Guide to Electric Vehicle Charging in Multi-Unit Residential Buildings

POLLUTION PROBE

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ABOUT

Pollution Probe is a national, not-for-profit, charitable organization that exists to improve the health and well-being of Canadians by advancing policy that achieves positive, tangible environmental change. Pollution Probe has a proven track record of working in successful partnership with industry and government to develop practical solutions for shared environmental challenges.

The Delphi Group is a Canadian strategic consultancy providing innovative solutions in the areas of climate change and corporate sustainability. As a pioneer in sustainability and environmental risk management, The Delphi Group has more than 25 years of experience in helping some of Canada's best-known companies improve the sustainability of their organizations – as well as the local and global communities in which they operate.

Natural Resources Canada (NRCan) seeks to enhance the responsible development and use of Canada's natural resources and the competitiveness of Canada's natural resource products. We are an established leader in science and technology in the fields of energy, forests, and minerals and metals, and use our expertise in earth sciences to build and maintain an up-to-date knowledge base of our landmass. NRCan develops policies and programs that enhance the contribution of the natural resources sector to the economy and improve the quality of life for all Canadians. We conduct innovative science in facilities across Canada to generate ideas and transfer technologies. We also represent Canada at the international level to meet the country's global commitments related to the sustainable development of natural resources.

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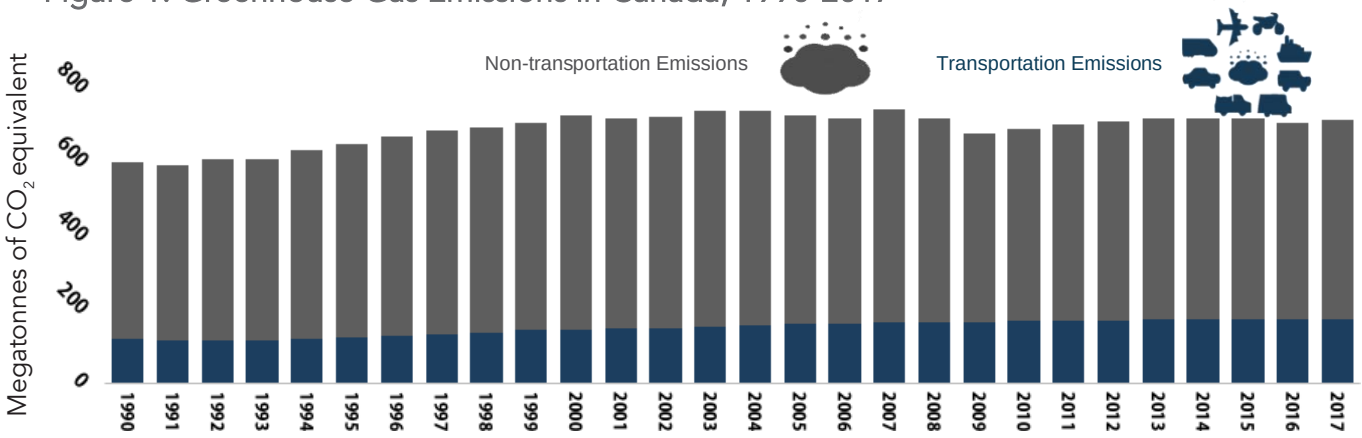
The purpose of this guide is to provide high-level guidance on important considerations for installing electric vehicle (EV) charging infrastructure in multi-unit residential buildings (MURBs). Given the rate at which the technology and any associated regulatory considerations addressed within this guide continue to evolve, it cannot be guaranteed that the information presented herein is up-to-date. It is recommended that a professional with experience specific to EV charging in MURBs is consulted prior to proceeding with an installation.

CONTEXT

Greenhouse gas (GHG) emissions in Canada grew 19% overall between 1990 and 2017, with a significant proportion of this growth driven by increases from the oil and gas and transportation sectors.[1] Transportation-related GHG emissions increased 43% over the same time period. The deployment of electric vehicles (EVs) presents an enormous opportunity to address emissions in the transportation sector, particularly in Canada where over 80% of the country's electricity generation comes from non-emitting sources. In addition, EVs can contribute to Canada's clean growth and climate change strategies, stimulate best practices in energy efficiency and clean technology and play a critical role in the broadening landscape of renewable distributed energy, storage technology and research, development and demonstration (RD&D).

Figure 1: Greenhouse Gas Emissions in Canada, 1990-2017



The market for EVs in Canada continues to expand rapidly. However, in order for the technology to become an integral part of a successful sustainable transportation system and contribute to the decarbonisation of the transportation sector, the social, environmental and financial needs of all users must be met. Ensuring that Canadians have access to charging where they live will be key to facilitating widespread EV adoption, given that a significant proportion of charging currently occurs at home. Some of the most critical outstanding barriers to charging at home are those specific to the increasing number of Canadians choosing to live in multi-unit condominiums, stratas and apartments.

Recognizing the importance of addressing the unique challenges associated with charging for the approximately one-third of Canadians currently residing in multi-unit residential buildings (MURBs), Natural Resources Canada (NRCan) commissioned Pollution Probe and The Delphi Group to produce a report entitled *Zero Emission Vehicle Charging in Multi-Unit Residential Buildings and for Garage Orphans* in 2019. The report identified key barriers to EV charging in MURBs and for garage orphans — those who reside in dwellings without access to a driveway or garage — and outlined existing solutions and best practices. It also highlighted a need for a clear understanding of the necessary steps required for EV charging station installation in MURBs, along with the responsibilities of each party involved.

In Budget 2019, the federal government announced the Zero Emission Vehicle Infrastructure Program (ZEVIP) aimed at deploying EV charging and hydrogen refuelling stations where Canadians live, work and play. Delivery of the program provides a timely opportunity to disseminate further information to effectively navigate the often complex process of installing charging infrastructure in MURBs.

ABOUT THIS GUIDE

The installation of EV infrastructure in MURBs is comprised of numerous steps and interrelated considerations. Adding further complexity to this process are the range of different stakeholders involved who need to be in agreement on an appropriate path forward. There could be over a hundred residents in a large condominium, each of whom have a say in whether, or how, their condo board or strata council proceeds with EV charging. Gaining consensus on the approach remains one of the most critical barriers to the effective installation of EV charging solutions that are capable of addressing both the immediate and long-term needs of building residents.

The uptake of EVs varies dramatically across the country, as do the number of individuals and families residing in MURBs. In general, large urban centres including Montreal, Toronto and Vancouver have more significant EV markets. They are also where the majority of the country's MURBs are currently concentrated. For this reason, the extent to which different jurisdictions have addressed the challenges associated with EV charging in MURBs through relevant regulatory instruments or requirements, also varies. Buildings located in areas where significant EV uptake has not yet occurred may face more significant challenges related to charging station installation, resulting in longer timelines.

No two buildings are alike and may vary dramatically in terms of size, age, layout and the make-up of the condo board or strata council. The EV charging solution determined most appropriate for one building will vary dramatically from that of the next. Solutions must take into account a wide range of considerations including the building's unique parking and electrical system configurations, electrical capacity, budget and the condo board or strata council's level of involvement in managing the charging infrastructure over time.

It is clear however, that EV uptake across Canada will continue to increase in the coming years, based on an increase in supportive policy and programs and the installation of necessary charging infrastructure. At the same time, a growing number of individuals and families are choosing to reside in MURBs. As the cost of EVs continues to come down, it will be increasingly important to address the unique charging-related challenges facing this significant proportion of the population in order to facilitate further uptake. While a number of solutions exist to provide charging options that are functional in the short-term, it is critical that installations in MURBs take a strategic, long-term approach to EV charging so as to avoid costly future upgrades. There are also opportunities to be leveraged through this process, including the use of innovative business models and the ability to provide an amenity that attracts residents or tenants.

This guide seeks to fill gaps in understanding about the process of installing EV charging infrastructure in MURBs with information and to enable further uptake of EV technology among an important segment of the population. The guide is not intended to be the last word on the subject; rather, it serves as a substantive step in making sense of the considerations involved, in an effort to ensure a more streamlined process. It walks through a high-level approach to installing EV charging infrastructure in both new and existing buildings, summarizes the types of responsibilities assigned to each stakeholder and points to additional resources that provide more detailed information. It is not intended to recommend any one EV charging solution over another as these decisions should be made in consultation with an expert. Instead, the guide provides the information that can serve as a foundation for more informed discussions, contributing to the successful installation of effective EV charging solutions.

This guide will be of value principally to those stakeholders responsible for addressing a request to install EV charging infrastructure in a MURB. It seeks to provide a common ground for discussions between electrical contractors, engineering firms, EVSE providers or EV advisors and the condo boards, strata councils or property managers looking to install EV charging stations. The guide also includes information that will be helpful for individuals who own or are interested in purchasing an EV and charging it in their condominium, strata or apartment. Utilities and other stakeholders who are often approached for information about EV charging installations in MURBs may also find it useful to have this guide on hand.

A Note on Safety

While this guide has made every effort to ensure the accuracy of its content, the technologies and regulatory considerations described herein continue to evolve at a rapid pace and therefore, it cannot be guaranteed that all information is up-to-date. EV charging stations place large electrical loads on the electrical system for long periods of time and there are risks involved if they are not installed correctly. It is imperative that installations are conducted safely and in accordance with all relevant codes and standards. One of the most important factors in a successful installation of EV charging infrastructure is ensuring that an experienced electrical contractor, engineering firm, EVSE provider or EV advisor who is well-versed in the rules applicable to a MURB is managing the process.[2] This guide should not be used in place of consulting and working together with a qualified professional in the design and installation of EV charging infrastructure.

Objectives and Methodology

The overall objectives for the development of this guide were as follows:

- Outline the types of EV charging station installation considerations that are likely to vary by building (e.g., electrical capacity, configuration of the building's electrical system, parking locations, etc.).
- Provide "step-by-step" guidance to walk relevant stakeholders through the necessary considerations for the installation of EV charging infrastructure, with a focus on roles and responsibilities.
- Identify potential barriers and strategies for streamlining the installation process for EV charging stations in MURBs.

The methodology for this study combined an in-depth literature review with a series of interviews with key subject-matter experts who have been directly involved in the installation of EV charging infrastructure in MURBs. The literature review included an investigation of research reports, policy documents, discussion papers and other guides. A review of these materials allowed for an assessment of existing information and possible data gaps related to the installation process, the roles and responsibilities of different stakeholders, critical barriers unique to MURBs and potential solutions for addressing them.

Telephone interviews were conducted with stakeholders across Canada to help fill information and data gaps identified through the literature review and to obtain a more targeted understanding of the step-by-step process for installing EV charging infrastructure in MURBs. Interviews were conducted with individuals and organizations with demonstrated experience specific to installations in MURBs. For this reason, the majority of interviewees were located in provinces where a more significant proportion of the population currently resides in multi-unit condominiums or apartments (i.e., BC, Ontario and Québec).

A total of 20 interviews with 27 stakeholders (some interviews involved more than one individual) were conducted between December 2019 and January 2020. Interviewees included representatives from the following stakeholder groups:

- Electrical contractors and electricians
- Electricity generation companies
- Electricity system operators
- Electric vehicle supply equipment (EVSE) providers
- Electric vehicle charging network operators
- Local distribution companies
- Residential property developers
- Property managers
- Not-for-profit organizations
- Automakers

In addition to representing their respective stakeholder groups, a number of the individuals interviewed also had personal experience with the installation of charging infrastructure in MURBs, having participated in the process at their place of residence.

Guide Outline

This guide is divided into three sections intended to provide direction on the installation of EV charging infrastructure in MURBs. It briefly introduces the context required to understand the process and outlines the necessary steps for addressing the need for charging infrastructure in existing (i.e., already built) or new (i.e., planned or under construction) buildings.

Section One provides an introduction to some of the general information that will prove useful prior to undertaking the installation of EV charging stations including a brief description of EVs, EV charging infrastructure and an overview of the benefits of charging in MURBs.

Section Two describes the different roles and responsibilities of the various stakeholder groups that will work together to undertake the installation of EV charging infrastructure in MURBs.

Section Three outlines a high-level installation process for existing buildings, highlighting where differences may exist for new buildings. It notes the responsibility of stakeholders for each step and directs the reader to additional resources and guidance materials where they can find further information. This section also discusses EV charging considerations that are likely to differ by building including electrical capacity, configuration of the electrical system, building design and physical infrastructure, parking supply and allocation, regulation and policy and potential costs.

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DEFINITIONS AND ABBREVIATIONS

Abbreviations

A	Ampere or amp
AC	Alternating current
BEV	Battery electric vehicle
DCFC	Direct current fast charger
EMS	Energy management system
EV	Electric vehicle (for the purposes of this report, EV refers to both battery and plug-in electric vehicles)
EVEMS	Electric vehicle energy management systems
EVSE	Electric vehicle supply equipment
GHG	Greenhouse gas
ICE	Internal combustion engine
kW	Kilowatt
kWh	Kilowatt-hour
MURB	Multi-unit residential building
OCPP	Open Charge Point Protocol
PHEV	Plug-in hybrid electric vehicle
V	Volt
ZEV	Zero emission vehicle

Definitions

The following definitions are used for the purposes of this guide.

Amperes (A), often referred to as amps, are the unit of measurement for current. Current is the flow of electric charge through a conductor, such as a copper wire.

Boring is a construction method that involves the drilling of holes in the ground.

Capacity is the ability of a piece of equipment to be subjected to a certain load.

Energy, measured in kilowatt-hours (kWh), is the product of the power (i.e., the rate at which energy is transferred) and the time over which it is supplied (Energy = Power x Time). An EV battery charging at 1,650 W for eight hours stores approximately 13 kWh of energy.

EVEMS are a "means used to control EVSE loads through the process of connecting, disconnecting, increasing, or reducing electric power to the loads and consisting of any of the following: monitor(s), communications equipment, controller(s), timer(s), and other applicable device(s)."[3]

EVSE is the technical name for an EV charging station or charging point. The function of an EVSE is to supply the electric energy to charge an EV.

Load is any device that uses electrical energy or changes it into other forms of energy (e.g., heat, light, mechanical energy). An EV plugged in to charge its battery is an example of an electrical load.

Power is the time rate at which energy (e.g., the energy a conducting wire carries to charge a battery) is transferred or converted. Power is expressed as the product of voltage and current, and is measured in watts (W). A watt is a per-second measure of energy transfer or conversion. A kilowatt (kW) is equal to 1,000 W and is one of the units typically used to express the maximum power characteristics of an electric motor or a transformer.

Trenching is a construction method that involves digging a trench in the ground to install, maintain or inspect conduits or cables.

Voltage (V) is a measure of electromotive force between two points in an electrical circuit. Voltage is measured in volts (V). Volts are also used to express the voltage applied to a circuit by an energy source, such as a battery or an electrical generator.

1 ELECTRIC VEHICLE CHARGING IN MULTI-UNIT RESIDENTIAL BUILDINGS

This section introduces the definitions and concepts that will be referred to throughout this guide. It provides a brief overview of EVs and EV charging infrastructure, describes different types of MURBs and highlights the importance of planning and developing an approach to EV charging.

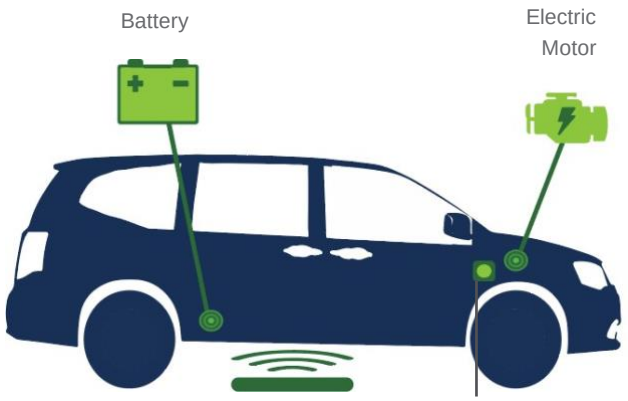
Electric Vehicles

An EV is powered fully, or partially, by an electric motor and a battery and does not emit exhaust gas during operations. While EVs have no harmful tailpipe emissions, GHG emissions and other pollutants may be emitted when generating the electricity that powers the vehicle. The environmental and human health impacts associated with vehicles that plug in vary based on the energy source used to generate the electricity (e.g., coal-fired power plants produce harmful emissions whereas wind is an emissions-free source of energy).

This guide considers two categories of EVs: battery electric vehicles (BEVs), which are powered solely by electricity, and plug-in hybrid electric vehicles (PHEVs), powered by electricity and gasoline. These are the most common types of EVs and are those that face the most barriers to uptake by residents of a MURB based on the need to plug them in (or in some cases provide wireless access) to recharge.

Battery Electric Vehicles (BEVs)

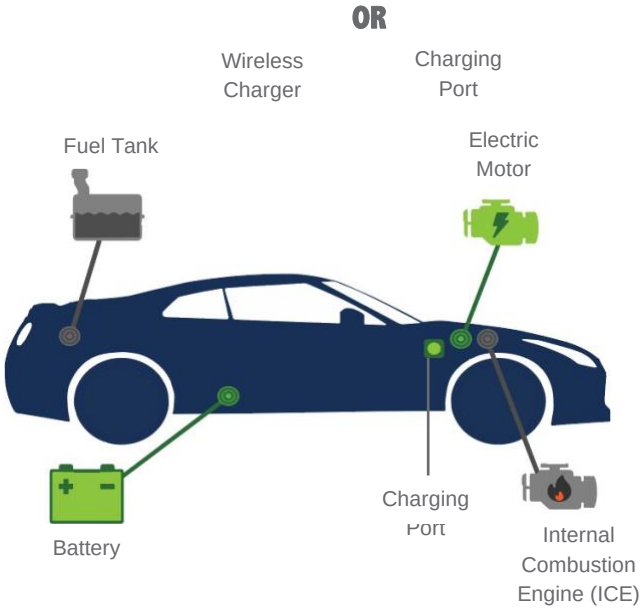
This vehicle type uses electricity stored in a battery pack as chemical energy to power an electric motor that propels the vehicle.[4] There is no engine, few belts or pulleys and the only moving parts are an electric motor, the wheels and cooling fluid pumps. The battery is recharged by plugging into an external electrical outlet, or in some cases may be charged wirelessly. BEVs are significantly more efficient at converting energy into motion than comparable conventional vehicles.



Plug-in Hybrid Electric Vehicles (PHEVs)

This vehicle type combines an electric motor, a rechargeable battery and an internal combustion engine (ICE). The battery can be charged by plugging the vehicle into an external power source, through regenerative braking and by the ICE. Some PHEVs operate exclusively on electricity until the battery is nearly empty, while others use both systems to power the vehicle simultaneously. Because they also use an ICE, PHEVs typically have smaller battery packs than BEVs, and as a result, less range when in fully-electric mode.

For the purposes of this guide, the term EV will refer to both BEVs and PHEVs.



Support for Electric Vehicles

The global sale of EVs is expected to continue to increase with improvements in battery technology, the availability of new makes and models from manufacturers and the development of supportive policy. Bloomberg predicts that the global demand for EVs will result in 11 million vehicles on the road by 2025 and 30 million by 2030. IHS Markit reported that 3.05% of light duty vehicle sales in Canada were zero emission vehicles (ZEVs) by the end of 2019, with 97% of those registered in BC, Québec and Ontario.

Under the Pan-Canadian Framework on Clean Growth and Climate Change — the federal government's plan to meet emissions reductions targets, grow the economy and build resilience to a changing climate — most provinces agreed to an ambitious target of 30% GHG emissions reductions below 2005 levels by 2030. The Pan-Canadian Framework comprises a suite of actions that jurisdictions can undertake to facilitate the transition to a low-carbon economy. Within the transportation sector, this includes enabling widespread electrification and the uptake of ZEVs.

In early 2019, the Government of Canada announced targets for 10% of vehicle sales to be ZEVs by 2025, 30% by 2030 and 100% by 2040. Budget 2019 announced a number of actions to support these ambitious targets, including $130 million over five years to deploy new ZEV infrastructure, $300 million over three years for a federal purchase incentive for ZEVs, $5 million over five years to work with automakers to secure voluntary sales targets, and a full tax write-off for light-, medium- and heavy-duty ZEVs purchased by businesses.

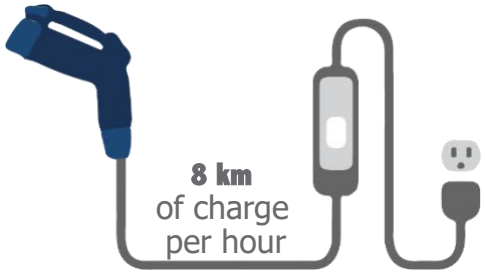
A number of other jurisdictions have developed EV deployment strategies and supportive policies. As of early 2020, two provinces offer vehicle purchase incentives to support increased uptake of ZEVs. The Government of British Columbia offers a rebate of up to $3,000 for the purchase of a ZEV and up to $2,000 per Level 2 charging station for condominiums, apartments and workplaces. The Government of Québec's Roulez vert program offers rebates of up to $8,000 on the purchase of a new EV and up to $600 on the purchase of a home charging station.

Electric Vehicle Charging

Electric vehicle supply equipment (EVSE), commonly referred to as an EV charger or EV charging station, is the intermediary equipment between a power source and the vehicle's charging port. The term EVSE refers to the cables, connectors and other devices that function to safely transfer power and enable the exchange of information between the electric circuit and the vehicle.

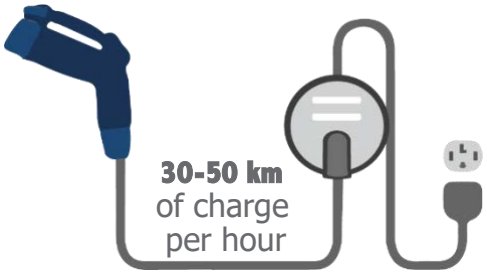
Level 1 Charging

This type of charging involves a standard electrical outlet, a 120 volt (V) alternating current (AC) and a standard three-prong household plug.[5] Level 1 is the slowest charging type and adds approximately 8 km of range per hour.[6] Almost all EV makes and models come with a Level 1 cord set charger as standard equipment. It generally takes between 8 and 30 hours to fully recharge an EV battery, making it most suitable for locations where a vehicle will be parked for long periods of time.[7]



Level 2 Charging

Level 2 charging requires the use of a 240V, AC plug. Depending on the vehicle's battery size, it can take between 4 and 10 hours to fully recharge, adding between 30 km and 50 km of range per hour.[8] Level 2 charging stations are practical for charging at home, the workplace and in public locations, such as restaurants, parks or parking lots and can also be programmed to charge during off-peak periods.



Level 2 offers both networked and non-networked charging options.

- **Networked**: Networked stations are part of a charging network and are connected to other stations via a hardwired connection, or a wireless or cellular signal. They allow for more advanced controls and provide a variety of functions including billing or payment collection, remote monitoring and updating, online reservation systems, mobile app integration, display screens for communication, charging station reports, user access controls, advertising and brand promotion. These solutions often require a subscription to an EVSE provider and there is the potential for them to be more costly to operate than non-networked charging stations. There are two main types of networked stations:
  - **Non-controllable** networked stations are often referred to as "smart chargers" and load management is achieved by calculating the maximum power available on a circuit and then distributing that power evenly between all EV charging stations connected to it. For example, if there is a maximum of 120A of power available on a circuit and three EVs are connected, each vehicle will be distributed 40A of power without tripping the breaker.
  - **Controllable** networked stations are often referred to as "intelligent chargers" and they are able to manage the load on a circuit as well as monitor the building demand so that they do not exceed peak demand. This helps to avoid incurring incremental demand charges.

- **Non-networked**: Non-networked charging stations do not have an internet connection and are often used in situations where the main function of the equipment is simply to charge the vehicle's battery without the need for further information. However, with the addition of a meter, many of these stations can allow for energy monitoring. Power sharing and access control features can also be incorporated via a key. Non-networked charging stations are unable to differentiate between users so it is not possible to track the energy consumed by each individual. As such, those using these types of stations are often charged a fixed fee for their energy usage. Non-networked chargers are not typically recommended for a MURB because they do not provide a means of determining who is using the charging station and are likely to require an upgrade to meet future charging needs at additional cost and waste.

Open Charge Point Protocol

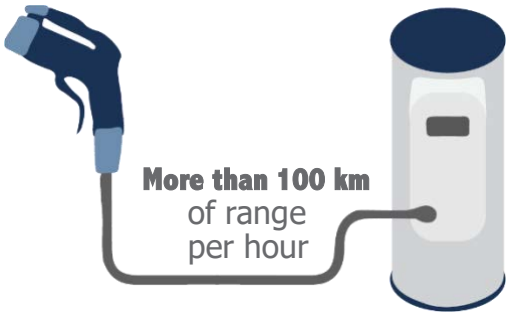
The Open Charge Point Protocol (OCPP) is an application protocol for communication between EV charging stations and a central management system, also known as a charging station network, similar to cell phones and cell phone networks.

OCPP enables communication between any compliant EV charging hardware and software regardless of which vendor originally sold or installed it. In other words, the aim is to create an open application protocol where EV charging stations and central management systems from different vendors can communicate with each other. In this way, if a specific EVSE provider ceased to exist, the EV owner could switch to another OCPP-based network. OCPP may also allow for load-management between different OCPP-compliant charger hardware.

Not all EVSE providers use OCPP and whether or not this is an important criteria for the charging installation should be discussed with the condo board, strata council or property manager.

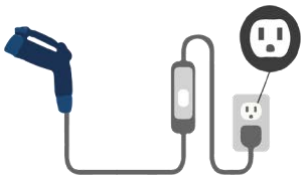
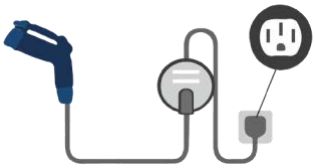
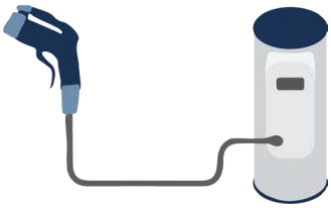
Direct Current Fast Charging (DCFC)

This type of charging is also known as a quick charge and power is supplied through a 480V direct current (DC) plug. DCFC stations can charge a BEV to 80% in approximately 25 to 30 minutes, adding more than 100 km of range per hour.[9] The use of a DCFC station is best suited to driving applications where it is necessary to recharge in a short period of time, such as along major highways. For a number of reasons (e.g., cost to install, amount of civil work required on site), DCFC are not typically an appropriate option for a MURB.



Public charging infrastructure continues to grow in Canada with a total of 11,586 EVSEs operating throughout the country as of December 31st 2019. A total of 9,717 of these were Level 2, 971 were DCFC and 898 were Tesla Superchargers.

Table 1: Electric Vehicle Charging[10]

	Level 1 Charging	Level 2 Charging	Direct Current Fast Charging
			
Description	120 V, 6-24 A[i] Connection to a standard electrical outlet via a three-prong plug	240 V, 12-80 A[ii] (typically 30) Connection via an AC plug (or hardwired)	480 V input with typical 350 – 400 V output (up to a potential 800 V), <200 A (typically 125A)[iii] Connection via a DC plug
Time to Full Recharge	8-30 hours	4-10 hours	25-30 minutes

Wireless Charging

Some newer EV models have wireless charging capabilities that use inductive charging — electricity being transferred via an air gap between two magnetic coils — to allow drivers to charge without plugging in.[11] It should be noted that retrofitting an EV that is not already equipped with wireless charging may void the manufacturer's warranty.

Electric Vehicle Connectors and Connection Type

EV charging stations can be hardwired to a power source or plugged into an electrical outlet.

Hardwired Unit: A more permanent connection to the electrical system or installation is often a more reliable option. While hardwired units can be moved, this is likely to require an electrician to uninstall them before installing in the new location.

Portable or Plug-in Unit: These charging stations include a power cord that can be plugged directly into an electrical outlet. Portable units can be attractive for those EV owners who need to charge in numerous locations or who plan to take the charging station with them when they move.

The most common ports and connector for Level 1 and Level 2 charging is the SAE J1772 plug, also referred to as a "J plug". Vehicles with this receptacle can use any Level 1 or Level 2 charging stations. This plug is standard to most EV models in North America, with the exception of Tesla. However, an adapter is provided with the purchase of a Tesla vehicle.

There is no single standard for DCFC stations. While Tesla has its own Supercharger network, other EV manufacturers use either the CHAdeMO or the Combined Charging System (CCS) for fast charging. These connectors are not interchangeable, meaning that a vehicle with a CHAdeMO port cannot charge using a CCS plug. Table 2 compares different types of connectors for EV charging.

i. A NEMA 5-20 plug can accommodate 15A. A TT30 can accommodate 24A.
ii. A 14-30 (dryer plug) is also common. A Tesla S can accept 80 A and 2021 Chevy Bolt can accept 46 A.
iii. These units may be measured in kW rather than volts and amps.

Table 2: Electric Vehicle Charging Station Connectors

	Charging Type	Compatibility	Connector
Port J1772	Level 2	100% of EVs (Tesla requires an adaptor)	
CHAdeMO	DCFC	Dependent on EV manufacturer (e.g., Nissan & Mitsubishi). Tesla requires an adapter.	
SAE Combo CCS	DCFC	Dependent on EV manufacturer (e.g., General Motors & Vokswagen). Not Tesla compatible.	
Tesla Supercharger	DCFC	Tesla only	

*Table adapted from *2020 Guide on How to Charge Your Electric Car with Charging Stations.*[12]

Electric Vehicle Energy Management Systems

Electric Vehicle Energy Management Systems (EVEMS) are mechanisms by which to control EVSE loads through connecting, disconnecting, increasing, or reducing electric power to the loads and can include, among other applicable devices:

- monitor(s)
- communications equipment
- controller(s), and
- timer(s)[13]

EVEMS have the ability to significantly increase the number of vehicles that can charge in a MURB by making efficient use of available electrical installations and reducing the need for additional infrastructure and electrical supply to power multiple EVSE.

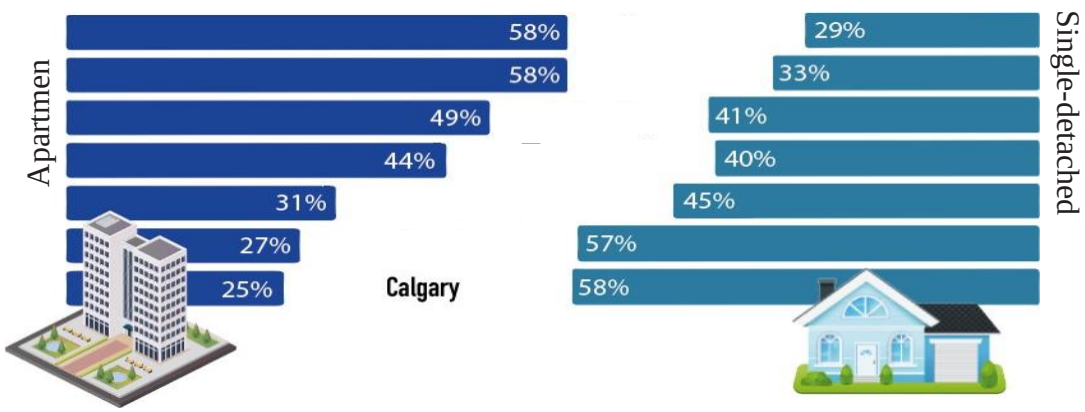
These systems can be organized according to two broad categories: load sharing or circuit sharing and load management. Refer to p. 62 for further information about the different types of EVEMS.

Multi-Unit Residential Buildings

MURBs are buildings with a common entrance and separate units. The Canadian Census uses this term to describe owned or rented apartments and condominiums constructed for dwelling purposes. MURBs must have one primary door for access, with each of the units connected by an interior door. The term refers to low-rise (two to three stories with a minimum of two floors above ground and four units), mid-rise (four to nine stories) and high-rise (10+ stories).[14]

As of 2016, Statistics Canada reported that 28% of occupied private dwellings were apartments (where apartment refers to building type rather than ownership type) including both low-, mid- and high-rise buildings, but not duplexes. For census metropolitan areas, this number was even higher at 35%.[15] Figure 2 shows the number of Canadians living in apartments versus single-detached homes in some of Canada's largest cities. In Vancouver, Montreal, Québec City and Toronto, more residents make their homes in apartment buildings than in single-detached homes.

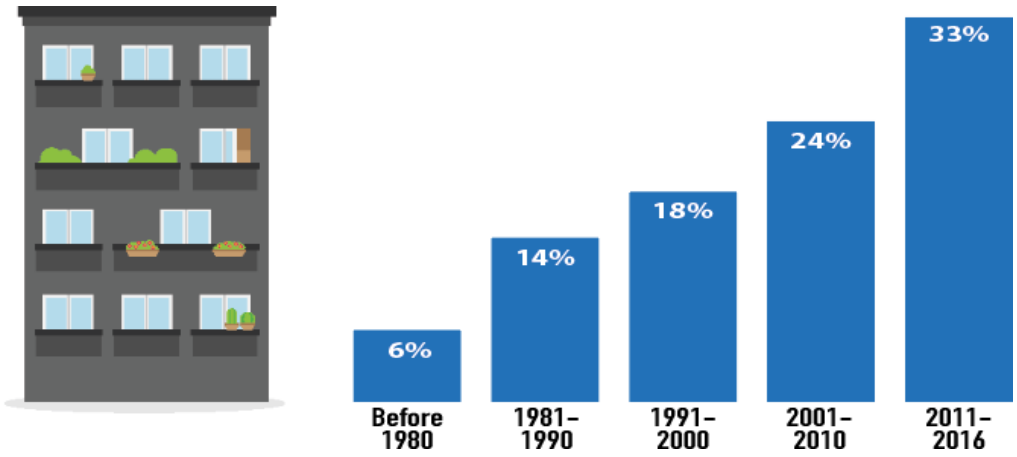
Figure 2: Dwelling Types in Major Canadian Cities



*Adapted from Statistics Canada. Infographic: Dwellings in Canada, 2016 Census of Population[16]

The 2016 Census also showed that condominiums represented an increasing percentage of new dwellings being constructed between 2011 and 2016. This points to an ever increasing number of Canadians making their homes in MURBs.

Figure 3: Condominiums as Percentage of New Dwellings Built between 2011 and 2016



*Adapted from Statistics Canada. Condominiums in Canada, 2016 Census of Population[17]

This guide further distinguishes MURBs as either new or existing. New MURBs are those being planned (i.e., yet to be built) or that are in the early stages of construction. Existing MURBs are those that have already been built or that are nearing completion (i.e., no further changes to the building's design or infrastructure will take place). The guide also makes reference to the following building ownership types:

- Condominium or Strata: A condominium, or condo, is a type of home ownership where an individual unit is owned in a large complex. These multi-unit structures are usually apartment buildings or complexes where individuals own a unit but share common areas and amenities (e.g., elevators, swimming pools, hallways, etc.). A strata is the term used in BC to refer to condominiums. The same concept of individually owned units with shared common areas applies.
- Apartment: An apartment typically has one owner, most likely a corporation, and its units are leased to individual tenants.

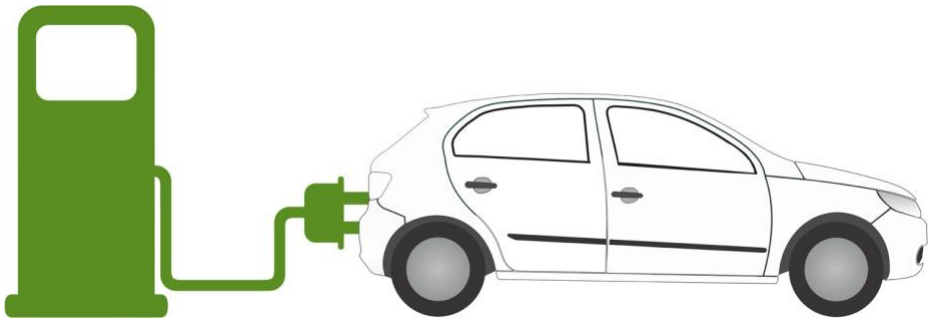
Many of the considerations outlined in this guide are applicable to condominiums or stratas and apartment buildings however, differences are highlighted where they exist.

Benefits Of Electric Vehicle Charging in Multi-Unit Residential Buildings

An increasing number of residential property developers, building owners and property managers have begun to see the benefits of installing EV charging stations in their buildings. The following are some of the potential benefits offered:

- Tenant or resident retention or attraction: The availability of charging infrastructure enables alternative commuting options within cities, thereby attracting and retaining tenants or residents who drive EVs. Residential property developers, building owners, property managers and landlords can leverage their environmental choices to positively influence brand perception and appeal, and differentiate themselves in what is an increasingly competitive market. In some jurisdictions, EV charging stations are considered the new luxury amenity.
- Alternate revenue streams: Building owners and property managers can tap into alternative revenue streams from the advertisement of products and services on charging stations. Revenue may also be generated through pay-for-parking services that include charging.[18] There may also be opportunities to explore innovative business models and partnerships that can address some of the upfront capital installation costs. Integrated EV charging solutions (e.g., EVSE with demand response capabilities) can help mitigate increases in operating costs or demand charges that would otherwise be incurred by increased EV loads.
- Convenience: The ability to charge at home is important to EV owners and they may be willing to pay more to live in a building that provides this convenience.
- Credits or points towards building certification programs: Installation of charging stations would qualify new and existing buildings for additional credits or points from building environmental performance assessment or certification programs, such as LEED or BOMA BEST. Obtaining such certifications have been shown to help boost a company's image and the desirability of a building.
- Energy Management: Some energy management solutions can help increase visibility of the building's overall energy usage, providing additional information for the condo board or strata council related to where to electricity costs can be reduced. These solutions can also integrate alternative energy sources (e.g., batteries, solar, etc.,) so that power can be managed more effectively.

While it is important to consider the benefits of installing EV infrastructure in MURBs, it should also be noted that as the EV market continues to grow, access to charging in these buildings is likely to become more of a necessity than an amenity.



2 STAKEHOLDER ROLES & RESPONSIBILITIES

A number of different stakeholders have a role to play in the installation of EV charging infrastructure in a MURB. This section introduces those who are involved and provides examples of the types of activities they may be responsible for throughout the process, bearing in mind that each installation is unique and will differ based on the priorities of those making the decisions and the specific requirements within the jurisdiction where the building is located.

The stakeholders outlined in this section may not be the only groups involved and the examples of the types of activities they may be responsible for is not exhaustive. For additional useful resources related to the roles and responsibilities of different stakeholder groups, see Appendix A.

Electrical Contractors

For the purposes of this guide, electrical contractor refers to professionals licensed to perform electrical work (i.e., those licensed to run an electrical contracting business). Electricians may be employed by an electrical contractor for the installation of EV charging in a MURB, however, there are certain activities that must be performed by the electrical contractor (e.g., applying for permits, meeting obligations related to conducting electrical work including safety requirements).

Electrical contractors play a critical role in the installation of EV charging infrastructure in a MURB. They are often one of the first points of contact for a condo board or strata council pursuing an installation, particularly in an existing building or retrofit situation. In many cases, they will act as the project manager, guiding condo boards, strata councils or property managers through the necessary steps for an installation and providing options tailored to the needs of a specific building. In other cases, an electrical contractor may be sub-contracted by an EVSE provider, engineering or consulting firm to perform required tasks.

In addition to handling the actual installation, electrical contractors may also provide guidance on discussions between the condo board or strata council and the EV owner, manage the interaction with any contractors for civil work or the utility if service upgrades are required, pull required permits and provide guidance on metering options. It is important to note that not all electrical contractors have experience with EV charging infrastructure in a MURB. For more information on the importance of working with an experienced electrical contractor, see p. 44.

Engineering or Consulting Firms or Electric Vehicle/Energy Management System Charging Solutions Providers

Engineering or consulting firms, or specialized EV or energy management system (EMS) charging solutions providers may also be retained to design, provide electrical engineering services and install charging solutions in MURBs, particularly for larger installations. These firms perform many of the same tasks as electrical contractors and will manage the overall installation process. However, as previously noted, there are certain steps that will require an electrical contractor. Engineering firms or specialized EV/EMS charging solutions providers may employ their own, or will have existing relationships with third party electrical contractors who will complete any necessary work.

In the case of a new MURB, an engineering firm or specialized EV/EMS charging solutions provider is often contacted to help provide guidance on accounting for EV charging while planning for the building, particularly in jurisdictions with EV readiness requirements. This could involve consultation around developing the most effective or appropriate electrical system for the building or to determine how to ensure enough capacity is built into the system to accommodate EV charging.

Electric Vehicle Supply Equipment Providers

The EVSE provider is involved in the installation process where their charging stations and/or energy management solution will be installed. This could include providing the charging solution directly (as opposed to through a third party retailer) or entering into an EV network service provider agreement to make use of their networked solutions.

In addition to offering charging stations and associated equipment, most EVSE providers also offer turnkey solutions for MURBs. This includes performing the same project oversight and management as some electrical contractors or engineering firms, and guiding condo boards, strata councils and property managers through the installation based on their own process and products. The EVSE provider may employ their own electrical contractor and electricians, or work with a third party to complete any required work.

Electric Vehicle Advisors

An EV advisor is an expert that may be sought out by a condo board, strata council or property manager to help oversee and provide unbiased input to the installation process, including helping to determine which charging stations to invest in. These experts may include non-profit organizations or private companies and will have significant experience and insight into the EV and EV charging market.

Utilities

For the purposes of this guide, the term utility will be used to refer to the local distribution company. Utilities play a key role in facilitating EV adoption within their service territory. With regards to MURBs, this may involve the utility providing information related to typical electrical consumption in a specific building, however getting involved in how the existing service is used is not typically within their mandate. As a trusted entity, many utilities are playing an important role in education about the installation process. For example, a number of utilities have developed helpful guides or web-based content to support EV deployment among their rate base. As the energy landscape continues to evolve, utilities are likely to become more involved in the transition to clean energy technologies and distributed resources, including those related to EV charging.

Utilities are also responsible for the connection of any new electrical service to the distribution system, including EV charging stations. In the case of a new building, the utility would be involved in connecting the building's service during development. While the load calculation for the service should take into account any potential EV charging stations, the connection process itself is not different than that of a typical service connection. The utility is typically only involved in an installation in an existing building if a service upgrade is required. However, this does not happen often as it is a situation that condo boards, strata councils or property managers look to avoid given the substantial associated costs.

Some utilities have dedicated staff resources to address barriers to EV charging, including those related to MURBs. Many utilities are pursuing innovative pilot projects to better understand whether they can play a greater role in providing solutions. A number of utilities in leading jurisdictions have also been engaging developers and building agencies to learn more about their future plans for different technologies, including EVSE.

Condo Boards & Strata Councils

Condominium corporations and strata corporations are legal entities that must follow laws, keep records, resolve conflicts, maintain property and follow a budget, similar to a business. All unit owners in a building are members of the condominium or strata corporation, which is responsible for managing and maintaining the common property and assets of the building on behalf of all unit owners.

The specific obligations of a condo or strata corporation are set out under the respective provincial or territorial Condominium or Strata Act but may include preparing or making available various records, holding general meetings, maintaining and repairing common property, complying with work orders that deal with common property, maintaining a reserve fund, determining the amount of contributions that owners make to the operating or reserve fund and paying common expenses.

Unit owners elect a board of directors (referred to as a condo board or strata council) who are responsible for managing the condominium or strata. The board or council will often hire a property manager to oversee day-to-day operations of the building and will meet regularly with the property manager to make decisions about the property. For the purposes of this guide, the terms condo board or strata council will be understood to mean those responsible for undertaking specific actions on behalf of the condominium or strata corporation.

The condo board or strata council plays a critical role in the installation process. Reaching consensus on the most appropriate path forward with regards to EV charging may be challenging given the number of individuals involved. The board or council may not convene often and when they do, there may be time needed to review previous work, which has the potential to slow the process. In addition, condominium and strata agreements create barriers to modifying parts of the building that are commonly owned on behalf of all unit owners (i.e., common elements). These requirements can be triggered when individual unit owners need to run electrical wiring from an electrical room to their parking space for the purpose of EV charging.

There are also condo or strata agreement rules that may impact the ability to make modifications and investments that would enable many or all owners to install EVSE in the future (e.g., panel or electrical room upgrades) and bring dedicated electrical sub-panels to parking areas. These rules can require formal notice periods, votes of a significant proportion of unit owners and legal amendments to the agreements that provide for the governance of condominium or strata, all of which can create delays, increase costs and contribute to non-approval.[19]

In jurisdictions outside of Ontario, condo boards and strata councils have the right to determine whether to approve a request to proceed with the installation of EVSE. Ontario enacted a regulatory reform commonly referred to as a "right to charge" in O. Reg. 48/01 under the Ontario Condominium Act, 1998. This right to charge outlines the process for an EV owner applying to install EVSE and the requirements of the condo board in terms of when and how they must respond. The condo board must approve an application to install unless certain exemptions exist.

For further information about the requirements of condo boards or strata councils related to EVs, please refer to the resources found in Appendix A.

Property Managers

The condo board or strata council is responsible for directing the property manager in terms of the support they will require related to the installation of EV charging infrastructure. Related to EVs, the role of the property manager is primarily to facilitate the process and if required, to help with the interaction between condo boards or strata councils and contractors. Condo boards or strata councils should be careful not to rely too heavily on a property management company to undertake all of the necessary work. The installation of EV charging infrastructure is a specialized project requiring considerable capacity to engage various parties and support the installation of the infrastructure. It may not be reasonable to assume that the property manager can execute all of these tasks given the number of other buildings they may have under their purview.

To help inform the process, property managers can also draw from the experience of their colleagues who may have gone through the installation process in other buildings. When it comes to making decisions and executing a plan around how to proceed with an installation, it is ultimately up to the condo board to indicate to the property manager what they would like to do.

Electric Vehicle Owners

For the purposes of this guide, the term EV owner is used to describe a condominium or strata owner, or a tenant who rents in an apartment building, who owns an EV or is looking to purchase one with the intent of charging at home. An EV owner is often responsible for initiating the discussion about the installation of charging infrastructure. They will need to obtain information regarding any existing condominium or strata policies on EV charging and will submit a formal application to install. Depending on the circumstances, the EV owner may be responsible for entering into the agreement with the EVSE provider or electrical contractor and in most cases, will at minimum cover the cost of the EV charging station and the electricity used to charge their vehicle.

Property Developers

Property developers are those companies responsible for the planning and construction of new buildings. They are responsible for the majority of decisions made related to EV charging in a new building, including hiring an electrical contractor and determining the number and location of charging stations.

Landlords

While not addressed at length in this guide, the term landlord refers to the owner of an apartment building. The landlord bears many of the same responsibilities as the condo board or strata council, however the process is often streamlined given that there is only one person or entity making the decisions.

Typical Responsibilities During the Installation of Electric Vehicle Charging Infrastructure

Table 3 shows examples of the types of responsibilities and considerations for different stakeholders involved in the installation of EV charging infrastructure in a MURB. This list is not exhaustive and is meant only to provide an overview of some of the potential considerations for stakeholder groups.

Table 3: Examples of Stakeholder Considerations Related to the Installation of Electric Vehicle Charging Infrastructure in Multi-Unit Residential Buildings

Stakeholder Group	Examples of Responsibilities
Electrical Contractors	• Initial consultation • Information gathering and assessment including review of architectural and electrical drawings • Electrical assessment • Site visit • Develop options and perform initial design • Provide cost estimates and quote • Safety and accessibility considerations • Perform installation including any electrical requirements • Apply for relevant permits (e.g., electrical and operating) • Ensure installation meets all relevant codes, standards and bylaws • Conduct electrical audit and work with the utility if required, to determine a building's existing capacity. This may include submitting a request to the utility to acquire load data or for any service upgrades • Prepare any necessary drawings or operations manuals • Managing the necessary connection of EV charging stations to a third party for billing and power sharing • Assisting in the development of an EV policy or updating appropriate standard operating procedures
Engineering or Consulting Firms or Electric Vehicle/ EMS Charging Solution Providers	• Initial consultation • Information gathering and assessment including review of electrical and architectural drawings • Electrical assessment • Site visit • Develop options and perform initial design • Provide cost estimates and quote • Safety and accessibility considerations • Ensure installation meets all relevant codes, standards and bylaws • Apply for any necessary variances (e.g., related to the use of Electric Vehicle Energy Management Systems) • Prepare any necessary drawings or operations manuals
EVSE Providers	• Examples for EVSE providers are similar to those of an engineering or consulting firm except that they may provide their own charging stations and access to their network. Solutions can be proprietary or non-proprietary (e.g., OCPP-compliant). • Potential involvement in obtaining the annual operating permit

Stakeholder Group	Examples of Responsibilities
EV Advisors	• Examples for EV Advisors are similar to those for an engineering or consulting firm but they may also be contacted early on in the process (i.e., prior to an electrical contractor) to provide more general information related to EVs and EV charging.
Utilities	• Assessing capacity of local distribution system (new MURB) • Connecting new electrical service • Conducting service upgrades in existing buildings • Provision of educational resources • Installation of metering solutions • Providing information to account holders regarding electricity usage • Offer pilot and/or incentive programs to test EV-related business models and new integrated technologies
Condo Boards & Strata Councils	• Consider request to install EVSE in the building • Gathering information to support the decision on how to proceed with EVSE installation • Obtaining the services of an electrical contractor, EVSE provider, engineering firm, EV/ EMS charging solutions provider or EV advisor to manage the installation (this may also be undertaken by the EV owner depending on the agreement with the condo board or strata council) • Working together with the property manager to determine roles and responsibilities • Consideration for number of EVSE to install, location of installation, ownership, cost allocation, maintenance of EVSE • Final decision about the installation of EV infrastructure and how costs will be recovered or allocated • Entering into agreement with EV owners • Developing an EV policy or updating appropriate standard operating procedures
Property Managers	• Provision of electrical or architectural drawings • Depending on agreement with condo board or strata council, may partake in any part of the process including being involved in gathering information, agreeing on electrical contractor or other service provider, developing contracts, EV policies, standard operating procedures, etc.
Property Developers	• Gathering information to support the decision on how to proceed with EVSE installation • Obtaining the services of an electrical contractor, EVSE provider, engineering firm or EV advisor to manage the installation • Consideration for number of EVSE to install and location of installation • Final decision about the installation of EV infrastructure
Landlords	• Examples for landlords will be similar to those followed by condo boards or strata councils
EV Owners	• Information gathering • Formal application for EV charging in the building • Depending on the circumstances, entering into agreement with EVSE provider or electrical contractor • Cover the cost to purchase and install a private EV charging station or contribute to the cost of common infrastructure upgrades • Cover the cost of personal energy consumption from the EV charging stations

3 GUIDANCE ON INSTALLING ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

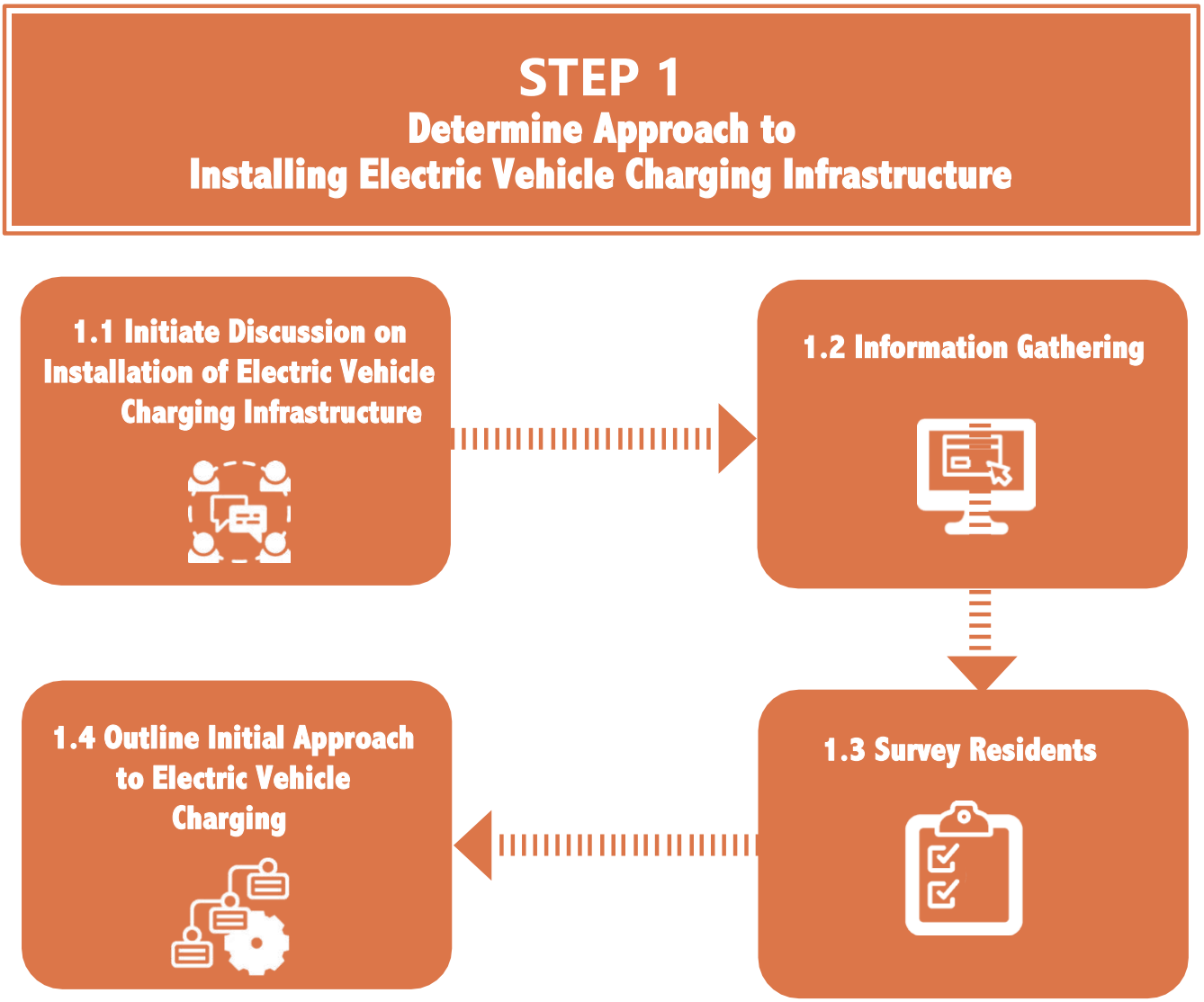
This section introduces a high-level approach to the installation of EV charging infrastructure in MURBs. The process outlined herein takes as its primary focus considerations for existing buildings, based on the fact that they are associated with some of the most significant challenges for EV charging. Often built before EVs were readily available, their electrical systems and the layout of their parking garages are not designed with EV charging in mind. However, a number of solutions in the market today can help to facilitate home charging, even for residents of older buildings.

There is a need to ensure that EV charging in MURBs is approached in a manner that accounts for the interests of all building residents and which anticipates future needs. Many of the common challenges encountered with the installation of EV charging infrastructure in existing MURBs can be avoided by addressing them during the planning phase for a new building. An increasing number of jurisdictions have begun to acknowledge that it is much easier and more cost effective to enable EV charging at the point when a building is being constructed. Given that new buildings have a lifespan of several decades or more, it is prudent to put in place electrical infrastructure that will enable increased EV use over time.

It is worth noting that each building is unique and will require a tailored EV charging solution. While general information is provided in this section, there may be differences in the order that steps are followed and requirements for each building. It is recommended that a qualified professional is involved in the design and installation of any EV charging infrastructure.

Considerations for New Buildings

The overall process and high-level approach to planning for the installation of EV charging in new MURBs parallels that of existing buildings with some critical distinctions, including the involvement of a different set of stakeholders. For the most part, the process for new MURBs is more straightforward as it does not differ substantially from the planning required for other amenities in a new building. Where differences exist, additional considerations are highlighted in the appropriate section. The guide also makes note of where specific steps are not required for new buildings.



Overview

For most condo boards, strata councils or property managers, the decision to consider installing EV charging infrastructure occurs after they have been approached by a unit owner or tenant who has purchased an EV, or is considering doing so, and who would like the ability to charge at home. However, in some cases there may be an interest on the part of a condo board, strata council or building owner to proactively plan for the inevitable need to provide EV-owning residents with access to charging options. There may also be an acknowledgement of the competitive advantage and potential for resident or tenant attraction associated with making EV charging stations available.

If an EV owner is looking to install a charging station, the request will often come by way of a formal written application outlining potential charging locations, options for managing the cost of the installation and electricity usage and identifying potential charging equipment. The resident will have already completed some background research and gathered information for the purpose of presenting potential options. This is an important and necessary step, particularly in situations where a request to install EV charging stations may be met with resistance. The more context provided to the condo board or strata council, the easier it will be for them to make a decision. However, they too are responsible for undertaking a similar process from the perspective of meeting the needs of all building residents. The preferred solutions for an individual EV owner may not align with those that will work best for the "greater good" (i.e. the collective needs of all MURB residents).

Condominium and strata legislation can create complicated and lengthy processes for any activities that require a modification to parts of the building owned on behalf of residents. These common elements are often affected by the installation of EV charging infrastructure. Depending on the jurisdiction, there may be a requirement to gain approval from a significant proportion of unit owners prior to proceeding.

While this guide includes information for individuals who own or are interested in purchasing an EV and charging in their condominium, strata or apartment, its primary purpose is to provide guidance to those stakeholders who are responsible for addressing a request to install EV charging infrastructure in a MURB. For this reason, the point at which a formal request to install an EV charging station is made by a resident is used as the jumping off point.

The condo board, strata council or property manager are responsible for most of the decisions affecting the installation however, the EV owner will typically provide input throughout the process.

Further resources on the installation of EV charging infrastructure from the perspective of a unit owner or tenant, including navigating discussions with the condo board or strata council can be found in Appendix A.

Considerations for New Buildings

When planning for the installation of EV charging infrastructure in a new MURB, it will be the property developer rather than the condo board, strata council or property manager, that will undertake the initial information gathering process. In some jurisdictions, municipal bylaws or design standards require that either energized outlets or EVSE are installed in a certain percentage of MURB parking spaces. These bylaws and design standards drive many of the considerations for new buildings, as opposed to voluntary action by a condo board or strata council. In some ways this can simplify the process as there are a set of rules in place for determining EV charging requirements.

Links to a number of excellent web-based resources and organizations working on improving requirements for new buildings are found in Appendix A.

1.1 Initiate Discussion on Installation of Electric Vehicle Charging Infrastructure

Responsibility: Condo Board or Strata Council

Other Stakeholders Involved: EV Owner, Property Manager & Building Residents

A condominium or strata corporation may already have a policy on EV charging and in the event that related infrastructure already exists, there may be an established relationship with a third party to provide installation or maintenance services. In these cases, an EV owner interested in a charging station should obtain a copy of the EV policy to familiarize themselves with the process and any requirements. It may also be helpful for the EV owner to discuss the installation process with others in the building who already use a charging station to gain a better understanding.

If an EV policy does not yet exist, it is a good idea to convene those involved in deciding how to proceed for an initial discussion. If the request to convene a meeting is coming from a unit owner or tenant, it should be presented in writing to the condo board or strata council so that there is a record. Convening as an initial step will ensure everyone is on the same page from the outset and will help streamline the process moving forward by ensuring a common understanding and a set of ground rules for working together successfully.

In most jurisdictions, condo boards or strata councils have the right to reject a request by EV owners to install a charging station. There are a variety of reasons why they may choose to this. They may wish to avoid the appearance of any preferential treatment of an EV owner, or they may not see the value of EV charging for the condominium as a whole. A lack of understanding of the complexities of EV charging station installation in a MURB may also deter condo boards or strata councils from delivering an affirmative response.[20]

This initial discussion will provide an opportunity to begin to explore the necessary steps required to install charging infrastructure, to gain clarity on the responsibility of each party throughout the process and to identify which other stakeholders will need to be brought in. Perhaps most importantly, it is a chance to determine the types of information that should be gathered to contribute to a basic level of understanding about EVs and EV charging infrastructure on the part of those involved. While an initial discussion is not a requirement, it can help to avoid future misunderstandings and to determine who will need to take the lead at different points in the process.

Some condo boards or strata councils may also wish to convene an EV committee comprised of a small number individuals responsible for taking the lead on gathering information and making minor decisions on behalf of its members. Those on the committee may be EV owners, which can help provide an informed perspective. While convening a committee has the potential to make the information gathering process easier, caution should be taken to avoid attachment to any one potential option for how and where to install EV charging stations prior to consulting with professional who can more accurately determine feasibility based on the building's layout, configuration of the electrical system and electrical capacity.

1.2 Initial Information Gathering

Responsibility: Condo Board, Strata Council and/or Property Manager
Other Stakeholders Involved: EV Owner

Prior to making any decisions about the installation of EV charging infrastructure, it is important for condo boards, strata councils and property managers to have some basic knowledge related to EVs and how they operate, different types of charging and potential solutions to address challenges specific to MURBs. At this point in the process, information gathering should not be aimed at determining individual charging solutions but rather to develop the level of understanding necessary to confidently discuss these options and make informed decisions when the time comes.

While specific informational needs will be determined by the condo board, strata council or property manager, Table 4 outlines some typical considerations for the initial information gathering. These considerations fall into two interrelated categories: general knowledge and awareness-building or building-specific.

There are a number of excellent web-based resources and organizations working on EV-related issues that can support increased knowledge and awareness-building related to EVs and EV charging (e.g., Fraser Basin Council and Plug In BC in BC, Plug'n Drive in Ontario, etc.).

Gathering building-specific information will require working together with the property manager to secure the necessary plans, drawings or access to the electrical room. As information is collected, potential questions for review with the electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor should also be documented to help guide the discussions.

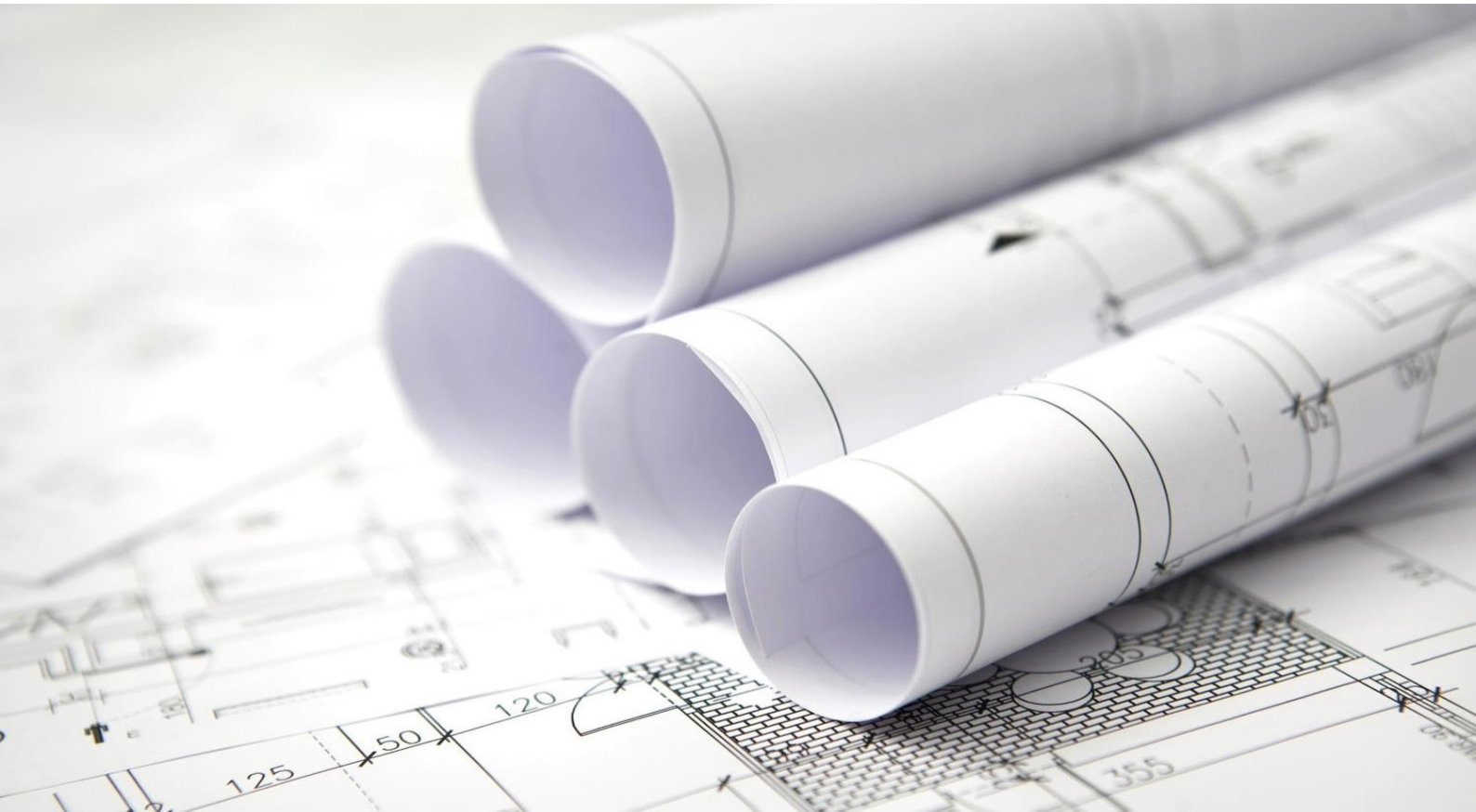


Table 4: Types of Information to Consider for Initial Information Gathering

Type of Information	Description
Charger Type 	Charging levels determine the rate at which electrical energy is drawn when an EV battery is being charged. The three main charging levels for EVs are Level 1, Level 2 and DCFC however, the latter is not typically used in MURBs due to the associated costs and necessary power supply. While Level 1 charging may be sufficient to address the current needs of many EV owners, it is recommended that whenever possible, Level 2 chargers are installed in a MURB to account for future charging needs as vehicle battery size increases and technologies continue to advance. See **Section One** for further information on EV charging.
Types of Charging Stations 	An initial scan of charging station models available in the market will help guide discussions with the electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor around those that would be of most interest. This review should not result in a final decision prior to discussing feasibility. Things to consider include whether the EV charging station will be wall-mounted or a pedestal/stand-alone, whether there is a need for a single or dual port charger or a preference for networked stations, which will require a strong enough Wi-Fi or cellular signal.
Type of Access 	Specific solutions for accessing EV charging stations should be determined in discussion with an electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor however, at this stage, a general understanding of potential options and preferences would be beneficial. Perhaps most critical is determining whether the intent is to install EV charging stations in private parking stalls, or in a shared or common area for multiple EV owners to access. Type of access may also involve determining what lighting may be necessary to ensure accessibility.[21]
Number and Location of Charging Stations 	Consideration should be given to the number of charging stations that will need to be installed (assuming the ability to accommodate them). The overall number may be further informed by a survey of residents about their intention to purchase an EV (see 1.3). However, this decision should not be based solely on this input as many residents may not have a good understanding of the current EV market. It will also be important to clarify whether EV charging stations will need to be installed indoors or outdoors and whether there are other factors determining where they should be located. A key consideration for determining location is the distance from the EV charging station to the electrical room or power supply as this can greatly affect installation costs.
Budget 	The cost of installing an EV charging station can vary dramatically based on the specific electrical and physical attributes of a building. Given the wide range of charging solutions available, it is important to have a sense of what the overall budget is. This will help to ensure that the options recommended are feasible from a financial perspective. In addition to the installation, consideration should also be given to costs associated with ongoing operation and maintenance. Potential costs associated with the installation of EV charging infrastructure may include: • Charging stations • Electrical audit or energy data assessment • Permitting • Potential upgrades to electrical infrastructure (e.g., panel upgrade) • Wi-Fi, cellular or other communication technologies • Electricity meters • Construction and installation[22]

Type of Information	Description
Cost Allocation 	Charging levels determine the rate at which electrical energy is drawn when an EV battery is being charged. The three main charging levels for EVs are Level 1, Level 2 and DCFC however, the latter is not typically used in MURBs due to the associated costs and necessary power supply. While Level 1 charging may be sufficient to address the current needs of many EV owners, it is recommended that whenever possible, Level 2 chargers are installed in a MURB to account for future charging needs as vehicle battery size increases and technologies continue to advance. See **Section One** for further information on EV charging.
Electrical System Considerations 	Certain types of information about the building's electrical system are required to design EV charging solutions tailored to its specific configuration. Condo boards or strata councils can help streamline this discussion by collecting necessary information in advance. The property manager is often involved in providing the required documentation and as such, should be involved in the process early on. Potential requirements include: • **Single line diagram or electrical drawing**: The property manager should have access to electrical drawings that clearly outline the building's electrical system. • **Information related to building's electrical capacity**: This may include transformer ratings and electricity bills for the house or common area meter. Depending on the jurisdiction, there may be different requirements for the type and amount of data required to calculate the building's electricity usage. • **Layout of the parking lot**: The property manager should also have access to diagrams showing the layout of the parking lot and electrical room, including the total number of parking stalls. Depending on the circumstances, the EV owner requesting a charging station may have already collected some of this information prior to approaching the condo board or strata council.
Energy Management 	It is important to give consideration to how energy will be managed in a building so that incremental costs or demand charges do not increase with the installation of EV charging infrastructure. Some energy management systems can give greater visibility and control over how energy is used. Condo boards, strata councils or property managers should seek out information on available energy management systems.
Local Context 	The installation and operation of EV charging stations must comply with a number of provincial and territorial codes, standards and regulations, as well as municipal zoning and parking bylaws, public utilities acts and federal measurement statutes. Appropriate permits are also required from local building and electrical inspection and permitting authorities. The application of these regulatory instruments will differ by jurisdiction and play an important role in determining feasible options for the installation of EV charging infrastructure. A number of EV charging initiatives specific to MURBs also exist including federal, provincial and municipal incentive or rebate programs for the installation of charging infrastructure. Determining eligibility for these programs can help with the decision of whether to install EV charging infrastructure. See **Appendix A** for currently available EV charging incentive programs and **Appendix B** for an overview of EV-related regulatory considerations.

Considerations for New Buildings

There are a number of factors that need to be considered when designing a parking garage in a new building to ensure it can easily accommodate EV infrastructure. As with an existing building, the focus should be on providing solutions that allow for equitable access to EV charging among all residents both in the short- and long-term. However, a new development provides an important opportunity to design out the challenges currently faced in an existing MURB related to how the parking garage is laid out and accessing the power supply.

Logistical considerations for EV charging may include pre-determining the number of dedicated or visitor parking spaces that will have access to EVSE, where they will be located in relation to the rest of the building (and main power supply), and the number that should be roughed in versus having the EVSE installed.

A property developer may have installed EV charging solutions in other buildings and can draw on this experience rather than undertaking the information gathering process from scratch. It is important for the developer to clearly understand the different charging options prior to consulting with an electrical contractor or engineering firm so that they can determine the trade-offs associated with different approaches and make an informed decision about what will be most effective. Energy management solutions should also be considered to effectively manage the building's overall power.

Regulatory requirements for EV charging infrastructure in new buildings vary by jurisdiction, with some provinces and municipalities currently in the process of adopting or updating relevant codes and bylaws to require that a percentage of parking is EV ready or has EVSE installed. For this reason, it is important for the property developer to review and become familiar with the potential requirements that they will be held accountable for.

1.3 Survey Residents

Responsibility: Condo Board, Strata Council or Property Manager
Other Stakeholders Involved: EV Owner & Building Residents

The more support there is for moving forward with the installation of EV charging infrastructure, the smoother the process will be. There may be members of the condo board or strata council that have an interest in EVs and can act as champions for moving forward. Conducting a resident survey to gauge interest in EV charging can be helpful for establishing an approach to EV charging within the condominium, strata or apartment. This survey may be as simple as a few questions inquiring about whether a resident owns or is considering the purchase of an EV, along with the make or model to establish charging needs. It could also include additional questions aimed at better understanding overall attitudes towards EVs, driving habits, preferences for where charging infrastructure is installed (e.g., in a private or shared space) and how costs are allocated.

Condo boards or strata councils that have successfully installed charging infrastructure in their building may be a valuable resource. Connecting with those who have experience with the process provides an opportunity to pose questions, discuss lessons learned and potentially take a tour of the EV charging solution in their building. However, not all condo

boards or strata councils will have knowledge of the full range of technical considerations or advancements in the EV market and their guidance should not supersede that of an electrical contractor, engineering firm, EVSE provider or EV advisor.

It should be noted that although this step can be helpful in collecting information and better understanding the needs of residents prior to contacting an electrical contractor, engineering firm, EVSE provider or EV advisor, these stakeholders can also provide this service or help inform the types of questions that may yield the most useful input.

1.4 Outline Initial Approach to Electric Vehicle Charging

Responsibility: Condo Board, Strata Council or Property Manager

It is recommended that condo boards, strata councils or property managers map out their initial thinking in terms of an overall approach to EV charging based on the information that they have gathered to-date. The approach should set the building up for future success (i.e., "future proofing") over the coming 10 to 20 years, rather than focusing on solutions that solely meet immediate needs. Long-term planning is an effective means of keeping costs down over time, as it avoids the need for expensive renovations or infrastructure upgrades as the number of EV owners increases.

At this stage, the approach need not take the form of a detailed EV policy that outlines specific rules or requirements for charging (e.g., the specific type of EVSE, where it can be installed or who is responsible for the cost of installing). These decisions should be made together with an experienced electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor, in parallel with solutions design. The approach should instead identify the goals, success factors and potential policy considerations, and provide high-level guidance related to the following:

- A commitment to working together with all relevant stakeholders to determine the most appropriate charging solutions. The importance of seeking out a qualified and experienced electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor for the design of any potential solutions to ensure a safe, timely and successful installation should be highlighted.
- A commitment on the part of the condo board, strata council or property manager to consider the needs of all residents, regardless of whether they own an EV. In other words, the priority should be to address the greater good of all those residing in the building.
- A commitment to move forward with solutions that take into account both current charging needs, and those of future EV owners, to the full extent possible.[23] This includes ensuring that any costs associated with installation are allocated in a manner that is fair to both current and future EV owners. For example, current EV owners should not be required to bear the full financial burden of installing infrastructure (e.g., cables or panels) that future users will benefit from. Conversely, current EV owners should not be permitted to install charging stations for free because there is available electrical capacity, while costs associated with future requests necessitating costly infrastructure upgrades fall to future EV owners.[2]

- To the extent possible, an overview of the relationship between the condo board or strata council and property manager and the responsibilities of each party throughout the process. Property managers may bring an informed perspective to the installation process based on similar past installations in other buildings. However, given the fact that they are likely responsible for overseeing numerous buildings, it may be more appropriate for property managers to be consulted where necessary rather than being expected to take the lead.

Where deemed appropriate, the approach to EV charging can be provided to the electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor so that they can design solutions that are in alignment. This document will also provide a foundation for later articulating more specific rules as part of an EV charging policy or standard operating procedure (see Step 5).

Considerations for New Buildings

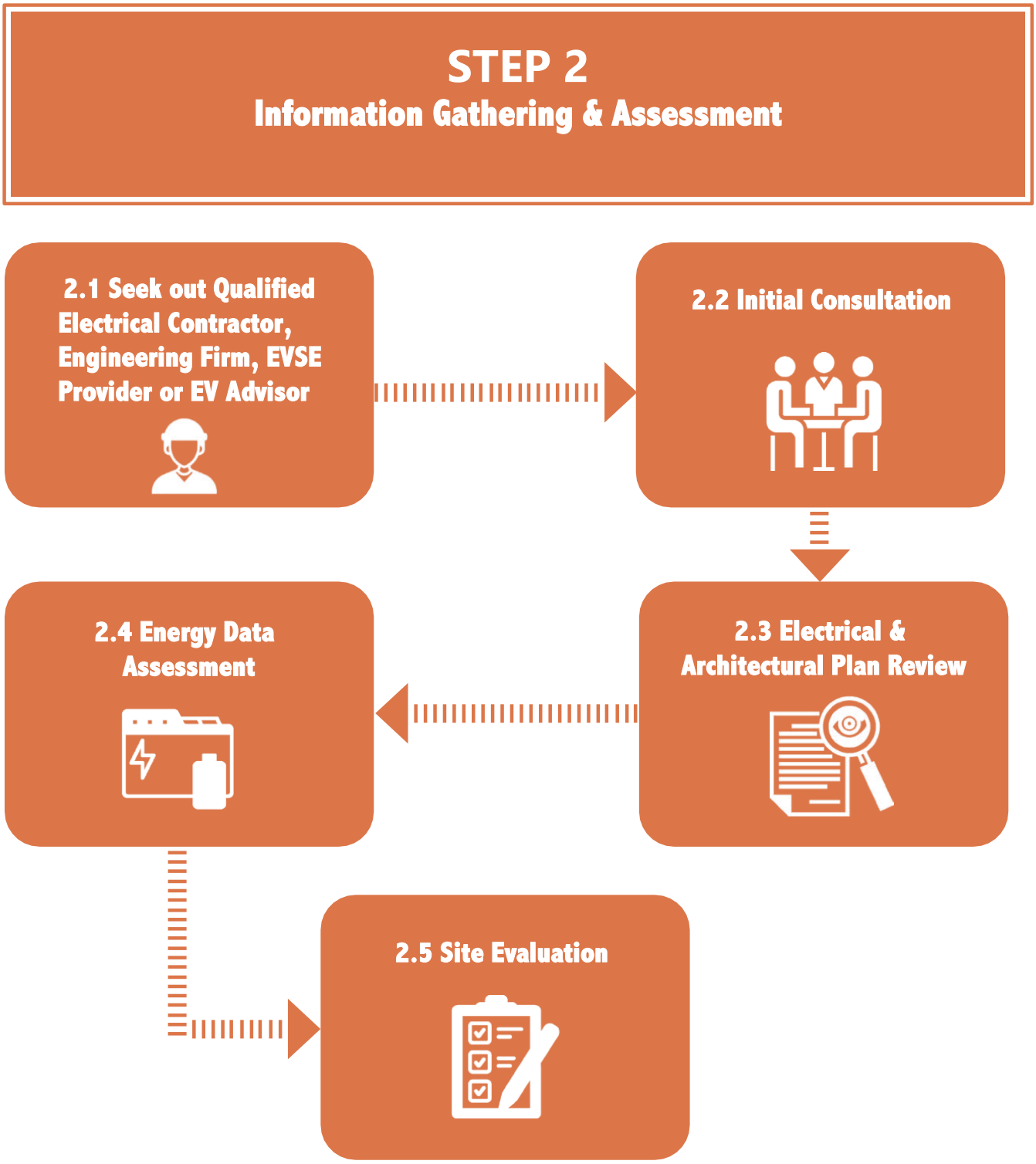
It is equally important to consider the overall approach to EV charging during the design and development of a new MURB. This will not likely require clearly defined language related to the relationship between different stakeholders or how infrastructure costs are allocated among unit owners since they do not yet reside there. It should however, commit to pursuing EV charging options that will set the building up for future success and to taking an approach that will allow for the equitable use of charging infrastructure by all residents.

Next Steps

Step 1 focused on a number of activities aimed at information gathering and developing an initial approach to the installation of EV charging infrastructure in a MURB. This includes the initiation of a discussion between all relevant stakeholders, the collection of building-specific and general information about EVs and EV charging, surveying residents about their intention to purchase an EV and the development of a document outlining the approach that will be taken to EV charging.

Upon completing the activities outlined in Step 1, the condo board, strata council or property manager should have a working knowledge of EVs, how they operate, different charging levels and any applicable regulatory considerations and incentive programs. There will also be a level of understanding of the receptiveness of residents to EV charging in the building. Each of these information points will facilitate informed discussions with the party responsible for designing EV charging solutions and ensure that those proposed are aligned with the specific needs and expectations of building residents.

The next step will focus on seeking out an electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor to guide the condo board, strata council and property manager through the more specific details of the installation process. This step will also involve the collection and review of building-specific information and an assessment of the capacity of the building's electrical system to accommodate EV charging.



Overview

Step 2 represents the point in the installation process where the condo board, strata council or property manager will seek out an electrical contractor, engineering firm, EV/ EMS charging solutions provider, EVSE provider or EV advisor who will assess the feasibility of installing EV charging infrastructure in the building. The party responsible for leading the solutions design will be provided with documents and drawings for the purpose of gaining a clear understanding of the building layout, electrical system and any potential barriers to installation. A site visit will be conducted to take additional measurements and examine elements of the building's infrastructure that may need to be seen in-person.

2.1 Seek out Qualified Electrical Contractor, Engineering Firm, EVSE Provider or EV Advisor

Responsibility: Condo Board, Strata Council, Property Manager or in some cases, EV Owner
Other Stakeholders Involved: Electrical Contractor, Engineering Firm, EV/EMS Charging Solutions Provider, EVSE Provider or EV Advisor

A licensed electrical contractor should be hired to complete any electrical work and to ensure that electrical infrastructure is made safe in accordance with all applicable codes and standards. The electrical contractor may employ additional electricians to do specific jobs however, they will be responsible for the overall design, planning and oversight of the installation. To be eligible for some rebate programs, the installation of charging stations must be conducted by a licensed electrical contractor.

Given the wide range of considerations unique to existing buildings, it is recommended that the party consulted have experience and expertise specific to EV charging infrastructure in MURBs. Installation involves the use of specialty equipment and the potential for more extensive electrical and civil engineering work.[25] Accurately evaluating the building's electrical load and the number of EVSE that can be installed before the electrical system reaches capacity can easily be done incorrectly. It may also be preferable to hire an electrician who has completed an EV-related training program for the added comfort of knowing they are familiar with the specifics of EV charging station installations.

Electric Vehicle Training Program

The Electric Vehicle Infrastructure Training Program is a non-profit partnership of automakers, utilities, EVSE providers, energy storage device manufacturers, electrical inspectors, electrical contractors, electrical workers and first responders. The EVITP was established in the U.S. and brought to Canada in 2012 in partnership with the National Electrical Trade Council, who acts as Canadian licensee for the program. The EVITP looks to establish a well-trained, nationally distributed group of electrical contractors able to install EVs. Courses cover a range of topics including customer relations, utility interconnect policies, demand response integration technologies, electrical storage devices as charging intermediaries, charging station fundamentals, integration of EV infrastructure with distributed generation and Canadian Electrical Code (CEC) standards and requirements.

For more information on EVITP in Canada, see http://www.netco.org/programs/green-programs/

The licensing body for the jurisdiction within which the building is found is likely to have a list of licensed electrical contractors on their website. Some of these lists provide further detail about whether a contractor offers charging station installation services. As with other retrofits or specialized installations, word of mouth can often be an important way to find an experienced electrical contractor, backed by a check of their credentials. Many EV societies, not-for-profit organizations and utilities also provide up-to-date lists of local electrical contractors that they know have successfully completed installations in MURBs.

Condo boards, strata councils or property managers may also choose to reach out directly to an EVSE provider if they would like to work with a specific company. Most EVSE providers offer full-service or turnkey solutions and will take care of all aspects of the design, installation and management of customer service and billing. These companies either employ their own electricians to undertake the installation, or have third party electrical contractors that they regularly work with. In this case, the condo board or property manager will interact with the EVSE provider and are not likely to have much direct contact with the electrical contractor. These types of services can be particularly attractive to condo boards, strata councils or property management companies that do not want the responsibility of managing ongoing payments and billing.

Another option is to secure the services of an engineering firm, specialized EV/EMS charging solutions provider or EV advisor. There are a number of companies that will design, plan and manage the entirety of the installation process. As with EVSE providers, these firms or EV advisors will either employ or work with a third party electrical contractor. Some utilities also offer turnkey programs specific to EV charging in MURBs where they will take care of the leg work, resulting in fewer hassles for condo boards, strata councils or property managers. In addition, some organizations offer advisory services to help condo boards and strata councils understand the installation process. For example, Plug In BC's EV Advisor service for buildings located within the province includes on-site presentations and site consultations.[26]

Many condo boards, strata councils or property managers will reach out to a number of electrical contractors, EV/EMS charging providers, EVSE providers or EV advisors to get a better sense of their options before deciding on who to consult.

For more information on where to find licensed electrical contractors, see Appendix A.

Considerations for New Buildings

Depending on the location of the building and the size of the project, there are a range of engineering firms, EV/EMS charging solutions providers, electrical contractors, EVSE providers or EV advisors that can lead the design of an EV infrastructure installation for a new building. Some firms specialize in EV infrastructure, particularly in areas where bylaws require a percentage of parking stalls are made EV ready or have EVSE installed. In many cases with new buildings, engineering firms will be tasked with the initial design work and oversight, particularly where it is a large project, whereas the installation is completed by an electrical contractor.

Some companies provide a full suite of services across all stages of the project, and it is recommended that property developers seek out one with previous experience specific to the installation of EV charging infrastructure in new MURBs. It is important that the building's load capacity is calculated appropriately to accommodate EV charging, and a professional with experience is in a better position to do so. Energy or demand management is an important consideration for a new building to ensure the building is set up for future success. As with an existing building, a licensed electrical contractor should complete any electrical work and ensure that it is made safe in accordance with local codes.

2.2 Initial Consultation

Responsibility: Electrical Contractor, Engineering Firm, EV/EMS Charging Solutions Provider, EVSE Provider or EV Advisor
Other Stakeholders Involved: Condo Board, Strata Council or Property Manager

There are a number of questions that a condo board, strata council or property manager will hope to address when contacting electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor candidates to determine if they will be a good fit. An initial consultation may take place over the phone or in-person. Table 5 provides examples of the types of questions that may be asked of the party contacted.

Table 5: Typical Consultation Questions

Question	Description
How many EV chargers can be installed? 	This is often the first question asked and the answer requires the electrical contractor, engineering firm, EV/EMS solutions provider, EVSE provider or EV advisor to conduct an assessment of the building's available electrical capacity. At this stage, the electrical contractor can explain how the existing electrical load is determined and outline the types of information the condo board, strata council or property manager may need to provide to help ensure an accurate load calculation. This discussion should include consideration for how to address both current and future capacity issues.
What types of EV charging stations should be installed? 	The electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor can provide an overview of chargers that may meet the needs of building residents based on the types of EV models owned, how frequently a charging station will be used and how quickly a driver needs to charge.
Does this work require an electrical permit? 	Electrical work in a MURB requires permits and inspections. The electrical contractor will be responsible for consulting with the appropriate permitting authority and can outline the process for obtaining permits and any associated fees.[27]
What is involved in getting power to the EV charger? 	An overview should be provided of the different factors that could affect where the EV charging stations are installed, the types of electrical equipment that may be required and the process for determining the most feasible options.
Can non-EV owners use the charging stations? 	Many condo boards, strata councils or property managers are concerned about whether EV charging stations should be installed in private or shared/visitor parking spaces. Consideration should also be given to how stations in common parking areas will be managed.

Question	Description
How much will the installation cost? 	A wide range of factors contribute to the overall cost of the installation. The electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor can introduce the types of factors that impact the costs.
What are the costs involved with EV charging once the stations are installed? 	Costs associated with the management and operation of the EVSE over time can be significant. Electricity charges include those related to energy usage and time of use or demand charges. Demand charges can be two to three times greater than energy costs if not managed appropriately. Consideration should be given to who will be responsible for electricity costs and how billing will be handled.

The party responsible for designing charging solutions will need to determine what the most pressing concern is for the condo board or strata council related to EV charging. Is it budget? Or securing buy-in from residents? Options can be tailored to help address specific concerns. These considerations should also be incorporated into what will end up being an EV policy.

The electrical contractor is also responsible for walking the condo board, strata council or property manager through next steps including information gathering, planning, design and installation. In some cases, they will be asked to present to the condo board, strata council or property developer in an effort to bring everyone up-to-speed and contribute to a more timely decision around procuring their services. The initial consultation is an important step because it provides the condo board, strata council or property manager with a sense of the approach the electrical contractor will take and whether it aligns with their needs.

2.3 Electrical & Architectural Plan Review

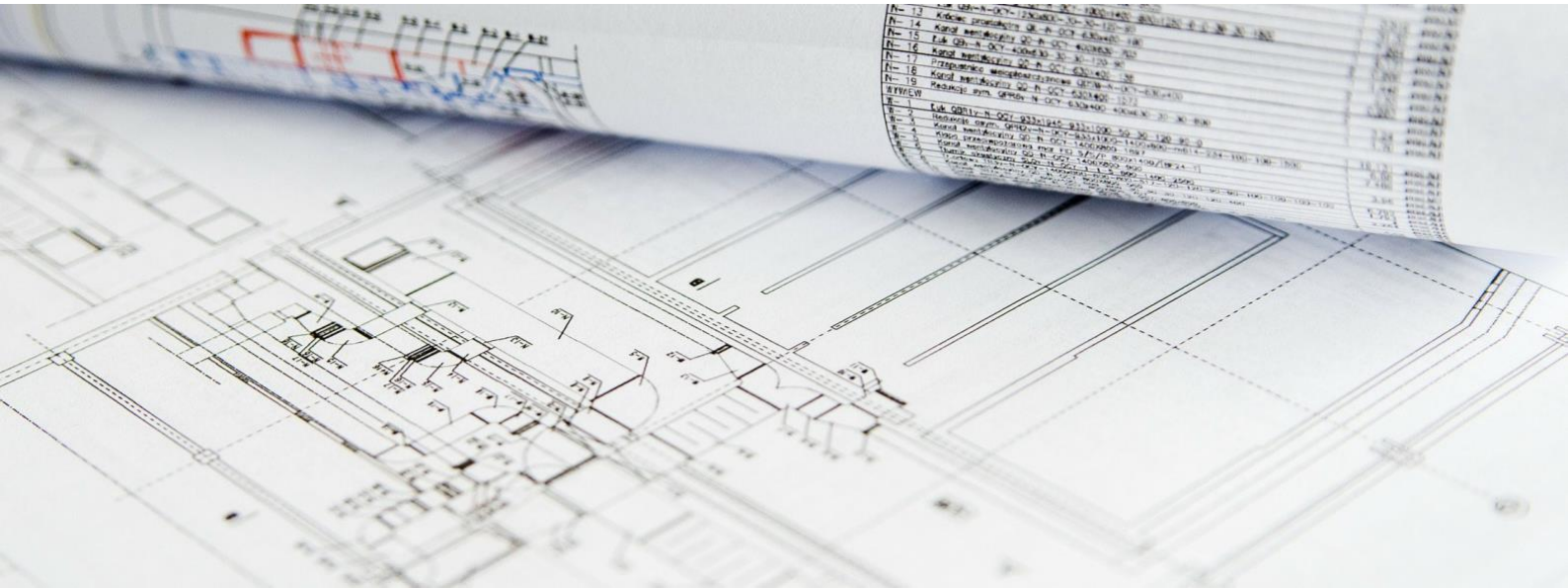
Responsibility: Electrical Contractor, Engineering Firm, EV/EMS Charging Solutions Provider, EVSE Provider or EV Advisor
Other Stakeholders Involved: Condo Board, Strata Council or Property Manager

The electrical contractor, engineering firm, EV/EMS solutions provider, EVSE provider or EV advisor will need to review any electrical and architectural site plans or drawings for the relevant areas of the building (e.g., electrical room and parking lot). These documents are typically supplied by the property manager or building owner for an apartment building.

Architectural plans: Drawings or blueprints should show the layout of the parking garage and include information about the use and dimensions of the spaces, as well as the surrounding structural elements (e.g., size and type of walls, location of doors, etc.). Electrical contractors, engineering firms, EV/EMS charging solutions providers, EVSE providers or EV advisors will need to determine how spaces are assigned prior to providing recommendations on potential EV charging options. The following are common parking assignments however, these will differ by building and jurisdiction:

- Assigned parking spaces: Parking in some buildings may be considered a common element and assigned to specific residents for their individual use. Where installation in an individual's space is not feasible, there may be the option to swap spots with another resident whose space has easier access to the electrical supply.
- Deeded parking spaces: Parking spaces may be owned by the unit owner and assigned by a deed. Swapping a deeded space with another resident to accommodate EV charging may be more challenging or not at all possible. This is due to the fact that it requires a legal transfer of property and there may be restrictions on which parking units are assigned to which residential units.[28]

Single-line diagram: A single-line diagram — representation of the power system using the simple symbol for each component — should be provided to show the network of main electrical connections and the arrangement of system components and their data (e.g., rating, voltage, circuit conductors and protective devices, resistance, etc.). The single-line diagram provides the roadmap to enable the proper design of equipment and protection. With the provision of a single-line diagram, electrical contractors are often able to determine available electrical capacity to accommodate EV charging.



2.4 Energy Data Assessment

Responsibility: Electrical Contractor, Engineering Firm, EV/ EMS Charging Solutions Provider, EVSE Provider or EV Advisor
Other Stakeholders Involved: Condo Board, Strata Council or Property Manager

The primary challenge related to the installation of EV charging infrastructure in a MURB from an electrical perspective has to do with available electrical capacity. Depending on the number of other devices drawing power, the building's transformers, electrical panels and feeders may have insufficient spare electrical capacity to accommodate a large number of dedicated EV charging stations.[29]

A load assessment is a requirement for designing appropriate EV charging solutions and is also requested for the purpose of securing an electrical permit prior to commencing the installation. A typical load assessment costs around $1,000 however, some stakeholders may provide one free of charge. Given the importance of this information for setting the course of a how a condo board, strata council or property manager will proceed with the installation of EV charging infrastructure, it is a good idea to invest in an assessment. It is recommended that the condo board or strata council cover the cost of the assessment so that it can be used by multiple EV owners.

The following should be considered when conducting an assessment of load capacity:

Existing electrical service for the building: The electrical contractor will use the rated capacity of the transformer and other electrical equipment, along with any other available information (e.g., single line diagram) to determine the electrical system's overall capacity. The capacity installed in a building may be less than the sum of all possible loads to account for the fact that not all appliances or equipment is used at the same time or at full capacity.[30]

Remaining spare capacity: Spare capacity is determined by calculating the difference between the electrical service delivered by the utility (a fixed amount designed into the building) and the maximum electricity consumed within the building. This is typically calculated using hydro bills or metering data showing hourly consumption. A number of jurisdictions state that hourly consumption data over the past 12 months can be used as the basis for this calculation which may require having a meter installed for a year to read consumption.

Where there is a single electricity meter for a building, it is easier to determine the spare capacity available to accommodate EV charging. However, in many MURBs, each unit has its own meter and billing information is specific to that customer. Some utilities offer aggregated metering data for larger buildings (e.g., 10+ units) as a means of addressing this challenge.[31] It should be the electrical contractor who connects with the utility to request any data on electricity consumption and not the condo board or strata council.

Charging system voltage compatibility: It is also necessary to determine whether adequate power supply is available at the correct voltage. In the majority of cases, the charging stations used in MURBs are Level 2 and rated at 208V or 240V. Power distribution in the building may be on individual circuits at 120V or 208V/240V. It may also be distributed at higher voltages to smaller transformers located in the parking garage.[32]

Future demand for power: Consideration should also be given to potential future demand for increased electrical power, including from sources other than EV charging. It is less expensive to install extra panels or conduit capacity during initial construction to accommodate greater uptake of EVs in the future.[33] It should be noted however, that electrical installations should not necessarily include large margins to accommodate future requirements as it has been shown that over time, residential power consumption has tended to decrease with technological advances.[34]

The applicable electrical code provides further detail about how the anticipated load should be calculated and outlines what is allowed for the connection. For large buildings or those MURBS with more complex electrical infrastructure, a Level 2 Energy Audit in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) may help to clarify how much spare capacity the building has.[35] Given the importance of an accurate accounting of available electrical capacity when planning for and accommodating EV charging, it should be left to an experienced professional.

Considerations for New Buildings

It is broadly recognized that it is more cost effective and pragmatic to install necessary electrical infrastructure for EV charging at the time of construction rather than post-construction. Adequate panel capacity and pre-wiring of electrical conduit to an energized outlet at each non-visitor parking stall in new residential buildings is required in many municipalities (primarily in BC although others have begun to pursue this option elsewhere). A qualified electrician will have experience sizing electrical infrastructure to accommodate EV charging both in the short- and long-term.

A new building is wired during construction to supply power to all necessary equipment and appliances. The appropriate sizing of this equipment is critical and should be performed by a qualified electrical contractor. The assessment for EV charging needs is built into the load assessment for the broader building. The relevant provincial or territorial electrical code will stipulate the detailed load calculations to be performed, as well as what is allowed for the connections, to ensure that the electrical infrastructure meets the needs of building users. Some of these rules will apply specifically to EV charging equipment, including the percentage of power draw allowed for all charging stations.[36]

Inadequate sizing of the electrical installation during construction can have a significant impact on the costs associated with EV charging infrastructure over the long-term as modifying existing infrastructure is expensive in terms of materials and labour.[37] However, large margins should not be included during the design phase to accommodate future requirements, particularly considering that not all electrical appliances are typically used at the same time and residential power has been shown to decrease with advances in technology. Most electrical codes provide allowances for variations in the load.[38]

See **Appendix A** for resources that explore the technical aspects of installing EV infrastructure in a new MURB.

2.5 Site Evaluation

Responsibility: Electrical Contractor, Engineering Firm, EV/EMS Charging Solutions Provider, EVSE Provider or EV Advisor
Other Stakeholders Involved: Property Manager

The electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor will conduct a site visit to confirm the information that has been gathered to-date. In situations where the single-line diagram or hydro bills could not be provided initially, a site visit will help secure the information required to calculate the capacity to accommodate EV charging. Because each MURB is unique, the site visit provides an opportunity to gather additional detail, particularly where there are considerations related to design or layout that may be useful to account for in-person.

While some site assessments are complementary when conducted as part of the installation process, there may be a cost so it is important to clarify before proceeding. The site visit should look to confirm the following:

- The physical layout of parking stalls, any potential civil engineering requirements or considerations for the spaces not previously discussed (e.g., deeded or assigned)
- Configuration of the electrical room and location of any infrastructure assets throughout the parking garage
- The capacity of the building's electrical system to accommodate EV charging

The electrical contractor will walk through the building, including the parking garage, to locate the electrical room and determine the distance from the power supply to the preferred parking stalls for installing EVSE. The following should also be considered when surveying the parking garage:

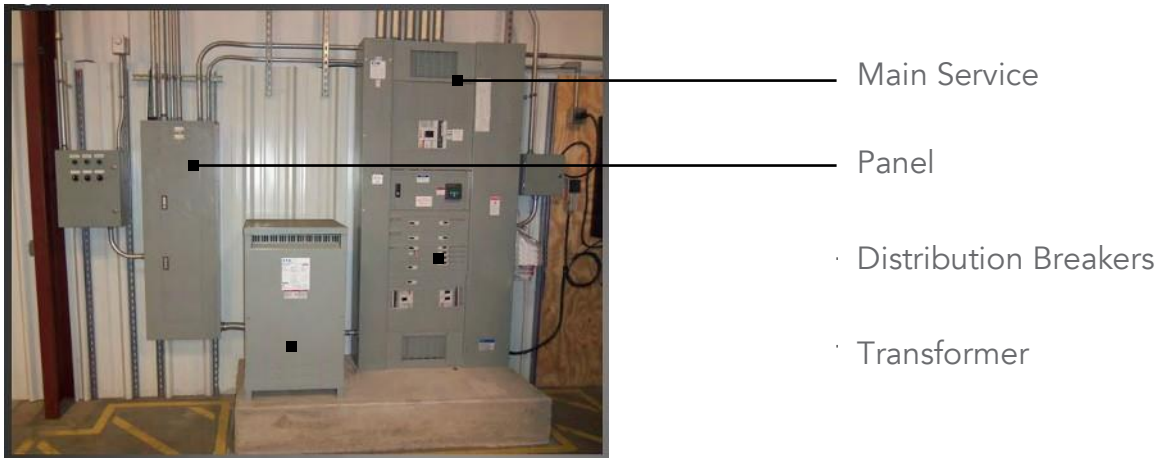
- Visibility and lighting in the vicinity of where the EVSE will be installed
- Proximity to building entrance or other destinations
- Potential physical barriers that would require construction (e.g., trenching, drilling, boring)
- Length and width of parking spaces (longer spaces have more room to fit charging stations)
- Available space on the floor or walls to install EVSE (dependent on mount type)
- Requirements for protecting EVSE from damage[39]

In addition, the equipment that distributes power throughout the building should be reviewed. This may include the following:

- Service box and the conductor or cable connecting it to the power system operated by the utility (often referred to as the customer service entrance)
- Transformers including those that step-down voltage located outside the electrical room
- Panels that distribute electricity to different circuits
- Conduit and wiring, typically run along the ceiling or wall for the purpose of carrying electricity throughout the building. The more distance the conduit is required to cover, the larger the wire size necessary to compensate for the voltage drop.[40]

- Disconnect switches used to cut off the electricity for safety or maintenance purposes
- Overcurrent devices (e.g., circuit breakers or fuses) that will cut off the current if the load exceeds the equipment rating[41]
- Different types of communications devices (e.g., Wi-Fi, LTE, radio, etc.)

Figure 4: Typical Main Service and Panel[42]



Once the electrical assessment and site visit have been completed, the electrical contractor will provide a report outlining the load capacity for the building and the number of EV charging stations (if any) that can be accommodated by the current service. The report may also outline potential options where there is not sufficient capacity (e.g., upgrading a panel, increasing the capacity of the existing electrical service or load management solutions). While upgrading a panel may be costly, increasing the capacity of an existing electrical service is often cost prohibitive and therefore, not an option typically pursued by a condo board, strata council or property manager.

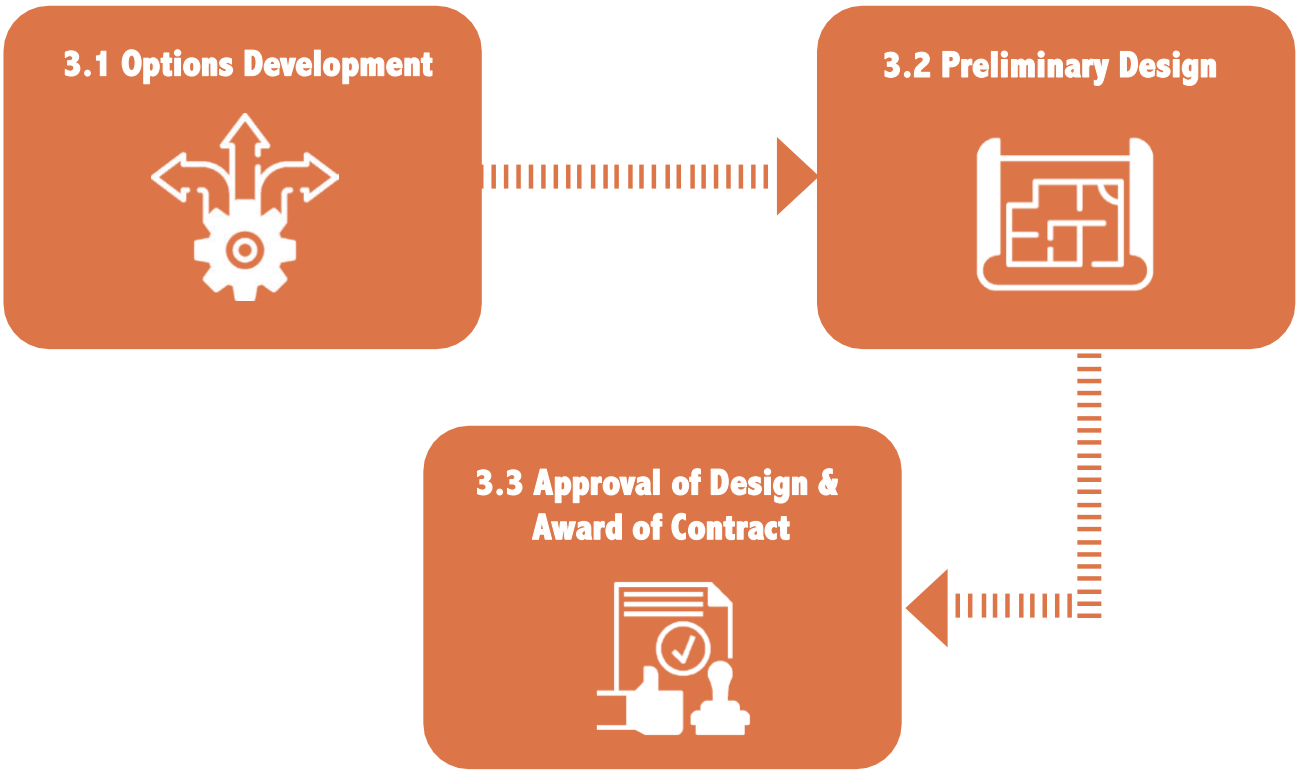
Next Steps

Step 2 outlined the need to seek out a qualified electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor to begin the process of planning for and designing an appropriate EV charging solution. It provided an overview of the types of information that should be gathered by the electrical contractor including single line diagrams, architectural plans or drawings and hydro bills, for the purpose of conducting an assessment of the building's electrical capacity. The types of considerations for a site visit were also discussed, including those related to the building's physical design and electrical equipment.

With the information gathered and confirmed as part of Step 2, the party responsible for the design of a charging solution should now have a good sense of any potential challenges associated with the installation of EV charging infrastructure in the building, and can begin to recommend the types of potential solutions that would be most effective. Consideration should also be given throughout this step to any preferences or requirements that will eventually be incorporated into a final EV policy or procedures.

The next step will focus on the preliminary design of a charging solution based on the specific needs, challenges and characteristics of the building. It will outline the different considerations for the design, introduce potential technologies and solutions for different scenarios, provide an overview of presenting options to the condo board, strata council and property manager and discuss planning for the installation.

STEP 3
Design, Documentation & Contract



Overview

With the necessary information gathered, the electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor can produce a preliminary design and provide options to the condo board, strata council or property manager for consideration. Step 3 outlines the factors that will be explored when determining options and designing an EV charging installation, and introduces potential solutions to typical barriers faced in a MURB. It outlines the presentation of a proposal to the condo board, strata council or property manager, their need to define the scope of work, the building out of the design, and approval and award of contract. An EV policy or procedures should also be developed in parallel with the design of potential EV solutions.

The examples of EV charging solutions and technologies outlined in this section are meant to provide a high-level overview of some of the options that exist in the market. However, there are likely to be other variations and in no way should the information provided herein take the place of input from an electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor.

For additional resources on the installation of EV charging in MURBs including technical guidance, see Appendix A.

3.1 Options Development

Responsibility: Electrical Contractor, Engineering Firm, EV/EMS Charging Solutions Provider, EVSE Provider or EV Advisor

The information gathered during the site evaluation and in discussion with the condo board, strata council or property manager provides the foundation for determining potential options for the installation of EV charging stations. Where possible, it is important to ensure that flexibility is built into the options presented in order to accommodate new technologies that may become available in future.

Considerations that will shape the determination of EV charging options for a MURB can be organized according to the following high-level, interrelated categories:

- Physical: Physical design considerations include the location of parking stalls in relation to electrical infrastructure, parking supply, parking design and connectivity.
- Technical: Technical considerations including challenges associated with the electrical system and its capacity to accommodate EV charging.
- Financial: Financial considerations include costs associated with the installation, operation and management of EV charging infrastructure.

These categories are explored in greater detail below.

Physical Considerations

There are a number of factors that contribute to determining the most appropriate location to install EV charging stations in a MURB. As previously noted, each building is unique and there is no one-size-fits-all solution. Table 6 outlines typical challenges associated with determining where to install EVSE.

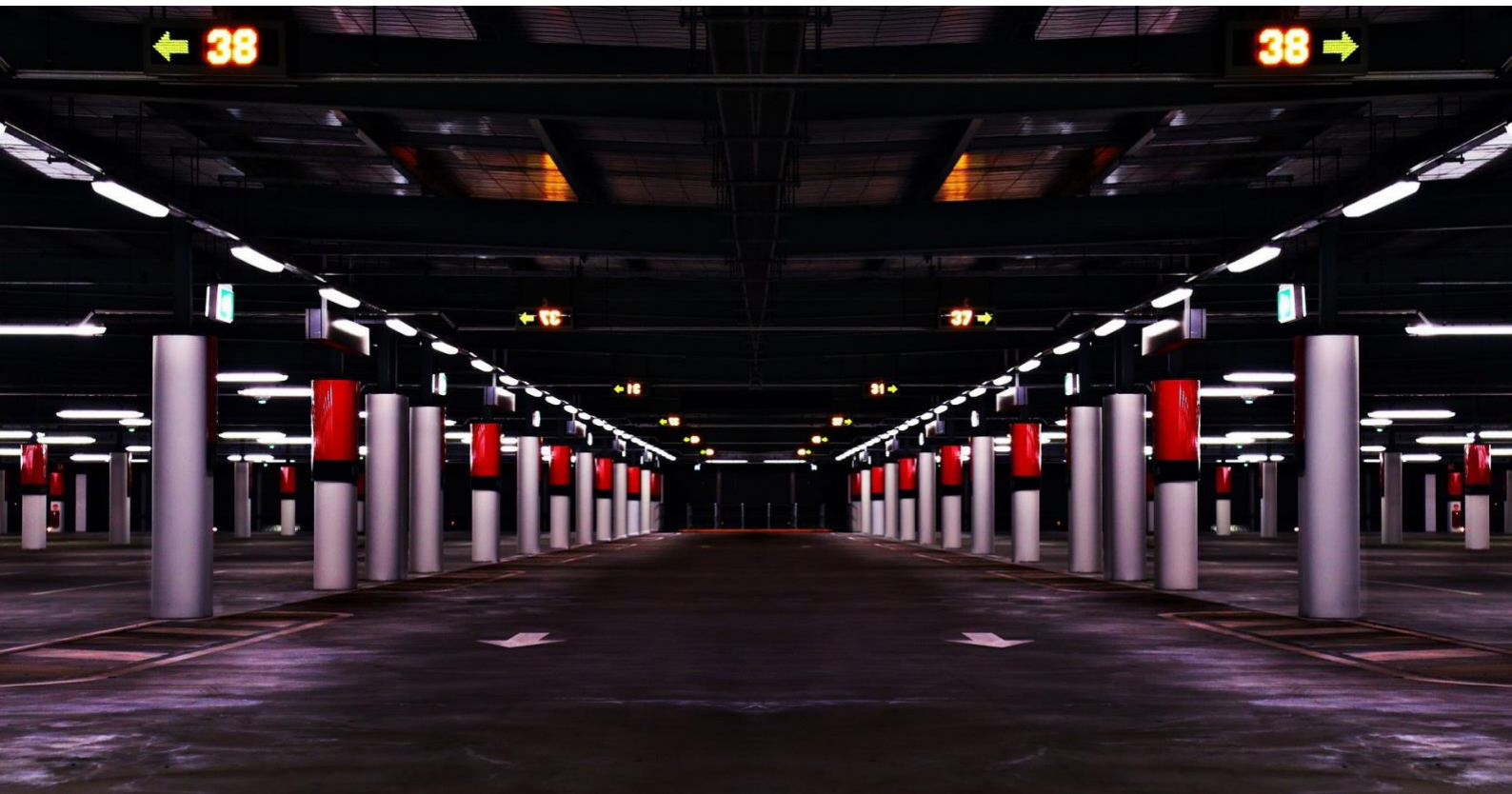
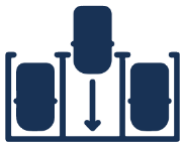


Table 6: Physical Considerations Related to Installing Electric Vehicle Charging Solutions in MURBs

Type of Information	Description
Proximity to Power Source 	Proximity to the electrical power source (e.g., electrical room, electrical panel or junction box) is one of the main factors in determining where to locate EV charging stations and any associated installation costs. While most EV owners are likely to prefer to charge in their own individual parking stall, this may not always be possible depending on where the space is located. Locating charging stations close to the power source should be prioritized wherever possible to keep costs down however, the specific layout of the building will determine what is ultimately feasible.[43]
Parking Supply 	Older buildings may have little or no parking, or a lack of regular access to a parking space. Parking stalls that are deeded may also limit the ability to re-assign spaces to accommodate EV charging as they are legally bound to the unit's title.
Parking Layout and Design 	Installing the EV charging station close to the power source is likely to result in less construction (e.g., trenching for conduit runs). The design of the parking lot may also make certain options like sharing a charging station impossible. Consideration should be given to whether the EVSE will be wall mounted (typically lower capital and installation costs) or floor mounted, with the latter requiring more space to accommodate. Dual mount options for charging equipment can help reduce overall installation costs as the incremental cost of adding another port is often much lower than that for the installation of an additional single port unit. In addition, consideration should be given to any protection the charging station will require from the elements, vehicle collision or other damage.[44]
Connectivity 	Underground parking garages may have poor wireless or cellular coverage which is required to operate some networked EV charging stations. Locations where the signal is strongest or where signal boosters can be installed may be preferable for EV charging.

Considerations for New Buildings

A number of Canadian jurisdictions have developed, or are in the process of developing, EV readiness requirements that apply to new residential developments. These requirements typically specify the minimum percentage of non-visitor parking stalls that must provide Level 2 (208V or 240V) charging capability featuring a complete electrical circuit terminating in an electrical outlet (often referred to as "EV Ready").[45] Many examples of EV-supportive MURB regulation for new buildings can be found in BC, where municipalities were given discretion to regulate EVSE through their zoning or parking bylaws (subject to conformity with other applicable laws) based on EVSE being considered "out of scope" of BC's Building Act.[46] A guide prepared on behalf of the City of Richmond outlined sample requirements including:

1. An energized outlet for each parking space that is capable of servicing a Level 2 EVSE
2. Labelling to support later installation
3. A "performance standard" specified by the City. This performance standard, which the City of Richmond set via a Technical Bulletin, sets out more specific electrical requirements to ensure enough electrical capacity is in place to allow for sufficient overnight charging, while also setting rules for the use of EVEMS.[47]

Other municipalities have followed the City of Richmond's lead, improving on the bylaw and bulletin, and in some cases, expanding it to include other land uses (i.e., not only residential). As of 2019, at least one municipality in Québec has also adopted a bylaw requiring electrical installations that will accommodate 240V EV charging stations in 20%- 25% of parking spaces in a new building with five or more units.[48]

Some jurisdictions have also outlined the need to have EVSE installed in parking spaces. For example, Tier 1 of the Toronto Green Standard specifies that 20% of parking spaces should feature EVSE in new residential buildings with the remainder of spaces designed to permit future EVSE installation. Tier 2 and Tier 3 set out higher voluntary performance requirements of 25% and 50% of parking spaces respectively, with the remainder as rough-in conduit.[49] Where bylaws or voluntary standards do not require it, condo boards, strata councils and property managers should still determine the most appropriate number of EV ready spaces based on future needs.

Technical Considerations

Electric Vehicle Charging Stations

Factors that play a role in determining the type of EV charging stations to install include a preference for a hardwired or plug-in unit, charging speed (accounting for the amount of power a specific vehicle make or model can accept), the need for smart or connected features, cost and warranty. Many of these factors were explored in Steps 1 and 2. The type of EV to be charged will also play a role. For example, a Tesla Wall Connector can only be used to charge a Tesla whereas, these owners are provided with a mobile connector that enables charging at third party stations. Whichever charging station is selected, it should be safety certified.

Networked or Non-Networked Charging Stations

Networked stations allow a charging installation to be expanded as needed to support increased EV adoption without the need for additional circuits and/or capacity.[50] However, given that networked charging stations require a wireless or cellular signal, consideration should be given to any additional costs associated with the possible need for cellular repeaters, wireless access points or cabled infrastructure to strengthen the signal in a parking garage. These costs can be significant if not planned for in advance and as such, should be highlighted in any proposal provided to a condo board, strata council or property manager. Some network solutions may provide a wireless network within the garage which removes the need for this cost consideration. Assigning responsibility for installing or facilitating the installation of any wireless or cellular equipment should be included in the final contract with the party responsible for designing a charging solution.

A networked approach may be preferred by some condo boards, strata councils or property managers because it allows for energy management and doesn't require input on site since the stations can be managed over the network. Pushback around EV installations in MURBs is often associated with a lack of understanding about the potential to share power and manage stations in an equitable way. Providing options that address these concerns can help to facilitate the decision-making process. As previously noted, whether to use a proprietary or OCPP charging system is also an important consideration when designing EV charging solutions in MURBs.

Electrical Capacity

The size of a building's transformer is determined by the total energy use required. This load is planned for when the building is being constructed and the capacity installed is usually less than the sum of all of the possible loads in the building due to the fact that all electrical appliances are unlikely to be drawing power at the same time. Transformers are typically sized with a buffer to account for times when extra capacity may be required (e.g., peak load times). This means that outside of peak times, there is likely to be some unused capacity however, there is often not enough to accommodate charging for an entire parking garage.

It is not considered a long-term solution to install a small handful of EV charging stations as this could necessitate the need for costly service upgrades as EV uptake continues over time. Instead, preliminary designs should prioritize options that will set the building up for future success, such as those that better manage existing capacity. A number of cost- effective technologies and load management opportunities exist that can allow for a greater number of vehicles charging without upgrading services.

Considerations for New Buildings

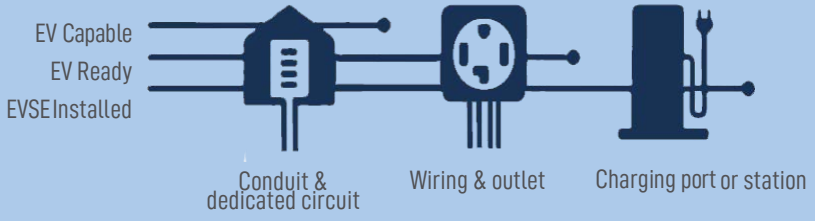
It is important to understand the various EV readiness options available when planning for charging in a new building. A report prepared on behalf of the City of Richmond outlined the following types:

EV Capable or Partial Electric Vehicle Supply Equipment: The specific definition for EV capable varies however, the intent is for the required electrical infrastructure to be partially installed in a way that requires only the wire to be pulled or the conduit/raceway, outlet and wire to be installed prior to EVSE installation. This is the least expensive option at the time of development however, it is more costly over the long run because it requires that additional electrical infrastructure is added at a later date. This option does not allow for the partial infrastructure to be verified during electrical inspection because it is not energized.

EV Ready or Energized: EV Ready is when all of the infrastructure required to charge an EV is installed, with the exception of the Level 2 charging station. This includes meters, transformers, subpanels, cables and associated raceways and energized outlets. This option would require that the EV owner purchase the EVSE to have it installed.

EVSE Installed: This option requires that all of the infrastructure required for charging an EV is available at the parking stall including the electrical equipment and the Level 2 charging station. While this is the easiest option for EV owners, it is the most costly to install during building development.[51]

Figure 5: Electric Vehicle Charging Station Readiness Options



*Adapted from AES Engineering, Fraser Basin Council & C2MP's *Residential Electric Vehicle Charging: A Guide for Local Governments*. Prepared for City of Richmond and BC Hydro

For further resources on EV readiness options, see **Appendix A**.

Financial Considerations

Some of the most important considerations in the design of an EV charging solution from the perspective of the EV owner, condo boards, strata councils or property managers are financial. Where possible, a budget provided in advance will allow for the design of solutions that align with what is financially feasible. However, condo boards, strata councils and property managers may be unwilling to provide a number before understanding their options.

Installation Costs

The cost of the EV charging station will vary based on the technical factors outlined above and may include the following:

- Charger type (e.g., Level 1 or Level 2)
- Power requirements (e.g., for Level 2, 208V/240V and 15A, 30A or 32A)
- Located indoors or outdoors
- Plug-in or hardwired
- Networked or non-networked (including Wi-Fi or cellular connection to the parking garage for networked systems)
- Single or dual port
- Wall-mounted or pedestal/stand-alone (wall-mounted stations will not require protective bollards and are typically easier to install)

In addition, there are a range of costs associated with the installation of EVSE in MURBs including those related to permitting, inspections, engineering (e.g., review, drawings), electrical work, construction and labour. Specific installation costs will vary greatly and should be determined on a case-by-case basis however, some of the factors contributing to overall cost include:

- Number of additional circuits required
- Length of conduit required (determined by distance from EVSE to power source)
- Necessary physical modifications (e.g., excavation, trenching or boring through parking garage walls or floors)
- Transformer or service capacity upgrades

Charging solutions focused on managing electrical capacity can contribute to reducing some of the expenses related to upgrading electrical infrastructure however, many of these costs will be fixed (e.g., the price of conduit).

Operation and Maintenance

Operation and maintenance costs over time can be more substantial than those associated with the installation of EV charging infrastructure. They can include the recovery of costs associated with electricity consumption and demand charges, EVSE network subscription, management time, billing transaction costs, maintenance and repairs.[52] An important consideration for many condo boards or strata councils is the amount of administrative burden associated with recovering the costs associated with the installation and electricity used by those charging. It can be time consuming to oversee the remittance of these costs and to monitor meters to determine energy consumption. Most charging software has the ability to adapt pricing with electricity output to ensure fair pricing. Where possible, it should be communicated that options exist that can provide for automated billing, particularly for those condo boards or strata councils that articulate the need for ongoing management to be as simple as possible.

Most condo boards and strata corporations seek to recover the cost of electricity used directly from the individual EV owner to avoid having other building residents subsidizing the cost. According to Measurement Canada, the federal body with jurisdiction over ensuring accuracy in the selling of measured goods (including electricity), any meter used as the basis for billing based on energy (kWh) or power (kW) delivered must be Measurement Canada-certified. Meters used for time-based charges (i.e., the number of minutes or hours vehicle is charging) however, do not require this certification. While most networked EVSE are designed with measurement systems to record the amount of energy dispensed, none are currently certified by Measurement Canada. This means that condo boards or strata councils will need to work with the electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor to determine the most appropriate approach to recovering the costs of electricity used in a way that is in line with regulations.

Restrictions on the resale of electricity by entities other than regulated utilities in the jurisdiction where the building is located should also be considered when determining options for apportioning electricity costs. While most Canadian provincial utilities commissions have not found that provision of EV charging services constitutes the sale of electricity, most have not yet considered the issue as part of a formal proceeding.[53] The electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor should keep abreast of any changes or developments related to the apportionment of electricity costs within the appropriate jurisdiction.

Time of Use and Demand Charges

Time of use charges in some jurisdictions are a means of applying different charging rates to utility customers based on when the energy is used. Utilities charge more during the day when electricity use is higher, and less overnight when it is at its lowest. Most EVs and EVSE have the ability to pre-program start times for vehicle charging and as a result, can do so outside of peak demand times, thus reducing time of use charges. Some EVSE also have the ability to program charging to respond to price signals from the utility.

Demand charges are additional fees that utilities charge based on the maximum amount of power that a customer used during the billing period, measured in kW.[54] This means that additional equipment switched on during peak demand time will result in higher fees than if energy usage were spread more evenly over time. For EVs, this means that charging solutions that allow for more evenly distributed electricity usage over time (e.g., load management) should be prioritized to avoid all EVs charging simultaneously, particularly during peak demand times. It should be made clear when presenting options for EV charging station installation to condo boards, strata councils or property managers that time-based load management can help ensure electricity bills are not as dramatically affected.

Considerations for New Buildings

A common financial challenge for new buildings is determining how to account for the upfront capital costs associated with installing the electrical capacity needed to accommodate EV charging. While some property developers may view this as a potential barrier, it is helpful to bear in mind that both consumer demand and supportive policy frameworks will contribute to the need for greater charging capacity in the near future. It is far less costly to design a new building with future EV charging in mind, than to retrofit after the fact. A new building without enough electrical capacity would require the same considerations as a retrofit, despite its having been recently built.

3.2 Preliminary Design

Responsibility: Electrical Contractor, Engineering Firm, EV/EMA Charging Solutions Provider, EVSE Provider or EV Advisor

The party responsible for designing a charging solution will now outline the most effective options for the building based on the factors noted in the previous step. It is recommended that whenever possible, more than one option is provided for a condo board or strata council to consider and compare. This will save time as there is a greater chance that one of the options will be approved.

This section provides a high-level description of some of the technologies and solutions that may be suitable for use in a MURB. It is beyond the scope of this guide to explore every possible option, particularly as there will be differences based on the unique configuration and characteristics of the building. Additional resources with more detailed information can be found in Appendix A.

Physical Considerations

The following options can address potential physical or design challenges within the parking garage.

Reassigning or Swapping Parking Spaces: In some cases, residents may be able and open to switching the location of their parking spaces to allow for those who own an EV to relocate closer to the power supply. Condo boards and strata councils may also have the authority to reassign parking spaces located in common areas. The re-assignment of spaces can be advantageous for grouping EV charging stations closer together and in proximity of the electrical room, maximizing the use of available parking space and capacity. However, there are a number of legal and financial factors that need to be considered when reassigning spots where they are deeded to a unit. The re-assignment of parking spaces is not considered an option that will contribute to planning for the future because while it enables charging for a handful of EV owners in the near-term, it cannot address the uptake required to meet the national target of 100% ZEVs by 2040.

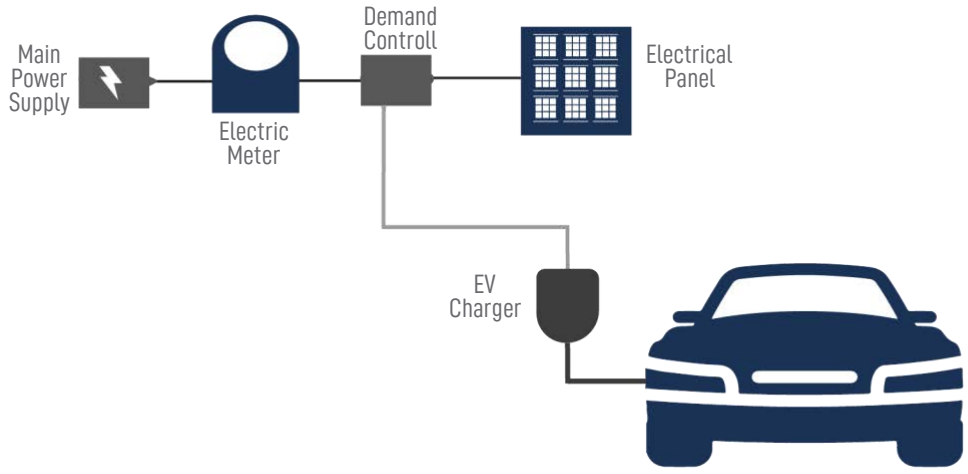
Shared or Communal Parking: While most EV owners will prefer to charge in their own parking stall, where space is constrained or there is an inability to swap spots, community or shared EV charging stations may be an option. This may involve installing EVSE in a location that intersects with several parking spaces and which can accommodate the shared use of a charging station by multiple vehicles. It could also involve the use of visitor parking spaces but this configuration often requires drivers to move their car around to different spaces and the condo board or strata council to monitor and police the spots, acting as a mediator should issues arise (e.g., someone is parked in the spot who is not charging). However, many EVSE providers offer solutions that track usage and manage billing for shared charging stations and provide EV owners with other features including information about real-time station availability, virtual waitlists and notifications to help coordinate access to shared parking locations.

Demand Controller: Space constraints in the building's electrical service room can create challenges when looking to upgrade electrical panel capacity or install additional sub-meters. A demand controller can be installed between the unit owner's meter and the electrical panel and has the ability to divert some of the power to the EV charging station while monitoring the overall electricity consumption of the panel. When the power being

used by the resident falls below a certain level, EV charging is accommodated. The demand controller will cut power to the charging station when the unit needs more power, preventing the panel's capacity from exceeding 80%. It is worth noting however, that when the demand controller cuts power to the EVSE, some EVs may stop charging. While some will attempt to restart after 15 minutes, assuming power failure, others will not start again without manual intervention.[55]

Tapping into the common electrical panel is not required with the use of a demand controller and because it is small in size, it can easily fit into electrical rooms with space constraints. It does however, require that the meter is accessible. This option is also an attractive solution because it allows EV owners to pay for usage on their existing meter and does not require a separate bill.[56] Demand chargers ensure that the power used to charge the EV occurs outside of peak times, thus avoiding potential demand charges. Relevant codes and standards should be consulted for rules on how to calculate the load for a demand controller as part of the total calculation for the building.

Figure 6: Example of Demand Controller Connecting Electric Vehicle Charger to the Main Power of a Single Unit Where the Electric Meter is Accessible[57]



Technical Considerations

There are a number of important technical considerations that the design of EV charging solutions should take into account, particularly where a building may have minimal spare electrical capacity. The following outlines key technical considerations for the installation of EV charging infrastructure in a MURB.

Dedicated Circuit

One of the least complex options for installing EVSE in a MURB is when a single branch circuit is used to power one charging station. Also referred to as a dedicated circuit, this option requires significant electrical system infrastructure to accommodate the electrical load and dedicated wiring to each parking stall. Given the potentially limited electrical capacity in many MURBs, this may not be a feasible option. Even where there is capacity to install a small handful of EVSE on dedicated circuits, this option will quickly eat up any spare capacity, likely requiring additional solutions in future.

Infrastructure Upgrades

A number of potential options are available where the load assessment determines that the building's electrical capacity may be constrained. The least preferable of these involves contacting the utility to request an upgrade to the building's electrical service. While in the majority of cases it is possible to increase capacity through service upgrades in collaboration with the local utility, the process can be complex and prohibitively expensive. As a result, this option is one that condo boards and strata councils look to avoid.

Electric Vehicle Energy Management Systems

EVEMS can be an effective means of addressing electrical capacity challenges and increasing the number of vehicles that can charge in a MURB by making efficient use of available electrical installations. These systems can be organized according to two broad categories: load sharing and load management. EVEMS can also be part of a broader building-level energy management system and integrate energy supplies, including solar, batteries and large electrical loads, such as HVAC.

Load Sharing

Load sharing, sometimes referred to as circuit sharing, is the connection of multiple EVSE to a single branch circuit with use of demand control to avoid exceeding the circuit rating. A report prepared for the City of Richmond outlined the following circuit sharing configurations, both of which could be used for EV charging in MURBs.

Static Load Management: This option involves equal power allocated to each EVSE. The available charging capacity is typically apportioned equally between all of the EVSE connected to the branch circuit. For example, where two EVSE are on one circuit, when one EV is charging, it would receive 100% of the available capacity. Where two vehicles are charging, they would each receive 50%. This option does not allow for dynamically changing the power apportioned between the EVSE based on the demand of a specific vehicle. Static load management is often chosen for small scale installations due to reduced installation costs, design simplicity, ease of system setup and avoidance of service fees.[58]

Dynamic Load Management: This option involves controlling charging based on available capacity and the demand request of each EVSE. Dynamic load management is the most flexible and efficient circuit sharing configuration as power delivery is based on the actual requirement at each EVSE. However, it requires communication capabilities and can be the most costly option due to proprietary systems, service fees and the potential for reduced charging performance compared to a dedicated circuit.[59]

A third option known as rotational or time-shared load management involves allocated charging according to a schedule or predetermined duration. This option is most suitable for vehicles that are parked for long periods of time and therefore not typically used in a MURB.[60]

Load Management

Load management is the control of the current drawn by the EVSE at the main switchboard of the building.[61] With load management, power can be supplied to multiple vehicles through a number of different configurations and by controlling the rate and timing of the charge. Effective load management options have the potential to significantly reduce the capacity required to charge multiple EVs by modulating power based on the needs of all of the vehicles connected to the same electrical installation.

Table 7 outlines load management systems available for use in a MURB at the panel, dwelling or building level, as described in a recent report prepared for the City of Richmond.

Table 7: Physical Considerations Related to Installing Electric Vehicle Charging Solutions in MURBs

Load Management Type	Description
Panel Demand Load Management	Panel demand load management or panel sharing, is charging based on the sharing of the capacity of a specific panel. This option is suitable for large MURBs.
Dwelling Demand Load Management	Dwelling demand load management is the control of charging based on the available capacity for a dwelling. This option involves connecting directly to the feeder that supplies a unit to control charging based on available capacity. See Demand Controller on p. 60 for a more detailed description of this option and the benefits ad challenges associated with its use.
Building Demand Load Management or Dynamic Load Balancing	Building demand load management or dynamic load balancing is the control of charging based on the available capacity for the building. The building's spare capacity is monitored and EV charging is controlled accordingly. It can also be used to work within pre-set demand limits based on cost considerations. It is however, a more expensive option and there may be a limited number of manufactures offering this solution. There are also potential challenges related to code issues, certification and patents.

*Table adapted from the report *Electric Vehicle Charging Infrastructure in Shared Parking Areas: Resources to Support Implementation & Charging Infrastructure Requirements*. Refer to this report for additional information and diagrams of different circuit sharing and load management options.[62]

Most EVSE providers have developed software that can intelligently manage the individual power among charging stations either through load sharing, load management, or both. When combined with the metering integral to the EVSE, each vehicle receives a charge as quickly as possible while not exceeding the rated electrical capacity for the site. This option also provides the ability to distinguish individual usage, making it easy for condo boards or strata councils to manage. While some EVSE providers require charging stations to be connected to each other or a master unit, others allow for charging stations to be scattered throughout the parking garage and on different floors where they communicate over a wireless network. There are proprietary and OCPP versions of load management systems and condo boards, strata councils or property managers should determine the most appropriate solution to meet their needs.

It should be noted that safety considerations are important for EVEMS where software controls the loading on circuits and panels. While overcurrent protection (i.e., circuit breakers and fuses) and bonding of electrical systems represent the fundamental safety mechanisms for protection against fire and shock hazards, EVEMS need to be designed in a manner that reasonable safeguards against reliance on such mechanisms.[63]

Technology companies and EVSE providers have also begun to explore options for addressing electrical system capacity challenges with options that incorporate energy storage solutions. Battery-supported EV charging systems that draw power slowly from the grid when demand is low are available in the market. These systems can supply power to a number of charging stations at the same time and are able to provide power through slow or fast charge.[64]

Considerations for New Buildings

Planning for load management at the time of construction can help avoid the need to design in additional capacity for the building's electrical system to accommodate EV charging. If the uptake of EV technology continues to increase, it is likely that many MURBs may need to use EVEMS to avoid exceeding available electrical capacity, which as previously noted, should not be designed with significant margins. The installation of EV charging stations that are not compatible with EVEMS, could require that they are replaced with those that are.[65]

The Canadian Electrical Code has recently been updated to allow for load management systems. Many of the municipalities that have amended zoning or parking bylaws to include requirements for EV charging in new residential buildings also note requirements for the use of EVEMS and a minimum performance standard as part of a technical bulletin. These performance standards or requirements help to ensure adequate power is provided to EVSE to improve the likelihood that vehicles will be fully charged overnight. This is accomplished by indicating the maximum number of EVSE that can be connected to the same circuit. Without these requirements in place, buildings may be designed for excessive load sharing and not able to provide a sufficient rate of charge.[66] Minimum performance standards are often based on typical daily driving distance, traffic congestion, topography and the climate zone.

The electrical contractor should be responsible for consulting any performance standards and determining how load management will be accounted for as part of any load calculations for the building. Some companies may have preplanned designs that can be tailored to the needs of the property developer. For further resources on EVEMS in new buildings, see Appendix A.

Financial Considerations

The types of costs associated with the installation of EV charging infrastructure were outlined in Step 3.1. It is also necessary to consider how costs will be allocated, including those related to the purchase, installation and maintenance of the EVSE, and ongoing electricity usage. Decisions need to be made about who will take ownership of the charging stations and any electrical infrastructure. In many cases, the EV owner will purchase and own the EVSE while the condo or strata corporation will take ownership of the infrastructure that is installed in the building (e.g., new panel).

Metering Considerations

To ensure that electricity consumption costs are appropriately apportioned to EV owners, it is recommended that revenue grade metering is provided on the electrical distribution equipment feeding the EVSE. A number of metering options that should be considered when determining how to recover costs associated with the EV infrastructure and the ongoing electricity costs are outlined below. The electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor will help to determine which metering type would be most appropriate, including the use of EVSE with integrated metering. The utility should also be contacted to determine their policies related to metering.

Existing common area account: Condo boards or strata councils can request that EV chargers are added to an existing common area account (i.e., the account used for electricity in common spaces including hallways, parking garages, the lobby, etc.). This option requires no additional service connections or meters however, it is not possible to differentiate electricity consumption specific to EV charging stations. This means that the condo board or strata council will be responsible for monitoring and determining billing and payment options. A flat fee is often charged on a monthly basis to cover the cost of electricity and in some cases, to recover the cost of the infrastructure.[67]

Separate EV meter: Condo boards or strata councils can request a separate meter and account to measure the electricity use specific to EV charging. For this configuration, a single meter is installed for the EV charging stations and the condo board or strata council is responsible for the costs associated with the new meter. While this option allows for electricity use from the EV charging stations to be billed on a separate account from the existing common use account, the condo board or strata council will still be responsible for managing payments for EV charging and determining how to bill according to use at each EVSE.[68] In addition, this metering option may miss an opportunity to take advantage of energy management options at the building level that include other large electrical loads. For example, if it is a warm day where a number of air conditioning units are turned on at the same time as a number of EVs are charging, power sharing is not a possibility between these two loads so capacity would be eaten up and overall demand charges may be higher.

Separate individual meter: With this option, individual unit owners would have their own separate meter installed for the EV charging station in their parking stall. The unit owner would be required to seek approval from the condo board or strata council for any related electrical work to install the meter and would be responsible for covering the costs of the meter installation. This option is the easiest for determining the specific electricity usage and billing can often be combined with the owner's unit account. However, it is not compatible with load management configurations and can be expensive.

Some utilities offer the option to consolidate billing and access information about multiple meters and accounts through a single bill. However, most utilities prefer to avoid installing a separate meter for each EVSE because it is an expensive option and the typical consumption on the meter over the course of a year is quite low. As a result, some utilities have mandated that new meters installed for the purposes of charging must be a separate meter for all EVSE and that any future charging stations would also be tied to this meter. This requires the condo board or strata council to plan for the future and determine how best to make use of load management rather than individually metering each new EVSE.

When a new meter is needed to accommodate EV charging, it is typically installed by the local utility. However, some condo boards, strata councils or property managers may already have a pre-existing relationship with a third-party sub-metering company that they would prefer to track specific charging. While a sub-metering company can provide information related to usage, this option does not allow for the use of load management unlike many of the charging stations currently in the market.

For further resources related to costing, see **Appendix A**.

Rebate Programs

A number of jurisdictions provide funding for programs that address challenges associated with barriers to EV charging in MURBs. These programs may include a rebate for the purchase and installation of charging infrastructure in a condominium or apartment. Some also offer consultation on EV charging solutions in MURBs. The option to apply for these rebate programs should be outlined for condo boards and strata councils when presenting preliminary charging design options as it could play a critical role in budgeting and decisions about how best to proceed. Some programs may have specific requirements that need to be met in order to apply which will also need to be reviewed in advance of making any decisions.

Considerations for New Buildings

Many EV charging rebate programs also apply to installations in new residential buildings. Property developers should review program requirements to determine if they are eligible. Additional business models are being explored by some property developers that involve partnering on the upfront costs of the EV-related infrastructure. This may involve a partner paying for the installation and retaining ownership of electrical assets in return.

3.3 Approval of Design & Award of Contract

Responsibility: Condo Board, Strata Council or Property Manager

Other Stakeholders: Electrical Contractor, Engineering Firm, EV/EMA Charging Solutions Provider, EVSE Provider or EV Advisor

The electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor will now develop an outline of different options, costs and the feasibility of residents having EV charging stations installed. The design process involves preparing drawings and necessary documentation for the installation, permitting or construction. A site plan should be drawn up for each parking level indicating the location of wiring and conduit, along with an electrical single line diagram for the building showing proposed circuits and panel layouts.

The electrical contractor, engineering firm, EV/EMS charging solutions provider EVSE provider or EV advisor should be prepared to present their initial proposal in-person to the condo board, strata council or property manager, if requested. Those in attendance will be introduced to the different potential options and the benefits and challenges associated with each. There are likely to be many questions that require answering before everyone has a good understanding and feels comfortable with what has been proposed.

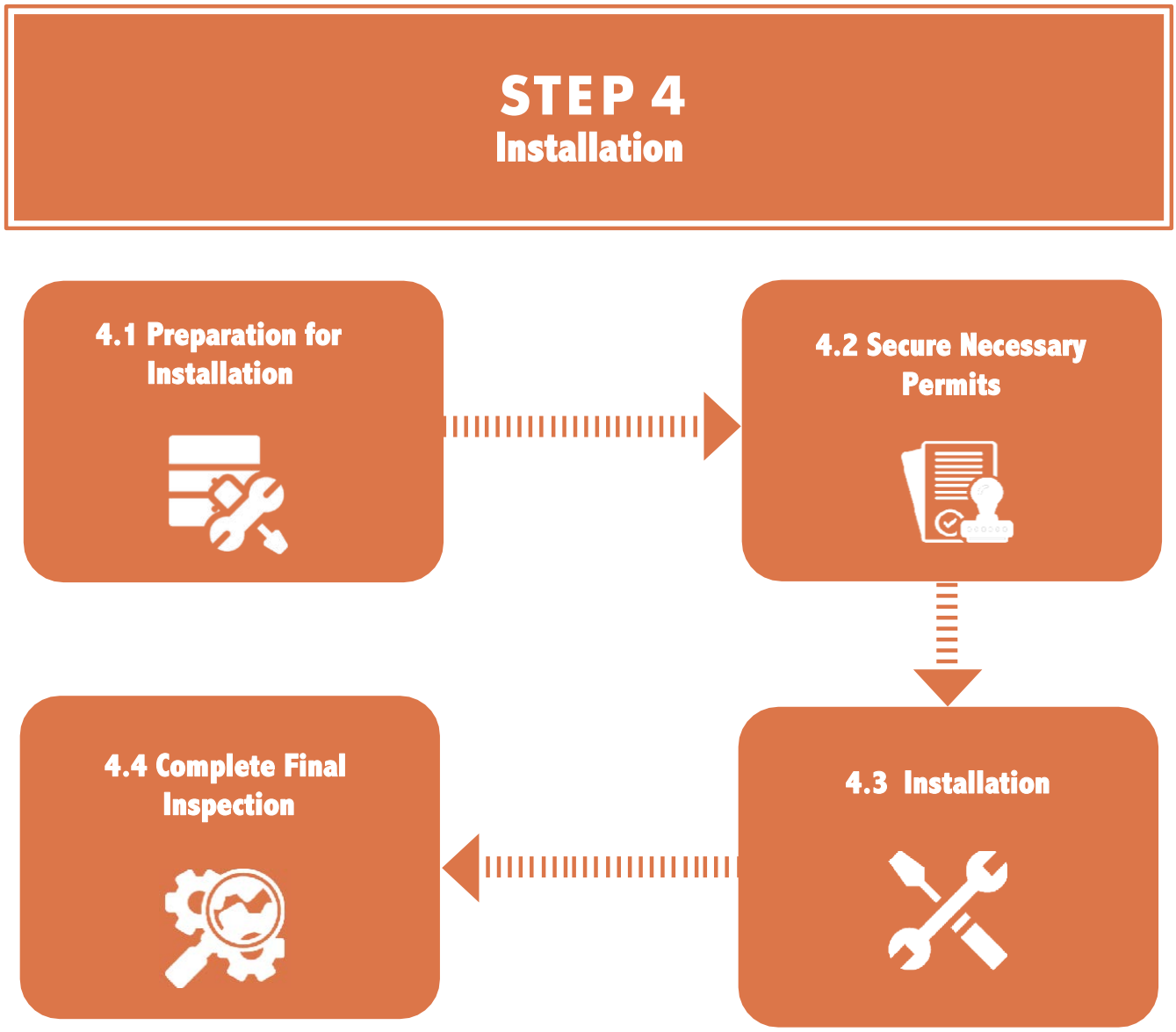
The condo board, strata council or property manager will need time to discuss and deliberate before making a decision about their preferred option. They will need to clearly determine the scope for the project and which considerations may not be necessary to pursue. Once there is agreement on a preferred option, the electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor will prepare a more thorough design, including any adjustments based on feedback from the condo board, strata council or property manager.

The electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor will also apply for any incentive programs or necessary variances to accommodate the preferred EV charging solution. Depending on the party leading the design process, there may also be a need to undergo a bidding process to determine who will complete the construction and installation. For example, an engineering firm may work with the condo board or strata council to put out a request for proposal (RFP) requiring qualified electrical contractors to submit a bid for the project. Applications would be evaluated based on a pre-determined set of criteria and a contract would be awarded to the successful candidate prior to commencing work.

Next Steps

Step 3 explored a number of considerations for the design of an EV charging solutions for a MURB. It discussed various technologies and options that would help to address the most critical challenges associated with installing charging infrastructure in a MURB. A number of considerations outlined in this section should also be incorporated into an EV policy or procedures.

With the preferred design approved by the condo board, strata council or property manager, preparation can now begin for the installation. The next step involves preparing for, and implementing the installation of the EV charging infrastructure and includes securing permitting, construction and final inspection.



Overview

With all of the planning and design completed and approval received from the condo board, strata council or property manager, the installation can proceed. This section will outline the process of preparing for and installing the EV charging infrastructure.

This step will require a significant amount of project management on the part of the electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor responsible for leading the project. Additional support for specific aspects of the installation will likely be required from those with a specialized skillset (e.g., additional electricians or a general contractor). The necessary permits will need to be secured prior to commencing the work and once completed, testing and inspections will ensure the installation has been completed safely and in compliance with relevant codes and standards.

4.1 Preparation for Installation

Responsibility: Electrical Contractor, Engineering Firm, EV/EMS Charging Solutions Provider, EVSE Provider or EV Advisor

The initial preparation for the installation may involve the following activities:

- Source required equipment (e.g., the EVSE, wiring, breakers, panels, etc.)
- Complete necessary site modification plans, drawings or construction documents
- Prepare to submit necessary information to secure permits
- Complete service upgrade or new service assessment, if required
- Coordinate the work conducted by all parties including any general contractors or the utility[69]

Charging stations can be sourced either directly through the EVSE provider or a retailer. All equipment should be certified for use in Canada by a recognized certification agency (e.g., CSA, cUL, cETL) or display certification marks that have been approved in the local jurisdiction.

Additional support may be required to proceed with the installation, including general contractors or additional electricians, depending on the specific design and project requirements. Roles and responsibilities and any other practicalities should be determined prior to commencing any work. While timelines will have been discussed during the design stage, these should be adjusted based on changes to project scope or requirements specific to the approved design (e.g., number of EVSE installed, necessary civil work or electrical upgrades).[70] Electrical contractors should work to the timeline agreed upon to the full extent possible, with the understanding that unanticipated challenges may arise once work begins. Potential risks should also be identified and a mitigation plan developed to address how they will be dealt with.

4.2 Secure Necessary Permits

Responsibility: Electrical Contractor

Electrical installations, repairs or replacement work must be completed in compliance with the applicable provincial or territorial electrical code. It is important that the most current edition of the code is followed as they are updated every few years to address emerging technologies and improvements in safety practices.[71] As previously noted, electrical work must be conducted by a licensed electrical contractor.

While provinces or territories are responsible for enforcing the safe installation and operation of technical systems, municipalities in some jurisdictions have been delegated the ability to issue electrical permits. This is a critical step in the installation process as the electrical system for a MURB will have a significant amount of power and there are very real dangers associated with installing EV charging infrastructure incorrectly or not to code. Electrical work specific to the installation of EV charging stations will require application for the appropriate

permits. Electrical permits, also referred to as a notifications, should be taken out before, or within a certain timeframe of the work commencing (typically 48 hours but this should be confirmed by the authority issuing the permit). The permit must be taken out by the person doing the work, in this case, the electrical contractor. The condo board, strata council or property manager should not attempt to take a permit out on behalf of the electrical contractor.

The electrical contractor should contact the permitting office with jurisdiction over the installation site to identify specific requirements however, the following are examples of the types of information that may be requested for an EVSE installation:

- Site Plan: The plan will identify the complete layout of parking spaces and the proposed use and location of the EV charging stations and other elements (e.g., electrical system components, lighting, signage, safety measures).
- Electrical Load Calculations: Load calculations are required to determine if the existing electrical service can handle the additional load from EV charging and that wiring methods are aligned with the relevant electrical code. All loads that will be managed by an EVEMS should also be identified and included in the load calculations.[72]
- Single-line Diagrams: Electrical plan single-line diagrams should show the building's electrical system, the point of connection to the power supply and the EVSE.
- EVSE Information: The EVSE provider's installation instructions and charger specifications may also be requested.[73]

The electrical contractor will also be responsible for calculating any associated permit fees, which will differ based on the type of work being done. In the majority of cases, documentation simply needs to be submitted to the appropriate permitting office for review and permit issuance. If all information is satisfactory and the proposal complies with applicable codes, the review and approval will occur within a short timeframe. Additional permits may be required depending on the specific project, including building permits for civil work. It is important to discuss with the permitting office with jurisdiction over the installation site to fully understand any requirements and fees prior to applying for permits.

4.3 Installation

Responsibility: Electrical Contractor

While the construction and installation process for EV charging infrastructure will vary widely depending on the specific building, customer, number and type of EVSE installed, many of the same high-level considerations will apply to the majority of installations.[74]

Table 8 outlines a range of considerations for a typical installation.

Table 8: Typical Installation Requirements for Electric Vehicle Charging Infrastructure in a Multi- Unit Residential Building

Task	Description
Permitting 	Permits should be posted in a visible location at the installation site.
Civil Work 	Necessary civil work should be performed in order to allow for the installation of wiring, conduit and the EVSE. The construction area should be secured and provide safe working conditions (e.g., temporary fencing, barriers, etc.). Civil work may include removing drywall, insulation or concrete to run conduit and/or wiring and trenching, drilling or boring to install junction boxes or subpanels.
Rough-in Inspection 	A rough-in inspection should take place once all branch circuit wiring and outlet boxes have been installed and prior to any wiring being concealed. This inspection will look to ensure that the electrical work has been completed in compliance with the electrical code for the appropriate jurisdiction and will outline whether any of the work needs to be fixed. If the inspection is not passed, work will need to be redone and another inspection scheduled.[75]
Run Conduit 	Where required, conduit should be run from the power source to the location where the charging station will be installed. Electrical contractors should consult electrical code requirements for the types and size of wiring and conduit to be used.
Pull Wires 	Wires should be pulled, ensuring they are sized to support the rated equipment load.
Mount EVSE 	The mounting surface should be prepared as per the EVSE provider's instructions. If mounting on the floor, a concrete foundation may be required that will allow conductors to enter through the base of the charging station.[76] If the station will be located on a wall or a pole, brackets may be installed to help allow for the mounting of the charging equipment. Consideration should also be given to keeping the area around the charging station organized through the use of cord or cable holders. This will provide a means of keeping the cords off the ground and out of the way.
Impact Protection 	Depending on where the EVSE will be installed in the parking garage, impact protection equipment (e.g., bollards) may be necessary to help protect it from damage.
Physical Considerations 	Clearly marked signage for the EV charging station should also be considered, particularly in shared charging spaces. Figure 6 shows examples of potential signage for use in a MURB. Some jurisdictions provide guidance or templates to help with the installation of signage, along with lists of potential sign suppliers. Some EVSE providers may also provide signage for purchase.[77] The installation of EV charging stations also offers an opportunity for branding or public education about the benefits of using EVs. The lighting configuration at the parking spaces should be considered when installing EVSE so that the EV owner can easily see the charging ports or control screens.[78]

Figure 6: Examples of Mounted and Pavement Signage for Electric Vehicle Charging in a Multi-Unit Residential Building

*Adapted from *EV Charging Stations for Multi-Unit Residential and Mix-Use Commercial/Residential Buildings*[79] and *Condominium Authority of Ontario*[80]

Considerations for New Buildings

In new MURBs, the utility will need to be engaged in decisions related to the connection of a new electrical service for the building to the local distribution system. This should occur early on in the design process. The types of electrical equipment (e.g., transformers, switch gears) required should be discussed so that the utility can plan accordingly. The electrical contractor responsible for the project will provide documentation to the utility related to the electrical needs of the building. The utility will then install the appropriate infrastructure to power the requested demand. While this process is not specific to EVs where a new building is concerned, there may be discussions about how the installation of any EV-related technologies will play a role in the overall electrical usage in the building.

4.4 Complete Final Inspection

Responsibility: Electrical Contractor

Other Stakeholders Involved: Permitting Office

Once the installation is complete and prior to use of the EV charging station, it is necessary to test the equipment that has been installed, make the electrical connection and complete a final inspection. The permit holder should contact the local permitting office to request an inspection. They will be required to provide information including a description of the work, the address of the job site, permit number, site details and inspection type (e.g., rough-in, final).[81]

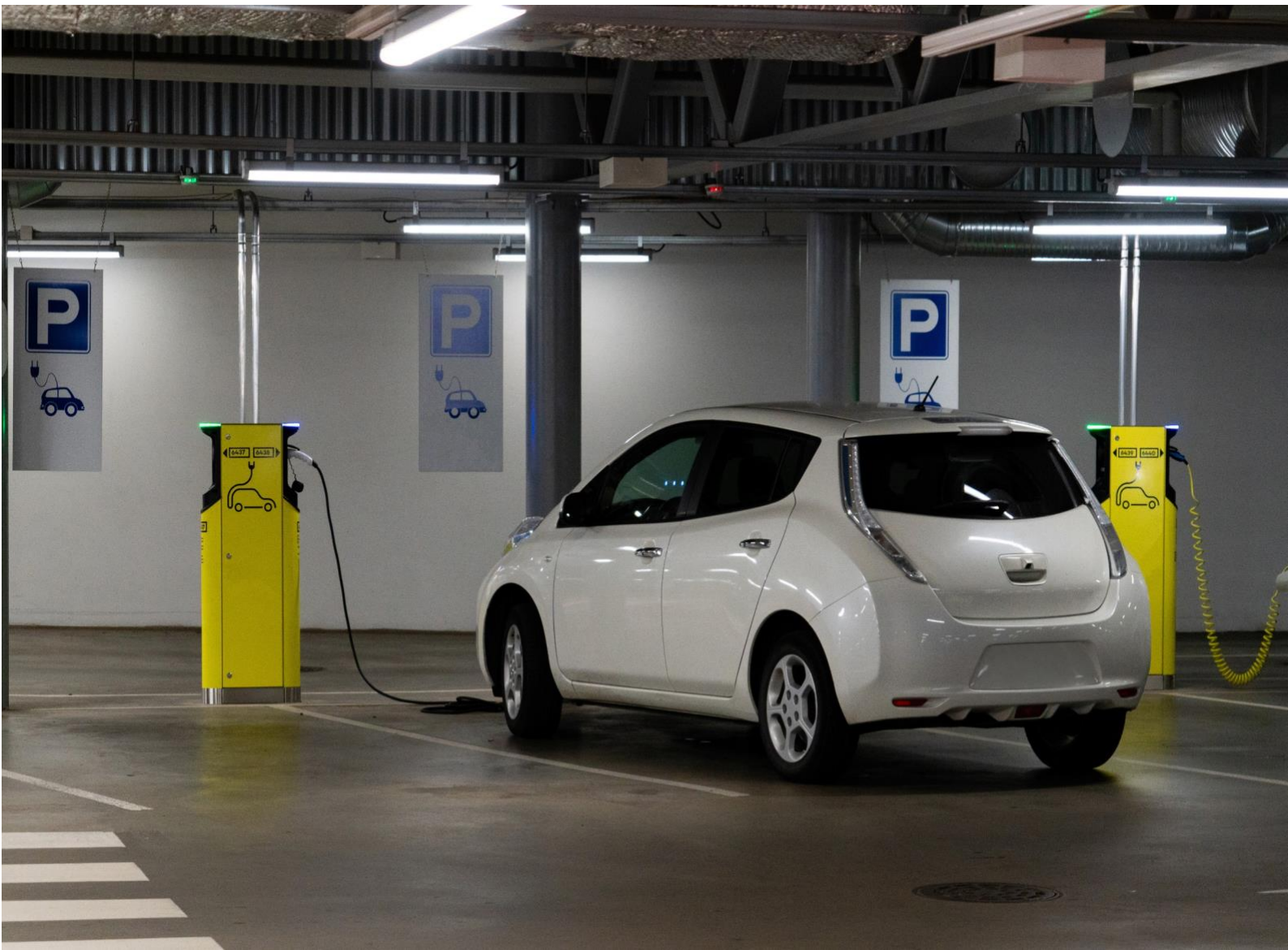
The inspection process will vary depending on the project and the jurisdiction within which it occurs. Inspections can take time for a MURB, particularly given that EVSE technologies are changing rapidly and inspectors may not have experienced many of them yet. The importance of the inspection should not be understated as EV charging infrastructure can affect safety if not installed correctly and there is a need to take the time to ensure equipment operates effectively under all conditions. Many inspectors are becoming more familiar with EVSE and EVEMS and as a result, are getting involved from the beginning of the process rather than upon completion of the project. This gives them a better sense of what to look for when performing the final inspection.

Once the inspection is complete, a Certificate of Inspection will be issued to the permit holder to confirm that the electrical work is in compliance with the local electrical safety code. A copy of the certificate should be provided to the condo board, strata council or property manager for their records. It is important to keep this document for insurance or resale purposes and some EVSE rebate programs may also require a copy in order to qualify.[82] With inspection completed, the electrical contractor can now perform any finishing work required, including the replacement of drywall or burial of any conduit or connectors.[83]

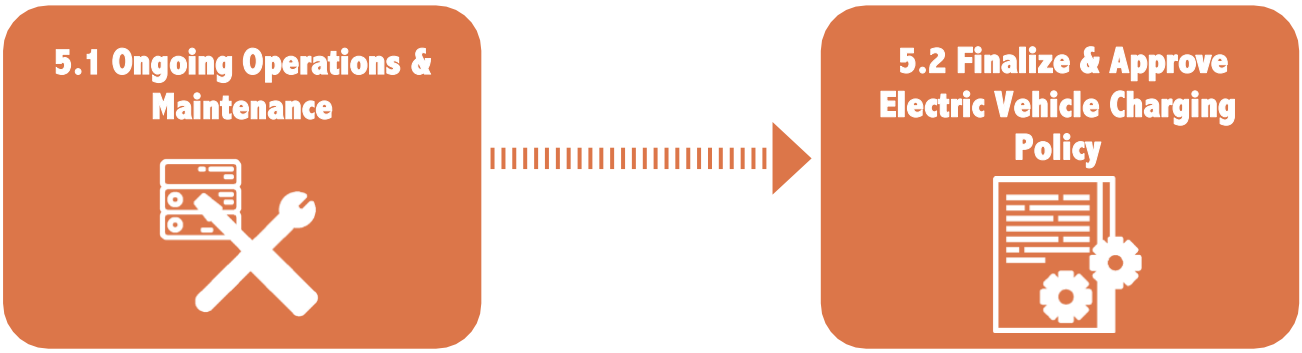
Next Steps

Step 4 provided an overview of the process for the preparation and installation of EV charging infrastructure. This step involved ensuring that a team is built to support the installation of the EV charging infrastructure and that all equipment and permits are secured prior to beginning work. The installation itself involves a number of different steps, however each project will have its own unique considerations. A final inspection will ensure that all work has been completed in accordance with the appropriate codes and standards.

With installation and inspection complete, the EV charging stations can be used. The following section will outline considerations related to operating permits, developing an EV charging policy, signing a contract with the EVSE provider (if not already working with one) and any necessary steps to complete the project.



STEP 5
Project Wrap-Up & Ongoing Considerations



Overview

The previous section outlined some of the most important steps in the installation process. There are also a number of considerations that will need to be addressed once the EV charging stations are ready for use. This section discusses some of the factors associated with ongoing maintenance and operations including securing an operating permit and entering into a contract with the EVSE provider. It also explores the importance of formalizing an approach to addressing future charging needs, either through an EV policy or standard operating procedures.

5.1 Ongoing Operations & Maintenance

Responsibility: Condo Board, Strata Council or Property Manager
Other Stakeholders Involved: Electrical Contractor, EVSE Provider or EV Advisor

The condo board, strata council or property manager will be responsible for the ongoing operation and maintenance of the charging stations once they have been installed however, they may have questions or look for further guidance from the party responsible for the installation. Typical operation and maintenance costs include electricity consumption and any related demand charges, EVSE network subscription fees, billing transaction costs and maintenance and repairs. A common maintenance issue for many EVSE is damage to the cords or connectors. Many EVSE providers use a modular equipment design which allows for the swapping out of any damaged components however, there may be cases where an entire sealed module needs to be replaced to maintain certification after repairs.

As previously noted, to facilitate load management and address barriers such as installation costs, some condo boards, strata councils or property managers may decide to install networked EV charging stations. In these situations, a contract with an EVSE service

provider that handles all aspects related to EV charging station operation, maintenance and customer billing may be preferred. This will involve assessing the options available from different EVSE providers prior to negotiating and signing a contract. While these services require considerably less administration on the part of the condo board, strata council or property manager, payment of ongoing fees (e.g., session fees + incremental fees on electricity costs) will still need to be managed. An experienced electrical contractor, engineering firm, EV/EMS charging solutions provider, EVSE provider or EV advisor can help determine the most appropriate options.

Periodic inspection of the EV charging stations is also recommended to ensure their continued safe use. This may involve the testing of equipment, communication systems and lighting by an electrical contractor to ensure all parts of the EVSE are in working order. The EVSE provider's guidelines should also be consulted as they will include a description of the maintenance requirements specific to their stations.[84]

5.2 Finalize & Approve Electric Vehicle Charging Policy

Responsibility: Condo or Strata Lawyer

Other Stakeholders Involved: Condo Board, Strata Council or Property Manager

It is important that the condo board, strata council or property manager give thought to formalizing the preferred approach to the use and future deployment of EV infrastructure in the building. This guide recommends developing a high-level approach to the installation of EV infrastructure early on, and considering policy and procedural implications in parallel with solution design. This step should involve finalizing more specific rules for unit owners, including those who may wish to install EV charging stations in future.

There are a number of avenues through which EV related rules can be outlined including as part of standard operating procedures, an update to condo or strata bylaws or an EV charging policy. There may also be interest in pursuing a combination of these options. Support for condo or strata bylaw updates and development of an EV charging policy could help make it more cost effective and easier for each condo or strata owner who wants to install EVSE. It is recommended that where possible, language in the bylaws remain high-level to allow for future changes whereas more specific rules are outlined in an EV policy. A policy can be easier to update if necessary in future.

An EV charging policy should consider including details about the following:

- Responsibility for installation, operation and maintenance costs
- Timing and installation requirements
- Reasonable insurance requirements
- Rules related to participation in any energy management system or use of any third party EVSE networks
- Obligations regarding repair and removal of EV charging equipment
- Reporting obligations regarding energy consumed
- Regulating EV charging behaviour or the management of EVSE in shared parking spaces or common areas
- Payment deadlines and processes[85]

A condo or strata lawyer should be engaged to help draft and finalize any necessary bylaw amendments, standard operating procedures or an EV charging policy.

The last step in the process of installing EV charging infrastructure in an existing building is for the electrical contractor to prepare any final drawings from the installation to the property manager for their records and to prepare any guidelines for operations and maintenance (in addition to those from the EVSE provider for the charging stations).

Considerations for New Buildings

In most jurisdictions, a condo or strata corporation is created when the property developer files the strata plan with the Land Title Office.[86] At the time of filing the strata plan, the developer can amend the Standard Bylaws or create new bylaws. Examples of new bylaws commonly filed include creating separate sections within the strata corporation and apportioning of common expenses by strata lot type. The developer can set the new strata council up for success by including some initial language about EV charging in the bylaws. See **Appendix A** for templates for strata bylaws on EV charging that can be used as a starting point.[87]

Next Steps

Step 5 has outlined a number of considerations related to the ongoing operation and maintenance of the EV charging infrastructure. It has also noted the importance of developing an EV charging policy, updating condo or strata bylaws or drafting standard operating procedures to continue to guide EV charging moving forward.

CONCLUSION

The market for EVs in Canada continues to grow, particularly among those individuals living in multi-unit apartments and condominiums. Given that a significant proportion of charging currently occurs at home, ensuring that all Canadians have access where they live will be key to facilitating widespread EV adoption. Recognizing the importance of addressing some of the most critical barriers associated with charging for the approximately one-third of Canadians currently residing in (MURBs) is therefore integral to further uptake.

The installation of EV infrastructure in MURBs is complex, yet it is unquestionably important given the commitment to the continued deployment of EVs across the country. This guide has sought to provide further information about the installation process in both new and existing MURBs, highlighting potential challenges and opportunities and noting roles and where responsibility lies in relation to specific activities. A greater understanding of the installation process will provide those involved with confidence in making informed decisions related to the most appropriate charging solutions capable of benefitting all MURB residents, and not only those who currently own an EV.

Perhaps most importantly, this guide has highlighted the importance of strategically planning for EV deployment in MURBs. The most important consideration for the installation of EV charging infrastructure, regardless of building type, is planning for the future success of the building (or "future-proofing"). While it may be attractive, particularly from a financial standpoint, for condo boards, strata councils or property developers to address requests to install charging stations on an as-needed basis, this approach is likely to lead to considerable challenges and costs down the road. Ensuring that charging installations in MURBs focus on future needs through the use of solutions that also make sense for today is critical to supporting the continued successful uptake of EVs over the long-term.

APPENDIX A: SELECTED RESOURCES, GUIDES AND WEBSITES

Guidance on Installing Electric Vehicle Charging Infrastructure

AES Engineering, Fraser Basin Council, C2MP. Residential Electric Vehicle Charging: A Guide for Local Governments. Prepared for City of Richmond and BC Hydro. https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/electric-vehicles/residential-ev-charging-a-guide-for-local-governments.pdf

AES Engineering, Fraser Basin Council, C2MP. Electric Vehicle Charging Infrastructure in Shared Parking Areas: Resources to Support Implementation & Charging Infrastructure Requirements. https://www.richmond.ca/_shared/assets/EV_Charging_in_Shared_Parking_Areas_Report51731.pdf

BC Hydro. Request EV Charging in Your Condo or Strata Building. https://electricvehicles.bchydro.com/charge/request-EV-charging-in-apartment-strata
BC Hydro. How to Install an EV Charging at an Apartment. https://electricvehicles.bchydro.com/charge/how-to-install-EV-charging-apartment

BOMA Canada. Electric Vehicle Charging Stations: For Multi-Unit Residential and Mix-Use Commercial/Residential Buildings. https://www.boma.bc.ca/media/19602/EVCS%20Info%20Booklet%20For%20MURBs%20-%20BOMA%20BC%20.pdf

Condominium Home Owners Association of BC. Installation of Electric Vehicle Charging Stations on Strata Properties in British Columbia. http://www.westcoastelectricfleets.com/wp-content/uploads/CHOA-report.pdf

Condominium Authority of Ontario. CAO's Step-by-Step Guide: Installing Electronic Vehicle Charging Systems. https://condoauthorityontario.ca/en-US/resources/electric-vehicle-charging-station-regulations/step-by-step-guide/

Hydro-Québec. Electric Vehicle Charging for Multi-Unit Residential Buildings. http://www.hydroquebec.com/data/electrification-transport/pdf/electric-vehicle-charging-for-multi-unit-residential-buildings.pdf

Metro Vancouver. Home Owners & Tenants. https://metrovancouver.org/services/air-quality/climate-action/transportation-programs/ev-strata-condo/homeowner-tenants/Pages/default.aspx

Pollution Probe and The Delphi Group. Zero Emission Vehicle Charging in Multi-Unit Residential Buildings and for Garage Orphans. https://www.pollutionprobe.org/zev-charging-in-murbs/

Plug In BC. Planning for Electric Vehicle Charging Infrastructure: A Toolkit. http://pluginbc.ca/resource/planning-electric-vehicle-charging-infrastructure-toolkit/

Plug In BC. Strata Bylaw Templates for EV Charging. http://pluginbc.ca/resource/strata-bylaw-templates-ev-charging/

Plug'n Drive. Make Your Condo EV Ready: 2018 Guide for Condo Owners, Boards and Managers. https://www.plugndrive.ca/wp-content/uploads/2018/08/Make-Your-Condo-EV-Ready-Guide.pdf

Signature Electric. EV Charging in Condos. https://www.signatureelectric.ca/blog/ev-charging-in-condos-one-bedford/

Electric Vehicle Charging Organizations & Stakeholders

AddÉnergie Technologies. https://addenergie.com/en/multi-residential/

Alectra Utilities. https://myaccount.alectrautilities.com/innovation/electric-vehicles-and-charging-stations.html

BC Hydro. https://www.bchydro.com/powersmart/electric-vehicles/charging.html

ChargePoint. https://www.chargepoint.com/en-ca/businesses/apartments-and-condos

Cielo Electric. https://cieloelectric.ca/

Electrify Canada. https://www.electrify-canada.ca/index

ENMAX. https://www.enmax.com/ev

EverCharge. https://evercharge.net

Fortis BC. https://www.fortisbc.com/services/sustainable-energy-options/electric-vehicle-charging

Fraser Basin Council. https://www.fraserbasin.bc.ca/ccaq_plug_in_bc.html

Hydro-Québec http://www.hydroquebec.com/transportation-electrification/electric-vehicles/

LeadingAhead Energy. www.leadingaheadenergy.com

Metro Vancouver. www.metrovancouver.org/services/air-quality/climate-action/transportation-programs/ev-strata-condo/Pages/default.aspx

PlugIn BC. EV Advisory Service. https://pluginbc.ca/ev-advisor-service/

Plug'n Drive. https://www.plugndrive.ca/condo-charging

PowerPros Electrical. https://www.powerpros.ca/

Signature Electric. https://www.signatureelectric.ca

SWTCH EV. https://swtchenergy.com/

Unico Power. https://www.unicopower.com/

Electric Vehicle Charging Initiatives & Incentives for Multi-Unit Residential Buildings

Nature Resources Canada. Zero Emission Vehicle Infrastructure Program. https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/zero-emission-vehicle-infrastructure-program/21876

BC Hydro. EV Incentives in BC. https://electricvehicles.bchydro.com/buying/EV-incentives-in-BC?utm_source=direct&utm_medium=301&utm_campaign=old_rebates

BC Hydro & Fortis BC. Clean BC Go Electric Charger Rebates. https://goelectricbc.gov.bc.ca/

Government of Québec. Roulez vert Program. https://vehiculeselectriques.gouv.qc.ca/

Finding a Certified Electrical Contractor

Alberta Electrical Contractors Association of Alberta. www.ecaa.ab.ca/membersearch.aspx

Technical Safety BC. www.technicalsafetybc.ca/find-licensed-contractor

Electrical Association Manitoba. www.eamanitoba.ca/directory/

Newfoundland Service Newfoundland. www.gov.nl.ca/snl/licenses/electrical/

Ontario Electrical Safety Authority. https://findacontractor.esasafe.com/

Corporation des Maîtres Électriciens du Québec. https://www.cmeq.org/trouver-un-entrepreneur/

Saskatchewan Electrical Contractors Association of Saskatchewan (ECAS). www.ecasask.ca

APPENDIX B: OVERVIEW OF RELEVANT REGULATORY INSTRUMENTS

There are a number of regulatory instruments used by governments, industry and other organizations to address EV charging in MURBs or for garage orphans. The following is taken from Pollution Probe and The Delphi Group's report on *Zero Emission Vehicle Charging in Multi-Unit Residential Buildings and for Garage Orphans*. It provides a brief introduction to some of the codes, standards, acts and bylaws related to EV charging in MURBs.

Codes and Standards

National Building Code of Canada

In Canada, provinces and territories have jurisdiction to enact and enforce their own building laws and codes. The National Building Code of Canada (National Building Code) is provided as a model to Canada's provinces and territories, but adoption is not mandatory. The National Building Code is one of three key national model codes relevant to the installation of EV charging stations in Canadian MURBs.[88] The Canadian Commission on Building and Fire Codes (CCBFC) is an independent, volunteer committee established by the National Research Council of Canada (NRC) to develop and oversee updates to the National Building Code, along with four other national codes (see also National Energy Code of Canada for Buildings).

The National Building Code addresses issues including the health, safety, accessibility, and protection of buildings from fire and structural damage and applies to the construction of new buildings or the demolition of existing ones. It is also intended to be applied to buildings that have been substantially renovated.[89] During consultations for this report, numerous stakeholders pointed out that the scope of the National Building Code can be expanded to include matters related to the environment and energy efficiency, particularly given the contribution of buildings to Canada's GHG emissions. Similar expansions have already taken place elsewhere in Canada (such as Ontario) and internationally, including in California and Oregon.

Many provinces and territories use portions of the National Building Code in the development of their own building codes or, in the case of Saskatchewan, adopt it in its entirety (in a previous version). A number of Canadian cities (e.g., Toronto and Vancouver) have been provided with jurisdiction over some or most aspects related to building, based on a special relationship with their respective provinces.

Some provinces (e.g., Ontario, excluding Toronto), favour a high degree of provincial consistency within their building codes, providing for limited exceptions related to regional safety.[90] In the case of Ontario, the province has already added EV charging requirements in the provincial building code intended to apply to the whole province (for non-multi-unit residential and commercial buildings). Other provinces have provided more latitude for municipalities to address matters related to building, and in particular, EV charging. For example, in the case of BC, the provincial government provided municipalities with the ability to regulate EV charging standards outside of BC's *Building Act*.[91]

Canadian Electrical Code

The Canadian Electrical Code (CE Code), published by the Canadian Standards Association, is another key national model code relevant to the installation of charging infrastructure in MURBs. The CE Code covers installation and maintenance of electrical equipment and seeks to ensure installers and consumers are kept safe from harm. The code is updated every three years to reflect the latest advances in technology and their safe implementation.[92] As with the National Building Code, the CE Code may be adopted by provinces and territories in whole or in part and modifications can be made to meet the needs of different jurisdictions.

Section 86 of the CE Code outlines requirements for installation of EVSE. Until recently, the code required that EVSE be supplied by a separate branch circuit which would support no additional loads (with the exception of ventilation equipment) and that for the purposes of load calculation, EV charging must be considered a continuous load (i.e., vehicle is charging at 100% continuously). In 2018, the CE Code was updated to permit load management and as a result, EVSE equipment may now be installed on a branch circuit that supplies other loads, provided that an EVEMS is also installed, in accordance with the code.[93]

National Energy Code of Canada for Buildings

The National Energy Code of Canada for Buildings (NECB) is a national model code that sets out technical requirements for the energy efficient design and construction of new buildings and substantial renovations to existing buildings. The NECB was designed to complement the other national building codes and it can be adopted by provincial and territorial, as well as some municipal, governments in its entirety or with modifications to suit local needs. It can also be used as a guideline for construction of new and energy-efficient buildings.[94]

The NECB establishes requirements for monitoring the energy usage of electrical distribution systems, sets limits on the size of conductors to minimize voltage drops, and establishes standards to govern the selection of transformers and electrical motors.[95] Because of its coverage of energy elements, the NECB has been discussed as an alternative location for EV charging requirements for MURBs. Some restrictions have been noted however, including the fact that the NECB is not yet broadly adopted by Canadian provinces.

Condominium and Strata Acts

The regulation of condominiums and stratas falls within provincial jurisdiction. Provincial condominium or strata acts create condominium or strata corporations and govern the interactions between condominium or strata owners and their condo board or strata councils. With regards to the installation of charging infrastructure, these acts set out the process that must be followed in order to run electrical cabling from a building's electrical rooms or subpanels to parking spaces, and other modifications required during installation. This is done via their jurisdiction of changes to what are often referred to as "common elements" (i.e., property owned on behalf of all condominium or strata owners).

Zoning and Parking Bylaws

The purpose of zoning bylaws is to set out rules to govern land use and to regulate how a property may be used for building and other purposes. This typically includes elements such as building size, placement, dimensions such as height, and requirements for amenities such as parking.[96] Parking bylaws are often used to regulate on- and off-street parking, including the number of parking spaces required for different land uses. Changes to parking can also be advanced through amendments to the parking sections of local government zoning

bylaws.[97] These bylaws tend to be passed at the municipal level, although they may be directly or indirectly impacted by provincial legislation, such as planning legislation. In some cases, zoning and parking bylaws may be a source of authority relating to EVSE installation requirements, although this depends on whether this area is subject to provincial building code authority. Stakeholders noted that, in many cases, municipal zoning and parking bylaws are subject to negotiation during development processes, meaning that they may not create consistent obligations depending on individual development negotiations.

Public Utilities Acts

Provincial public utility legislation broadly governs the provision of electricity and other regulated "monopoly" services (such as natural gas distribution) to the public. With few exceptions, these acts limit the ability of entities, other than regulated public utilities, to sell electricity. Ontario Energy Board staff argued that selling EV charging services is distinguishable from the act of electricity retailing, and therefore does not trigger equivalent regulatory governance from the Ontario Energy Board.[98] Most Canadian provincial utilities commissions (other than BC's[99]) have not found that provision of EV charging services constitutes the sale of electricity; however most have also not yet considered the issue as part of a formal proceeding. Even in BC, the BCUC provided a clear suggestion to the provincial government that it consider some form of ministerial action to ensure that entities providing EV charging services are not subject to full regulation as public utilities, recognizing the many differences between providing EV charging services and the role of a traditional public utility. Stakeholders are anticipating a response from the BC government on this point. Therefore, while it could create barriers to cost recovery if other provinces follow the BCUC's decision without some form of exemption or exclusion from applicable utility legislation, most stakeholders hope that this will not create a major barrier across Canada going forward.

Federal Measurement Statutes

In many cases when EVSE are installed in MURBs, they do not have a dedicated utility meter, meaning that a condo corporation or strata council needs to individually bill electricity to EVSE users to ensure fair recovery of costs of electricity consumed in EV charging. While most new networked EVSE are designed with measurement systems to record the amount of energy dispensed, they must be approved by Measurement Canada — the federal body with jurisdiction over ensuring accuracy in the selling of measured goods — if they are being used to sell electricity on the basis of energy (such as electricity).[100]

In situations where meters are not Measurement Canada approved, EV owners may be charged a flat rate, a time-based rate, or a blended rate (e.g., billed for parking and time) to charge their vehicle.[101]

Residential Tenancy Acts

Provincial landlord tenant laws govern the relationship between landlords and tenants and set out the obligations of landlords, including for apartments. Until EV use becomes more common, landlords may be hesitant to install EV charging infrastructure and typically, residential tenancy acts do not address EV charging, despite the fact that tenants may wish to install chargers. Under the BCUC's governing legislation, landlords are permitted to resell electricity to their tenants, but only if their tenancy is within certain time limits (e.g., less than five years) and it is not resold to others.[102] Because in most other provinces EV charging has not been found to be retailing electricity, this has not been a major issue outside of BC.

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