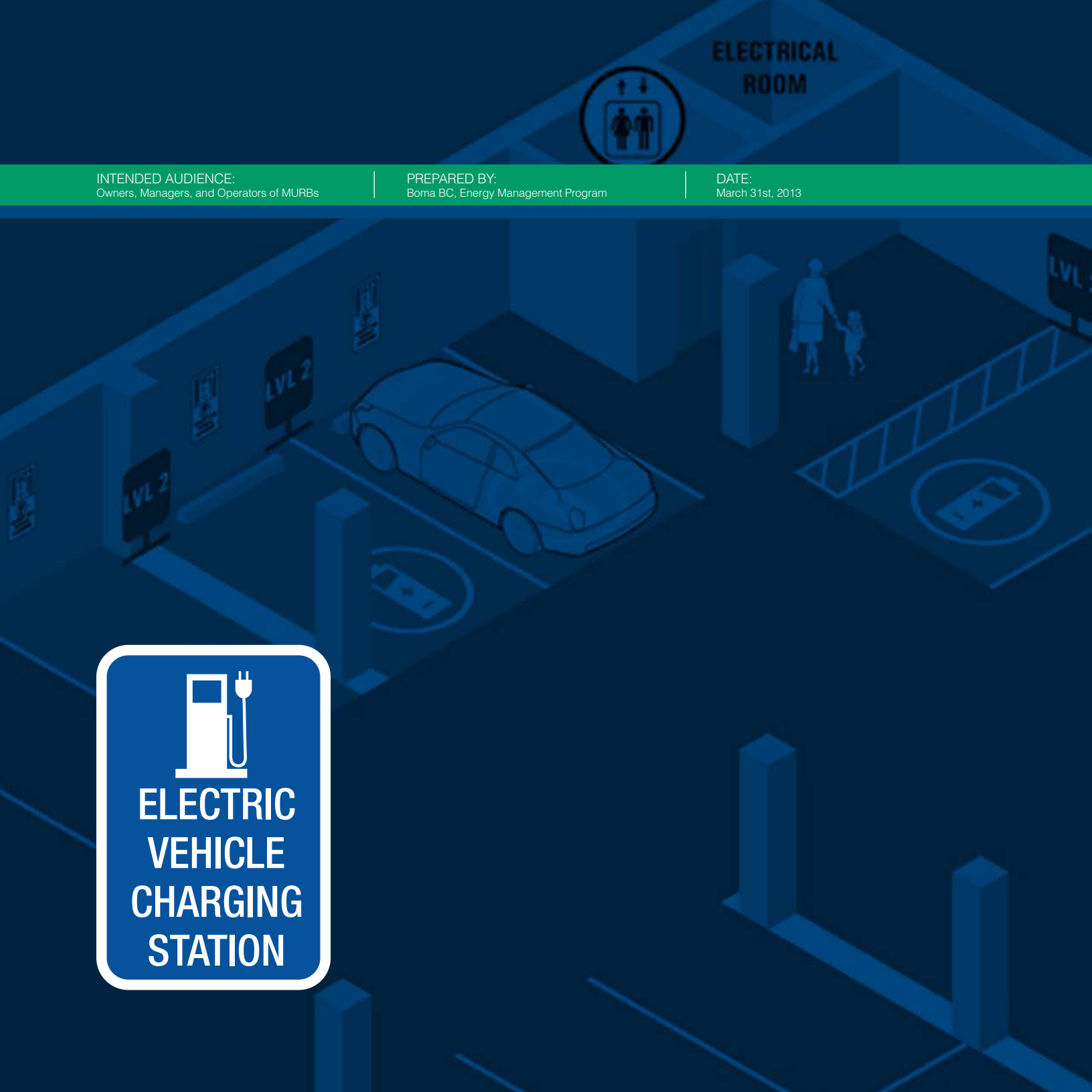




# ELECTRIC VEHICLE CHARGING STATIONS

For Multi-Unit Residential and Mix-Use Commercial/Residential Buildings





INTENDED AUDIENCE:  
Owners, Managers, and Operators of MURBs

PREPARED BY:  
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# 1. BOOKLET INTRODUCTION



In partnership with the province of British Columbia's Clean Energy Vehicle Program, and in consultation with industry experts, the Building Owners and Managers Association of BC (BOMA BC) has developed an Electric Vehicle Charging Station (EVCS) information package to support an overall market transformation to clean energy vehicles. This package was created for building owners, managers, and operators of multi-unit residential buildings and mix-use commercial/residential buildings (MURB). However, many of the principals throughout may be applied to other facility types. The intent of this document is to increase awareness and understanding of the selection, installation and maintenance of an EVCS.

*BOMA BC, in partnership with the province of BC, has developed an Electric Vehicle Charging Station (EVCS) information package to support an overall market transformation to clean energy vehicles.*



## 2. ELECTRIC VEHICLE CHARGING STATIONS (EVCS)



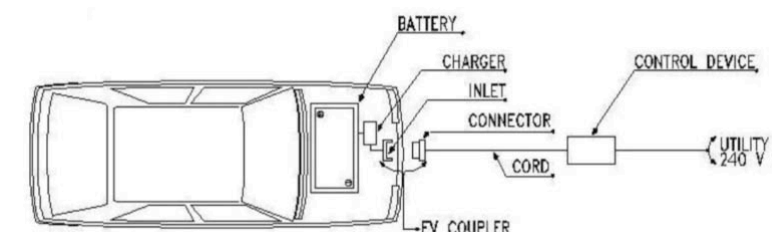
### 2. 1 ELECTRIC VEHICLE CHARGING STATIONS (EVCS)

Popularity of electric vehicles (EV) is increasing, especially amongst those who are concerned with the increase in carbon emissions, and our current dependency on petroleum powered transportation. For a successful transition to EV's to occur there needs to be a sufficient charging infrastructure in order to reduce range anxiety for potential EV owners. Currently the majority of existing infrastructure is located in public areas, and commercial spaces and single family dwellings. There is a need to expand this infrastructure to MURBs because a growing number of BC's population resides in this type of dwelling. In the City of Vancouver alone, approximately 60% of residents live in MURBs (representing 360,000 individuals, or 8% of the province's population). Installing charging stations in these types of Multi Unit Residential Buildings will allow for easy and stress free charging for the EV owner during the night.

### 2. 2 BASICS

#### 2.2.1. EV AND EVCS COMPONENTS

EVCS delivers electrical energy from the power source to the EV, and ensures that an appropriate, and safe, flow of electricity is supplied to the vehicle. EVCS is the main interface between user, vehicle, and utility.



- **Battery** - Located on-board the vehicle and is the power (DC) storage component
- **Charger** - Converts power from AC to DC to charge the battery
- **Inlet** - Connection point on the vehicle
- **Connector** - Connection point from the charging station
- **EV Coupler** - Describes the connection between the 'Inlet' and 'Connector'
- **Control Device/Charging Station** - Provides power from the utility (AC)

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2. ELECTRIC VEHICLE CHARGING STATIONS (EVCS)

2.2.2. EVCS LEVELS

There are 3 levels of EVCS, see table below:

	Volt	Amps	Charge Time
Level 1 AC	120	15-20	8-20 Hours
Level 2 AC	240	20-90	3-8 Hours
Level 3 DC Fast Charge	400-500	<=125	15-30 min

Level 1 (120-V AC)

Level 1 EVCS provides charging through a 120-volt (V) AC plug and requires electrical installation per the National Electrical Code. Most, if not all, Electric Vehicles (EV) will come with a Level 1 EVCS cord-set so that no additional charging equipment is required. On one end of the cord is a standard three-prong household plug (NEMA 5-15 connector). On the other end is a J1772 standard connector that plugs into the vehicle.

Level 1 is typically used for charging when there is only a 120-V outlet available (e.g. residential locations). Based on the battery type and vehicle, Level 1 charging adds about 5 to 8 km's of range to an EV per hour of charging time.

Level 2 (240-V AC)

Level 2 EVCS can easily charge a typical EV battery overnight, and will be a common installation for the home and workplace, as well as fleet and public facilities. Level 2 EVCS offers charging

through a 240-V (typical in residential applications) or 208-V (typical in commercial applications) electrical service. These installations are generally hard-wired for safe operation, although a wall plug connection is possible. Level 2 EVCS requires installation of charging equipment, and a dedicated circuit of 20 to 80 amp (A), depending on the EVCS requirements. Level 2 equipment uses the same connector on the vehicle as Level 1 equipment. Based on the battery type, charger configuration, and circuit capacity, Level 2 charging adds about 16 to 30 miles of range to an EV per hour of charging time.

Level 3 (DC Fast Charging)

DC fast-charging EVCS (480-V AC input to the EVCS) enables rapid charging at sites such as heavy traffic corridors and public fueling stations. A DC fast charger can add 95 to 125 miles of range to an EV in 20 minutes.

2.2.3. EVCS CONFIGURATIONS

The following are typical configuration options for EVCS:

- Wall-mounted or pedestal/stand-alone
- Single charging head or multi-head
- Communication, reservation, or payment systems
- Commercial or residential grade
- Indoor or outdoor rated

2.2.4. EVCS BENEFITS

Tenant Attraction and Retention, Corporate Branding

Offering charging is a direct way to attract and retain tenants who are EV-drivers. Hosting a charging station is a highly visible way to exemplify your building's or property management company's environmental values. This may help contribute to a "green" image that attracts and retains tenants and customers who share these values. By offering this service for free, as many facilities currently do, you will add a new dynamic to your corporate branding.

User Charging and Parking Fees

Charging-station hosts have the opportunity to generate revenue directly from people who use the station's services. Although the re-selling of electricity at a higher rate than specified by the utility is strictly prohibited in BC, you can collect revenue for charging through pay-for-parking services. Using these types of systems typically requires installation of advanced EVCS

*With a growing number of local and regional carbon-reduction policies, charging station owners may be able to benefit from the value of carbon emissions offset by their stations.*

products. It should be noted that, currently, many facilities are opting out of charging for use of the station, and are instead providing it as a free service.

Tenant/Employee Attraction and Retention

Buildings or companies that offer charging may be able to attract and retain tenants/employees who want to charge EVs during the day. In addition, it can be very important to many tenants/employees, even those who don't drive EVs, that their building/ employer is proactive with transportation planning.

Advertising Opportunities

Each time an EV driver visits a charging station there is an opportunity to advertise. A station host could advertise its own products or services in this way, or sell advertising space to another organization.



## 2. ELECTRIC VEHICLE CHARGING STATIONS (EVCS)

*BOMA Best Credits*

Installing a charging station will earn additional points towards a BOMA BEST (Building Environmental Standards) certification. BOMA BEST is Canada's largest environmental assessment and certification program for existing buildings. It is a voluntary program designed to assess and improve the environmental performance and management of existing buildings of all sizes across Canada. The Program helps applicants to critically assess six key areas of environmental performance and management: energy, water, waste and site, emissions and effluents, indoor environment, and environmental management system. Becoming BOMA BEST certified may contribute to improving an organization's image, and thus attract environmentally conscious customers and employees.

*Contribution to LEED Certification*

Installing a charging station contributes toward attaining LEED (Leadership in Energy and Environmental Design) certification. LEED is an internationally recognized system for rating the energy and environmental performance of buildings. Becoming LEED certified may also contribute to improving an organization's image.

*Value of Avoided Carbon Emissions*

With a growing number of local and regional carbon-reduction policies, charging station owners may be able to benefit from the value of carbon emissions offset by their stations.

*Improved Public Health*

Depending on the source of electricity, the use of EV's may reduce pollution and emissions which over the long-term could lead to improved public health.

*Increased Energy Security*

Many station owners have an interest in promoting the energy-security benefits of EVs by making charging stations available.

## 2.2.5. EVCS BARRIERS

While there are many benefits associated with hosting and promoting EVCS, there are some significant barriers which must be addressed.

*Building Management and Building Resident Negotiations*

There exists the potential for difficult negotiations between building management and tenants surrounding the approval of installations of EVCS. Disagreements can arise when there are legal restrictions, or a general unwillingness to allow switching of parking spaces to accommodate a less costly installation.

*Ownership or Responsibilities are Unclear*

Parties may be uncertain about who should assume responsibility for electrical upgrades, maintenance, and decommissioning of the equipment.

*Inadequate Infrastructure*

Larger and older buildings can present physical limitations that could pose problems. These may include inadequate electrical capacity and internet connection, or substantial distance between electrical panel and designated parking.

## 3. SELECTING A LEVEL 2 EVCS



## 3.1. TYPES AND TYPICAL COST

The costs of owning and operating a charging station include equipment, installation, maintenance, and electricity costs. You can reduce these costs by taking advantage of discounts and incentives. The actual cost of the EVCS varies greatly when type, quality, options and sophistication is considered.

*The following describes the differences between Level 2 EVCS:*

- **Basic** - standard safety features and status lights
- **Smart** - enhanced displays, charging timers, communications capabilities, and keypads
- **Intelligent or networked** - enhanced durability and ergonomics, payment card readers, billing software, advanced displays, wireless communication, automated diagnostics, computer-controlled power flow, internal metering, and smart-grid compatibility

The following table shows the approximate cost of a commercial grade "Smart" EVCS unit.

Type of Charger	Specifications	Typical Cost Per Unit
Level 2, Wall-mounted, 240V	No payment or reservation system Suitable for indoor parking garages	Single Head \$2,500 Dual Head \$3,000
Level 2, Pedestal Type, 240V	No payment or reservation system Suitable for indoor/outdoor parking locations	Single Head \$3,000 Dual Head \$4,000

## 3.2. EVCS INCENTIVE PROGRAMS

Currently the only active incentive program for EVCS is the BOMA BC Clean Connect incentive program.

## 3.2.1. BOMA CLEAN CONNECT – EV CHARGING STATION INCENTIVE PROGRAM

BOMA BC, in partnership with the Province of BC, is offering a limited time incentive program (March 31st, 2013 to March 31st, 2014), for the purchase and installation of 125 Level 2 (240V) electric vehicle charging stations (EVCS). This program is intended to support the increase of EVCS across multiple building types and locations throughout BC, by offering a substantial incentive to participants (up to a maximum of \$4,500 per station).



*For further information on BOMA Clean Connect please contact:*

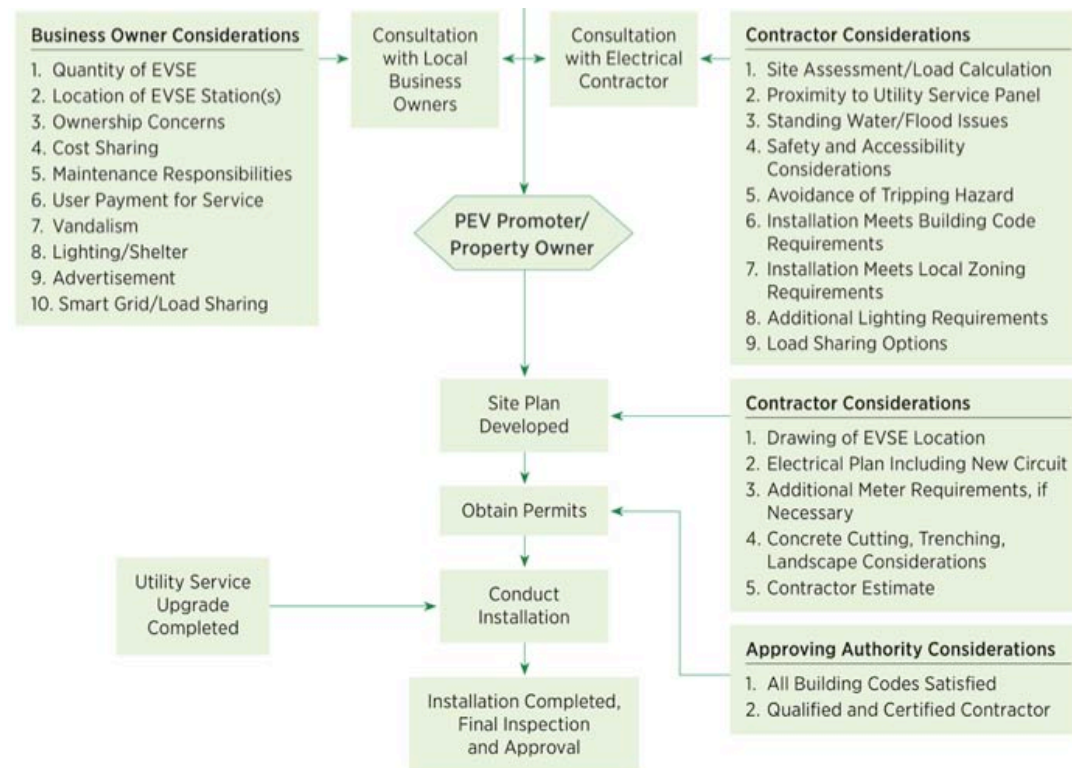
**BOMA BC**  
Tel: 1-604-684-3916  
Web: [www.boma.bc.ca](http://www.boma.bc.ca)

# 4. INSTALLING AN EVCS

## 4.1. INSTALLATION PROCESS

In MURBs, the overall process involved in installing an EV charging station will be fundamentally different, and more challenging, than installation in a single home or public space. This is due to the fact that both the EV owner, and apartment manager/owner, must be involved in any installation decisions. In addition, the ownership of the EVCS needs to be clearly identified.

The chart below shows the overall installation process of an EV charging station. This table also identifies a few stakeholders, and highlights the considerations of each.



## 4.2. PARKING SPACE CONSIDERATIONS

Existing elements such as landscaping, walkways and other structural elements should be considered in an EVCS site plan. These elements could add costs if removal or relocation is required, and may also act as barriers to accessible charging.

### Cost Considerations:

- Trenching
- Curb cuts
- Drilling through hard-scaping or structural elements for electrical requirements
- Protection from traffic and weather
- Placement, visibility and accessibility
- Distance from panels



## 4.3. POWER REQUIREMENTS

Power requirements will be dictated by what the level of the EVCS is. Most facilities have accessible 120V circuits sufficient to power level 1 EVCS. Level 2 charging requires 208-240 volts, and at least 15-30 amps. Many jurisdictions require, or recommend, a dedicated branch circuit for level 2 charging. The existing electrical panel in most installations, especially older structures constructed prior to 1960, may not have the system capacity to handle such large and continuous loads required to charge EVs.

## 4.4. CONNECTORS AND PLUGS

Most modern EVCS have a standard connector and receptacle based on the SAE J1772 standard developed by SAE International. Any vehicle with this receptacle can use any Level 1 or Level 2 EVCS. All major vehicle and charging system manufacturers support this standard. This widespread support should eliminate drivers' concerns about whether their vehicles are compatible with available charging infrastructure.

## 4.5. TRANSFORMER REQUIREMENTS

Transformer size is dictated by the building's total energy use. A 10-15% buffer for extra capacity is added to this figure. If 10-15% capacity does in fact exist, this would be enough to sustain a few electric vehicles, but insufficient to handle a full conversion of the vehicles parked to electric power. If, however, the transformer's extra capacity is limited, or many EVCS need to be installed, a new transformer will be required and the overall cost of the installation will be significantly higher.

4. INSTALLING AN EVCS

4.6. METERING

When planning the installation of an EVCS, a decision must be made as to whether or not a separate meter will be used to track energy consumed by the EVCS, or required to do so. The owner must determine if a utility owned meter will be used, or an existing system that has communication capability (Wi-fi, Ethernet, etc.) and will track energy usage.

Advantages of an EVCS with an advanced metering system:

- Track usage
- Notifications (available or charge complete)
- Reservation capabilities
- Manage electrical loads
- Easy management
- Bill customers

**Note:** Complications for network connections arise in garages where repeaters may need to be installed in order to guarantee network signals. Potential installation sites should be assessed for their network connection ability.

*The cost of capital infrastructure, and determining who will incur these costs, are two important factors which must be addressed.*

4.7. COST

In multifamily buildings, cost will be a primary consideration in evaluating the installation of EVCSs. The cost of capital infrastructure, and determining who will incur these costs, are two important factors which must be addressed. Common costs associated with EVCS installation include the following:

- Charging Station
- Permits
- Electrician Assessment
- Electrical Panel Upgrade
- Electricity meter
- Installation

If the user of the EVCS is a renter it may be unreasonable to expect them to cover the installation cost of an EVCS. Even if the user of the EVCS is an owner, the installation costs may also be too high for a single owner to pay for.

*Factors affecting the cost and installation time of EVCS include:*

- Level of charging station
- Number of circuits and EVCS units installed
- Indoor versus outdoor installation
- Required electrical upgrades
- Required ventilation
- Vicinity of electrical panel to desired EVCS location
- Trenching and adding electrical service or panels

See the table below for a sample breakdown of costs associated with a basic Level 2 charging station. Please note that these costs are just estimates and that an EVCS contractor would need to be contacted to obtain precise pricing.

Labour	Number of Hours	Labour Rate	Total Cost
Initial Site Visit	2	\$75.00	\$150.00
Permit Application	1	\$85.00	\$85.00
Installation	4	\$100.00	\$400.00
Inspection or Approval	2	\$75.00	\$150.00
Labour sub-total			\$785.00
Materials	Number of Units	Cost per unit	Total Cost
Level 2 - Smart EVCS	1	\$3,000.00	\$3,000.00
Elec. Capacity Requirements	1	\$780.00	\$780.00
#12 THHN Wire	400	\$0.30	\$120.00
Conduit - 3/4 EMT	100	\$3.00	\$300.00
40 Amp Fused Disconnect	2	\$115.00	\$330.00
Miscellaneous	n/a	\$400.00	\$400.00
Materials sub-total			\$4,930.00
Cost Total			\$5,615.00



4. INSTALLING AN EVCS

4.8. SIGNAGE

Signage is recommended for public and commercial access charging stations, and clear language should be used to minimize confusion for drivers of hybrid electric vehicles (which do not need to be charged). It is recommended that the term “charging” be incorporated so that the purpose of the stall is clear. This also encourages drivers to move their EV once charging is complete. Information on the charging station should also indicate voltage and amp levels, and any fees or safety information. Electrical codes may require hosts to indicate date of installation, equipment type, model, and owner contact information.

Vertical or pole-mounted signage is the most common, however, pavement markings, similar to those used for handicapped accessible parking spots, could also be used for EV spaces. Green signage is recommended as blue signage can be mistaken for wheelchair or accessible location. Local control over parking, including penalties for non EV vehicles parking in EV stalls, is recommended.

User visibility begins with way-finding systems that provide consistent and clear signage to direct EV drivers to parking spaces. Signage should have a hierarchy which helps to direct drivers and organize the EVCS infrastructure network at the urban scale. Consistency and visibility of signage throughout a city, province, or region, can help drivers locate EVCS regardless of network access.



5. MAINTAINING AND MANAGING AN EVCS



5.1. EVCS MAINTENANCE

Typically there are relatively few EVCS maintenance requirements, however, all usable parts can wear, and periodic inspections should be conducted to ensure that all parts remain in good working order. Here are a few maintenance suggestions:

- The charging cord should be stored securely so it is not damaged, and the system should be kept clean.
- Testing and inspection of EVCS equipment, communications systems, and lighting, should be conducted periodically by a qualified electrical contractor.
- The EVCS manufacturer’s guidelines will disclose specific maintenance requirements.
- Repair of accidental damage or purposeful vandalism may also be required.

Unless otherwise agreed, the EVCS hosts or owners are typically responsible for managing the use and maintenance of the EVCS and parking space.

5.2. ENERGY MONITORING AND BILLING

Electricity costs will depend on the type of EVCS installed, as well as the amount and timing of EV charging. It is important to discuss the effects of EV charging on electricity rates and loads with the electrical utility. At this point in time, BC Hydro has not implemented time of use rates.

If the station is non-utility owned or metered, a service fee

could be used instead of charging for actual electricity use. It is important to remember, however, that the owner cannot resell electricity in BC at a higher rate than has been approved by the BC Utilities Commission.

A number of payment models are being explored, all of which are designed to make paying for charging simple and convenient. Drivers might subscribe to a charging service, swipe their credit card, enter a charging account number, or insert coins or bills into a meter to charge their EVs. In many cases drivers will only be charged a single fee for parking and charging or just for parking.

5.3. LOAD MANAGEMENT

With the new smart grid infrastructure, the utility has many different options available to them to manage EV charging:

- Time of use rates – charge more for peak time charging
- Demand response – allows utility to send signal to customers to cut back on loads during high peak demand on grid.
- Real Time Pricing – pricing signals sent to customer through communications mediums which allows customer to know when to charge during cost effective periods.

To date, BC Hydro has not made any indication that time of use rates will be explored or implemented in the future. As a result, it is likely that demand response will be the chosen mechanism used to manage the electrical load increase associated with EV charging.



# 6. SAFETY

In addition to meeting Canadian safety standards, there are some other safety considerations which must be addressed.

## 6.1. INDOOR CHARGING STATIONS

There are also additional safety concerns associated with hosting an EVCS indoors.

### Ventilation

Most EV and PHEV batteries do not require ventilations systems. However, some batteries such as lead acid or zinc air emit hydrogen gas when charged. This can cause an explosive condition. If charging is taking place indoors, ventilation requirements should be taken into consideration, and the EVCS should contain controls that can turn on the ventilation system when required, or stop charging should the ventilation system fail.

### Flood Zones

All approved locations for EVCS installation should be above design flood elevation (DFE). If EV station is located below DFE, station should be dry, or wet flood-proofed, to protect equipment from floodwaters.

## 6.2. LIGHTING AND SHELTER

Adequate lighting surrounding charging station is recommended for safety and convenience. Lighting should be sufficient to read signs, instructions, or controls, on the EVCS. Although shelter is not required for out-door rated equipment, protection from environmental factors may provide added incentive to EV users.

## 6.3. VEHICLE COMPONENTS

EVs contain the following high voltage components:

- Charge port which is the connecting port to charging station and is located under the vehicle hood
- High voltage cables which carry high voltage current between each of the high voltage components located under hood and undercarriage
- Traction motor which converts three-phase AC power to drive power, propelling vehicle located under the hood.
- High-voltage battery which stores and outputs DC power needed to propel the vehicle located on undercarriage (discussed in more detail in following section)
- High-voltage battery service disconnect which isolates the battery from the rest of the high voltage electrical system located on the rear seat floor

The following high voltage safety measures are present in EVs:

### Circuit Insulation

Insulates the high voltage positive and negative circuits from the metal chassis

### Reducing the risk of electrocution

The high voltage components and harnesses have insulated cases, or orange-coloured coverings, which provide insulation and easy identification. The high voltage battery case is electrically connected to the vehicle ground which protects occupants from high voltage electric shock.

### Identification

High voltage components are labelled “WARNING” and all high voltage harnesses are coated in orange.

# 7. ADVANCED TECHNOLOGIES/ SUPPORTING TECHNOLOGIES



As EV and EVCS technology advances we will start to see more intelligent ways to manage charging networks as well as charging itself.

## 7.1. ADVANCED CHARGING STATIONS

- “Smart Charging”, or charging when demand is low, thereby mitigating demand and capacity issues from usage at peak times
- Vehicle-to-Grid and Grid-to-Vehicle (V2G and G2V) charging, there is potential for smart-grid technology to enable EVs to be used as distributed storage devices, feeding electricity stored in their batteries back into the system when needed
- Wireless charging equipment, reduces tripping hazards

## 7.2. EVCS NETWORK SYSTEMS

Finding EVCS will be an easy task as networks are created to locate and manage charging stations. These networks can or will soon be able to help users:

- Find available locations
- Reserve spots
- Pay for charging
- View your EV charging level
- Smart Charge
- V2G and G2V





BOMA BC is the Building Owners & Managers Association of British Columbia. It was founded in 1911, and has over 350 member firms which represent over 100 million square feet of prime commercial real estate in the province. Members benefit from various program and service offerings, including; networking events, educational resources, lobbying efforts, and energy and environmental programs (BOMA BEST, Energy Management Assistance, BOMA uTrack, e-Energy Training, and Total Waste Management).

*"Voice of the commercial real estate industry in BC"*







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