EV-Ready Plan (see more in Section 4.2), owners and boards can determine which approach best meets their needs.

3.3 User fees for EV charging

An important consideration for condo boards and apartment owners is how to structure user fees for EV charging. By setting fees, the cost of electricity incurred from charging can be recovered and EV drivers pay their fair share for the building's electricity consumption. User fees can be structured in three different ways:

- **Flat fee** — All users pay the same monthly fee for unlimited charging.
- **Hourly fee** — Users pay a rate for every hour of charging. Hourly fees can be prorated when load-sharing occurs using EVEMS (for example, $1.50/hour when getting full capacity; $0.75/hour when sharing with one other vehicle; etc.).
- **Energy (volumetric) fee —** Users pay a rate for every kilowatt-hour of electricity they consume (e.g., $0.10/kWh).

Table 3 compares these three different models for user fees.

Table 3. Comparing EV user charging fee approaches

	Flat fee	Hourly fee	Energy (volumetric) fee
Administration	Building estimates monthly charging costs and divides among users	Charging service provider monitors individual usage and bills users	Charging service provider monitors individual usage and bills users
Equipment required	EV chargers	Networked EV chargers	Networked EV chargers equipped with Measurement Canada-approved meters[21] to measure electricity consumption
Fairness/ accuracy	Users who consume the least electricity are forced to pay the same as users who consume the most	Users pay for a close approximation of the amount of electricity consumed*	Users pay for the precise amount of electricity consumed
Savings for users	None	Can respond to time-of-use pricing**	Can respond to time-of-use pricing**
Additional costs to administer	Managing the billing process could be a cost Adjusting the level of the fee may require a	Hardware costs and monthly fees for charging service provider	Hardware costs and monthly networking fees for charging service provider Added cost of meters

	vote at a general meeting for condos		
Recovery of electricity costs	Buildings may fail to recover electricity costs if tenants charge their cars more than expected	Buildings can recover electricity costs	Buildings can recover electricity costs

* Charging speed can vary by the state of charge. As the battery approaches its full capacity, for example, the rate of charging may decrease significantly.

** Unlike some other Canadian provinces, Alberta does not have time-of-use pricing available to most consumers.

Implication of recouping costs for EV charging

Across Canada, provincial utility legislation recognizes entities selling electricity to the public as utilities and requires that utilities obtain regulatory approval to set rates for their customers. What does this mean for entities, like MURBs, looking to provide EV charging services for a fee?

To date, no province has ruled that EV charging providers should be subject to utility regulations. In B.C. and Quebec for example, regulators have concluded that EV charging providers are exempt, allowing entities like MURBs to set user fees at their own discretion.[22] Most provinces, including Alberta, however, have not yet issued any binding opinion on this subject.

The Pembina Institute will monitor regulatory oversight of EV charging in Alberta and provide updates in subsequent editions of this guide.

4. Putting it all together

4.1 Implementing an EV-ready retrofit in your MURB

Below, we outline a process for considering and implementing a comprehensive 100% EV-ready retrofit in a multi-unit condominium or apartment (summarized in Figure 8).

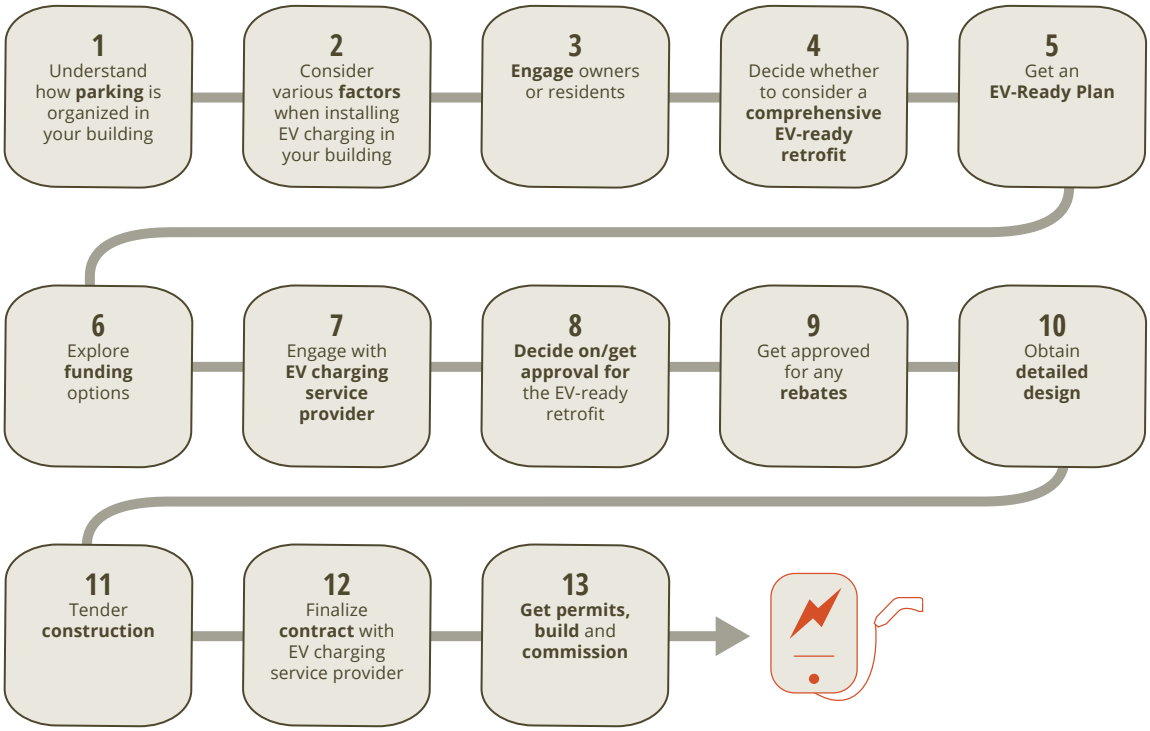

Figure 8. Workflow for implementing an EV-ready retrofit

1) Understand how parking is organized in your building

- Learn about legal parking designations — Review the condo plan, parking leases, covenants, and stall assignments. Property managers or condo lawyers can assist.
- If unit owners do not have a long-term right to park in an assigned parking space, it may make more sense for a condo corporation to own and pay for EV charger installations and lease use to owners. Otherwise, the unit owner is likely to pay for the charger.

2) **Consider these factors when installing EV charging in your building**:
    - **Cost-effectiveness —** Would you be willing to invest more upfront for a 100% EV-ready retrofit that will ultimately be more cost effective for all residents? Are short-term or long-term costs more important? Does your building have a budget?
    - **Scalability and future-proofing —** How long is the building likely to remain standing? Will the building still be in use when most vehicles will be EVs (i.e., 10 to 20 years from now)? Is it important to avoid the potential for stranded assets (such as initial installations for EV charging infrastructure that may need to be replaced as demand grows)?
    - **Access —** Should all residents in your buildings ultimately be able to access EV charging? Do you want to provide access to EV charging for visitors, only pre-approved residents, or even the public?
    - **Cost allocation —** Can the condo corporation pay for common electrical expenses that may eventually be used by everyone (e.g., in an EV-ready retrofit)? Should unit owners pay for EV chargers in their assigned parking spaces? Should drivers pay for the cost of the electricity they use?
    - **Ease of implementation —** As more people purchase EVs, how important is it that drivers have a simple, assured process to access EV charging?
3) **Engage owners or residents**
    - Determine if residents are interested in optimizing the building for EVs and support exploring feasibility through an EV-Ready Plan prepared by an electrical engineer or consultant.
    - A simple survey, like the example in EV-Ready Plan scope Appendix A, can help. Ask:
        - Are unit owners or residents interested in being able to easily install EV charging in their assigned parking space?
        - Are unit owners willing to support an EV-Ready Plan with an approximate cost?
4) **Decide whether to seriously consider a comprehensive EV-ready retrofit to make all assigned parking EV-ready.**
    - For condos, this decision could be made at a general meeting, or by the board.
    - If the condo board or apartment owner decides not to consider an EV-ready retrofit at this time, consider:
        - Implementing a few EV chargers in a commonly accessible parking location (e.g., visitor parking) as a short-term measure. Request a quote from one or

more experienced electrical contractor(s) with EVITP training and certification.[23]
    - Creating a policy about whether and how residents can make changes to common property and use the buildings' common electrical systems to implement EV charging in their assigned parking space.
- Only proceed with a plan for an EV-ready retrofit if you think it is possible the owners would be willing to invest at least $700 per resident to give all residents access to EV charging in their assigned parking space.

5) Get an EV-Ready Plan

- Contact experienced electrical engineering consultants and/or EV charging service providers with electrical engineers to get proposals and quotes for an EV-Ready Plan, which is a feasibility study of how to provide EV charging to every unit with an assigned parking space.
- The EV-Ready Plan should include:
    - A review of the building's electrical systems
    - A calculation of the building's available electrical capacity to serve EV loads
    - Determination of how much load-sharing using EVEMS is appropriate for the building
    - Conceptual electrical design options (these could be simple wiring plans or electrical single-line diagrams)
    - Cost estimates
    - Description of the EV chargers and the charging management services that EV charging service providers can offer
- The scope of an EV-Ready Plan is included in Appendix B. The District of Saanich, British Columbia, has created a draft Request for Proposals that can be used to solicit proposals from engineering firms for EV-Ready Plans.[24] See also the "Involving an Electrical Engineer in your EV-Ready Plan and EV-ready Retrofit" section below.

6) Explore funding options

- Consider various ways of funding the project including reserve funds, bank loans, and/or special assessments for the residents.
- Many EV-ready retrofits cost $1,000 to $1,500 per parking space for the outlet. Unit owners pay additional costs to install EV chargers when they buy an EV.

7) Engage with EV charging service provider

- An EV charging service provider may be recommended as part of the EV-Ready Plan. Alternatively, consider requesting proposals for services from multiple

charging service providers. Electrical engineers and/or contractors can help select EV charging service providers.

- See Section 2.4.2 for services to consider from an EV charging service provider.

8) Decide whether to pursue the EV-ready retrofit (Condos: get approval)

- Share the EV-Ready Plan with residents.
- Schedule a General Meeting (either an Annual or Special General Meeting) and invite the organization that prepared the EV-Ready Plan to present and answer questions.
- Draft resolutions. This should be done by a condominium lawyer, property manager, or other suitable entity. Resolutions should include:
  - Decision to pursue EV-ready retrofit
  - Procedures for unit owners to implement EV chargers, once construction is complete. This should include who owns EV chargers.
  - User fees
- Decide at a General Meeting whether to implement the Plan and the total budget for the Plan.

9) Get approved for any rebates

- Learn about the Federal Zero Emissions Vehicle Incentive Program (ZEVIP), which funds chargers.
  - Several delivery organizations support the rollout of funding through this program so you will not need to apply to the government directly. The organizations include: the Alberta Municipal Climate Change Action Centre, the SouthGrow Regional Initiative in southern Alberta, Green Economy Canada, Eco-West Canada, EPCOR Utilities, and the Atmospheric Fund. A full list can be found on Natural Resources Canada's website.[25]

10) Obtain detailed design

- An electrical engineer can prepare a detailed electrical design for the project. Sometimes, an electrical engineer will work with a contractor or EV charging services firm to provide design oversight on the project.

11) Tender construction

- An electrical engineer can help administer a competitive bidding process for construction work to complete the EV-ready retrofit.
- Some condominium boards rely on EV charging service providers to select contractors, or directly award the work to the contractor who helped prepare the EV-Ready Plan.

12) Finalize contract with EV charging service provider

- Formalize the relationship with an EV charging service provider.

13) Get permits, build and commission

- EV-ready retrofits require electrical permits and an operating permit.
- The first tranche of EV chargers will be installed.
- Engineers, contractors and/or EV charging service providers should commission the systems to ensure chargers are working effectively.

4.2 Consider whether to involve an electrical engineer to coordinate your EV-ready retrofit

Property owners and managers often hire an electrical engineer to help prepare an EV-Ready Plan and provide the services needed for the retrofit. An EV-ready retrofit usually constitutes a major electrical renovation, and it is appropriate to involve a professional engineer. An electrical engineer can:

- Prepare the EV-Ready Plan and present information about the project with the condo board or building owner
- Help owners select an EV charging service provider and EV charger model(s)
- Produce detailed electrical design, including a list of reconfiguring that will be required
- Provide cost estimates
- Assist owners with competitive tendering to select an electrical contractor for project implementation
- Conduct field review of construction works
- Commission EV charging systems

Securing an electrical engineer, or an engineering firm, to act as an independent agent on your behalf has many advantages including that, unlike contractors, engineers have professional liability insurance. The insurance protects against any liabilities associated with the design of a project. Engineering fees are usually about 10% to 20% of the total project costs, although it can vary.

While boards and owners can work directly with an electrical contractor and/or an EV charging service provider, rather than an electrical engineer, doing so can entail risks.

Examples of EV readiness in Alberta

Retrofits

ONE Properties has installed 10 EV chargers in their Edmonton ICE District parkade, which serves residential and commercial (hotel, hockey arena, and offices) needs. They have a plan for offering more charging in another area of the parkade. ONE plans to install several chargers in their Edmonton and Calgary properties through assistance from the Federal ZEVIP EV funding program. ONE works with numerous contractors with EV charger experience.

In Calgary's East Village redevelopment area overseen by the Calgary Municipal Land Corporation, the Arris building, which includes towers with 200 parking stalls, will receive nearly 100 chargers. The chargers will be installed in two phases starting with the installation of 38 chargers, followed by an additional 60 chargers timed to meet increased demand.

New builds

Strategic Group has installed four chargers in The Capital in Edmonton; Oxford Development has installed two chargers in the Mayfair in Edmonton. Bucci Developments has built four chargers in the Dominion complex in Calgary.

Appendix A. Resident survey for EV-ready retrofits

The following survey is a template for owners of MURBs to gauge interest in EV-ready retrofits among their residents.

1) Do you plan on driving an electric vehicle (EV) in the future?

- ☐ I already drive an EV
- ☐ Yes
- ☐ No
- ☐ I don't know

2) If yes, when do you plan on acquiring an EV?

- ☐ In the next year
- ☐ In the next 2 years
- ☐ In the next 5 years
- ☐ In the next 10 years
- ☐ I'm not sure

3) Would you like to eventually be able to charge an EV in your assigned parking space?

- ☐ Yes
- ☐ No
- ☐ I'm not sure

4) How important is it that you are able to charge an EV in your assigned parking space?

- ☐ Very important
- ☐ Fairly important
- ☐ Important
- ☐ Somewhat important
- ☐ Not at all important

5) **“EV-ready” parking spaces have an electrical outlet or junction box adjacent so drivers can easily install an EV charger in the future. Would you be interested in our building making your assigned parking space EV-ready?**

- ☐ Yes
- ☐ No
- ☐ I’m not sure

6) **Our building could hire an electrical contractor or engineer to produce an EV-Ready Plan. The EV-Ready Plan would include an evaluation of feasible designs to make parking spaces ready for charging EVs and an estimate of the costs of a renovation. Preparing and drafting an EV-Ready Plan would cost approximately $4,000. Do you support creating an EV-Ready Plan?**

- ☐ Yes
- ☐ No
- ☐ I’m not sure

Appendix B. EV-Ready Plan scope

An EV-Ready Plan outlines how energized outlets or junction boxes at parking stalls can be installed in MURBs, so that residents can easily plug in or hardwire a Level 2 charger. Plans are prepared by a licensed electrical contractor or registered electrical engineer.

This section was adapted from BC Hydro's EV-Ready Plan Requirements *document.*[26]

The scope of an EV-Ready Plan includes:

1. Property details

- Number of residential units
- Number of residential parking stalls
- Number of commercial/visitor parking stalls, if applicable
- Number of chargers to be installed
- Number of existing EV-ready parking stalls

2. Electrical capacity assessment (in kilowatts)

- Existing capacity of the electrical panel
- Existing peak demand on the electrical panel
- Spare electrical capacity prior to EV charger installation

3. Charging performance assessment

A charging performance assessment evaluates the charging power required to provide adequate energy for drivers' charging needs if all parking stalls are being used by EVs. The assessment can be used to determine a reasonable number of EV chargers for each electrical circuit. By limiting excessive load-sharing, buildings can ensure sufficient power and charging speeds for drivers.

The assessment includes a description of how charging performance was determined and the variables taken into account. Factors that affect charging performance include but are not limited to:

- Average daily distance travelled by vehicles
- Climate
- Topography
- Demographics of residents (e.g., number of drivers, household sizes)
- Vehicle size and efficiency

Any guidelines, standards, or recommendations used in the charging performance assessment should also be included in the EV-Ready Plan, with an explanation of why they were referenced. Table 4 provides an example of minimum charging performance recommendations developed by AES Engineering Ltd. for the City of Calgary specifically. (Note: included only as an example and not necessarily as guidelines that should be followed)

Table 4. Example of minimum charging performance recommendations

Circuit breaker size	Example number of EV chargers per circuit (by average daily weekday vehicle kilometers travelled)			
	35 km or less	40 km	45 km	50 km
20 A	1			
30 A	1	1	1	1
40 A	4	3	3	2
50 A	5	4	4	3
60 A	7	6	5	4
70 A	8	7	6	5
80 A	10	8	7	6
100 A	12	11	9	8
125 A	15	14	12	11

4. Recommended EV-ready solution

- The number of recommended chargers per circuit (e.g., 4 chargers per 40 A circuit breaker)
- Total potential load of chargers
- Spare capacity of the electrical panel after charger installation
- If the existing electrical capacity is adequate to meet charging needs; if a service upgrade is required, identify what this would entail
- Assessment of the existing telecom/network infrastructure and whether it can support networked EV chargers (e.g., cellular or Wi-Fi availability in parkade)
- Cost of operating the telecom/network infrastructure
- Compatible Level 2 networked charger and EV Energy Management System models

5. Cost estimate

- Cost estimate of installing electrical infrastructure, network upgrades, and chargers

Appendix C. Supplementary figures

See Section 2.2 for a discussion of energy management systems.

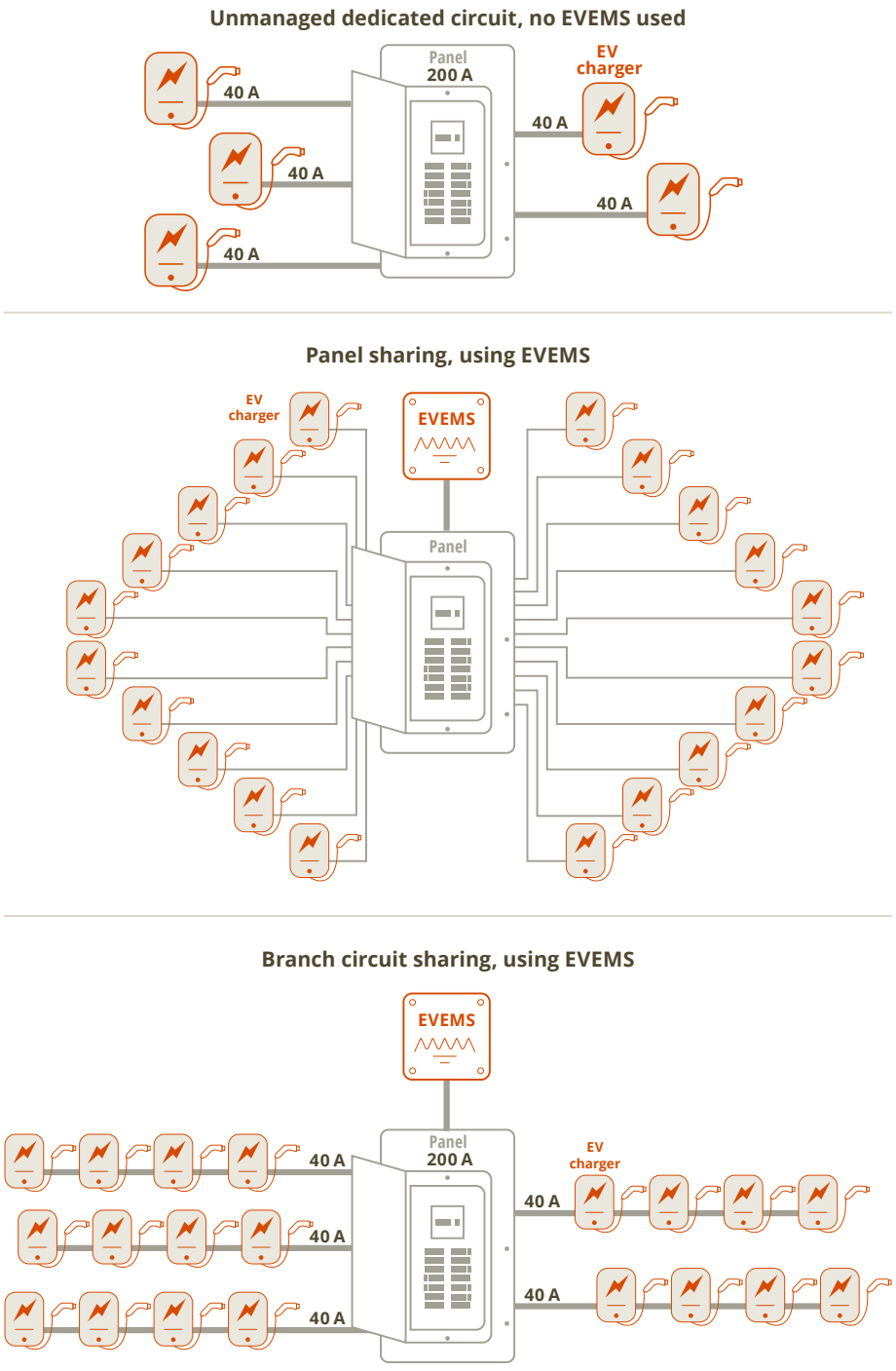

Figure 9. Configurations of EV energy management systems in a MURB

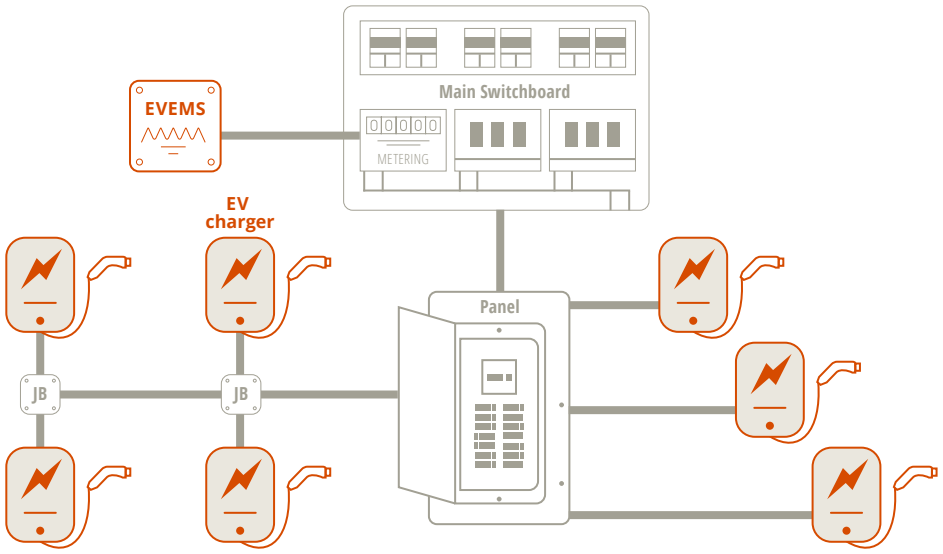

Figure 10. Configuration for service monitoring of EV energy management system

Source: Figures 9 and 10 adapted from AES Engineering[27]

Appendix D. How policymakers can support EV readiness in MURBs

Policymakers at the federal, provincial, and local level need to support EV readiness in multi-unit residential buildings in Alberta, and across Canada, by implementing several measures that reduce the upfront costs of EV-ready developments and retrofits so that the transition to electric cars is sustainable and also attainable for a broader segment of the population.

Below is a list of key policy recommendations, which, while not exhaustive, are important measures to start with:

Require 100% EV-ready parking in new residential developments

Municipalities in Alberta should amend **parking** and **zoning bylaws** to require that all parking spaces in new residential buildings be EV-ready. The City of Toronto and several municipalities in British Columbia have adopted this requirement. By making parking spaces EV-ready during construction, apartments and condos avoid expensive EV-ready retrofits later. Provincial and federal policymakers can support these efforts by amending **building codes** to likewise include EV-ready parking requirements.

Provide rebates for EV-ready retrofits

Alberta and its municipalities should offer **financial incentives** to encourage the installation of EV-ready retrofits. British Columbia's CleanBC EV-ready rebate program provides a model. BC Hydro offers up to $3,000 to support the cost of drafting an EV-Ready Plan with an electrical contractor or engineer and up to $600 per parking stall for the installation of EV-ready infrastructure, to a maximum of $120,000.[28] The federal government can also provide additional funding, by expanding the existing Zero Emission Vehicle Infrastructure Program to include EV-ready retrofits in multi-unit residential buildings. In addition, municipalities can consider providing additional rebates as a top-up, as some regions and cities in B.C. do.[29]

Explore financing opportunities for EV-ready retrofits in MURBs

The federal government, province, and municipalities should explore opportunities to offer **low-interest loans and grants** to multi-unit residential properties, to reduce the one-time expense of EV-ready retrofits and allow for long-term repayment.

Explore utility investment in EV-ready infrastructure

Provincial regulators and utilities could also consider including EV-ready retrofits in the rate base of utilities. This would allow **utilities to invest in EV-ready charging infrastructure** and recover costs through the electricity rates paid by their customers, as they do with other capital investments in the grid. With their expertise in building and maintaining electrical infrastructure, utilities are uniquely well suited to undertake EV-ready retrofits at low cost.

In the U.S., regulators in 34 states and the District of Columbia have approved some form of utility investment in EV charging infrastructure.[30] The most common model of utility investment has been "make-ready" programs, with utilities covering the infrastructure costs to make sites EV-ready, while the property owner invests in the charger itself.

We recommend that the Alberta Utilities Commission explore how utility investment in EV charging might advance regulatory goals to provide a safe, reliable, and low-cost electricity system. With most EV drivers charging their vehicles overnight during off-peak hours, utilities may be able to minimize the need for distribution improvements and capacity additions.[31] The additional electricity sold from EV charging could lead to more revenue and wider distribution of fixed costs across more kWh of electricity, potentially resulting in lower rates. In the future, bi-directional charging technologies, which enable EVs to store and supply electricity to buildings and to the grid, could also potentially help to minimize electricity system costs.

Appendix E. Glossary

Battery electric vehicle (BEV): A vehicle driven by an electric motor that is powered by a battery pack that requires charging.

Charging service provider: A company that offers EV chargers and EV energy management systems, as well as billing services, regular reports on usage levels, and maintenance services.

Electric vehicle (EV): For the purposes of this guide, an EV is the same as a battery electric vehicle.

Electric vehicle energy management system (EVEMS): A class of technologies that monitor and control the electrical loads of EV chargers. By controlling the timing and speed of EV charging, EVEMS can minimize the electrical capacity and circuits that must be allocated for EV chargers, significantly reducing the cost of installing chargers.

Electric vehicle supply equipment: Also referred to as EV chargers. The assembly of cables, connectors, and apparatus that transfer power and exchange information between the electrical circuit and the vehicle.

EV-ready: Preparing a parking stall with an energized outlet or adjacent junction box, so that an EV charger can be plugged in or hardwired at a future date.

EV-capable: Preparing an electrical panel with spare space and electrical capacity to support installation of a branch circuit and EV chargers at a future date.

Level 1 charger: Plugged in to a standard 120 V alternating current household outlet with a regular three-prong plug. Suitable for some residential applications.

Level 2 charger: Plugged in or hardwired to a 208 to 240 V alternating current outlet, like those used by ovens and clothes dryers. Suitable for residential and commercial applications. Multi-unit residential buildings usually use this type of charger.

Level 3 charger or direct current fast charger: Draws power from a 480 V or higher direct current. Achieves the fastest charging speeds available. Suitable for commercial applications; typically deployed where drivers need to charge quickly and with enough power to travel long distances.

Multi-unit residential building (MURB): Buildings, such as apartments and condominiums, that contain multiple separate residential units.

Networked EV charger: Also referred to as "smart" chargers. EV chargers with Wi-Fi, cellular, or other network capabilities that allow them to connect to a larger charging network and communicate with other chargers.

Plug-in hybrid electric vehicle (PHEV): A vehicle with both an electric motor, powered by a battery pack, and an internal combustion engine. The battery pack can be recharged by plugging into an outlet or charger or through regenerative braking. Typically, when the battery is depleted, the engine switches to internal combustion.

Endnotes

[1] International Energy Agency, *Global EV Outlook: Securing Supplies for an Electric Future* (2022), 32. https://iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf

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