CORPORATION OF THE TOWNSHIP OF ESQUIMALT

A G E N D A

ENVIRONMENTAL ADVISORY COMMITTEE MEETING

January 24, 2019
7:00 p.m.
Wurtele Room, Esquimalt Municipal Hall

---

1. **CALL TO ORDER**

2. **LATE ITEMS**

3. **APPROVAL OF THE AGENDA**

4. **MINUTES**

   (1) Minutes of the Environmental Advisory Committee meeting, November 22, 2018 — Pg. 1 – 2

5. **NEW BUSINESS**

   (1) Referral from Council for Review and Feedback: Letter from Larisa Hutcheson, Parks & Environmental Services, Capital Regional District, dated December 20, 2018, Re: Capital Region Local Government Electric Vehicle and Electric Bike Infrastructure Planning Project — Pg. 3 – 180

6. **REPORTS FROM STAFF LIAISON**

   (1) Plastic Bag Bylaw

   (2) Green Building Checklist – Draft Attached — Pg. 181 – 183

7. **ADJOURNMENT**

CORPORATION OF THE TOWNSHIP OF ESQUIMALT

MINUTES
ENVIRONMENTAL ADVISORY COMMITTEE

Thursday, November 22, 2018
7:00 p.m.
Wurtele Room, Municipal Hall

PRESENT: Waheema Asghar – Chair
Ronn Stevenson – Vice-Chair
Brenda Bolton
Lorne Argyle
Louise Blight
Paul Helston
Susan Low
Councillor Lynda Hundleby (Council Liaison)
Councillor Ken Armour (Council Liaison)

STAFF: Tricia deMacedo, Planner 2 (Staff Liaison)
Bill Brown, Director of Development Services
Deborah Liske, Recording Secretary

1. CALL TO ORDER

Chair Asghar called the meeting to order at 7:02 p.m.

2. LATE ITEMS

There were no late items.

3. APPROVAL OF THE AGENDA

Moved by Louise Blight, seconded by Lorne Argyle that the agenda of the Environmental Advisory Committee meeting of November 22, 2018 be approved as presented.
The motion **CARRIED**.

4. MINUTES

(1) Minutes of the Environmental Advisory Committee meeting, September 27, 2018

Moved by Lorne Argyle, seconded by Louise Blight that the minutes of the Environmental Advisory Committee meeting of September 27, 2018 be approved as presented.
The motion **CARRIED**.

5. NEW BUSINESS

(1) Memorandum from Tricia deMacedo, dated September 17, 2018, Re: Environmental Options for Cigarette Butt Disposal

Committee members discussed options for dealing with cigarette litter. Tricia deMacedo, Staff Liaison responded to questions from the committee. Committee comments included:

- Need for:
  - Identification of extent and location(s) of problem
  - Strategy development
  - Education

Moved by Louise Blight, seconded by Lorne Argyle, that the Environmental Advisory Committee recommends that Council have staff further investigate the extent of the problem within the municipality and report back.
The motion **CARRIED**.

6. REPORTS FROM STAFF LIAISON

(1) Climate Change Adaptation Planning

Ms. deMacedo, Staff Liaison provided an overview of the Together for Climate Project.

(2) Greenhouse Gas Reporting

Ms. deMacedo, Staff Liaison provided an update on the accounting of the Township of Esquimalt corporate greenhouse gas emissions.

(3) Green Building Checklist

Ms. deMacedo, Staff Liaison provided an overview of the municipal green building checklist and advised the checklist will be updated. Ms. deMacedo requested committee members prepare to provide feedback and suggested revisions to the checklist at the next committee meeting.

Ms. deMacedo and the Director of Development Services responded to questions from the committee.

7. ADJOURNMENT

The meeting adjourned at 8:02 p.m.

_____ Waheema Asghar, Chair This day of , 2018	Certified Correct: _____ Anja Nurvo, Corporate Officer

Making a difference...together

Parks & Environmental Services
625 Fisgard Street, PO Box 1000
Victoria, BC, Canada V8W 2S6

T: 250.360.3078
F: 250.360.3079
www.crd.bc.ca

December 20, 2018

File: 5220-20
Electric Vehicle Strategy

Mayor Desjardins and Council
Township of Esquimalt
Via e-mail: rachel.dumas@esquimalt.ca

Dear Mayor Desjardins and Council:

RE: CAPITAL REGION LOCAL GOVERNMENT ELECTRIC VEHICLE AND ELECTRIC BIKE INFRASTRUCTURE PLANNING PROJECT

In October 2018, the Capital Regional District (CRD) Board recommended that all final reports associated with the Capital Region Electric Vehicle (EV) and Electric Bicycle (E-Bike) Infrastructure Planning Project be shared with all local governments in the Capital Region for information.

Working closely with members of the CRD Climate Action Inter-Municipal Working Group, the CRD Climate Action Program recently completed the Capital Region Electric Vehicle and Electric Bike Infrastructure Planning Project. The objective of the project was to better understand and assess opportunities for local governments to advance EV and E-Bike charging infrastructure in public and private locations throughout the region. The project involved a public and developer's focused survey, community and local government capacity building events, local research and analysis, and the development of two documents:

1. *Capital Region Local Government Electric Vehicle (EV) + Electric Bike (E-Bike) Infrastructure Planning Guide*, *November 2018* by Watt Consulting Group – This guide provides locally-focused research findings and includes recommendations for CRD and municipal consideration related to: charging station procurement, pricing for public EV vehicle charging, signage, and EV and E-Bike charging requirements in new buildings.

2. *Electric Vehicle and E-Bike Infrastructure Backgrounder*, *September 2018* by Watt Consulting Group – This document provides baseline information that was collected and analyzed to inform the Guide. It includes detailed public and developer's survey results.

If you have any questions about this project, please contact Glenn Harris, Senior Manager, Environmental Protection at gharris@crd.bc.ca or 250-360-3090. The CRD Climate Action Program will continue to work with municipalities and electoral areas to support regional collaboration on climate action.

Sincerely,

Larisa Hutcheson
General Manager, Parks & Environmental Services

cc: Glenn Harris, Senior Manager, Environmental Protection
Nikki Elliott, Coordinator, Climate Action Program

Capital Region Local Government Electric Vehicle (EV) + Electric Bike (E-Bike) Infrastructure Planning Guide

Prepared by: WATT Consulting Group

Prepared for: Capital Regional District

November 2018

Acknowledgements

The *Capital Region Electric Vehicle ("EV") and Electric Bicycle ("E-Bike") Infrastructure Planning* project was undertaken by the Capital Regional District ("CRD") with funding support from BC Hydro Sustainable Communities.

The CRD Climate Action Inter-Municipal Working Group are acknowledged for input and guidance throughout the process of this project.

Responsibility for the content of this report lies with the authors, and not the individuals nor organizations noted above.

WATT Consulting Group authored the *Backgrounder* and *Infrastructure Planning Guide* documents.

Contents

1. Overview

Transportation and mobility are rapidly evolving, driven by a range of factors from climate change, technology, economics, and general consumer preferences. The electrification of transportation is part of this emerging and evolving transportation landscape that has and continues to allow consumers to save significant fuel costs and reduce their overall impact on the environment. Electric vehicles (EVs) have been emerging over the last 10 years both within the Canadian and global context; in the last three years alone, there has been a 214% year-over-year growth in EV sales in Canada.[1] Increases in EV sales have been accompanied by greater diversity in EV models and improved battery range, which is appealing to a broader range of consumers while simultaneously alleviating range anxiety.

While EVs do not address congestion issues, which continue to plague a number of communities in Canada, they do support community greenhouse gas (GHG) emission reduction goals as the transportation sector typically represents a significant share of GHG emissions. Local governments are uniquely positioned to capitalize on this opportunity to reduce GHG emissions through supporting EV adoption through the provision of public EV charging stations and requirements for new buildings to be EV-ready. Support from local governments is indispensable for increasing EV adoption in the short-term as the EV market continues to develop.

Electric Bikes (E-Bikes) are another emerging transportation phenomenon that are gaining popularity worldwide. Similar to EVs, E-Bikes can help communities achieve their GHG emission reduction targets. Further, with supportive cycling infrastructure in place, E-Bikes have the potential to substitute for, or completely replace, almost all trips taken by a gasoline powered car, which could address congestion issues and mitigate parking challenges within urban areas. However, E-Bikes still face a number of barriers (see Section 2.3) that are limiting their uptake. Fortunately, local governments can address many of these barriers through policy and planning efforts.

Both EVs and E-Bikes will continue to be critical components of the larger transportation picture and this document outlines how local governments in the Capital Region could have a significant role in helping make these emerging forms of transportation more prevalent in their communities.

1.2 About the Project

Working with and on behalf of local governments, the Capital Regional District (CRD) has undertaken the *Electric Vehicle (EV) and Electric Bicycle (E-Bike) Infrastructure Planning Project* to understand and assess opportunities to advance EV and E-Bike charging infrastructure in public and private locations throughout the region. EV and E-Bike technology is rapidly advancing and this project is focused on the current landscape. The key objectives of this project are to:

- Understand opportunities for local governments to accelerate uptake of EVs and E-bikes;
- Collect feedback from the development community and general public to better understand the barriers and opportunities for EV and E-bike charging;
- Draw on resources and lessons learned from other communities;
- Identify priority locations for new EV charging stations in the Capital Region; and
- Create an infrastructure planning guide outlining options for local governments on how to advance EV and E-bike charging infrastructure in the region.

1.2 About the Guide

The *Infrastructure Planning Guide* (this document) is the second of two key project outcomes and contains strategies for local governments and electoral areas, as well as private development, to expand EV and E-Bike charging infrastructure in the Capital Region. The *Capital Region EV + E-Bike Infrastructure Planning "Backgrounder"* is a companion to this document. It was developed as a summary of EV / E-Bike research and included examples of best practices from leading jurisdictions, intended to inform this document. Supporting information for many of the conclusions from this document can be found in the Backgrounder.

This document contains the following information:

- An overview of existing EVs and E-bikes, charging station technology, trends in EVs and E-bike ownership in the Capital Region and elsewhere, and key barriers to uptake;
- Prioritized locations for future installation of public EV charging infrastructure and improved management of public EV charging stations;
- Opportunities to increase EV and E-Bike charging infrastructure in new development; and
- Recommended approaches for retrofitting existing buildings for EV charging.

Note, while this report only focuses on EV and E-Bikes, reducing distances travelled, reducing the reliance on automobiles, improving vehicle efficiency and switching to low or no greenhouse gas emitting fuels should all be considered as part of a sustainable transportation strategy. Fully hybrid vehicles and fuel cell electric vehicles (FCEVs) are types of electric vehicle that cannot be plugged in and charged and are therefore not included in this document.

With EV and E-Bike and other zero emissions transportation technology rapidly changing, and prices continuing to decline, policy will need to continuously be updated and refined to reflect the latest trends. This document is intended to be a "living document".

In September, 2018, the City of Richmond procured a document prepared by C2MP, the Fraser Basin Council and AES Engineering titled "Residential Electric Vehicle Charging: a Guide for Local Governments" for use by local governments across BC (herein referred to as 'the provincial guide'). The provincial guide contains a comprehensive analysis and recommendations that support this document. Content from the provincial guide is referenced throughout this document, where appropriate and noted.

The City of Richmond also released another recent publication prepared by AES Engineering, Hamilton & Company, C2MP, and the Fraser Basin Council titled "Electric Vehicle Charging Infrastructure in Shared Parking Areas". Content from this document is also referenced throughout this document, where appropriate and noted.

Acronyms

The following acronyms are referenced throughout this document:

BEV A Battery Electric Vehicle ("BEV") is powered exclusively by electricity and must be plugged in to charge. BEVs can be charged via an EV charger or by a typical wall outlet. BEVs can, on average, travel anywhere from 100 to 400 kilometres with a fully charged battery before requiring a charge.

CRD The Capital Regional District ("CRD") is the regional government for 13 municipalities and three electoral areas on southern Vancouver Island and the Gulf Islands, serving more than 392,000 citizens. The CRD provides regional decision-making on issues that transcend municipal boundaries and enables effective service delivery to residents.

E-Bike An Electric Bicycle ("E-Bike") is a type of bicycle with an electric motor of 500 watts or less and functioning pedals that is limited to a top speed of 32 km/h without pedalling.

EV An Electric Vehicle ("EV") is a class of vehicles that runs fully or partially on electricity. EVs have a battery along with (or instead of) a gasoline tank, and an electric motor along with (or instead of) an internal combustion engine.

EVSE Electric Vehicle Supply Equipment ("EVSE") refers to infrastructure installed and used to provide electricity for the purposes of charging an electric vehicle.

MURB Multi-unit Residential Building ("MURB") is comprised of a common entrance and separate units that are also known as apartments constructed for dwelling purposes.

OCP An Official Community Plan ("OCP") is a local government's core planning document that contains a statement of objectives and policies to guide decisions on planning and land use management.

PHEV A Plug-In Hybrid Electric Vehicle ("PHEV") is fueled with both gasoline and electricity. PHEVs can travel between 20 and 60 kilometres powered by an electric engine and a fully charged battery, and/or 500 to 900 kilometres powered by an internal combustion engine and a full tank of gasoline.

ZEV A Zero Emission Vehicle ("ZEV") is a vehicle that emits no exhaust gas from the onboard source of power. A ZEV is an all-encompassing term that refers to all types of electric vehicles including plug-in hybrids, battery electric vehicles, and hydrogen fuel cell vehicles.

Terminology

The following terms are referenced throughout this document and may not be widely understood:

EVEMS	Electric vehicle energy management systems ("EVEMS") refer to a variety of technologies, including service provision, that allow multiple vehicles to charge on the same circuit. EVEMS are also referred to as "load sharing", "power sharing", or "smart charging" systems.
Garage Orphan	A garage orphan refers to a household that does not have access to a carport or garage, and therefore does not have the ability to charge an EV on-site.
Range Anxiety	Range anxiety refers to the fear of running out of battery power before the next opportunity is available to charge an electric vehicle.
Level 1 Charger	A Level 1 charger uses a standard house plug (120V) and can be used for overnight charging at home or all-day charging at work. When charging cars overnight (8–10 hours), Level 1 chargers can fully recharge most PHEVs and "top up" a BEV from a typical work commute.
Level 2 Charger	A Level 2 charger uses a dedicated 208V or 240V circuit like those used for clothes dryers. Level 2 chargers are generally the preferred option for home charging. Level 2 is also appropriate in public locations where cars generally park for one or more hours, which allows EV owners to top up their charge while shopping, recreating, or working.
Level 3 (Direct Current Fast Charger)	A Level 3 charger or DCFC can provide about an 80% charge in half an hour. Direct current fast charging is currently (based on today's technology and costs) not considered suitable for residential installations due to the high cost of equipment, installation, and power requirements. Not all electric vehicles can plug into a DCFC charger.

2. Understanding EVs + E-Bikes

2.1 What is an Electric Vehicle ("EV")?

For the purposes of this document, an electric vehicle is considered any vehicle that runs fully or partially on electricity. An EV receives power in whole or in part from an electric motor, depending on the type (e.g., a Battery Electric Vehicle relies completely on the electric battery for energy, whereas a Plug-In Hybrid Electric Vehicle can use either the electric engine or an internal combustion engine to propel the car). Hybrid vehicles are a type of electric vehicle, but cannot be plugged in and charged and are therefore not included in this document.

EV Types / Technologies

There are two distinct vehicle types, shown below:

Battery Electric Vehicles ("BEVs") run exclusively on electricity and need to be plugged into an outlet or charging station to recharge the battery. The typical battery range varies from 100 km to over 400 km. Examples of BEVs include Chevrolet Bolt (left), Nissan Leaf, Tesla Model S.

Plug-In Hybrid Electric Vehicles ("PHEVs") have both an electric motor and an internal combustion engine. The electric motor needs to be charged at an outlet or charging station and typically has a shorter battery range than BEVs, and PHEVs use the internal combustion engine when the battery is low or when extra propulsion power is needed. Examples of PHEVs include Hyundai IONIQ (left), Kia Optima, Chevrolet Volt.

EV Models + Characteristics

As of May 2018 there are 36 existing EV models (11 BEVs and 25 PHEVs) that are available in British Columbia. See the *Backgrounder (page 3)* for a complete list or visit www.pluginbc.ca. Table 1 presents the extent of characteristics of these BEVs and PHEVs.

Table 1. Summary of Electric Vehicle Models + Characteristics

Type	Vehicle Range* (km)	Vehicle Cost (CAD$)
BEV	155 – 539 *Median: 201*	28,800 – 200,200 *Median: 36,000*
PHEV	19 – 85* *Median: 27*	31,999 – 152,715 *Median: 56,700*

*Vehicle range represents electric battery range only.

2.2 About EV Charging Stations

There are four types of charging stations: Level 1, Level 2, Level 3 and Tesla Supercharger. Figure 1 illustrates the key differences between a Level 1, Level 2, and Level 3 charger whereas Table 2 shows the difference in charging range between Level 2 and Level 3 chargers

Level 1 charging stations are household outlets which provide 120V of AC power to the vehicle. This type of charging takes the longest time, and is typically a good option overnight.

Level 2 charging stations provide a higher amount of AC power (240V) to the vehicle. Level 2 charging stations recharge the batteries in about four hours. These stations are the most commonly available public charging stations, and can be installed in parkades, surface lots or even curbside.

Level 3 charging stations are the quickest-charging stations, in that they provide 480V DC power, and are able to charge a full battery in less than an hour. The charging station is about the size of a fuel pump at a gas station.

Tesla Supercharger is a special Level 3 charger that can only be used to charge a Tesla vehicle; other makes of EVs do not currently have access. These stations are owned and operated as part of the Tesla network of superchargers world-wide and are typically sited to support the long distance travel needs of Tesla owners, but increasingly are being installed

within cities to facilitate charging for those living condos and others without access to home charging. Note: Tesla Superchargers are not referenced in this document as they cannot be used my most EV users.

Figure 2. EV Charging Infrastructure Pyramid

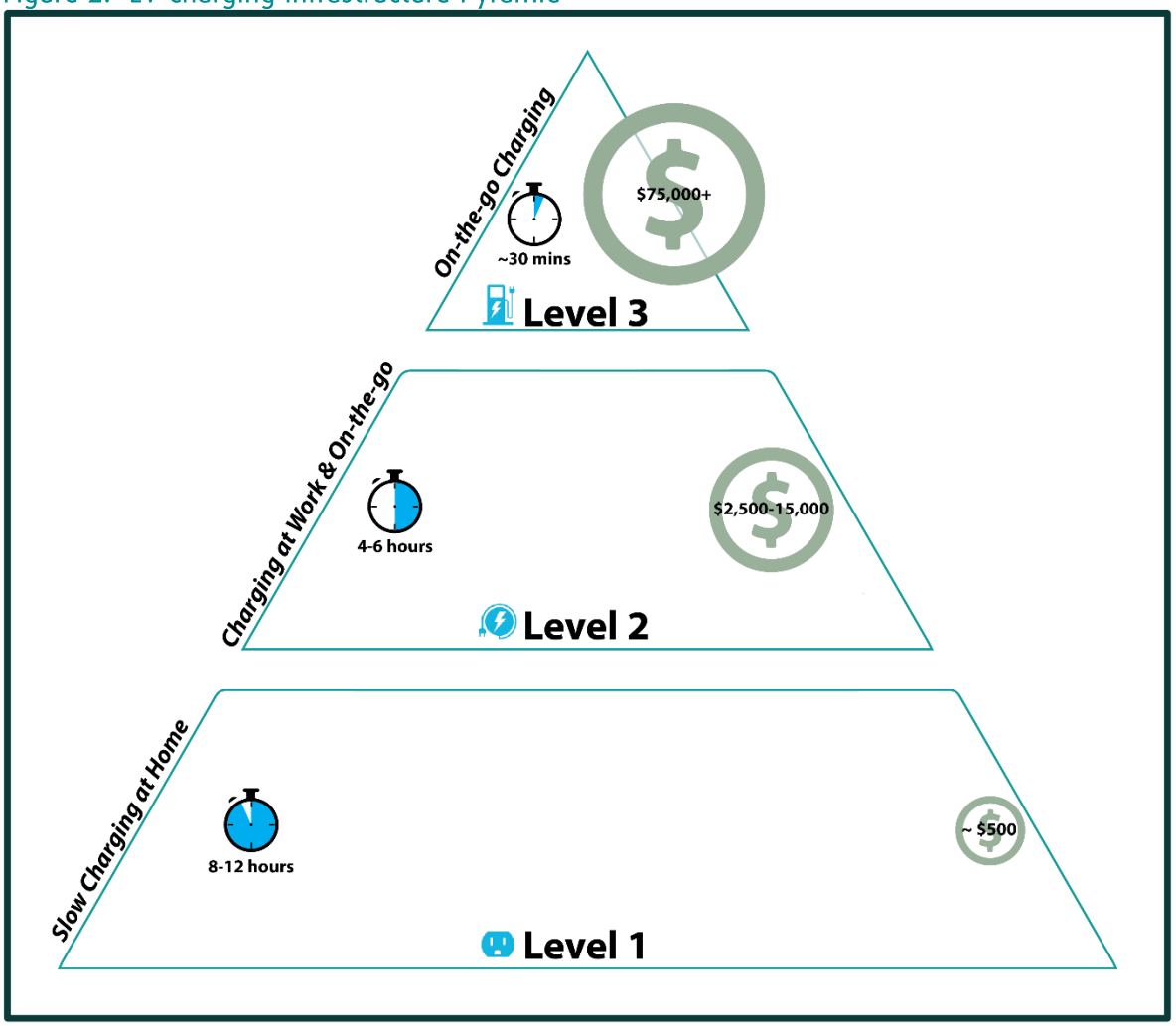


Table 3. EV Charging Range Based on Charging Level[1]

Vehicle Type	Charging Range Per Hour (Level 2 Charger)	Charging Range Per Half Hour (Level 3 Fast Charger)
BMW i3	42 km	103 km
Chevy Bolt	41 km	273 km
Chevy Volt	18 km	no fast charging
Mitsubishi Outlander PHEV	12 km	28 km
Nissan Leaf (2nd Generation)	17 km *(option for 34 km)*	194 km
Tesla Model S	45 km	–*
Tesla Model X	43 km	–*
Tesla Model 3 Long Range	60 km	–*
Volkswagen e-Golf	21 km *(option for 41 km)*	161 km

*Tesla models are typically charged at a Tesla Supercharger station, which provide 321 km for Model S, 306 km for Model X, and 399 km for Model 3 in 40 minutes.

Based on the data above, the percentage increase in terms of charging speed between a Level 2 and Level 3 charger ranges from 133% to 1041%. However, this comes with a trade-off; there is a significant cost difference between a Level 2 and a Level 3 charger. Therefore, it is imperative to consider careful and strategic siting of Level 3 charging stations in select locations that will yield the highest utility (for a detailed discussion about siting considerations for Level 2 and Level 3 charging stations, see the *Backgrounder, Section 5.1)*.

According to BC Hydro, about 95 percent of all car trips in the province are less than 30 kilometres. The approximate charging time for 30 kilometres of range varies from 6-7 hours (Level 1 charger), 1-3 hours (Level 2 charger), and 10 minutes (Level 3 DCFC). For more information see BC Hydro's report entitled: Unplugged: Myths to block road to the electric car dream (April 2018).

[1] This table has been modified from the provincial guide "Residential Electric Vehicle Charging: A Guide for Local Governments".

EV Charging Needs

EV charging needs vary based on location; home charging for example usually includes a Level 1 or 2 charging station as charging typically occurs overnight. EV charging infrastructure requires a comprehensive plan to provide a charging network that will be adequate and convenient to existing EV owners (and to encourage prospective EV owners). A complete charging network comprises chargers at homes, work and other destinations, publicly accessible locations, and along highway corridors. The importance of providing a public network is critical not only for EV owners that want to charge "on the go", but also for the EV owners that do not have access to charge at home (i.e., "garage orphans" who live in a multi-unit residential building or a home without a driveway or garage). See ***Background Section 2.2*** for a more detailed discussion on this topic.

Needs and expectations of EV owners have changed over time. Early adopters of EVs were willing to accept challenges; however, current prospective EV owners are less willing to deal with barriers. One key barrier that was identified in the CRD public survey is lack of access to charging at home.

Table 3 below presents a summary of charging needs for both existing and prospective EV owners based on a 2015 study, which illustrates that many early adopters had access to charging at home".[2]

Table 3. EV Charging Needs Based on Charging Level

EV owners (BC Sample)	Prospective EV owners (Canada-wide Sample)
97% have access to home charging (Level 1)	66% have charging access at home (Level 1)
75% have installed a Level 2 Charging Station	19% have access to a Level 2 Charging Station
86% were aware of at least one public charger	33% have seen at least one public charger *(Higher awareness in BC than rest of Canada)*
Infrequent use of public chargers (once per month or year). Respondents reported that after a learning period they had little need to use public charging infrastructure	Typical public charger locations that were identified by prospective EV owners in BC: Shopping malls, Retail & Grocery Stores

Key Challenges

Understanding the key challenges to EV adoption is critical to determining the most appropriate suite of policies, strategies, and incentives that could be implemented to alleviate barriers and increase EV adoption rates. A detailed summary of the key challenges to EV adoption in the Capital Region are included in the *Backgrounder, Section 6.1* and are summarized below. The barriers identified below are derived from the CRD public survey and the academic literature.

High Purchase Price	EVs are generally $35,000 or more, owing largely to battery costs. Potential EV buyers may fail to acknowledge the "total cost" of EV ownership compared to gasoline-powered vehicles, which includes no gasoline and limited maintenance. Purchase price was identified as the most significant barrier in the CRD public survey.
Lack of Ability to Charge at Home	For households that do not have access to a carport or garage, the inability to access on-site charging overnight can be a major problem. Approximately 20 percent of the respondents in the CRD public survey selected "don't have the ability to charge at home" as a key barrier to EV ownership. This can include residents in a multi-unit residential building who do not have access to charging station or a single-family home / townhouse without a driveway or garage, for example.
Availability of Public Charging Stations	Potential EV buyers cite a lack of access to EV charging as a barrier to ownership, which includes lack of access to charging at home (i.e., "garage orphans") or lack of access away from home (i.e., at work, school, shopping, or public facilities). The CRD public survey also reported this barrier; about 21% of respondents indicated that the lack of public chargers in the region is a barrier to EV ownership.
"Range Anxiety" – Real Vs. Perceived	Range anxiety refers to the fear of running out of battery power before encountering the next opportunity to charge. Range anxiety has been demonstrated to be much higher among potential EV purchasers as compared to EV owners. Studies

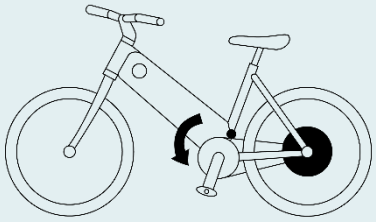
	have shown that a large gap exists between perceived and real-word range anxiety which can be alleviated by driving experience. Research has also found that as the range of an EV increases, so does the willingness to purchase of vehicle. Range anxiety was reported as a barrier in the CRD public survey.
Lack of Familiarity with EV Technology	Much of the general public has limited understanding of EV technology and its practical benefits, and no prior experience driving or riding in an EV. A 2017 Canadian survey by Plug'N Drive found that more than 40 percent of interviewed EV owners were introduced to EVs by a friend, a relative or a colleague before owning one. Many gasoline-powered car owners had never been exposed to an EV before buying their car.[3]
Lack of Variety in Model Types	EVs are generally only available in compact or sub-compact models, limiting their appeal to the broad consumer audience. Further, their current popularity has led to dealerships unable to meet demand within a reasonable timeframe. One study[4] indicated that EVs will need to become available in a broader set of vehicle types, or consumers will need to shift their interests in EV vehicle types, if EVs are to achieve high percentages of vehicle purchases.

2.3 What is an Electric Bike ("E-Bike")?

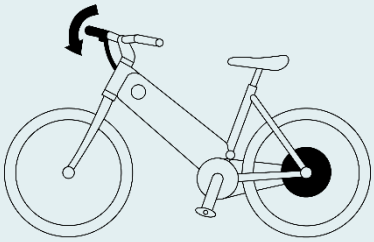
E-Bikes are electric bicycles with an electric motor of 500 watts or less and functioning pedals that is limited to a top speed of 32 km/h without pedalling.[5] The amount of assistance the motor supplies depends on the size of the motor: smaller motors work to only assist the rider's pedaling and larger, more powerful, motors can propel the bike forward without the rider needing to pedal.

E-Bikes are classified according to their power, and there are three distinct classes, broadly described in Table 4. Table 5 presents an overview of E-Bike performance and costs.

Table 4. E-Bike Classes



Pedal Assist (also known as "pedelecs") automatically provide power (or assistance) when the user encounters conditions where increased physical effort is required, which can be beneficial for reducing the physical exertion required for going up steep grades or pedalling against a strong headwind, for example.



Power-On-Demand systems only provide power when initiated by the user using a throttle typically integrated into the handgrip.

Hybrid systems combine both the automated pedal-assist sensor and the option to manually engage the motor by utilizing the throttle.

A discussion of E-Bike charging requirements is summarized in Section 5.0.

Table 5. Summary of Select E-Bikes Available in Canada in 2018, Performance + Cost

Type	Name / Model*	Battery Range (km)	Top Speed without Pedaling (km/h)	Cost (CAD$)
Pedal-Assisted / Power-on-demand	Stark Drive City	40	25	399
	Spark	80	32	1,300
	Interceptor | Electric Cruise Bike	-	32	3,800
-	OHM-EbikeBC XU450	40-80	32	2,500
Pedal-Assisted	OPUS Grid	38	32	2,500
Pedal-Assisted with options	Opus Connect	125	32	3,600
-	Powerfly 5 Women's	-	32	4,600

*Juiced Bikes sells two models (OceanCurrent and CrossCurrent S) that travel at higher top speeds than a typical E-Bike at 38km/h and 45km/h respectively.

Key Challenges

Similar to EVs, a list of the key challenges to E-Bike adoption is included in the ***Backgrounder***, ***Section 6.1***. A summary of the key challenges is provided below:

High Purchase Price

Similar to the price barrier identified for EVs, E-Bikes are generally more expensive than regular bikes. The cost differences vary depending on geography; in North America the differences are approximately 25-40%. The CRD public survey found that the cost of E-Bikes was the largest barrier identified by survey respondents.

Lack of Secure Parking, Security + Fear of Theft

E-Bikes are more expensive than regular bikes and as such, require secure facilities to prevent theft. In recent studies E-bike owners expressed concern and anxiety about the security of their E-Bike. [6,7]

Concerns about theft are partially explained by lack of secure bike parking. The CRD public survey found that the lack of

secure parking is a barrier facing prospective E-Bike owners. Approximately 27 percent and 15 percent of respondents selected "afraid that it might be stolen" and "lack of places to park an E-Bike", respectively, as factors for why they have not purchased an E-Bike.

General Safety Concerns

Numerous studies have confirmed the issue of safety as a key barrier to E-Bike adoption and a concern for E-Bike owners. The two primary safety issues are (1) the actual safety of the E-Bike itself including its higher operating speed relative to a regular bicycle and (2) safety of riding an E-Bike on the road. The CRD public survey found that approximately 22 percent of respondents selected "concerned about safety" as barrier to E-Bike ownership. A number of qualitative responses pertained to the need for better cycling infrastructure including protected bike lanes.

Social Stigma

Research has also reported the stigma attached to E-Bikes. Some people perceive E-Bikes as "cheating", as it takes away the physical effort required to pedal a regular bicycle. E-Bike owners reported being judged by their work colleagues, who deemed an E-Bike as a more suitable form of transportation for those with mobility challenges. [8]

2.4 The Larger EV Policy Context

While local governments have specific roles in supporting both EV and E-Bikes (see Section 2.5), other levels of government and utilities have and continue to be involved in promoting electric vehicles, as well. A brief description is provided outlining the roles of each respective government / utility.

Federal Government

The Canadian government recently released *Transportation 2030*, which is a strategic plan for the future of transportation in Canada. The plan is guided by five unique themes including "green and innovation transportation". As part of the government's commitment to this theme, the 2017 budget dedicated $120 million for EV and alternative fuelling infrastructure and $17.2 million for Transport Canada and Environment and Climate Change Canada to develop and implement heavy-duty vehicle retrofit and off-road regulations as well as a clean fuel standard.[9] Both the provision of funding for EV charging stations and clean fuel standards, once developed, are expected to help support and increase EV adoption.

At this time, the federal government has not adopted a specific EV policy; however, recommendations have been made by universities and think-tanks for the government to consider adopting a Zero-Emission Vehicle (ZEV) mandate, which would require auto manufactures to sell a minimum percentage of electric vehicles. For a more detailed description of the ZEV mandate, and other EV policy recommendations, see *Canada's Electric Vehicle Policy Report Card*, published by SFU's Sustainable Transportation Action Research Team.[10]

BC Provincial Government

The BC government's role in EV promotion has been through the Clean Energy Vehicle Program (CEVP), which is administered through the New Car Dealer Association of BC.[11] The goal of the program is to make clean energy vehicles (i.e., EVs) more affordable for British Columbians. To date, the BC government has committed over $40 million toward the program, of which $37 million has been specifically allocated to the CEVforBC vehicle incentive program.[12] This program offers incentives of $5,000 off the purchase price or lease of a new BEV or PHEV and $6,000 toward a hydrogen fuel-cell vehicle. In addition to CEVforBC, the CEVP has also dedicated funding to charging infrastructure incentives / investments for both Level 2 and Level (DCFC) stations.

On November 20th, 2018, the BC government announced that it will introduce legislation in 2019 to phase in targets for the sale of zero-emission vehicles (ZEVs). Specifically, the legislation will set targets of 10% ZEV sales by 2025, 30% by 2030, and 100% by 2040.[13] To support these targets, the BC government will commit to the following actions:

- Expand the size of the provincial Level 3 DCFC charging network to 151 sites. There are already 71 completed or underway and with federal government and private-sector funding, another 80 will be implemented.
- Increase the size of the CEVP by allocating another $20 million to the program in 2018. This will bring the program up to $57 million in total.
- Review the incentive program and expand over time so buying an electric vehicle becomes more affordable to middle- and lower-income British Columbians.

The BC government has a number of other policies in place that support EV adoption including the provincial carbon tax ($35 / tonne of CO2e) and the renewable and low carbon fuel requirements regulation, among others.

BC Hydro

BC Hydro has also been involved in supporting EV adoption.[14] Their involvement has been multifaceted and three specific examples are as follows:

- Working with the BC and federal governments to explore opportunities to expand the DC fast charging station network across the province.
- Assessing the DC fast charging market and researching next-generation architecture to keep up with growing and evolving market needs.
- Providing certified electrician recommendations to EV owners looking to install charging infrastructure.

BC Utilities Commission

The BC Utilities Commission (BCUC) regulates the sale and resale of electricity in BC. Municipalities who sell electricity to its residents are exempt from the BCUC. BCUC is currently undertaking an inquiry to explore the potential regulatory issues and opportunities in the EV charging stations market. The Inquiry's Phase One Report was released on November 26, 2018.

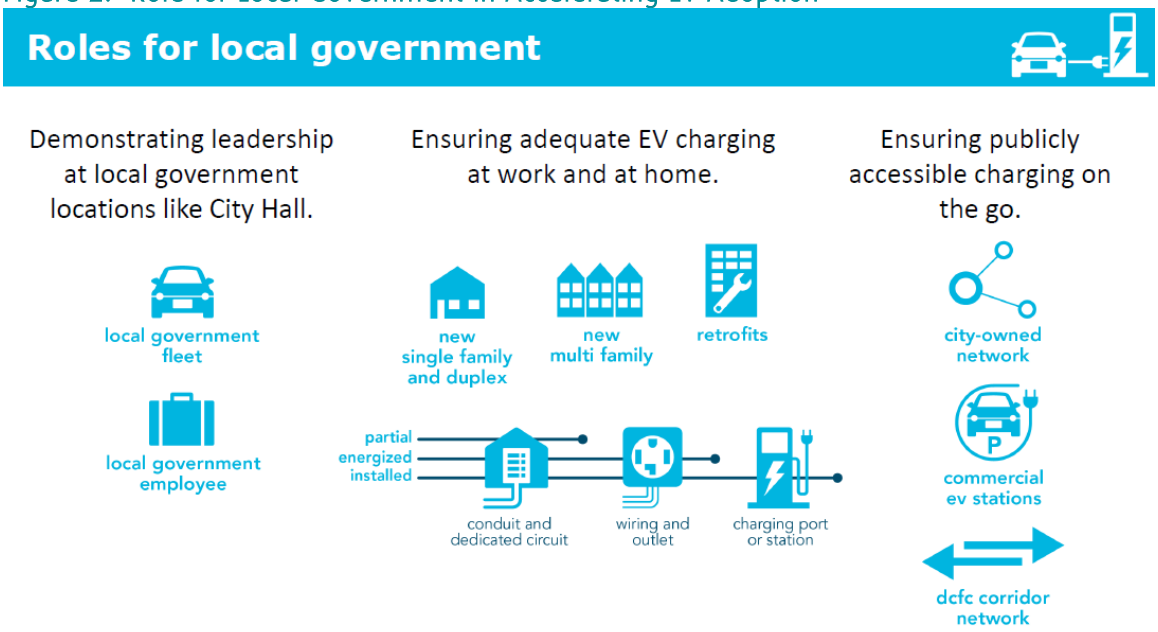
As indicated in the inquiry FAQ, the services, rates, and rate design associated with EV charging are currently in an early development stage in BC. But, with the growing popularity of EVs and increasing availability of public charging stations—currently over 1,000 in the province—there is a need to assess the regulatory needs, or lack thereof, that would "be associated with EV charging service, and can also include the setting of rates for EV charging service and any other matters that are of concern or interest to stakeholders".[15] More information about the inquiry is found online.[2]

[2] More information about the BCUC Inquiry is available here: https://www.bcuc.com/ApplicationView.aspx?ApplicationId=613 and here: http://www.bcuc.com/Documents/Proceedings/2018/DOC_50755_02-08-2018_BCUC-EV-Charging-FAQ.pdf

2.5 Local Government Roles

Local governments are in a unique position to promote and advance emerging mobility options such as EVs and E-Bikes. As shown in the Figure 2 below, there are at least three ways local governments play a role.

Figure 2. Role for Local Government in Accelerating EV Adoption[3]



While the figure above is more specific to EVs, local governments can accelerate both EVs / E-Bikes in their communities by doing the following:

- Leadership at Municipal Hall | Local governments can electrify their fleets by adding EVs or E-Bikes or providing charging access for employees. Over the past few years, a number of municipalities and the Capital Regional District have been gradually transitioning their fleets to electric.
- Requiring Charging Equipment in New Developments | Local governments can facilitate opportunities for EV / E-Bike charging in new developments through requirements in zoning or parking bylaws. This can include a requirement for new buildings to be EV-

[3] Image Credit: City of Langley, BC Hydro, C2MP

ready, the requirement for an EV charging station, and/or access to an electric outlet for E-Bike charging. See Section 5.2 (Local Government Policy Mechanisms) for details.

- Provision of a Publicly Accessible Charging Network | Local governments can play a role in the provision and management of publicly accessible EV / E-Bike charging stations, as discussed in detail in Section 4.0 (Public Charging),

CRD's Zero Emissions Fleet Initiative

The Zero Emissions Fleet Initiative is 'technology neutral' and is testing multiple zero emissions fleet alternatives including Fuel Cell Electric Vehicles, Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles and E-Bikes to identify zero emissions alternatives that can meet operational requirements in a cost effective manner.

3. EVs + E-Bikes in the Capital Region

3.1 Uptake in the Capital Region

The *Backgrounder, Section 3.2* reports local EV ownership data using results from the 2017 CRD Origin Destination Household Travel Survey.[16] The summary of vehicles by fuel type identified 255,300 vehicles in the Regional Planning Area with approximately 1,900 (0.7%) being "electric-only". The data show electric vehicles represent 1% (or less) in almost all municipalities / electoral areas. The only exceptions are North Saanich (2%) and the Salt Spring Island Electoral Area (4%). This represents an increase from the 2011 survey where only 100 electric-only vehicles were reported (less than 0.001%). Nevertheless, the survey does indicate that EV ownership has increased significantly since the 2011 survey.

In addition, as described in the *Backgrounder, Section 3.1*, EV sales across BC have continued to rise. BC saw 1,400 EVs sales in the first quarter of 2018, representing an increase of 58% over the previous year. BC also currently has the highest per capita EV sales across Canada. These trends indicate that EV sales will likely continue to grow, especially as the costs of batteries decline.

3.2 Regional EV Charging Network

According to ChargeHub, as of November 2018, there are approximately 120 EV charging stations in the Capital Region, 116 of which are Level 2, and 4 of which are Level 3 (DCFC).[17] Refer to Figure 3. The sites of charging stations vary; however common location sites for municipally / regionally managed stations include:

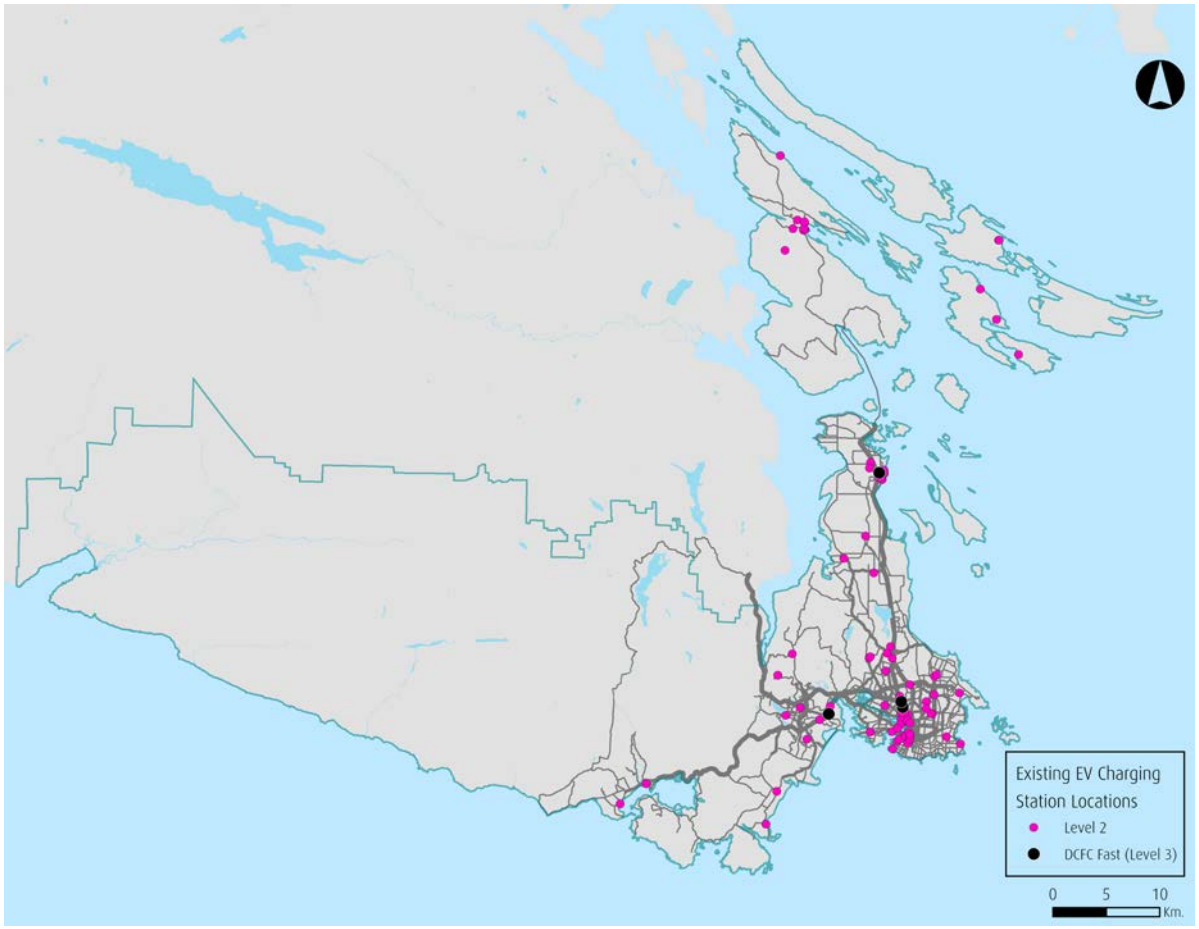
- Libraries | public libraries are generally evenly distributed across a municipality or region's area where people typically spend anywhere from 30 minutes to 2 hours. For example, a charging station is available at the Juan de Fuca Branch of the Greater Victoria Public Library in Colwood.
- Municipal Halls | a number of municipal halls in the Capital Region host a Level 2 charging station including the municipalities of Esquimalt, Oak Bay, Sidney and Central Saanich, Metchosin, Colwood.
- Major Parks | parks and open spaces are generally strong candidates for Level 2 charging stations as they are popular destinations for the public and can maximize the visibility – and convenience – of a charging station.

- Community or Recreation Centres | they are often evenly distributed across a region's extents, typically one in each municipality where the community gathers for activities, social or sporting events, and/or or public information. They usually contain dedicated parking, which makes them suitable to host a charging station. Charging stations are available at the Pearkes Recreation Centre and Gordon Head Recreation Centre in Saanich, SEAPARC Recreation Centre in Sooke and ArtSpring on Salt Spring Island.
- Park and Ride Facilities | park and rides are civic parking locations that connect public transportation systems. Vehicles are typically parked for several hours, making these locations suitable candidates to host a Level 2 charging station. Park and ride facilities can also be used by vehicles parking for a shorter period of time, making them candidates for a Level 3 charging station, as well. Level 2 charging stations are available at the Colwood Park and Ride.
- Public Parkades | public parkades serve different trip purposes; commuters may use them for all parking whereas downtown customers may use them for a shorter period of time (i.e., 1-2 hours). Given the variation in dwell times, they are candidate locations for Level 2 charging stations. A total of 8 Level 2 charging stations are available in the City of Victoria's public parkades including three in the Broughton Street Parkade.

Capital Region Local Governments Support the Public Network

Over the past six years local governments across the Capital Region have installed publicly available Level 2 charging stations at municipally owned buildings including municipal halls, libraries and recreation centres and continue to expand the public charging network.

Figure 3. Locations of Publicly Accessible EV Charging Stations in the Capital Region (as of November 1, 2018)[4]



[4] New EV charging station are coming online each year and therefore the map presented in Figure 3 could quickly become outdated. NRCAN maintains an up-to-date database showing EV charging station locations in Canada and could be found online at: https://www.nrcan.gc.ca/energy/transportation/personal/20487#/find/nearest

3.3 Policies + Regulations in the Capital Region

To understand local policy priorities with respect to EVs and E-Bikes, a review of all thirteen municipalities' Official Community Plans (OCPs) (and equivalent plans in the three electoral areas) was completed. A detailed table is presented in the *Backgrounder, Section 4.0*. It should be noted that OCPs are not updated regularly and EV policy has emerged relatively recently. A summary of the key findings is provided as follows:

- Seven of 13 municipalities in the CRD were found to contain an EV policy in their OCP. A number of communities provide no direction at all (e.g., Central Saanich, Langford, Metchosin, Saanich, and Sidney) whereas other communities have at least one policy including North Saanich, Oak Bay, Victoria, and View Royal.
- Esquimalt and Colwood—two municipalities that recently updated their OCPs—were found to have the most detailed EV policies including specific direction to expand the public charging network along with requiring new developments to be EV-ready and/or provide a charging station.
- The Juan de Fuca electoral area is comprised of seven communities, each of which has an OCP. None of these communities' OCPs were found to have any policy language on EVs or E-Bikes.
- Almost all of the Southern Gulf Islands and the Salt Spring Island electoral areas contain EV policy direction.
- None of the communities within the Capital Region provide policy direction around E-Bikes. This may be due to the fact that E-Bikes are a recent emerging technology and planning policy has not caught up.

As of September 2018, the Town of View Royal is the only municipality in the Capital Region to have a requirement for electric vehicle charging in new developments. The Town's Zoning Regulation Bylaw requires commercial or multiple unit residential developments with more than 100 parking spaces to have access to an electric vehicle charging station on the lot, in a location which is accessible to the patrons or residents.[18]

4. Public Charging

4.1 Objectives of a Public EV Charging Network

Research has shown that the presence of a public EV charging network is a critical consideration for potential EV buyers. In cities such as Montreal, for example, many EV owners who live in the core part of the city do not have access to a home charging station. As such, the City has strategically sited 400 of its 475 public charging stations on-street to provide viable charging opportunities for households that do not have access to a carport or garage, and therefore do not have the ability to charge an EV. It was reported that having access to a public charging network in Montreal has been valuable for increasing EV uptake among prospective EV owners.[19]

The location of public EV charging stations (i.e., where the stations are physically sited) can influence the personal travel patterns of those electric vehicle users, including the specific travel routes they take and where they shop.[20] Results from the CRD public survey (see *Backgrounder, Section 8.1*) also confirm the importance of a public charging station network. A majority of the respondents identified the need for more public charging stations.

The objectives of a public charging network are three-fold:

1. Reducing Range Anxiety: To help alleviate range anxiety by providing drivers with the opportunity for "lifeline" charging, which refers to the ability to charge a vehicle when its battery is almost depleted;
2. Increasing the EV Profile: To create public awareness and understanding of electric vehicles and increase exposure and knowledge of EV technology; and
3. Accommodating Garage Orphans: To provide viable charging opportunities for households who do not have access to off-street parking (colloquially known as "garage orphans").
4. Equity: To support equitable access to EV charging infrastructure irrespective of income / housing type.

These objectives form the basis of the recommendations outlined in this section.

4.2 Regional EV Charging Network Gaps

The outlined regional EV charging network is the result of the infrastructure gap analysis. The purpose of the infrastructure gap analysis was to evaluate where EV charging stations gaps exist in the Capital Region, and to identify the highest priority locations for new charging stations to guide future site selection. The infrastructure gap analysis estimated EV charging station suitability using a Geographic Information System (GIS) by quantitatively assessing individual built environment and transportation criteria that approximate demand for EV charging. The methodology and results of the infrastructure gap analysis are described in detail in the *Backgrounder, Section 7.2*.

The four criteria included in the infrastructure gap analysis were selected based on a review of the academic literature, as follows:

- Residential Density | Number of multi-unit residential dwelling units divided by residential land area (square feet).
- Commercial Density | Commercial building floor area (square feet) divided by commercial land area (square feet).
- Land Use Mix | Evenness of building floor area distribution across multi-unit residential, commercial, and office uses.
- Traffic Exposure | Estimated average daily traffic (ADT).

The following tables (Table 6 and Table 7) identify recommended priority locations for future EV charging stations including both Level 2 and Level 3 (DCFC) stations. Priority locations do not include on-street charging stations but a detailed discuss of on-street charging station considerations is provided in Section 4.4. The recommended priority locations are organized into three distinct geographic areas, as presented below.

1. Core Area, which includes the City of Victoria, District of Saanich, District of Oak Bay, Township of Esquimalt, and Town of View Royal;
2. West Shore, which includes the City of Colwood, City of Langford, District of Metchosin, District of Highlands, and District of Sooke; and
3. Peninsula, which includes the District of Central Saanich, District of North Saanich, and Town of Sidney.

The infrastructure gap analysis did not include the Southern Gulf Islands, Juan de Fuca Electoral Area, and Salt Spring Island as they scored very low on the built environment and transportation criteria. This was due to the use of normalized data for the entire Capital Region when creating the composite suitability index. In particular, multi-family residential land uses are limited to non-existent for these geographies. For this reason, the outputs of the geospatial analysis did not produce meaningful results to inform decision-making as only a handful of the 200x200 metre cells had registered values. Other considerations when siting public stations relevant to these locations are described below (see 'Other Siting Considerations').

The tables also include "opportunity sites", which are defined as locations that are typically under municipal control including public parks, libraries, recreation centres, parkades, park and rides, on-street (i.e., curbside locations), etc. Opportunity sites have been identified as priority locations, where appropriate, to help inform the municipality where they could site new charging stations. In some priority locations there were no opportunity sites identified due to the absence of public amenities in these areas; in these instances, consideration will need to be given to siting the charging station on non-municipally owned property.

It should also be noted that further technical study would need to be undertaken to determine whether the location has the electrical capacity to host a charging station.

Table 6. Recommended Locations for New Public EV Charging Stations, Level 2

Priority Location		Municipality	Sub-Area	Opportunity Sites	Rationale
See Figures 4, 5 and 6 below for the recommended priority locations based on the gap analysis modelling results.					
1.	Cordova Bay	Saanich	Core Area	• Non-municipal opportunity site required	• Cordova Bay currently has no EV charging stations but has both the residential and commercial density to make this location suitable for a charging station(s).
2.	Esquimalt Town Centre	Esquimalt	Core Area	• Esquimalt Recreation Centre	• According to the Township, the existing charging station at this location has moderate utilization. An additional charging station would be beneficial in the near future to support the high residential / commercial density and the new Esquimalt Town Centre.
3.	Stadacona Village	Victoria	Core Area	• Stadacona Park	• There are currently no EV charging stations in the area and there is a high density of MURBs.
4.	Cook Street Village	Victoria	Core Area	• Beacon Hill Park	• There are currently no charging stations in Cook Street Village. The village scores high in land use mix.
5.	Admiral's Walk	View Royal	Core Area	• Non-municipal opportunity site required	• There are currently no charging stations in or around Admiral's Walk and the area has high commercial density.
6.	Strawberry Vale	Saanich	Core Area	• Rosedale Park	• There are currently no EV charging stations in this high residential density area.
7.	Keating	Central Saanich	Peninsula	• Non-municipal opportunity site required	• There are currently no EV charging stations in this area, which has moderate residential density.

Priority Location		Municipality	Sub-Area	Opportunity Sites	Rationale
8.	Brentwood Bay	Central Saanich	Peninsula	• Greater Victoria Public Library - Central Saanich Branch	• There is one existing charging station and the location has moderate residential / commercial density.
9.	Six Mile Pub	View Royal	West Shore[5]	• CRD Integrated Water Services	• There are currently no EV charging stations in this high residential density area.
10.	Goldstream Village	Langford	West Shore	• City of Langford City Hall	• There is one existing charging station in the area. The area has high residential / commercial density and the right land use mix.
11.	Westshore Town Centre	Langford	West Shore	• Non-municipal opportunity site required	• There are currently no EV charging stations in the area; commercial density (i.e., shopping centre) is high.
12.	Saseenos	Sooke	West Shore	• Sooke Library (new)	• There are currently no EV charging stations in Saseenos, which has moderate residential density and limited commercial amenities. As such, consideration should be given to a location in Sooke town core.

[5] Note, this priority location is geographically located in the Town of View Royal and is therefore in the "Core Area". However, for the cartographical purposes, it is shown in the West Shore map given its location on the western boundary of View Royal and its proximity to Colwood.

Figure 4. Recommended Priority Locations for Level 2 Charging Stations, Core Area

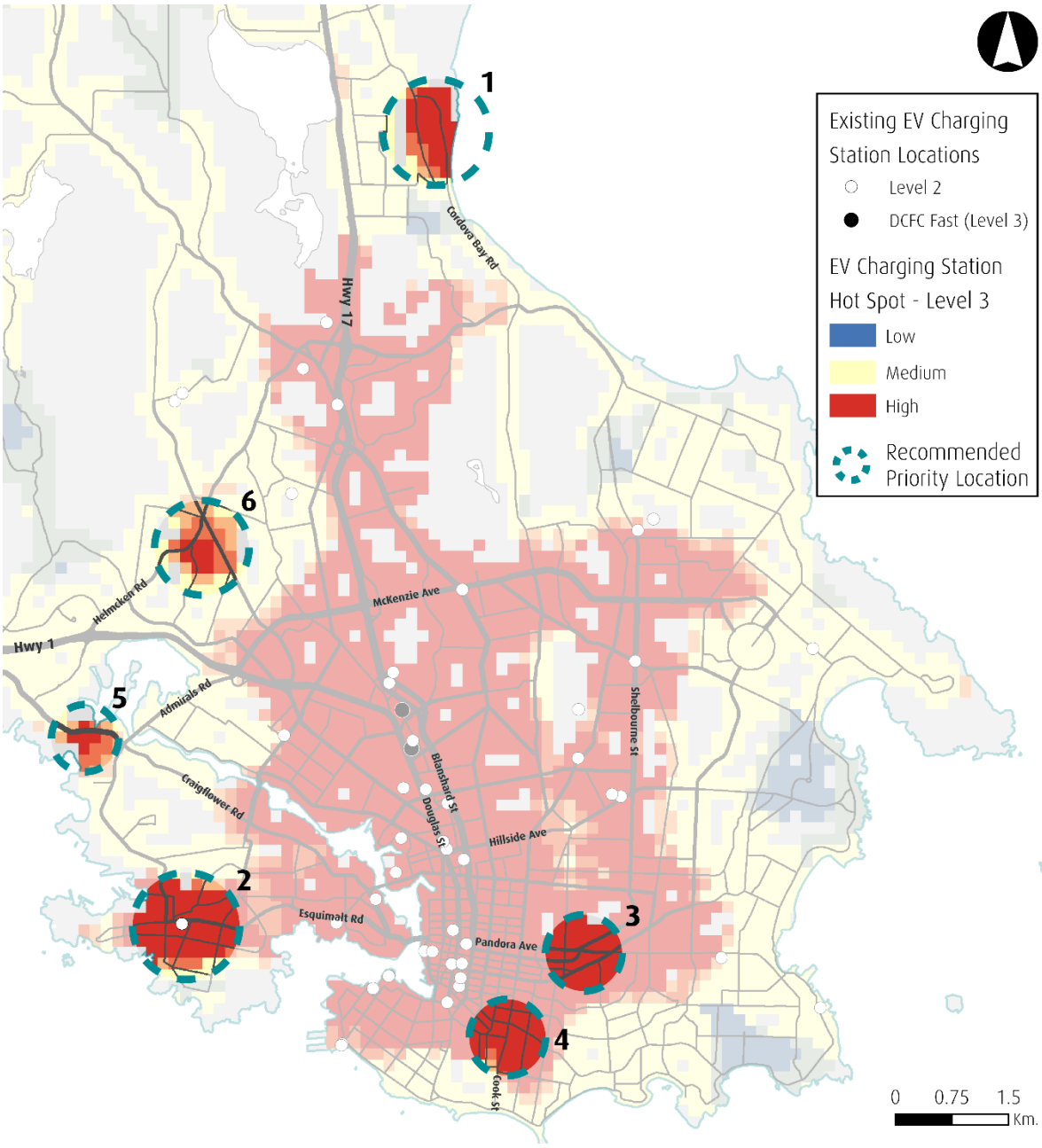


Figure 5. Recommended Priority Locations for Level 2 Charging Stations, Peninsula

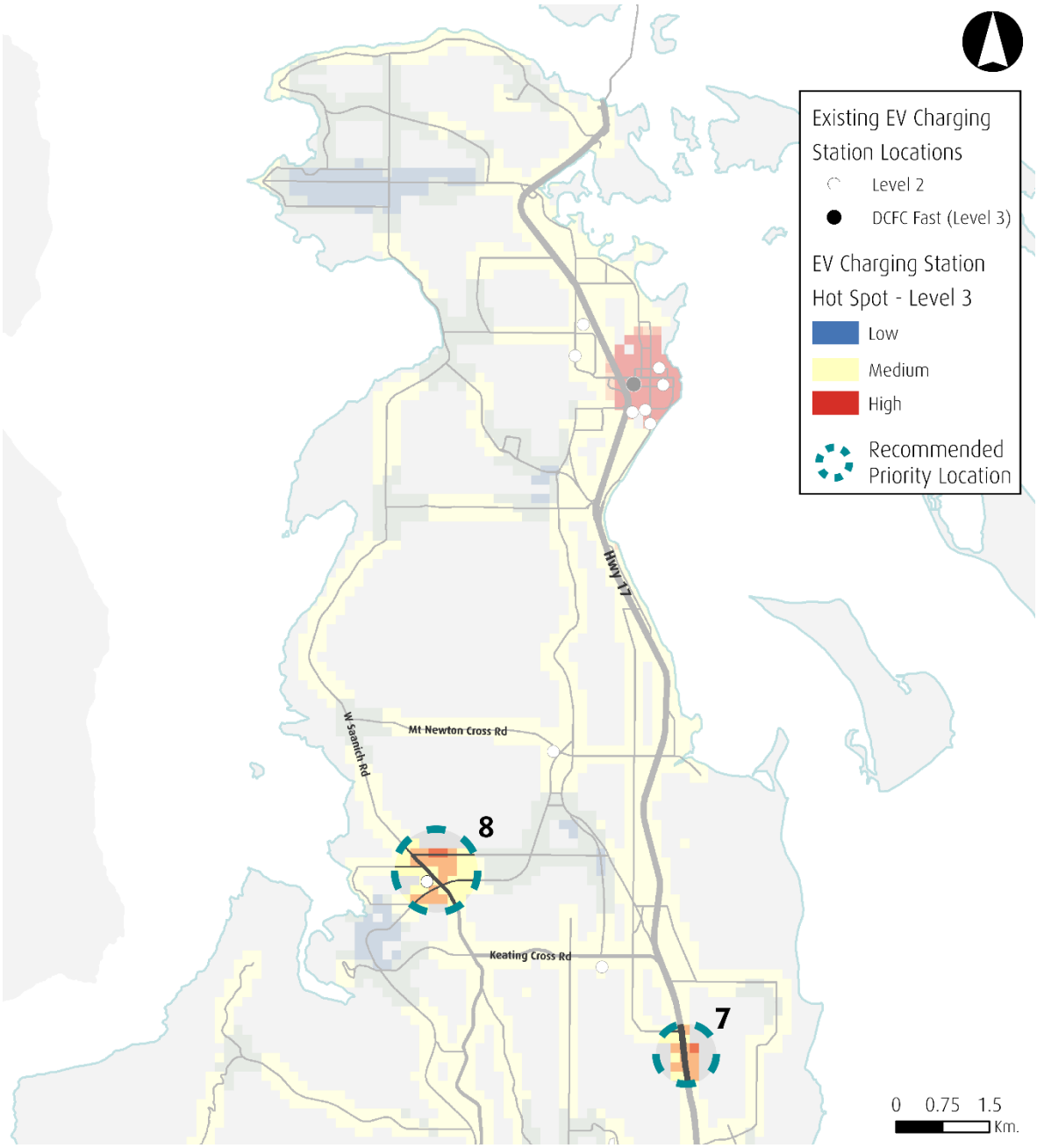


Figure 6. Recommended Priority Locations for Level 2 Charging Stations, West Shore

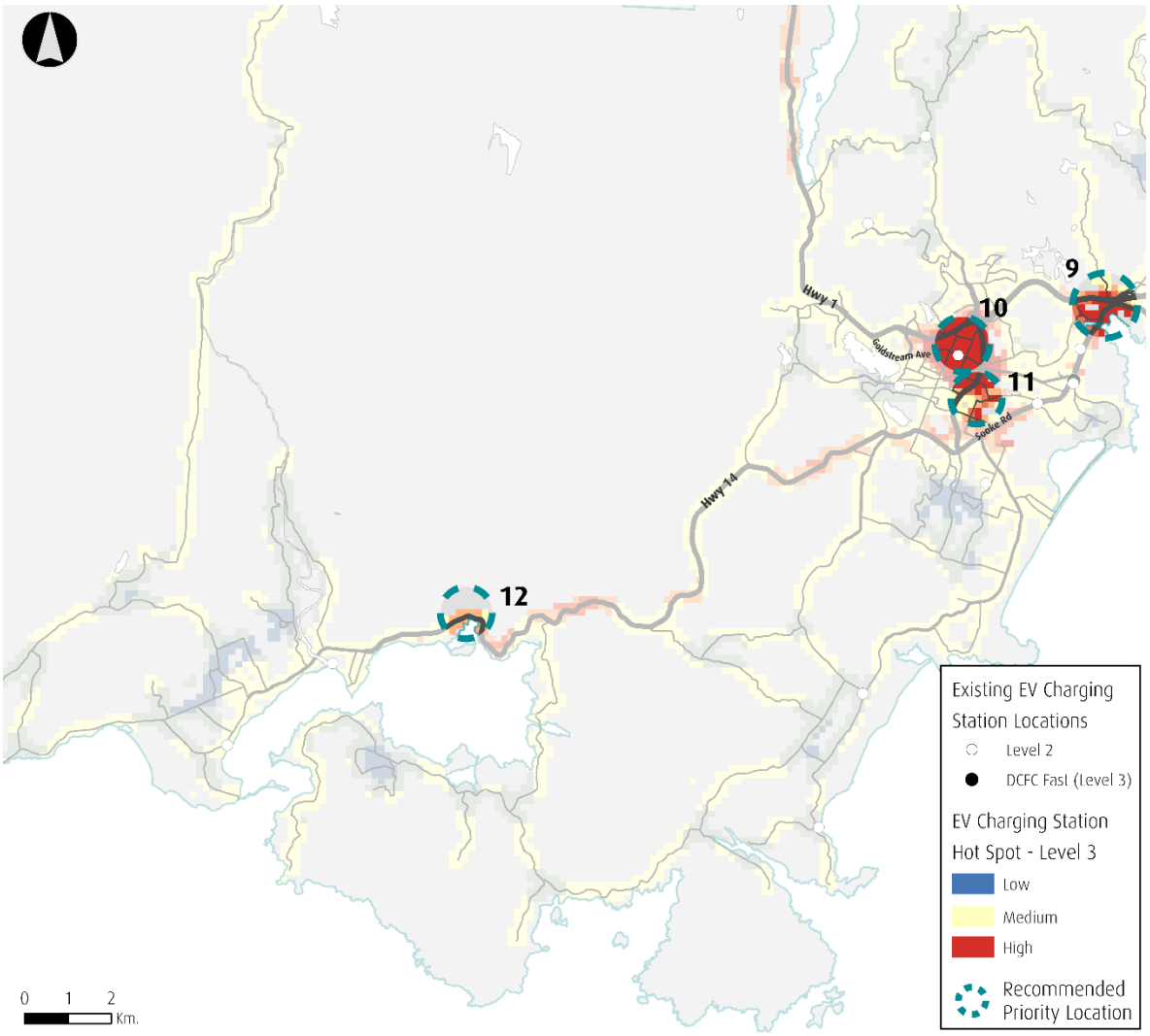


Table 7. Recommended Locations for New Public EV Charging Stations, Level 3 (DCFC)

Priority Location		Municipality	Sub-Area	Opportunity Sites	Rationale
See Figures 7, 8 and 9 below for the recommended priority locations based on gap analysis modelling results.					
1.	Broadmead Village	Saanich	Core Area	• Greater Victoria Public Library - Bruce Hutchison Branch	• The combination of its proximity to Highway 17 (commuting route), commercial density and land use mix make this location suitable for a DCFC.
2.	Elk / Beaver Lake Regional Park	Saanich	Core Area	• Elk / Beaver Lake Regional Park - Eagle Beach Parking Lot	• Located along Highway 17 (commuting route) and popular destination for residents and visitors alike.
3.	Town of View Royal Town Hall	View Royal	Core Area	• Town of View Royal Town Hall	• Located along Old Island Highway (commuting route), and would be under direct control of Town of View Royal.
4.	Helmcken Park and Ride	View Royal	Core Area	• Helmcken Park and Ride	• Located along Highway 1 (commuting route).
5.	McTavish Exchange	North Saanich	Peninsula	• McTavish Park & Ride	• Located along Highway 17 (commuting route).
6.	Swartz Bay	North Saanich	Peninsula	• Non-municipal opportunity site required	• High volume of traffic entering / exiting Swartz Bay; EV users could charge their vehicle while waiting to board ferry.
7.	Westshore Town Centre	Langford	West Shore	• Non-municipal opportunity site required	• Located along commuting route with high commercial density.
8.	Highway 14	Sooke	West Shore	• Seaparc Leisure Complex or Sooke Library (new)	• Located along commuting route in proximity to downtown Sooke.

Figure 7. Recommended Priority Locations for Level 3 Charging Stations, Core Area

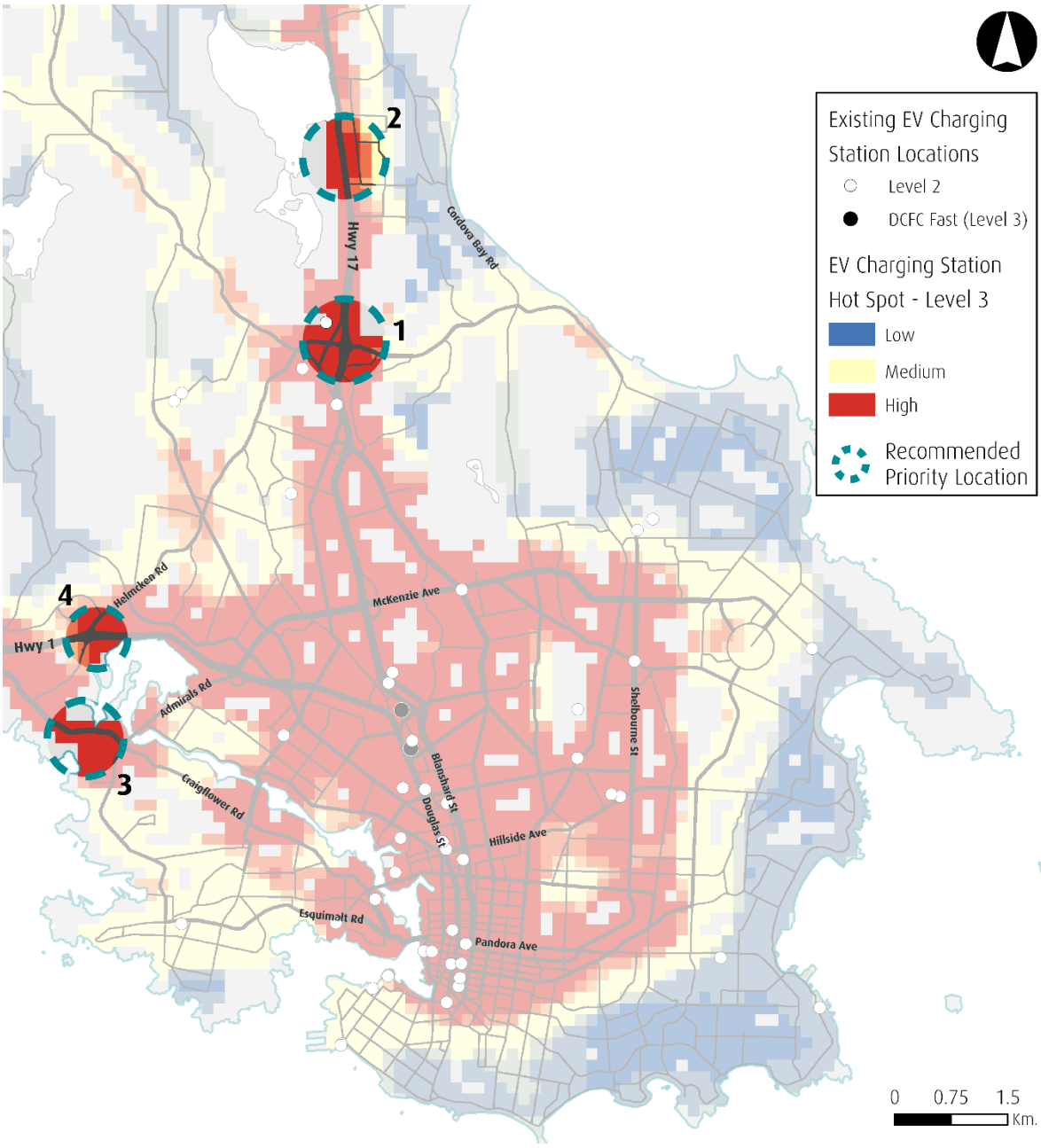


Figure 8. Recommended Priority Locations for Level 3 Charging Stations, Peninsula

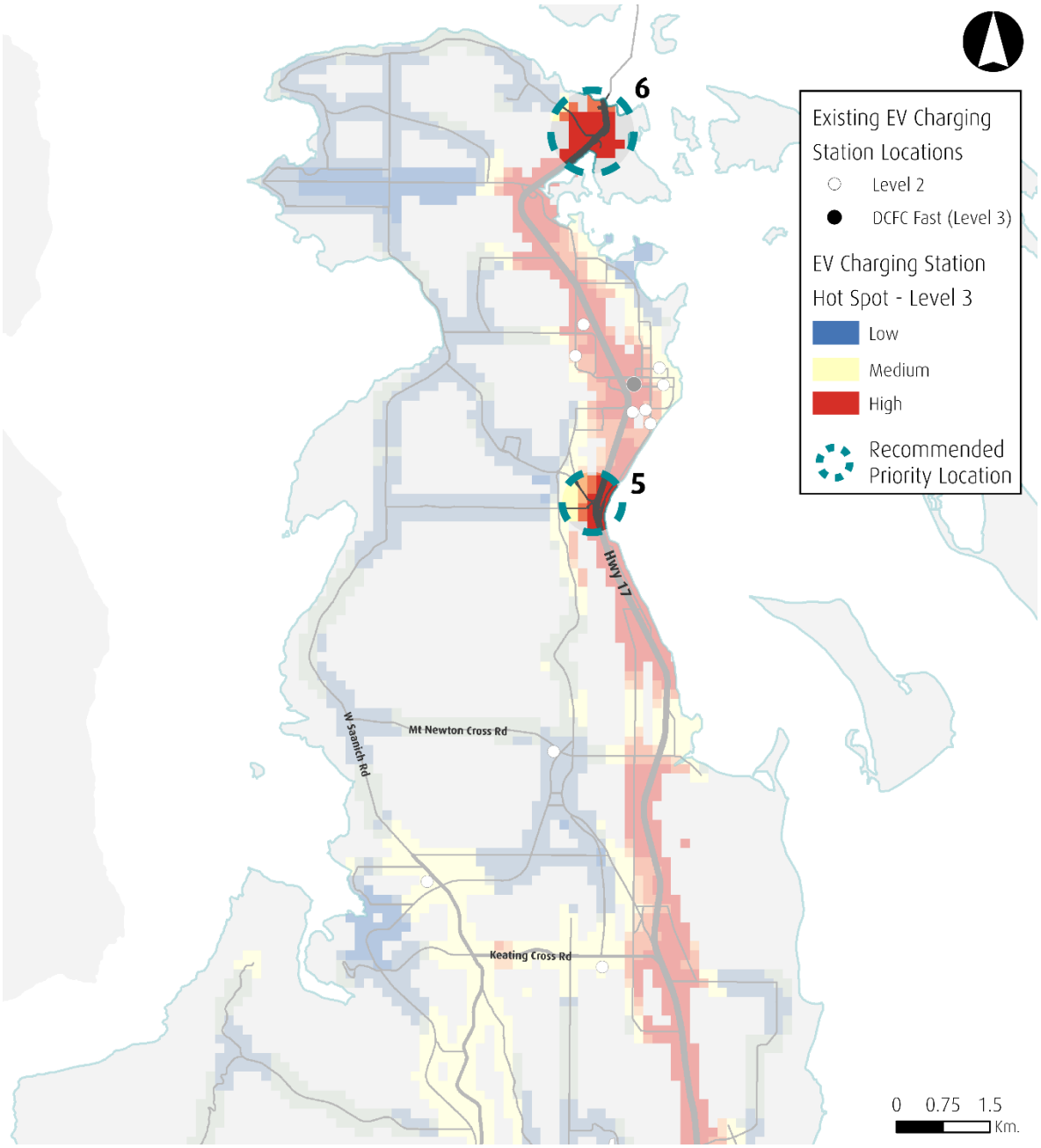
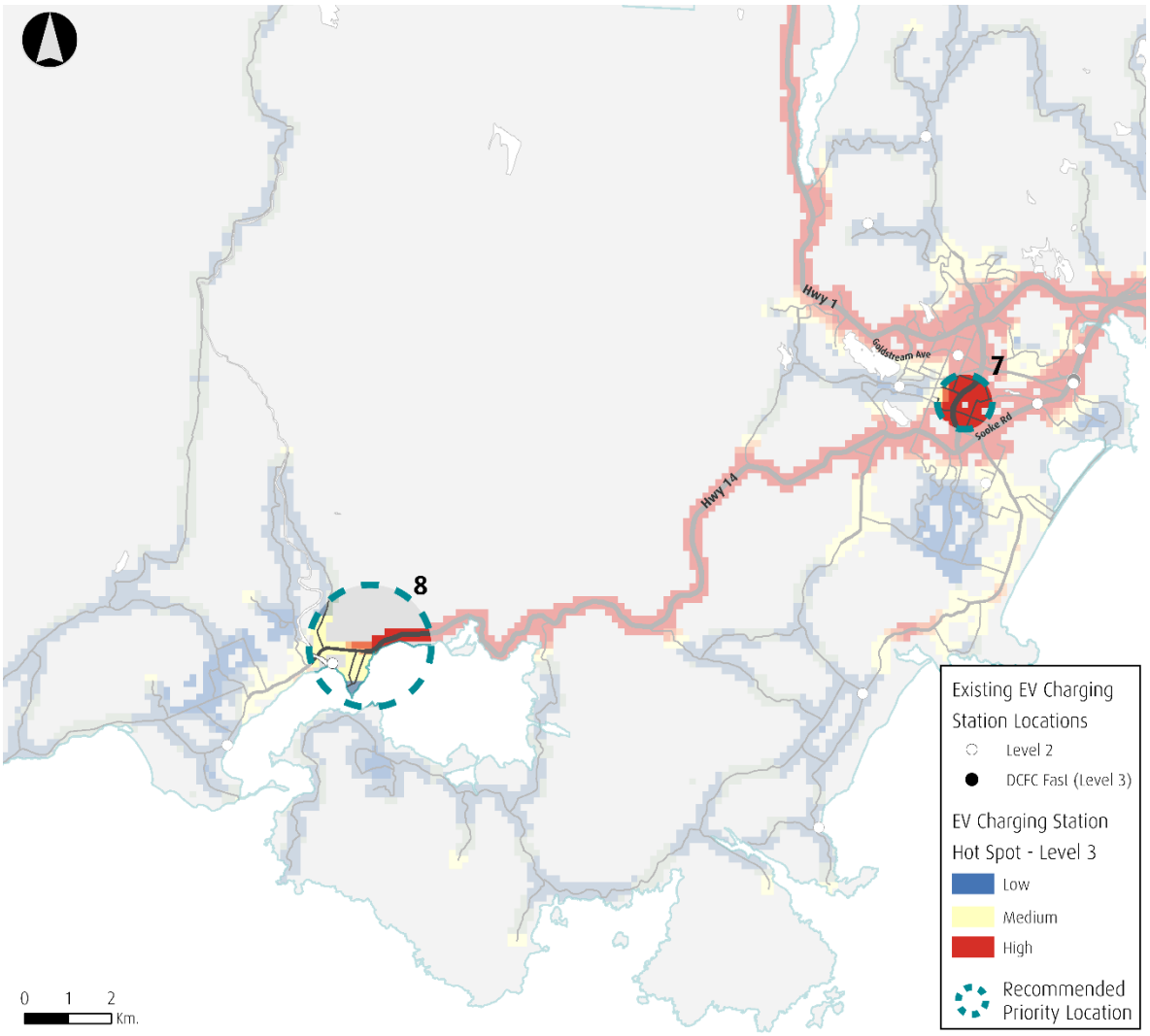


Figure 9. Recommended Priority Locations for Level 3 Charging Stations, West Shore



Other Siting Considerations

The recommended priority locations shown in the tables above are based on quantitative and measurable criteria that were included as part of the infrastructure gap analysis. While the criteria are comprehensive, there are other qualitative criteria and technical considerations that municipalities / electoral areas should be mindful of when siting an EV charging station, as follows:

- Rural Commuting Routes | Even though rural areas in the Capital Region have comparably lower residential / commercial density and land use mix, they should not be overlooked for EV charging stations. In particular, highways and arterials with higher traffic volumes in more rural areas including Sooke, Metchosin, North Saanich, and Central Saanich, Juan de Fuca, Southern Gulf Islands and Salt Spring Island should be considered for public charging infrastructure.
- Tourism Attractions | Tourism attractions are places with a high public presence putting pressure on the existing EV networks from visitors.
- Electrical Capacity & Accessibility | For Level 3 DCFCs in particular, they require large amounts of electrical current and may result in utility upgrades and dedicated circuits. There are important technical considerations including [a] whether the location has sufficient area for the charging equipment and universal access; [b] whether it has accessible power supply at a reasonable cost; and [c] whether the location is accessible to traffic from all directions.[21]
- Clusters of Older Multi-Unit Residential Buildings | Current or prospective owners may not have access to charging and a limited ability to retrofit. Public EV charging equipment may support these garage orphans. See Section 4.4 for a summary of On-Street EV Charging Considerations.
- EV Charging Banks | Some cities such as Portland, Oregon, have sited multiple charging stations in one location (referred to as "charging banks"). Known as "Electric Avenue" located in the core part of Portland, EV users can access four Level 3 DCFC charging stations and two Level 2 charging stations.[22]

  Experts[23] have recommended charging banks such as Electric Avenue for a variety of reasons including [a] additional options for charging in case one charging station is not operational; [b] less queuing / congestion anxiety, which can reduce the wait time for a user who has access to multiple stations; EV charging station usage data from California

and Oregon showed that EV users avoided single station locations for risk that the station would be in use or not operational; and [c] as EV uptake continues to grow rapidly, investing in more charging stations per location will provide some future-proofing.

- Pedestrian Traffic | High pedestrian traffic areas offer both visibility to charging stations and potential mobility challenges. EV charging equipment should not interfere with pedestrian routes; the charging stations should not be placed in an area that would cause a cord to be a tripping hazard.[24] Charging station site choices should consider building entry ways, pathways, street crossings and meeting points that do not impede pedestrians.
- Future Proofing Opportunities | As EV ownership increases, local governments may want to increase the number of charging stations at each site. Significant resources can be saved by considering access and future electrical capacity when determining an initial site. Pre-emptive civil and electrical works can be done during an initial install that would accommodate additional charging stations at a lower cost in the future.

4.3 EV Charging Station Signs and Directional Markings

The following section identifies the recommended design and application of EV charging directional signs, identification signs and paint markings to ensure consistency throughout the Capital Region and improve recognition among EV drivers with varying levels of familiarity. Installing signage is critical to support EV adoption in the near future. Over time, signage may not be as necessary as technology improves such as mobile apps and in-dash GPS navigation systems becoming more advanced to help EV users locate a charging station.

Directional Signs

Directional signs are installed on public roads to provide guidance to EV drivers on the location and distance to public EV charging stations. Recommended directional signs are identified in Table 8.

Table 8. Recommended EV Charging Station Directional Signs

	Name	Intent / Application	Size	Reference
	A1. EV Charge Station Information Sign	The primary EV charging directional sign that, in combination with arrow and distance tabs signs (below), directs EV drivers to the location of EV charging stations.	600mm (W), 600mm (H)[1]	MoTI, Sign Series Zi-128
	A2. Level 3 Charging Tab Sign	Supplemental sign positioned below an Information Sign (above) where directional or distance information is directing EV drivers to a Level 3 ("fast charge") EV charging station.	600mm (W), 300mm (H)[1]	MoTI, Sign Series Zi-128-Tc
	A3. Arrow Tab Sign[2]	Supplemental sign positioned below an Information Sign (above) to identify a change in direction required to access EV charging (sign may be rotated).		MoTI, Sign Series Zi-128-T (set)
	A4. Distance Tab Sign[2]	Supplemental sign positioned below an Information Sign (above) to indicate the distance to EV charging. Distance may be expressed in metres (m) or kilometres (km).		

Notes:

[1] Larger signs required where the posted speed limit exceeds 50 km/h.
[2] Sample tab signs are 2 of 16 Ministry of Transportation and Infrastructure standard tab signs to accompany the EV Charge Station Information Sign (above). Refer to MoTI Electric Vehicle Signage Package, Sign Series Zi-128-T for a full listing of arrow and distance tab signs.

Identification Signs

Identification signs are installed adjacent to assigned EV parking stalls. They confirm for EV drivers that identified parking stalls are for EV parking, and to non-EV drivers that they may not park in identified EV parking stalls. Table 9 presents different EV charging station signs; the cells shaded in dark grey are recommended for universal adoption in the Capital Region.

Table 9. EV Charging Station Identification Signs (recommended are shaded grey)

	Name	Intent / Application	Size	Reference
	B1. EV Charge Station ID + No Parking Sign	The identification sign to be placed at the end of a parking space adjacent an EV charging station identifying the space for EVs and prohibiting parking by non-EVs. This sign should not be installed in combination with the B2 or B3 signs (below).	300mm (W), 450mm (H)	MoTI, Sign Series Zi-129-LRD
	B2. EV Charge Station ID Sign	The identification sign to be placed at the end of a parking space adjacent an EV charging station intended to be occupied by EVs. This sign should be installed in combination with the B3 sign (below) to prohibit non-EV parking.		MoTI, Sign Series Zi-132-1
	B3. EV Charge Station No Parking EV Exception Sign	The regulatory sign to be placed at the end of a parking space adjacent an EV charging station that is intended to be occupied by EVs and prohibits parking by non-EVs. This sign should be installed in combination with the B2 sign (above) to identify the space to EV drivers.		MoTI, Sign Series Zi-131
	B4. EV Charge Station Time Limit Sign	This sign indications the maximum allowable stay in an assigned EV parking space. This sign should be used in combination with either B1 (above) or B2 and B3 (above).		MoTI, Sign Series Zi-130

Of the EV charging station identification signs shown above, it is recommended that local governments use "B1" (i.e., "No parking except EV Charging"). This sign has been recommended in other best practices documents because of its clear language; specifically, the term "charging" [a] helps eliminate confusion for drivers of hybrid electric vehicles (who are not permitted to park in these stalls except while charging) and [b] indicates that the stall should only be used for EVs that require a charge.[25]

Example of EV signage at the Gordon Head Recreation Centre in the District of Saanich.

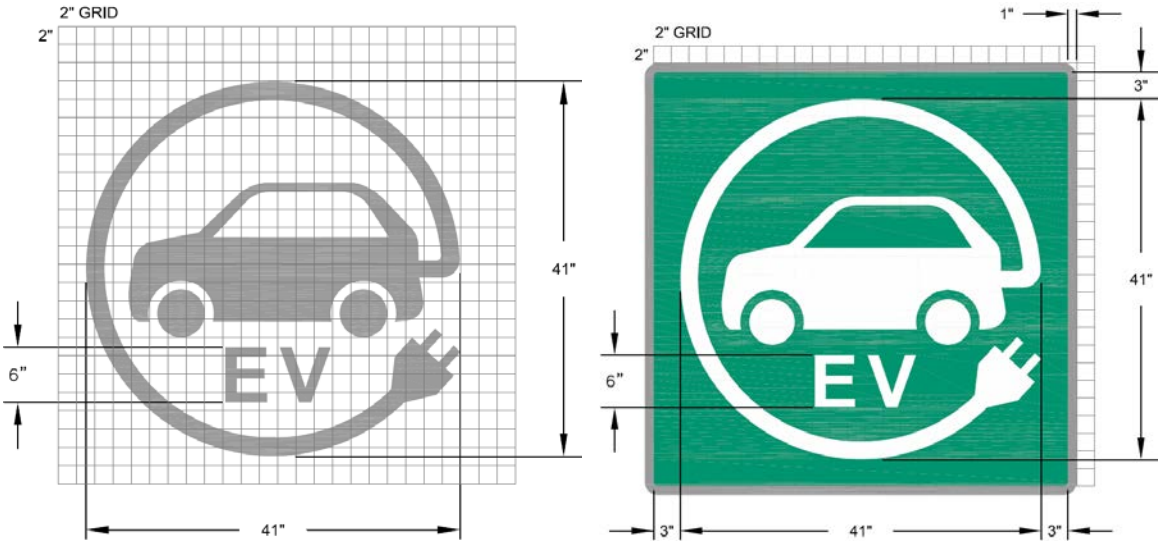
The EV charge station time limit sign (i.e., "B4") should accompany this sign as it indicates a time limit for how long an EV user could charge their vehicle for. Time limited signage is especially valuable for Level 2 charging stations where a vehicle may be inclined to park for several hours. While the time limited signage may encourage turnover, it also requires regulatory enforcement, which requires staff resources and time.

Pavement Marking

The standard pavement marking used to demarcate EV parking stalls is a vehicle encircled by an electric cord / plug with "EV" indicated below the vehicle. All paint markings are white.

An enhanced treatment consisting of a green background and bounding box may be applied to address concerns with compliance among non-EV drivers or for improved exposure. Refer to Figure 10.

Figure 10. Recommended EV Parking Space Pavement Marking, Basic (left), Enhanced (right)



Recommended Marking of Green Parking Stalls

The photo shown to the left is the recommended EV parking stall marking.

The entirety of EV parking stalls have been painted green in certain locations in the Capital Region. This treatment is not recommended due to higher capital costs, the need for on-going maintenance, and the potential slipping hazard in wet conditions. The photo shown to the left is the recommended EV parking space marking.

4.4 On-Street EV Charging Considerations

The provision of on-street charging (also referred to as "curbside charging stations") is particularly valuable in meeting the needs of "garage orphans", which refers to households that do not have access to a carport or garage, and therefore would not have the ability to charge an EV on-site at home. This issue has been recognized by a handful of cities in North America who see on-street charging stations as one potential solution to accommodate garage orphans. These cities include, but are not limited to, Vancouver, Seattle, Toronto, and Montreal—all of which have programs and/or pilot projects currently in place to make on-street charging a viable option for residents.

The following is a list of on-street EV charging considerations of which local governments should be mindful:

1. Signage & Wayfinding | As discussed in Section 4.3, signage and wayfinding is critical for both finding and designating EV charging stalls in public areas. Consideration should be given to the signage and wayfinding options described previously. More importantly though, on-street charging must include signage indicating a time limit and may require enforcement if users do not have to pay for electricity.

On-Street Charging in Montreal

The City of Montreal has the most advanced on-street charging station network of any Canadian city. Many EV owners who live in the core part of the city do not have access to a home charging station. As such, the city has strategically sited 400 of its 475 public charging stations on-street to provide viable charging opportunities for garage orphans. The City is hoping to have 600 on-street charging station by the end of 2018.

2. Electrical Capacity | Placement of on-street charging must consider the available electric capacity. This can include the presence of electrical or street light poles placed between

the back of curb and sidewalk. In addition, evaluating the existing electrical capacity can include [a] the electrical system at the location of the desired installation and [b] the capacity of the local neighbourhood system to support multiple EVs charging simultaneously.[26]

Example of an EV charging station mounted on a public utility pole in Los Angeles. Photo credit: Barry Lank

3. Placement of On-Street Charging Stations | Placement of an on-street charging station needs to be integrated with other elements in the public right-of-way. As an example of factors to consider, the City of Vancouver's Curbside Electric Vehicle Pilot program has strict placement criteria, which include [a] it can only be installed where there is a curb in the utility/planting strip; [b] minimize removal of vegetation; and [c] preserve as much sidewalk width (path of travel) as possible, but yielding no less than 1.5m – if there is no utility/planting strip
4. Obtaining Local Business Support | Businesses in proximity or adjacent to a proposed on-street charging station should be consulted. Such businesses may perceive they would be negatively impacted, but they also may benefit from having their EV-using clients and patrons access the parking spots. Their support is important to managing the municipality's relationships with businesses and the success of on-street EV charging.
5. Land Use Mix | Streets with a greater mix of land uses may be more suitable for an on-street charging station.

On-Street Charging in Seattle

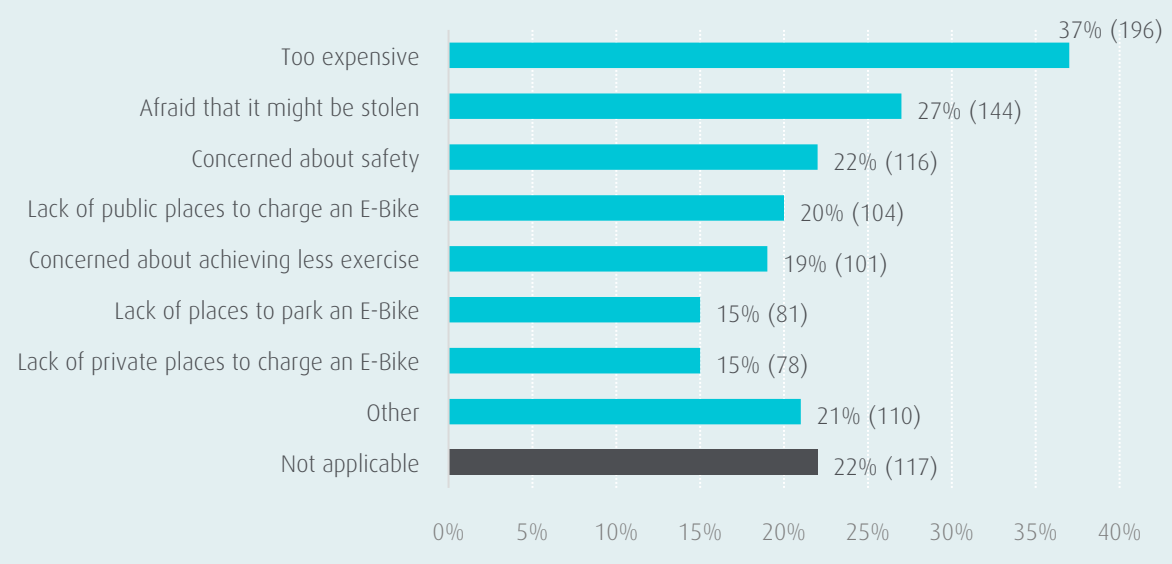
The City of Seattle implemented the EV Charging in the Public Right-of-Way (EVCROW) program in 2017, which is a pilot allowing for the installation of EV charging stations at curbside locations in the public right-of-way. . The City of Seattle's EVCROW program uses "Urban Centres and Urban Villages" as one of its siting criteria. This refers to the densest neighbourhoods in the city that provide a diverse mix of uses, housing, and employment opportunities. Its siting criteria include [a] Urban Centres and Urban Villages, and [b] commercial zoning frontage outside of Urban Centres and Urban Villages.

4.5 Public Locations for E-Bike Charging Stations

As discussed in Section 2.3, range anxiety is not a commonly reported barrier by E-Bike users and prospective users. The literature has identified a number of other more prominent barriers facing E-Bike ownership including safety, lack of secure parking, and the social stigma associated with riding an E-Bike.

The CRD public survey found that concerns of bicycle theft and a lack of public charging locations were key barriers to E-Bike ownership. Refer to Figure 11.

Figure 11. Summary of Barriers to E-Bike Ownership, CRD Public Survey



About 20% of survey respondents selected "lack of public places to charge an E-Bike" as a barrier, which has not been identified in the literature. A related question asked respondents if they would feel comfortable parking their E-Bike in a publicly accessible location. The responses were mixed on this question; a third of the 509 respondents checked "yes", a third checked "no", and the final third checked "don't know, unsure at this time".

A follow-up open-ended question asked "what would make you feel comfortable parking your E-Bike in a publicly accessible location"; common responses included:

- Locked or supervised area
- A secure designated E-Bike parking facility
- Surveillance cameras
- A paid parking facility for E-Bikers users

The survey data and literature confirm that, unlike EVs, the actual location of an E-Bike charging station is less important for overall use. What matters more is access to secure parking to minimize theft.

4.6 E-Bike Parking Design Guidelines

Based on the survey data presented in the previous section, there is an opportunity to address these concerns and increase E-Bike ownership in the Capital Region through the provision of bicycle parking that is purposefully designed to accommodate E-Bikes.

How to Design Bike Parking for E-Bikes?

Secure and well-designed bicycle parking intended for conventional bicycles will also appeal to E-Bike users. Based on the CRD public survey and barriers identified in the literature, E-Bike users place particular importance on the following three factors:

1. **Security** | Increase facility security to address theft concerns;
2. **Size** | Design larger bicycle parking spaces to accommodate E-Bikes; and
3. **Electrification** | Provide access to an electrical outlet to facilitate charging.

Security

E-Bikes typically cost between $2,000 and $5,000, representing significantly higher costs than most conventional bicycles. As a result, E-Bike owners seek bicycle parking with a greater level of security to protect against bicycle theft as compared to conventional bicycle owners. This heightened level of security is also of benefit to conventional bicycle owners.

The following is necessary to achieve a basic level of security in long-term[6] bicycle parking facilities:

- Ensure all racks and mounting apparatuses are of a material and gauge that they cannot be physically altered / manipulated
- Ensure all racks and mounting apparatuses are securely fastened to the ground or wall
- Control access to shared bicycle rooms by way of a lock or keypad
- Ensure bicycle parking areas are adequately lit at all hours

The following are opportunities to further enhance security in long-term bicycle parking facilities:

- Provide individual, self-contained bicycle lockers
- Locate bicycle parking within view of high traffic areas to create "passive surveillance"
- Install video surveillance (CCTV) and associated signage in bicycle parking areas

Short-term bicycle parking, or less than two hours, does not require the same level of security as long-term facilities. Basic security is achieved by ensuring all racks and mounting apparatuses cannot be physically altered / manipulated and are securely fastened to the ground or wall.

[6] Long-term bicycle parking facilities generally refers to use beyond two hours while short-term refers to use of less than two hours. For more, see the City of Victoria Bicycle Parking Strategy, available online at: https://www.victoria.ca/assets/Departments/Engineering~Public~Works/Documents/parking-bicycle-strategy.pdf

Size

There are an increasing number of cargo and larger bicycles in operation. The pedal assistance provided by an E-Bike makes larger bicycles capable of carrying cargo and/or multiple passengers more appealing. As a result, a greater proportion of E-Bikes are larger bicycles (both longer and wider) as compared to regular bicycles. Refer to Table 10. Accordingly, bicycle parking intended for E-Bikes should consist of a greater number of larger spaces to accommodate E-Bikes.

Table 10. Typical Bicycle Dimensions

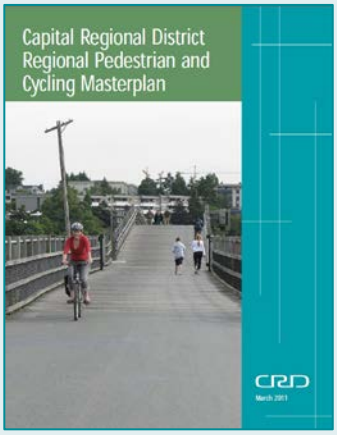
	Conventional Bicycle	Large / Cargo Bicycle	Difference
Length	1.8m	2.5m	+0.7m
Width	0.6m	0.9m	+0.3m

*Dimensions in the table above refer to the physical dimensions of the bicycles, not the operating envelope. They are based on the CRD PCMP design guidelines.

Electrification

An E-Bike requires access to an electrical outlet to facilitate charging, which is typically achieved in one of two ways:

1. Charging infrastructure may be incorporated directly within the bicycle parking rack / mounting apparatus. This typically requires purpose-design placement of electrical conduit / receptacles in or adjacent the floor.
2. E-Bike parking may be located no more than 2 metres from a standard 110V wall receptacle. Attention should be given to ensuring the E-Bike parking location relative to the wall receptacle will not result in a tripping hazard or impede bicycle maneuvering.



CRD Regional Pedestrian + Cycling Masterplan

Completed in 2011, the Pedestrian + Cycling Masterplan ("PCMP") lays out a plan of action for achieving a significant shift in patterns and modes of transportation throughout the region. The PCMP, Appendix B, includes detailed guidance on the design of bicycle parking and other cycling trip end enhancements.

The PCMP is available on the CRD's website: www.crd.bc.ca/project/regional-transportation/pedestrian-cycling-master-plan

What proportion of bicycle parking spaces should be designed specifically for E-Bikes?

Generally speaking, bicycle parking that is specifically designed for E-Bikes will also appeal to riders of regular bicycles. The added costs associated with E-Bike parking—security, size, electrification—are minimal and are significantly less than retrofitting a bicycle parking facility in future to accommodate E-Bikes.

The recommended proportion of bike parking spaces in new multi-unit residential buildings and commercial developments that should meet E-Bike design criteria are identified in Table 11. The recommendation is informed by research and E-Bike trends. The recommendation for 50% electrified for long-term bicycle parking spaces is derived from the City of Vancouver, which requires 50% of long-term bicycle parking spaces in new developments to have access to an electrical outlet.

Table 11. Recommended Proportion of Bike Parking Spaces Meeting E-Bike Design Criteria

	Design Criteria		
	Secure	Electrified	Large / Cargo Bicycle
Long-term Bicycle Parking	100%	50%	10%
Short-term Bicycle Parking	-	10%	10%

4.7 Usage Fees for Public Charging

Free charging has been the norm in municipalities around North America as it is largely seen as an effective way to incentivize use and support early EV adoption. However, free charging can also send an incorrect price signal about the cost of charging / using an EV and may result in opposition and decreased utilization when a fee is eventually introduced.[27]

Almost all municipalities in the Capital Region do not currently charge a user fee for public charging with the exception of the Township of Esquimalt, which has a nominal user fee of $1.00 per hour.[28] As EV ownership and sales continue to rise in the Capital Region and BC more broadly, there may be additional demand for public charging stations, which justifies the need to implement a user fee for municipally managed stations.

Implementing a fee for charging station utilization is considered best practice in the longer term and should be pursued for the following reasons:

1. Limit the length of charging sessions and encourage turnover
2. Encourage at-home charging to reduce public costs
3. Manage increasing demand for public EV charging
4. Signal the value associated with receiving electricity for the vehicle

There are two main approach to usage fees, as follows:

1. Price per kWh | this approach is generally seen as fair and consistent but may not encourage turnover. Note: If fees are based on energy or power management, further federal approvals are required by Measurement Canada[7].
2. Price per time | pricing by time can encourage turnover as users pay a fee for every minute or hour they use the station. Note: If fees for the use of charging stations are based on time, they are currently exempt from inspection or any intervention by Measurement Canada[7].

[7] See federal, Measurement Canada brief here: https://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm04839.html

Table 12. Usage Fees for Charging in Select Jurisdictions

Municipality / Operator	Basis of Fee		Fee	
	Time	Electricity	Level 2	Level 3
Esquimalt, BC			$1 / hr	--
Montreal, QC			$2.50 / charge OR $1 / hr	$10 / hr
NB Power			$0.30 / kWh	$15 / hr
Nova Scotia Power			$0.30 / kWh	$15 / hr
Vancouver, BC			$2 / hr	$16 / hr
Whistler, BC			$0.35 / kWh	--

When establishing a usage fee, consideration should be given to the comparable costs of fuel for a gas-powered vehicle. Usage fees should be set below the costs of gasoline to provide costs savings for EV owners and to broadly help accelerate the adoption of EVs. Table 13 below presents EV charging costs, calculated as an equivalent cost of gasoline.[8]

Table 13. EV Usage Fees Compared to Cost of Gasoline[29]

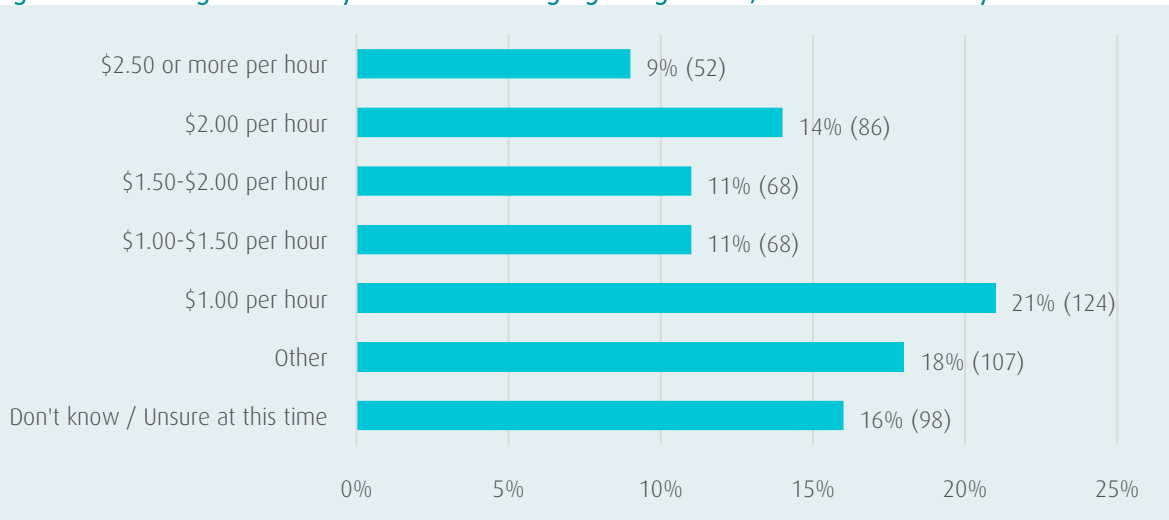
Type of Charging	Rate	Cost for 100km (assumes 20kWh/100km)	Equivalent Gas Price (assumes 8L/100km)
Charging at Home	$0.11/kWh	$2.20	$0.28/L
Public Level 2 Charging	$1/hour	$3.03 (@6.6kW)	$0.38/L
Level 3 DCFC 50kW	$16/hour	$6.40 (@50kW)	$0.80/L
Level 3 DCFC 30kW	$16/hour	$10.67 (@50kW)	$1.33/L

A shown in Figure 12, the majority of respondents in the CRD Public Survey indicated they would be willing to pay $1.00 / hour for public charging. Open-ended responses to this question included

[8] Table adapted from Dunsky Energy Consulting.

everything from public charging stations should be free, to higher willingness to pay for a Level 3 station, to not charging per hour but by time or use. Overall, there is support to introduce usage fees for public charging.

Figure 12. Willingness to Pay for Public Charging Usage Fees, CRD Public Survey



Recommendation: Implementing Hourly Usage Fees in the Capital Region

Based on best practices and implementation ease, consideration should be given to implementing **hourly usage fees** for public stations in the Capital Region. An hourly fee is easier for a user to understand and can also encourage higher turnover compared to the option of paying per kWh. A rate of **$1 per hour** for Level 2 stations is seen as appropriate for introducing usage fees, which is consistent with the Township of Esquimalt and the results of the public survey. The fee could be adjusted based on overall utilization of the stations.

A rate of **$16 per hour** is recommended for Level 3 DCFC stations (50 kW), which is consistent with the rate in the City of Vancouver. These fees result in a higher cost than charging at home, but still offer cost savings when compared to a gasoline-powered car.

If usage fees are adopted, it should be noted that local governments may be required to pay licensing fees to access the pricing function.

4.8 Procurement Practices

In June 2017, the Province of BC released a Corporate Supply Arrangement (CSA)[9] for supply and installation of electric vehicle charging stations.[30] The purpose of the CSA is to reduce procurement timelines for climate action-related goods and services that best support climate action-related planning. The supply arrangement is available to all BC government ministries as well as other broader public sector organizations, including local governments. Utilizing a streamlined procurement process, the CSA allows local governments to purchase the following:

- Level II charging stations for electric vehicles
- Installation for electric vehicle charging stations
- Optional features such as hangers and plugs

The Province of BC website includes the full details regarding the CSA.[10] Importantly, the CSA includes a number of required standards and certifications that the EV charging stations must meet. Local governments in BC have access to the CSA, which include the following provisions

- CSA, Underwriters Laboratories, or other recognized certification approved for use in Canada
- Weatherproof to minimum of NEMA 3R
- Ability to operate in a temperature range of -30 to 50C
- Charging station cord is a minimum of 5.5m in length and has a universal SAE J1772 compliant connector
- Network capable units are Building, Automation and Control (BACnet) compatible

The output and input functions must be:

- Capable of Level 2 AC charging, minimum rated voltage and amperage of 208V/240V and 40A
- Compatible with incoming voltage 208V-240V
- Over-current protection that prevents circuit breaker trips

[9] Corporate Supply Arrangements (CSAs) are supply arrangements which are available to all ministries and may also be available to broader public sector organizations.

[10] https://www2.gov.bc.ca/gov/content/governments/services-for-government/bc-bid-resources/goods-and-services-catalogue/ev-charging-stations#info

Beyond the requirements identified above in the CSA, there are a number of other minimum specifications that local governments should consider when purchasing Level 2 charging stations for their respective communities. The City of Surrey uses the following specifications.

Management / Reporting:

- Financial management platform for payment processing and reporting
- Web-portal access to performance metrics via dashboard & report application, including
    - Location of chargers
    - Latest metered power
    - Electric km delivered
    - Total energy delivered
    - Total electric km
    - Total GHG emissions avoided
    - Load statistics (min/max)
    - Number of stations
    - Station status
    - Charging Activities (current/daily/monthly/by date range)
    - Trends by selectable date ranges

Software Features:

- User app for payment, usage notification, etc.
- Compatibility with parking enforcement systems and 3rd party hardware solutions
- Load management, or building energy management capabilities
- Payment system PCI compliance
- Seamless interoperability/payment acceptance with other EVSE user/payment apps

Joint Purchasing

Many local governments within in the Capital Region participate in the Greater Victoria Joint Purchasing Group (GVJPG). The GVJPG was formed by public organizations that are responsible for purchasing goods and services. The purpose of the GVJPG is to increase the purchasing power of the individual participants by obtaining favorable pricing through competitive processes, increased

collective volumes and contract administration. Additional participating organizations may opt to enter into a contract with the successful vendor for the purchase of the products and services described in a specific RFP based on the terms, conditions, prices and percentages offered by the vendor in the original proposal. The GVJPG could be used as a vehicle to purchase EV and E-Bike infrastructure that could provide procurement benefits, while providing flexibility to participants.

5. EV & E-Bike Charging in New Development

This section provides an overview of how local governments could increase opportunities for EV and E-Bike charging in new developments. The BC Building Act provides provincial legislative direction, but local governments also have the ability through policy, regulation, and incentive mechanisms to increase EV and E-Bike charging in new developments. This section draws on content from the provincial guide ("Residential Electric Vehicle Charging: a Guide for Local Governments") and feedback collected through the CRD developer's survey and workshop, *Backgrounder, Section 8.2)*.

A discussion of considerations for existing buildings can be found in Section 6.0.

5.1 BC Building Act

The BC government has indicated that local government EV charging requirements are "out of scope" of the Building Act. As such, the BC Building Act does not directly impede local governments' ability to implement requirements for electric vehicle charging infrastructure, as noted in the Building Act Guide, as follows:

- If the requirements do not concern a matter addressed in the Building Code, they are 'out of scope' of the Building Act and local governments can regulate these matters if they have authority to do so in other statutes.
- Electric vehicle charging stations/plug-ins: Electric vehicle charging stations concern the number, location, and type of charging stations (and related matters such as signage) required in a building or facility to charge electric vehicles that use the building for parking. This includes wiring or pre-ducting for electric vehicle plug-ins.

More information about the BC Building Act is found in Section 2.0 of the provincial guide.

5.2 Local Government Policy Mechanisms

Local governments have a menu of policy options available to them to support EV and E-Bike charging in new developments. A summary of each mechanism is discussed below. This section is primarily focused on EVs.

Planning Policy

Section 3.3 identified local government OCP policies in the Capital Region that support EVs. In general, the OCP policies direct the municipality / electoral areas to accelerate the adoption of EVs within their communities. Specifically, the policies support the provision of EV charging stations in public locations and the installation of charging infrastructure in new developments. Some municipalities such as Saanich and Victoria have adopted specific climate action plans, which provide further direction around the role of electric vehicles in meeting municipal climate goals.

A Community Energy and Emission Plan (CEEP) is an example of another high-level policy document that may provide recommended actions to advance policy requirements or negotiate EV charging infrastructure during rezoning.[31]

Negotiating EV Charging Infrastructure – Rezoning & Development Approvals

Another tool local governments could use to accelerate EV adoption is to adopt a formal or informal policy that includes negotiated provision of EVSE in new residential construction as part of rezoning or contingent on development approval. One of the main benefits of this mechanism is that it can allow both local governments and developers / builders to become comfortable and acquainted with EV charging infrastructure prior to a formal requirement.

This mechanism, however, presents several potential drawbacks[32], as follows:

- Each development must be negotiated separately, which may require greater administrative resources / time
- The EV charging infrastructure requirement may not be fully known, resulting in project costing uncertainty
- The level of EVSE installed may be insufficient to meet future demand
- Proposed developments that are not subject to a rezoning would be excluded from this process
- In strata-owned buildings, a policy that negotiates or requires only a percentage of residential parking stalls to be EV-ready or wired for EV charging could result in future conflicts within the strata. With EV ownership continuing to rise, a mismatch could occur between EVSE-serviced parking stall ownership and EV owners requiring a charge

Zoning Bylaw

Communities such as the Town of View Royal have taken the approach to require EV charging infrastructure for residential and commercial uses in their zoning bylaw (see Section 3.3). Advantages to this approach are as follows:

- EVSE and/or charging station requirements can be tailored to various residential land use designations including single family, duplexes, multi-unit residential, or townhomes, for example
- EVSE requirements through the zoning would require all new construction in those zones to provide EVSE infrastructure

One of the main challenges with this approach is that some municipalities may have multiple residential designations, which could add complexity and significant resources to the process. In addition, this approach also limits flexibility. For example, a proposed development may include EV charging infrastructure and meet the intent of the bylaw but may not meet every stated requirement. If it does not meet every requirement, the applicant would have to apply for a variance, which adds additional time and process to development applications.

Parking Bylaw or Schedule

Another policy mechanism that is becoming commonplace is the introduction of a requirement in a parking bylaw or schedule requiring parking stalls in newly constructed residential buildings to include EV charging infrastructure. As discussed in the *Backgrounder, Section 4.3*, a number of municipalities in Metro Vancouver including Richmond, Burnaby, Vancouver, the District of North Vancouver, and Port Coquitlam are using this policy mechanism to require Level 2 charging access in new residential dwellings.[33]

The City of Richmond has identified electric vehicles as an important component of advancing sustainability. The City recently amended Section 7 (Parking and Loading) of its Zoning Bylaw to require that all new residential parking stalls feature an energized outlet capable of providing "Level 2" EV charging.

The greatest advantage of this mechanism is its simplicity and flexibility to both local governments and developers alike. It allows the local government to set a percentage or number of EVSE-ready stalls per unit, which is applied to all new residential parking stalls.

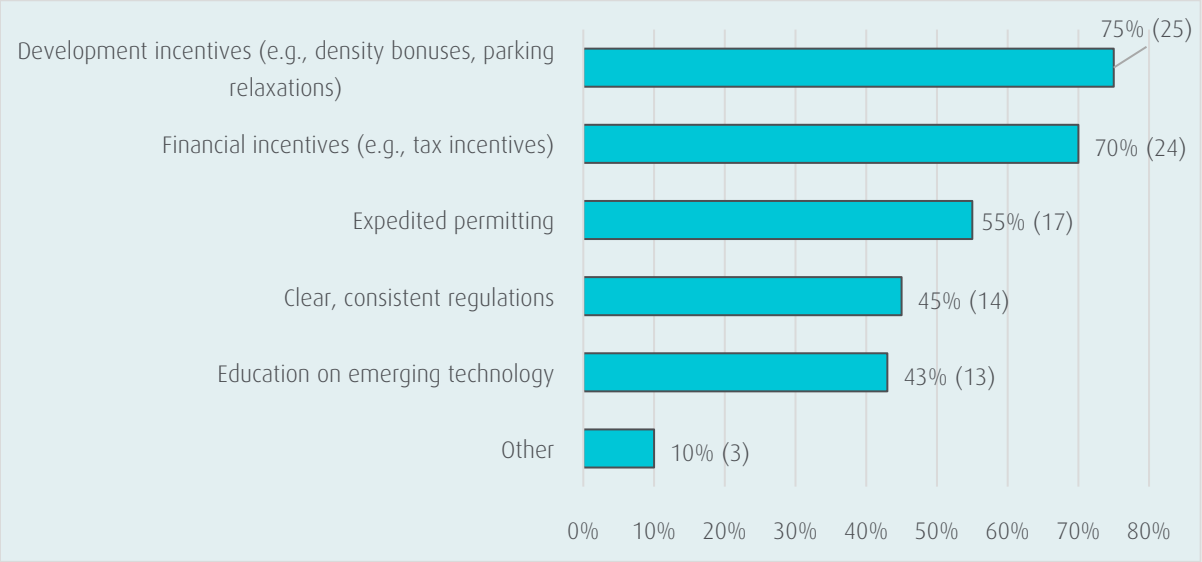
Incentive Mechanisms

In addition to the mechanisms described above, local governments could employ a variety of policy / incentive tools in the short-term to advance EV charging infrastructure in new developments. These short-term mechanisms can help create momentum and familiarity with EV charging in new development. Examples are provided as follows:

- Density Bonuses | A density bonus (i.e., an increase in the floor area ratio) can incentivize the inclusion of EV charging infrastructure in a new development. While this mechanism has not been widely applied in the BC context, communities such as the City of Port Coquitlam are considering this tool. The City is in the process of updating its zoning bylaw to include requirements for electric vehicle charging infrastructure. To offset the cost of providing the EV charging infrastructure, the City will consider reductions in Community Amenity Contributions or density bonus contributions.[34]
- Community Amenity Contributions | Community amenity contributions (CACs) are negotiated amenity contributions agreed to by the developer and local government as part of a rezoning process initiated by the developer. Community amenity contributions typically include the provision of amenities, affordable housing and/or financial contributions towards amenities. The agreed-to contribution is obtained by the local government, if the local government decides to adopt the rezoning.[35]

The CRD development / building industry survey asked respondents how local governments can support EV charging infrastructure in new developments. As shown in Figure 13, the majority of respondents (75%) indicated that development incentives would be preferable compared to other actions such as expedited permitting, for example.

Figure 13. Actions to Support EV Charging Infrastructure in New Developments, CRD Development / Building Industry Survey



5.3 Charging Requirements – Infrastructure Considerations

As reported by multiple sources, the majority (over 90%) of EV owners charge their vehicle at home or at work.[36] In addition, the provision of EV and E-Bike charging opportunities in suburban residential areas are especially critical as these residents may not have access to the same sustainable transportation options as their urban counterparts. This section provides information about the types of charging infrastructure to consider for residential land uses including costs and electrical needs.

Requirements for Single-Family Homes, Duplexes, and Townhouses

As discussed in Section 2.2, EV charging at home can either be done with a regular 110V outlet (i.e., Level 1), or with a Level 2 (208/240 volt) charging station. An 110V outlet is sufficient for the purposes of charging an E-Bike; however, a Level 2 EV charger is recommended for residential land uses with a driveway or off-street parking such as a single family home, duplex, or townhouse. Section 2.4 of the provincial guide reported that charging stations rated at 40A (i.e., 208-240V) provide a reasonable charge time and allow for load sharing.

If no additional circuits are available for the charging infrastructure and dedicating a 40A circuit would lead to a panel upgrade and additional costs, a "load miser" or "watt miser" is recommended. These would allow a Level 2 charger to share a circuit with a dryer or a stove; the

EV could only charge when the appliance on the circuit is not in use. This load sharing option is permitted under the Canadian Electrical Code.[37]

The costs of EVSE to support a Level 2 charger vary and are subject to a number of factors including the building and site configuration, calculated load, and panel size. The provincial guide (page 17) provides a summary of these costs, which are shown below (these are estimates only):

- New construction | $200-$500 per dwelling unit, which includes materials and labour for an energized outlet on a dedicated 40A 240V circuit
- Retrofitting | $500-$1,200 per dwelling unit
- Total cost of EVSE / Charger | $600-$1,400 plus labour to hardwire

Requirements for Multi-Unit Residential Buildings

Those living in a multi-unit residential building may not have access to charging opportunities for their EV or E-Bike and presents a significant barrier to accelerating EV adoption in multi-unit residential buildings.

Retrofitting the building for EV infrastructure can be cost prohibitive and complex due to shared parking configuration in multi-unit residential buildings. Some data show that the installation costs, which include EVSE and labour, were averaged to be $6,800 per retrofit EV parking stall.[38]

While retrofitting is an option, albeit an expensive one, ensuring EV charging infrastructure is installed at the time of construction can significantly reduce the cost and institutional barriers to EV ownership. Table 14 includes a summary of the costs of installing EVSE.

Table 14. EV-Ready Installation Costs Per Stall[11]

Type of Charging[12]	Costs ($/stall)**		
	Townhouse	Mid-Rise	High-Rise
Dedicated Level 1*	$126 (least cost option)	$847-$881	$1,443
Dedicated Level 2	$2,655	$2,314-$2,448	$3,023
Load Sharing, Level 2***	$307	$566-$572	$760

*No additional life cycle costs for Level 1

**Additional life cycle costs are estimated at $8000 over 20 years, assuming $2,000 per Level 2 charger and $6,000 in services costs

***This depends on the building type but assumed a 4-way load sharing arrangement or 18-way load shared with an 80A circuit

5.4 Model Language for New Development

As local governments explore different policy mechanisms to advance EV and E-Bike charging infrastructure in new developments, consideration should be given to policy and regulatory language that has already been adopted. This section includes examples of regulatory language that been included in municipal zoning bylaws stating the requirements for EV and/or E-Bike charging infrastructure.

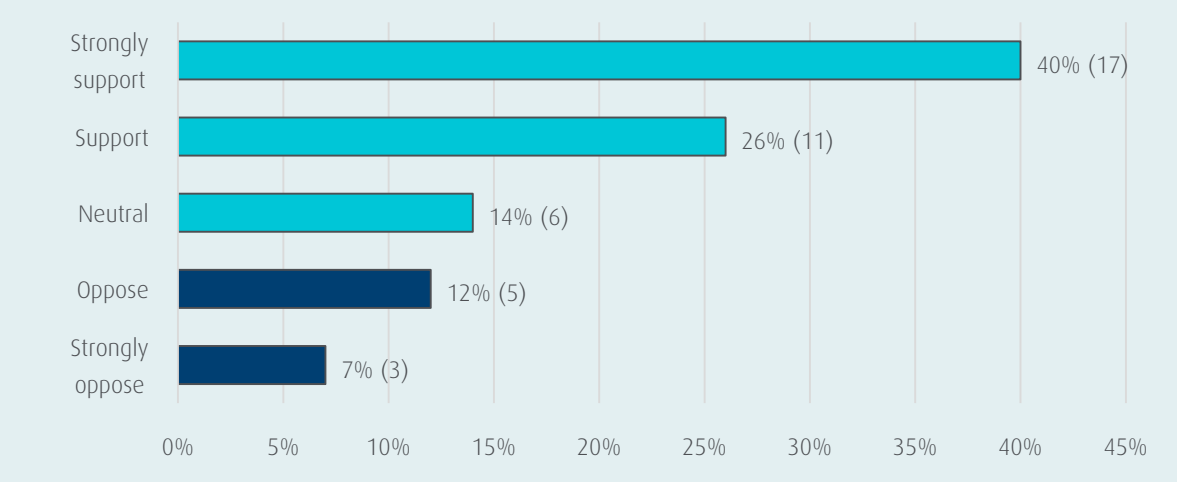
Note: it is recommended that municipalities / electoral areas focus on advancing EV-ready requirements, which can [a] allow for the future installation of EV charging stations based on demand and [b] not represent a significant cost for developers / builders.

[11] This table has been adapted from the provincial guide "Residential Electric Vehicle Charging: A Guide for Local Governments".

[12] "Dedicated" refers to dedicated circuits, which is intended for a single appliance such as dryer, oven, or in this case, an electric vehicle. "Load sharing" can significantly reduce the infrastructure costs associated with EVSE installation by avoiding the inherent costs of dedicated circuits. According to AES Engineering Ltd, a Level 2 load sharing installation is less than one-third the cost of a dedicated circuit installation.

An important part of developing EV-ready policy and regulations is obtaining feedback from the developer / building industry. As such, questions were included in the CRD development / building industry survey to gauge their support. As shown in Figure 14, most of the survey respondents (41%) strongly support local governments in the Capital Region requiring new developments to be EV-ready. Even though the majority of the survey respondents selected "development incentives" as the top local government action to support EV charging infrastructure in new developments, the findings below indicate that there is strong support for EV-ready regulations in the Capital Region. However, local governments should consider further consultation with the development / building industry community before adopting EV-ready regulations.

Figure 14. Support for EV-ready Regulations, CRD Development / Building Industry Survey



The recommended regulatory language for both EV-ready and E-Bike parking requirements are provided on the following page. In addition to the requirement to have access to an EV-ready parking stall, regulations should also include a requirement for labelling the outlet for EV charging to deter other non-EV users and to increase the visibility of EV charging. In addition, to allow for future load sharing / load management, the regulations should communicate the requirements for a performance standard for EV energy management.

The City of Richmond created a bulletin on Electric Vehicle Charging Infrastructure Requirements that provides a clear and concise explanation of the EV Charging Infrastructure Requirements that were adopted in that City in 2017. The bulletin can serve as a useful guide for local governments when they consider similar regulations.

The following regulations are recommended for local governments in the Capital Region:

Residential EV-Ready Requirements

For new buildings, structures and uses, all residential parking spaces, excluding visitor parking spaces, shall feature an energized outlet capable of providing Level 2 charging or higher to the parking space.

Energized outlets, provided pursuant to section xx.x(1) above, shall be labelled for the use of electric vehicle charging.

Where an electric vehicle energy management system is implemented, the Director of Engineering may specify a minimum performance standard to ensure a sufficient rate of electric vehicle charging.

Commercial EV-Ready Requirements

For new buildings, structures and uses, 10 percent of all commercial parking spaces shall be provided with an energized outlet capable of providing Level 2 charging or higher to the parking space.

E-Bike Parking Requirements (Multi-Unit Residential & Commercial)

Long-Term Bicycle Parking:

One 110V electrical outlet must be provided for every two long-term bicycle spaces.

Short-Term Bicycle Parking:

10% of bicycle parking spaces must have access to an 110V electrical outlet.

6. Retrofitting

This section is directly based on and summarizes content from the provincial guide (Section 3.0). While retrofitting is more costly than EVSE installation at the time of construction, it is needed to provide viable charging opportunities. This section presents a summary of how local governments can help alleviate barriers and support retrofits in multi-unit residential buildings.

6.1 Cost Barriers & Solutions for Multi-Unit Residential Building Retrofits

There are two cost barriers when retrofitting multi-unit residential buildings to add EV charging infrastructure.

1. Upfront Costs: immediate costs are incurred during the process of retrofitting, including the required electrical permits to perform the work, labour, materials, and the EV supply equipment (EVSE).
2. Long-term Costs: long-term costs are incurred when the building reaches the capacity of its electrical service (e.g., through the addition of additional EV infrastructure in the building over time or other factors that increase the building's electrical load), requiring capacity upgrades to the building to accommodate additional EV infrastructure.

For upfront costs:

- Data from Plugin BC indicates the cost for multi-unit residential building retrofits in British Columbia can range from $4,000 to $8,000 per dwelling unit with an average of $6,800 per unit. Whole building retrofits would be must greater.
- As a result, this high upfront cost can be a barrier among building owners and/or strata corporations as it reduces the financial feasibility of retrofits and the cost effectiveness depending on the number of building residents who own an EV vehicle.
- To address this cost, the Province of BC is recently offered an incentive program to cover 75% of costs, up to $4,000, for the installation of a Level 2 charging station. This can potentially reduce the average cost to $2,800 for each station installed. This program closed in July 2018 as the funding was fully allocated.

For long-term costs:

- Typically a cost estimate is $5,000 for an addition 200A of service (sufficient for five 40A charging stations operating in parallel, or additional stations operating with load-sharing technology, also known as EV energy management systems).
- Costs could be higher if an upgrade to the distribution transformer (that converts high-voltage electricity to lower voltage levels for consumer use) is required.
- As a result, building residents may be reluctant in supporting retrofits unless the costs are evenly distributed in order to address issues of perceived unfairness where early adopters pay less than later consumers to obtain EV charging station.

One of the most viable solutions to address these costs is to design for EVEMS (i.e., load sharing), which would allow for a greater number of parking spaces to be served within the limited electrical capacity of an existing building. The use of an EVEMS to redesign electrical service in the building to accommodate EV infrastructure for each parking space would be significantly more cost-effective than adding EV infrastructure to select parking spaces in an ad hoc approach. A full discussion of the costs of different load sharing options is available in a City of Richmond costing report titled "Electric Vehicle Charging Infrastructure in Multifamily Developments – Requirement Options and Costing Analysis".[39]

6.2 Social and Legal Barriers & Solutions for Multi-Family Building Retrofits

There are social and legal barriers that pertain to retrofitting multi-family buildings. In apartment buildings, landlords are typically the only decision-maker and determine whether EV charging should be provided. A tenant may submit a request to the landlord (and go through dispute resolution if necessary) to install EV charging infrastructure, but landlords are not required by law to provide charging access to EVs.

For strata buildings, there are additional social and legal barriers beyond those encountered for apartment buildings that require the involvement of the strata corporation. In general, strata boards are more risk-averse and less inclined to learn about and agree to EVSE upgrades. As a result, they may be less willing to invest in a legal review to determine if the retrofits are feasible.

The following identifies more examples of barriers and potential solutions for multi-unit residential building retrofits, as reported in the provincial report.

Swapping Parking Stalls

The installation of EVSE may not be appropriate for each parking stall; whether an EV user may be permitted to access a parking stall may be dependent on how the stall is held, as follows:

- Common property: In some cases, these parking stalls may be assigned, and the strata corporation has the ability to reassign them. In other cases, the common property stall may be held through a lease, and the provisions of this lease will indicate whether owners may trade stalls.
- Limited common property: The ability to swap a limited common property stall depends on how it was designed. Sometimes a resolution must be passed unanimously at an annual or special general meeting. In other cases, an application may be required to amend the strata plan, which is costly and can be complex.
- Strata lot: The strata corporation has no authority to swap these spaces because each space is the property of the registered owner.

Strata Resolutions Required for Electric Vehicle Infrastructure Installation

Municipalities should be mindful of the following barriers when requiring EV infrastructure installation:

- A multi-family building owned by a strata corporation require a three-quarter strata majority to pass a bylaw that allows for the installation and use of EV infrastructure
- Residents may decline a request for EV infrastructure without reasonable cause by voting against the strata resolution. This has been reported as one of the most common barriers for multi-family building EV charging retrofits.[40]
- One of the main reasons why resolutions fail is due to the perception that EV charging will benefit only a small number of strata members. Moreover, members who do not see a benefit may be reluctant to share the cost of any infrastructure upgrade. Strata corporations can alleviate this barrier by clearly articulating options for cost recovery and cost sharing

Supporting Access to Electric Vehicle Charging in Existing Residential Development

According to research by Plug In BC, there are a number of education and outreach initiatives that can be pursued to improve the chances of EV infrastructure being approved by a strata corporation, as follows:

- Explaining how strata corporations can ensure EV owners are paying for their electricity (whether through metered, networked, or fixed-fee solutions) can significantly improve reception to the purchase and installation of EV infrastructure.
- The provincial charging program has an EV Advisor[13] who spends time with residents, strata councils, and strata memberships (at annual general meetings or special general meetings) to provide information, answer questions, and address concerns. Stratas have responded positively to the availability of a third-party information source that does not have a vested interest in selling EV infrastructure.
- Municipalities can consider having someone trained on staff, or in a combined Energy Advisor role, to provide this resource to residents and strata corporations. There may also be an opportunity to align outreach with existing programs or regional initiatives to take advantage of cross-promotional opportunities as they arise.
- Metro Vancouver's EVcondo.ca[14] is an online web resource that has FAQs for strata members and residents. Plug In BC also has a resource called navigating stratas[15] page has additional resources.

To overcome potential barriers to installing EVSE in multi-family buildings, a strata corporation could work with the EV owner to have them to pay for the ongoing operational costs, including the cost of electricity, some cost recovery on the infrastructure, and the network fee (if applicable). If the charging station is located in their parking stall, the EV owner could pay for the charging station hardware and installation. This can help reduce the financial burden on the other residents and provides transparency on how costs would be covered.

[13] More information about the EV Advisor is available online at: https://pluginbc.ca/incentives/charging-solutions-incentives/
[14] More information about this Metro Vancouver resource is available online at: http://www.metrovancouver.org/services/air-quality/climate-action/transportation-programs/ev-strata-condo/Pages/default.aspx
[15] More information about Plug In BC's navigating stratas website is available online at: https://pluginbc.ca/charging-stations/nav_stratas/

- Strata members in communities with new-build EV infrastructure requirements have been more likely to see EV infrastructure not as a cost but as an investment in their unit's eventual resale value.

6.3 Strata Rule Recommendations and Cost Reconciliation Issues

Section 4.0 of the provincial guide includes a series of recommendations for how local governments could encourage EVSE installation in new and existing multi-family buildings. Specifically, municipalities should consider the following recommendations as part of rezoning and approvals processes for new buildings:

1. Encourage developers to enter into a covenant under section 219 of the *Land Title Act*, which requires the owner of the land to keep the EVSE in operation. The covenant would be binding on the strata corporation. This is to avoid a situation where a strata council, by 3/4 vote, amends its bylaws to decommission or prevent use of EVSE.

2. Encourage developers to include the following in the strata corporation bylaws:

    a. the right of an owner, occupant, or tenant to install EVSE in the appropriate parking stall, provided they sign an Alteration and Indemnity Agreement on EVSE installation;
    b. the responsibilities of a strata corporation to manage and maintain the common property electrical infrastructure intended for EV charging, including costs of future repairs, maintenance, and upgrades to applicable electrical infrastructure, excluding EVSE; and
    c. the responsibilities of an owner, occupant, or tenant with regard to installation and use of EVSE.

Stratas could consider various requirements in their bylaws to help facilitate EVSE installation. For example, if an owner, occupant, or tenant is requesting to install EVSE in a common property stall, the strata could:

- Require them to notify and/or obtain consent from the strata corporation priority to the installation.
- The owner / occupant / tenant could sign an Alteration and Indemnity Agreement where the terms would be determined by the strata council.

- Require the owner / occupant / tenant to pay a user fee, where the amount should be fair and reasonable.

In situations where the strata is installing EVSE for use in a common property stall that would be used by multiple tenants, the strata could:

- Set out the amount of the user fee and how it will be charged and collected
- Determine how the parking stall will be used and managed including [a] whether consent and a user agreement must be obtained and signed before using the stall [b] time limits on how long the user could use the stall' and [c] whether visitors are allowed to park in the stall

More details around strata rule recommendations and cost reconciliation issues is found in the report: *Residential Electric Vehicle Charging: A Guide for Local Governments*.

7.0 Resources

In addition to the content found in *Infrastructure Planning Guide*, there are a number of resources that can assist in municipalities in advancing both EV and E-Bikes in their respective jurisdictions. A summary of resources is found below:

- Residential Electric Vehicle Charging: A Guide for Local Governments | The guide provides municipalities with specific guidance around improving access to at home EV charging in both new and existing residential buildings. https://pluginbc.ca/wp/wp-content/uploads/2018/10/Residential-EV-Charging-A-Guide-for-Local-Governments.pdf
- Electric Vehicle Charging Infrastructure in Shared Parking Areas: Resources to Support Implementation & Charging Infrastructure Requirements | This guide provides resources to support implementation of EV charging infrastructure in shared parking areas with direction on infrastructure configurations, delivery models, variance request requirements, and considerations for strata bylaws. https://pluginbc.ca/wp/wp-content/uploads/2018/10/EV-Charging-Infrastructure-in-Shared-Parking-Areas-Resources-to-Support-Implementation-and-Requirements.pdf
- City of Richmond Electric Vehicle Charging Requirements Bulletin | A concise document intended to inform owners/applicants, designers and builders of new residences of requirements for residential parking spaces to feature electrical outlets capable of providing "Level 2" electric vehicle charging:

  https://www.richmond.ca/__shared/assets/engineering0549762.pdf
- Capital Region Local Government Electric Vehicle (EV) + Electric Bike (E-Bike) Infrastructure Backgrounder | This document provides baseline information that has been collected and analysed to inform this Guide.
- Provincial Clean Energy Vehicle Program | BC's Point of Sale Incentive Program designed to make clean energy vehicles (CEV's) more affordable for British Columbians: https://www.cevforbc.ca/clean-energy-vehicle-program
- Provincial EV Charging Station CSA | Provides information about the provincial Corporate Supply Arrangement for the supply and installation of EV Charging stations:

https://www2.gov.bc.ca/gov/content/governments/services-for-government/bc-bid-resources/goods-and-services-catalogue/ev-charging-stations

- Plug In BC | Plug In BC is a program of the Fraser Basin Council and is a broad collaborative between government, industry, academic institutions, EV owners, NGOs and utilities. The program lays the groundwork for plug-in electric vehicles and related charging infrastructure in British Columbia:

  https://pluginbc.ca/

- City of Vancouver EV Ecosystem Strategy | The City of Vancouver's EV Ecosystem Strategy builds on the City's experience with electric vehicles since 2007 and formalizes its role in the expansion of charging options until the year 2021:

  https://vancouver.ca/files/cov/EV-Ecosystem-Strategy.pdf

- Emotive | a BC wide campaign to promote electric vehicles: https://pluginbc.ca/outreach/

References

[1] Fleetcarma. (2018). Electric Vehicles Sales Update Q2 2018, Canada. Available online at: https://www.fleetcarma.com/electric-vehicles-sales-update-q2-2018-canada/

[2] Axsen, J., S. Goldberg, and J. Bailey. (2015). Electrifying vehicles: insights from the Canadian plug-in survey. Simon Fraser University, Burnaby, B.C. Available online at: http://rem-main.rem.sfu.ca/papers/jaxsen/Electrifying_Vehicle_(Early_Release)-The_2015_Canadian_Plug-in_Electric_Vehicle_Study.pdf

[3] Plug'N Drive. (2017). Driving EV Uptake in the Greater Toronto and Hamilton Area: How Driver Perceptions Shape Vehicle Ownership in the GTHA. Available online at: http://www.plugndrive.ca/wp-content/uploads/2017/07/EV-Survey-Report.pdf

[4] Singer, M. (2016). Consumer Views on Plug-in Electric Vehicles – National Benchmark Report. National Renewable

Energy Laboratory. Available online at: http://www.afdc.energy.gov/uploads/publication/consumer_views_pev_benchmark.pdf

[5] Insurance Corporation of British Columbia. (2018). *Electric Bikes*. Availble online at:

http://www.icbc.com/vehicle-registration/specialty-vehicles/Low-powered-vehicles/Pages/Electric-bikes.aspx

[6] Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., & Handy, S. (2014). Experiences of electric bicycle users in the Sacramento, California area. Travel Behaviour and Society, 1(2), 37–44.

[7] Dill, J., Rose, G. (2012). Electric bikes and transportation policy. Transport. Res. Rec. 2314, 1–6.

[8] Jones, T, et al. (2016). Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. Journal of Transport Geography. 53, 41-49.

[9] Government of Canada. (2018). Transportation 2030: Green and Innovative Transportation. Available online at: https://www.tc.gc.ca/eng/future-transportation-canada-green-innovative-transportation.html

[10] Sustainable Transportation Action Research Team. (2016). Canada's Electric Vehicle Policy Report Card. Available online at: https://sfustart.files.wordpress.com/2016/11/canadas-electric-vehicle-policy-report-card.pdf

[11] CEV for BC. (2018). Clean Energy Vehicle Program. Available online at: https://www.cevforbc.ca/clean-energy-vehicle-program

[12] Wilson, K. (2018). BC government assigns $10 million to incentivize clean energy vehicle purchases. Available online at: https://www.straight.com/life/1141261/bc-government-assigns-10-million-incentivize-clean-energy-vehicle-purchases

[13] Government of BC. (2018). Provincial government puts B.C. on path to 100% zero-emission vehicle sales by 2040. Available online at: https://news.gov.bc.ca/releases/2018PREM0082-002226

[14] BC Hydro. (2018). How we support electric vehicles. Available online at: https://www.bchydro.com/powersmart/electric-vehicles/bc-hydro-electric-vehicles.html

[15] BCUC. (No date). Electric Vehicle (EV) Charging Service Inquiry – FAQ. Available online at: http://www.bcuc.com/Documents/Proceedings/2018/DOC_50755_02-08-2018_BCUC-EV-Charging-FAQ.pdf

[16] Malatest. (2017). 2017 Capital Regional District Origin Destination Household Travel Survey. Available online at: https://www.crd.bc.ca/docs/default-source/regional-planning-pdf/transportation/crd-2017-od-survey-report-20180622-sm.pdf?sfvrsn=4fcbe7ca_2

[17] ChargeHub. (2018). Charge your EV in Victoria. Available online at: https://chargehub.com/en/countries/canada/british-columbia/victoria.html?city_id=377

[18] Town of View Royal. (2014). Town of View Royal Zoning Bylaw. Available online at: http://www.viewroyal.ca/assets/Town~Hall/Bylaws/900%20-%20Zoning%20Bylaw.pdf

[19] Phone conversation with City of Montreal Director of Urbanism on April 26, 2017.

[20] Bruce Power, Plug'n Drive and Pollution Probe. (2016). Policy Submission to Pan Canadian Framework on Clean Growth and Climate Change: Accelerating the Deployment of EVs. Available online at: http://www.pollutionprobe.org/wp-content/uploads/Accelerating-the-Deployment-of-Electric-Vehicles.pdf

[21] WXY Architecture + Urban Design. (2012). Siting and Design Guidelines for Electric Vehicle Supply Equipment. Available online at: https://www.transportationandclimate.org/sites/default/files/EV_Siting_and_Design_Guidelines.pdf

[22] Portland General Electric. (2018). Electric Avenue. Available online at: https://www.portlandgeneral.com/residential/electric-vehicles-charging-stations/electric-avenue

[23] Email correspondence with Plug In BC Program Manager on November 13, 2018.

[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] Clean Technica. (2018). Electric Vehicle Charging Infrastructure: Guidelines for Cities. Available online at: https://cleantechnica.com/files/2018/04/EV-Charging-Infrastructure-Guidelines-for-Cities.pdf

[28] Township of Esquimalt. (2018). Electric Vehicle Charging. Available online at: https://www.esquimalt.ca/municipal-hall/sustainability-environment/electric-vehicle-charging

[29] Dunsky Energy Consulting. (2018). Recommendations for EV Charging Infrastructure in North Vancouver.

[30] https://www2.gov.bc.ca/gov/content/governments/services-for-government/bc-bid-resources/goods-and-services-catalogue/ev-charging-stations#info

[31] City of Richmond. (2018). Residential Electric Vehicle Charging: A Guide for Local Governments.

[32] Ibid.

[33] Ibid.

[34] AES Engineering Ltd. Electric Vehicle Charging Infrastructure in New Multifamily Developments - Requirement Options and Costing Analysis. Available online at: http://udi.bc.ca/wp-content/uploads/2017/06/Final-Report-r004-EV-Requirements-20170404.pdf

[35] Province of BC. (2018). Density Bonusing & Amenities. Available online at: https://www2.gov.bc.ca/gov/content/governments/local-governments/planning-land-use/land-use-regulation/zoning-bylaws/density-bonusing-amenities

[36] PlugIn BC. (No date). Home & Work Charging. Available online at: https://pluginbc.ca/charging-stations/charging-at-home/

[37] City of Richmond. (2018). Residential Electric Vehicle Charging: A Guide for Local Governments.

[38] Ibid.

[39] AES Engineering Ltd., Hamilton & Company, C2MP, Fraser Basin Council. (2018). Electric Vehicle Charging Infrastructure In Shared Parking Areas. Available online at: https://www.richmond.ca/__shared/assets/EV_Charging_in_Shared_Parking_Areas_Report51731.pdf

[40] Ibid.

Capital Region

Local Government Electric Vehicle (EV) + Electric Bike (E-Bike) Infrastructure Backgrounder

Prepared by: WATT Consulting Group

Prepared for: Capital Regional District

September 2018

Contents

1. Overview

Working with and on behalf of local governments, the Capital Regional District (CRD) is undertaking the *Electric Vehicle (EV) and Electric Bicycle (E-Bike) Infrastructure Planning Project* to understand and assess opportunities to advance EV and E-Bike charging infrastructure in public and private locations throughout the region. EV and E-Bike technology is rapidly advancing and this project is focused on the current landscape. The key objectives of this project are to:

- Understand opportunities for local governments to accelerate uptake of EVs and E-bikes;
- Collect feedback from the development community and general public to better understand the barriers and opportunities for EV and E-bike charging;
- Draw on resources and lessons learned from other communities;
- Identify priority locations for new EV charging stations in the Capital Region; and
- Create a best practices guide outlining options for local governments on how to advance EV and E-bike charging infrastructure in the region.

The Backgrounder (this document) is the foundational document for the *EV + E-Bike Infrastructure Planning Project*. It contains all baseline information that has been collected and analyzed in developing an understanding of issues and opportunities for EV and E-Bike infrastructure in the Capital Region. It is a companion document to the *Capital Region Local Government EV + E-Bike Infrastructure Planning Guide*, containing the necessary detailed baseline information and allowing the *Infrastructure Planning Guide* to be succinct and focused on providing direction and strategies.

Specifically, this document contains the following information:

- An overview of existing EVs and E-bikes, charging station technology, trends in EVs and E-bike ownership in the Capital Region and elsewhere, and key barriers to uptake;
- A summary of relevant community plans and policies from the Capital Region that support EV and E-bikes and the deployment of charging infrastructure;
- A synthesis of "lessons learned" from research and interviews with leading municipalities;
- An overview of the approach and results from a mapping exercise undertaken to identify gaps in the existing EV charge station network in the Capital Region; and
- A summary of findings from surveys and working sessions held to gather input and learn from the development industry and the general public.

2. Electric Vehicles + Electric Bikes 101

2.1 Electric Vehicles

Electric vehicles are a class of vehicles that run fully or partially on electricity. They have a battery instead of a gasoline tank, and an electric motor instead of an internal combustion engine. There are five distinct types of electric vehicles: Battery Electric Vehicles (BEVs), Plug-In Hybrid Electric Vehicles (PHEVs), Conventional Hybrids, Fuel Cell Vehicles (FCVs), and Extended Range Electric Vehicles (EREVs). Table 1 presents an overview of the existing EVs available in British Columbia. While conventional hybrid vehicles, FCVs, and EREVs are featured below, they are not discussed elsewhere in this Backgrounder. The focus of this Backgrounder is on BEVs and PHEVs exclusively.

BEVs run exclusively on electricity and need to be plugged into an outlet or charging station to recharge the battery. The typical range (kilometers) varies from 100 kilometres to over 400 kilometers. Examples of BEVs include the Nissan Leaf, Ford Focus Electric and the Tesla Model S.

PHEVs have an electric motor and an internal combustion engine – the electric motor also needs to be charged at an outlet or charging station but PHEVs typically have a smaller electric range than BEVs and use the internal combustion engine once the battery dies. Examples of PHEVs include the Chevrolet Volt, Kia Optima and Mitsubishi Outlander.

Conventional Hybrids are fueled with gasoline only, but are able to recapture some kinetic energy from the braking system which is converted into electricity to charge the battery. The battery helps to power the vehicle.

Fuel Cell Vehicles (FCVs) are a type of electric vehicle that use a fuel cell, instead of a battery. Those cells generate electricity by using oxygen from the air and compressed hydrogen. Their range and refueling processes are comparable to conventional cars. They produce only water and heat as a by-product. Examples of FCVs include the Hyundai Nexo, Honda Clarity Fuel Cell, and Toyota Mirai.

Extended Range Electric Vehicles (EREVs) have an electric motor and include an auxiliary power unit, typically an internal combustion engine. The difference with the PHEVs is that the electric motor is used constantly to move the vehicle, and the internal combustion engine is used as a generator that recharges the battery when it dies.

Table 1. Electric Vehicles Available in British Columbia (as of May 2018[1])

Vehicle Type	Vehicle Name	Range (km)		MSRP (CAD$)
		Electric Range	Full Range	
BEV	BMW i3	183	183-303	$56,000
	Chevrolet Bolt	383	-	$43,195
	Ford Focus Electric	185	-	$34,998
	Hyundai IONIQ Electric	200	-	$35,649
	Kia Soul EV	179	-	$35,895
	Nissan Leaf	242	-	$35,998
	Smart fortwo ED	155	-	$28,800
	Tesla Model S	338-539	-	$96,650 – 191,900
	Tesla Model X	322-475	-	$110,200 – 200,200
	Tesla Model 3	350	-	$45,600
	Volkswagen e-Golf	201	-	$36,355
PHEV	Chevrolet Volt	85	676	$38,995
	Porsche Panamera S E Hybrid	26	897	$113,400
	KIA Optima PHEV	47	982	$42,995
	Chrysler Pacifica PHEV	53	911	$53,440
	Cadillac CT6 PHEV	50	692	$86,770
	Honda Clarity PHEV	77	552	$41,680
	Hyundai Sonata	43	944	$43,999
	Hyundai IONIQ PHEV	43	TBD	$31,999
	Toyota Prius Prime	40	1,035	$32,990
	Mitsubishi Outlander	35	944	$42,998
	Ford Fusion Energi	35	982	$33,588
	Volvo S90 PHEV	34	655	$74,950
	Volvo XC90 T8	27	547	$86,450
	Volvo XC60 T8	27	537	$70,250
	Audi A3 e-tron	26	605	$45,900
	BMW 530e	25	572	$67,500
	BMW i8	24	533	$152,715
	BMW 740e	23	548	TBD
	BMW 330e	23	556	$51,500
	BMW X5 xDrive40e	23	886	$74,950
	Porsche Cayenne S E Hybrid	23	791	$90,400
	Mercedes-Benz S550e	23	725	$117,900
	Mercedes-Benz GLC 350e	23	TBD	$59,900
	Mercedes-Benz GLE 550e	19	738	$83,900
	Mini Cooper S E Countryman	19	439	$43,490

2.2 EV Charging Station Types

Charging stations are commonly referred to as electrical vehicle supply equipment (EVSE). Generally there are three types of charging stations: Level 1, Level 2, Level 3.

	Level 1 AC, 120V	**Level 2** AC, 240V	**Level 3** DC fast charging
Type	Level 1 charging stations utilize household outlets that provide 120V of AC power (120V) to the vehicle. This type of charging is cheapest and typically involves little to no infrastructure, but is the slowest of the three charging station types.	Level 2 charging stations provide a higher amount of AC power to the vehicle and require their own circuit (similar to larger household appliances). These are the most common form of public charging station and installation costs are significant less than Level 3 charging stations	Level 3 charging stations provide the fastest charging option, although installation costs are significantly higher than other charging station types. These stations appeal to EVs needing a "top up" during longer distance trips that approach or exceed battery range.
Cost (approx.)	**$500** (retrofit)	**$2,500 - $15,000+** installation cost	**$75,000+** installation cost
Key Stats	**3–8 km** per hour of charge time **8-12 hrs** for a full charge	**18–45 km** per hour of charge time **4-6 hrs** for a full charge	**90-150 km** per hour of charge time **0.5-1 hrs** for a full charge
Common Uses	Charging at home (overnight) or at work (all day)	Charging at home or at work, or for charging "on the go" (parking lots)	Charging "on the go", commonly longer distance trips

An October 2017 white paper by the International Council on Clean Transportation Electric Vehicle examined the status of charging infrastructure in major electric vehicle markets in North American, Europe, and Asia.[2] The white paper reported that the costs of installing EV charging infrastructure

has been declining over the past couple years. Based on a review of costs for EV charging stations, typical costs for a Level 2 station, which include administrative, installation, and siting, range from $6,500 to $20,000, whereas a Level 3 station varies from $50,000 to $130,000.[3] The variation in costs for both charging station types is attributed to factors such as different networking capabilities (e.g., number of connectors), geographical context (e.g., urban vs rural), and type of station (e.g., mounted on the wall vs stand-alone). See Section 2.4 for 'EV-Ready' cost considerations.

A number of local suppliers offer charging stations from a variety of manufacturers. Refer to Table 2 for a list of charging station manufacturers.

PlugIn BC maintains a full database of charging station manufacturers and local suppliers that may be referenced for the most up-to-date list - https://pluginbc.ca/incentives/manuf_list

A Tesla Supercharger is a special Level 3 charger that can only be used to charge Tesla vehicles. These stations are owned and operated as part of Tesla's world-wide network. They are typically sited to support the long-distance travel needs of Tesla vehicle owners, but are increasingly being installed in cities to facilitate charging for Tesla owners living in multi-unit buildings and others without access to home charging.

Table 2. EV Charging Station Manufacturers (as of September 2018[4])

Manufacturer	Key Functions	
	Load Management	Data Tracking
AddEnergie/Flo	Some units	Yes
AeroVironment	Some units	No
BMW	Some units	Some units
Bosch	No	No
ChargePoint	Some units	Yes
EFACEC	Yes	Yes
Elmec & EVduty	Some units	Some units
EV Box	Yes	Yes
EVoCharge	Yes	Yes
Hubbell	Some units	Some units
JuiceBar	Some units	Some units
JuiceBox	Some units	Yes
Leviton	Some units	Some units
Liberty Plugins	Yes	Yes
PowerPost	Yes	Yes
SemaConnect	Some units	Yes
Siemens	Some units	Some units
Sun Country Highway	Some units	Some units
Thermolec	Yes	Yes
WattZilla	No	No

2.3 Load Management & Load Sharing

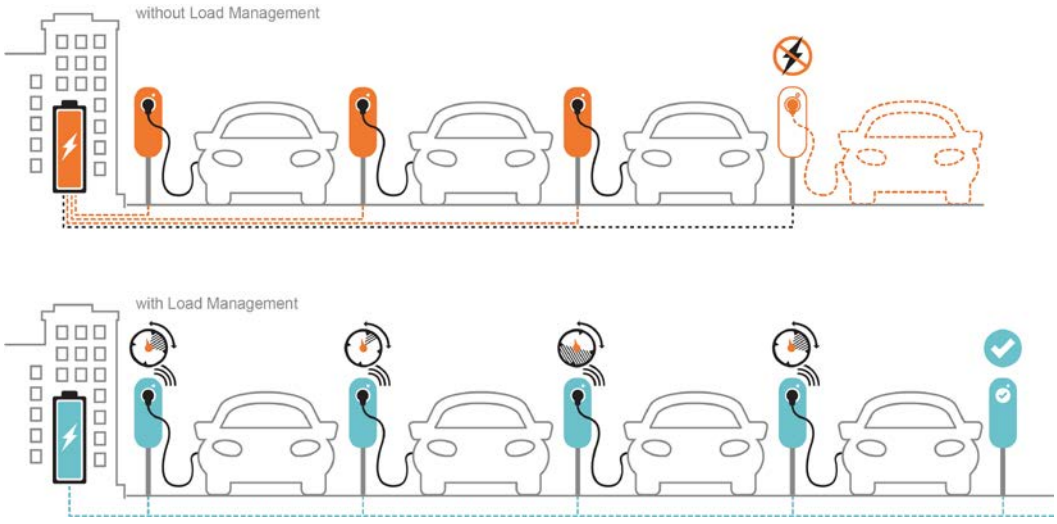
Load management and load sharing refer to control technologies that reduce peak power demand and improve the overall utilization of EV charging systems.[5] The technologies help reduce electric infrastructure costs and provide the capability to control the time of use, which can be utilized to

reduce the impact on the utility's system. Both terms are used interchangeably for the general public but are distinguished by electrical engineers for technical purposes.

In general, load management / sharing refers to a method where multiple EV charging stations share the same electrical line. This is commonly used in cases where the electrical capacity is not sufficient for all the required charging stations.[6] The ability to distribute the available power of the existing grid connection to all connected charge points is ideal not only for multiple charging points, but in case there is a need for future expansion and increase in the number of EV charging points.

In principle, this is a classic example of peak saving, which British Columbia has been doing over the past several years. It is also known as Demand Side Management (DSM), which allows utilities to reduce demand for electricity during peak usage times. New load management technologies are constantly under development by both the public and private sector; examples of organizations / manufacturers that load management technology include BC Hydro, AddEnergie/Flo, AeroVironment, ChargePoint, Leviton, and Siemens, among others.[7] Figure 1 provides an illustrative example of how load managements works in practice.

Figure 1. Illustrative Example of Load Management[8]



2.4 EV-Readiness & Retrofits

EV-Ready, is considered a parking stall that is provided with conduit and an energized outlet capable of providing power to an electric vehicle charging station. It is a measure used to future-proofing a development to easily accommodate a future EV charging station.

The City of Richmond procured a costing study to better understand installation costs for various architypes of new multi-unit buildings. Costs per charging unit depended on the EV charging technology and ranged from $561 (Level 2, 4-way load shared 'energized') to $2,610 (Level 2, dedicated 'energized').[9]

Retrofit costs, especially in multi-unit buildings, are typically much greater (averaged $6,800 per charging unit based on results from a previous provincial incentive program).[10] Retrofits to an entire building, requiring additional panel upgrades, retrofits to the electrical room and transformer upgrades would significantly increase the average cost per station. Retrofits to an existing single-family home are typically less onerous and less costly (if home has existing electrical capacity and space).

2.5 E-Bikes

E-Bikes are electric bicycles with an electric motor of 500 watts or less and functioning pedals that are limited to a top speed of 32 km/h without pedalling.[11] Electric bicycles in British Columbia must comply with all standards outlined in the Motor Assisted Cycle Regulation, BC Reg. 151/2002. In summary, to be considered an electric bicycle it must meet the following characteristics:

- Electric motor of up to 500 watts,
- Functional pedals,
- Maximum speed of 32 km/h when power assisted, and
- The power assist must disengage in any of the following: rider stops pedaling, throttle is released, brake is applied.

If the above mentioned characteristics are met then there is no requirement for driver's license, vehicle registration, or insurance. However a bicycle helmet must be worn and the rider must be at least 16 years old.

E-Bikes have a range of benefits beyond (or in addition to) those provided by a traditional, non-motorized bicycle. E-Bikes make cycling possible for a much wider diversity of people as they can

increase the length of bicycle trips, minimize the impact of hills and other terrain challenges, and allow people to bike with heavier cargo loads. This increase bicycle accessibility for women, seniors, and people with disabilities. Research has shown that E-Bikes are ridden twice as far and twice as often as traditional bicycles. Though E-Bikes offer riders some assistance, riders are still required to pedal and therefore achieve similar health benefits to that of a traditional bicycle.[12]

The amount of assistance the motor supplies depends on the size of the motor: smaller motors work to only assist the rider's pedaling and larger, more powerful, motors can propel the bike forward without the rider needing to pedal. E-Bikes are classified according to their power, and there are three distinct classes. There are three types of E-Bikes, broadly described as follows:

The **pedal-assist**, also known as pedelecs, enhances the efforts of the rider only when they are pedaling. Two sub-categories exist in pedal-assist: the first provides assistance upon detecting pedal strokes and the second provides assistance when a chosen level of torque is reached. An example of a pedal-assist bike is the OPUS Grid.

The **power-on-demand** bikes only provide power on demand – this is initiated by the rider using a throttle which is typically located on the handgrip.

The third class is a **hybrid** of the pedal-assistance and power-on-demand. There is both a pedal-assist sensor and the option to engage the motor by utilizing the throttle on the handgrip. Examples of hybrid bikes are the Spark, Juiced OceanCurrent and CrossCurrent S, and the Interceptor Electric Cruise Bike.

Figure 2 provides an illustration of how pedal-assist differs from power-on-demand.

Figure 2. Pedal-assist (left) vs. Power-on-demand (right)[13]

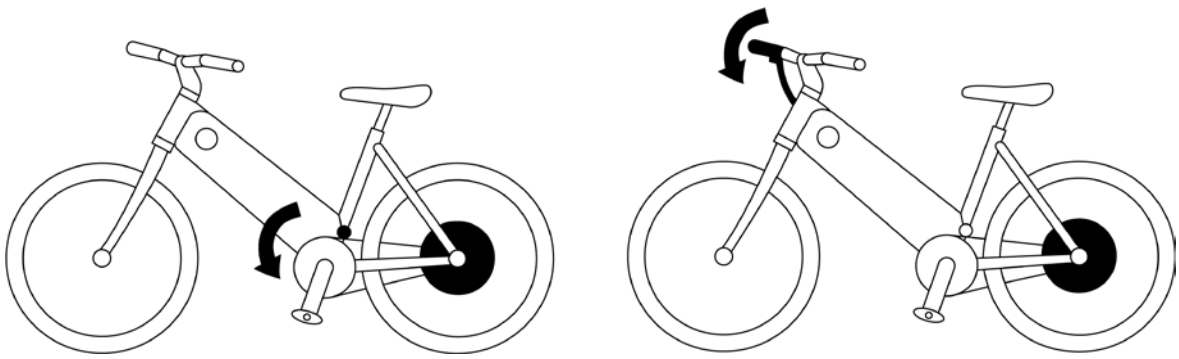


Table 3 presents an overview of E-Bike performance and costs. Broadly speaking, E-Bikes costs typically range from as low as $1,300 to as much as $4,600 with range varying from 38 to 125 kilometres. However, prices have been reported to be even lower than $1,300; Stark Drive has released a number new E-Bike models with prices as low as $399 for the Stark Drive City. It should also be noted that almost any bicycle can be retrofitted into an E-Bike with the use of a conversion kit (e.g., Hub motor, mid drive, all-in-one, friction drive) reducing the cost but without providing the same user experience, degree of integration, and ride. The cost of a conversion kit is approximately $150-$250.

Table 3. Summary of Select E-Bikes Available in Canada in 2018, Performance + Cost

Type	Name / Model	Battery Range (km)	Top Speed without Pedaling (km/h)	Cost (CAD$)
Pedal-Assisted / Power-on-demand	Stark Drive City	40	25	399
	Spark	80	32	1,300
	Juiced OceanCurrent (500W)	67-120	38	2,100
	Juiced CrossCurrent S	54-108	45	2,300
	Interceptor | Electric Cruise Bike	-	32	3,800
-	OHM-EbikeBC XU450	40-80	32	2,500
Pedal-Assisted	OPUS Grid	38	32	2,500
Pedal-Assisted with options	Opus Connect	125	32	3,600
-	Powerfly 5 Women's	-	32	4,600

3.0 EV + E-Bike Trends

3.1 Electric Vehicles in BC

The following is an overview of the latest EV sales data in British Columbia as a comparison to the country as a whole.

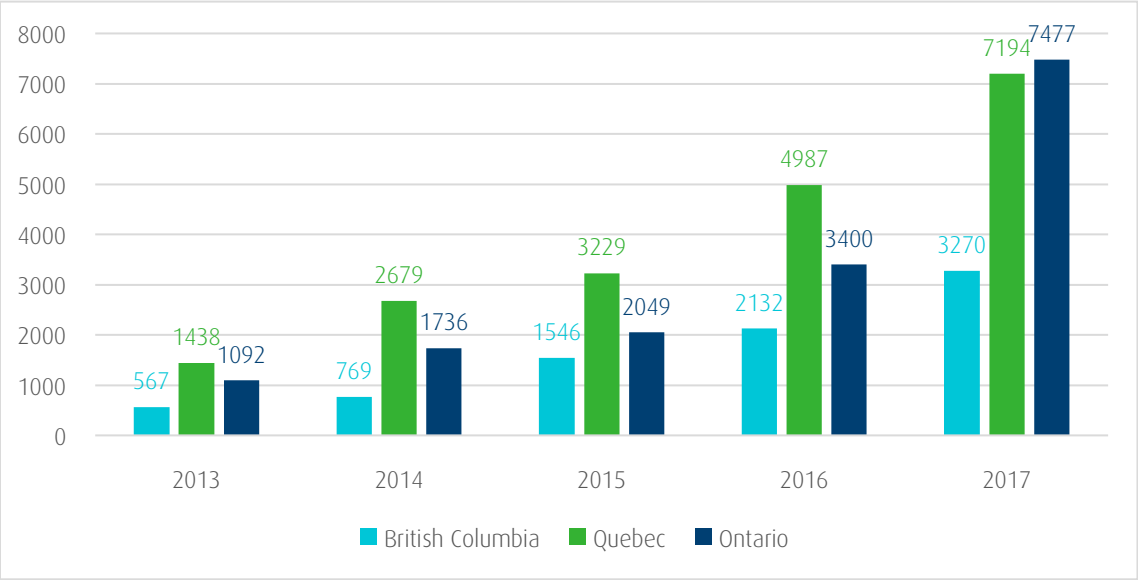
BC's Total EV Sales Compared to Canada

The EV market in BC, much like the rest of Canada, has been growing rapidly over the last 10 years. Data from fleetcarma, published in June 2018, indicate that electric vehicle sales increased

by 75% in the first quarter of 2018 compared to the first quarter of 2017.[14] There was a total of 6,600 EVs sold in the first quarter of 2018 with 4,000 PHEVs and 2,600 BEVs.

Electric vehicle ownership in BC has continued to climb, especially in the last 5 years. BC saw 1,400 EVs sales for the first quarter, representing an increase of 58% over the previous year. Data show that from 2013-2016, there were approximately 5,000 EVs sold in BC. In 2017 and in the first quarter of 2018 alone, there were 4,670 EVs sold, which is almost equivalent to the number of sales over a four year period (2013-2016).[15] Figure 3 shows EV growth across three of Canada's leading EV provinces. Notably, BC's population as of 2018 is 4.8 million, which is significantly smaller than both Quebec (8 million) and Ontario (14 million). Therefore, even though there were more absolutely sales of EVs in Quebec and Ontario, BC saw more EV sales on a per capita basis.

Figure 3. Annual EV Sales, 2013-2017, by Province[16]

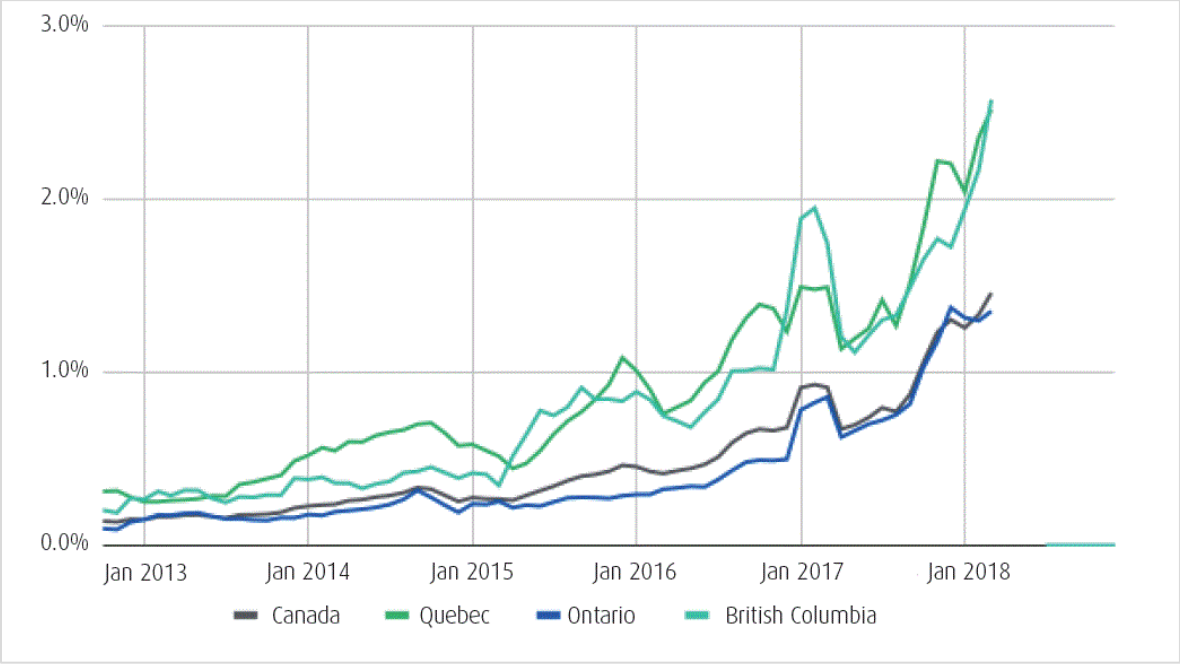


BC's EV Market Share Compared to Canada

EV market share—the portion of electric vehicles sold compared to the total automotive market—has also been growing in the last 5 years. The percent of EV sales compared to passenger car sales across the country is 5%, which is slightly higher from the all-time high of 4.6% in December 2017.[17] EV sales currently represent 1.4% of all vehicle sales in Canada, which is also higher than the previous high of 1.3% in December 2017.

In British Columbia, EV market share set a new high of 2.6% at the end of March 2018, representing an increase from 1.7% in the three preceding months. As shown in Figure 4, BC has seen the highest portion of EV market share growth in the last two years when compared to the national average and Quebec and Ontario—the two largest EV markets. According to Statistics Canada data, in the month of March 2018 there were 53,588 passenger cars sold nationally. British Columbia and territories represented approximately 11% (6,069) of this total, compared to 29% in Quebec, and 44% in Ontario.[18]

Figure 4. EV Market Share in BC (3 month average), January 2013 to January 2018[19]



Most Popular EVs in BC Compared to Canada

Similar to national trends, the Chevrolet Volt was one of the most popular PHEVs in BC in the first quarter of 2018 with 133 sales. The Mitsubishi Outlander (one of the first widely-available sport-utility vehicles) recorded the highest number of sales at 140. The Chevrolet Bolt was the most popular BEV vehicle at the national scale, followed by the Nissan Leaf, at 581 and 505 sales, respectively. In BC, the Tesla Model X was the most popular BEV with 197 sales compared to the Bolt at 139 sales in the first quarter of 2018. Table 4 and Table 5 present the top three BEV and PHEV vehicles sold in BC in the first quarter of 2018.

Table 4. Top BEV Sales in BC, Q1 2018

Vehicle Name	Q1 2018 Sales	Percent of All BEV Sales
Tesla Model X	197	29%
Chevrolet Bolt	139	20%
Nissan Leaf	98	14%

Table 5. Top PHEV Sales in BC, Q1 2018

Vehicle Name	Q1 2018 Sales	Percent of All PHEV Sales
Mitsubishi Outlander	140	21%
Chevrolet Volt	197	20%
Toyota Prius Prime	103	15%

3.2 Electric Vehicles in the Capital Region

In June 2018, the Capital Regional District released results from the 2017 CRD Origin Destination Household Travel Survey.[20] The survey study area includes all 13 municipalities in the CRD, the Juan de Fuca Electoral Area and Salt Spring Island. In total, 7,392 households were surveyed, which represents a sample rate of about 4.2% of all households in the study area.

In addition to the survey's valuable data on the types of trips being made across the region, it also includes demographic characteristics such as population by age, dwelling type occupational status and vehicles by fuel type.

The summary of vehicles by fuel type identified 255,300 vehicles in the Regional Planning Area with, approximately 1,900 (0.7%) being "electric-only". This represents an increase from the 2011 survey where only 100 electric-only vehicles were reported (less than 0.001%). Unsurprisingly, single-detached households represented the largest number of dwelling types with an electric vehicle (1,300), followed by apartment / condo (300), and row / townhouses (200).

Table 6 shows the percentage of electric-only vehicles by municipality / electoral area. The data show electric vehicles represent 1% (or less) in almost all municipalities / electoral areas. The only exceptions are North Saanich (2%) and the Salt Spring Island Electoral Area (4%). Nevertheless, the survey does indicate that EV ownership has increased significantly since the 2011 survey.

Table 6. Percentage of Electric-only Vehicles, by Municipality

Municipality / Electoral Area	Percentage of Total Vehicles
Central Saanich	<1%
Colwood	1%
Esquimalt	1%
Highlands	--
Juan de Fuca Electoral Area	1%
Langford	1%
Metchosin	<1%
North Saanich	2%
Oak Bay	1%
Saanich	1%
Salt Spring Island Electoral Area	4%
Sidney	1%
Sooke	1%
Victoria	<1%
View Royal	1%

3.2 E-Bikes in the Capital Region Today

With E-Bikes being an emerging mobility phenomenon, there is limited ownership data that is publicly available. To gather an understanding of general E-Bike trends and sales, telephone interviews were held with five bicycle shops in the Capital Region. The purpose of the interviews was to [a] understand the types of E-Bikes available to customers [b] the price range of E-Bikes [c] E-Bikes sales as a proportion of total bike sales and [d] whether the bicycle shops see a growing market for them. Table 7 presents a summary of the findings.

Table 7. Summary of E-Bike Sales at Select Bicycle Shops in the Capital Region

Bicycle Shop	Most Popular Models	Price Range	E-Bike Sales as % of Total Bike Sales
Fairfield Bicycle Shop	Electra Townie Go!, Surface 604	$2,000-$6,000	33%
Fort Street Cycle	Cannondale Quick	$3,600-$8,000	1-2%
Goldstream Bicycles	Devinci e-griffin, OPUS WKND, Del Sol LXI	$3,000 to $3,600	Unsure
North Park Bikes	Opus Connect, Electra Townie Go!	$2,500-$5,000	5%
Oak Bay Bicycles	Cube Touring Hybrid One 500, Trek Verve Plus	$2,800-$6,600	20%

All of the bicycle shops reported that there is a growing market for E-Bikes. Oak Bay Bicycles reported that E-Bike sales are growing at a rate of 20% per year while Goldstream Bicycles stated that the store has sold more E-Bikes in the first few months of 2018 than in the last two years combined. Some of the bicycle shops indicated that sales could increase even further if the price of E-Bikes decreases. Sales in the Capital Region generally follow the trend globally. Worldwide sales of E-Bikes were estimated to be 36 million units in 2015 and 100 million by 2035, with the majority of sales being in Asia.[21]

In addition to the bike shops above, residents in the Capital Region also have the option of shopping at Pedego and other stores that specialize in E-Bikes. Companies such as Rad Power Bikes are also helping drive E-Bike sales in North America by offering consumers the ability to shop online for an E-Bike model and have it shipped directly to their door.

4. Plan + Policy Review

4.1 Official Community Plans in the Capital Region

To understand local policy priorities with respect to EVs and E-Bikes, a review of all thirteen municipalities' Official Community Plans (OCPs) and three electoral areas was completed. The results are presented in Table 8.

Notes:

1. No references to E-Bikes were noted in any OCP documents. Accordingly, E-Bikes are not included in the summary table below.
2. The Juan de Fuca electoral area is comprised of seven communities, each of which has an OCP. None of these communities' OCPs were found to have any policy language on EVs or E-Bikes. The Southern Gulf Islands and Salt Spring Island electoral areas are in the Islands Trust Area, and are therefore all land use planning decisions are under the authority of the Islands Trust. The table only includes a community if policy was identified.

Table 8. Overview of EV OCP Policies in the Capital Region

Municipality / Island	Established Policies
Colwood	Policy 8.2.6.6, direction to: • Install public charging stations • Review parking standards to include EV charging stations in new development
Esquimalt	Multiple policies, as follows: • Encourage installation of EV charging in medium-high density residential (Section 5.3) • Encourage installation of EV charging infrastructure in commercial/mixed-use developments (Section 6.1) • Increase capacity for alternative fuelling such as electric (Section 13.3.6) • Pursue installation of EV charging capacity in new buildings during re-zoning (Section 13.3.6) • Provide fast chargers in commercial areas where there is quick customer turnover (Section 24.5.4)
Galiano Island	Land Transportation Policy A: • The Local Trust Committee may require EV charging stations instead of parking spaces. Parking standards may be established for EV charging stations in appropriate locations
Highlands	Policy 15, Section 5.3.2: • Increasing access to low impact renewable powered vehicle technology such as EV charging stations Policy 2, Section 6.4: • Encourage EV charging station installation as part of emission reduction policies
Mayne Island	Policy 2.4.1.10 (Section Retail Commercial): • Provision of EV charging stations in lieu of parking spaces for commercial uses
North Pender Island	Policy 3.1.3.2 (Section Road Transportation): • Encourage EV charging stations to reduce auto-dependence Policy 4.7.2 (Section Climate Change and Adaptation): • Provision of EV charging stations in lieu of parking spaces for commercial uses

Table 8. Overview of EV OCP Policies in the Capital Region, cont.

Municipality / Island	Established Policies
North Saanich	Policy 18.7.11e (Section 18.7, Greenhouse Gas Reduction):

	• Promote low-emission vehicles with EV plug-in charging posts at private and public locations through re-zoning or development variances
Oak Bay	Section 8.3.3 (Multi-Unit Residential DPA): • Provide EV charging stations
Salt Spring Island	Policy B.5.1.2.15 (Section Village Land Use Objectives and Policies): • Cooperation of MoTI with Salt Spring Island Transportation Commission to consider licencing EVs in or near villages
Saturna Island	Policy E.5.11 (Section Climate Change Mitigation and Adaptation): • Provision of EV charging stations in lieu of parking spaces for commercial uses
South Pender Island	Policy 6.1.3 (b) iii (Section Land Transportation): • The Local Trust Committee may require EV charging stations instead of parking spaces. Parking standards may be established for EV charging stations in appropriate locations
Victoria	Policy 7.10.4: • Provision of EV parking at key destinations
View Royal	Policy TR 3.12: • Encourage new developments to be EV charge ready

As shown in Table 8, policy direction around electric vehicles varies considerably across the Capital Region. A number of communities provide no direction at all (e.g., Central Saanich, Langford, Metchosin, Saanich, Sidney and Sooke) whereas other communities have at least one policy including North Saanich, Oak Bay, Victoria, View Royal, and several of the Southern Gulf Islands.

Esquimalt and Colwood—two communities that recently updated their OCPs—were found to have the most detailed EV policies including specific direction to expand the public charging network along with requiring new developments to be EV-ready and/or provide a charging station.

While the District of Saanich was not found to have any EV policy in its OCP, the District does identify the importance of EVs in its Climate Action Plan, which sets a target of 5,000 EVs in the community by 2020.[22] The City of Victoria recently adopted the 2018 Climate Leadership Plan. One of the priority actions is to design and implement a vehicle electrification strategy to promote and support the transition to electric vehicles.

Not a single community within the Capital Region provides any policy direction around E-Bikes. This may be due to the fact that E-Bikes are a recent phenomenon; however, it does indicate that planning policy has not caught up with this emerging technology.

4.2 EV Specific Regulations in the Capital Region

The Town of View Royal is the only municipality in the Capital Region that currently has a requirement for electric vehicle charging in new developments. Per their Zoning Regulation Bylaw, the regulation reads as follows:

> *For every commercial or multiple unit residential development that requires more than 100 parking spaces, an electric vehicle charging station is required on the lot, in a location which is accessible to the patrons or residents.*

4.3 EV & E-Bike Specific Regulations in Other Parts of British Columbia

A handful of Lower Mainland municipalities have specific regulations and policies for EV and/or E-Bike charging infrastructure in development. Table 9 features regulations in three select jurisdictions. A comprehensive summary of regulations from all communities is in Appendix A.

Table 9. Overview of EV & E-Bike Regulations for Select Municipalities in Metro Vancouver

Land Use	Municipality		
	City of Vancouver	District of North Vancouver	City of Richmond
Commercial	A minimum of one parking space for every ten parking spaces, plus one space for any additional parking spaces that number less than ten, shall be provided with an energized outlet capable of providing Level 2 charging or higher to the parking space.	Target 10% of parking stalls wired for level 2 (240v) charging. Appropriate amounts of level 1 (110v) and level 2 (240v) charging will be determined based on: • Proximity to regional roads and highways • Expected length of stay based on long term land use tenure	N/A
Multi-Family Residential	• 100% of parking stalls, excluding visitor stalls, are provided with an energized outlet capable of providing Level 2 charging or higher in new multi-family buildings including rowhouses • Each two Class A bicycle space must have an electrical outlet	• 20% of parking stalls EV-ready, wired for level 1 (110v) charging. • Conduit in place so all stalls can later be wired for level 1 (110v) charging. • All secure bicycle storage must include level 1 (110v) electric outlets for electric bicycle charge	Require all parking stalls, with the exception of visitors parking, in all new residential construction, including single family homes, duplexes, townhomes, and multifamily buildings to feature an energized outlet capable of providing Level2 charging or higher to the parking space.
Single-Family Residential	New one-family, two-family, rowhouses, and laneway houses must have an energized outlet capable of providing Level 2 charging or higher to garage or carport.	N/A	As above

Other municipalities in Metro Vancouver are in the process of developing their EV regulations. A telephone interview with the City of Surrey confirmed that the City is in the "policy development" stage at this time.[23] They are planning to adopt similar EV regulations to Richmond, which would require 100% of parking stalls in residential developments to be EV-ready. The City of Surrey is also planning to adopt a requirement for commercial buildings but the exact percentage is unknown at this time.

City of Burnaby Council recently approved bylaw requirements to make all new residential parking spaces EV-ready by providing an energized outlet for Level 2 charging, including in single-family homes and multi-family buildings of all sizes.[24] The official bylaw language is not yet in place, however, amendments to the Zoning Bylaw to reflect these changes are forthcoming. The City is also reviewing options for EV charging requirements for new commercial and institutional development, investigating opportunities for providing public charging, and exploring the use of electric vehicles in municipal fleets.[25]

The City of Vancouver and District of North Vancouver are the only local governments that were found to have specific regulatory language on E-Bikes. The City of Vancouver's bicycle parking requirements require 50% of off-street long-term bicycle parking spaces to have access to an electric outlet.[26] The District of North Vancouver requires that all secure bicycle storage include level 1 (110v) electric outlets for electric bicycle charging.

4.4 Regulatory Aspects of Selling Electricity for EV Charging

The BC Utilities Commission (BCUC) regulates the sale and resale of electricity in BC. Municipalities who sell electricity to its residents are exempt from the BCUC. BCUC is undertaking an inquiry to explore the potential regulatory issues and opportunities in the EV charging stations market.

As indicated in the inquiry FAQ, the services, rates, and rate design associated with EV charging are currently in an early development stage in BC. But, with the growing popularity of EVs and increasing availability of public charging stations—currently over 1,000 in the province—there is a need to assess the regulatory needs, or lack thereof, that would "be associated with EV charging service, and can also include the setting of rates for EV charging service and any other matters that are of concern or interest to stakeholders".[27] The results of this inquiry will have direct implications

for how municipalities establish a fee and set rates for their municipally owned EV charging stations. More information about the inquiry is found online.[1]

A related regulatory issue pertains to the Strata Property Act, where regulations were amended in March 2018 to "include user fees for services or costs of service that only apply to common property and common assets". This effectively allows a strata corporation to adopt a bylaw or rule that determines a cost for electric vehicle charging at a fixed rate per hour of charging, which would include the cost of electricity and the cost of any upgrades or maintenance requirements of the strata corporation.[28] Even though these amendments have been made to the Strata Property Act, strata corporations are still not legally permitted to sell electricity according to BCUC laws. Section 21 of the Utilities Commission Act requires any entity selling electricity to register as a public utility, which makes it difficult for a strata to sell electricity to EV owners.[29]

The issue facing the Strata Property Act will also need to be considered in the BCUC inquiry.

[1] More information about the BCUC Inquiry is available here: http://www.bcuc.com/Documents/Proceedings/2018/DOC_50755_02-08-2018_BCUC-EV-Charging-FAQ.pdf

5.0 Public EV Charging Additional Considerations

Municipal policy and regulation may be one of the most effective ways to provide opportunities for EV charging, and thereby help increase EV adoption rates. However, there are a number of other practices and actions that municipalities have pursued to site and manage EV charging infrastructure. This section presents a summary of some of those practices, touching on the Capital Region, Metro Vancouver, and the cities of Portland and Montreal.

5.1 Public Charging Station Networks

A 2015 report by the International Council on Clean Transportation (ICCT) analyzed the actions that are impacting electric vehicle deployment in the 25 most populated US metropolitan areas. One of the study's most relevant findings is that the number of public chargers per capita is a significant factor in a city's EV share. Public charging infrastructure can help alleviate range anxiety, extend the functional range of an EV, offer an economic incentive when the electricity is provided for free, and demonstrate support from municipalities and businesses.[30] With 120 charging stations in the Capital Region, there are approximately 31 stations per 100,000 people.

In the Capital Region, almost all municipalities provide publicly accessible EV charging stations. According to ChargeHub, in July 2018 there were approximately 120 EV charging stations within the region, 116 of which are Level 2, and 4 of which are Level 3 (fast charger).[31] Common locations for municipally / regionally managed stations include:

- Libraries
- Municipal Halls
- Community or Recreation Centres
- Park and Ride Facilities
- Public Parkades

The City of Montreal has taken a different approach to siting its City-owned charging stations. Many EV owners who live in the core part of the city do not have access to a home charging station. As such, the City has strategically sited 400 of its 475 public charging stations on-street to provide viable charging opportunities for the "garage orphans" that is, households that do not have access to a carport or garage, and therefore do not have the ability to charge an EV. It was reported that having access to a public charging network in Montreal has been valuable for increasing EV uptake among prospective EV owners.[32] The City is planning to provide another 200 public EV stations by the end of this year, which would bring its total to 675.[33]

Both the City of Portland and City of Vancouver explained how Level 2 charging stations in their respective cities are found in locations that are highly visible and where dwelling times are typically longer than an hour. These locations include park and rides, community centres, grocery stores, malls, and coffee shops and parks. The City of Vancouver specifically sites charging stations[34] based on the following criteria:

- Level 2 chargers | where people typically spend 1–2 hours such as community centres and malls
- DC Fast chargers | where people typically spend 45 minutes to an hour including restaurants, coffee shops, downtown hubs, and grocery stores
- Neighbourhood site specific DC fast chargers | sites with higher density, older housing stock, and higher rates of rental properties

The City of Portland has an initiative called "Electric Avenue", which is a research project between Portland State University, Portland General Electric, and the City of Portland that allows EV owners and E-Bike users to park and charge their vehicle. One of the main objectives of Electric Avenue is to raise awareness among the general public of a parking and charging "oasis" in downtown Portland. Electric Avenue offers four Level 2 stations and 1 Level 3 fast charger.[35,36] An important part of the project's success has been its visibility and the convenience it has provided to EV users.[37] Plug In BC also reported that "clustering" of stations is becoming a best practice. In addition to the convenience benefits identified in Portland's Electric Avenue initiative, clustering stations also gives EV users more confidence that they will receive a charge due to the larger number of stations that could be available.[38]

The City of the Montreal was the only interviewed municipality that reported how clustering Level 2 charging stations in one location was not successful, such as the 16 stations around City Hall. They have found that it is more useful and strategic to site the stations in areas where they are visible.[39]

A 2018 Nissan Leaf parked in the EV only parking stall at the Oak Bay Municipal Hall. Municipal Halls are a common location for municipally-owned EV charging stations.

5.2 Paying a Fee for Public Charging Station Use

Almost all municipalities in the Capital Region do not currently charge a user fee for utilization of a public charging station. The only exception is the Township of Esquimalt. The Township only has one publicly accessible charging station. Due to the increasing demand for the EV charging station, a user fee of $1.00 per hour came into effect on July 4, 2017. Since 2014, station use has increased by more than 50% each year. The revenues collected will be used to fund sustainability initiatives through the Township's Sustainability Reserve Fund.[40]

The rationale[41] for introducing the fee is five-fold, as follows:

1. Manage increasing demand
2. Limit the length of charging sessions
3. Provide neighbourhood charging for EV drivers without access to an at-home charger
4. Avoid conflict between station users
5. Reduce range anxiety for current and prospective EV drivers

While charging a user fee for public use is not a common practice in Canada, some leading EV municipalities such as Montreal and Vancouver do have established fees in place. In Montreal, the rates are set by the province through the Electric Circuit initiative, which is the largest public charging station network in the province. Rates for a Level 2 station are $2.50 per charge or $1 per hour, which is billed per minute while the vehicle is connected to the station. This rate structure allows for flexibility in the charging time needed by drivers. Level 3 stations are $10 per hour and are billed per minute while the vehicle is connected to the station.[42]

As of spring 2017, the City of Vancouver started charging a user fee for public charging stations at City-owned locations. The reasons for introducing the fee are similar to Esquimalt, especially for helping encourage turnover. The City found that on average, users were connected to the charging stations for about 3 hours each session, which was approximately double the amount of time required to receive a full charge.[43] The rates are as follows:

- Level 2 station – $2 per hour ($0.033 per minute)
- Level 3 station – $16 per hour ($0.267 per minute)

Other municipalities that the project team spoke with including the City of Surrey, City of North Vancouver, City of Port Coquitlam, City of Richmond, and City Burnaby all confirmed that they have plans in the immediate future to introduce a fee for their public charging stations, which indicates that there is trend toward this practice in the Metro Vancouver region.

6.0 Barriers to EV & E-Bike Adoption

6.1 Electric Vehicles

Research has identified a number of barriers to electric vehicle adoption. Understanding the key barriers are critical for determining the most appropriate suite of policies, strategies, and incentives that could be implemented to alleviate barriers and increase EV adoption rates. Based on a review of the literature and experience from other jurisdictions, a summary of the most common barriers to EV adoption are summarized as follows. This section also includes results from the online public survey that was open to residents in the Capital Region from June to July 2018. More information about the survey is presented in Section 8.0.

"Range Anxiety" – Real Vs. Perceived

Widely reported as one of the most commonly reported barriers, potential EV buyers cite range anxiety as one of main reasons why they do not purchase a vehicle.[44,45] Range anxiety refers to the fear of running out of battery power before the next opportunity is available to charge a vehicle. Battery range is generally improving in newer vehicles with some vehicles capable of travelling over 500+ km on a single charge. However, the perception of range anxiety is still a key barrier to adoption. Studies have shown that a large gap exists between perceived and real-word range anxiety which can be alleviated by driving experience.[46] Research has also found that as the range of an EV increases, so does the willingness to purchase of vehicle.[47]

A recent survey by BC Hydro found that more than six in 10 British Columbians reported that there is not enough charging infrastructure in BC to make them feel comfortable about purchasing or leasing an EV. This issue though, is more related to perceived range anxiety as BC Hydro reported that approximately 95% of car trips in BC are less than 30 kilometres. In addition, the study also reported that the availability of EV models is improving in the province with newer vehicles offering greater range.[48]

The issue of perceived range anxiety was also identified in the Capital Region public survey, where 11 of 58 respondents indicated that it is a barrier affecting their decision to purchase an EV. However, perceived range anxiety appears to be less significant of an issue for residents in the Capital Region compared to other geographies.

While perceived range anxiety is less of an issue for residents in the Capital Region, survey respondents were also asked to state challenges with EV ownership. This question was directed to

those who own an EV or plan to purchase one. Specifically, 111 of 540 respondents identified range anxiety as a challenge. Responses to this question largely fit into two themes, as follows:

- Limited range for long-distance travel
- Lack of public charging facilities to alleviate range anxiety, specifically, the lack of level 3 (DCFC) stations

Purchase Price

The price of an electric vehicle, which is strongly influenced by battery costs, have been identified as being one of the most significant obstacles to widespread EV adoption.[49] Research and consumer surveys have consistently found that price is a major barrier to EV sales. The 2017 survey by Plug'n Drive confirmed that the top reason gasoline-powered car owners choose not to purchase an EV is price.[50]

Plug'n Drive's final report highlighted the importance of communicating the "total cost of ownership" of a gasoline-powered car versus an EV. An understanding of the total cost of ownership can increase the likelihood that drivers of small and mid-size cars making a decision to purchase a plug-in hybrid or a battery electric vehicle.[51] The BC Hydro study reported that the total costs of ownership for three 2018 EV models was less expensive than three comparable gas-powered cars. For example, it reported that a Nissan Leaf is $1,465 cheaper than a Honda Civic over an annual basis, which is mostly due to fuel costs ($449 for electricity vs. the Civic's $1,705 in gas at 20,000 kilometres per year).[52]

Purchase price was identified as the most significant barrier in the Capital Region public survey. Specifically, 30 percent of the respondents selected "EVs are too expensive" as the main factor for why they do not own or plan to purchase an EV. Qualitative responses confirmed that the existing price of an EV is not yet financially competitive with an internal combustion engine.

Lack of Knowledge + Experience with EV Technology

Most potential EV buyers have little knowledge of electric vehicles and almost no experience with them. Public consumer surveys have shown that many consumers do not even know someone with practical experience driving or charging EVs.[53] A 2017 Canadian survey found that more than 40% of interviewed EV owners were introduced to EVs by a friend, a relative or a colleague before owning one. Gasoline-powered car owners had never been exposed to an EV before buying their car.[54] In sum, lack of experience and familiarity with EVs can act as a major barrier to widespread adoption and perpetuate myths about the technology itself.

Charging Time

On average, a gasoline-powered vehicle can refuel in approximately 4 minutes, whereas an EV requires approximately 30 minutes at a DC fast charger station and up to several hours from a 110 or 220 V outlet, depending on the battery size.

Lack of Variety in Model Types

Various studies and consumer experiences have identified the lack of variety of EVs at the dealership as a barrier to EV adoption. One study indicated that EVs will need to become available in a broader set of vehicle types, or consumers will need to shift their interests in EV vehicle types if EVs are to achieve high percentages of vehicles purchases.[55] This appeared to be less of a barrier / issue in the Capital Region public survey where only 10% of respondents indicated that the lack of model or vehicle types is a significant factor.

A recent article published in Business Insider identified 30 distinct electric vehicle models that are slated to come to the market by 2025. These vehicles, to be offered by several different car manufacturers, will include SUVs (e.g., Tesla Model Y, Audi e-tron, Mercedes-Benz EQC, Volvo XC40), sedans (e.g., Subaru Crossover, Volkswagen I.D.), a pick-up truck offered by Tesla, and luxurious vehicles such as the Porcshe Taycan.[56] Greater diversity in model types will appeal to a broader segment of the market.

Availability of Public Charging Stations

This barrier, which is one of the most relevant for this project, confirms that the location of public EV charging stations plays an important role in the personal mobility patterns of EV owners, including the specific travel routes they take and where they shop.[57] In BC, the majority (over 90%) of EV owners charge their vehicle at home or work.[58] This trend has been observed in other parts of Canada, across the United States[59] and around the world.

Even though most EV owners charge their vehicles at home, research has shown that the lack of public charging stations can act as a major impediment to EV adoption. Research has found that the limited availability of rapid-charging stations (i.e., DC Fast Chargers) is the largest barrier to adoption as there are limitations on desired charge time.[60]

The Capital Region public survey also reported this barrier; about 21% of respondents indicated that the lack of public chargers in the region is a barrier to EV ownership. Part of this barrier might be explained by the lack of opportunity to charge at home, discussed below.

Lack of Ability to Charge at Home

For households that do not have access to a carport or garage, the ability to access charging overnight can be a major problem.[61] In the City of Montreal, for example, many of the EV owners who live in the core part of the city do not have access to a home charging station (referred to as "garage orphans"). It was reported that having access to a public charging network in Montreal has been valuable for increasing EV uptake among prospective EV owners.[62]

Approximately 20 percent of the respondents in the Capital Region public survey selected "don't have the ability to charge at home" as a key barrier to EV ownership. Qualitative responses to this barrier included three main themes, as follows:

- The resident lives in an apartment rental building with no ability to charge an EV
- The resident lives in a condo building with no ability to charge an EV
- The resident does not have a driveway / garage, which limits the ability to charge an EV

6.2 E-Bikes

As a newer mobility trend, many consumers are unfamiliar with E-Bikes and those who own—or have expressed interest in purchasing one—have reported technological, social, environmental, and security barriers. As a new and emerging transportation option, the research has not caught up with all of the consumer attitudes and concerns regarding E-Bikes; however, this section presents the latest research on barriers, which are important for informing policy direction. Relevant results have also been included from the Capital Region public survey.

Price

Similar to the price barrier identified for EVs, E-Bikes are generally more expensive than regular bikes; in North America the differences is approximately 25-40% Results from the Capital Region public survey found that; approximately 37 percent of respondents selected "too expensive" as the main factor contributing to their decision to not purchase an E-Bike. This was the most selected barrier.

One study asked respondents about their perceptions of cycling and of E-Bikes as well as their willingness to pay for an E-Bike. It found that price was identified as the largest hindrance to purchasing an E-Bike; however, those who were given access to an E-Bike had much higher willingness to pay for one.[63] The researchers concluded that people are largely unaware of the benefits of an E-Bike and showed greater interest once their knowledge of them improved.

The perception of E-Bikes being expensive is also a barrier. One study conducted 27 interviews with E-Bike users to understand why they purchased one and what their overall experiences have been. The perception of E-Bikes being expensive may derive from the assumption that E-Bikes are meant to be used for recreational activities (i.e. as a substitute for road bikes or other forms of recreation) and not for transportation (i.e. as a substitute for cars).[64] E-Bikes may be expensive relative to regular bikes, but their true cost depends on what kinds of trips they are used for. For example, when compared to a car, E-Bikes are significantly cheaper; the study's participants noted that the savings from gas and insurance costs can make E-Bikes even more cost effective.[65]

A March 2018 report by Portland State University presented results of a North American survey of electric bike owners. The survey did not identify price as a barrier as it was focused on those who own or regular operate an E-Bike; however, the report did report that E-Bikes have the capacity to replace various modes of transportation commonly used for utilitarian and recreational trips including motor vehicles, public transit, and regular bicycles. The majority of the utilitarian trips

being made by an E-Bike are replacing motor vehicle trips.[66] These findings can help put the price of an E-Bike into context, especially when compared to the price of a motor vehicle.

Research has shown that people are largely unaware of the benefits of an E-Bike and showed greater interest once their knowledge of them improved.[67]

Lack of Secure Parking

Closely related to the price of an E-Bike is the concern about theft. Multiple studies have found E-Bike owners have concerns and anxiety about the security of their e-bike.[68].[69] Concerns about theft are partially explained by lack of secure bike parking. One study investigated the motives for e-bike purchases, rider experience and perceived impact on mobility, health and wellbeing through in-depth interviews with e-bike owners. E-Bike owners reported that parking E-Bikes is a challenge at major transportation hubs such as public parking facilities due to a lack of space or issues with design. Participants explained how it can be hard to find bike stands in city centres that can accommodate an E-Bike.[70]

In addition, parking in public parking facilities was identified as challenging because of the difficulty with maneuvering in and out of bike parking areas and the heaviness of the bike itself, which makes it hard to lift over obstacles. As a solution, participants identified the need for more secure long-stay valet style parking in city centres and transportation hubs with provision to charge batteries. Reported issues with parking specifically include the lack of suitable racks to accommodate an e-bike and the need for more secure long-term parking to avoid leaving the E-Bike outside.[71]

The Capital Region public survey also found that the lack of secure parking is a barrier facing prospective E-Bike owners. Approximately 27 percent and 15 percent of respondents selected "afraid that it might be stolen" and "lack of places to park an E-Bike", respectively, as factors for why they have not purchased an E-Bike. Combined, this represents 42 percent of the total responses, which indicates that the lack of secure bike parking is a critical issue that requires policy attention.

Social Stigma

Studies have shown that there is sometimes a stigma attached to E-Bike use. Some people perceive E-Bikes as "cheating", as it takes away the physical effort required to pedal a regular bicycle and people are uninformed about how E-Bikes could also be used for utilitarian purposes

and substitute for car trips.[72] E-Bike owners reported being judged by their work colleagues, who deemed an E-Bike as a more suitable form of transportation for those with a disability or for older people. Some E-Bike owners have reported that the perception of E-Bikes as being used for recreational purposes was considered cheating by their peers, who were uninformed about how E-Bikes could also be used for utilitarian purposes and substitute for car trips.[73]

This issue did not surface as much in the Capital Region public survey; however, some qualitative response in the survey included "they are ridiculous; ride a proper bike"; "I'm a stronger rider, no need for one"; "concerned about looking like a huge dork". While these sentiments were in the minority, they still indicate a perceived stigma around using electric bikes.

General Safety Concerns for Current & Prospective E-Bike Owners

Numerous studies have confirmed the issue of safety as a key barrier to E-Bike adoption and a concern for E-Bike owners. Safety can be organized into two categories: [a] the actual safety of the E-Bike itself including its higher operating speed relative to a regular bicycle and [b] safety of riding an E-Bike on the road.

Specifically, the lack of speed restrictions of E-Bikes has been reported as worrisome, especially if the E-Bikes use bike lanes or multi-use paths as the main cycling infrastructure for travel.[74] A related safety issue is the challenge of visually distinguishing E-bikes from regular bicycles. Car drivers may underestimate the speed at which an E-Bike is approaching, resulting in a potential conflict.

E-Bike owners, as a subset of cyclists more general, report concerns regarding road safety, particularly around interacting with cars on the road. The Capital Region public survey found that approximately 22 percent of respondents selected "concerned about safety" as barrier to E-Bike ownership. A significant number of the qualitative responses around safety pertained to the need for better cycling infrastructure including protected bike lanes.

6.3 Summary of Barriers to EV & E-Bike Adoption

The research presented above confirms that there are a number of barriers—technological, economic, social, and infrastructure—to EV and E-Bike adoption. For this *Backgrounder,* and the *Infrastructure Planning Guide* more broadly, the availability of EV charging stations is a key barrier to adoption that require both policy and regulatory attention. While there are several real and perceived barriers with E-Bikes, the importance of secure and safe parking facilities is critical for accommodating the needs of both current and prospective E-Bike users.

7.0 Infrastructure Gap Analysis

7.1 Purpose of a Public Charging Station Network

As described in previous sections, research has shown that the presence of a public EV charging network is a critical consideration for potential EV buyers. In addition, the location of public EV charging stations (i.e., where the stations are physically sited) can influence the personal travel patterns of those electric vehicle users, including the specific travel routes they take and where they shop.[75] Results from the Capital Region public survey (see Section 8.0) also confirm the importance of a public charging station network. A majority of the respondents identified the need for more charging public charging stations.

The purpose of the infrastructure gap analysis will be to evaluate where EV charging stations gaps exist in the Capital Region, and to identify the highest priority locations for new charging stations to guide future site selection.

A review of the key objectives for a public charging station network was prepared below to help inform and guide the infrastructure gap analysis. The information draws on the results from the public online survey and summary of best municipal best practices. The objectives of a network are three-fold:

1. Tackling Range Anxiety: To help alleviate range anxiety by providing drivers with the opportunity for "lifeline" charging, which refers to the ability to charge a vehicle when its battery is almost depleted;
2. Increasing the EV Profile: To create public awareness and understanding of electric vehicles and increase exposure and knowledge of EV technology; and
3. Accommodating Garage Orphans: To provide viable charging opportunities for families who do not have access to off-street parking (colloquially known as "garage orphans").

In relation to DC Fast Chargers specifically, the BC Ministry of Energy and Mines[76] has identified the following four guiding principles for deployment across the province, including:

- Connect priority travel corridors across the province, where "priority travel corridors" are defined as travel corridors that either have a large volume of commuter traffic, support cross jurisdictional travel, or support tourism within BC.
- Ensure infrastructure deployment allows for safe travel in the province.
- Support regions with dense plug-in electric vehicle (EV) adoption.
- Maximize population areas served.

It is also noted, that while it is unreasonable to expect that every station in BC's fast-charging network will meet all four principles, these guiding principles should be referenced and balanced whenever new locations are considered, in the context of the network as a whole.

7.2 Methodology

A geospatial analysis was conducted using the Esri ArcGIS and R software packages to evaluate where EV charging stations gaps exist in the Capital Region, and to identify the highest priority locations for new charging stations.

The infrastructure gap analysis estimates EV charging station suitability using a Geographic Information System (GIS) by quantitatively assessing individual built environment and transportation criteria that approximate demand for EV charging. All the criteria are then integrated together to create a composite index that assesses suitability across the region. An overview of the criteria used is described in Table 10, outlining the criteria, their definition, the data source, and relevance as a proxy for EV charging station demand. The analysis combines parcel-level data from BC Assessment and other objective built environment and transportation data from the Capital Regional District, BC Transit, and PlugShare.com.

Table 20. Overview of Infrastructure Gap Analysis Criteria

Type	Theme	Criteria	Definition	Source
Quantitative	Built Environment	Residential Density	Number of multi-family residential dwelling units divided by residential land area (sq. ft.)	BC Assessment
		Commercial Density	Commercial building floor area (sq. ft.) divided by commercial land area (sq. ft.)	BC Assessment
		Land Use Mix	Evenness of building floor area distribution across multi-family residential, commercial, and office uses	BC Assessment
	Transportation	Traffic Exposure	Estimated average daily traffic (ADT)	Capital Regional District
Qualitative	Transportation	Existing EV Charging Station Locations[2]	Location of existing Level 2 and 3 public electric vehicle charging stations	PlugShare.com
		Park and Ride Facilities	Location of existing BC Transit park and ride facilities	BC Transit
		Public Parking Facilities	Location of public parking facilities	BC Assessment
	Built Environment	Institutional Buildings	Location of institutional buildings, including recreational and cultural facilities, hospitals, schools, and universities/colleges	BC Assessment
		Parks and Playing Fields	Location of parks and playing fields	BC Assessment

The analysis used a two-stage approach to evaluate EV charging station suitability and identify priority hotspots. First, a composite index was created by combining four quantitative criteria together: residential density, commercial density, land use mix, and traffic exposure. This predicted the suitability of areas across the region, showing locations of low, medium, and high demand for EV charging stations. Second, a hotspot analysis was conducted and the qualitative criteria were

[2] Existing charging station data was obtained from PlugShare.com July 2018. All stations were geo-coded and added as a layer to the geospatial analysis.

overlaid on top of the results to identify existing gaps and priority locations (by comparing against existing EV charging station locations) and ideal opportunity sites to locate a station (by comparing against the presence of institutional buildings, parking facilities, and parks).

Note: the intent was to do a technical analysis to guide infrastructure planning and investment at a regional level. While not considered in the analysis, it is assumed that there may be specific municipal and electoral area considerations that are unique to that community (ex. niche tourism and economic development opportunities, local per capital EV ownership rates, etc.)

The analysis followed nine major steps:

1. The Capital Regional District was spatially divided into 150-metre grid cells to generate the unit of analysis. These units are small enough to introduce site and localized neighbourhood characteristics, but are manageable from a site suitability, data management, and computer processing perspective.[77]
2. The Building Information Report, Residential Inventory Extract, and Commercial Inventory Extract from the 2018 property assessment roll from BC Assessment were joined with the Capital Regional District's property cadastre.
3. For the built environment criteria, gross building floor area and land area at the parcel level were calculated for multi-family residential, commercial, and office properties.
4. For the traffic exposure criteria, arterial and collector links were retrieved from the 2008 CRD Regional Transportation Model. Average daily traffic (ADT) was estimated from PM peak hour volumes to identify an initial threshold of 22,000 vehicles per day (two-way total) for a high-volume roadway, 15,000 vehicles per day for medium-volume, and less than 15,000 for low-volume. Following an initial review of the results, local knowledge of commuter routes and daily traffic patterns were used to finalize the classification.
5. All the criteria were then aggregated and summarized at the grid cell level.
    a. For the built environment criteria, the average net residential and commercial density and the land use mix was calculated for each cell.
    b. For the traffic exposure criteria, a 25-metre buffer was generated for the road network to operationalize the analysis. The rationale of a 25-meter buffer was to reflect the short driving distance that a vehicle would need to travel to access a Level 3 charging station from the network. Grid cells that fell within the 25-metre buffer were then intersected and joined with the traffic exposure layer and assigned a score. Cells received a score of "0" if there were no roadways; "1" for

low-volume roadways; "2" for medium-volume roadways; and "3" for high-volume roadways.

6. Each quantitative criteria was normalized from 0 to 1 to create comparable measures before calculating the composite index.
7. Weights were developed to evaluate EV charging station suitability separately for Level 2 and Level 3 charging stations. The weights were informed by the literature and assigned to each criteria based on their relative suitability for a Level 2 versus a Level 3 charging station (see Table 11). A weight of 60% was assigned to high, 30% to medium, and 10% to low for a total of 100%.
8. The composite index was calculated by summing the criteria together. The equations for the Level 2 and 3 composite index took the following forms:

   Level 2 Suitability = (0.6 · Residential Density) + (0.6 · Commercial Density) + (0.3 · Land Use Mix) · (0.1 · Traffic Exposure)

   Level 3 Suitability = (0.1 · Residential Density) + (0.3 · Commercial Density) + (0.3 · Land Use Mix) · (0.6 · Traffic Exposure)

9. Based on the results of the composite index, a hot spot analysis was conducted to generate the final Level 2 and Level 3 suitability maps. The hot spot analysis identifies statistically significant spatial clusters of high values (hot spots, i.e., areas where EV charging demand would be high) and clusters of low values (cold spots, i.e., areas where EV charging demand would be low).

Qualitative criteria were not included in the composite index as a reliable scoring and weighing system could not be developed for the purposes of the analysis. Instead, they were used to help inform and prioritize one hotspot location over another by identifying "opportunity sites" that were ideal for an EV charging station based on the research and literature.

Table 11. Summary of Weighting by Criteria

Type	Theme	Criteria	Weighting	
			Level 2	Level 3
Quantitative	Built Environment	Residential Density	High	Low
		Commercial Density	High	Medium
		Land Use Mix	Medium	Medium
	Transportation	Traffic Exposure	Low	High
Qualitative	Transportation	Existing EV Charging Station Locations	N/A	
		Park and Ride Facilities		
		Public Parking Facilities		
	Built Environment	Institutional Buildings		
		Parks and Playing Fields		

7.3 Results

All of the mapping results are presented in Appendix B. The mapping results have been organized by four distinct geographic areas, as follows:

1. Capital Region, which includes all 13 municipalities and three electoral areas;
2. Core Area, which includes the City of Victoria, District of Saanich, District of Oak Bay, Township of Esquimalt, and Town of View Royal;
3. West Shore, which includes the City of Colwood, City of Langford, District of Metchosin, District of Highlands, and District of Sooke; and
4. Peninsula, which includes the District of Central Saanich, District of North Saanich, and Town of Sidney.

At a regional scale, the priority locations were ranked and identified for both Level 2 and Level 3 charging stations across geographic areas, shown in detail in Appendix B. The *Infrastructure Planning Guide* will provide recommendations for future charging infrastructure across the region.

8.0 Public + Development Industry Engagement

The project team conducted two online surveys over the months of June and July 2018—one directed at the general public and the other to the development / building industry. The public survey was focused on perceived barriers and opportunities around EV and E-Bike ownership as well identifying how best EV charging opportunities could be facilitated in the Capital Region.

The developer / industry survey was focused exclusively on EVs and was intended to [a] understand existing developer uptake in EV charging infrastructure in new buildings, [b] collect feedback on the barriers facing developers / builders to make their buildings EV-ready, and [c] gather feedback and support for municipal policies and actions that could be adopted to advance EV charging infrastructure in new development.

All of the survey results are presented in Appendix C and Appendix D.

The follow section provides a discussion of the key findings from the surveys.

8.1 Public Survey

High-Level Findings

Detailed findings from the survey are presented in the following sections. Below is a high-level summary of the respondents. This survey contained 24 questions. The survey was open from June 12, 2018 to July 8, 2018. *Note, the analysis of results includes both completed and partially completed surveys, which, when combined, provide a larger overall sample. Responses in partially completed surveys still represent valid data when analyzed in isolation.*

High-level findings are as follows:

- There was a total of 592 completed surveys.
- There was a total of 110 partially completed surveys.
- Survey responses were received from all parts of the Capital Region along with the Southern Gulf Islands, Salt Spring Island and Juan de Fuca Electoral Areas. Those living in the District of Saanich, City of Victoria, and District of Sooke represented the highest number of survey respondents at 28%, 26%, and 8%, respectively.

- The majority of survey respondents live in a single family home (64%), followed by multi-family building (17%).
- About 40% of the respondents own two vehicles, followed by 37% who own one vehicle. A total of 7% of respondents do not own a vehicle.
- The 30-39 age group represented the largest age cohort (24%), followed by 40-49 (22%) and 60-69 (21%).
- The majority of survey respondents fall in the $100,000-$150,000 household income bracket (24%), followed by $80,000-$100,000 (15%), indicating that survey respondents were generally from higher income households. 11 percent of respondents were in the under $40,000 income bracket, while 26 percent fell between the $40,000-$80,000 range.

Electric Vehicles

EV Ownership Trends + Motivations

The public survey asked respondents to indicate the type of vehicle they currently own. Of the 702 respondents, 186 indicated battery electric vehicle, representing about 27% of all responses. The majority selected "gasoline" at 76%, with only a few selecting plug-in hybrid electric vehicle (2%). For those who do not own an EV but are interested in buying one, the majority of respondents indicated that they would buy one in the next 5+ years (21%) while 17% were unsure or do not know at this time.

For those who own an EV or are considering one in the future, the vast majority of respondents selected "reduce personal impact on the environment" as the top reason for doing so. This represented 78% of the responses, followed by "realize financial savings" (60%), and "battery range has improved" (56%).

These motivating factors are useful for understanding the EV market and what factors matter most to consumers and prospective EV owners locally. An EV's ability to reduce one's impact on the environment was a common theme in the question asking respondents to identify the benefits—or potential benefits—of owning an electric vehicle.

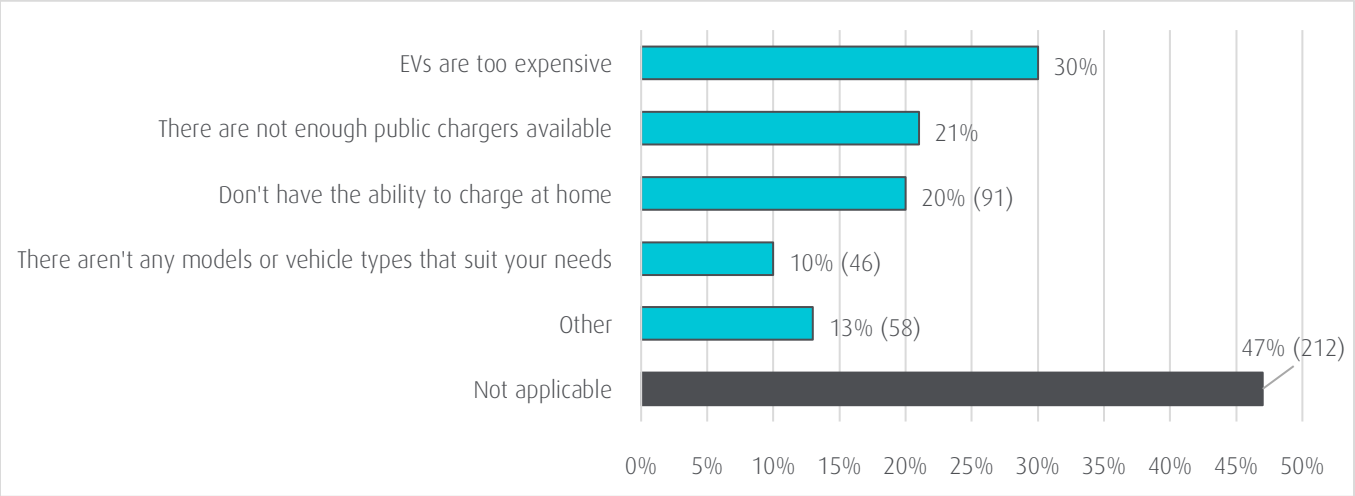
Barriers to EV Ownership

As discussed in the previous section, there are a number of barriers facing both existing and prospective EV owners. As such, a question was included in the public survey to understand local barriers in the Capital Region and corroborate what was identified in the literature. The close-ended question specifically targeted those who do not own an EV or plan on buying one. However,

EV owners may have selected "not applicable" when answering this question, which may explain why 47 percent of respondents selected this option. As shown in Figure 5, the top three barriers include: [1] EVs are too expensive, [2] there are not enough public chargers available, and [3] don't have the ability to charge at home.

Respondents were also given a chance to select "other". Only 11 of the 58 respondents indicated that range anxiety is a barrier affecting their decision to purchase an EV. Even though range anxiety was not included an explicit response option, the data indicate that it does not appear to be as significant of a barrier for why residents in the Capital Region are not purchasing an EV.

Figure 5. Summary of Barriers for non-EV owners



Another factor that emerged in the qualitative responses pertained to the respondent's current gasoline vehicle. Specifically, respondents indicated that their current vehicle still has "life" in it, and they would not need to replace it for another 5 years, for example. This consideration might help explain why the majority of respondents indicated "the next 5+ years" as the time horizon for when they would considering buying an EV.

As discussed in earlier sections of this Backgrounder, residents who live in a multi-family building are referred to colloquially as "garage orphans", that is, households that do not have access to a carport or garage, and therefore do not have the ability to charge an EV. To test whether this is, or could be, a problem in the Capital Region, a cross-tabulation was performed between "household type" and "barriers to EV ownership". The results are as follows:

- The results indicate that for those living in a multi-family building, the largest barrier to EV ownership is "don't have the ability to charge at home", which represented 40 of 146 responses (27%).
    - This was higher than all of the other household types including single detached home, where only 8% selected "don't have the ability to charge at home".
- Analyzed differently, the option "don't have the ability to charge at home" was selected 91 times, of which 40 represented respondents who live in a multi-family home, which represents 43% of the total.

These results, while not causal, generally confirm that those living in multi-family buildings in the Capital Region are at a disadvantage due to the lack of ability to charge an EV at home.

Challenges to Owning / Operating an EV

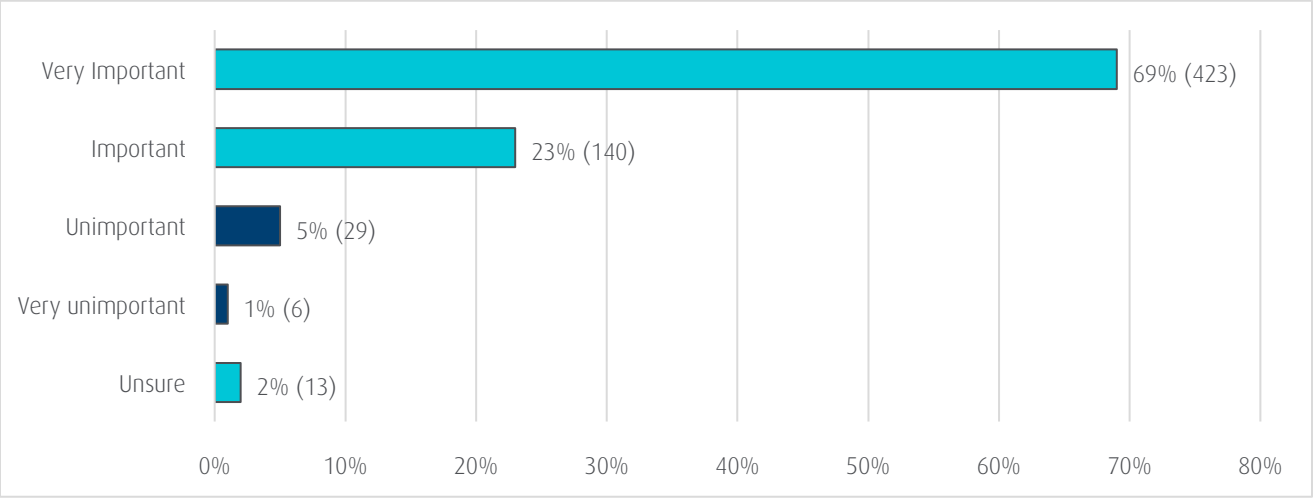
The survey was designed to capture feedback from current EV owners, as well. One of the survey questions asked: "what are, or could be, the challenges of owning an electric vehicle for you / your household?" There were 540 responses to this question. Key themes are as follows:

- Even though range anxiety was not identified as a barrier to prospective EV ownership, 111 of 540 responses identified range anxiety as a challenge
- The lack of public charging stations was identified as another core challenge, which is correlated to range anxiety
- Similar to the preceding section, the lack of the ability to charge at home was identified as a challenge. Some respondents indicated that they live in a multi-family building and do not have viable opportunities to charge their vehicle.

Importance of EV Charging Infrastructure

One of the main objectives of the public survey was to obtain feedback on EV charging infrastructure, specifically, where the public sees the greatest opportunities to expand opportunities for EV charging. Unsurprisingly, the majority of respondents indicated that having access to an at-home charger is "very important" with regard to owning or deciding to purchase an EV (see Figure 6).

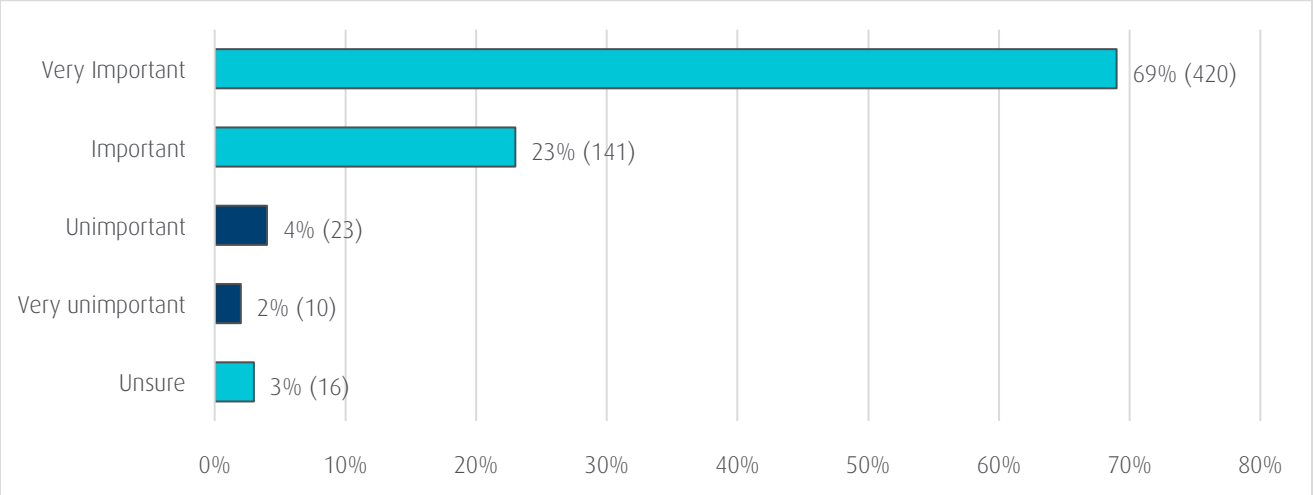
Figure 6. Importance of Access to Home Charging for EV Ownership



A cross-tabulation was performed to determine whether household type matters with respect to the overall importance of access to at-home charging. Those living in a single detached home overwhelmingly selected "very important" to this question, or approximately 71% of 394 responses. This trend was also observed for other household types, as well, especially those living in multi-family buildings; of the 105 respondents who indicated that they live in a multi-family building, 65% selected "very important". It should be noted that the majority of the survey respondents identified single family home as their household type (65%), which explains why there is a large disparity in the overall responses by household type.

Figure 7 displays the results of the question "how important is it for electric vehicle adoption that the local governments in the capital region ensure new residential construction be "future-proofed" to allow for easy installation of electric vehicle charging equipment in the future?"

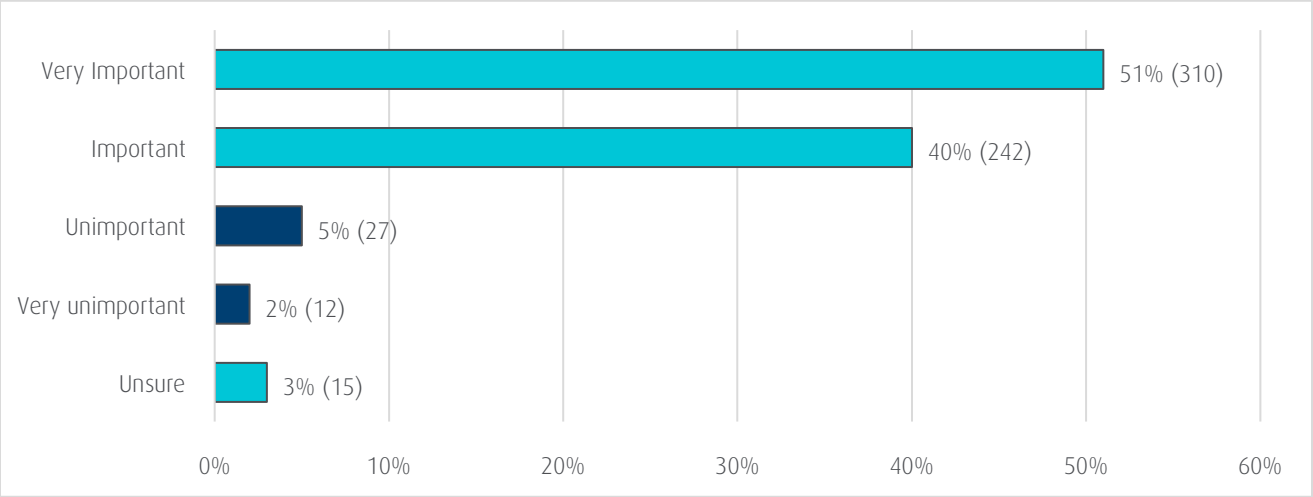
Figure 7. Importance of Future Proofing New Developments to be EV-Ready



The results shown above demonstrate clear support for EV-ready buildings, which is something that local governments in the Capital Region have the ability to regulate through their zoning bylaws. This will be further explored in the Best Practices Guide.

Respondents were also asked to indicate the importance of access to a public charging station network with regard to owning or deciding to purchase an EV. Figure 8 presents the results. The results demonstrate that access to a public charging station network is important with approximately 91% of respondents selecting "very important" and "important".

Figure 8. Importance of Access to a Public Charging Station Network for EV Ownership



Related to having access to a public charging network is the question of whether there should be a fee in place to charge one's vehicle. This was included as a survey question and framed as good practice for reducing congestion for other EV users and for helping offset maintenance and operating cost, as discussed in Section 5.2. 21% of respondents selected "$1.00 per hour" as a reasonable fee for public charging, which would represent a logical transition for EV users who do not currently pay a fee for public charging except in Esquimalt.

Other respondents however, indicated that $1.50-$2.50 per hour is reasonable (~25% of respondents). Open-ended responses to this question included everything from public charging stations should be free, to higher willingness to pay for a Level 3 station, to not charging per hour but by time or use. This topic will be further explored in the Infrastructure Planning Guide.

Finally, respondents were also asked to indicate the importance of having access to at-work charging. Unlike access to at-home charging or future proofing new developments, results were mixed on the importance of at-work charging:

- 33% selected "very important"
- 39% selected "important"
- 19% selected "unimportant"

Siting Public EV Charging Stations

As part of developing the methodology for the infrastructure gap analysis and informing the siting criteria, questions were included in the survey to provide respondents the opportunity to rank the importance of seven public charging station locations. The following were listed:

- Major roads and highways
- Community centres
- Libraries
- Parks
- Downtown areas
- On-street
- Public parkades

The questions were designed to differentiate between Level 2 and Level 3 (DCFC) charging stations. Results for the Level 2 locations are as follows:

- Public parkades ranked highest with 32% of the total responses ranked "1", and 23% of the total responses ranked "2".
- Major roads and highways received 25% of the total responses ranked "1", but it also received 27% of the responses ranked "7", indicating that respondents view major roads and highways as both important and unimportant locations for Level 2 chargers.
- Community centres received the 18% of the total responses ranked "2", which was the highest after public parkades.
- Downtown areas received an almost equal distribution of being ranked 1, 2, and 3, which indicates public support for these locations.

Results for the Level 3 (DCFC) locations are as follows:

- Major roads and highways was overwhelming ranked as "1", with approximately 65% of the total responses.
- Public parkades was also ranked high, representing 26% of the total responses ranked "2"
- Both on-street and downtown areas received the highest share of second and third rankings. While they were not ranked first, they are clearly important locations for Level 3 chargers in the view of the public.

A follow-up open-ended question asked respondents to list other locations that are or could be important for hosting an EV charging station. A common response was "shopping malls", which

was mentioned in 72 responses—or 20% of the total. Results indicate is that public parkades are the most important locations for Level 2 stations whereas major roads / highways are the most important for Level 3 stations.

E-Bikes

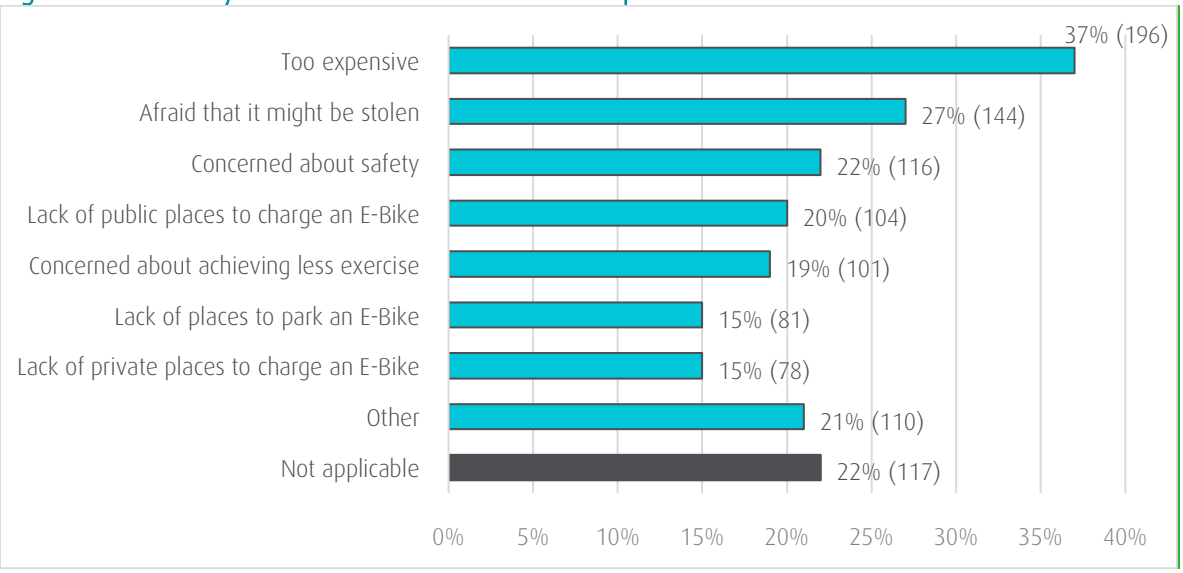
The survey included seven questions on E-Bikes ranging from general ownership, to interest in purchasing an E-Bike, and barriers for existing and prospective E-Bike users. Results of the key findings are presented below.

General findings are summarized as follows:

- Overall, only 16% of 599 respondents own an E-Bike
- About 22% of 586 respondents are planning to purchase an E-Bike in the next two to three years compared to 48% who are not planning to at all
- Respondents are generally familiar with E-Bikes; 54% have seen them on the streets; 35% have spoken to an owner of one; and 30% have done research or looked for information about an E-Bike.

Similar to EVs, both current and prospective E-Bike owners face a number of barriers / challenges. A summary of the main barriers identified in the literature was provided in Section 6.2, which are generally consistent with what was found in the survey. See Figure 9 for a summary of the barriers.

Figure 9. Summary of Barriers to E-Bike Ownership



Respondents could select all answers that applied, reflected in percentages above

The results indicate that price (i.e., too expensive) is the top barrier to E-Bike ownership, followed by "afraid it might be stolen", and "concerned about safety". Other barriers such as "lack of places to park an E-Bike" and "concerned about less exercise" were also selected, which have been found in the literature, as well. About 20% of respondents selected "lack of public places to charge an E-Bike" as a barrier, which to the best of the project team's knowledge, has not been identified in the literature.

For those who selected "other", common responses included [a] concerns about weather and [b] people's preference for a regular bicycle.

In response to the open-ended question "would you feel safe riding an E-Bike around the capital region?" the majority of respondents said yes; however, for those who wrote "no", many indicated that the bike infrastructure is not yet in place for them to feel safe.

The final question in the E-Bike section of the survey asked respondents if they would feel comfortable parking their E-Bike in a publicly accessible location. The responses were mixed on this question; a third of the 509 respondents checked "yes", a third checked "no", and the final third checked "don't know, unsure at this time". A follow-up open-ended question asked "what would make you feel comfortable parking your E-Bike in a publicly accessible location"; common responses included:

- Locked or supervised area
- A secure designated E-Bike parking facility
- Surveillance cameras
- A paid parking facility for E-Bikers users

8.2 Development / Building Industry Survey

This survey contained 13 questions. This section provides a high-level summary of the findings, which included 41 completed submissions and 22 partially completed ones. The survey was open from June 20, 2018 to July 26, 2018.

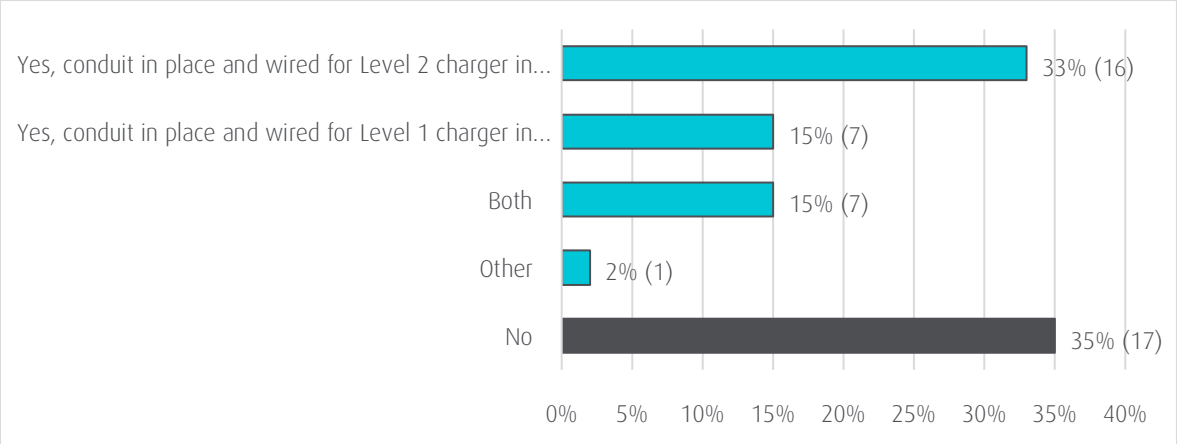
The first few questions of the survey asked the respondents to identify where they work in the region (multiple responses permitted), their role in the industry, and the types of buildings they construct. Findings are as follows:

- The City of Victoria, District of Saanich, Township of Esquimalt, and City of Langford represented the most popular municipalities where respondents have building projects at 72%, 53%, and 34%, respectively (tied between Esquimalt and Langford)
- The majority of respondents are property owners / developers (50%), followed by design professionals (30%), and "other" (25%)
- The most common types of buildings that are constructed among respondents include large residential (61%) and small residential (52%) with small scale and large scale commercial at 33% and 28%, respectively.

Experience with EVs

Survey respondents were asked to indicate if any of their recent developments have been EV-ready (see Figure 10). While 35% selected "no", 33% selected "yes, conduit in place and wired for Level 2 charger in the future". About 15% selected "yes, conduit in place and wired for Level 1 charger in the future". The installation costs per unit ranged from $300 to $5,000.

Figure 10. Degree of EV-Readiness

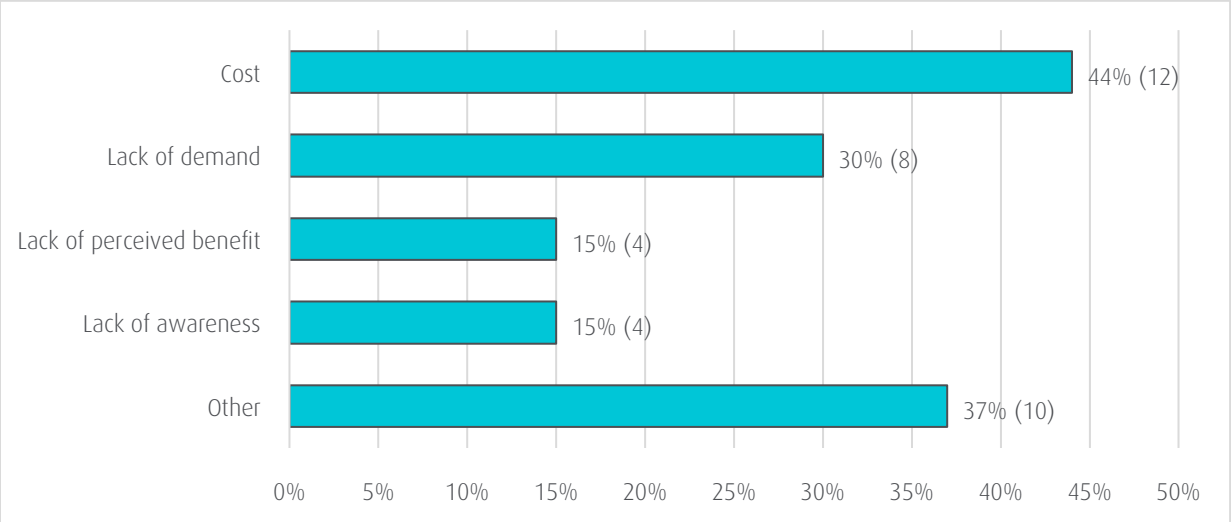


Respondents were also asked if any EV charging stations have been installed in their recent developments; 60% selected "yes" compared to 40% selecting "no". The reasons for installing an EV charging station ranged from environmental stewardship, obtaining a LEED credit, marketing to prospective tenants / owners, and consumer demand. For those who have installed an EV charging station, the majority (79%) installed a Level 2 charger with costs ranging from $1,000 to $5000 per station.

Barriers to Installing EV Charging Stations

As shown in Figure 11, there are a number of reasons why developers / builders are not installing EVs with "cost" and "lack of demand" being the top reasons. For those who selected "other", responses included the unknowns / uncertainty around who pays for the electricity and the lack of current demand. Respondents were allowed to select multiple options.

Figure 11. Summary of Barriers to Installing EV Charging Stations in New Developments



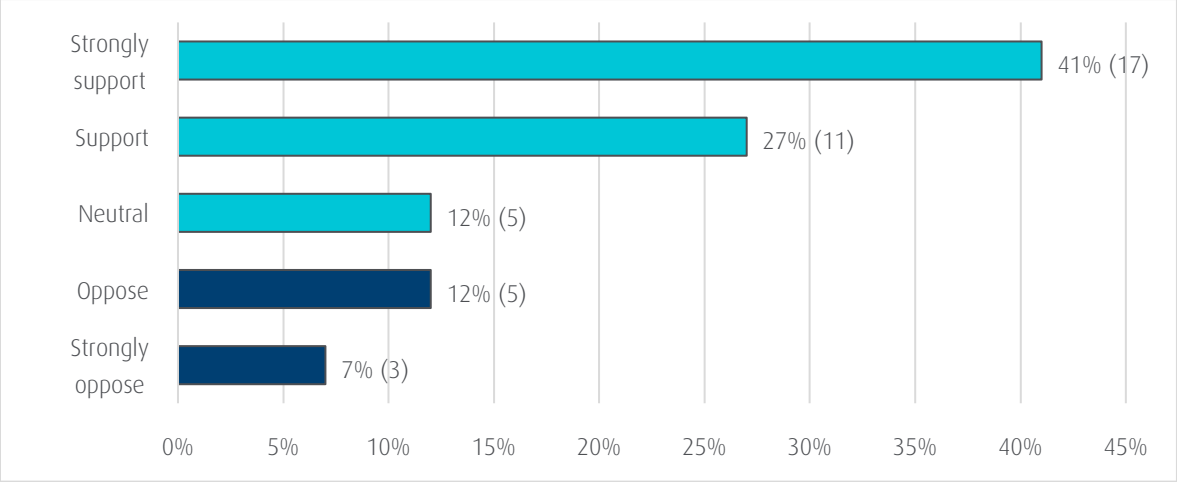
On the topic of demand, a question in the survey asked respondents to indicate the level of demand they see for EV charging today, in the next 5+ years, and the next 10+ years. A small percentage selected "high demand" and "moderate demand" for EVs today; the majority indicated moderate demand in the next 5+ years (50%) and a significant percentage indicated high demand in the next 10+ years (76%).

Policy + Regulation

As discussed previously in this Backgrounder, a number of municipalities in Metro Vancouver are adopting policy and regulation to require new buildings to be EV-ready in their respective jurisdictions. In the Capital Region, the Town of View Royal is the only municipality that has regulation in its Zoning Bylaw requiring the provisions of EV charging stations in new developments. An important part of developing EV-ready policy and regulations is obtaining feedback from the developer / building industry. As such, questions were included in the survey to gauge their support.

As shown in Figure 12, most of the survey respondents (41%) strongly support local governments in the Capital Region requiring new developments to be EV-ready.

Figure 12. Level of Support for EV-ready Regulations in the Capital Region



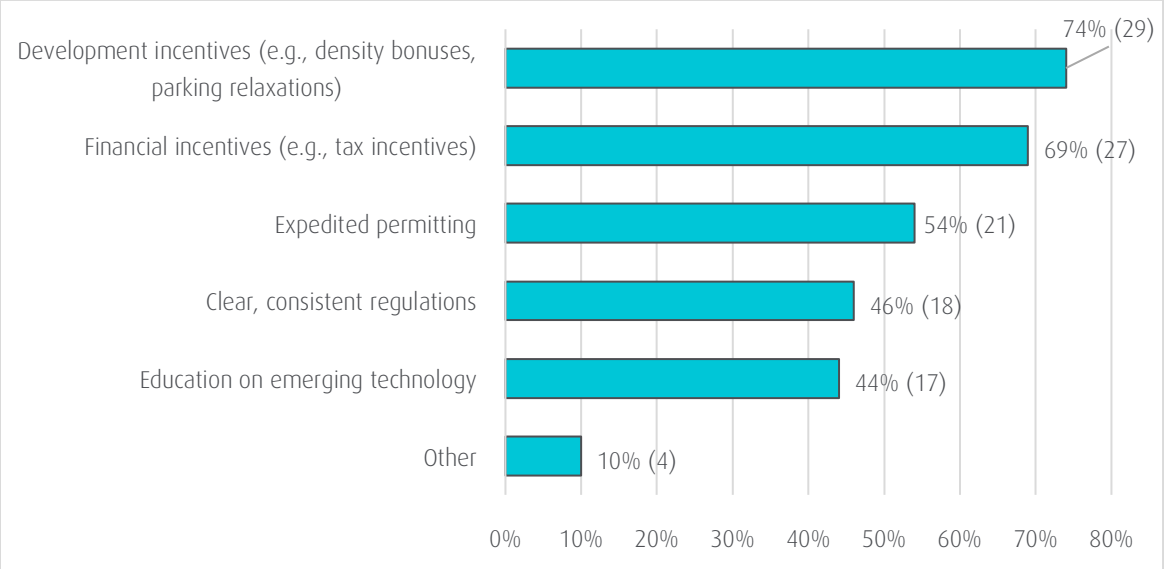
hile there is strong support for EV-ready policy and regulation, survey respondents also expressed their opposition and concerns, summarized as follows:

- Concerns over increased costs to developers, leading to increased housing costs
- The market should decide based on consumer demand
- General opposition to governments regulating this area

Respondents were also asked to comment on EV-ready bylaws, specifically whether they like the approach municipalities are taking in Metro Vancouver with requiring 100% of multi-unit residential parking stalls to be 'EV-ready' for Level 2 charging. About half of the 33 respondents indicated that they like the approach but the other half cited concerns ranging from the requirement being too high, to potential complications with strata councils, and how the market should dictate what is appropriate.

Finally, respondents were asked to respond to the question "how can local governments support electric vehicle charging infrastructure in new developments?" Results are shown in Figure 13. As the graph shows, both "development incentives" and "financial incentives" are the top actions that should be adopted to support EV charging in new developments.

Figure 13. Summary of Actions to Support EV Charging Infrastructure in New Developments



Key Takeaways from Development / Building Industry Survey

The key takeaways from the survey are as follows:

- Developers / builders are making their buildings EV-ready and/or including EV charging stations in new developments
- Both cost and lack of demand are the main reasons why developers / builders are not installing EV charging stations in new developments
- Overall, there is strong support for local governments in the Capital Region requiring new developments to be EV-ready through policy, although there are concerns around increased costs and too much government regulation
- Development incentives and financial incentives are the top actions that should be adopted to support EV charging in new developments.

8.3 Development Industry Meeting

A presentation and workshop session focused on electric vehicles was hosted at the Urban Development Institute Capital Region's (UDI) breakfast session on Thursday, July 19 2018. The session included a presentation by CRD staff, staff from the City of Victoria and District of Saanich, and the consulting team responsible for this project as well as concurrent work in Metro Vancouver. Approximately 60 people were in attendance. Attendees were primarily UDI members and included representatives from the development industry, professionals (i.e., architects, planners), local government staff, and elected officials.

Attendees were arranged in working groups near the end of the session. Three questions were posed to each group:

Q1. What is your current experience with EV charging in the new developments?
Q2. Do you have concerns about installing these in your new development projects?
Q3. What do you need in order to feel more comfortable installing these in your projects?

A summary of responses and discussion from the working groups is below:

- Issues around metering, equitable distribution of costs, and challenges with stratas assigning cost were raised as key issues. Consideration also needs to be given to differentiating rates for short- and long-term parking (i.e., customer vs employee).
- Concern was expressed over investment in charging infrastructure that may be obsolete (or "old technology") in future, and committing to a specific charging technology or supplier that may not exist in future.
- Further testing and confidence with load management system was identified as being important in easing uncertainty over building electrical requirements.
- A level of urgency with charge station installation was expressed as the region is in a period of growth and delaying installing charging infrastructure will result in more buildings requiring retrofit at a later date (and at higher cost).
- It was suggested that financial or development process incentives would encourage inclusion of charging infrastructure in new development. Some participants cautioned that added regulation results in additional development cost and time.
- Certain participants indicated that EV chargers are a marketable feature that they use to attract buyers / leases and suggested that others should do the same.

- The group indicated support for this initiative and the guidance / certainty it will provide on concerns such as development cost implications, technology options, and infrastructure suppliers.
- Widespread use of electric vehicles will not address issues of single-occupant vehicle use and suburban "sprawl"-type land development.
- The group reiterated the value of the session and the timeliness of this information being presented as land developers consider install EV chargers and municipalities look to enact bylaws to require them.
- A desire was expressed for the UDI to establish a working group to guide work on this from the development industry.
- A desire was also expressed for a reference guide for the detailed installation of charging stations to streamline electrical design work.

References

[1] PlugIn BC. (2018). Electric Vehicles Available in BC. Available online at: https://pluginbc.ca/wp/wp-content/uploads/2018/05/Electric-Car-Handout-8.5x14_180515.pdf

[2] Hall, D., & Lutsey, N. (2017). Emerging Best Practices for Electric Vehicle Charging Infrastructure. The International Council on Clean Transportation. Available online at: https://www.theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf

[3] Ibid.

[4] PlugIn BC. (2018). Charging Station Equipment. Available online at: https://pluginbc.ca/incentives/manuf_list/

[5] AES Engineering Ltd. (2017). Electric Vehicle Charging Infrastructure in New Multifamily Developments – Requirement Options and Costing Analysis. Available online at: http://udi.bc.ca/wp-content/uploads/2017/06/Final-Report-r004-EV-Requirements-20170404.pdf

[6] PlugIn BC. (2016). What is load management? Available online at: https://pluginbc.ca/faq/what-is-load-management/

[7] PlugIn BC. (No date). Charging Station Equipment. Available online at: https://pluginbc.ca/incentives/manuf_list/

[8] NewMotion. (2018). Dynamic Load Balancing: Get Ready for the Future. Available online at: https://newmotion.com/en/products/services-for-business/dynamic-loading-balancing

[9] UDI. (2017). City of Richmond: Electric Vehicle (EV) Charging Infrastructure. Available online at: http://udi.bc.ca/city-richmond-electric-vehicle-ev-charging-infrastructure/

[10] Data provided by Plug In BC Program Manager on July 17, 2018.

[11] Insurance Corporation of British Columbia. (2018). *Electric Bikes*. Retrieved from: http://www.icbc.com/vehicle-registration/specialty-vehicles/Low-powered-vehicles/Pages/Electric-bikes.aspx

[12] Fyhri, A & N Fearnley. (2015). Effects of e-bikes on bicycle use and mode share. Transportation Research Part D: Transport and Environment. 36, 45-52.

[13] Graphic courtesy of Norbert Haller.

[14] Schmidt, E. (2018). Electric Vehicle Sales Update Q1 2018, Canada. fleetcarma. Available online at: https://www.fleetcarma.com/electric-vehicles-sales-update-q1-2018-canada/

[15] Schmidt, E. (2018). Electric Vehicle Sales in Canada. fleetcarma. Available online at: https://www.fleetcarma.com/electric-vehicle-sales-canada-2017/

[16] Schmidt, E. (2018). Electric Vehicle Sales Update Q1 2018, Canada. fleetcarma. Available online at: https://www.fleetcarma.com/electric-vehicles-sales-update-q1-2018-canada/

[17] Schmidt, E. (2018). Electric Vehicle Sales Update Q1 2018, Canada. fleetcarma. Available online at: https://www.fleetcarma.com/electric-vehicles-sales-update-q1-2018-canada/

[18] Statistics Canada. (2018). New motor vehicle sales. Available online at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010000101&pickMembers%5B0%5D=1.7&pickMembers%5B1%5D=2.2&pickMembers%5B2%5D=3.1&pickMembers%5B3%5D=5.1

[19] Ibid.

[20] Malatest. (2017). 2017 Capital Regional District Origin Destination Household Travel Survey. Available online at: https://www.crd.bc.ca/docs/default-source/regional-planning-pdf/transportation/crd-2017-od-survey-report-20180622-sm.pdf?sfvrsn=4fcbe7ca_2

[21] MacArthur, J., Harpool, M., & D. Scheppke. (2018). A North American Survey of Electric Bicycle Owners. National Institute for Transportation and Communities, NITC-RR-1041.

[22] District of Saanich. (2018). Electric Vehicles and Vehicle Charging Stations. Available online at: http://www.saanich.ca/EN/main/community/sustainable-saanich/climate-change-energy/programs-rebates/electric-vehicle-charging-stations.html

[23] Phone conversation with City of Surrey Manager of Parking Services on June 15, 2018

[24] City of Burnaby. (2018). Electric Vehicles in Burnaby. Available online at: https://www.burnaby.ca/City-Services/Policies--Projects---Initiatives/Environment/Environmental-Sustainability-Strategy/ESS-and-CEEP-In-Action/Electric-Vehicles-in-Burnaby.html

[25] Ibid.

[26] http://bylaws.vancouver.ca/parking/sec06.pdf

[27] BCUC. (No date). Electric Vehicle (EV) Charging Service Inquiry – FAQ. Available online at: http://www.bcuc.com/Documents/Proceedings/2018/DOC_50755_02-08-2018_BCUC-EV-Charging-FAQ.pdf

[28] Gioventu, T. (2018). Condo Smarts: Making room for electric vehicles. *The Province*. Available online at: https://theprovince.com/life/homes/condo-smarts-making-room-for-electric-vehicles

[29] BCUC. (2018). Electric Vehicle Charging in Stratas. BCUC Regulation of Electric Vehicle Charging Service Inquiry. Available online at: http://www.bcuc.com/Documents/Proceedings/2018/DOC_51112_C32-2_Mackenzie_Written-Evidence.pdf

[30] Lutsey, N., Searle., Chambliss, S., Bandivadekar, A. (2015). Assessment of Leading Electric Vehicle Promotion Activities in United States Cities. Available online at: http://www.theicct.org/leading-us-city-electric-vehicle-activities

[31] ChargeHub. (2018). Charge your EV in Victoria. Available online at: https://chargehub.com/en/countries/canada/british-columbia/victoria.html?city_id=377

[32] Phone conversation with City of Montreal Director of Urbanism on April 26, 2017

[33] Phone conversation with City of Montreal Director of Urbanism on June 20, 2018.

[34] Email correspondence with Capital Regional District Climate Action Program Coordinator on July 12, 2018.

[35] Portland State University. (No date). Electric Avenue: Plug In. Charge Up. Drive On. Available online at: https://www.pdx.edu/sites/www.pdx.edu.electricavenue/files/electric_avenue_faq.pdf

[36] World Trade Center Portland. (2018). Plug in, Charge up, Drive on: Electric Avenue. Available online at: http://wtcportland.com/electricavenue/

[37] Phone conversation with City of Portland Policy & Research Analyst on April 17, 2017.

[38] Phone conversation with Plug In BC Program Manager on August 28, 2018.

[39] Phone conversation with City of Montreal Director of Urbanism on April 26, 2017.

[40] Township of Esquimalt. (2018). Electric Vehicle Charging. Available online at: https://www.esquimalt.ca/municipal-hall/sustainability-environment/electric-vehicle-charging

[41] Ibid.

[42] Government of Quebec. (2018). Public Charging Stations.
Available online at: http://vehiculeselectriques.gouv.qc.ca/english/particuliers/recharge-publics.asp

[43] Plug in BC. (2017). City of Vancouver Approves Fees at EV Charging Stations.
Available online at: https://pluginbc.ca/vancouver-approves-ev-charging/

[44] Washington State Department of Transportation. (2015). Washington State Electric Vehicle Action Plan 2015-2020.
Available online at: http://www.wsdot.wa.gov/NR/rdonlyres/28559EF4-CD9D-4CFA-9886-105A30FD58C4/0/WAEVActionPlan2014.pdf

[45] Needell et al. (2016). Potential for widespread electrification of personal vehicle travel in the United States. Nature Energy, 16112, 1-7.

[46] McKinsey & Company. (2017). Electrifying insights: How automakers can drive electrified vehicle sales and profitability.
Available online at: https://www.mckinsey.de/files/161223_mckinsey_e-vehicles.pdf.

[47]

BC Hydro. (2018). Unplugged: Myths block road to the electric car dream. Available online at:
https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/news-and-features/Report-unplugged-myths-block-road-to-EV-dream_April%202018.pdf

[49] Sierzchula, W, Bakker, S., Maat, K. and van Wee, B. (2014). The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy, 68, 183–194.

[50] Plug'N Drive. (2017). Driving EV Uptake in the Greater Toronto and Hamilton Area: How Driver Perceptions Shape Vehicle Ownership in the GTHA.
Available online at: http://www.plugndrive.ca/wp-content/uploads/2017/07/EV-Survey-Report.pdf

[51] Dumortier, J. et al. (2015). Effects of providing total cost of ownership information on consumers' intent to purchase a hybrid or plug-in electric vehicle. Transportation Research Part A: Policy and Practice 72: 71-86.

[52] BC Hydro. (2018). Unplugged: Myths block road to the electric car dream. Available online at:
https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/news-and-features/Report-unplugged-myths-block-road-to-EV-dream_April%202018.pdf

[53] The National Academy of Sciences. (2013). Overcoming Barriers to Electric-Vehicle Deployment: Interim Report.
Available online at:
http://gabrielse.physics.harvard.edu/gabrielse/papers/2013/OvercomingBarriersToElectricVehicleDeployment.pdf

[54] Plug'N Drive. (2017). Driving EV Uptake in the Greater Toronto and Hamilton Area: How Driver Perceptions Shape Vehicle Ownership in the GTHA. Available online at: http://www.plugndrive.ca/wp-content/uploads/2017/07/EV-Survey-Report.pdf

[55] Singer, M. (2016). Consumer Views on Plug-in Electric Vehicles – National Benchmark Report. National Renewable Energy Laboratory. Available online at:
http://www.afdc.energy.gov/uploads/publication/consumer_views_pev_benchmark.pdf

[56] Matousek, M. (2018). 30 electric cars you'll see on the road by 2025. Available online at: https://www.businessinsider.com/electric-cars-that-will-be-available-by-2025-2018-1

[57] Bruce Power, Plug'n Drive and Pollution Probe. (2016). Policy Submission to Pan Canadian Framework on Clean Growth and Climate Change: Accelerating the Deployment of EVs. Available online at: http://www.pollutionprobe.org/wp-content/uploads/Accelerating-the-Deployment-of-Electric-Vehicles.pdf

[58] Plug In BC. (2018). Home & Work Charging.
Available online at: https://pluginbc.ca/charging-stations/charging-at-home/

[59] US Department of Energy. (2018). Electric Vehicles: Charging at Home.
Available online at: https://www.energy.gov/eere/electricvehicles/charging-home

[60] Ipsos MORI. (2017). Speed and availability of charging biggest barriers to electric car adoption by 2040. Available online at: https://www.ipsos.com/ipsos-mori/en-uk/speed-and-availability-charging-biggest-barriers-electric-car-adoption-2040

[61] The National Academy of Sciences. (2013). Overcoming Barriers to Electric-Vehicle Deployment: Interim Report. Available online at:
http://gabrielse.physics.harvard.edu/gabrielse/papers/2013/OvercomingBarriersToElectricVehicleDeployment.pdf

[62] Phone conversation with City of Montreal Director of Urbanism on April 26, 2017.

[64] Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., & Handy, S. (2014). Experiences of electric bicycle users in the Sacramento, California area. Travel Behaviour and Society, 1(2), 37–44.

[65] Ibid.

[66] MacArthur, J., Harpool, M., & D. Scheppke. (2018). A North American Survey of Electric Bicycle Owners. National Institute for Transportation and Communities, NITC-RR-1041.

[67] Fyhri, A, et al. (2017) A push to cycling—exploring the e-bike's role in overcoming barriers to bicycle use with a survey and an intervention study. International Journal of Sustainable Transportation, 11:9, 681-695.

[68] Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., & Handy, S. (2014). Experiences of electric bicycle users in the Sacramento, California area. Travel Behaviour and Society, 1(2), 37–44.

[69] Dill, J., Rose, G. (2012). Electric bikes and transportation policy. Transport. Res. Rec. 2314, 1–6.

[71] Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., & Handy, S. (2014). Experiences of electric bicycle users in the Sacramento, California area. Travel Behaviour and Society, 1(2), 37–44.

[72] Jones, T, et al. (2016). Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. Journal of Transport Geography. 53, 41-49.

[73] Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., & Handy, S. (2014). Experiences of electric bicycle users in the Sacramento, California area. Travel Behaviour and Society, 1(2), 37–44

[74] McLeod, K. (2015). Electric Bicycles: Public Perceptions & Policy: Results and analysis of a national survey of American bicyclists. Available online at: https://bikeleague.org/sites/default/files/E_bikes_mini_report.pdf

[75] Bruce Power, Plug'n Drive and Pollution Probe. (2016). Policy Submission to Pan Canadian Framework on Clean Growth and Climate Change: Accelerating the Deployment of EVs. Available online at: http://www.pollutionprobe.org/wp-content/uploads/Accelerating-the-Deployment-of-Electric-Vehicles.pdf

[76] Fraser Basin Council. (2015). A Gap Analysis for BC's Electric Vehicle Direct Current Fast Charging Network. Available online at: https://pluginbc.ca/wp/wp-content/uploads/2015/10/BC-DCFC-Gap-Analysis-Report-FBC_Aug-2015.pdf

[77] Krizek, K.J. (2003). Operationalizing neighborhood accessibility for land use–travel behavior research and regional modelling. *Journal of Planning Education and Research, 22*: 270–287.

Appendix A.

Summary of EV Regulations in Metro Vancouver Communities

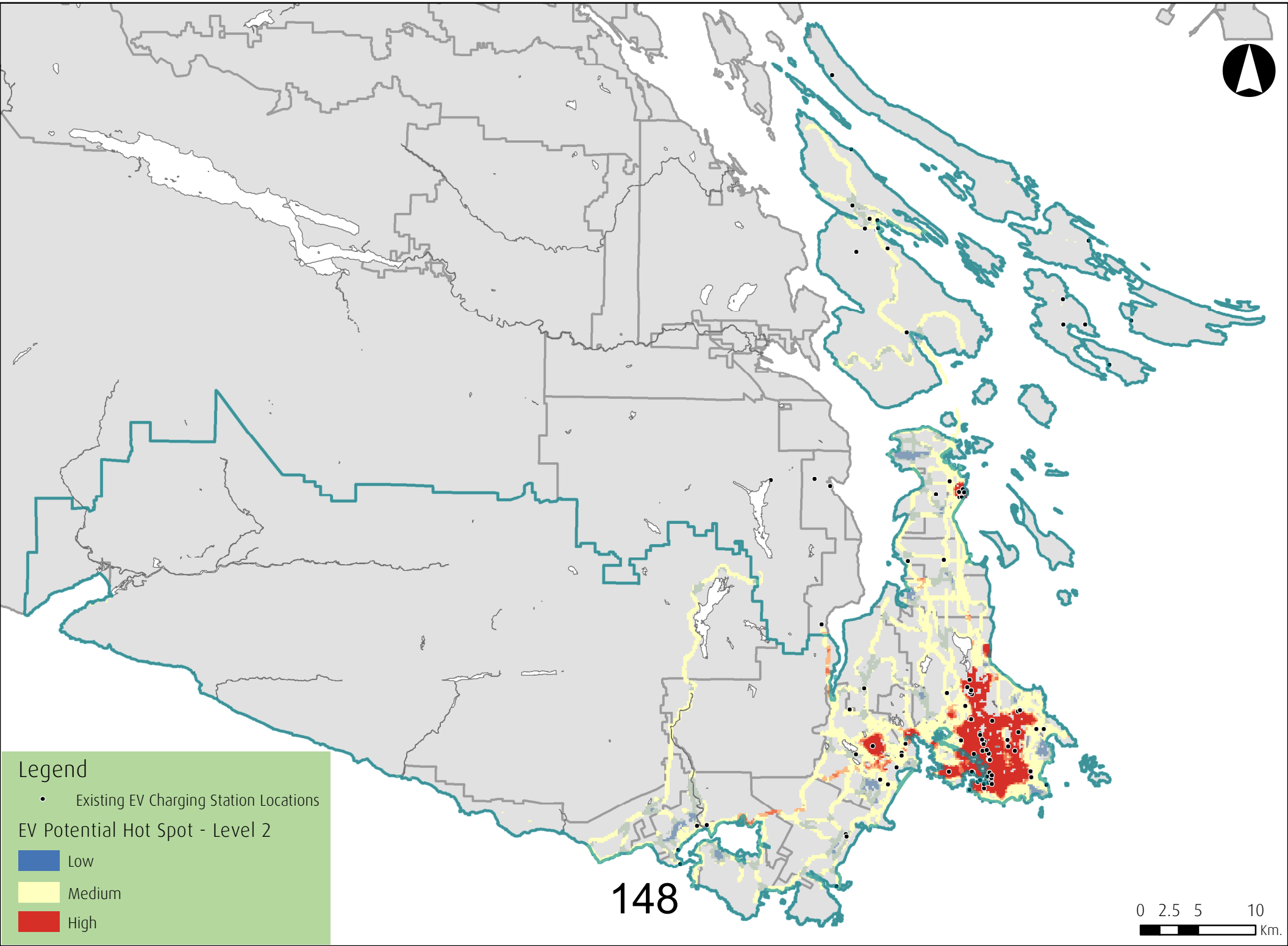
ADOPTED REGULATIONS / POLICIES / BYLAWS. SOURCE: METRO VANCOUVER, APRIL 2018

	City of Vancouver	District of North Vancouver	City of North Vancouver	City of Richmond	City of Port Coquitlam	District of West Vancouver
Multi-family	100% of parking stalls, excluding visitor stalls, are provided with an energized outlet capable of providing Level 2 charing or higher in new multi-family buildings including rowhouses. An alternative compliance pathway based on a performance standard (approved by the Chief Building Official) would allow EV Energy Management Systems to be used. By-law changes come into effect January 1, 2019.	20% of parking stalls EV-ready, wired for level 1 (110v) charging Conduit in place so all stalls can later be wired for level 1 (110v) charging. All secure bicycle storage must include level 1 (110v) electric outlets for electric bicycle charge	20% of stalls with Level 2 receptacle. Space in electrical room/panel to supply remaining 80% with charging.	Require all parking stalls, with the exception of visitors parking, in all new residential construction, including single family homes, duplexes, townhomes, and multifamily buildings, as of April 1, 2018, to feature an energized outlet capable of providing Level2 charging or higher to the parking space.	Require rough-ins of Level 2 EV charging infrastructure in the parking area, with outlets accessible to each resident parking spot (not required for visitor spots). Outlets may be shared between spaces (must be within 3 m of parking space).	All new multi-family development provide an appropriate number of dedicated EV plug-in outlets, ideally one for each unit, and new commercial developments over 1500m2 in floor area provide for an expansion of the public electric vehicle charging network.
Commercial	A minimum of one parking space for every ten parking spaces, plus one space for any additional parking spaces that number less than ten, shall be provided with an energized outlet capable of providing Level 2 charging or higher to the parking space.	Target 10% of parking stalls wired for level 2 (240v) charging. Appropriate amounts of level 1 (110v) and level 2 (240v) charging will be determined based on: •Proximity to regional roads and highways •Expected length of stay based on long term land use tenure	None	None	Promote pre-wiring or rough-ins for Level 2 EV charging for a share of parking spaces via Environmental Conservation DP, or rezoning	None
Single Family	New one-family, two-family, rowhouses, and laneway houses must have an energized outlet capable of providing Level 2 charging or higher to garage or carport. Exemption may apply where EV circuit would cause the house panel to exceed 200A; in this case, a raceway must be installed.	None	Circuit to and capacity for Level 2 in 100% of parking spaces.	Require all parking stalls, with the exception of visitors parking, in all new residential construction, including single family homes, duplexes, townhomes, and multifamily buildings, as of April 1, 2018, to feature an energized outlet capable of providing Level2 charging or higher to the parking space.	Require rough-ins (adequate electrical panel capacity, conduit and electrical boxes) of Level 2 EV charging infrastructure in the parking area to ensure one space per unit has access to outlet.	None
Policy Method	Parking Bylaw (changed from Building Bylaw in 2018)	Stand-Alone Policy	Sustainable Development Guidelines	Zoning Bylaw	Zoning Bylaw	Stand-alone policy
Mandatory	Yes	Yes	No (Near-mandatory)	Yes	Yes	Yes
Website	http://council.vancouver.ca/20180314/documents/cfsc3.pdf	https://www.dnv.org/property-and-development/supporting-electric-vehicles	(see Item 5) http://www.cnv.org/-/media/city-of-north-vancouver/documents/council-meeting-agenda/2016/2016-09-12-regular-agenda-package-for-september-12-2016.pdf	Item #19 of Richmond's November 27th Council agenda	http://www.portcoquitlam.ca/dynamic/page11394.aspx	May 2012 Report to Council (see Eve for a copy)
Bylaw Language	**Parking By-law No. 6059** 4.14.1 (a) one-family dwelling, two-family dwelling, one-family or two-family dwelling with a secondary suite or lock-off unit, rowhouse, and laneway house, each storage garage or carport shall be provided with an energized outlet capable of providing Level 2 charging or higher to the storage garage or carport, except where the provisions of Sentence 10.4.3.1.(2) of Division B of the Building By-law apply; (b) multiple dwelling, multiple dwelling component of a multiple-use development, or rowhouse, all parking spaces provided for residential use, excluding visitor parking spaces, shall be provided with an energized outlet capable of providing Level 2 charging or higher to the parking space; (c) commercial building or commercial component of a multiple-use development with ten or more parking spaces, a minimum of one parking space for every ten parking spaces, plus one space for any additional parking spaces that number less than ten, shall be provided with an energized outlet capable of providing Level 2 charging or higher to the parking space; and (d) commercial building or commercial component of a multiple-use development with less than ten parking spaces, a minimum of one parking space shall be provided with an energized outlet capable of providing Level 2 charging or higher to the parking space. Building By-law No. 10908 2) Where the requirements of section 4.14.1(a) of the Parking By-Law would cause the dwelling unit calculated load to exceed 200 A in one-family dwellings, twofamily dwellings, one-family dwellings with secondary suite or a lock-off unit, two family dwellings with secondary suites or a lock-off unit, row housing, or laneway houses, the installation of an energized outlet for Level 2 charging may be omitted provided that a minimum nominal trade size of 21 raceway supplied with pull string leading from the dwelling unit panelboard to an electrical outlet box is installed in the storage garage or carport and is labelled to identify its intended use with the electric vehicle supply equipment. 3) Where an electric vehicle energy management system is implemented, Chief Building Official may specify a minimum performance standard to ensure a sufficient rate of electric vehicle charging."	**1. For multifamily developments:** '- 20% of parking stalls are EV-ready, wired for level 1 charging - Conduit is in place so that 100% of parking stalls can later be wired for level 1 charging - Allocation of EV parking spaces is the responsibility of developers and/or strata organizations '2. For commercial and industrial development, in the range of 10% of parking stalls are EVready, wired for level 2 charging. The following criteria will be used to determine on a caseby-case basis the appropriate amount of level 1 and level 2 charging to be provided: - Proximity to regional roads and highways; and - Expected length of stay based on long term land use tenure (e.g. more charging infrastructure will be needed where the stay is longer). '3. All secure bicycle storage is to include level 1 electrical outlets for electric bicycle charging.		7.15 "Provision of Electric Vehicle Charging Infrastructure 7.15.1 For new buildings, structures and uses, all residential parking spaces, excluding visitor parking spaces, shall feature an energized outlet capable of providing Level2 charging or higher to the parking space. 7.15.2 Energized outlets, provided pursuant to section 7.15.1 above, shall be labeled for their intended use for electric vehicle charging. 7.15.3 Where an electric vehicle energy management system is implemented, the Director of Engineering may specifY a minimum performance standard to ensure a sufficient rate of electric vehicle charging."	Definition: "Roughed-in electric vehicle charging Infrastructure" means a Level 2 service including a 240v or 208v circuit breaker on an energized electrical panel connected by raceway to an outlet. Requirement: 1) One parking space per dwelling unit shall be provided with roughed-in electric vehicle charging infrastructure including an electrical outlet box located within 3 metres of the unit's required parking space. 2) In a building with a common parking area, such as an apartment building or building with a mix of commercial and residential uses, a separate single utility electrical meter and disconnect shall be provided in line with the electrical panel(s) intended to provide for charging of electric vehicles.	All new multi-family development provide an appropriate number of dedicated EV plug-in outlets, ideally one for each unit, and new commercial developments over 1500m2 in floor area provide for an expansion of the public electric vehicle charging network.

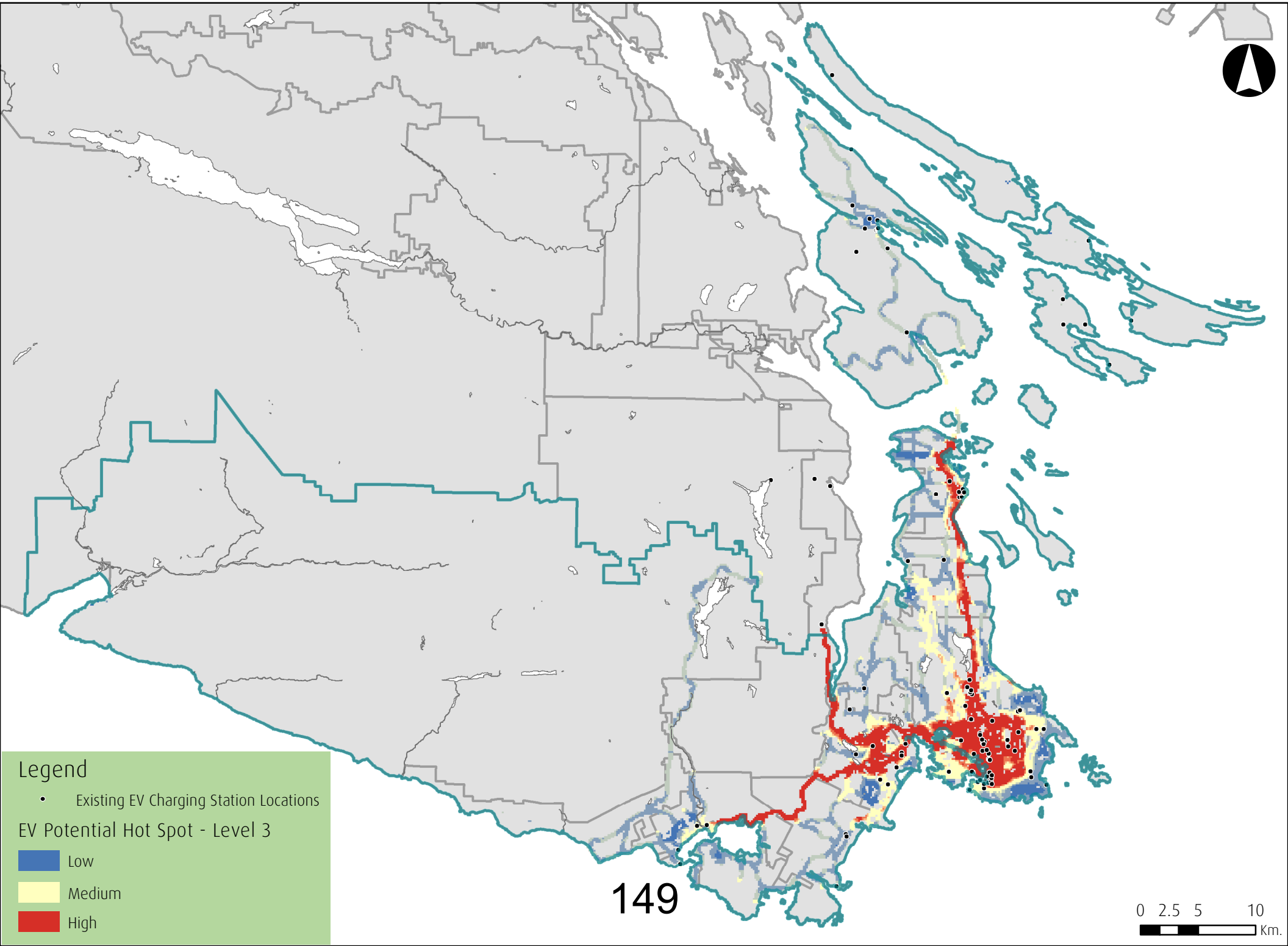
Appendix B.

Infrastructure Gap Analysis Mapping Outputs

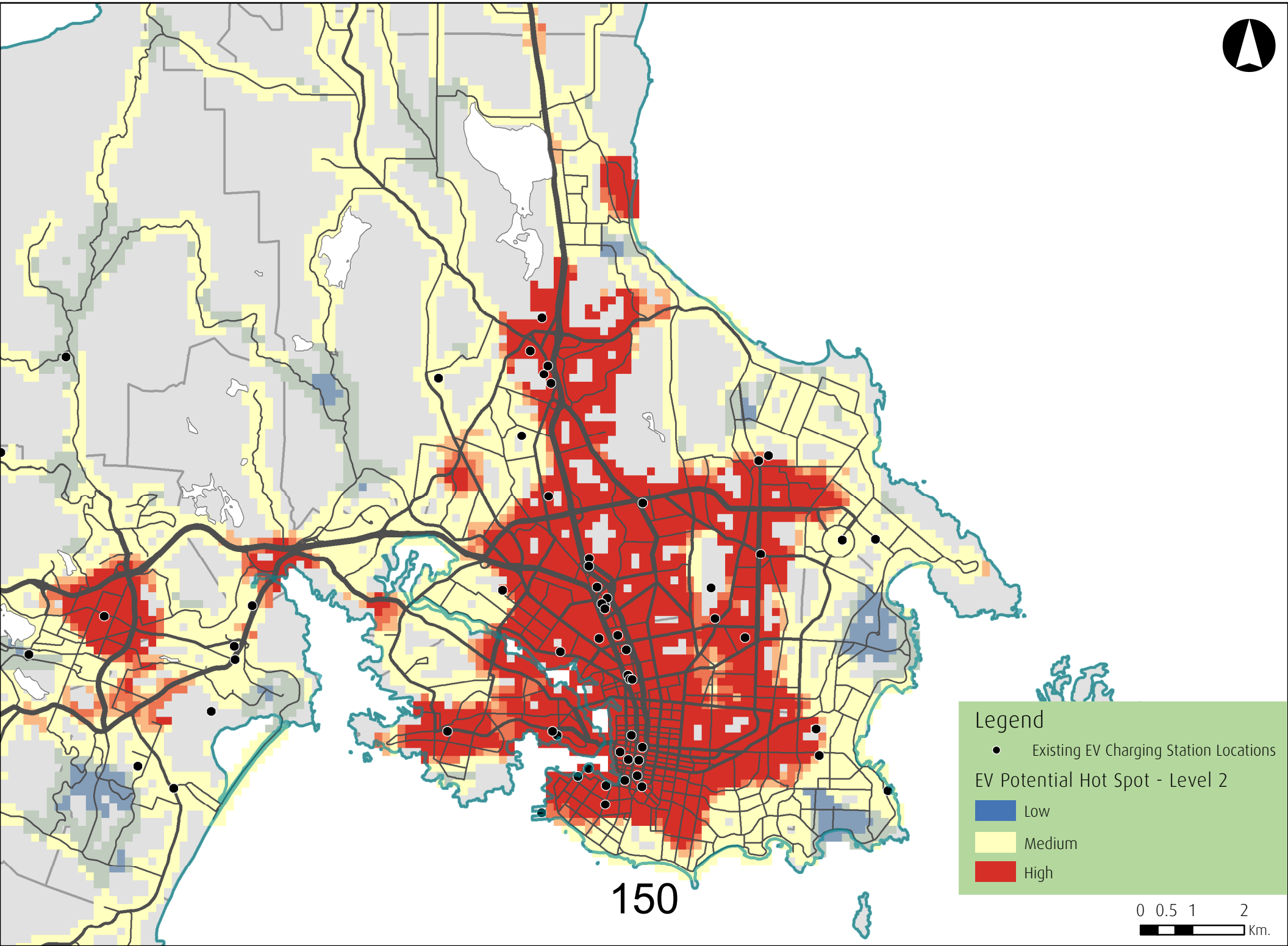
Map 1: Region - Level 2



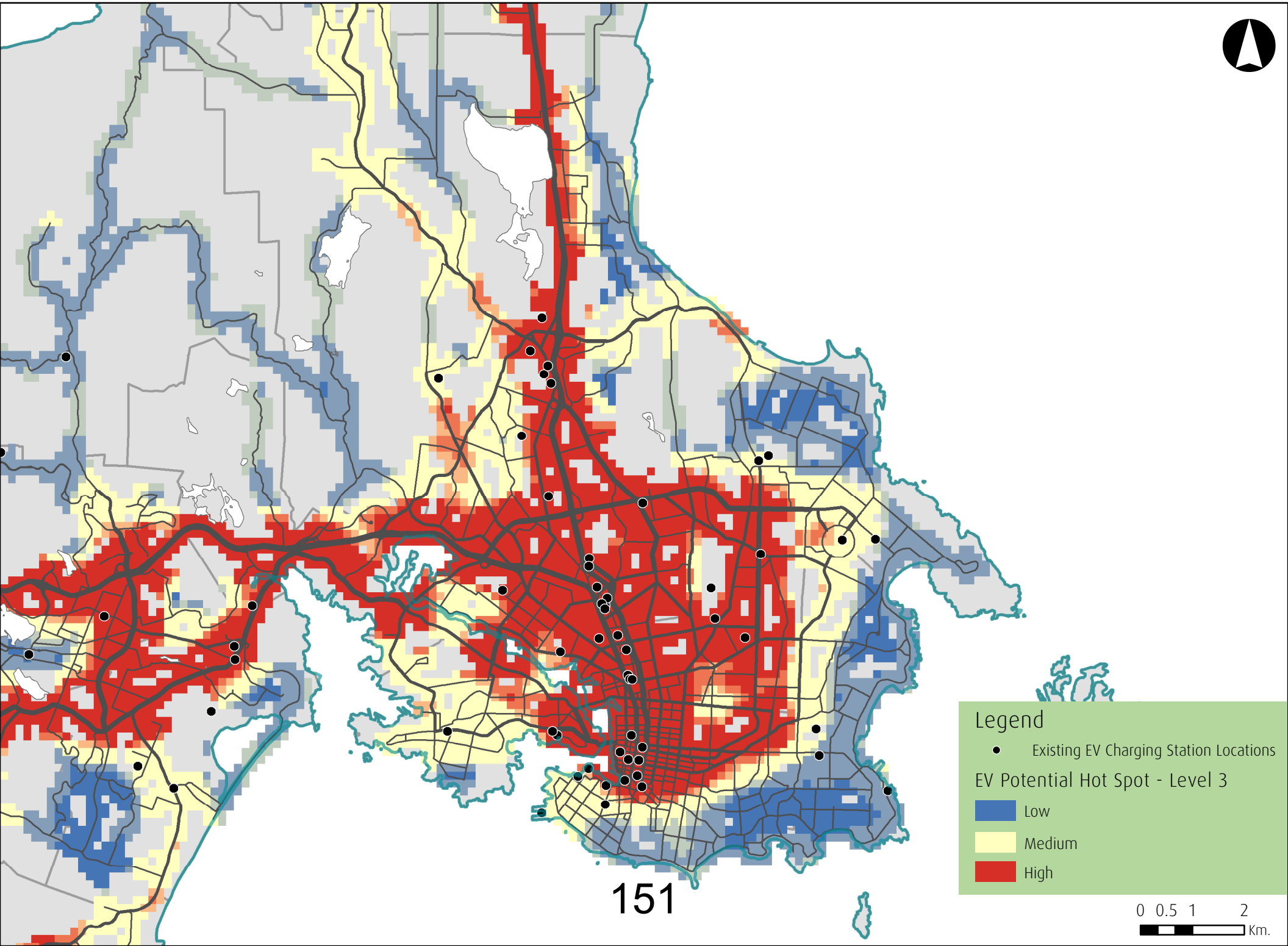
Map 2: Region - Level 3



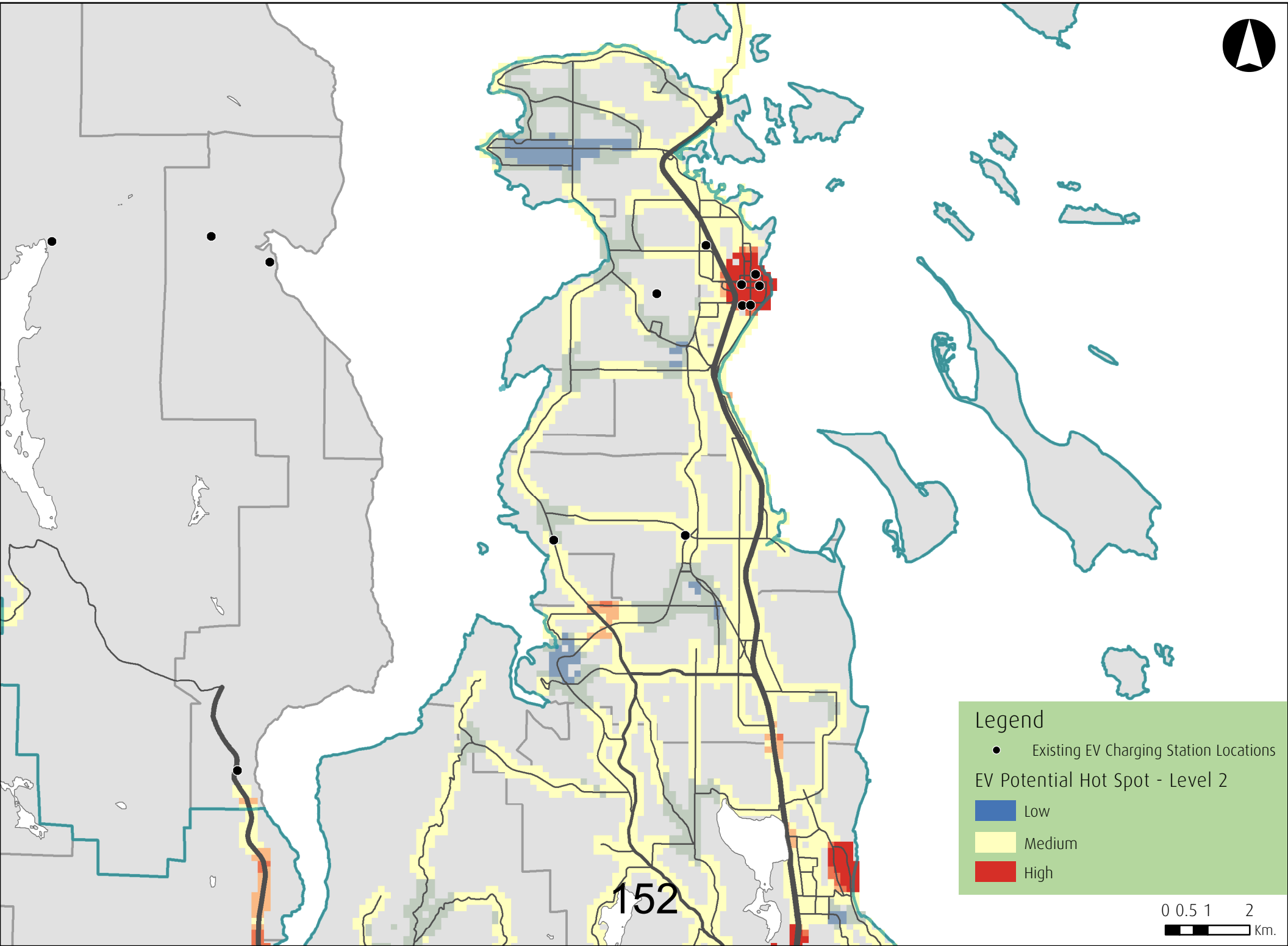
Map 3: Core - Level 2



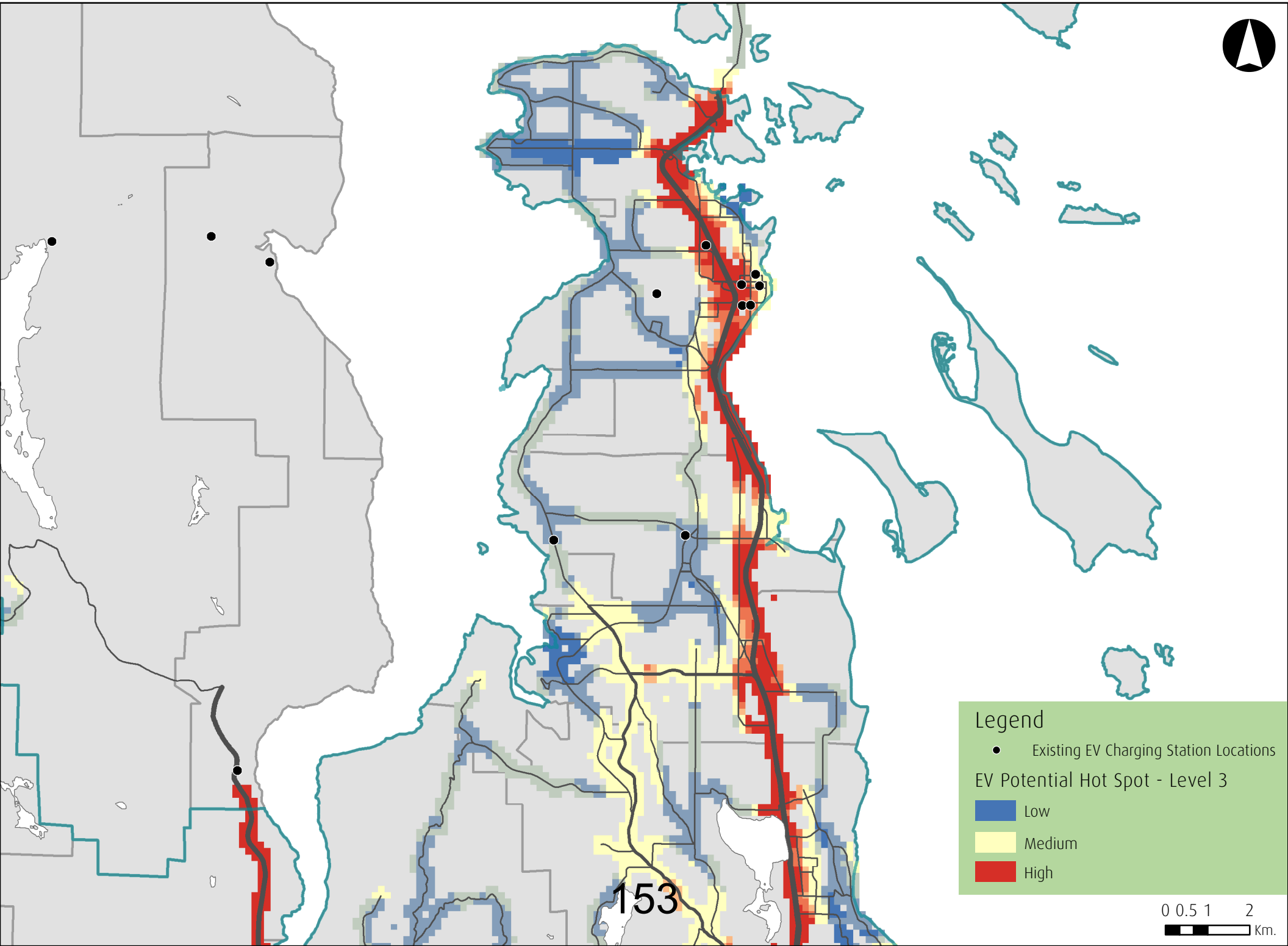
Map 4: Core - Level 3



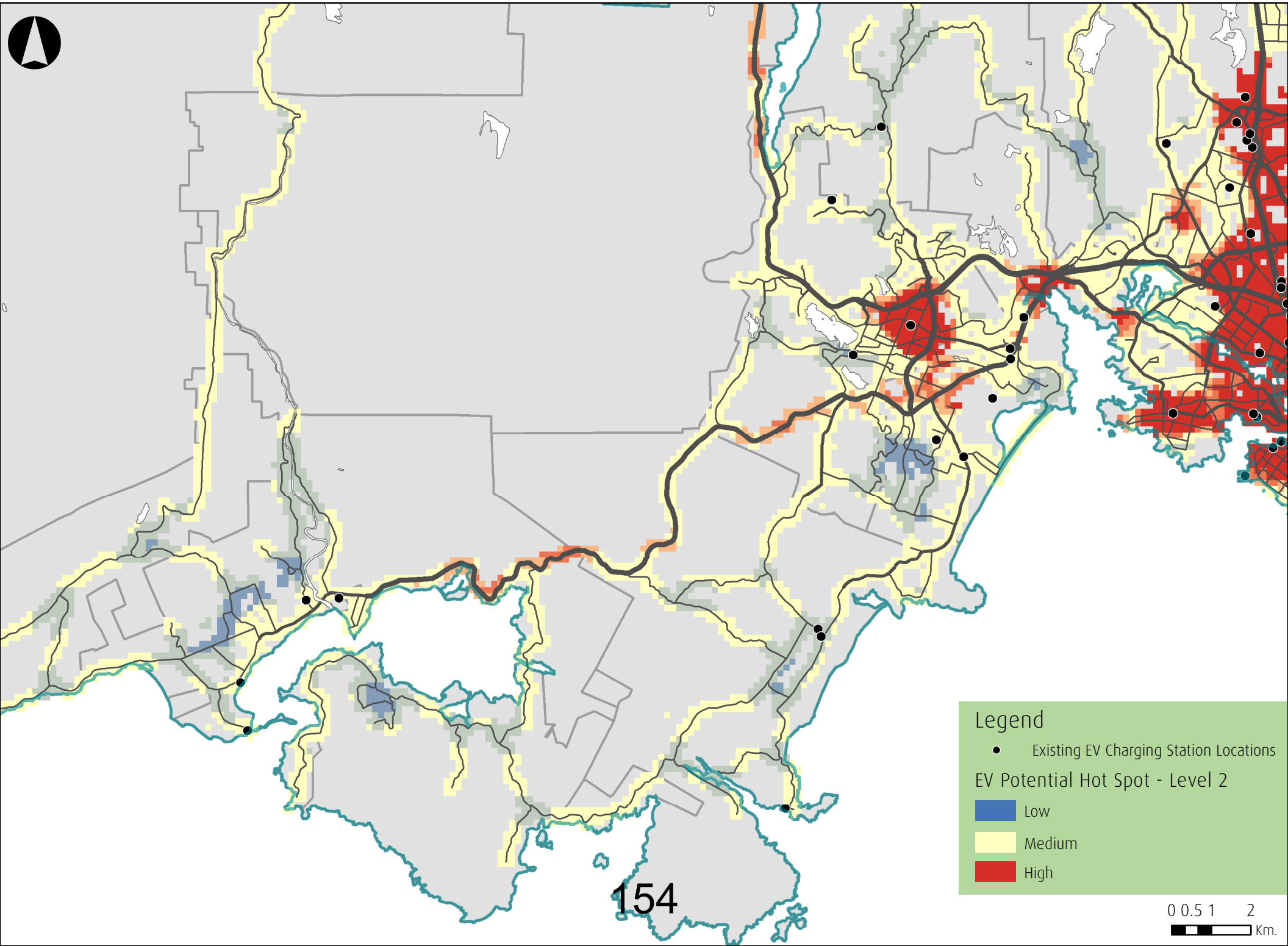
Map 5: Peninsula - Level 2



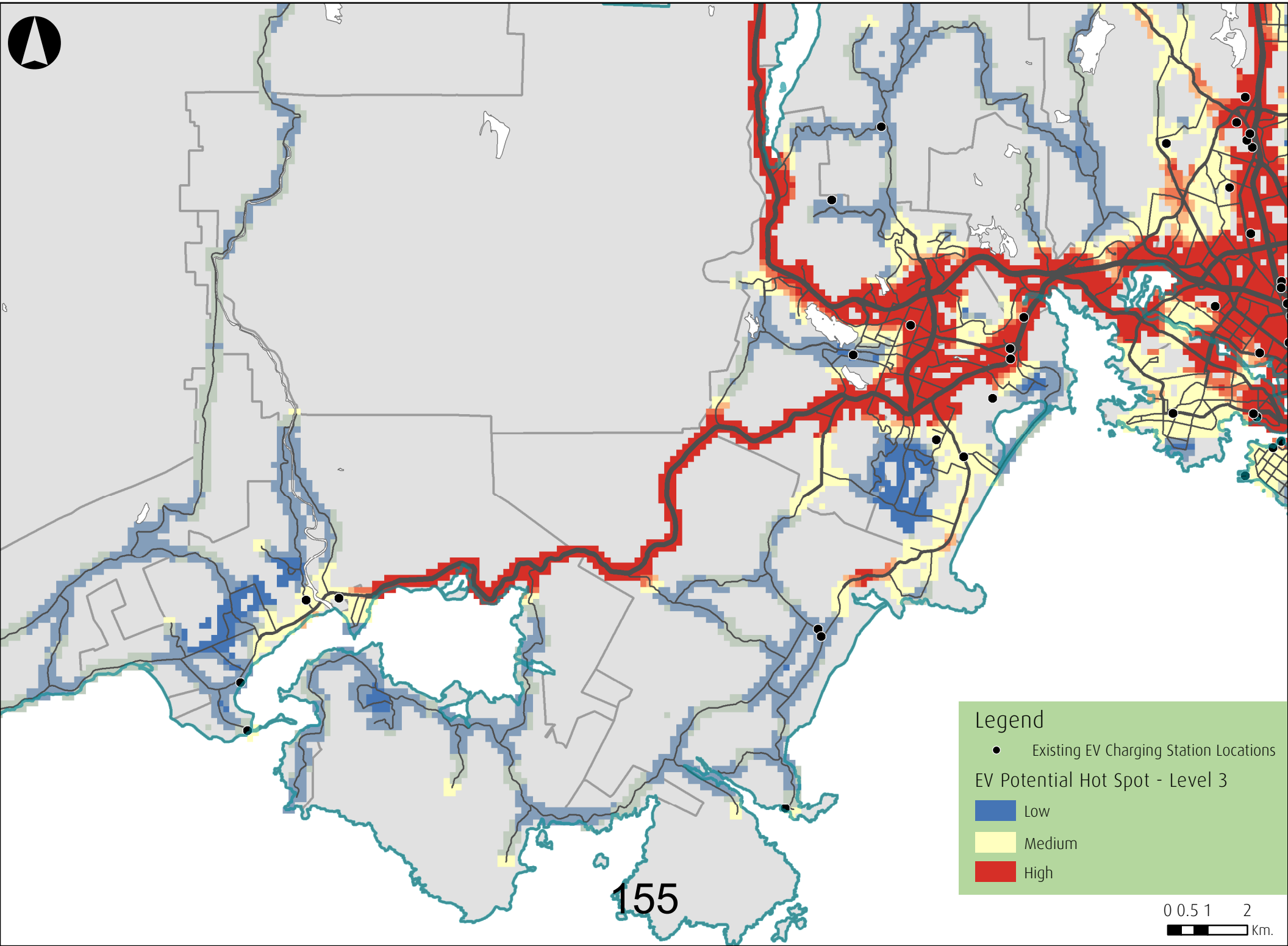
Map 6: Peninsula - Level 3



Map 7: West Shore - Level 2



Map 8: West Shore - Level 3



Appendix C.

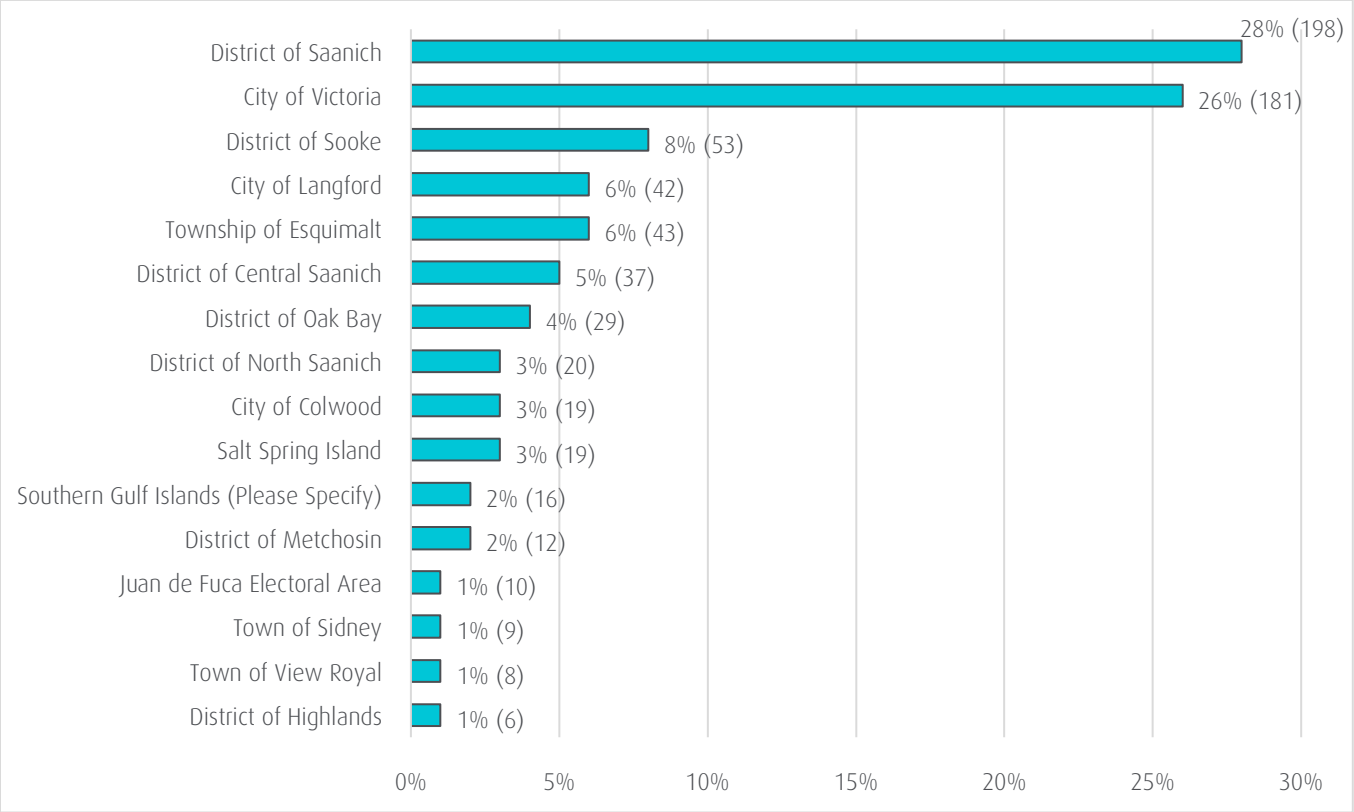
Summary of Public Survey Responses

Public Survey

Public Survey quantitative results are shown in the following charts. Qualitative results are summarized in the Backgrounder.

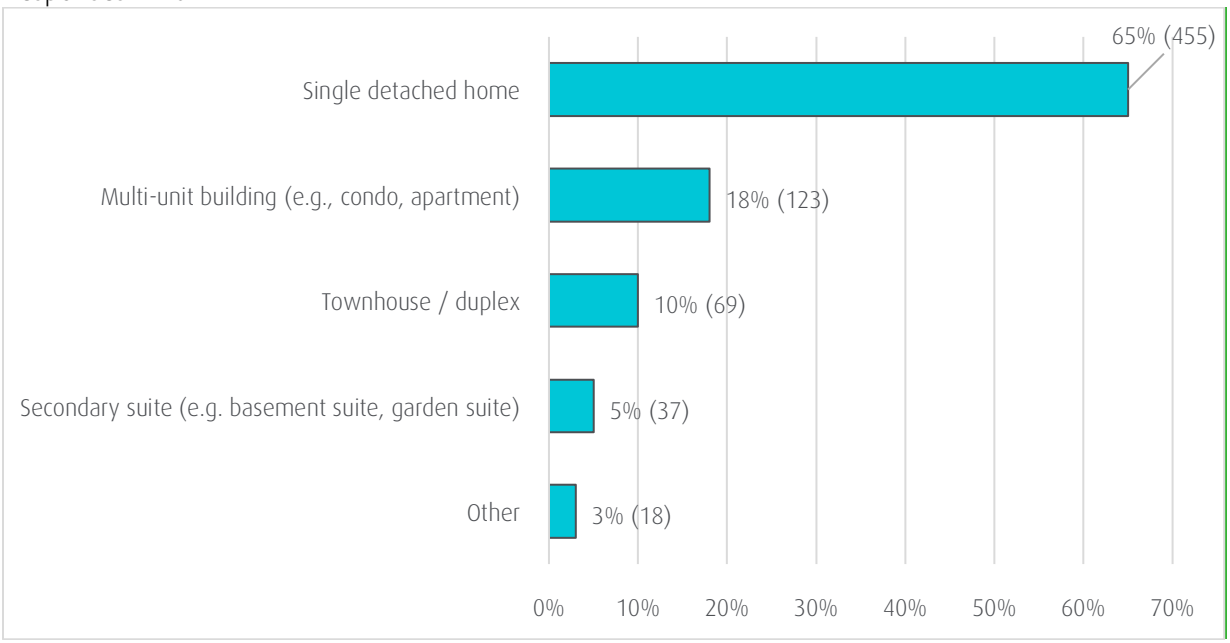
General Questions

1) To get a sense of geographic representation, which part of the region do you live in?
   Responses = 702



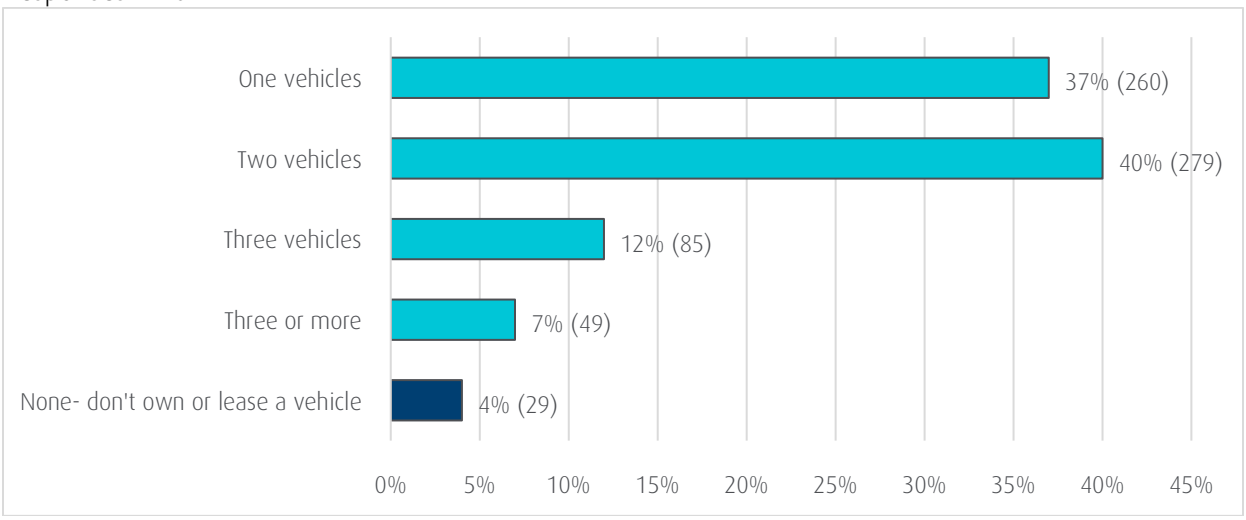
2) Which best describes your home?

Responses = 702



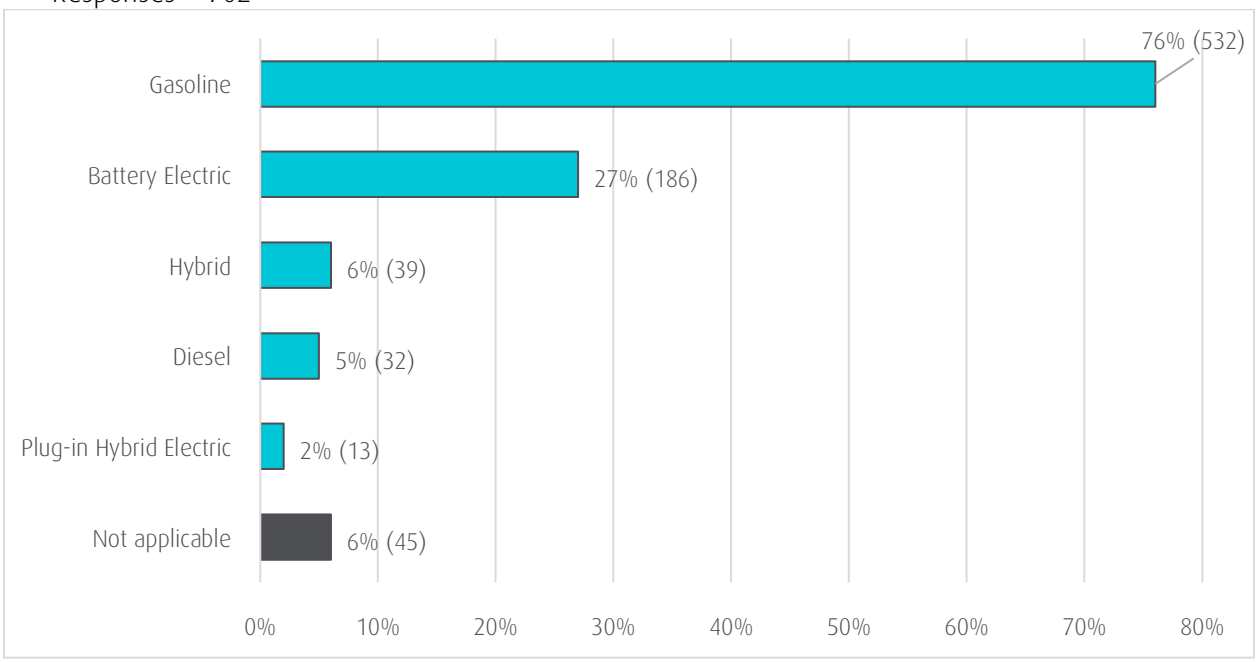
3) How many vehicle(s) does your household currently own or lease? [Please exclude off-road vehicles and RV's]. Please select one response only.

Responses = 702



4) What is the power source of your vehicle(s)?

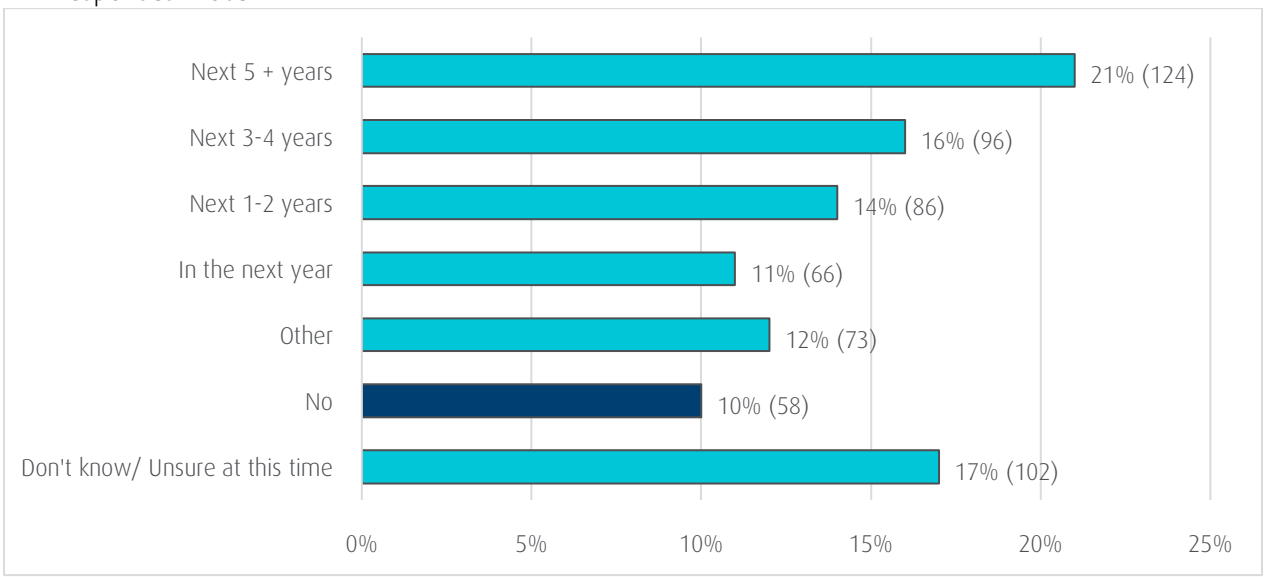
Responses = 702



General Electric Vehicle Questions

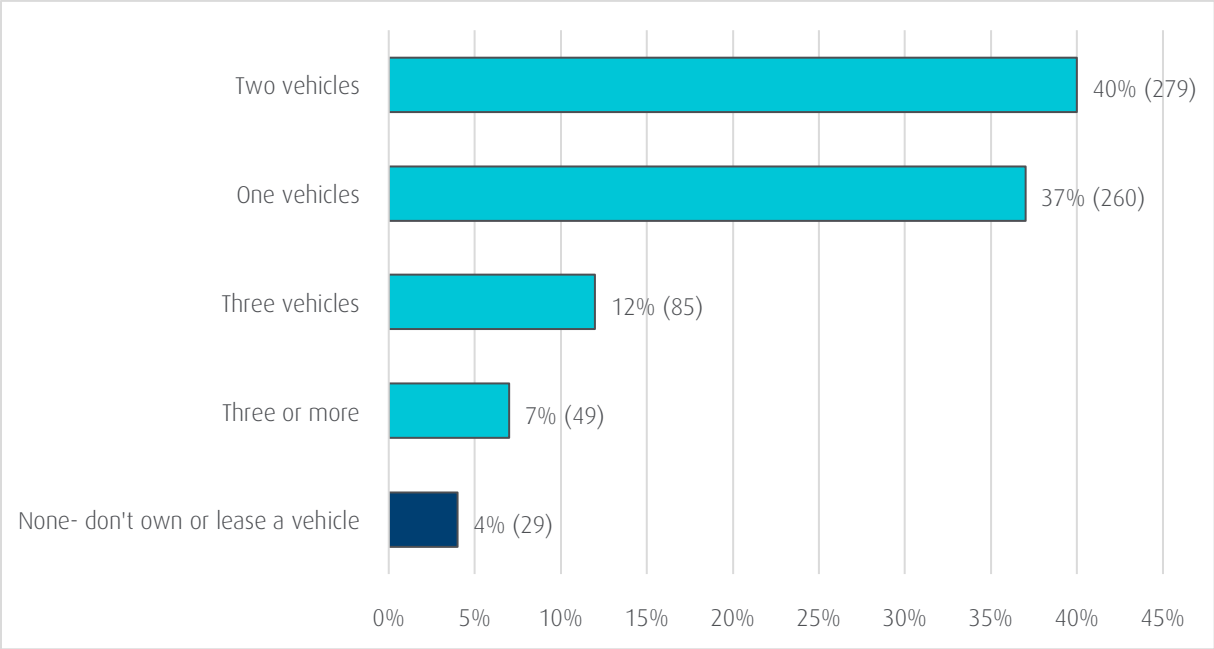
5) Do you plan to purchase an electric vehicle in the future?

Responses = 605



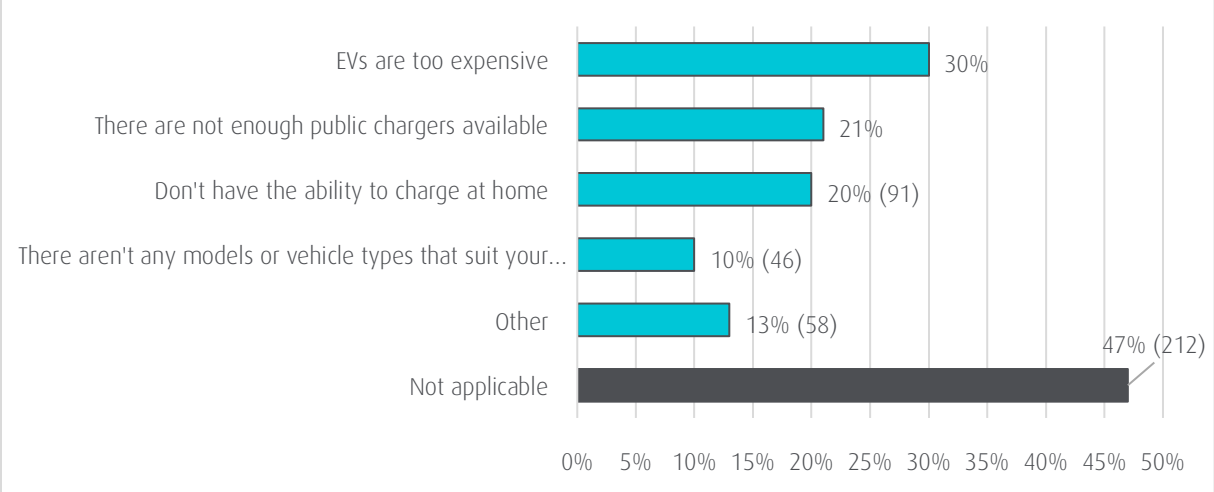
6) **If you own an electric vehicle or plan on buying one, what are the factors contributing to that decision?** (Please select all that apply)

Responses = 593



7) **If you do not own an electric vehicle or do not plan on buying one, what are the factors contributing to that decision?** (Please select all that apply)

Responses = 450



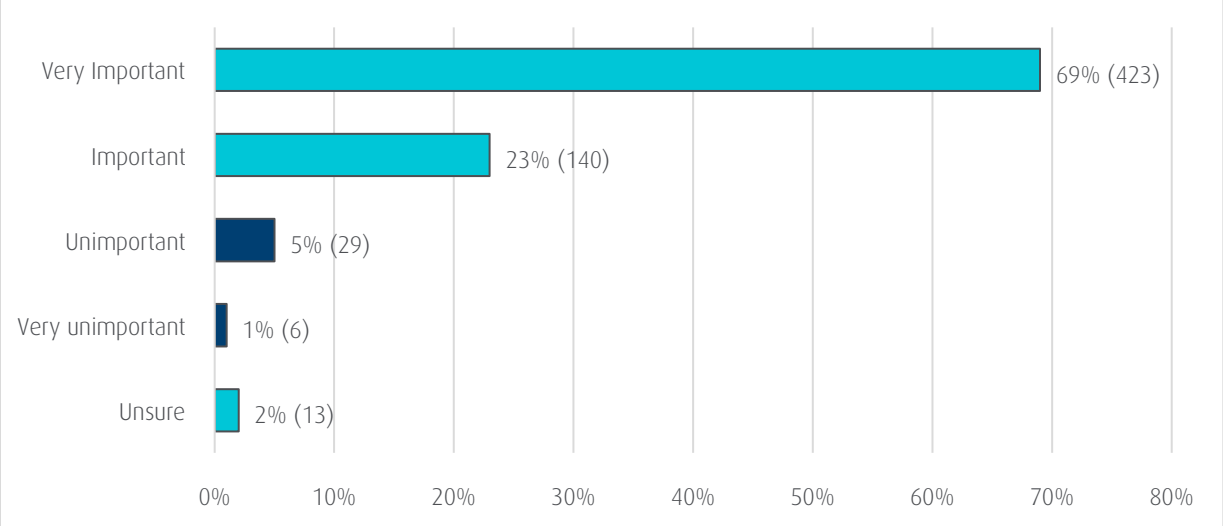
8) What are, or could be, the benefits of owning an electric vehicle for you / your household?
Responses = 538

9) What are, or could be, the challenges of owning an electric vehicle for you / your household?
Responses = 540

10) What could be done in the capital region to lessen some of the challenges or enhance some of the benefits? (Please be as specific as possible)
Responses = 520

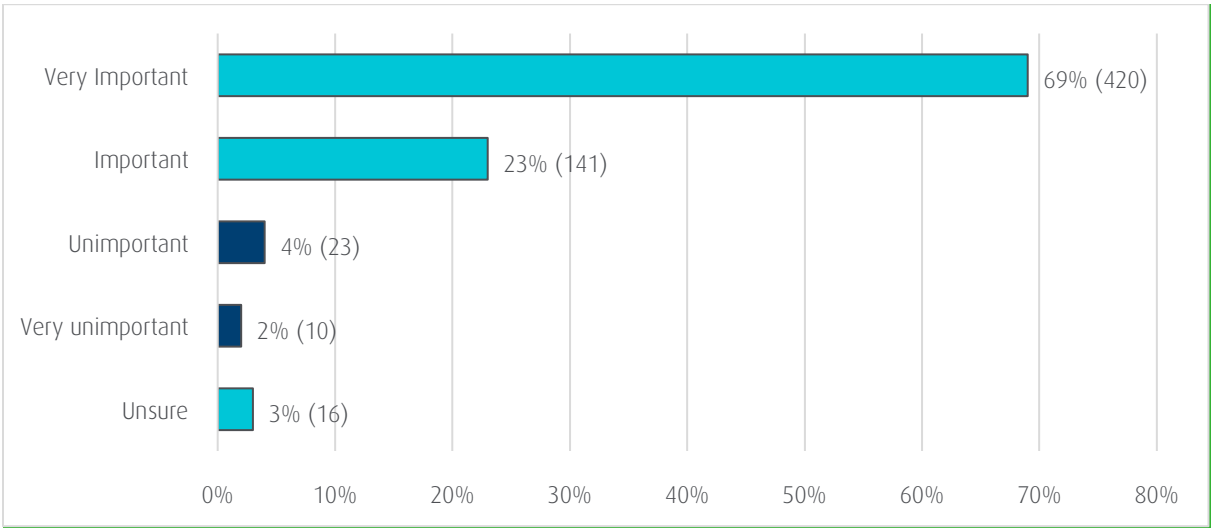
Electric Vehicle Infrastructure Questions

11) How important is access to an at-home charger with regard to owning or deciding to purchase an electric vehicle?
Responses = 611



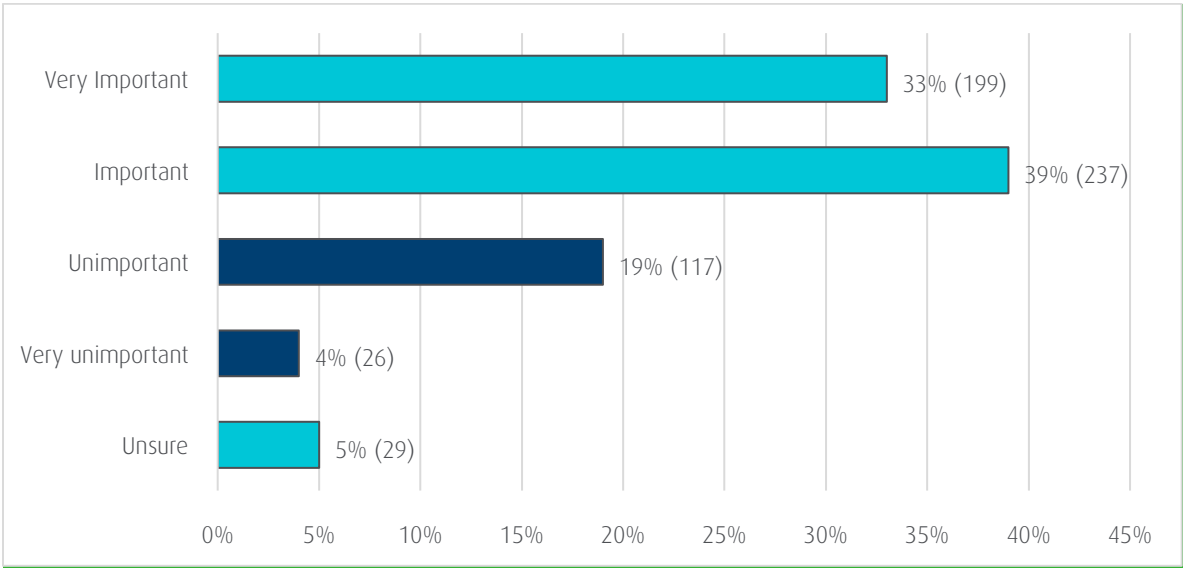
12) How important is it for electric vehicle adoption that the local governments in the capital region ensure new residential construction be "future-proofed" to allow for easy installation of electric vehicle charging equipment in the future?

Responses = 610



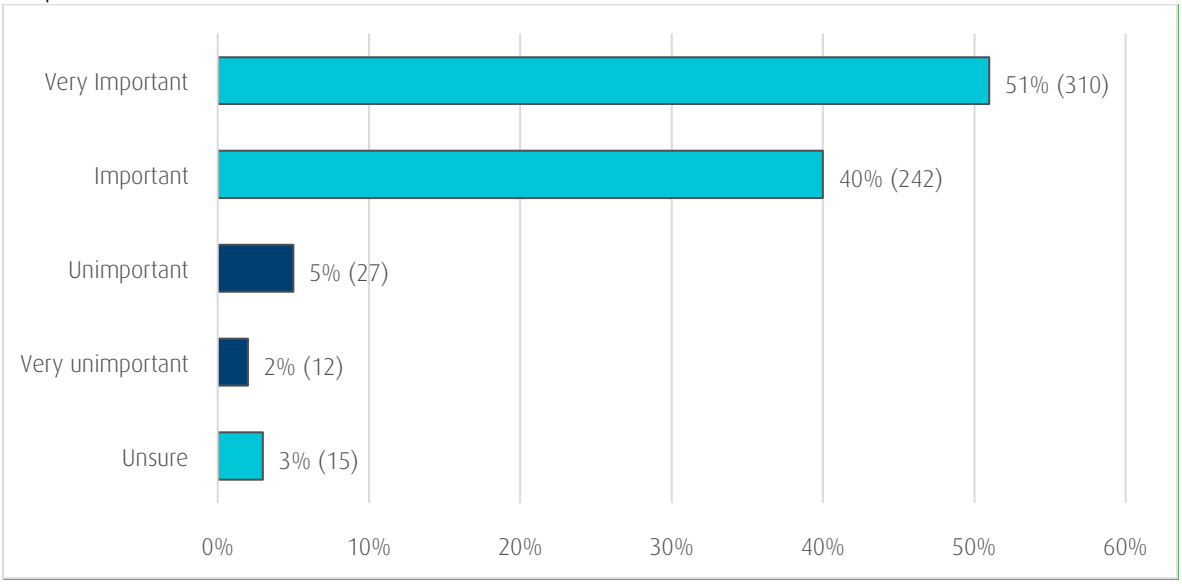
13) How important is access to an at-work charger with regard to owning or deciding to purchase an electric vehicle?

Responses = 608



14) **How important is access to a public charging station network with regard to owning or deciding to purchase an electric vehicle?** A public charging station network refers to charging stations that are located in publicly accessible places (e.g., shopping malls, libraries, parks, municipal halls, etc.)

Responses = 606



15) **In which public locations do you think it is most important to have a Level 2 charger?** Please rank the following public places from 1 (most important) to 7 (least important). A Level 2 (Alternating Current) charging unit can fully charge a vehicle in 4-6 hours (depending on the vehicle) and can add 16-25 kilometres of range in an hour of charging. It requires 220 volts or 240 volts and up to 80 amps.

Major roads and highways

Choice	Total	%
1	145	2
2	55	10
3	53	10
4	46	9
5	42	8
6	52	10
7	141	26

Community centres

Choice	Total	%
1	61	11
2	101	19
3	88	17
4	82	15
5	91	17
6	91	17
7	19	4

Libraries

Choice	Total	%
1	21	4
2	37	7
3	51	10
4	86	16
5	92	18
6	117	22
7	118	23

Parks

Choice	Total	%
1	30	6
2	48	9
3	76	14
4	89	17
5	105	20
6	94	18
7	86	16

Downtown areas

Choice	Total	%
1	77	15
2	95	18
3	120	23
4	82	15
5	70	13
6	51	10
7	36	7

On-street

Choice	Total	%
1	56	10
2	88	16
3	72	13
4	81	15
5	78	14
6	75	14
7	91	17

Public parkades

Choice	Total	%
1	186	32
2	130	23
3	91	16
4	64	11
5	43	7
6	31	5
7	30	5

16) In which public locations do you think it is most important to have a Level 3 charger?

Please rank the following public places from 1 (most important) to 7 (least important). A Level 3 (Direct Current Fast Charger) can deliver 80% of a full charge to an EV in 30 minutes. It requires 200 to 450 volts or up to 200 amps.

Major roads and highways

Choice	Total	%
1	370	68
2	43	8
3	26	5
4	29	5
5	13	2
6	18	3
7	47	9

Community centres

Choice	Total	%
1	25	5
2	69	14
3	68	14
4	88	18
5	114	23
6	96	19
7	34	7

Libraries

Choice	Total	%
1	15	3
2	16	3
3	53	11
4	71	14
5	87	17
6	119	24
7	137	28

Parks

Choice	Total	%
1	15	3
2	42	8
3	47	9
4	71	14
5	101	20
6	113	23
7	108	22

Downtown areas

Choice	Total	%
1	77	15
2	95	18
3	120	23
4	82	15
5	70	13
6	51	10
7	36	7

On-street

Choice	Total	%
1	56	10
2	88	16
3	72	13
4	81	15
5	78	15
6	75	14
7	91	17

Public parkades

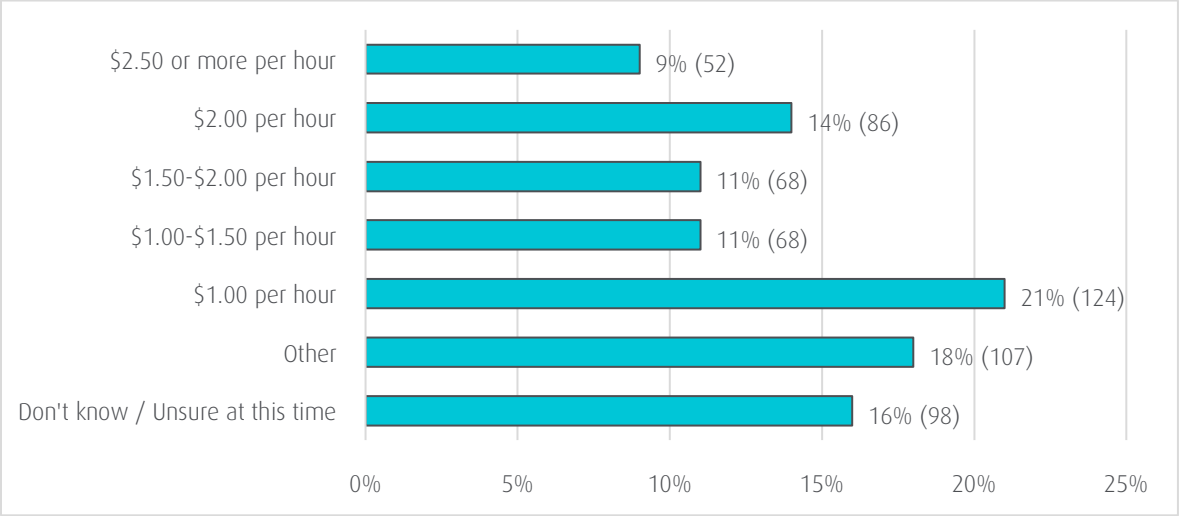
Choice	Total	%
1	76	14
2	133	25
3	99	18
4	84	16
5	53	10
6	38	7
7	54	10

17) Are there any other locations that would be important for hosting a public charging station? Respondents= 362

18) How much would you consider is a reasonable fee per hour for public charging?

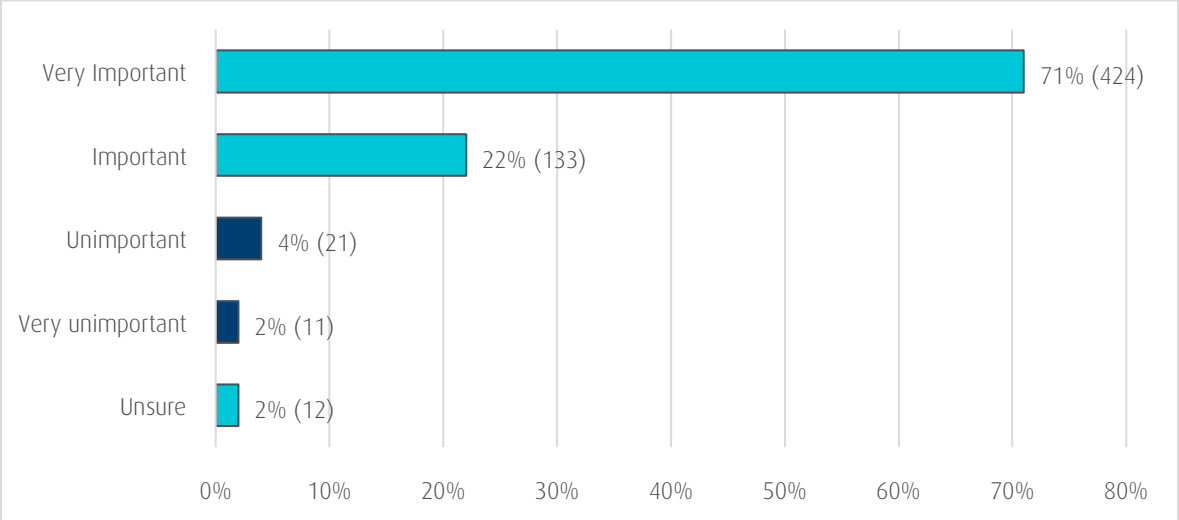
Charging a modest fee for use of public charging is considered good practice for reducing congestion for other EV users and for helping offset maintenance and operating costs.

Respondents= 603



19) How important is it that your local or regional government take steps to promote the use of EVs in order to reduce your community's greenhouse gas emissions?

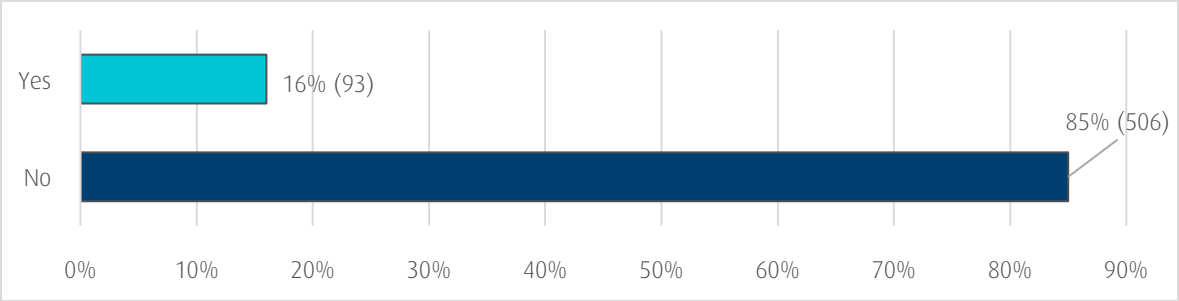
Responses = 601



E-Bike

20) Do you currently own an E-Bike?

Responses = 599



21) What are, or could be, the benefits of owning an E-Bike for you / your household?

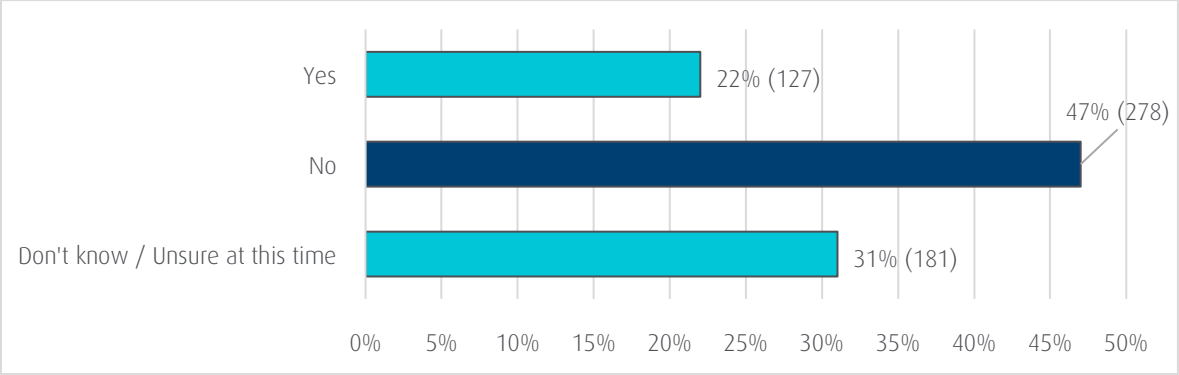
Responses = 495

22) What are, or could be, the challenges of owning an E-Bike for you / your household?

Responses = 480

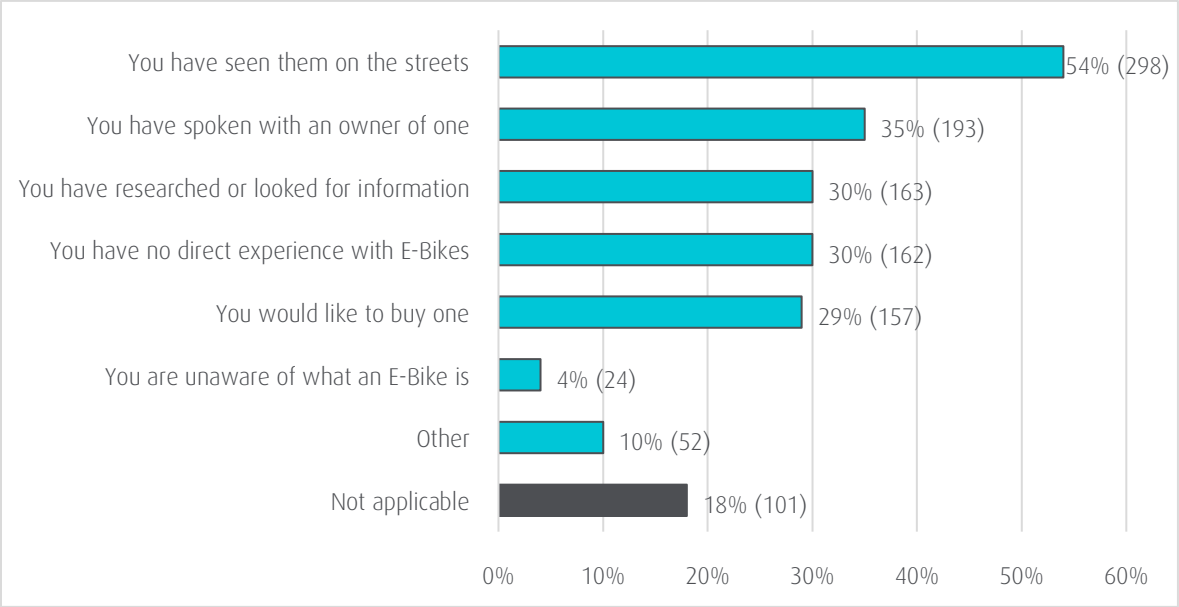
23) Do you plan on purchasing an E-Bike in the next two to three years? (Please select one response only)

Responses = 586



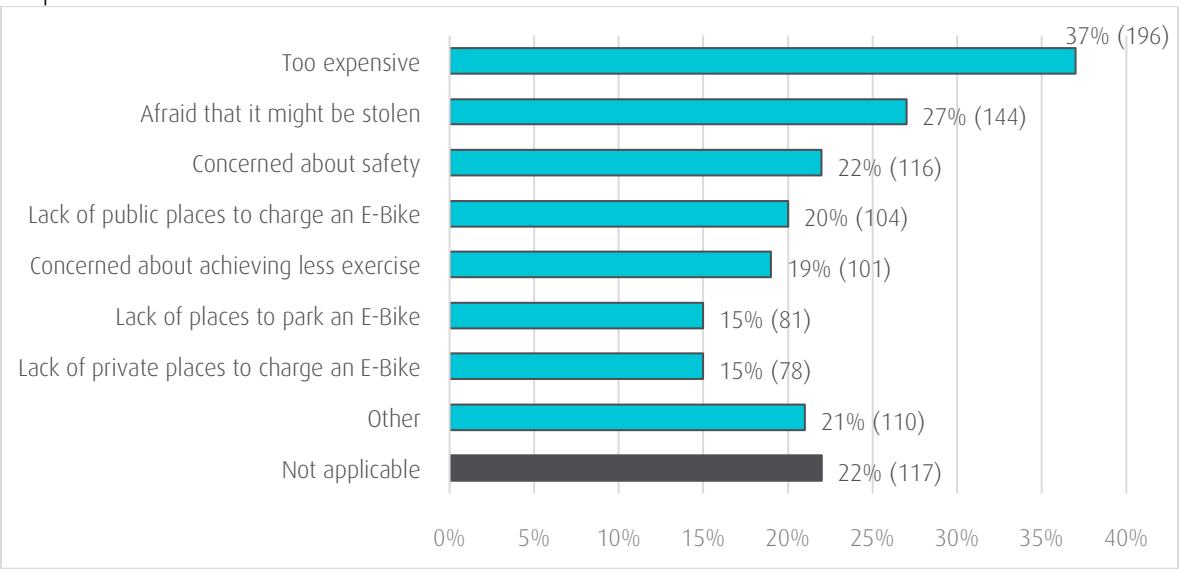
24) **If you do not own an E-Bike, which of the following statements are true?** (Please select all that apply)

Responses = 549



25) **If you do not own an E-Bike or do not plan on buying one, what are the factors contributing to that decision?** (Please select all that apply)

Responses = 531

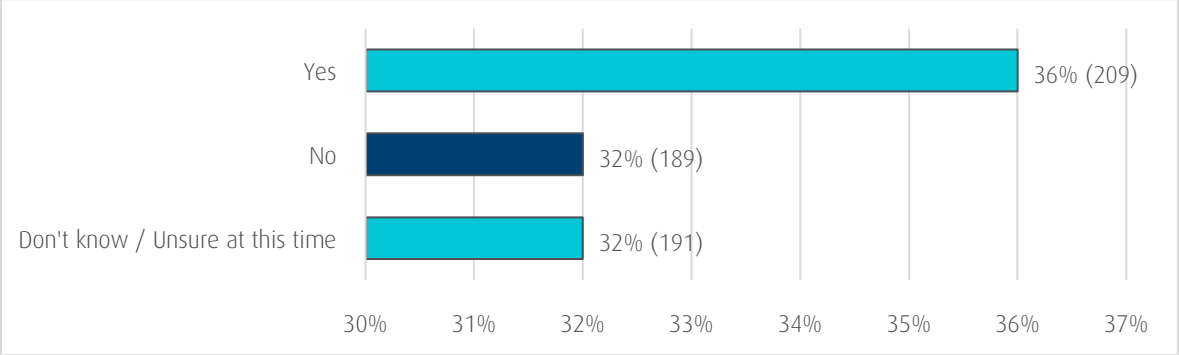


26) Would you feel safe riding an E-Bike around the capital region? If no, why not?

Respondents = 526

27) Would you feel comfortable parking your E-Bike in a publicly accessible location?

Respondents = 590

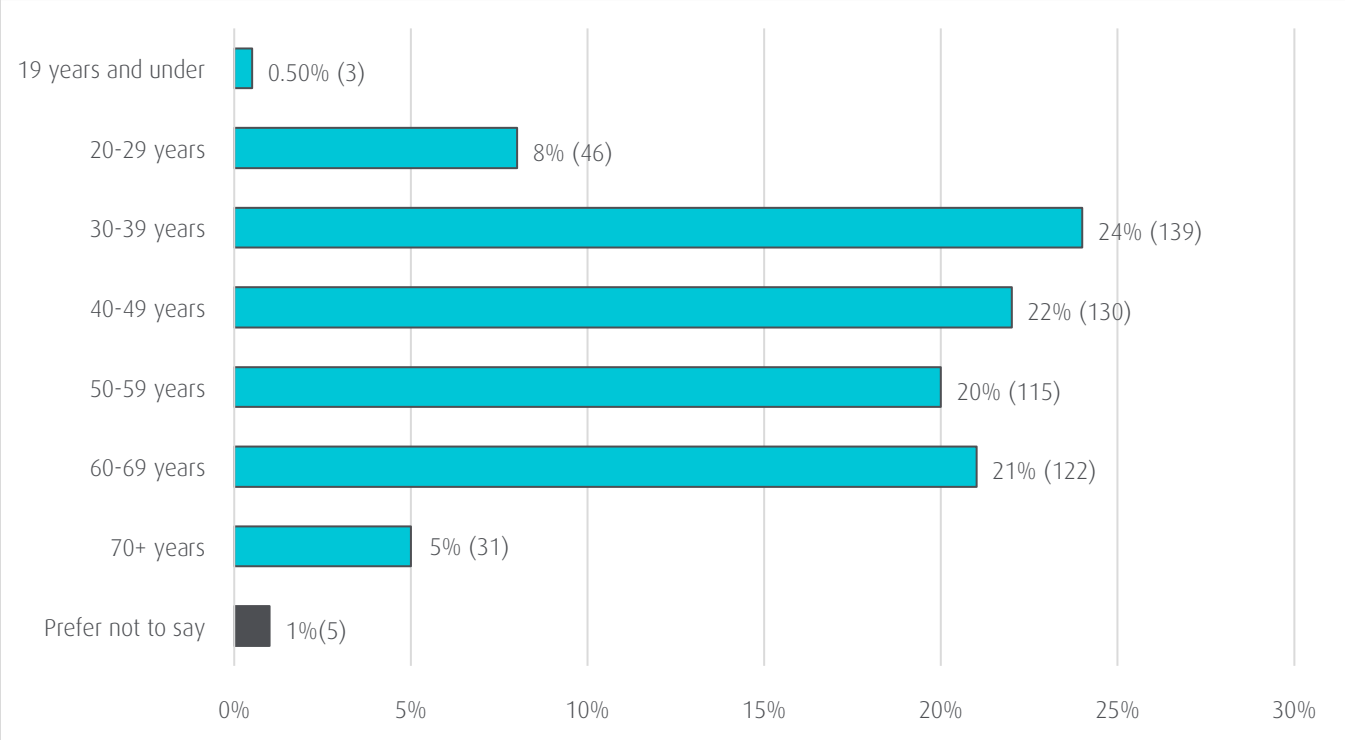


If you selected no above, what would make you feel comfortable parking your E-Bike in a publicly accessible location?

Demographic Questions

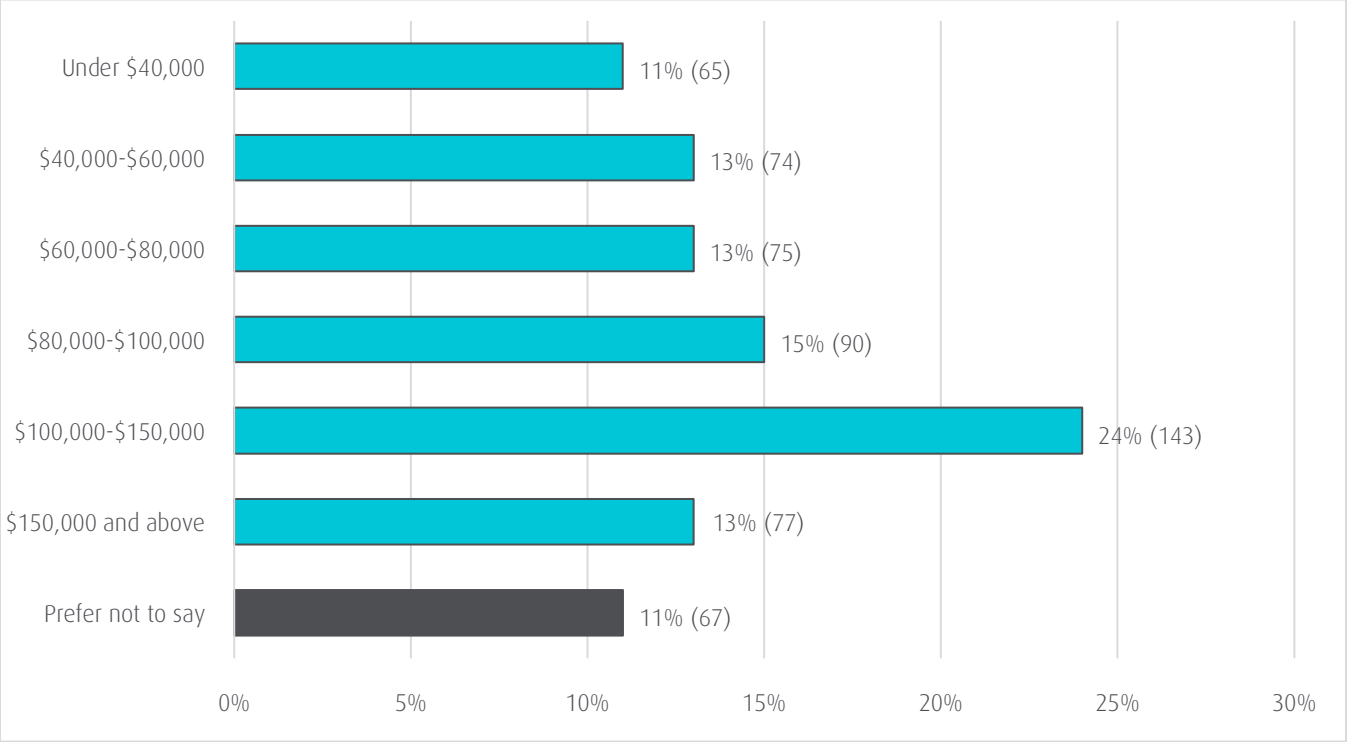
28) Which of the following age groups do you belong to?

Respondents = 591



29) Which of the following best describes your household income per year (before taxes)?

Respondents = 591



Appendix D.

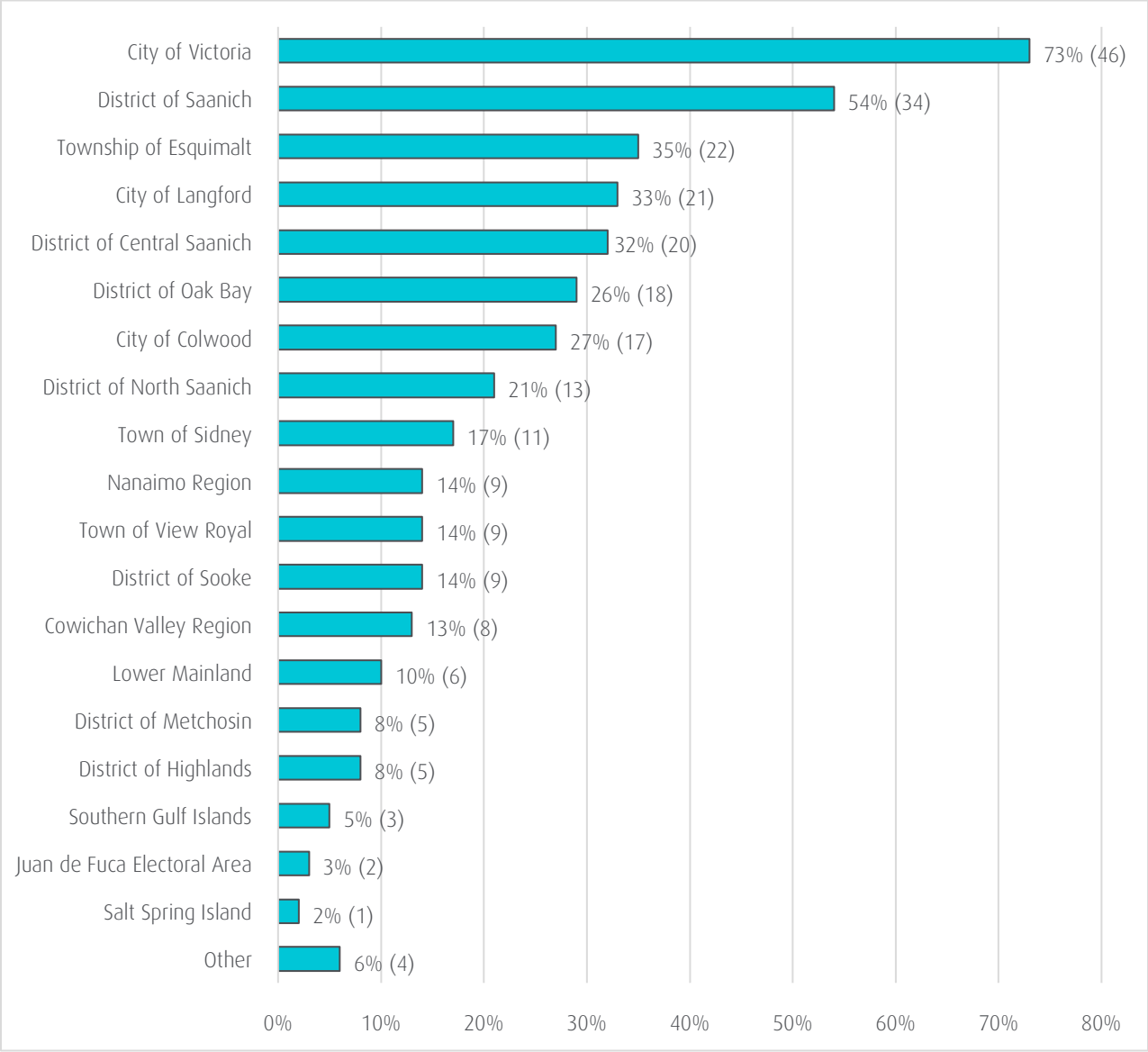
Summary of Developer Survey Responses

Developer Survey

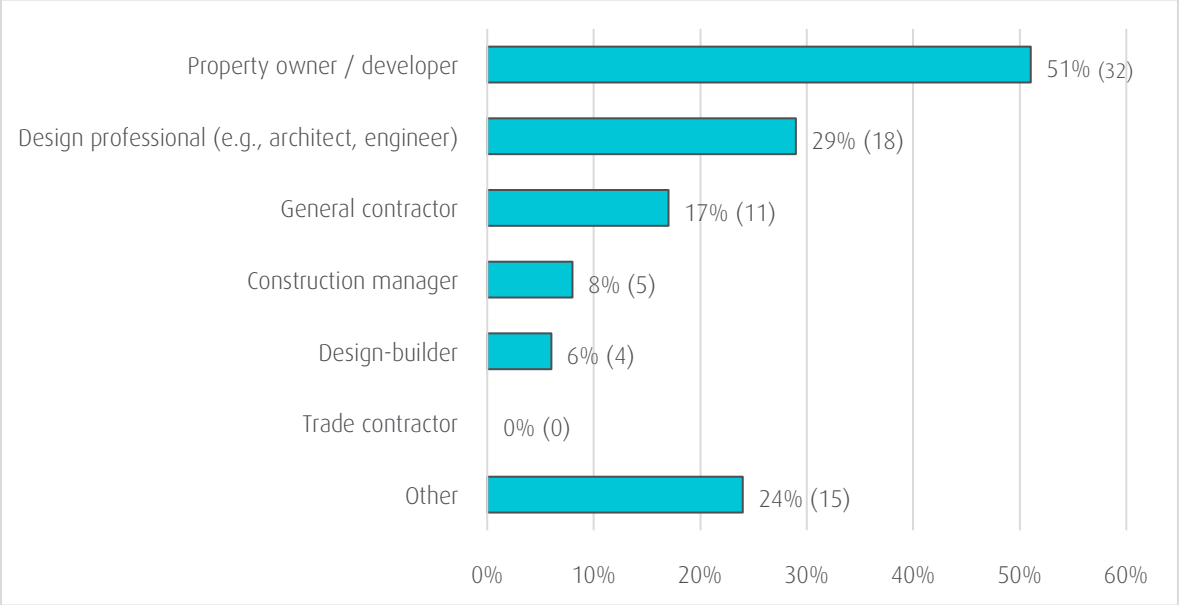
Developer Survey quantitative results are shown in the following charts. Qualitative results are summarized in the Backgrounder

About You

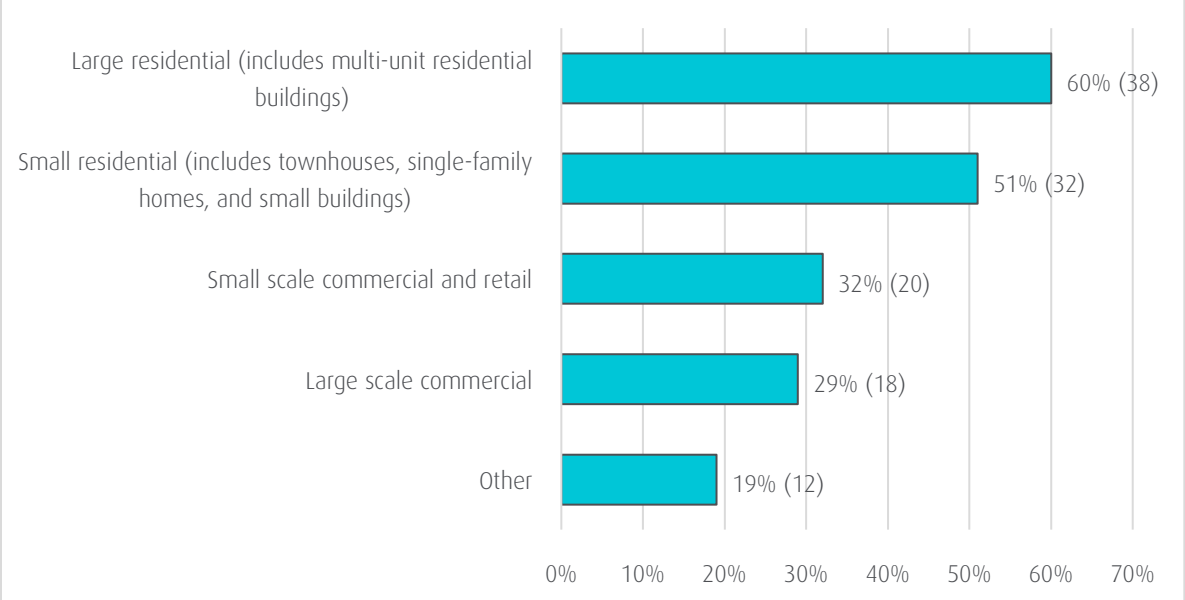
1) **Which municipality / electoral area do you currently have building projects in?**
(Check all that apply)
Respondents= 63



2) **How would you describe your role in the building industry?** (Check all that apply)
Respondents= 63

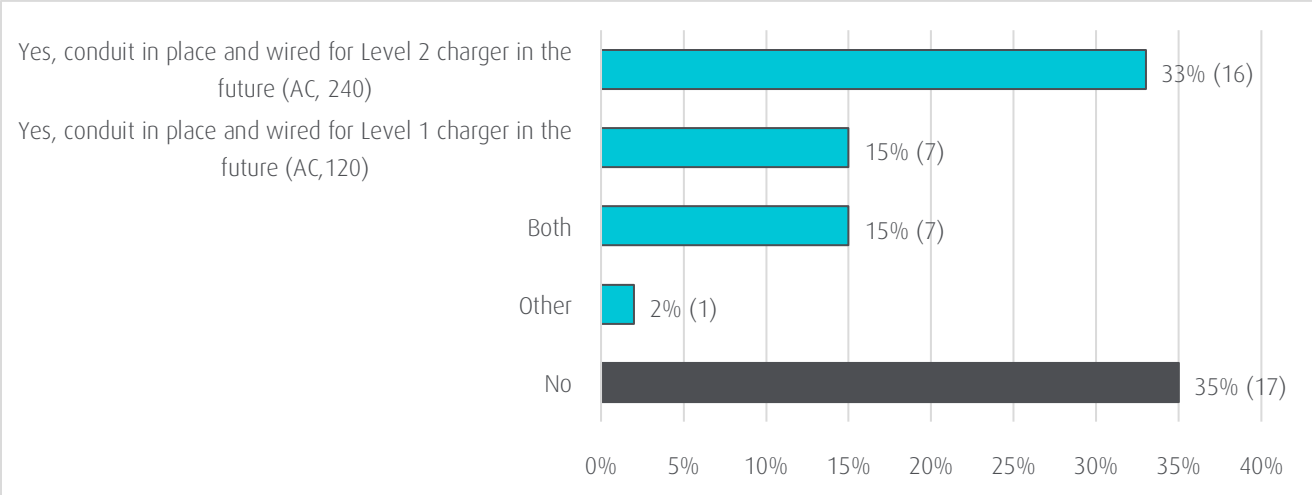


3) **Which types of buildings do you construct?** (Check all that apply)
Respondents= 63



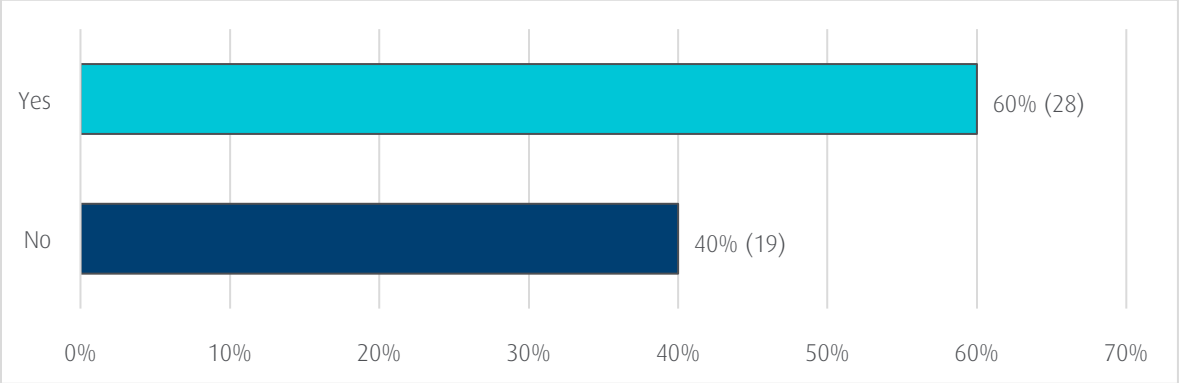
Your Experience with Electric Vehicles

4) **Have any of your recent developments been "EV-ready"?**
Respondents= 48

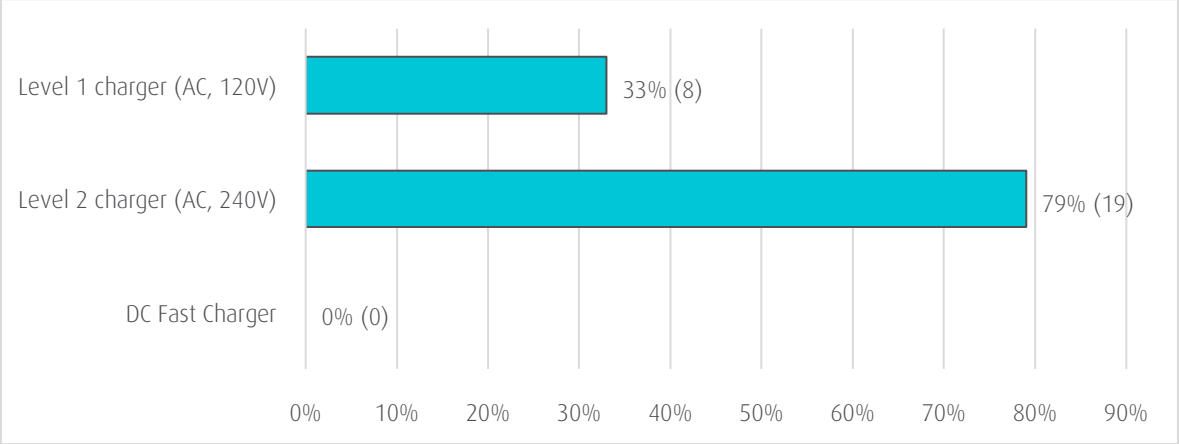


If yes, what was the approximate cost per unit?

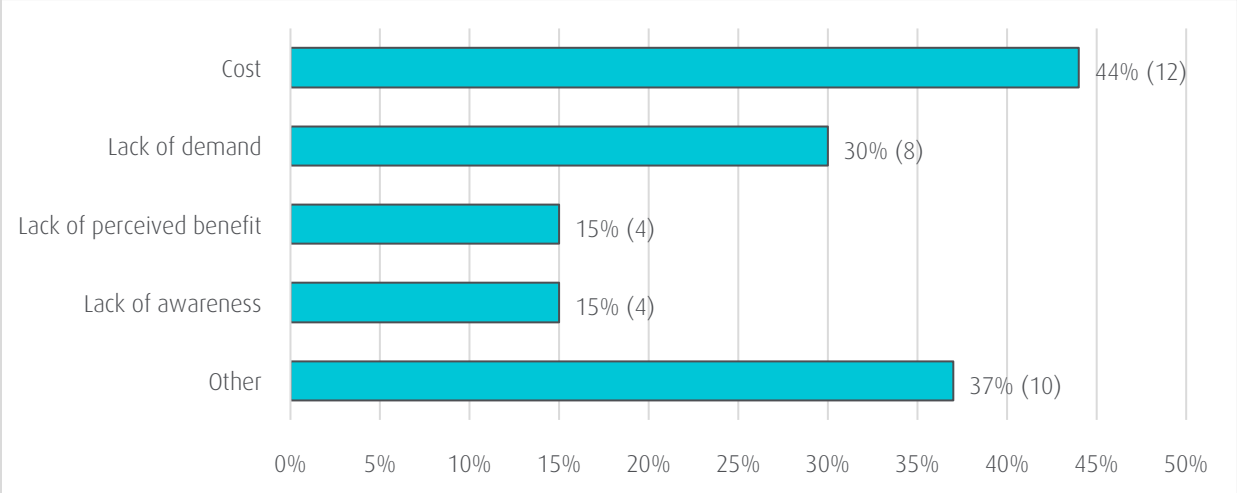
5) **Have electric vehicle charging stations been installed in any of your recent developments?** If yes, what were the main reasons for doing so?
Respondents= 47



6) If you have installed a charging station(s), could you please indicate the type and how many?
Respondents= 24

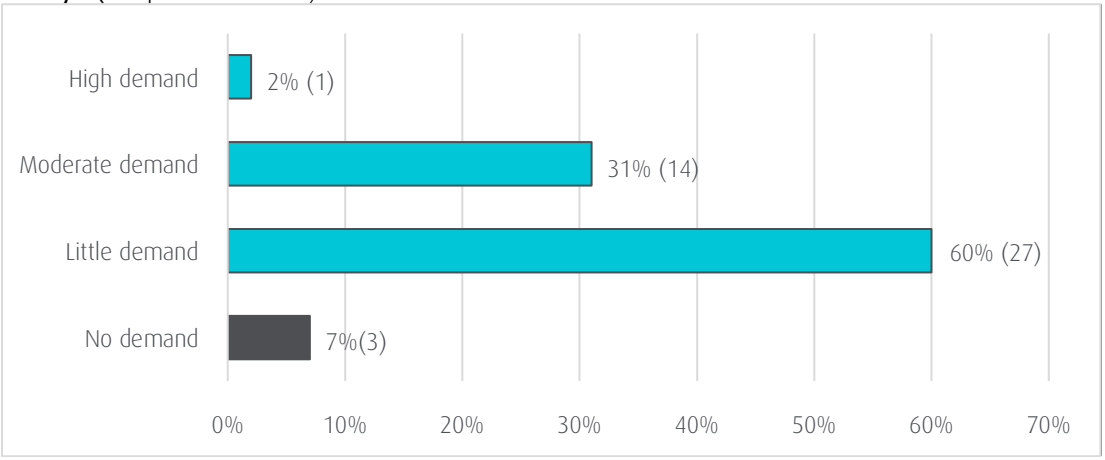


7) If you have not installed a charging station or do not plan on installing one, what are the factors contributing to that decision? (Check all that apply)
Respondents= 27

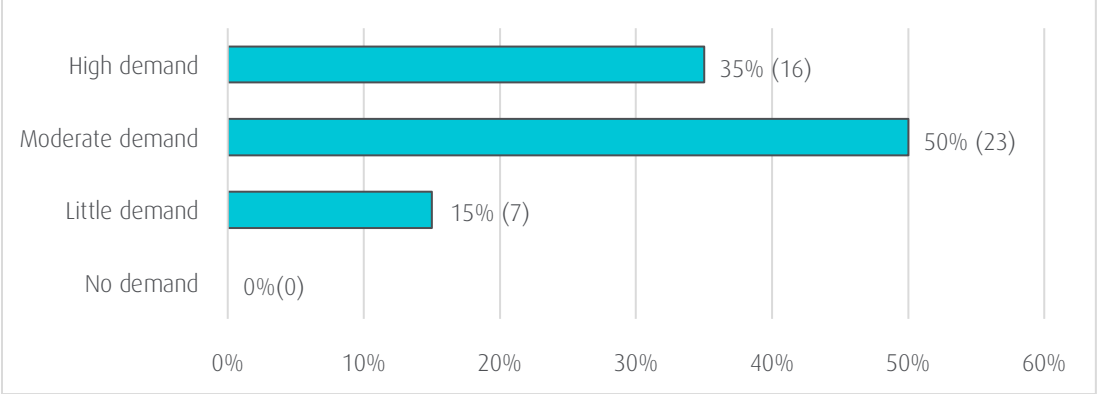


8) What level of demand do you see for electric vehicle charging…

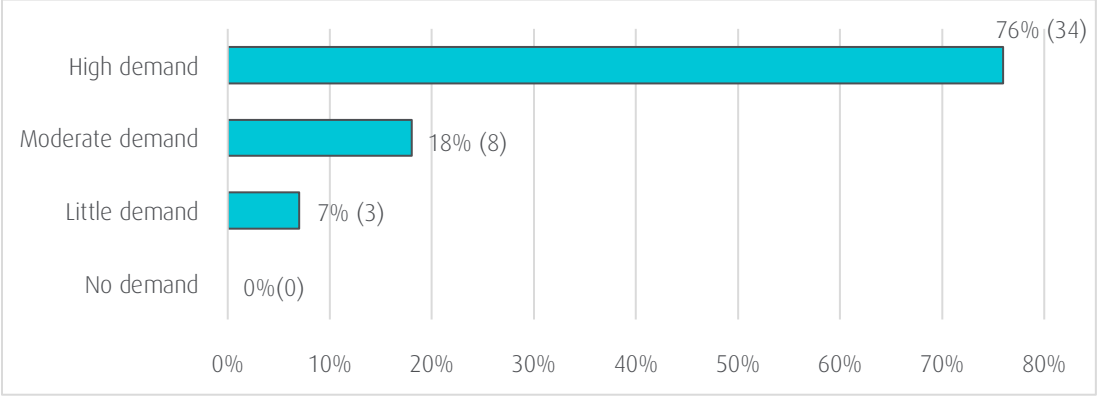
a. **Today? (**Respondents= 45)



b. **In the next 5 years? (**Respondents= 46)

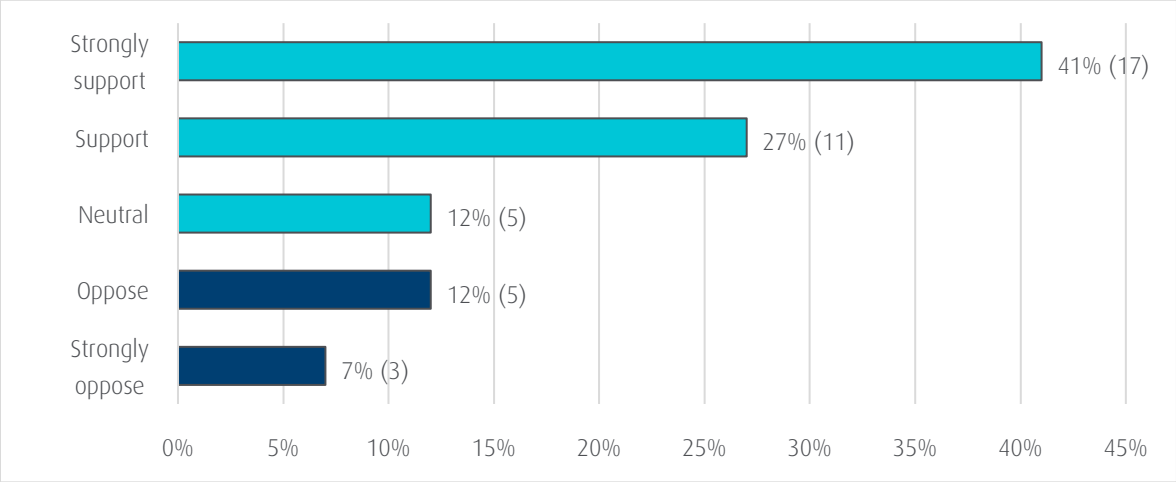


c. **In the next 10 years? (**Respondents= 45)



Policy & Regulation

9) A recent study in the City of Richmond found that the cost of installing a Level 2 dedicated energized outlet (i.e., EV-ready) across four large building archetypes is between $2,600 (for a dedicated stall), and $560 (utilizing 4-way load management). The cost has been estimated to be between $50 and $200 in single family developments. **What is your level of support for local governments in the capital region requiring new developments to be EV-ready?**
Respondents= 41

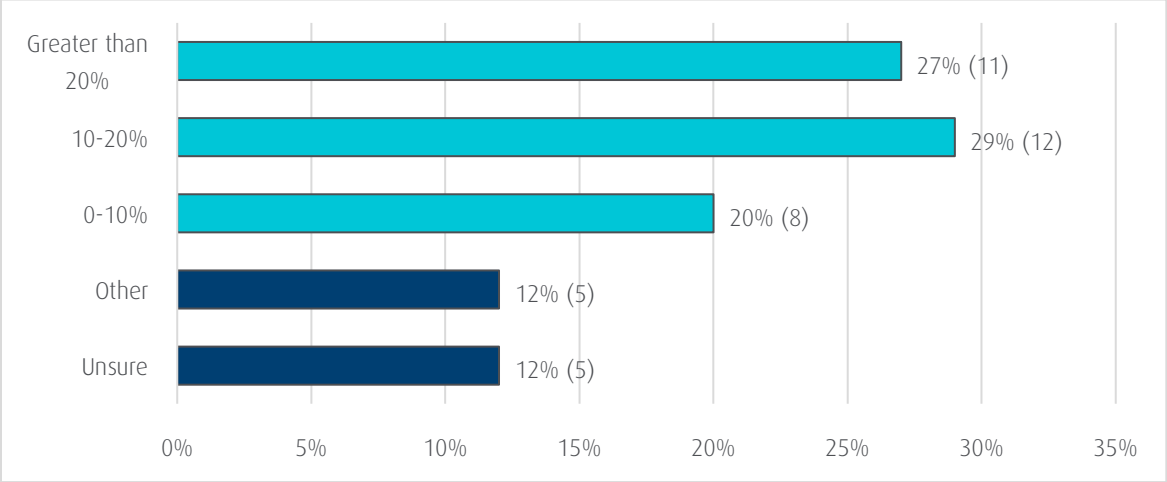


a. Could you please elaborate on your response above?

10) Multiple municipalities across British Columbia have enacted 'EV-ready" bylaws. Due to the complications related to stall assignments and high costs for retrofits, common practice is to require 100% of multi-unit residential parking stalls to be 'EV-ready' for Level 2 charging. **Would this approach be appropriate for municipalities in the capital region? If not, what approach would?**
Respondents= 33

11) In non-residential developments, what percentage of required off-street parking stalls do you think should be EV-ready?

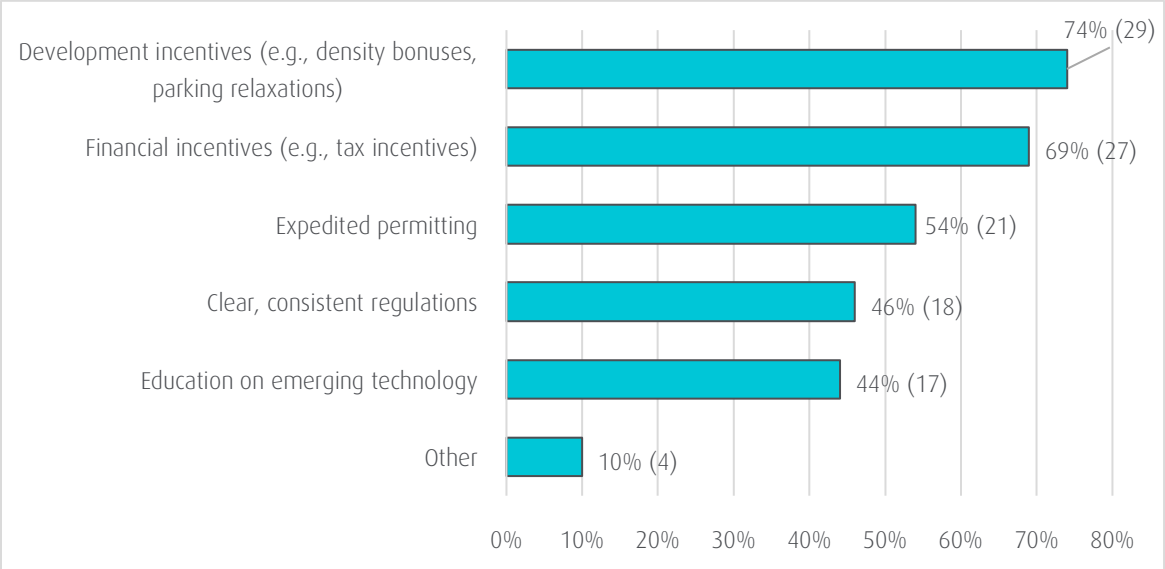
Respondents = 41



a. Could you please elaborate on your response above?

12) How can local governments support electric vehicle charging infrastructure in new developments? (Check all that apply)

Respondents = 39



13) Do you have any final comments you would like to share?

Respondents = 16

Draft -for discussion

Green Building Checklist

Completed checklists form part of the application package reviewed by staff and ultimately, Council. New buildings and developments have impacts that last well beyond the construction period. Reducing the consumption of natural resources and increasing resilience to a changing climate are part of the challenge of building more sustainably. This checklist will help you identify and present how your project will help the Township meet its goals of becoming carbon neutral by 2050.

Applicant's Name _____

Site Address _____

1.0 Certification		Please Check
1.1	Step Code (Please indicate level) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	
1.2	EnerGuide rating	
1.3	LEED	
1.4	Passive House	
1.6	Living building	
1.7	Other (Built Green BC, R-2000, Green Shores etc.)	
2.0 Siting		
2.1	New buildings > 10 m^2 are located > 20 m from the high water mark (HWM) of the Gorge Waterway.	Required
2.2	New buildings >10 m^2 are located at least 10 m from the HWM from the outer coastline.	Required
2.3	Flood Construction Level has been established using sea level rise projections for the life of the building.	
2.4	Habitats of threatened and endangered species have been protected from impacts of development.	
2.5	Buildings are located within disturbed or developed areas.	
3.0 Shoreline Protection Measures		
3.1	Landscaping within 10 m of the high water mark consists primarily of native plant and tree species.	Required
3.2	A conservation covenant has been signed to protect sensitive ecosystems within 10 m of the shoreline.	
3.3	At least one native tree capable of (now or in the future) supporting the nest of a Bald Eagle, Osprey etc. has been retained or is planted within 30 m of the high water mark (HWM).	
3.4	Removal of at least 30% of hardened shoreline and replacement with erosion control measures designed to improve the habitat of the shoreline.	
3.5	Light from building and landscaping does not cast over water.	
	Wildlife habitat has been incorporated into seawall design.	

4.0 Stormwater Absorption and Treatment		
4.1	An on-site stormwater retention system has been designed to retain at least the first 3 cm of rainfall from each rain event.	
4.2	Stormwater will be treated for pollutants prior to release to the stormdrain system or to a surface water source.	
4.3	The project features a green roof.	
4.4	The total amount of impervious surface is not greater than 20%.	
5.0 Water Conservation		
5.1	The irrigation system has been designed to reduce potable water use by 50% compared to conventional systems.	
5.2	Waterless urinals will be used.	
5.3	Water features use re-circulating water systems.	
5.4	Rainwater will be collected for irrigation purposes.	
5.5	Toilet and kitchen sink drains are separate from other drains to the point of exit.	
5.6	An approved greywater reuse system will be installed.	
6.0 Trees/Landscaping		
6.1	The project is designed to protect as many native and significant trees as possible.	
6.2	There will be no net loss of trees.	
6.3	Trees will be planted in soil volumes calculated to support the full grown size of the tree.	
6.4	At least 25% of replacement trees are large canopy trees.	
6.5	Topsoil will be protected from compaction, or stockpiled and reused.	
6.6	Erosion control measures have been designed and installed to prevent erosion of topsoil.	
7.0 Biodiversity		
7.1	New landscaping is predominantly native plant and tree species.	
7.2	Invasive species will be removed from landscaped areas.	
7.3	At least two biodiversity features have been incorporated into the new or existing landscaping (see section 18.5.3 of the OCP for ideas).	
8.0 Energy Conservation		
8.1	The building is pre-plumbed for solar hot water.	Required
8.2	Install a greywater heat recovery unit.	
8.3	Passive cooling is supported through flow-through ventilation design, low E windows, solar shades, shade trees etc.	
8.4	Passive heating is supported via building orientation, window design and thermal mass.	
8.5	The building will have necessary structural support and conduit for Solar PV.	
8.6	Obtain minimum of 20% of building energy consumption through community based or on-site renewables, such as district energy, waste heat recovery, geothermal, solar PV, solar hot water.	
8.7	Heating uses a low carbon heating source, such as air source heat pump.	

9.0 Transportation		
9.1	Building will have a car share or bus pass program for residents.	
9.2	Enhanced facilities for bicyclists such as showers, lockers, storage etc.	
9.3	Charging infrastructure for E-bikes will be provided.	
9.4	EV charging conduit supplied to 100% of residential parking units.	
9.5	30% of residential parking spaces include an electrical outlet or EV charging equipment.	
9.6	Adequate space in the electrical system to provide EV charging for 100% of parking stalls.	
9.7	For commercial buildings, Level 2 or Level 3 EV charging provided for employees and/or visitors.	
10.0 Materials/Waste		
10.1	Employs at least 3 advanced framing techniques described in the CHBA builder's manual to reduce unnecessary lumber and sheathing.	
10.2	Uses at least two materials which are certified for recycled content.	
10.3	Uses engineered structural material for two major applications (>10% of floor area).	
10.4	5 major building elements made from >50% recycled content.	
10.5	Use foundation, floor and >50% of walls from existing building.	
10.6	Deconstruct at least 50% of existing building for material salvage.	
10.7	Use at least five major materials or systems produced in BC.	
10.8	Use certified sustainably harvested wood for one major structural or finishing application (eg framing, plywood, floors)	
10.9	Eliminate use of wood from threatened trees.	
	Recycling area provided within residential suites.	
10.10	Recycling collection area for multi-family buildings.	
10.11	Pickup of compostables provided in multi-family units.	
10.12	Construction waste management practices used to reduce and separate waste and divert at least 50% from the landfill.	